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## Women and Diversity

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## *Preface*

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The world is heading with a notion that it is equal for men and women in terms of opportunities and rights. However, this situation is just a perception and cannot be found in reality. Apart from inequalities between men and women, this diversity can be explained by understanding the uniqueness of individual differences, race, gender, ethnicity, sexual orientation, age, religious & political beliefs, socio-economic status and ideologies, etc. It is the result of demographic and philosophical differences depicted in the behaviour of individual and groups in their social structure. Diversity gives meaning, beauty, completeness and balance to life if accepted gracefully, whereas non-acceptance of the diversity victimizes women.

Generally, the attitude of Indian public towards social and cultural characteristics is somewhat different varying from caste, creed, religion, etc. This diversity in characteristics and the difference in attitudes towards it gave birth to many kinds of discrimination between men and women. These distinctions are not only associated with religion, caste, birth, colour, etc., but also with diverse qualities of knowledge, intelligence, skill, ability, experience, etc. of the man and woman. That is, at the social level, women and men have never found a place of equality since ancient times. Male dominance has always been seen in society, except for a few occasional female dominated tribe societies. All kinds of female discrepancies occurring in the society start from family, home and community. Every discrepancy in families, households and community is declared rightly in the guise of hollow rules of the associated civilization. A young girl who is suffering from such anomalies starts living life accordingly. Due to these discrepancies, there is a difference in the level of knowledge, skill, ability, experience and intelligence between men and women.

Though India is improving its status in achieving gender equality but still gender difference is pre-vailing in almost all the components. An attempt to depict the gender difference, which should be improved to achieve diversities as a prerequisite of women empowerment, is kept in view in this book. The concept is explained under diversity aspects, its forms and status of women in workplace, health, food and nutrition situations, political status of women, entrepreneurship, social security, media, etc., all of which are contributing to making the lives of women a challenge.

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# Entrepreneurship Development of Women in India Focusing its Status, Opportunities and Challenges

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## Introduction

The Indian economy has grown steadily over the last decade, and there has been a parallel surge in the number of startups and new businesses in the country. A majority of these have been founded by men. While many Indian women have ambitions towards entrepreneurship, it is often more difficult for them to succeed. In fact, India has been found to be in a group of countries where women business owners (as well as women leaders and professionals) struggle with less favourable conditions, pronounced cultural biases, and a lack of business resources such as finances, capital, training and development.

A society in which women cannot realise their full potential, loses out on the significant potential for innovation, economic growth and job creation. For instance, a recent study showed that in India, measures to close the gender gap could lead to a 6.8-percent gain in GDP. Another study estimated that advancing women's equality in India could boost its GDP by \$0.7 trillion in 2025 or 16 percent as compared to the 'business as usual' scenario. Moreover, entrepreneurship remains critical to harness the economic potential of women and thus, achieve the sustainable development goals (SDGs) by 2030.

Role of Women in Economic Development is vital to achieve the inclusive growth. Entrepreneurship is one of the means to involve them in Nation building and Economic Development. Till 1980s, only a very few women took Entrepreneurial activities in India. In 1980, "New Delhi Declaration and Plan of Action" adopted to emphasize on development of entrepreneurial skills among the women. The decade (1980-1990) witnessed several institutional initiatives towards women entrepreneurship. It's only after the liberalization of Indian economy in 1990s, with the opportunities poured in and along with institutional support, women entrepreneurship started to flourish. In this chapter, the concept and classification of Women Entrepreneurs is discussed. The hurdles faced by women to set up the enterprises and the government schemes for Women Entrepreneurship development are also analyzed. The success story of few Indian women entrepreneurs is narrated in brief. Finally it is concluded that the success of Women Entrepreneurship among City dwelling Upper middle Class Women should also be spread to Women in country side. In India, because of culture & traditions, women are supposed to perform household activities & take care of family and because of these reasons women entrepreneurship is very low. But due to the widespread of education and social awareness during last three decades now women are showing interest in starting their own venture. Hence there is a considerable growth of women entrepreneurs. Now a days, Indian women are willing to accept challenges & assume responsibility in economical, social and political groups. Generally, they engage them in tiny or small cottage industries, but recent study show that women have been starting ventures in all the sectors equivalent to men.

In India, Women entrepreneurs are classified as follows:

1. Women with adequate education & professional qualification getting engaged in the business;
2. Middle-class women who have an education but lack training;
3. Women who take up a business enterprise but face financial difficulties.

### **Women Entrepreneurs in India: A glance at the figures**

On an individual level, some women have strong entrepreneurial ambitions. Interestingly, several of the interview partners mentioned that they got inspired by male role models such as Bill Gates or Steve

Jobs, or that they were introduced to the “startup world” by their male friends who are entrepreneurs. On an institutional level, the government has launched several schemes to augment the entrepreneurial motivations of women and there is more noticeable political will to empower them.

However, looking beyond high individual and political aspirations and investigating the statistics of how many women actually own businesses shows a rather sobering balance. Literature on the subject often cites data from the Sixth Economic Census, which was conducted between January 2013 and April 2014. Out of 58.5 million businesses counted by that census, 8.05 million were owned by women, which correspond to a rate of 13.76 percent of women among the total number of entrepreneurs in India. The World Bank Enterprise Survey, meanwhile, found that in 2014, the percentage of firms with female participation in ownership was 10.7 percent. While more recent data is not available, interview partners, as well as recent media reports, highlighted a steady rise in the number of startups founded by women.

The low rates of women entrepreneurship are reflected in a dismal score in the Index of Women Entrepreneurs, where India is ranked 52<sup>nd</sup> out of the 57 surveyed countries. The fact that few women own companies, is part of a larger phenomenon of weak engagement of women in business. This further relates to a low female labor force participation rate as well as women having fewer opportunities to become business leaders, professionals and technical workers. Indeed, despite high economic growth rates as well as an increase in the proportion of working-age women in the population, the participation in the work force has decreased from 35 percent in 2005 to just 26 percent in 2018. According to a World Bank Enterprise Survey, the percentage of women in leadership positions in 2014 was as low as nine percent.

It is hardly a surprise, therefore, that the World Economic Forum’s Gender Gap Report finds India’s gender gap to be particularly prevalent in the indicator group “economic participation and opportunity,” where the country is ranked 142<sup>nd</sup> out of 149 countries. India’s overall rank, which takes into account three further indicator groups, is 108<sup>th</sup>. Unequal education is an issue holding women back, and it is not a coincidence that states with relatively higher literacy rates also have more women entrepreneurs. The top five states with the highest percentage of women entrepreneurs are Tamil Nadu, Kerala, Andhra Pradesh, West Bengal, and Maharashtra.

To be sure, India is a highly diverse country, and so are the forms of entrepreneurship women engage in. The availability of micro-finance has ameliorated women's empowerment and entrepreneurship and 98 percent of businesses owned by women are micro-enterprises, where approximately 90 percent of them operate in the informal sector. Interview partners observed that women entrepreneurs are often active in social areas and sectors such as health, clean energy and zero waste, education, women's hygiene, fashion, cosmetics, food and nutrition, garments and textiles, and services (such as management and human resources).

### Challenges and Obstacles faced by Women Entrepreneurs

Availing finance and juggling many responsibilities are major hurdles faced by women in initiating, requiring and managing an enterprise. Other hindering external factors include gender discrimination, inaccessibility to information, training opportunities, infrastructure, etc. Some internal factors such as risk aversion by women, lack of self-esteem and self-confidence, lack of vision etc. also hinder women's entrepreneurship. Lack of or insufficient education facilities results in lack of knowledge and information about availability of raw material, access to finance and government's schemes and facilities and other existing or upcoming opportunities. In India, as per the 2011 census, 30 per cent of women are illiterate compared with 13 per cent illiteracy among men. Women in India are mostly economically dependent from their husbands which reduces their ability to bear the risks and uncertainties involved in launching a business. The educational level and family background of their husbands also influence women's participation in entrepreneurship. Lack of awareness about opportunities and lack of awareness amongst women about the financial assistance offered (incentives, loans, and schemes) by the institutions in the financial sector is one of the major challenges.

Hence, in spite of financial policies and programmes for women entrepreneurs, financial support has reached only few women entrepreneurs. Achievement motivation is found to be scarce among women because of the Indian socialization pattern and socio-cultural factors which are gender biased. Their domesticated role is widely accepted and assumed.

Although the Indian society is fast evolving, it remains a male-driven/patriarchal society in which women have to fight many battles in order to become successful entrepreneurs. Although the principle of gender equality is enshrined in the Constitution of India, which confers equal rights and opportunities to both men and women. In practice, women are still widely considered as “*abla*” i.e. weak. This de facto gender inequality serves as a major barrier to women’s entry into business. In India, parental immovable property (land/building/house) or business goes to the male child by succession. This is one amongst the many reasons why women face difficulty in obtaining finance, managing the working capital and credit. In addition, women entrepreneurs often have to take loans in the names of their husbands, fathers, or brothers and consequently by default involve them into the business.

Women entrepreneurs often do not have a proper organizational set-up to pump in a lot of money for canvassing and advertisements. They have to compete with seasoned men entrepreneurs and such competition often results ultimately in the liquidation of women-led enterprises. Gender-insensitive Business Development Support systems (BDS Providers) often create discriminatory environment for women entrepreneurs in the process of starting and managing their businesses, especially during registration, finances procurement, marketing, etc., sectors that are all male-dominated.

Women need to devote considerable amount of time for their business if they want it to grow. Meanwhile by contrast, if a woman is unable to devote sufficient time to her family, many conflicts will emerge. If family members are not supportive, cooperative or encouraging, women are most likely to choose not to pursue an enterprise, as Indian women typically place more emphasis on family ties and relationships. Married women have to walk a fine line between business and family. Women’s family and personal obligations are sometimes a great barrier for succeeding in a business career. Only few women are able to manage both home and business efficiently, devoting enough time to perform all their responsibilities.

After the challenges related to accessing finance, marketing their products/services is yet another common problem. Maintaining an existing business or accessing fresh business opportunities requires strategic marketing skills. Women entrepreneurs may not be as comfortable as male entrepreneurs in areas where they interact mostly

with men. They face challenges due to socio-cultural and psychological factors which makes them less assertive, less communicative and less able to negotiate and garner support for their decisions. Apart from that, the size of operations is often too small to allow marketing at national/state level, women lack mobility owing to their household responsibilities or their inability to travel alone, in addition to the lack of information regarding channels of distribution, or even their centralized business processes may prevent them from travelling outstation (production and other factors may suffer in their absence). In the international markets of imports and exports, very few female entrepreneurs are found to be exporting or contemplating export. Apart from above-cited limitations related to the scale of marketing, the procedural requirements of export may be a drawback to attempting to tackle the export market.

Coordinating factors for production also represent a challenge for many women entrepreneurs. They cannot easily coordinate the production process, particularly with the ever changing technology. Very few women can sustain such production situations. Women's flair for technology again, depends upon their sociocultural upbringing, which may make them believe it is a men-dominated field. Women who aspire to become entrepreneurs would find it challenging to keep abreast of technological advancements. The installations of new machineries during expansion of the productive capacity and similar factors may discourage women entrepreneurs from venturing into new areas. Women-controlled businesses are often small and it is at times difficult for women to access the information they need regarding technology, technical training, innovative schemes, concessions, alternative markets of 18 technology, etc. Very few women entrepreneurs make use of advanced software available like statistical softwares, SAP, accounting packages like TALLY, animation softwares 3D MAX, and even internet facilities. However, technology utilization and dependence in businesses vary depending upon the type of enterprises. Women who enter areas requiring highly technical knowledge are either supported by their husband or achievement oriented. Once woman opt for a product or service that is technical in nature however, they become comfortable with it very quickly. They learn to select machineries, product attributes, deal with technical problems and oversee technical engineers. They too access technology through exhibitions, brochures and other materials sent by suppliers.



Another challenge encountered by women entrepreneurs is lack of management skills, usually because of lower propensity of previous business/job experience. Furthermore, support providers discriminate against women entrepreneurs to a large extent when providing consultations and guidance. One more intricate problem faced by women entrepreneurs is the management of the working capital. Working capital is required for maintaining finished stock to meet the market demand, for production and for meeting marketing and other administrative expenses. It is generally very difficult for women entrepreneurs to access such loan facilities from financial institutions as women may be unable to provide security or guarantee.

Society's attitude towards women entrepreneurs, unequal opportunities amongst men and women and broadly a lack of self-confidence haunt women entrepreneurs. This low level of self-confidence, will-power and optimistic attitude amongst women create a fear of committing mistakes which affects their business. The family members and the society are often reluctant to stand beside their entrepreneurial endeavour. Women tend to start business about ten years later than men, on average. Motherhood and traditional socialization pattern have been cited as reasons for delayed entry into entrepreneurial activities.

### **National trends of Women's Entrepreneurship**

Any strategy aimed at economic development would be imbalanced without the involvement of women. The hidden entrepreneurial potentials of women have gradually been changing with the growing sensitivity to the role and economic status of women in the society. Besides skill, knowledge and adaptability in business being the main reasons for women to emerge into business ventures, there are various environmental factors like Policies, Legal framework, Market and Geographical areas which influence women entrepreneurship development process.

According to the Sixth Economic Census released by the Ministry of Statistics and Programme Implementation, women constitute around 14% of the total entrepreneurial base in India i.e. 8.05 million out of the total 58.5 million entrepreneurs. While some are accidental entrepreneurs due to the lack of other work opportunities, many others are driven by a specific mission or goal.

The average employment in women-owned enterprises is only 1.67 people per business.

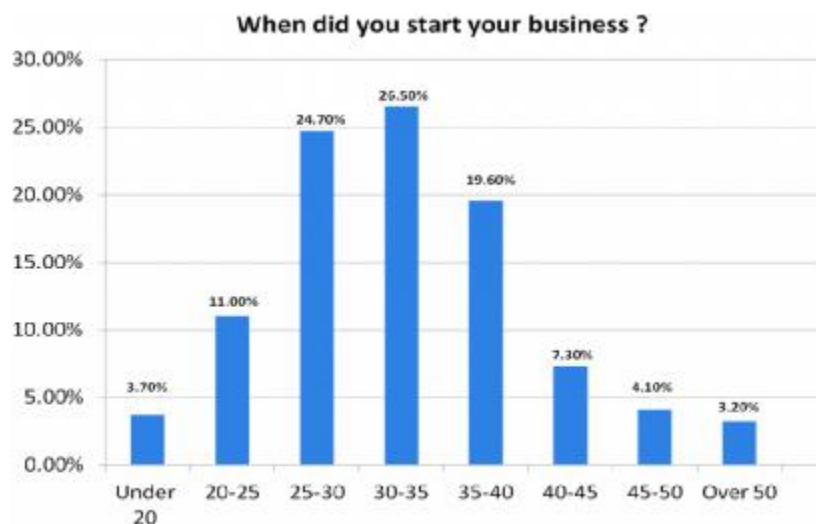
### Women's Web Survey on Women & Entrepreneurship in India

In 2019, Women's Web conducted a survey on Women & Entrepreneurship in India which looked at the **key motivations and challenges of women entrepreneurs**, to see what has changed in these years.

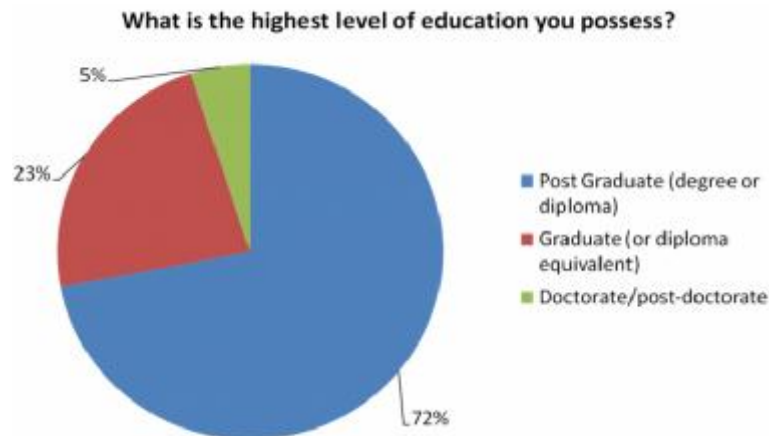
The Women & Entrepreneurship in India 2019 study was conducted online between between December 2018 – April 2019 and received responses from around 220 women entrepreneurs across the country. Below are the results, which will be of interest to entrepreneurs, entrepreneurs-in-the-making, mentors, advisors, funding firms and anyone with an interest in the story of women and entrepreneurship in India.

### Education and Age

The majority entrepreneurs that were surveyed had started their businesses **between the ages of 25 and 35. 51.2% of women fall under this criteria.** Another **19.6% of women started their business between the ages of 35-40.** This leads us to infer that a majority of urban women entrepreneurs do have some work experience before starting their own ventures. Only a small number (11%) had started before turning 25, some possibly very soon after finishing their education.



A similar response was also seen on the question of education. **Around 72% of women who answered the survey are post graduates.**



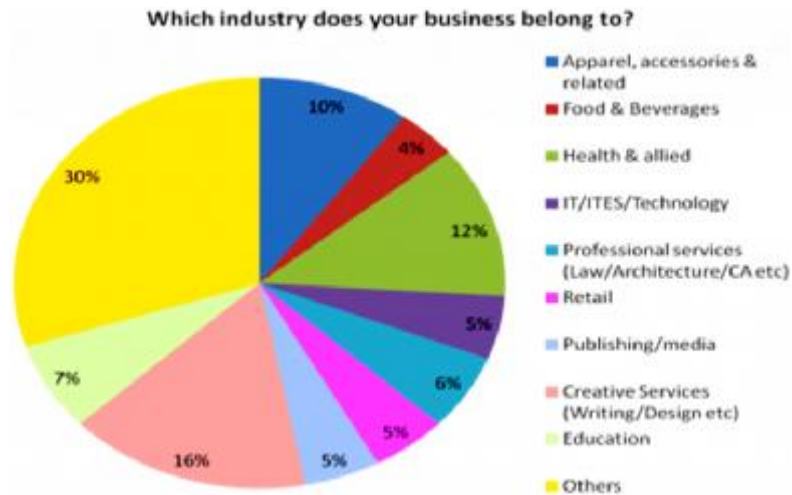
### City and Industry

The largest number of women took the survey were **based in Mumbai** (30%) while the NCR region and Bangalore accounted for 15% each. Among all the metropolitan cities Chennai had the lowest turnout in the survey with around 3%.



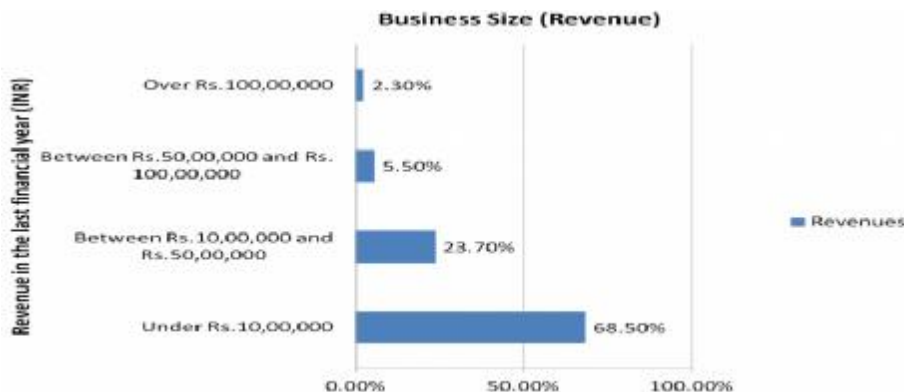
Industry wise, the largest segment of women entrepreneurs (16%) belong to the **Creative Services category (Writing/Design etc)**. The second and third position is held by **Health & allied** and **Apparel & accessories** respectively. Apart from that about 30% belong to the other sector which includes Travel and tourism, Manufacturing etc. The largest chunk of women entrepreneurs belonging to the creative

services field is possibly because this sector has relatively low entry barriers – these are professionals capitalising on an existing skill they have or one they have acquired, and does not need significant capital besides a computer and a mobile/Internet connection for the most part.



### Business size (revenue and employees)

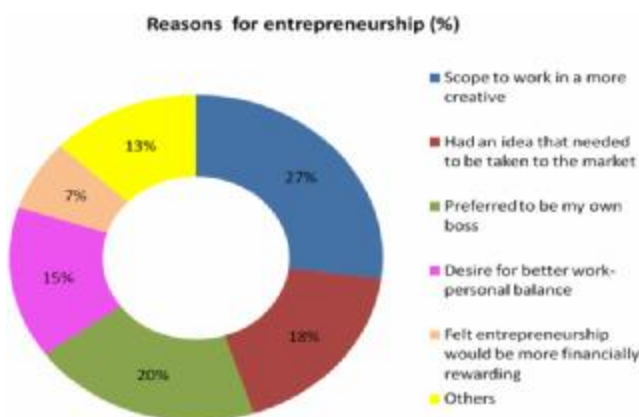
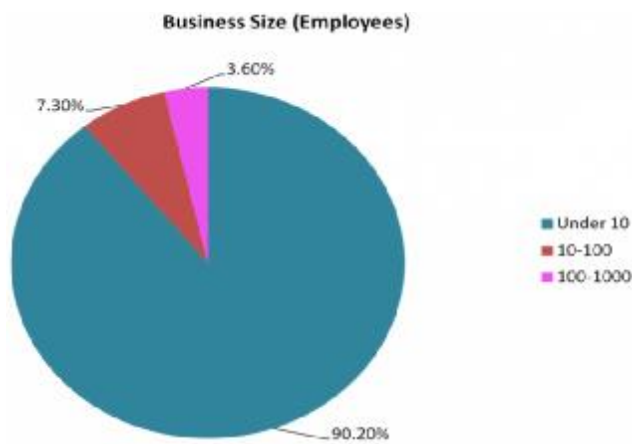
On the category of business size measured by the criteria of Revenues and No.of employees, the majority of women-owned businesses were likely to be **micro-enterprises or small businesses**, with 68.5% reporting a revenue of under Rs.10,00,000 (Rs. 10 Lakh or 1 Million) in the last financial year. Another 23.7% reported revenues of between Rs.10,00,000 and Rs.50,00,000 (Between Rs.10 Lakh and Rs.50 Lakh/Between Rs. 1 million and 5 million).



In accordance with these revenue findings, a majority of enterprises that is **90.2% had under 10 employees in their firm**. It is important to note that while some women build large and scalable businesses, many more are in the micro-business area, and need support of a different kind than start-ups would; for e.g. raising funds from investors is not usually a concern for micro business owners, but smart working capital management could be a priority.

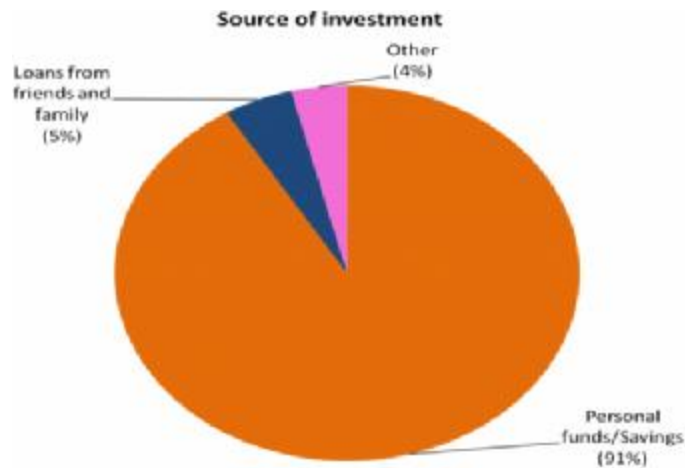
### Why Entrepreneurship?

The scope of becoming more creative is what drove most women (27%) to start their own business. 20% were inspired by the feeling of being one’s own boss and another 18% started due to the presence of a specific idea that they wanted to take to market.



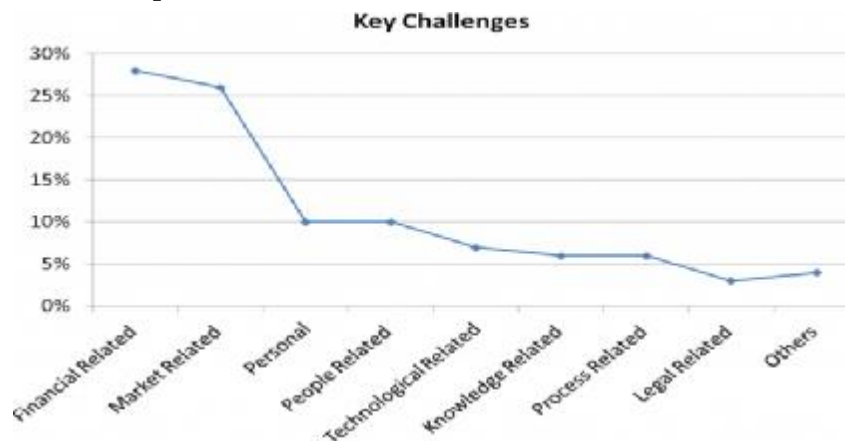
## Start-up capital for the business

In the majority of cases **women entrepreneurs (91%) used personal funds and savings** as the source to start their business. This ties in with the fact that the majority of women are micro and small business owners.



## Key challenges

While when it comes to Key Challenges at present majority of women entrepreneurs choose **Financial and Marketing** related challenges (**28 and 26% respectively**). In multiple researches too, most small business owners cite cash flow management, growing the business to a medium sized business, and acquiring consistent new customers are the major challenges, and these are no different for women entrepreneurs in India.



## Achieving Goals

When asked about what were the things that would aid them in achieving their major **goals in next 3 years then most of them ( 18%) responded by selecting scaling up and better marketing skills and support.**

While 'scale' may be relative, it is clear that most women entrepreneurs need better marketing skills such as better go to market strategies, stronger customer retention skills, and digital marketing and data management skills.

## How Gender Impacts their Work

In this particular survey, women entrepreneurs were asked about some crucial questions regarding the social environment in the workplace in India.

When asked about that how much do you agree that a **women starting business in India faces more challenge than a man then around 49% women strongly agreed** with this statement – this illustrates that women do perceive gender as an important factor that adds to the challenges that they face.

The Women Entrepreneurs in India 2019 Survey reveals the many challenges that women entrepreneurs are grappling with, as well as what drives them, and what else they need in order to flourish.

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## Women and Diversity

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# Women and Diversity

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## *Preface*

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The world is heading with a notion that it is equal for men and women in terms of opportunities and rights. However, this situation is just a perception and cannot be found in reality. Apart from inequalities between men and women, this diversity can be explained by understanding the uniqueness of individual differences, race, gender, ethnicity, sexual orientation, age, religious & political beliefs, socio-economic status and ideologies, etc. It is the result of demographic and philosophical differences depicted in the behaviour of individual and groups in their social structure. Diversity gives meaning, beauty, completeness and balance to life if accepted gracefully, whereas non-acceptance of the diversity victimizes women.

Generally, the attitude of Indian public towards social and cultural characteristics is somewhat different varying from caste, creed, religion, etc. This diversity in characteristics and the difference in attitudes towards it gave birth to many kinds of discrimination between men and women. These distinctions are not only associated with religion, caste, birth, colour, etc., but also with diverse qualities of knowledge, intelligence, skill, ability, experience, etc. of the man and woman. That is, at the social level, women and men have never found a place of equality since ancient times. Male dominance has always been seen in society, except for a few occasional female dominated tribe societies. All kinds of female discrepancies occurring in the society start from family, home and community. Every discrepancy in families, households and community is declared rightly in the guise of hollow rules of the associated civilization. A young girl who is suffering from such anomalies starts living life accordingly. Due to these discrepancies, there is a difference in the level of knowledge, skill, ability, experience and intelligence between men and women.

Though India is improving its status in achieving gender equality but still gender difference is pre-vailing in almost all the components. An attempt to depict the gender difference, which should be improved to achieve diversities as a prerequisite of women empowerment, is kept in view in this book. The concept is explained under diversity aspects, its forms and status of women in workplace, health, food and nutrition situations, political status of women, entrepreneurship, social security, media, etc., all of which are contributing to making the lives of women a challenge.

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## **Diverse Occupations and Occupational Health Hazards of Women Work Force**

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Work place should be safe and robust because it is directly relevant to productivity. Inappropriate work place can cause numerous health problems and diseases. Women are integral part of work force in various occupations of India. This chapter will outline health hazards faced by women workers who are employed in different sectors.

### **Occupational Health**

Occupational health can be described as safety and wellbeing of workers at their relevant work place which results into sound physical, mental and social condition of workers. The prime purpose of occupational health is to create an operational circumstance for the workers so that they do not suffer from any occupational disease (Ganguli, 2007).

### **What is hazard?**

A hazard is a causing factor or potential risk for life or health of human who is involved in any particular occupation. A health hazard may create serious and acute disease or chronic disease. The whole human body or any body part can be affected by occupational hazards. The term hazardous is the substance which is dangerous and has one or more characteristics of flammable, corrosive, toxic or reactive.

## Types of hazards

Following six types of hazards can be found at work place (Fig. 1)-



**Fig. 1:** Types of Health Hazards

## Physical hazards

Physical hazard arises when a physical agent causes poor health condition such as extreme environment conditions, burns and shocks due to electricity, occupational deafness due to heavy noise, ionizing and non-ionizing electromagnetic radiation etc.

## Chemical hazards

When a chemical agent causes ill effects to human health, it is called chemical hazard. These chemical agents can penetrate into the human by means of inhalation, ingestion or skin absorption. Some of the examples of chemical agents are-

1. **Metals** - Lead, As, Hg, Cd, Ni , Co
2. **Aromatic Hydrocarbons** - Benzene, Toluene, Phenol
3. **Aliphatic Hydrocarbons** - Methyl alcohol
4. **Gases** - N<sub>2</sub>, CH<sub>4</sub>, CO<sub>2</sub>, CO, H<sub>2</sub>S, HCN, Ammonia, SO<sub>2</sub>, Cl<sub>2</sub>

## Biological Hazards

Exposure of biological organisms at work place which are harmful to human health are called biological hazards. The threat will be more dangerous and direct through contamination or indirect through damage to the environment. Few examples of biological agents are bacteria, viruses, protozoa, fungi etc. and the diseases caused by these microorganisms are-Tetanus, Tuberculosis, Anthrax, Brucellosis (Milkmen), Gonorrhoea, Hepatitis, HIV, Malaria, Hookworms, tapeworms, Tinea-infections, Psittacosis, Coccidiomycosis etc.

## Ergonomic Hazards

Ergonomic hazards are result of poor job design, awkward postures, heavy lifting, poor equipment design, repetitive motions and manual material handling. These factors lead to musculoskeletal injuries and accidents.

## Psychosocial Hazards

Psychosocial hazards include lack of job satisfaction, insecurity, poor interpersonal relations, lack of interest in job, low motivation, boring tasks etc. Psychological & behavioral changes may include hostility, aggressiveness, anxiety, depression, alcoholism, drug addiction, sickness absenteeism etc.

Prevalence of Health hazards amongst Women Workers in Diverse Employment Sectors:

The proportion of employed women in various sectors has been increased tremendously. They are major work force in various sectors in India such as agriculture, health, small scale industries etc. The main objective of this chapter is to outline types of hazards women encountered at their work place.

## Occupation Health Hazards of Women in Agriculture

Agriculture and allied sectors are the foremost source of revenue of rural people in India and they are highly dependent on these sectors for their livelihood. Women play crucial role in agriculture and allied sectors. Agriculture is not only a major occupation but it is identified as one of the most hazardous industries. Demos et al. (2013) analyzed that farmers mentioned more health issues than non-farmers at a

statistically significant level. Heart diseases were found more common among farmers. Various causal factors may affect adversely the health of farm women related to agriculture industry. They come in the contact of harmful chemicals when they get exposed to pesticides, weedicides, fertilizers etc. Dust and minor grain particles enter to their body through inhalation which may cause breathing problems. Farm women work under adverse environmental temperature, rain and strong wind. Their skin gets exposed to intense sun light which causes skin diseases. As far as ergonomic hazards are concerned, farm women work in awkward postures while performing agricultural and allied activities. It leads to musculoskeletal diseases and pain in related body parts. It has been illustrated in past researches that women involved in agricultural and allied sectors face numerous health hazards which occur due to their occupation. Parimalam (2015) found that low back pain, ankle and knee pain were common musculoskeletal problems of tribal male and female while doing agricultural operations. Even all of them reported frequent sprains in legs, neck, low back and shoulders. Singh (2017) reported that maximum women who were involved in livestock activities; had back pain followed by shoulder pain and neck pain as symptoms of musculoskeletal disorders.

All male and female workers in agriculture and its allied sectors are vulnerable group for occupational health hazards particularly for respiratory disorders, cancer, neurologic disorders, injuries, skin problems, hearing loss, and stress (Zejda et al. 1993). Other than these diseases, slips, falls, insects and snakes bites are also widespread problems of farm women as they work outdoors in uneven agricultural land. There is a need for ergonomic interventions for reducing MSD's. Women working in agriculture and allied sectors should be aware enough to use personal protective equipment so that they can be protected from harsh environmental conditions.

### **Occurrence of Health Hazards of Women Employed in Small Scale Industries**

Small scale industries in India have contributed significantly not only in the growth of economy rather in women empowerment also. Small scale industries contribute almost 40% of the gross industrial value in the Indian economy. These industries are crucial for the country in many ways such as use of underutilized resources, employment generation and livelihood security of people. Women play

major role in these small scale industries such as textile, processed food, handicraft etc. Working conditions of small scale industries may be different on the basis of its type of work, location and owners' perception. The working conditions in SSEs may be much better than those in larger enterprises with a similar type of production (Paoli 1992). However, evidence of few researches is pointer to the fact that workers in the SSIs face numerous types of occupational health hazards.

Bandyopadhyay (2012) reported that almost forty per cent women were involved in the garment industry. Musculoskeletal problems were reported as the most prevalent health hazards. Highest musculoskeletal diseases were found in the neck, upper back, lower back, shoulder and hands/wrist/fingers amongst the workers.

Edralin (2001) found that women workers in different industries were suffering from eye contamination and injuries. Eye contamination was caused by chemical dust or particulate matter while injuries occurred while using pointed objects. In other studies also, diverse health problems such as headache, respiratory diseases, skin allergies, and reproductive dysfunctions were reported. According to a research conducted by Tiwari (2016), both males and female workers were working as slate-pencil cutters. These workers were getting exposed to free silica and ended having respiratory disorders in many cases. One more study was conducted by Vaidya et al. (2015) to study work-related health threats of women who were involved in various operations of Brick Kiln and Construction Industry. They were exposed to CO and dust. An assortment of diseases was found amongst women workers for example headache, bodyache, problems with vision, cough and breathlessness.

Women work force is considered as equally important for obtaining economic growth of any country. Hence, it is high time for government to take steps for the welfare of this stratum of society. Policies, rules and regulations should be formulated and implemented so that women can be safe at work place (Lu, 2011).

It is noteworthy to emphasize that women are involved in diverse field of small scale industries from garment industry to construction industry. Unfortunately all the researches indicate to the circumstance that prevalence of risk factors is quite high for the people working in all small scale industries. Administrative regulations can prove to be a boon for improving health and safety of women workers.

## Occupational Health Hazards amongst Women Working in Health Care Sector

WHO (2016) reported that 38 per cent female workers were contributing in health sector, in which the ratio of male-female was 1.6. Looking to the location of work place, 59.2% health workers were in urban areas and 40.8% were in rural areas. This data give a glimpse of noteworthy contribution of women in health care sector and they have been important segment of health care sector in India, whether in urban areas or in rural areas. Workers in health industry do their job for well-being of sick people but in response they are at risk while doing their job. It has been proved through many researches. Ndejjo et al. (2015) analyzed health hazards amongst women working in health sector in Uganda. Majority of them were female workers (71.5 %) and they reported biological and non - biological causing agents for health risks at work place such as cuts, wounds, musculoskeletal injuries, stress etc.

Findings of another study conducted by Senthil et al. (2015) highlighted prevalence of biological, chemical and psychosocial health hazards amongst male and female health care workers. Incongruous working condition was also reported by workers which resulted into lack of inspiration and efficiency. Widespread hazards amongst health workers cited by Mohanty et al (2019) were physical, chemical, biological, reproductive, stress, musculoskeletal disease and so on.

From the above findings, following common health hazards amongst women are identified (Table 1), who are working in diverse employment sectors-



**Table 1:** Common Health Hazards Amongst Women.

S. No.	Type of Health hazards	Cause	Occupational disease/Effect
1.	Physical hazards	Agricultural tools and equipment Extreme heat at work place Noise Vibration	Accidents, injuries Heat cramps Noise disability Vibration induced diseases
2.	Chemical hazards	Pesticides Weedicides Fertilizers Gas and vapor inhalation Metals	Pneumoconiosis Cancer Skin diseases Silicosis Necrosis Asbestosis Liver damage etc.
3.	Ergonomic hazards	Heavy load carrying Awkward posture during working Repetitive motion	Musculoskeletal disorders such as neck pain, shoulder pain, back pain etc. Sprain
4.	Biological hazards	Handling of infected animals Exposure of insects, snakes etc at farm	Brucellosis, influenza, anthrax, Insects and snake bites
5.	Psycho social hazards	Poor working condition, erratic work shift, excessive work load	Stress, depression

## Control Measures

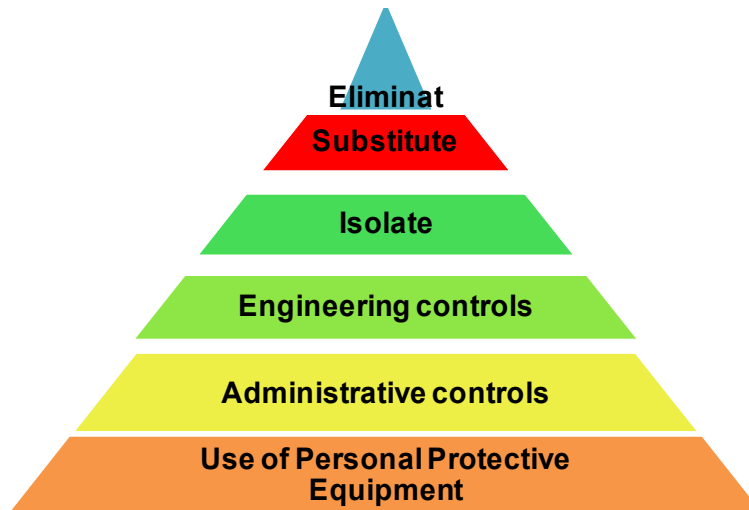
Fig 2 indicates measures to control occupational health hazards. Application of PPEs (Personal Protective Equipment) such as face mask, gloves, head cover etc. depending on the occupation is one of approaches to prevent health risk at work place. Generally, employees do not utilize PPE especially farm workers. Designing of comfortable and tailor made PPE is also important. Workers should be aware about benefits of using PPE.

Another important measure at administrative level is to formulate policies and rules for providing health and safety to workers at work place. Workers should not be allowed to work at a place which is hazardous and dangerous to their health and life. Strict rules should be framed for the industries to improve working conditions for their workers. Workers should be compensated for any kind of accident, injury or work-related disease. Policy framework is essential for providing mandatory compensation for such workers who compromise their health and safety for employment.

Engineering measures comprise of physical modifications in the work center and procedures such as ergonomic interventions at work

place, removal of excessive noise, modification in the procedure to cut short harmful substances and other relevant approaches to remove or prevent occupational health hazards.

Another measure for preventing work-related health hazards is to isolate workers from hazards. Deactivation, discharge and removal of hazardous energy are few strategies to isolate it from workers.



**Fig. 2:** Control Measures for Prevention of Occupational Health Hazards

Substitute means the hazard should be replaced with another one which is less dangerous and has lower risk. For examples, replacing organic manure and pesticides by chemical fertilizers and pesticides would be safer to handle for farmers and farm women.

The most important and effective preventive measure will be to eliminate totally the potential hazards from work place, be it any industry, hospital, farmer's field etc. Though practically this measure is difficult but if the hazards will be eliminated totally, it is an ideal working conditions.

Along with these control measures, awareness amongst workers is fundamental for success of these controlling measures programs. Workers should know about causing agents of work-related health risks and various techniques to control or eliminate these risks. Training and educational approach might be a way forward towards the sustainable solution.

## Conclusion

Women work force has increased enormously in almost all occupations such as farming, animal husbandry, fisheries, small scale industries and health industries since a decade. It provides economic empowerment to the women. Despite this fact, control or removal of work-related health hazards amongst women is a major concern, but has been mostly underestimated. These hazards may be physical, chemical, biological or any other type. Education and awareness to work safely are key measures for workers. Preventive procedures should be followed to remove or decrease work-related health hazards. Policy formulation and implementation is essential to provide safe work place to the workers.

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# **Advances in Academic Research and Development**

*Volume - 4*

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# **Chapter - 1**

## **Law**

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# Chapter - 1

## Law

Dr. P. Arun

### Abstract

Indian constitution is a standout amongst the most proficient composed constitution that any nation has ever produced. The purpose for this paper is intended towards investigating or exploring about the article 370 of the constitution, purpose, advantages and disadvantages and also deeply discussed about article 35 A and their discriminatory.

**Keywords:** article, constitution

### Introduction

Article 370 of the Indian constitution gave special status to Jammu and Kashmir a region located in the northern part of Indian subcontinent which was administered by India as a state from 1954 to 31 October 2019 and a part of the larger region of Kashmir, which has been the subject of dispute between India, Pakistan and China since 1947-conferring it with the power to have a separate constitution, a state flag and autonomy over the internal administration of the state. The article was drafted in Part XXI of the Constitution: Temporary, Transitional and Special Provisions. The Constituent Assembly of Jammu and Kashmir, after its establishment, was empowered to recommend the articles of the Indian constitution that should be applied to the state or to abrogate the Article 370 altogether. After consultation with the state's Constituent Assembly, the 1954 Presidential Order was issued, specifying the articles of the Indian constitution that applied to the state. Since the Constituent Assembly dissolved itself without recommending the abrogation of Article 370, the article was deemed to have become a permanent feature of the Indian Constitution.

This article, along with Article 35A, defined that the Jammu and Kashmir state's residents live under a separate set of laws, including those related to citizenship, ownership of property, and fundamental rights, as compared to residents of other Indian states. As a result of this provision, Indian citizens from other states could not purchase land or property in Jammu & Kashmir.

On 5 August 2019, the Government of India issued a constitutional order superseding the 1954 order and making all the provisions of the Indian constitution applicable to Jammu and Kashmir based on the resolution passed in both houses of India's parliament with 2/3 majority. Following the resolutions passed in both houses of the parliament, he issued a further order on 6 August declaring all the clauses of Article 370 except clause 1 to be inoperative. In addition, the Jammu and Kashmir Reorganisation Act was passed by the parliament, enacting the division the state of Jammu and Kashmir into two union territories to be called Union Territory of Jammu and Kashmir and Union Territory of Ladakh. The reorganisation took place on 31<sup>st</sup> October 2019.

### **Purpose**

The state of Jammu and Kashmir's original accession, like all other princely states, was on three matters: defence, foreign affairs and communications. All the princely states were invited to send representatives to India's Constituent Assembly, which was formulating a constitution for the whole of India. They were also encouraged to set up constituent assemblies for their own states. Most states were unable to set up assemblies in time, but a few states did, in particular Saurashtra Union, Travancore-Cochin and Mysore. Even though the States Department developed a model constitution for the states, on 19 May 1949, the rulers and chief ministers of all the states met in the presence of States Department and agreed that separate constitutions for the states were not necessary. They accepted the Constitution of India as their own constitution. The states that did elect constituent assemblies suggested a few amendments which were accepted. The position of all the states (or unions of states) thus became equivalent to that of regular Indian provinces. In particular, this meant that the subjects available for legislation by the central and state governments was uniform across India.

In the case of Jammu and Kashmir, the representatives to the Constituent Assembly requested that only those provisions of the Indian Constitution that corresponded to the original Instrument of Accession should be applied to the State and that the state's constituent assembly, when formed, would decide on the other matters. Government of India agreed to the demands shortly before the above meeting with the other states. [note 1] Accordingly, the Article 370 was incorporated into the Indian Constitution, which stipulated that the other articles of the Constitution that gave powers to the Central Government would be applied to Jammu and Kashmir only with the concurrence of the State's constituent assembly. This was a

"temporary provision" in that its applicability was intended to last till the formulation and adoption of the State's constitution. However, the State's constituent assembly dissolved itself on 25 January 1957 without recommending either abrogation or amendment of the Article 370. Thus, the Article was considered to have become a permanent feature of the Indian constitution, as confirmed by various rulings of the Supreme Court of India and the High Court of Jammu and Kashmir, the latest of which was in April 2018. The clause 7 of the Instrument of Accession signed by Maharaja Hari Singh declared that the State could not be compelled to accept any future Constitution of India. The State was within its rights to draft its own Constitution and to decide for itself what additional powers to extend to the Central Government. Article 370 was designed to protect those rights. According to the constitutional scholar A.G. Noorani, Article 370 records a 'solemn compact'. Neither India nor the State can unilaterally amend or abrogate the Article except in accordance with the terms of the Article.

Article 370 embodied six special provisions for Jammu and Kashmir: Central legislative powers over the State were limited, at the time of framing, to the three subjects of defence, foreign affairs and communications.

1. Other constitutional powers of the Central Government could be extended to the State only with the concurrence of the State Government.
2. The 'concurrence' was only provisional. It had to be ratified by the State's Constituent Assembly.
3. The State Government's authority to give 'concurrence' lasted only until the State Constituent Assembly was convened. Once the State Constituent Assembly finalised the scheme of powers and dispersed, no further extension of powers was possible.
4. Article 370 could be abrogated or amended only upon the recommendation of the State's Constituent Assembly it exempted the State from the complete applicability of the Constitution of India. The State was conferred with the power to have its own Constitution.
5. Central legislative powers over the State were limited, at the time of framing, to the three subjects of defence, foreign affairs and communications.

## **Human rights**

### **Education and employment rights**

The state government officials of Jammu and Kashmir have issued "permanent resident certificates". However, these certificates differ by

gender. The certificates issued to females are marked "valid only till marriage", while certificates for males have no such markings. If a woman married to an Indian outside of Kashmir, she was denied a new certificate. These certificates are required by the Jammu and Kashmir state officials from anyone seeking to acquire immovable property, education or employment within the state. Under the state laws, the Jammu and Kashmir High Court quashed the appointment of Susheela Sawhney in 1979—a Kashmiri-born woman, as assistant professor in the Government Medical College because she was married to a man outside of Kashmir. Numerous other women—such as Sunita Sharma, Anjali Khosla, Abha Jain, Kamla Rani, Reeta Gupta and others—sued the state government on different but related matters, charging discrimination based on their gender. These cases were reviewed in 2002 by the full bench of the state's High Court, which overturned the past rulings and found that the state has discriminated based on gender. According to Cottrell, the autonomy and special status granted to the state of Jammu and Kashmir makes it possible "for it to have rather lower standards of human rights".

### **Women's rights**

In 2004, the Jammu and Kashmir Legislative Assembly passed the Permanent Residents (Disqualification) Bill—also known as the Daughter's Bill. The new law sought to deprive daughters of the state's permanent residents [note 8] of all their native-born rights and privileges if they marry someone who is not the subject of Jammu and Kashmir. This law applied only to the female descendants of Kashmir subjects, and does not apply to the male descendants.

According to Sehla Ashai, per its provisions, "the women who married non-state subjects [men from other states of India or abroad] could no longer claim state subject status, would thereby lose both preferential treatment in government hiring and the ability to acquire new property in the state". The opponents to this bill argued that this is a "violation of Kashmiri women's fundamental rights under the Indian Constitution" and that the bill discriminated human beings by their gender. The supporters argued that if this bill failed to pass it "would be the end of constitutionally guaranteed autonomy for Jammu and Kashmir" and that the law was created to "protect the ethnic identity of the people of Jammu and Kashmir". The bill was supported by the state-based Jammu & Kashmir National Conference Party and Jammu and Kashmir Peoples Democratic Party, but challenged by the Indian National Congress party. It was reintroduced in J&K legislative houses in August 2004 as an amendment to the state constitution, but it

failed to pass the Upper House of the state by the required two-thirds majority.

In 2010, the Permanent Residents (Disqualification) legislation was reintroduced in the state's legislative houses, with support from the two main state-based parties. It again attracted criticism that "such bills have no sanction in the legal and constitutional history of the state or in Article 370.

### **Advantages and disadvantages of article 370**

There are various advantages and disadvantages of article 370

<b>SL. No.</b>	<b>Advantages</b>	<b>Disadvantages</b>
1.	Attempts to unite Kashmir with other states of India	Instilled insecurity in the locals as they have to give away their dual citizenship
2.	Propagates One Nation One Constitution Slogan	Kashmiri Muslims feel it threatens the state's unity and integrity
3.	Open doors for growth and development in	Add on to the political vulnerability and instability in the Valley
4.	Private investors can invest and boost the economy of the state	Hampers the delicate relationship with Pakistan. It is like a nail in the coffin
5.	Better medical and education facilities can be provided to the residents of the Valley	Implants the seeds of insecurity in certain section of citizens.
6.	Central government can curb corruption since it is a UT now.	The implementation of the abrogation of Article 370 is a threat to the democracy. It is an attempt to polarize and appease the Hindu population in the valley
7.	Authorities are in a better position to curb terrorism and instill peace in the Valley	Safety of Kashmiri girls is questioned. Certain Hindu fascists have threatened to marry girls of the region. This is out rightly sexist.

### **Article 35A of the constitution-an overview**

#### **Introduction**

Article 35A is a unique provision of the Constitution of India. It is a part of the Constitution, but does not figure in the bare Act! One does not find Article 35A after Article 35 in the Constitution. Article 35 is followed by Article 36. But, 35A can be seen in Appendix i of the Constitution. (See Annexure I) It was conceived exclusively for the benefit of the State of Jammu and Kashmir through a Presidential Order issued in 1954. It empowers the Jammu and Kashmir State Legislature to define the State's 'permanent residents' and their special rights and privileges. It was specially devised to save the State subject laws that had already been defined under

the Dogra ruler Maharaja Hari Singh's regime and notified in 1927 and 1932 (See Annexure II). However, this Article which came into force in 1954 without a place in the bare Act of the Constitution was unknown to the public. It came into limelight only when cases were filed in the apex court challenging its validity, thereby raising an intense debate.

### **Historical background**

Through the 1927 and 1932 notifications, Maharaja Hari Singh, the ruler of the princely state of Jammu and Kashmir, imposed a law defining the State subjects and their rights. The law also regulated migrants to the State. Following Independence, the State joined the Union of India through an instrument of accession to India signed by Hari Singh in October 1947. After Jammu and Kashmir's accession to India, Sheikh Abdullah who took over the reins from Hari Singh in 1949 negotiated the State's political relationship with New Delhi, which led to providing special status through the formulation of Article 370, the subject of intense debate for long.

Article 370 guarantees special status to the State of Jammu and Kashmir as clause (1) (d) specifically states that 'such of the other provisions of this Constitution shall apply in relation to that State subject to such exceptions as the President may by order specify. Article 35A is one such exception issued through Presidential Order in 1954 known as Constitutional Order No. 48 which can be found as Appendix i to the Constitution. However, under the 1952 Delhi Agreement (See Annexure III) between Sheikh Abdullah and Jawaharlal Nehru, several provisions of the Constitution were extended to Jammu and Kashmir through the 1954 Presidential Order Article 35A, not a part of the original Constitution, was conceived under the 1952 Delhi Agreement entered into by Jammu and Kashmir with India. In other words it is a byproduct of Article 370 of the Indian constitution. Jammu and Kashmir's Constitution was framed in 1956. It retained Maharaja Hari Singh's definition of permanent residents: All persons born or settled within the State before 1911 or after having lawfully acquired immovable property and resident in the State for not less than ten years prior to that date. All emigrants from Jammu and Kashmir, including those who migrated to Pakistan, are considered state subjects. The descendants of emigrants are considered state subjects for two generations. The permanent residents law prohibits non-permanent residents from permanent settlement in the State, acquiring immovable property, government jobs, scholarships and other aid. However, the Permanent settlement law was interpreted as discriminatory against the women of Jammu and Kashmir as it disqualified them from the state subject rights, if they married non-permanent residents. But, in a



landmark judgment in October 2002, the Jammu and Kashmir High Court held that women married to non-permanent residents will not lose their rights. The children of such women don't have succession rights

### **Special features of article 35 A**

**Separate constitution:** J&K is the main state <sup>[6]</sup> in India which has its very own Constitution. The Constitution of J&K was instituted by a different Constituent Assembly set up by the State and it came into <sup>[6]</sup> constrain on 26 January 1957.

**Emergency provisions:** The Union of India has no energy to proclaim Financial Crisis under Article 360 in the state. The Union can proclaim crisis in the state just if there should arise an occurrence of War or Outside Aggression. No announcement of crisis made on the grounds of interior aggravation or impending threat thereof should have impact in connection to the state unless (an) it is made at the demand or with the simultaneousness of the legislature of the state or (b) where it has not been so made, it is connected in this manner by the President to that state at the demand or with the simultaneousness of the administration of that state. In December 1964, Articles 356 what's more, 357 were stretched out to the state.

**Basic duties, directive principles and basic rights:** Part IV (Directive Principles of the State Policy) and Part IVA (Fundamental Duties) of the Constitution are definitely not relevant to J&K. Notwithstanding other major rights, Articles 19(1)(f) and 31(2) of the Constitution are still pertinent to J&K; henceforth the Fundamental Right to property is still ensured in this state. In the Indian Sacred history just a single Fundamental Right has been included up until this point and that is Right to Education. This right too isn't reaching out to J&K.

**High court of J&K:** The High Court of J&K has constrained powers as analyzed to other High Courts inside India. It can't proclaim any law unlawful. Not at all like High Courts in different states, under Article 226 of the Constitution, can't it issue writs with the exception of for requirement of Fundamental Rights.

**Official languages:** Arrangements of Part XVII of the Constitution apply to J&K just seeing that they identify with (i) the official dialect of the Association; (ii) the official dialect for correspondence between one state and another; or between a state and the Union and (iii) dialect of the procedures in the Incomparable Court. Urdu is the official dialect of the state however utilization of English is allowed for official purposes unless the state assembly gives generally.

**Miscellaneous:** Certain exceptional rights have been conceded to the lasting inhabitants of J&K with respect to work under the state, procurement of relentless property in the state, settlement in the state, and grant and different types of help as the state government may give. The fifth Schedule relating to the organization and control of Schedule Areas and Scheduled Tribes and the sixth Schedule relating to organization of ancestral territories are not relevant to the province of J&K.

**Autonomy in certain matters:** Any activity of the Union Legislature or Union Executive which brings about adjustment of the name or domains or a global arrangement or ascension influencing the demeanor of any piece of the region of the state requires the assent of the State Legislature or the State Executive (all things considered) to be compelling. The Union has no energy to suspend the Constitution of J&K.

### **Effects of article 35A**

A most prominent feature of the Constitution of Jammu & Kashmir, as distinguished from the rest of India, is the provision for the special treatment of 'permanent residents' of Jammu & Kashmir. The permanent residents are such persons as are declared so by any existing law of the State or by any future law enacted by the Legislature of the State. As stated in the Article, any such law may either confer special rights or privileges or impose restrictions upon the permanent residents with respect to employments under the State Government, acquisition of immovable property in the State, settlement in the State and the right to scholarships and other forms of aid as the State Government may provide. Such legislation shall be valid notwithstanding that it is inconsistent with the Fundamental Rights conferred by the Constitution of India upon the other citizens of India [e.g. by Articles. 15(1), 16(1), 19(1) (e)-(f) of Part III of the Constitution dealing with the fundamental rights]

### **Why article 35a is being debated**

A Delhi based NGO, 'We the Citizens', challenged the validity of Article 35A in the Supreme Court in 2014 on the grounds that it was not added to the Constitution through an amendment under Article 368. It was never presented before Parliament, and came into effect immediately, the petitioner argued. A two judge Supreme Court Bench comprising the then Chief Justice J.S. Khehar and Justice D.Y. Chandrachud referred it to a three-judge bench after the Attorney General opined that it raised constitutional issues. The court accepted the plea of the State Government that the challenges to the Article be heard after Diwali. In another related case in the apex court, two

Kashmiri women argued that the state's laws, flowing from Article 35A, had disenfranchised their children. They contended that this provision was gender biased and against Article 14 of the Constitution as a permanent resident status is denied to the children of a Kashmiri woman who marries a man from outside Jammu and Kashmir. However, it does not apply to the children of a Kashmiri man marrying a woman from outside the State; this is discriminatory.

### **Position of the state and union governments**

The Central Government is of the view that the matter in the apex court is more 'procedural in nature' rather than a substantive issue on the desirability of the law. The Union Home Ministry is not directly addressing the issue and would not be filing an affidavit. The Attorney General will undertake the task and explain the Government's stand on the matter. The Union Law Officer would reiterate the legal aspects as they exist in the Constitution.

The Union Home Minister Shri Rajnath Singh has assured the Kashmiri people on the legal challenge to Article 35A and said that the Centre would not do anything that would hurt the sentiments of the people of Jammu and Kashmir. However, questions pertaining to this Article are pending before the apex court which has to pronounce a verdict on its constitutionality. The Jammu and Kashmir Government on its part has taken a stand seeking dismissal of the petition. Further, it has argued that the State has powers under Article 370(1) (d) to apply the Constitution of India to Jammu and Kashmir with exceptions and modifications as the President may by order specify, that is in keeping with Article 35A which was issued as a Presidential Order in 1954 under Article 370 of the Constitution.

### **Recent developments**

On 30th October, the Supreme Court deferred by three months the hearing in this case, after the Centre said that it had appointed Dineshwar Sharma as an interlocutor to hold negotiations with various stakeholders in the State and requested to adjourn the matter for six months.

### **Conclusion**

The Article 370 is changeless and won't be annulled according to before judgment of Supreme Court of India. India and Pakistan are guaranteeing over the place that is known for J&K however in all actuality it's as yet debated arrive. This Article will remain insofar as joined country will constrain India and Pakistan to lead plebiscite in entire Kashmir not by

tuning in to India or Pakistan but rather the voices of Kashmiri individuals. We trust that the general population of J&K should choose on the off chance that they might want to remain with India or not. For that plebiscite should be directed and at exactly that point can some other approaches or moves be made calmly and viably. We need to concede that India's military quality or we can state powerful run without a plebiscite will doubtlessly prompt more bloodshed in the area and monetary ramifications for the entire of India without an assurance that Pakistan won't strike back at a later point in time. The contribution of UN conveyed a global measurement to this contention, a "snare" which would end just when the Kashmir issue is tastefully settled. The control and directions which has been given or characterized in Article 370 must be executed legitimately and entirely in province of J&K. J&K is the most burning issue which should be comprehended however is pending since more than Sixty years of freedom because of a few errors committed by the legislators. This is the opportune time to take legitimate choices with respect to the status of Jammu and Kashmir, if appropriate advances are not taken now then it is conceivable that issue will fire up more in coming future and will keep Jammu and Kashmir from improvement even the entire world will be developed. Need of plebiscite and re-election of constituent assembly becomes necessary.

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**Chapter - 2**  
**Cultural Heritage: Value Addition to Home  
Furnishing Items through Rajasthani Phad Folk  
Art**

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# Chapter - 2

## Cultural Heritage: Value Addition to Home Furnishing Items through Rajasthani Phad Folk Art

Dr. Sunita Dixit

### Abstract

India has a rich and vibrant cultural heritage. The important part is that we the people of India have still kept that culture alive. We still can witness our ancient cultural influences in our modern routine. We treasure our heritage with pride. Paintings are also a big part of our culture. There are myriad painting styles that find their roots in India and have stories attached to them. One such painting style is Phad painting. Phad is an indigenous painting style of the state of Rajasthan, India, that depicts the narratives of the folk deities of the state. This style of painting is the blend of Rajput and Mughal styles of painting. Originated thousands of years ago, this fabled heritage of Bhilwara is done on a long piece of canvas called Phad. This study focuses on the rejuvenation of these art forms in home furnishing items. Phad art is one of the pilgrimage of Rajasthan, currently it don't find much uses on textiles and home decors. As the art contains vibrant colours so it can be used for decorating our walls, frame of the mirror, khadi cushions, and small wooden items and for fulfilling other such purposes. This fusion of art will not only make the home interior beautiful but also it will save this beautiful art from being extinct as well. In the present study Phad folk art from past to present has been analysed, Phad designs were introduced in home furnishing items, consumer acceptance of Phad folk-art in-home furnishings were studied and the cost of prepared items were calculated. If this art get transformed on home accessories it will get a good consumer acceptance and the commercialization of this folk painting will generate new sources of non-agriculture income. This will also be helpful in achieving eminence in the national and international market, and this profitable running is one of the instrumental ways to survive this traditional art form.

**Keywords:** cultural heritage, Phad painting, folk art, rejuvenation, home furnishing, commercialization

## Introduction

Traditional art and craft, practiced by various craft-guilds in the country are the evidence of Indian cultural heritage. Though the narratives depicted in the form of painted façade or scroll-paintings are the genesis of traditional Indian visual language, the scarcity of public awareness and seclusion from the mass is becoming a threat to economic sustainability of those craft-guilds as well as cultural sustainability of our heritage. India has always been the land that portrayed cultural and traditional vibrancy through its conventional arts and crafts. The states and union territories sprawled across the country have their own distinct cultural and traditional identities, and are displayed through various forms of art prevalent there. Every region in India has its own style and pattern of art, which is known as folk art. The folk and tribal art of India are very ethnic and simple, and yet colourful and vibrant enough to speak volumes about the country's rich heritage. The folk arts in India apparently have a great potential in the international market because of its traditional aesthetic sensibility and authenticity. The rural folk paintings of India bear distinctive colourful designs, which are treated with religious and mystical motifs. Some of most famous paintings of India are Madhubani painting of Bihar, Patachitra painting from the state of Orissa, warli painting of Maharashtra and other such folk-art forms.

Folk art is however not restricted only to painting, but also stretches to other art forms such as pottery, home decorations, ornaments, cloths-making, and so on. In fact, the potteries of some of the regions are quite popular among foreign tourists because of their ethnic and traditional beauty. However, these art forms have been on the decline, some time back, but the rising interest of people in local arts have been thriving day by day. The government of India, as well as other societies and associations, have therefore made all efforts to promote such art forms, which have become an intrinsic part of India's cultural identity. Tribal art generally reflects the creative energy found in rural areas that acts as an undercurrent to the craftsmanship of the tribal people. Tribal art ranges through a wide range of art forms, such as wall paintings, tribal dance, tribal music, and so on. This study focuses on the rejuvenation of these art forms in home furnishing items. The folk art that has been studied so far is Phad Painting of Rajasthan.

Phad painting is a valuable pilgrimage of Rajasthan. Phad painting (Mewar style of painting) or Phad is a religious scroll painting practised in Rajasthan state of India. This is a unique scroll making folk art; this style of painting is traditionally done on a long piece of paper or canvas known as Phad. Since, Phad art is the valuable pilgrimage of India so it is needed to

achieve a good place in our houses. As the art contains vibrant colours so it can be used for decorating our walls, frame of the mirror, khadi cushions, and small wooden items and for fulfilling other such purposes. This fusion of art will not only make the home interior beautiful but also it will save this beautiful art from being extinct as well. In the present study Phad folk art from past to present has been analysed, Phad designs were introduced in home furnishing items, consumer acceptance of Phad folk-art in-home furnishings were studied and the cost of prepared items were calculated.

## **Methodology**

### **Study of Phad art**

Varied cultures of India also mean an abundance of singular art traditions. Our epics, scriptures, mythologies, abound with stories and the traditions feed off these tales becoming multi-layered narratives. Phad painting of Bhilwara is yet another one, a 30 feet long scroll painting on cloth depicting episodes from the lives of Hindu gods, goddess and local deities. Still in practice in Rajasthan, not much is known about it elsewhere.

So, the use of this art in Home furnishings is one of the instrumental ways to survive the folk forms.

### **Selection of articles**

To introduce the Phad art in home furnishings, the articles must be eye catching, it should get a good place on the walls, etc. So the three articles were selected for introducing the Phad art in homes. The articles are-A Mirror with a broad frame, A Wooden knife and A Cushion made of khadi fabric.

These three articles may help to enhance the beauty of the Phad art.



**A wooden frame for mirror**

## Selection of designs

The Phad is unique in the manner it is formatted and made. There is a set pattern of how the characters are placed and the colour scheme. Every available inch of the canvas is crowded with figures. In order to fulfil this requirement of Phad art, 15-20 designs were selected on the basis of the theme-wedding ceremony, the king and the queen, radha-krishna. The designs that were selected have somehow relation with the above themes. The selected designs were arranged in accordance with the theme.

Some of those designs are-



## Sketching of selected designs

In order to trace the design on the articles they were needed to be sketched on the paper. The sketching of the designs were done according to the area covered by design on the article. Some of those were small in size, some were large and some of the designs were in medium size. They were drawn free hand by using a pencil and a scale were used to measure the area of that design.



**Sketching of king & queen**



### **Tracing and colouring of designs**

Once the designs were sketched, they were arranged in a proper manner. This sequence of the designs was traced on the article and the colouring begins. The colours were used in a layer pattern from lighter to darker value. Firstly, the light Orange colour for limbs and torso of the figures; Red, Green, Blue for general clothing; Yellow for the ornaments; green for tress, plants and vegetation, Brown for architectural structures.

The black outline gives the final touch to the design. The linear expressions create a lively effect. The detailing of the design were done with black colour outlines and the entire composition was enclosed with a thick border by using reddish brown colour.



**Colouring of frame of mirror**



**Colouring of wooden knife**



**Colouring of cushion covers**

## **Result and discussion**

### **Selection of Phad folk art**

The Phad folk art has been one most valuable pilgrimage of Rajasthan which is now acknowledge on global state. Though this art is acknowledge at global state but don't find much uses on textiles and home decors, except as a few decorative painted wall panels. The art needs to be popularized in order to preserve its reminiscent beauty by adapting it on some common home accessories. The folk art and the traditional idea that are the glitters of our culture, when applied on interior decoration of residence by commercial aspect will gain polarity and its value will be enhanced on global state.

### **Selection of articles**

In order to introduce the Phad art in home decor accessories, those items were selected which are easy to move, and which are most commonly used

in indoor furnishings and layout. These articles reflect the owner's taste and create a personal atmosphere where they are placed. These articles can break the boundaries of traditional decorating patterns by making the use of Rajasthani Phad art and recombined to form new concept.

The articles that were selected for transforming the Phad art are: A mirror with a broad frame, Wooden knives and Cushion covers made of khadi fabric.

**A mirror with a broad frame:** Mirror is found in every homes and shelters, so first preference was found for mirror. The frame surrounding the mirror is made of 'sheesham wood'. The length of this frame is 16inches while the breadth is 14inches. Sheesham wood will increase the durability of this frame as it protects it from insects and termites.

**Wooden knife:** A plane wooden knife with a carved structure of Peacock, generally used for decorative purposes was found with a plane surface. This surface became a good place for transformation of Phad art. This fusion enhanced the beauty of the carved knife.

**Cushion covers:** The cushions are also one of the common home decors. These cushions maintain the beauty of our living room. So, it was found to be the next choice after mirror and knife. The world is know falling for khadi fabric, due to its weave, elegance and as an eco-friendly fibre so these cushions were made with khadi fabric.

## The finished articles

### Article-1



A mirror with a frame showing the wedding ceremony through Phad art.

**Article-2**



**The wooden knives-Phad Painting**

**Article-3**



**The cushion covers made of khadi fabrics showing the traditional Phad painting of the King and the Queen**



**The dancing picture of Radha-Krishna**



**Home decor items with the fusion of Phad Painting**



## Acceptability of Phad art in home furnishing items among youth

For knowing the acceptability of Phad art, the respondents are between the age group of 20-30 years. The sample size is 30.

Since, the youth is conscious and curious about knowing the facts and beauty of our tradition, hence they were preferred for this survey

**Table 1**

S. No.	Topics	Yes		No	
		No. of respondents	%	No. of respondents	%
1.	Do the consumer know about Phad art.	7	23	23	76
2.	Do the consumer like the articles.	30	100	0	-
3.	Do the consumer like the color and motifs used in the articles.	30	100	0	-
4.	Do the consumer appreciates the fusion of this art form with the home furnishing items.	30	100	0	-
5.	Will the consumer accept this art form in home furnishing.	29	97	1	3

S. No.	Topics	Agree	%	Disagree	%
6.	Use of this art form in home furnishing items can bring it to global level.	30	100	0	-
7.	This traditional art form adds beauty to these articles.	29	97	1	3

S. No.	Topic	Article 1 mirror		Article 2 Wooden knife		Article 3 Cushion covers		All articles		None of them	
		No.	%	No.	%	No.	%	No.	%	No.	%
8.	The article most appreciated by the consumer.	3	10	5	17	5	17	17	56	-	-

## Result

To satisfy the youth consumer with something that doesn't belong to this era is no joke. Youths are the one who will not easily get satisfied in terms of home decors and accessories. They are very strong on their tastes and preferences. But the fusion of both the traditional and modern era in

home furnishing items was willingly accepted by the youth consumer. A 100% response was obtained by the consumer for this concept. They were also agreed with concept that this traditional art form adds beauty to these home decors items. Among those three articles, 10% appreciated the mirror, 17% appreciated the wooden knife and 17% for cushion covers. Overall 56% consumers appreciated all articles. This shows that the art can connect all the time periods. It also proves a point that even 700 years old art form can still increase the beauty of the interior of our residence, this shows that the art can merge with any time period. Hence, one can say that the traditional folk-art forms will not have an end if it keeps having such youths as a helping hand to pull it out whenever it starts falling.

### Cost calculation of articles

Articles	Quantity	Material used	Labour charges	Total cost
Mirror	1	935	150	1,085
Wooden knife	2	220	80	300
Cushion covers	2	260	100	360

### Conclusion

India is marked as by its rich traditional culture and heritage of Tribal/Folk arts and culture. These paintings give aesthetical feelings and remind us about the native life through their colourful line drawings. Phad art is one of the pilgrimage of Rajasthan, currently it don't find much uses on textiles and home decors. If this art get transformed on home accessories it will get a good consumer acceptance and the commercialization of this folk painting will generate new sources of non-agriculture income. This will also be helpful in achieving eminence in the national and international market, and this profitable running is one of the instrumental ways to survive this traditional art form.

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**Chapter - 3**  
**Rabindranath Tagore's Educational Philosophy  
and Its Relevance in the Present-Day Context**

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# Chapter - 3

## Rabindranath Tagore's Educational Philosophy and Its Relevance in the Present-Day Context

Bhagyashree Das and Monika Gohain

### Abstract

Rabindranath Tagore was one of the most prominent philosopher, poet, music composer, play writer, novelist, and painter of India. He contributed towards almost every field. His idea and views on education has very much impacted the education system of that time and also has brought into light the different drawbacks of it. This chapter discussed about his life philosophy and his viewpoints on education. Also, the relevance of his educational ideas in the present context is also discussed in detail.

**Keywords:** Rabindranath Tagore, life philosophy, educational philosophy, relevance

### Introduction

A society's transformation is mostly dependent on the tool called education. It is very clear that the progress of a country is fully dependent on the skills and knowledge of its citizen. So, the educational setup of a country should be set in such a way which will lead to the cultural, political, economic, moral, development of the society. Philosophy provides the foundation to design the entire educational setup of a country. The aims and objectives of education, its curriculum, method of teaching, etc should be prepared in a sound philosophical base. The philosophy on which the education is based should aim at meeting the present day needs and should help in preparing every individual not only for their personal growth but also can prepare them to contribute for the progressive social change.

Many Philosophers from different times like Mahatma Gandhi, Rabindranath Tagore, John Dewey, Maria Montessori, Radhakrishnan, etc. have forwarded different educational philosophies and it is seen that their educational philosophy has greatly impacted upon the education systems. One of the prominent Indian Philosopher was Rabindranath Tagore, who has highly influenced the education system with his spiritualistic, naturalistic,

and humanistic, ideas. So in this chapter the educational philosophy of Rabindranath Tagore and relevance of his ideas in present day context will be discussed.

### **Life sketch of Rabindranath Tagore**

Rabindranath Tagore was born in the year 1861 on 7<sup>th</sup> May. He was a philosopher, educationist, poet, novelist, artist, painter, composer and he has left his impression on cultural, educational, political and social life of India. He was the Nobel Prize winner for his greatest work “Gitanjali” in 1913, which is a collection of poem.

He started his education in England but later he dropped out from formal education and learned Shakespeare works on his own. After learning literatures from different language, he came back to India. He worked on Bengali literature and majorly contributed towards its development. Tagore was recognized internationally for his works. Thus he had many contributions not only towards the field of literature but also different fields such as education, culture, and social. He died in the year of 1941.

### **Life philosophy of Rabindranath Tagore**

Before going to discuss Tagore’s Educational Philosophy, we must first understand his philosophy towards life which are discussed below-

1. **Principle of harmony:** The basic principle of his philosophy is that he explains harmony in three contents, with nature, with man and international relations. The individual should maintain a harmonious relationship with nature, with other human beings as well as mutual understanding among the people of the world.
2. **Tagore as vedantist:** He was a Vedantist. He believed in the Brahma, as the supreme soul. He viewed that God is the creator of the universe and he is the supreme powerful. He resides in each and every aspect of nature. So he believed that even there is diversity in the world in terms of race, color, caste, culture, tradition etc. but still there is unity among all.
3. **Rabindranath Tagore as yogi:** As a Yogi, he emphasized on continuous effort for the development of self.
4. **Rabindranath Tagore as spiritualists:** Rabindranath Tagore was spiritualistic. He believed that music can lead to spiritual development.
5. **Rabindranath Tagore as idealist:** He was an idealist philosopher, who believed that God is the supreme authority. The God is the



only truth and the rest are illusion. Man should free themselves from the illusionary world to realize the ultimate truth which is God.

6. **Rabindranath Tagore as humanist:** Tagore said men are created by supreme power. So all human being should be served with love, and respect. So serving human beings will ultimately lead to serving God.
7. **Rabindranath Tagore as naturalist:** According to him, nature is the best teacher and education obtained through communication with nature can help in the harmonious development of child. Therefore, man should try to build an intimate relationship with nature.
8. **Rabindranath Tagore as patriotic:** Tagore was a patriotic person and a great poet and this patriotism can be felt in his writings. “Jana Gana Man Adhi Nayak Jai Hai” is the greatest contribution towards his motherland.
9. **Rabindranath Tagore as internationalist:** As an Internationalist he viewed that all human beings are created by one supreme authority. So everyone around the world should try to establish love, affection, respect, peace and unity among each other irrespective of religious or cultural differences.

### **Educational philosophy of Rabindranath Tagore**

Tagore was against the traditional system of education that was prevailing in his time. He emphasized on an education system which draw out the creative abilities and natural potentiality of a child. He believed that education should bring the child closer to their culture and civilization.

The main principles of Tagore’s educational philosophy are as follows:

1. **Freedom in education:** According to Tagore a child should be given ample freedom in order to contact with their natural surroundings. Only freedom can help them to acquire experiences on their own pace and effort and they will be able to express their emotions, feelings, and it will lead to development of natural abilities.
2. **Promotion of creative self-expression:** According to him, education should not only develop a child’s intellectual abilities but also develop his senses and emotions. He had given importance on music, arts, craft, drawing, drama, etc as an aid to aesthetic development which will lead to creative self-expression.

3. **Active communication with nature and man:** According to Tagore, education should be imparted in a natural atmosphere of beauty, colours, forms, sounds, etc. He believed that it will help in building intimacy and communication with nature. As nature is the best teacher, so contacting nature will help in the spontaneous and natural development.
4. **Promoting humanism:** As he was humanist philosopher, he maintained that education should inculcate love and respect in the minds of students for all the individuals.
5. **Promoting internationalism:** Promotion of feelings of international understanding among the students is one of important principles of Tagore's educational philosophy. Only then unity and harmony can be established around the world.

On the basis of the above principles Tagore forwarded aims, method of teaching, curriculum, role of teacher, and discipline of education.

### **Aims of education**

Tagore's views on aims of education are discussed below:

1. **Personality development:** The ultimate aim of education is the all-round development of child's personality through self-realization.
2. **Spiritual development:** Education should always help the child to understand his inner self, which will lead to spiritual development.
3. **Intellectual development:** For the intellectual development, focus should be placed on to develop curiosity, imaginative ability, alertness, creative thinking, etc.
4. **Physical development:** Another aim of education is the development of a healthy physique, especially in early years. Therefore, he placed importance on yoga, sports, exercise, physical labor, etc.
5. **Development of moral character:** Tagore emphasized on the moral character formation as an aim of education. Developing moral character will lead to the formation of good character.
6. **Development of scientific outlook:** One of the important aims of education should be to develop scientific attitude in the child's mind. It will help the child to think rationally and logically about the mysteries of nature.
7. **Acquisition of vocational efficiency:** In order to make the students self-sufficient, Tagore emphasized developing vocational efficiency as an important aim of education.

- 8. Development of international attitude:** Education should inculcate the values of internationalism in the minds of students, for the establishment of unity, integrity and a sense of universal brotherhood.

### **Curriculum and co-curricular activities according to Tagore**

According to Tagore, curriculum must be comprehensive and broad, so that it can cover all aspects of child's life such as physical, mental, social, aesthetic, moral and spiritual. He stressed on the inclusion of such activities and subjects which will develop scientific attitude and vocational efficiency of the students.

According to Tagore, the curriculum should include the following subjects:

- 1. Language:** The study of language should include mother tongue, other Indian languages, English, German, Latin, French, Chinese, Russian, etc.
- 2.** Mathematics should be included for developing problem solving ability of the child.
- 3. Science:** Different branches of science such as natural science, physics, chemistry, botany, zoology, general science, health science, etc should be there in the curriculum.
- 4. Social Studies:** The subjects like history, citizenship training, geography, economics, sociology, etc. as a part of social studies should be included.
- 5.** Agricultural and different technological subjects should also get an important place in the curriculum.
- 6.** Religious Education, philosophy, psychology should also form an integral part of the curriculum.

As Tagore stressed on the all-round development of a child's personality, so he emphasized on the inclusion of Art, dance, drama, music, sports and games, drawing, exhibition work, workshop, social services, etc. as part of Co-curricular activities. He was of the view that the co-curricular activities will help to develop qualities like problem solving, leadership, kindness, moral character, etc. In his opinion, a teacher should participate in the activities along with students; it will create a strong mutual bond between them.

## Method of teaching

Traditional Methods of teaching was never supported by Tagore. He was of the view that method of teaching should develop the potentialities and natural tendencies. The teaching methods should be practical and as per the interests of the children.

The following are the methods of teaching suggested by Tagore:

1. **Activity-centred method:** The students should be provided education by engaging them in different activities like drama, dance, exercise, swimming, climbing, doing daily activities, etc. which will essential for the development of both mind and body.
2. **Teaching while walking:** According to Tagore, teaching should be done through excursions and tours. It is fruitful because the child will get firsthand experience and thus the topic is easily understood.
3. **Debate and discussion:** Debate and discussions should be organised as a method of teaching because it helps to develop the oratorical abilities of the students. It will also lead to express them, develop their own ideas, and lead to problem solving.
4. **Heuristic method:** In this method, students ask questions to teachers and the teacher clear their doubts by providing appropriate answers. Again, teacher put questions to students to check how much they have understood and this process goes on and on.

## Medium of instruction

According to Tagore, mother tongue should be the medium of instruction, as it is easily understandable and the young children can easily express them with the help of it. He also placed importance on English language as a medium of instruction at the higher level of education.

## Role of teacher

Tagore believed that teacher should be a Guru, i.e. a respectable person, who have immense knowledge and who is always there for their students. He should be like their parents and the relationship between the students and teacher should be close like that of the Vedic age in Gurukula. He should be a lovable and kind person, and should not be strict to his students. Again, for proper learning of his students, the teacher should create an environment where children are given maximum freedom, where they can explore the nature, their potentiality and inner self. He should also guide the students, whenever needed.

## **Discipline**

Tagore was against of strict discipline and believed that imposing strict rules and regulations will only suppress the abilities of the child. So, he maintained that discipline is a thing that can be developed from within. He said, child should be given free environment to interact with his surrounding and it will enable them to judge their behaviour. Self-discipline is helpful not only to manage own behaviour but also to rectify each other's mistakes, and thereby helping in proper adjustment.

## **Santiniketan and Visvabharati**

In the year 1901, Tagore established an ashram named "Santiniketan" in Birbhum. Later it was transformed into a school which was entirely based on his principles of education. It was a residential school constructed amidst nature away from the busy city life. In Santiniketan, education was provided to students through a family environment, as all the students and teacher had to stay together. Again, the teaching-learning was not restricted within the four walls of schools, but provided in open and free natural surroundings. The students have a daily routine where they have to perform certain duties and activities such as waking up early, cleaning, do morning and evening prayer, yoga, exercise etc. along with their classes. Importance was paid on the all-round development of the students i.e. creative, physical, moral, and mental, etc.

Later Santiniketan was reconstructed into a University known as Visvabharati in 1921. The prime objective of this University was to promote international brotherhood, by gathering culture from different parts of the world. Much importance has been paid on the cultural education. There were facilities of studying about different cultures from different parts of India as well as from different parts of the world so that not only the Indian students but also the foreign students can study about different cultures. It will meet the objective of unifying mankind. It was a co-educational institution which focused on simple living and high thinking. There were several departments in the Visvabharati such as Sishu Bhavan, Vidya Bhavan, Kala Bhavan, Sangeet Bhavan, Silpa Bhavan, etc. to meet different purposes of students and community. In this University Tagore established a separated department for women education named Nari Bhavan. Visvabharati was also based on the same principles and ideals followed in Santiniketan.

## **Relevance of Tagore's ideas in the present context**

Rabindranath Tagore's educational philosophy has influenced education system to a great extent. His views are practical and it's relevant in present

time. Following are some of his ideas on education which have relevancy in the present time:

- 1. Freedom in learning:** Tagore viewed that providing freedom to the learners will enable them to learn, on their own pace, to explore the environment freely which will also develop their inner talents. It is said to be relevant in the present time, because our education system does not provide ample freedom to its students. It imposes rules and regulations which may limit the capacities of the students.
- 2. Self-expression:** He also emphasized on the introduction of different activities like drama, music, sports, art, craft, exercise, etc through which the child can express their emotions, feelings, skills and potentialities. It is relevant because, all round development of a child can take place only when they are given an environment where they can fully express themselves and it will also promote creativity.
- 3. Activity-centred method:** Another important idea of Tagore's educational philosophy is the activity-centred method. Learning through activities will lead to better understanding of the topic. In the present education system more importance is given on the theoretical aspect rather than practical. Thus it is only leading to memorisation. So, education should be activity-centred.
- 4. Promotion of international unity:** The promotion of international brotherhood, integrity, love and affection among the people of the entire world is necessary to promote peace as well as unity among the people of different countries.
- 5. Importance on physical education:** Now-a –days, it is seen that the children are mostly busy in using mobiles, laptops, rather than going outside and play with their peers. It will only lead to degradation of social values, and it may have some negative impact on their health. So, Tagore's importance on yoga, exercise, swimming, climbing, different sports, etc is relevant in present day context.
- 6. Self-discipline:** Students must be provided an environment where they can govern their own behaviours. They can see what is bad and what is not for which there is the need of self-discipline. But the present education system has imposed strict rules and regulations, where a student does not find opportunity for rectifying their own mistakes. So self- discipline said to be relevant in the present time.

7. **Development of scientific attitude:** In a country like India, different superstitions, blind beliefs, social evils etc. are still prevalent. It is hindering the society's progress. So, Tagore's idea of developing scientific attitude of people through education is one of most relevant aspect.
8. **Importance on vocational development:** Tagore's emphasis on building efficiency of students is also considered to be important in order the curb unemployment in the country.
9. **Teacher-student relationship:** Tagore emphasized on a cordial relationship between teacher and his students. It is relevant in present time because it is seen that relationship between teacher and student is not that intimate where the students can fully express their need and requirement.
10. **Importance to natural environment:** It is seen that human beings are destroying nature for their own benefits. Thus, it is affecting the entire ecological circle. Therefore his philosophy of respecting, loving and to be kind towards nature is much relevant in the present time.
11. **Moral development:** Present society is witnessing degradation of moral values. The values like respecting elders, kindness, honesty, helping others etc are vanishing slowly from the society. So his viewpoint of building moral character is important in the present time.

## Conclusion

Tagore was against the formal education system and he therefore put forwarded his own philosophy of education, which can remove the existing problems of education. From the above discussions, it is clear that Tagore has brought revolutionary ideas on educations which were much ahead of its time. His ideas are still relevant, and if brought into effect can bring a lot of positive changes in education system as well in the society.

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**Chapter - 4**  
**Necessity of Information and Information  
Seeking Behaviour in Social Development**

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# Chapter - 4

## Necessity of Information and Information Seeking Behaviour in Social Development

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### Abstract

Information is an important commodity in human environment, like food and other basic needs; it is looked upon as a human necessity in information age. Information; irrespective of disciplines and activities has projected towards the growth of human beings. Information has far-reaching impact on the society in all the aspects of life. Information is the gain in terms of knowledge and is received in terms of senses. Information is the product of the human brain in action. It may be abstract or concrete.

**Keywords:** information, seeking behavior, information literacy, library, knowledge

### Introduction

Information is a concept of great richness. Accurate, useful and timely information on new products, new process, new patents and standards and research in progress are essential for today's competitions. Information enables man to perform his day-to-day duties. There is no life in the modern society, without information. We are living in the so-called 'information society' or 'information age' where information is one of the most important factors of life. Today, every person needs a variety of information in his day-to-day life, to make the simplest of decisions. Modern society generates huge amounts of information by using different tools and media and this in turn gets consumed by the society.

Information has been a very important element in the development of human society. It has shaped the way in which people think and act. All human beings to take decisions in their routine lives and to get the positive result out of it use information. Therefore the Need for right information at the right time is of utmost importance. All the human activities are directed towards information-producing and information-consuming practices. Information has become the central focus in the new dimensions and spheres

of Telecommunication, Television, Telemetric, Computers, Publishing firms, Radio, Satellite Communication etc. Those people who are engaged in Agriculture, Industry, Research and Development, Bureaucracy, Journalism and Entertainment are running after information. They collect, process, store, disseminate and use information in several forms for different purposes. If human society is marching towards development and progress, it is only due to information. Information has tremendous impact on society in all the walks of life.

Information has become an ingredient of man's life cycle to such an extent that there can be no life in the modern society without information. Information is the input of knowledge and is always received through the senses. "Information is the product of the human brain in action. It may be abstract or concrete. When an individual begins to think a variety of images and sensations flash across his mind. This makes some information to accumulate in his mind and his memory retains some pieces of knowledge".

"The crucial role that information plays can be gauged from the vast areas of human activities in which it finds applications that include: growth of knowledge and wisdom, decision making and management. Human progress has become possible because of the existence and awareness of knowledge created by the past generations, cultures and societies. The base of knowledge is information. Information, which is the result of a meaningful response to a stimulus, when correlated, synthesized and stratified during the course of time, becomes knowledge. Knowledge applied and tested over a long period of time by a continuous stream of minds resulting in its acceptance, as truth becomes wisdom. Thus wisdom is a part of human heritage".

Information is a concept of great richness. Accurate, useful and timely information on new products, new process, new patents and standards and research in progress are essential for today's competitions. Information enables man to perform his day-to-day duties. There is no life in the modern society without information.

### **Information literacy**

The Study understands the background thinking about the origin, evolution and implications of information of, information literacy over the society. Today's society is modern society called as the information society in which literacy skills are quite essential characteristics of every member of such society.

The National Forum on Information Literacy, defines information Literacy as “the ability of know when there is a need for information, to be able to identity, locate, evaluate and effectively use that Information for the issue or problem at hand” <sup>[1]</sup>. The term “Information Literacy” refers the set of skills required to identify information sources, access to information, evaluating it and using it effectively, efficiently and ethically. According to Karisiddappa “Information may be a single fact or it may be a whole cluster of facts; but still it is a unit; it is a unit of thought. It can have any dimensions, it is that intellectual entity which we receive the block of knowledge” <sup>[2]</sup>. Further, we receive information is the peoples’ messages, ideas and practices about different needs care implies knowledge about the basic common issues.

Today every person needs a variety of information in his day-to-day life, to make the simple decision. Modern society generates huge amount of information by using different tools and media and this in turn gets consumed by the society. Information is one of the several basic resources that is needed and utilized by human beings for their development and prosperity. It is a dynamic, vast and exhaustive resource that affects all disciplines and all peoples.

Information is scattered in the every corner of our society. Different types of information are scattered in different social institutions like educational institutions, commercial institutions, libraries, museums and everywhere. Besides this, enormous information is now available on online, through World Wide Web (www) and information on web is doubling in every second. Perhaps some information also comes to individuals in unfiltered forms. These information exploration situations are seriously a new challenge for individuals. Information literacy among the man is essential to obtain right information for the use is right purpose.

### **Basic principles of information literacy**

The following are the basic principles of information literacy,

- a) An individual have such skills to know when he/she needs information and where to locate it effectively and efficiently.
- b) Through information literacy an individual is well equipped by the technological skill which is needed to use the modern libraries as a gateway to information.
- c) Ability to individual to analyze and evaluate the information he/she obtain.

- d) Having confidence in using information to make a decision or create a product.

Thus, it is the first base of thinking about information literacy skills and its objectives of the background source for this entitled study.

### **Library as the means of storing knowledge and dissemination**

Libraries are a common heritage as then are the repositories of knowledge about human history, its development and diversity. These are the treasures and treated as a gift from one generation to another. From the past and ancient times, the building and setting up of libraries have been a measure of civilizational progress. Across the world, libraries have contributed to providing people with opportunities for gaining knowledge and for promoting intellectual advancement.

Modern society is considered as information consciousness is wide spread now is referred is the modern society. In this regard, information society is going to be treated libraries as modal points of local information dissemination.

Literacy is one of the main places on which cultural, said and economic development of the country depends. In a country like India, public libraries have responsibilities to increase the humble of literate and educated people through appropriate programmes. Libraries can also provide a solid based to the national literacy mission. There are enough cases of people shipping back to illiteracy for want of reading material; therefore, over libraries has act as tools for sustaining literacy in the country.

As the familiarity of understanding the role of libraries is considered as a source of preservation of knowledge, the development of any information study is depending upon the historical development of libraries. Therefore, the functioning of the libraries in communicating the source of knowledge is the second important component of this present study.

### **Information seeking behavior**

Different human beings seek information from different sources and in different formats for undertaking various responsibilities and tasks. It requires them to seek information for altering goals and objectives in education, economy, politics, social activities etc. For eg, student and teachers in the field of education, need information for gaining more knowledge by using different tools and media. Wilson T.D. (1999) <sup>[3]</sup> has defined information behavior as “the totality of human behaviour in relation to sources and challenges of information, including both active and passive

information seeking and information use”. Further, it is the “micro-level” of behaviour used by the searcher in interacting with information systems of all kinds. Behave in this regard, the “behavioural characteristics of information seeking which describes the activities of the information seeker engaged in the ‘active search’ mode of information seeking.

The nature of information access to the needs, seeking behaviour patterns would be determined by the individuals’ work activities. As the result the information access varies from person to person according to their needs. The information and information seeking behaviour an individuals’ way and manner of gathering and sourcing for information for personal use, knowledge updating and development would be determined by some of the factors like the personal attitudes, the kinds of information being sought and the ways and sources with which needed information is being sought <sup>[4]</sup>. Similarly there are other factors which determine the information seeking behaviour of an individual or a group of individuals such as the purpose for which information is being required, the environment in which the user operates, users skills in identifying the information and sources preferred for acquiring the needed information.

As there is a nexus between the information gathered about the particular item and the theoretical models developed by the information seeking behaviour and is this “Information need upon the need of understanding these theoretical perspectives used by behavioural seeking studies in the use of present information study.

### **ICT as the quick means of disseminating information**

CT comprises a diverse set of technological tools and resources to create, disseminate, store and manage data and information <sup>[5]</sup>. Traditional ICT tools e.g., T.V., Radio and telephone have already established their credibility and effectiveness in promoting the developmental schemes in rural and marginalized areas. The modern ICT tools are computers, internet, and wireless technologies along with powerful software which can process and integrate sound, text and video into electronic media.

The world-wide electronic network of computers, popularly referred as internet and wireless telephony have generated an unprecedented global flow of information, people, products, capital and ideas with the emergence of digital communication technologies, internet carries pictures, drawings, moving images, sound and text altogether.

With regard to the impact of ICT on Rural Empowerment that it has opened the door for outsourcing without changing the geography. These new

outsourcing opportunities create employment, generate income and enable poorer country to participate in the global market in a similar way, ICT provides a dynamic way to connect people with their government and access information easily, efficiently and cost effectively.

As it has been aptly quoted is one of the verses of Francis Bacon.

That,

“Where is knowledge?

It is lost in wisdom

Where is wisdom?

It is lost in information.”

This quote implies the answer to the question that who is the richest person in this modern age? It is not the wise, talented and intellectual but it is the informant one considered as the richest person in this modern age. In this age of Information Communication Technology (ICT), now the poverty is assessed in information terms rather than in economic terms. It is believed that a well-informed citizenry can exercise its rights to carry out its responsibilities in a better way and that in turn can enhance their income level too <sup>[6]</sup>. In our country the economic and social structure is so rigidly interlinked that no single formula for poverty for poverty reduction can be evolved.

It has to be an integrated approach enabled to address the social, economic, religious and political factors responsible to cause and perpetrate poverty. In brief, timely access of information and knowledge resources, can change the face of our poor living in rural, isolated and under privileged regions <sup>[7]</sup>.

Thus, to some extent the efficacy of poverty reduction work depends on poor peoples ability to empower themselves, to access information and knowledge resources through which they would be able to analyze the situation, learn necessary skills and participate in equal economic opportunities without changing their geographical boundaries.

### **ICT evolution and its significances**

Due to rapid evolution of micro processor technology, the computer power is being doubled in 18 to 24 months while advances in fibre-optical network technologies, doubling the communication power within 6 months (NUDP-2001a). The technological advances have also drastically reduced the cost of transmitted digital information anywhere in the world and enabling the villagers to gain the benefits of modern ICT.



Since, early 1980's government and non-government agencies are making efforts to generate the awareness about of computers and its potential in rural development. The National Informatics Centre (NIC) was set up and through Computerized Rural Information System Project (CRISP), the NIC and Rural Development Ministry Collaborated to deploy ICTS in each District Rural Development Agencies: DRDA, (Bhatnagar 2000). The emphasis was given for the implementation of ICT, particularly in social sectors, e.g. Education, health and rural development. ICT has established its utility and significant role in poverty alleviation as experimented worldwide by various development agencies:

- The poverty alleviation strategies have been concerned with improvement in the provision of in credit to enhance small and medicals scale business, effective livelihood and product.
- Modern ICT has to offer in meeting the information communication needs of rural communities in respect to marketing, training programmes, empowerment of women and disadvantaged growth, building self-help network and strong gram root participation <sup>[8]</sup>.
- ICT can improve the access to health services, micro credit and government services, providing training and education, create direct employment opportunities and provide support to rural poor in production, storage and marketing of farm and non-farm products by providing demand demand-drivers information and services <sup>[9]</sup>.
- Access to information is the key for building human capabilities. The flow of information and data be available to the people of all clams, carts and regions irrespective of the language they speak for over all property of country and thus, in brief, modern digital ICT has opened up new vistas in the life of poor, rural and disadvantaged and in minimizing rural-urban divide to a minimum.
- In this way, in conclusion, we can say, that technology has dominated all spheres of life. The education and knowledge are the field where, we can see the most influential impact of information technology. Knowledge, education and library are known to be sisters. Over several years, the education process has seen drastic changes in imparting knowledge. Libraries are the effective tools in disseminating knowledge.

### **Social Networking Sites (SNS)**

In this modern era social media enable users to generate interpersonal connections based on common grounds. Social networking sites (SNS)

Friendster, LinkedIn, MySpace, Face book, Twitter, Whatsapp, My Life, You Tube, Wikipedia have been set up personal communities, allow users to make comments on the profiles of their friends and send private messages <sup>[10]</sup>. So Social networking sites SNS are being used regularly by millions of people because of this, the impact of SNS is increased. It is a modern communication channel through which people are connected to share with others experiences, ideas, messages, pictures and information of interest <sup>[11]</sup>. In the modern age social networking sites are boon for the internet users. Many marketing companies, organizations, etc. are using social networking sites to promote their products and services. Social networking sites are web-based services that allow individuals to construct a public or semi-public profile within bounded systems <sup>[12]</sup>.

The social networking is a platform to build social relations or social network among people who like to share activities, backgrounds, interests of real life. According to the computing Dictionary; “Social networking site on any website is designed to allow multiple users to publish contents of them. The information may be on any subject and may be for consumption by friends, mates, employers, employees just to mention a few.

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**Chapter - 5**  
**Yoga and Its Possibilities to Manage Stress**

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# Chapter - 5

## Yoga and Its Possibilities to Manage Stress

Aman Sambyal

### Abstract

Stress may be a state exhibit by a selected syndrome which consists of all non-specifically induced changes within the biological system. Now days, stress becomes the inevitable a part of the citizenry life due to the fast-changing life. Today's world may be a aggressive world and called as world of attainment. So to realize the objectives citizenry can do anything by making their life drastic and routed. They left everything beyond and concentrated only on their attainments. It fabricates tension, stress and anxiety within the lifespan of citizenry and that they become ill, frustrated, physically unfit and socially unattended. It has become criticize of health problem and is entirely executioner in the struggling world. Stress is the most significant peril to this period. Stress is most valuable toxin for human life known to man. It can harass any one's physical, mental, enthusiastic and social equalization. It also can intrusive with the body metabolism, digestion, appetite, sleep, sexuality and even fertility. To deal with these sorts of problems person took the encouragement of Yoga. Yoga contributes various techniques (asana, pranayama, kriya etc) to deal with stress, tension and anxiety. Yoga has both preventive and therapeutic benefits. It has been shown to supply both physical and mental benefits to the body and therefore the mind. How they accommodate to fight with stress, tension and anxiety. Yoga plays a role of medicine to make the body well-balanced physically or mentally and combat stress.

**Keywords:** stress, yoga, yogasana, pranayama

### Introduction

Stress and anxiety are common responses to such extraordinary circumstances. Our stress systems have transformed to reply in highly adaptive ways, thereby empower humans to affect these challenges <sup>[1]</sup>. While many of us are lacking and worried about the current health problems and all of us are struggling to adapt this new reality. Nevertheless, no one can

successfully transform stress and adapt comfortably. The current scenario will affect some more than others. Researcher and clinicians working in the field of stress adaptability have the opportunity to develop a research agenda for examining stress adaptability in the general population and in patient across during this modern global crisis. In addition, they also have the responsibility to share what is already known about stress adaptability and what evidence-based recommendations for stimulate mental adaptability <sup>[2]</sup>. It should be highlighted that distress and anxiety are ordinary reactions to a situation as terrifying and unpredictable. Stress related reactions may comprise changes in attentiveness, irritability, anxiety, insomnia, minimize the productivity, and interpersonal disputes. This may be accurate for the overall population, but especially apply to more directly affected groups (e.g. who provided health care services). The perspective of our daily lives, our potential to travel and interact freely has suddenly been restricted. To assist adaptation to mental health effects, several section of advice are available from the rich adaptability literature. Promoting social linked of the utmost significance as loneliness and social isolation. Moreover, thinking about the routine day to day activities and promoting self-care <sup>[3]</sup>. Also, increased attention should even be paid to the prospective role of exercise and nutrition in promoting adaptability <sup>[4]</sup>. In addition to prolong healthy behaviors, the WHO also instructs taking regular media breaks <sup>[5]</sup>. One of the most reproducible detecting in stress and adaptability research is that the higher the controllability of a stress situation is the better individuals cope with the circumstances. The component regulate this include living conditions, poverty, inexperience, poor approach to healthcare, uncertainty about the long period of time (i.e. risk of unemployment), genetic background, earlier life experiences and social encouragement <sup>[6]</sup>. In order to discard this metal pressure, Yoga plays a significant role to remain stress free and to be mentally stable in this current circumstance.

## **Yoga**

Yoga is a philosophical arrangement of exercise and meditation originated in India, about 2000-4000 years ago <sup>[7]</sup>. It is a traditional method of meditation, elaborated by the saints or rishis of prehistoric India. Yoga is an ancient teaching designed to bring equilibrium and health to the physical, mental, emotional, and spiritual dimensions of the individual. It is prolonged popular practice in India that has become progressively more familiar in Western society. The word Yoga means union of our individual consciousness with the Universal Divine Consciousness during a super conscious state mentioned as Samadhi <sup>[8, 9]</sup>. They practiced yoga as an



valuable method of controlling their mind and physical activities. At that time saints or rishis (wise men) explored nature and the harmonious universe in their meditations. They discovered the laws of the universe and spiritual domain and gained an understanding into the connections within the universe. They investigated the universal laws, the laws of nature and therefore the components, life on earth and therefore the powers and energies at add the universe - both within the outside the world and also on spiritual level. The unification of matter and energy, the creation of the universe and therefore the effects of the elementary powers are illustrate and explained within the Vedas. Much of this detail has been rediscovered and settled by latest science. Yoga in lifestyle could also be a system of doing comprise of eight levels of development within the section of physical, mental, social and spiritual health.

Every single human being is desire to live in harmony with oneself and the flourishing environment. However, in modern world greater physical and emotional demands are continuously placed upon many section of life, which result more and more persons undergoes physical and mental tension such as stress, anxiety, insomnia, and there's an disparity in physical activity. When the body is physically healthy, mined is obvious, focused and stress is in restraint. This gives the expanse to attach with loved ones and carry on with socially healthy relationships. When an individual are in good health, then they are in touch with their inner Self, with others and surroundings on a much immeasurable level, which adds to their spiritual health. However Yoga helps an individual to combative with stress, tension, insomnia and anxiety. There are numerous forms of yoga which vary in specific practices, while maintaining the purpose of regulating the mind and body <sup>[7]</sup>. General elements of the numerous forms include postures (Asanas), which are held for a particular duration of time, controlled breathing exercises (Pranayama) and meditation. Yoga practice has the universal aim of facilitating the growth and combination of the body, mind and breath to produce systemic, physiological and psychological effects <sup>[10]</sup>. Specifically, the occurrence of a strong and adjustable body which is freed from soreness, a balanced autonomic nervous system empower all physiological systems to function optimally and a relaxed, accessible and reposeful mind <sup>[11]</sup>. Systematic practice of yoga can boost discipline, willpower, determination and mind is clearly focused <sup>[12, 13]</sup>. Under these circumstances, yoga can play a essential role to minimize and abolish such problem. Moreover, it develops optimum level of health to lead happy and prosperous life.

## **Types of yoga**

The following points help us to explain it:

- 1) Karma Yoga (yoga of action).
- 2) Jnana Yoga (yoga of knowledge & wisdom).
- 3) Hatha Yoga (yoga of attaining physical & mental purity).
- 4) Raj Yoga (yoga of awakening the psychic awareness & facilities).
- 5) Mantra Yoga (yoga of freeing the mind by utilizing a second vibration).
- 6) Laya Yoga (yoga of conscious dissolution of individuality).
- 7) Bhakti Yoga (yoga of intense devotion).

### **1. Karma yoga**

Karma yoga is one among the main aspects of yoga. It's the primary step and is important so as to know the stage of perfection in yoga. It can be defined as 'action', which everyone performs either consciously or unconsciously. These are physical in nature and performed by everybody. It's the frame of mind with which the actions are performed. The motto of karma yoga is give & give only and not to take any things.

### **2. Jnana yoga**

Jnana yoga is that the yoga of knowledge and wisdom, which mean to get the meditative state. It's the method of meditative awareness and brings us closer to our inner mature or to awaken the intellectual faculty. The aim of Jnana yoga is that the removal of speculative knowledge and to possess experimental knowledge, which taken through one's own understanding and experiences.

### **3. Hatha yoga**

Hatha yoga is commonest aspects of yoga. It comprises the practices of varied asana, mudras, Pranayama and kriyas for the purification of the body and concentration of the mind. It's the way to attain the physical & mental purification and balance. The aim of hatha yoga is to eliminate toxins and impurities from the body that does accumulate due to dietary habits. Once the toxins and impurities are eliminated from the body then it reaches the state of purification, which helps to cause the state of balance within the functioning and performance of the internal organs and systems.

### **4. Raj yoga**

The word raj means 'king', so raj yoga is that the king or royal or higher or supreme yoga. The essential theme of raja yoga is to develop the active

potential within the human personality. It comprises the observance of Yama, Niyama, Asana and Pranayama, Pratyahara, Dharana, Dhyana and Samadhi <sup>[14]</sup>. It has been further divided into two groups as external yoga & inner yoga.

- a) **External yoga:** It's also referred as bahiranga yoga. It consists of Yama, Niyama, Asana and Pranayama. They modify the external personality, behaviour and actions.
- b) **Inner yoga:** It's also referred as antaranga yoga. It includes Pratyahara, Dharana, Dhyana and Samadhi. It's a mental process of observation, analysis, reflection, contemplation, meditation and achievement.

## 5. Mantra yoga

Mantra yoga is also referred as '*Japa Yoga*'. It comprises of chanting of the mantra systematically over 12 years, which gave spiritual powers. It's the force which discharge or release the mind or mental nature from bondage. These impurities create attraction towards royal (rajasic) qualities of life. The royal (rajasic) nature is expressed by the mind in a specific way. The mind is vibrating because it wants to entertain or recreate itself within the absence of entertainment or recreation, the mind would be absolutely quite, still and peaceful. The main aim of mantra is to free the mind from the worldly attraction.

## 6. Laya yoga

The word Laya means 'to dissolve'. In short it is constantly remembering god all the time, while performing daily routines. The techniques of Laya yoga are more meditative in nature. Its aim is awakening of energy centre and deals with the experiences of the psychic or spiritual body.

## 7. Bhakti yoga

Bhakti yoga may be a system of intense devotion with emphasis on faith. The true follower of bhakti is one while is free from guilt, egoism, unaffected by either happiness or sorrow and has not a single enemy. He has faith in innocence, simplicity and truthfulness, so he would be considered a saint.

## A brief introduction of stress and anxiety

Stress has becomes a general thing of human's life in modern world. The current world is known as the world of fulfillment and also called as a

world of stress. It conquers everywhere, whether it's a corporate organisation, endeavour, institution, and any social or economic activity and even it is a family. Right from the birth till death, a human being passes through various stressful situations. Stress is a pattern of physiological, behavioral, emotional, physical and cognitive responses to real or imagined stimuli that are distinguish as blocking a goal or otherwise threatening individual's well-being. It is a common condition, a response to a physical warning or psychological distress, which produces a number of chemical and hormonal reactions within the body. Stress can be understood as the responses of the body which occur in conflicting situations. These situations are distinguished by human being as a threat to her/his physical or emotional well-being. The responses towards these situations take place at the physiological level and the psychological level. At the physiological level, there may be changes in heart rate, pulse rate, blood pressure, excretion of hormones, etc. At the psychological level, there may be changes in attention, concentration, memory and attentiveness and also in the emotional state (like anger, fear, hate, sadness, etc.). Stress generally occurs as a result of vital events in life such as tough competitions, getting low scores in an examination, recent breakup in friendship, not getting a satisfactory job, a fight with others and so on. There are several other factors which may cause stress in a person like diseases, encompasses living conditions, poverty, problems in relationship, challenges of adolescence, wrong habits, high expectation, unrealistic goals, death of close relative, tough competition, discrimination, fast changing life and many more. Intensity of stress differs from person to person and generally depends on perception of the particular situation by that person. A situation may be easy to handle for one person, while it may produce a big challenge to another. Stress may be beneficial as it motivates us to perform better and learn new skills. During severe stress, an individual may become uncomfortable and distressed. Chronic and severe stress reduces our body's ability to fight diseases. It can lead to various psychosomatic diseases such as peptic ulcer, migraine, diabetes mellitus, high blood pressure, etc. It could even end in attack, brain stroke and even death. Several psychological disorders such as anxiety attacks and depression may also result from chronic and severe stress. In essence, the body prepares to fight or flee, pumping more blood to the heart, muscles and shutting down all non-essential functions. As a short-lived state, this reaction serves the body well to defend itself. When the stress reaction is continuing for a long time, however, the normal physical functions that have in response either been exaggerated or shut down become dysfunctional. However, the fact is-we cannot avoid stress. Therefore, management of stress is

mandatory. Yoga has been considered a panacea for stress. Yoga practices once become how life, can play a crucial role in stress management.

Previous researches explain that meditation and other stress-reduction techniques have been studied as possible treatments for depression and anxiety. One such practice, yoga, has received less attention within the medical literature though it has become increasingly popular in recent decades. Available reviews of a good range of yoga practices suggest they will reduce the impact of exaggerated stress responses and should be helpful for both anxiety and depression. Over time, the constant state of stress can lead to elimination of the system and ultimately diseases such as obesity, diabetes, autoimmune disorders, depression, substance abuse, and cardiovascular disease [15, 16]. During this respect, yoga functions like other self-soothing techniques like meditation, relaxation, and exercise. By reducing perceived stress and anxiety, yoga appears to modulate stress response systems. This, successively decreases physiological arousal e.g., reducing the heart rate, lowering vital sign, and easing respiration. There is also evidence that yoga practices help increase pulse variability, an indicator of the body's ability to reply to worry more flexibly. Small but intriguing studies further distinguish the effect of yoga on the stress response. In previous study it showed that yoga practitioner had the excessive pain tolerance and short pain-related brain activity. The study underscores the worth of techniques, like yoga asanas, pranayama, meditation etc which will help an individual regulate their stress and, therefore, pain responses [17, 18]. In some other studies, it has been found that through meditation, stressful individual can accomplish a state of deep psychosomatic relaxation associated with highly significant decrease in oxygen exhaustion within practicing Savitri pranayama (a slow, rhythmic and deep breathing) and Shavasana [19].

The following table represents the different indicator of stress which affects the normal functioning or experienced by an individual during the determined critical situations which are unfavorable. These symptoms are the results of survival stress, internal stress, environmental stress, relationship stress, unusual circumstance, cognitive dissonance, psychological stress, physical stress, financial stress and job stress.

<b>Physical</b>	<b>Psychological</b>	<b>Emotional</b>	<b>Cognitive</b>
Hair loss	Irritability	Enhance smoking	Memory issue
Pain in the Head	Moodiness	Crumbling teeth	Disorientation
Stiffness in neck	Anxiety	Nail biting	Confusion

Backache	Anger	Hair pulling	Slowness of thinking
Facial or jaw pain	Withdrawal from other people	Wrinkling forehead	Slowness of comprehension
Stomach Tidiness	Feeling of insecurity	Enhance alcoholism	Difficulty in calculating
Swollen joints	Loneliness	Enhance drug utilization	Difficulty in decision-making
High blood pressure	Helplessness	Unexpected changes in social habits	Poor concentration
Skin disorder	Sleeplessness	Inclination to accidents	Loss of objectivity
Muscle spasm	Unhappiness	Sleeping disorder	Limited attention span
Lower back pain	Depression	Changes in job performance	Blaming others
Fatigue	Feeling irreversible	Short tempered	Tension
Changes in sexual inclination	Isolation or Loneliness		
Minimize the rate of inflammation	Discouragement or Frustration		
Continuous working	Rapid change in Mood		

### Yoga for stress relief

Yoga is most recognized category of exercise, stretching, aerobic exercise and meditation. The definition of yoga is ‘union or to attain or to join or to bind or harness or to yoke or joint together’ <sup>[20]</sup> it interrelate the brain and body concentrating on balance act, profound breathing, extending and unwinding. Patanjali is father of yoga about 06 century B.C. appeared within the great epic The Mahabharata written by sage Vyas and containing The Bhagavad Gita. Krishna explains to Arjuna about the spirit of Yoga as practiced in everyday lives (‘Song of the Lord’), uses the term ‘yoga’ extensively during a sort of ways. Yoga developed from of the Hindu, Jaina, and Buddhist stern customs in India. Yoga is an ancient craftsmanship that is characterized as the association of the spirit with God <sup>[21]</sup>. It’s a way of individual otherworldly improvement that uses reflection to bring enlightenment, self-acknowledgment and at last the achievement of God and happiness. Gradually, a definitive objective of yoga was called Samadhi, or self-acknowledgment <sup>[22]</sup>.

Yoga modify stress response and individual's aspect, towards worry alongside developing self-assurance, enlarge one's feeling of prosperity, and

making a sentiment of unwinding and smoothness <sup>[23]</sup>. Yoga, which is a way of life, is characterized by balance, health, consonance, and pleasure. Meditation, being part of yoga, which is the 07<sup>th</sup> limb of Ashtanga Yoga a state of alert rest as developed by Maharishi Mahesh Yogi, who founded a new technique of meditation, commonly known as transcendental meditation. By practicing yoga, an individual is meant to succeed in a state of mental equanimity, where responses to favorable or unfavorable external events are well under the individual's supremacy, and responses are moderate in intensity. Regular practices of yoga build lucidity and coolness, enhance body awareness, relive stress patterns, relax the minds and acuminate concentration <sup>[24]</sup>. The science of yoga may be a powerful course of knowledge, which facilitates the practitioners to achieve illuminated physical health, serene mind, continues spiritual uplift, and fabricates the ability for harmonious social living. Yoga has both preventive and therapeutic benefits. It has been shown to supply both physical and mental benefits to the body and therefore the mind. The many physical benefits of yoga are it enhance flexibility and muscle joint mobility, strengthens, tones, and builds muscles, rectify body posture, strengthens the spine, reduce back pain, improves muscular-skeletal conditions such as imperfect knees, tight shoulders and neck, swayback and scoliosis, increases endurance, creates balance, smoothness and agility, stimulates the glands of the endocrine system, improves digestion and proper elimination, increases circulation, improves heart conditions, improves breathing disorders, enhance immune response, decreases cholesterol and blood sugar levels and assist weight loss. The mental benefits comprise, it increases body awareness, relieves chronic stress patterns within the body, refreshes the body by relieving muscle strain, modify the mind and body, centers attention, acuminate concentration, and liberate the spirit. Western doctors and scientists are discovering additional health benefits of yoga. Yoga through its techniques of meditation, asanas, and pranayama yields a positive effect within the controlling of stress in teenager. The processing of sensory information is accelerating during the practice of Pranayama and meditation. This improvement was believed to flow from to improved eye-hand coordination, attention, concentration, and relaxation.

### **Asanas (Postures)**

Asana means slow stretching activities performed to enhance the entire body fitness. It means holding the body during a particular posture to bring stability to the body and mind. In short, it consists of physical posture and movement to release tension, remove toxins and prepare the mind for

meditation. These are performed to stay the body flexible, agile, and young. It also enhances the sweetness of the body by reducing inappropriate accumulation of fat within the body. Asana are often performed from young age to adulthood without any problem. There are 84 lakh of various Yoga Asanas <sup>[25]</sup> which helps individual to relate with physical and psychological state also as meditative poses. Practice of asanas is required to urge out of stress, tension and anxiety which ultimately make the body exceptionally strong and relaxed. They're trained in supine and prone position of the body respectively.

### 1. Padmasana (Lotus pose)

Padmasana acquires its name, while performing it resembles a lotus. It is also known as kamalasana. It's a cross-legged yoga posture which helps deepen meditation by calming the mind and alleviating various physical ailments. It regulate physical and mental condition with the increasing the immediate sense of well-being and concentration <sup>[26]</sup>. It is best method among all asana for meditation and for reciting mantras.

**Benefits:** Padmasana is one among the foremost relaxing poses. This asana is beneficial for Japa, Pranayama, Dharana, Dhyana and Samadhi. It improves digestion, reduces muscular tension, blood pressure under control, relax mind and helps in improvement of immunity. It gives blood supply to the pelvic region, which helps pregnant ladies during childbirth and also reduces menstrual discomfort.

### 2. Makarasana (Crocodile pose)

This is taken from Sanskrit root Makar, which means crocodile, by doing this asana the body resembles a crocodile. It is a yogic pose useful for relaxation of back and shoulder.

**Benefits:** This asana is practiced for relief in all prone postures or it can be reassurance method. It gives deep relief to the shoulders, spine, lower back and all orthopedic ailments. It is very helpful in slip disc, cervical and sciatica. It is also beneficial in counter the stress and anxiety.

### 3. Shavasana (Yog-Nidra)

Its name comes from Sanskrit root Shava means corpse or dead body. This asana is also known as death pose or mrituasana or Yog Nidra. This asana is especially useful for meditation and Japa. The practice of this asana focuses at releasing the mind from the body. In this current scenario, it has been accepted as a remedy for psychosomatic diseases.



**Benefits:** It is found very helpful in controlling of stress and its consequences, beneficial to relieves all kinds of tensions and gives rest to both body and mind. It gives relaxes the entire psycho-physiological system and also relief from mental stress and strain. This asana helps to cure high or low blood pressure, improves digestion, manage blood circulation and mind feels refreshing after a prolonged illness.

#### 4. Vajrasana (Pelvic pose)

Vajra signify Diamond in Sanskrit so this yoga posture has been named after the shape it takes, that of a diamond or thunderbolt. Vajrasana is finest asana for relieving Stress, Tension and Anxiety. It forms the body especially strong and healthy. Relax before, during and after the yoga pose.

**Benefits:** It helps in enhances blood circulation in the lower abdomen, boost digestion. This asana cures acidity, cure constipation, relieves excessive gas trouble, food gets digested well, reduce pain in stomach when one sits in vajrasana after taking meal. It also helps in strengthened the nerves of legs & thighs, makes knee & ankle joints flexible and prevents certain rheumatic diseases. In Vajrasana spine is erect without much effort. It is beneficial for practice of pranayam and also known as meditative asana. It helps in keeping the mind stable.

#### 5. Trikonasana (Triangle pose)

Tikona is made from two separate words in which the word 'tri' means three and word 'Kona' means an angle or triangle. So it resembles three arms triangle made by the trunk and limbs, it has also been names as Triangle Pose. This asana requires keeping eyes open while doing it to sustain the balance. This yoga pose requires holding it for 30 seconds. It is best to do the asana in the morning as are energized and the food is digested completely.

**Benefits:** Trikonasana improves the blood flow in body. It cures indigestion, cure high or low blood pressure, and increases concentration and balance. It calms mind and takes the stress away. Trikonasana burns fat and reduces obesity.

#### 6. Bhujangasana (Cobra pose)

In this asana the body is raised like hood of a snake, so this is also known as snake or cobra pose. In Sanskrit roots, snake is also the symbol of energy. This is helpful in awakening the kundalini or serpent power or latent energy.

**Benefits:** Bhujangasana is finest asana for stress management. It stimulates digestive system and regulates metabolism, thus help in reduces

abdominal fat, control weight, removes gases, relieves constipation and improves digestion. It also helps in removing cervical spondylitis, slip disc and all other spinal disorders. It increases flexibility, elevates mood, aids kidney function and keeps fatigue away.

### 7. Halasana (Plough pose)

The shape of this posture resembles a plough, so it is known as plough pose. This asana enhances the fertility and vitality of the whole body. It provides stability and concentration, which provides the sense of well-being.

**Benefits:** This asana is good for people with a tendency for high blood pressure. It stimulates blood circulation, prevents constipation, develops the abdominal muscles and maintains the elasticity of the spinal columns.

### 8. Sarvangasana (Shoulder stand)

It is derived from the Sanskrit word sarvanga, which means all, whole, entire, complete and anga means limb or body, so its combined meaning is entire body or all the limbs. It is also called as shoulder stand.

**Benefits:** This asana diverts the flow of blood into the thyroid glands and stimulates the parathyroid glands and normalizes their functions. It strengthens the arms and shoulders and keeps the spine flexible, nourishing the brain with more supply of blood. It stretches the heart muscles by returning more venous blood to the heart. It also tones up the functioning of kidney, lungs, stimulates gastric juices and relieves constipation or indigestion.

### 9. Vrikshasana (Tree pose)

It resembles the shape of a tree, so it is called as Tree Pose. It represents the stable and balanced stance of a tree. It is one of the best asanas for beginners, which helps in balancing on each leg.

**Benefits:** Vrikshasana improves nerve-muscle coordination, balance, endurance and alertness. It improves mental capabilities and keeps stable. It invigorates the entire body by stretching it, increases stamina and keeps focused. It boosts self-confidence and relaxes the nervous system.

### 10. Tadasana (Mountain pose)

Tada means palm tree or mountain Pose. It is a base pose from which all the other asanas emerge. Therefore, it's rightly called the 'mother' of all yoga poses. This asana teaches one to attain stability and firmness and forms the bottom for all the standing asanas.

**Benefits:** Tadasana helps restore balance and increase height up to a certain age. It steadies breathing, increases awareness, relieves tension, and

improves blood circulation. It increases energy and harmonizes body and mind.

## 11. Surya namaskar (Sun salutation)

It is a yoga exercise, which incorporating a sequence of 12 powerful yoga asanas, which is possible to perform at sunrise <sup>[27, 28]</sup>. It is also known as salute of sun in Sanskrit language <sup>[27, 28]</sup>. It reactivates all the body parts and enables regulation of hormonal secretions of all the internal glands.

**Benefits:** Sun Salutations is a complete type of exercise for whole body fitness. It provides a good cardiovascular workout, stretch every part of the body and makes stomach, intestines, heart and lungs healthy, when used with breath coordinate the body with the mind. Even more impressively, these sequences improve the spinal cord and waist flexibility, which takes the spine through almost every possible range of motion. These postures can be used as a warm-up routine or warm-up exercise.

## Pranayam (Yogic breathe)

The word Pranayama is taken from two Sanskrit words '*Pran*' means vital force or life or breath and word '*Ayama*' means the control of Prana. So it means the control of the vital force by concentration and regulated breathing. In short, the control of Prana through the concentration of thought and regular breathing is known as Pranayama. This is a systematic and rhythmic control of breathing performed to improve the internal functioning of the whole body. Pranayama has three phases as

- a) **Puraka:** Inhalation of air into the lungs.
- b) **Rechaka:** Exhalation of air from lungs.
- c) **Kumbhaka:** In a particular posture, the holding of breath is done. During this no exhalation and inhalation is done.

There are different types of Pranayama, which helps individual to inspire, motivate, regulate and balance the vital force in the whole body. Pranayama is essential for the purification of mind and strengthen the nervous system. It also helps in relieving stress, decreasing anxiety, increasing feeling of emotional, social and spiritual well-being <sup>[29, 30, 31, 32, 33]</sup>. It is clarity, steadiness and one-pointedness of the mind <sup>[34]</sup>.

## 1. Bhramari pranayama

It is derived from bhramara which means a black bee. While performing this Pranayama, the sound which is produced is resembles the buzzing of a bee. The sound vibration is heard and felt more distinctly in the brain. The humming sound should be smooth and in a controlled manner.

**Benefits:** It relieves stress and helps in alleviating anxiety, anger and hyperactivity. The resonance effect of humming sound creates a smoothing effect on the mind and the nervous system. Moreover, it is also useful in making concentration and meditation.

## 2. Anulom-Vilom pranayam/Nadi Shodhan pranayam

In this Pranayama, the main feature is alternate breathing through the left and right nostrils without or with possession of breath. The Nadi Shodhan pranayama may be a breathing technique that helps out clears the blocked energy channels, thus tranquil and quiet the mind. This technique is additionally referred to as Anulom Vilom pranayama. Nadi Shodhan pranayama helps relax the mind and prepares it to enter a meditative state. It interpreted as a reduction in concerned nervous system activity <sup>[35]</sup>. Practicing it for just a few minutes every day helps keep the mind calm, happy and peaceful. It helps in releasing accumulated tension and fatigue.

**Benefits:** It exerts the therapeutically for circulatory and respiratory problems. It is excellent breathing technique to let out the accumulated stress, calm and relax the mind. It helps harmonize the left and right halves of the brain, which correlate to the logical and emotional sides of our temperament. Helps purify and balance the Nadis-the subtle energy channels, thereby make sure the smooth flow of prana (life force) through the body. It also maintains the body temperature and helps in enhancing immunity.

## 3. Sheetal pranayama

The word sheetal means cool, the practice of sheetal Pranayama has a cooling effect on the entire system of body and mind. Sitali is additionally called tongue hissing due to the sound produced when rehearse it. The tongue is curled into a tube and through inhalation the air passes over the moist tongue, cooling down and refreshing the throat. In this Pranayama the tongue curls out and breathes with a sibilant sound of Si-Si-Si.

**Benefits:** It resonates the heart and activates the respiratory system. It eliminates the cough accumulated in the wind pipe and corrective asthma. The constant practice of this Pranayama, strengthens the nervous system, mind becomes calm, capable of concentration and rouses spiritual power.

## 4. Kapalabhati

Kapalabhati is a category of breathing exercise, which encourage overall well-being and good health. The word kapalabhati is withdraw from the root of Sanskrit words, in which word kapala means skull or forehead and word

bhati means shining or illuminating <sup>[36]</sup>. It means one, who provides luster to the forehead. This technique is alike to the Bhastrika Pranayam and practice alike to the Jala Neti.

**Benefits:** This exercise is the purifier of forehead, which helps in improving concentration and memory. It de stress, prevents depression and brightens or boosts the mind. It can cure asthma, wheezing, sinusitis, heartburn, acidity and improves digestive system including liver, intestines, pancreas etc.

## 5. Deep breathing

Deep Breathing should lengthen the years that an individual can live and make happier, more productive and energetic life style too. Breathing deeply may be well-known stress reliever and features a multitude of health benefits also. However, in stressful life an individual often breathe very shallowly most of the time, but with a little effort. Deep breathing can become an easy and unconscious part of our everyday life. By making a conscious decision to pivot on our breath for a part of each day, one should regularly breathe deeper without having to think about it at all.

**Benefits:** Deep Breathing makes calmer, stress free and relax the mind. It helps to detoxify the body and reduce pain. It helps to improve posture, simulates the lymphatic system and enlarges our cardiovascular capacity. Deep Breathing gives energy and strengthens the major organs of the body and on the whole helps to regulate weight.

## 6. Omkar/om chanting

Omkar is act as continuous contemplation and clears the barricade from mind. It is a sound that can remind of that state of feeling. While shouting the word Om, the mind turns entirely and absorbed the practitioner remain undisturbed by the external world or environment. The sound Om reminds of the Lord of the Creation. Then the understanding of soul, the Self happens, and there will be an absence of barricade, that is, barricade in path will vanish.

While performing the shouting of Om, the feeling of elevation, totality of consciousness comes to then witness consciousness dawns in and mind gets completely change. Clarity begins in thinking and feeling. The whole body undergoes a change as so alive, so filled with prana, and the entire barricade in path are removed. Just the memory of Lordship, of the Divine can remove barricade from mind. This is the beauty of omkar.

## Conclusion

From the above discussion, it has been concluded that yoga are the foremost popular and recognized techniques used by an individual to cope or deal with stress, tension and anxiety. Yoga has joined arrangement of standards and activities which will significantly help to affect stress and anxiety. Yoga may be a holistic practice which strengthens our body physically also as mentally. Since the prehistoric time, yoga has been used as a holistic relaxation practice which is effective against hypertension, obesity, anxiety, insomnia and aging. Yoga and meditation are the magnificent factors to measure a healthy life and it is not a substitute to medicines but rather a precautionary measure to keep diseases away. The general public interest towards yoga and meditation is increasing day by day due to their positive effects in mental and physical health. The ultimate aim and goals of yogic sciences is not only to attend optimum physical and psychological state but also to raise the extent of unconsciousness of an individual. The pathway of mechanism is extremely much crystal clear that it understands and nourishes the body and mind simultaneously. A healthy life is often smartly achieved if an individual can grasp to adopt regular practice of yoga and meditation. It combines various techniques to get rid of stress, enhance concentration, relaxed mind, bring down the pain, relive tension, body posture, self-worth, mental calmness and enhance feeling of overall wellness and well-being of an individual. As a result, the body's protection mechanism also improves in such a condition. If all the systems of body work correctly and remain healthy there will be no rise of any disease and it will boost immunity. So, let's not wait this time for the health issues to come knocking at our door but rather beat it with ease. In this way we can peruse the Yoga i.e. Asanas and Pranayam in our daily routine for healthy lifestyle. The available evidence suggests that yoga practice is safe and may bring many health benefits to practitioners, whether help them to manage illness and other chronic condition.

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**Chapter - 6**  
**What Lies Ahead? A Study of Kim Stanley**  
**Robinson's the Ministry for the Future for**  
**Exploring the Anthropocene Elements**

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# Chapter - 6

## What Lies Ahead? A Study of Kim Stanley Robinson's the Ministry for the Future for Exploring the Anthropocene

### Elements

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#### Abstract

The article endeavors to explore and explicate the Anthropocene elements in Kim Stanley Robinson's *The Ministry for the Future* (2020). This highly ambitious systems novel of Robinson presents a highly ambitious portrayal of the dangers that our world is facing today from uncontrolled environmental degradation, global warming, rising sea-levels, unsustainable development, excessive carbon emission, an ever-widening gap between the haves and have-nots-the combined powers of which seeks to redefine the very scope and breadth of what novel can be. The 106 chapters of the novel abound in descriptions and commentaries on actual sciences like atmospheric and oceanic sciences, a heatwave in India decimating 20,000,000 people in a week, portrayal of daunting geo-engineering projects like pumping water out from under the ice caps to prevent these caps from sliding into the ocean and thus raising sea levels, dyeing the Arctic Ocean yellow to prevent it from absorbing sunlight, operations conducted by shadowy eco-terrorist networks, deliberately bringing down airliners to jeopardize commercial air travel, commentaries on various aspects of blockchain technology, carbon taxes, quantitative easing, some stand-alone stories and testimonies of characters who either suffered the wrath of mother nature or endured slave-like conditions under some exploitative, corporate power, and even some episodes of dark comic relief where anonymous characters engage in lengthy dialogues, etc. to name a few. The article finally wants to draw attention to the way Robinson has drawn parallels between the exploitation of the environment and exploitation of the hapless and poor by the greedy, capitalistic powers and advocates sustainable development as the only way out of this evil cycle of greed, corruption, and exploitation, that thrives on the destruction of nature and humanity alike.

**Keywords:** ecosophy, Anthropocene, climate fiction, Kim Stanley Robinson, eco-fiction, ecocriticism, speculative fiction

## Introduction

Kim Stanley Robinson's *The Ministry for the Future* presents before us a picture of a world in the 2030s during when in 2023, a heatwave sweeps across the Indian state of Lucknow to kill millions of people, and in 2025 the eponymous governmental organization is formed headed by Mary Murphy. The story takes place over the course of the next 20 years since the 2023 event took place, and traces the paths of Mary Murphy and the sole survivor of the heatwave, Frank May.

J.R. Burgmann, in his review of the novel for Australian Book Review, describes the setting of the novel thus: "Set just a few years from now and spanning multiple decades, *The Ministry for the Future* recounts the rise of the eponymous ministry, established in Zurich in 2025 to work with the IPCC, the United Nations, and all governments signatory to the Paris Agreement" (J.R. Burgmann). The action of the novel mostly takes place around the 2030s, and situation described here seems to be an extension of the situation of our present-day world when we are struggling with the problems of global warming, rising sea temperatures, melting of Arctic ice caps, etc. to name a few. Although the present novel under discussion is confined very much to our own home planet, Robinson has explored vast stretches of space and ventured into depths of time in many of his past works. In the 'Three Californias' trilogy comprising of *The Wild Shore*, *The Gold Coast*, and *Pacific Edge*, he has explored the saga of Orange County, California in an alternative future 21st century, while in the 'Mars Trilogy' comprising of *Red Mars*, *Green Mars*, and *Blue Mars*, he deals with the settlement of the human colonies in the planet Mars over the course of two centuries. In the novel *2312*, he expands his vision from the confines of Mars to the solar system, while in *Aurora*, he moves even further to other star systems. His *New York 2140* imagines the future New York City inundated as a result of two major surges.

Since this study will attempt to explicate the elements of good and bad Anthropocene from a primarily ecosophical point of view, we should first familiarize ourselves with these two very important concepts. The term Anthropocene was coined by the Nobel laureate chemist Paul Crutzen (Crutzen & Ramanathan 2000; Falkowski *et al.* 2000) and has since then become highly popular. In short, it envisages the dawn of an era where humans have collectively become a geologically influential force. Now, the

term ‘ecosophy’ was first coined by Felix Guattari in his article “For an Overhaul of Social Practices” that appeared in *Le Monde Diplomatique* (Oct. 1992). Here, he stresses the need for founding the principle of ecosophy “that would link environmental ecology to social ecology and to mental ecology” (266). Later, this term was expanded by Gregory Bateson in his *Steps to an Ecology of Mind*, and then by Arne Naess. For Naess, ecosophy is simply “a philosophy of ecological harmony or equilibrium” (*The Deep Ecology Movement* 8).

## **Anthropocene and its discontents**

### **i) Extinction and the Anthropocene**

One of the primary points of focus for the novel is to describe as vividly as possible the dangers that the current rate of accelerated mass extinction poses for our future generation. The novel in its attempt to detail the dangers of extinction events in a most directed, clear-sighted, and fiercest manner possible, incorporates an enormous wealth of statistical information and data gleaned from various sources that seem to lend the narrative a scholarly edge. However, even while attempting to describe through raw details and meticulously culled stats the effects of climate change on our life and planetary ecosystem as a whole, the work never loses sight of its primary aim which is to keep the narrative as much connected to the real, human interests and making it as less abstract as possible.

It is now universally acknowledged in the scientific community that the actions of humans are causing irreparable damages to the biodiversity of the planet and the global climate also. Researchers like Dr. Steffen *et al.* (2007) have already pointed out the fact that we have already entered the Anthropocene epoch where the changes that our actions are causing seem to be leaving an indelible footprint on the geological history of the planet. The enormity of the impact is such that even if we adopt some of the most stringent measures for de-carbonizing and limit the emission of greenhouse gases, as much as 18% of the presently endangered species will be lost by 2050 (Thomas *et al.* 2004). This is why the novel also exhorts us to not become complacent with the decrease in daily global CO<sub>2</sub> emissions in 2020, compared with its mean 2019 levels. Also, in case we fail to curb our present levels of pollution, a situation might arise where as many as 35% of the presently endangered species could go extinct by 2050 (Peterson *et al.* 2004). Ceballos *et al.* (2015) also show how humans have induced a global loss of biodiversity, while Newbold *et al.* (2016) carefully explore the impact that such a loss of biodiversity can have on global sustainability. Robinson’s novel is based to a great extent on this picture of bad

Anthropocene and he masterfully keeps switching between the description of the Anthropocene mass extinction as a geologically significant event and its actual effects on the scale of individual nations and continents. McKenzie Wark, in his *Molecular Red: Theory for the Anthropocene* (2015) applies the term ‘metabolic rift’ to the Anthropocene extinction since according to him, the Anthropocene represents a kind of break or rift in the system of flows where some of the elements which once went into making the flow possible are no longer replenished by the output thus making it impossible for the cycle to renew itself (xiv).

The novel extensively employs a rich assortment of carefully analyzed facts and well-researched data to strengthen its vision of the Anthropocenic mass extinction event. The age of Holocene or the Anthropocene as we have termed it is one where we, the humans have become geologically significant enough to influence the climate on a planetary scale and we have used this opportunity to only accelerate the pace at which the species are disappearing as a result of our mindless depredation and exploitation of the natural resources. The novel makes it clear time and again that what we, the humans, as the first sentient species on Earth have achieved has only ushered in an era of unprecedented bio-geological catastrophe. The novel describes, “The current rate of extinctions compared to the geological norm is now several thousandfold faster, making this the sixth great mass extinction event in Earth’s history and thus the start of the Anthropocene in its clearest demarcation, which is to say, we are in a biosphere catastrophe that will be obvious in the fossil record for as long as the Earth lasts. Also the mass extinction is one of the most obvious examples of things done by humans that cannot be undone, despite all the experimental de-extinction efforts, and the general robustness of life on Earth” (*The Ministry for the Future* 54-55). It also comments on the intricate interrelationship between the phenomena of ocean acidification and de-oxygenation, in which an increase in one is bound to cause a concomitant increase in another. In his ‘Science in the Capital’ trilogy, we find mention of oceanic acidification as one of the most persisting problems that is threatening the oceanic ecosystem. Also, the present novel keeps adding bits of statistics and data to help us visualize in numerical terms, the extreme precariousness of our situation, which however never seems to pose any barrier towards our enjoyment of the aesthetics of narrative flow. The novel keeps us thoroughly informed with such facts such as “already more of the sun’s energy stays in the Earth system than leaves it by about 0.7 of a watt per square meter of the Earth’s surface,” and this is contributing towards an inexorable rise in global average temperature (*The Ministry for the Future* 41).



Robinson, for a significant part of the narrative, appears to be concerned with depicting the magnitude of the extinction event on a global, geological scale which prompts us to view the effects of the Anthropocene from a god's eye perspective. It pits our age of extinction against the other geological ages like the Permian to emphasize how "in terms of total percentage of species gone from the land", our age seems to be the record-setter. It also warns us of the aftermaths of an actual extinction event when "famine, dislocation, and war-possibly nuclear war" (*The Ministry for the Future* 309) could take place thus leading to the demise of our entire civilization. In the novel *2312*, we get to see such a dire vision of the future Earth which has been wrecked with the aftermaths of centuries-long climate change, and it is presented in stark contrast to the techno-utopian realm of the 'spacers'. In the Earth of *2312*, we see how man's inability to reverse the degradation of climate has led to the problems of overpopulation, ecological catastrophes, extreme political instabilities, and unrest, thus forcing the wealthier section of the human population to flee their home planet and reside in the asteroids and moons of Jupiter. These eco-catastrophes remind one of Latour's idea of 'revenge of Gaia' ("An Attempt at a Compositionist Manifesto" 473), where he envisages the environmental problems happening on Earth as reactions from an otherwise stable Gaia.

Also, phrases and expressions such as "irreversible and unfixable catastrophe" (310), climate impacts becoming irreversible (185), Earth moving further beyond "an irreversible tipping point" (159), the world getting irrevocably pushed into "jungle planet" mode (341) abound in the novel, all of which put an extra emphasis on the irreversibility of the damage. In its portrayal of the vision of a future troubled by global warming, rising sea temperatures, and melting ice caps in the polar regions, the novel strikes us as an unparalleled work of climate fiction. As a work of pure speculative fiction, the primary concern of the novel is with the future. Naturally, we come across such a vision of an imagined future when "The Arctic Ocean's ice cover melted entirely away in the late summer of 2032, and the winter sea ice that formed in the following winter was less than a meter thick, and broken up by winds and currents into jumbled islands of pancake ice..." (*The Ministry for the Future* 159). It imagines how the sea level would rise by 110 meters than what it is at present as the global temperature will continue to soar beyond 5 or 6 degree Celsius and probably even more thus "rendering great stretches of the Earth uninhabitable by humans" (*The Ministry for the Future* 160). However, it never loses hope even when the picture of such a bleak, barren and post-mass-extinction future is presented. It states how the efforts are underway to "thicken the

Arctic sea ice in winter, which would allow it to hold on longer through the summers” (160).

Time and again, the novel makes its comparison between man’s economic exploitation and depredation of the poor and the same committed on his environment. The inequality in the level of per capita income is one of the most pressing problems that the present age has to address before any progress can be made in terms of human welfare. It presents irrefutable statistics and data to bolster its point-of-view: “The four billion poorest people alive have less wealth than the richest ten people on the planet...” (*The Ministry for the Future* 167). Even when the work focuses primarily on the extinction events, it never fails to connect it with the sufferings of the millions of poor. It describes the problem of the “tragedy of the time horizon” (184, 185), which is based on the assumption that people cannot imagine and successfully relate themselves to the sufferings of the people in the future. It stresses that unless we grow considerate enough of the dangers waiting for us in the future, we should not be able to redress the ecological damages that are being done at present, which as time passes will only become even more irreparable than before: “...many of the worst climate impacts will be irreversible. Extinctions and ocean warming can’t be fixed no matter how much money future people have, so economics as practiced misses a fundamental aspect of reality” (*The Ministry for the Future* 185). Wark, in his *Molecular Red: Theory for the Anthropocene* remarks, “The unspeakable secret about climate change is that nobody really wants to think about it for too long. It’s just too depressing!” (xvi). Robinson never fails to connect the planetary dimension of the catastrophes it is describing with the individual dimension. The novel advocates the need of connecting the scientific and economic practices to ideology and reality of the actual world and points out that the lack of connection with the reality or concern for the wellbeing of the fellow human beings is one of the major drawbacks of our current phase of mostly unsustainable progress. As part of its series of suggestions for realizing the vision of a sustainable future, the novel calls for an alternative economy chiefly aimed at decarbonizing the world: “If we don’t fund a rapid carbon drawdown, if we don’t take the immense amount of capital that flows around the world looking for the highest rate of return and redirect it into decarbonizing work, civilization could crash” (*The Ministry for the Future* 200).

The work does not content itself with the mere presentation of the big picture of a steadily deteriorating planet, rather it also imagines specific situations where the catastrophes have already occurred and strives to

portray them in vivid details. The very first chapter of the novel starts with the description of the fierce power of the Sun and shows how the several days' long heatwave is wreaking untold havoc on the hapless people of the Indian town of Lucknow. It specifically deals with the story of the survival of one Frank May, who is the only other human protagonist besides Mary Murphy who seems to have any significant role in the narrative. The novel describes the rise of the Sun in the days when the heatwave begins thus: "And then the sun cracked the eastern horizon. It blazed like an atomic bomb..." (*The Ministry for the Future* 11). Robinson has on many occasions pointed out the danger that countries like India stand to face in the wake of rising global temperature and this colossal heatwave seems to be the fulfillment of the prophecy in his fictional world which is never removed quite far from reality. The holocaust-like heatwave unleashed by the Sun reads like the Sun's revenge against what Margulis terms as "the arrogant habitat-holocaust" (*Dazzle Gradually: Reflections on the Nature of Nature* 86) of the humans. The first chapter is full of harrowing descriptions of the blazing power of the Sun as it describes the helplessness of puny human beings when caught in the fury of an astronomical object. Robinson, in one of his interviews (2019) has remarked that "the things we can do are minuscule on the scale of planetary energy flows" (Robinson), and the description of the haplessness of the people in the wake of such an ecocatastrophe seems to illustrate the point perfectly. Ursula Heise has commented in her *Sense of Place and Sense of Planet* (2008), that both literature and criticism have found it difficult to address the problem of climate change appropriately by carefully maintaining a balance between an engagement with the cultural frameworks of our time, and the impact of the planetary systems, and in case of Anthropocene, the task becomes even harder since no novelist can hope to project a speculative yet credible picture of the environmental conditions of this Anthropocene since Earth has not undergone such a stage even in the last few million years. However, Robinson's *The Ministry for the Future* seems to have accepted the challenge and passed the test with flying colors.

When the novel describes the damage that an infuriated nature can inflict on the humans, the humans are portrayed as utterly helpless, and tiny creatures totally detached from the godlike power of an indifferent nature, but when it comes to bringing change into the world, the natural world and human beings are presented as extremely and intimately interrelated. The first chapter depicts the magnitude of the heatwave sweeping across Lucknow through various comparisons. Even when people in the open seek to move into the shades, just being touched with the "sunlight was like

getting pushed toward a bonfire” (14), the surfaces of metal objects literally burn in the sun as one could see “heat waves bouncing over them like air over a barbecue” (14), and everything, living and dead, is scorched in the heat of the Sun as the entire town turns into a morgue. Even when breathing, one can only smell the steamy, scorched air entering one’s nostrils. The only comparison that comes to Frank’s mind is based on the picture of what he once read which stated that if the Earth captures all the energy radiated by the Sun and does not reflect any of it, all the oceans would burn and boil, and here, “he could well imagine what that would be like” (*The Ministry for the Future* 22). This heatwave catastrophe is but one among many other environmental disasters to follow, and as the novel makes it clear, it is the direct result of the anthropogenic environmental pollution.

When the novel describes the global repercussions of the worsening climatic conditions, it carefully builds its picture based on the well-researched data from our present-day world, and so the world it imagines becomes a world very much recognizable to us. Robinson has viewed science fiction as “the literary realism of our time” (“Science, Justice, Science Fiction” 5), and as such, it is no wonder that his world-building would attempt to connect itself most thoroughly with the experiences of the readers at present. The novel predicts that the next victim of the heatwave will be Europe and it is based on the currently available data which shows that in the span of 15 years Europe has seen the five hottest summers in the last 500 years. Also, in the 2003 heatwave, as many as 70,000 Europeans were killed while in the 2010 heatwave, some 56,000 Russians were killed. The novel always takes care to connect the description of the effects of climate change taking place on a global scale with the experiences of the individual. This is quite in keeping with the spirit of the ecosophy which prompts one to adopt a holistic, integrated, and universal outlook towards the world and all its entities in general. The novel predicts that with the rising temperatures, as the ice keeps melting and permafrost thaws, very soon, there will be only rivers and no roads for the Siberians to walk on for the greater part of the year. When Tatiana Voznesenskaya, the fictional head of the ministry’s legal division, speaks of the need for “a new religion! Some kind of Earth religion, everyone family, universal brotherhood” (49), it clearly calls for an appreciation of the world from an ecosophical point of view.

The novel deals with the events taking place in and around the 2030s and it states, “The thirties were zombie years. Civilization had been killed but it kept walking the Earth, staggering toward some fate even worse than

death” (*The Ministry for the Future* 241). The Indian heatwave that killed twenty million people in the opening chapter is now compared to such events as the Holocaust that killed six million people, the Palestinians’ Nakba, and the traumatic partition event of India, etc. It has also been compared to the purposeful killings of soldiers during World War One which took place across four years. The human inaction and callousness towards the human life, in general, have been marked as the primary agents behind the heatwave catastrophe: “Not a pathogen, not genocide, not a war; simply human action and inaction, their own action and inaction, killing the most vulnerable” (*The Ministry for the Future* 242).

The author, by presenting a most ferocious and powerful picture of the near future, constructs a fictional ‘novum’ by employing the technique of cognitive estrangement. Commenting on the psychological impact of the cognitive estrangement effect, Robinson remarks, that the power of estrangement effect lies “in pulling readers momentarily out of their ordinary world views” and giving “them the chance to see things anew” (Robinson, “Notes for an Essay on Cecelia Holland”, 60). Its depiction of the ecological and geological catastrophes is vivid, violent, and moving and serves both as warnings to our generation, as well as reminders for an urgent change. As Adele Elia, a French glaciologist in the novel, attempts to foresee the impact of the massive Antarctic glacial basins as these continue to deposit thousands of kilometers of ice sheets into the sea, she describes how it means “Doom for all coastal cities, beaches, marshes, coral reefs, many fisheries. Would displace ten percent of the world’s population, disrupt twenty percent food supply. Like a knock-out punch to dazed fighter. Civilization kaputt” (*The Ministry for the Future* 66). In fact, among the two major pulses that inundated New York City in his novel *New York 2140*, the first pulse was caused by the collapse of the Antarctic and Greenland ice sheet in the 2050s, as a result of which the global sea-level rose by 10 feet. The Second Pulse was caused by the melting of the Aurora Basin in Antarctica which then triggered a worldwide chain of ice sheet collapses and a consequent rising of the sea-level by 40 feet. This is how the melting of the ice sheets in the glaciers has been depicted as delivering a civilization-scale knock-out blow to mankind in *New York 2140*.

## ii) **The nexus of capitalism, ideology, politics and hegemony**

“But act they must. Because civilization was trembling on the brink. They were going down”, writes Robinson in *The Ministry for the Future* (306).

The novel simply does not content itself with employing mere statistics for portraying a most believable and near-apocalyptic picture of the near future, rather it goes beyond the appearance to the analysis of the actual dynamics that makes the existence of such power structures possible that keep on preying on the poor, hapless and unwitting populace and the natural environment through their inhuman, unsustainable and discriminatory practices. It imagines capitalism as a patient waiting on his deathbed for the end; sees science sans ideology as a mere perversion, and warns that all our attempts to structure, systematize, categorize and regulate our phases of history and culture would be of no avail if there is no civilization to back it, and for the existence of anything that remotely resembles a civilization the existence of the natural world is a must. So, it is for our own sake that we have to save the environment. His vision is essentially an ecosophic one as he constantly emphasizes the need for adopting an interconnected and ecocentric approach. Robinson feels Capitalism has already done irreparable damages to the psyche of the individuals belonging to the less privileged class, and now it is living in a coma, becoming a zombie-like system, that has lost “any hope of returning to health” (342). The novel champions the sustainable development as the panacea for our evils and observes that indulging in an unrestrained hedonistic and consumerist lifestyle will lead us nowhere, rather it will only prolong the game which we are playing against our civilization itself which even if we happen to win there will be no reward waiting for us: “You can short civilization if you want. Not a bad bet really. But no one to pay you if you win. Whereas if you go long on civilization, and civilization (therefore) survives, you win big. So the smart move is to go long” (*The Ministry for the Future* 254). In our quest for furthering our material benefits, and increasing the level of comforts and luxury we are waging a war against the environment. It is not just in this novel, but also in the Mars Trilogy novels which are completely set in Mars, where we see Robinson exploring the implications of systems such as cooperative commonwealths and exposing the shortcomings of capitalist economies.

Even when Robinson philosophizes, he never loses its touch with the individual, and even when he talks at lengths about the need for adopting an alternate currency, elaborates on de-carbonization, and proposes an alternate financial system all geared towards the end of achieving a sustainable future, in a very ecosophical way, he always expresses his concern for the intrinsic and potentially infinite value of the human life and civilization in general which surpasses anything that we might hope to measure with our materialistic measurements. The novel points out that we should not judge the monetary value of nature and human civilization in terms of mere gains

or losses, rather we should admit that our “civilization is effectively a fiscal infinity, a human infinity” (*The Ministry for the Future* 279). The over-reliance and overconfidence in our present-day systems have made us only so much incredibly blind towards the aftermaths of an imminent civilizational crash that we are not ready to give off even an inch of our current level of materialist comfort. Financial systems all over the world have become only better in waging war against the environment and thus deprive the common masses of their due by siphoning off their and also nature's resources to enrich even further the richest few, thereby “making those few so rich that they could imagine surviving the crash of civilization, they and their descendants living on into some poorly imagined gated-community post-apocalypse in which servants and food and fuel and games would still be available to them” (*The Ministry for the Future* 305). Also, the author observes, that we are becoming painfully oblivious to the plain fact that money would be worthless if there is “no civilization to back it” (305). John Cairns Jr. in his “The Human Economy is a Subset of the Biosphere” also advocates for the adoption of an ecocentric approach: “Since the human economy is totally dependent upon the biosphere and humans are dependent on the biospheric life support system, why are [we] tolerant of the type of economic growth that damages the biosphere? ...Humankind should only engage in activities that nurture the biosphere” (269-70).

Just as the work keeps its focus intact on the global view of our planet being adversely affected as a result of the climate changes even when it engages our attention in the imagined circumstances around individual episodes, in a similar manner, even when it strives to present the periodized picture of our civilization’s cultural and historical phases from a god’s eye perspective, it never forgets to criticize and castigate the individual political powers for their irresponsible attitude towards climate change. At one point, Robinson categorizes various phases of our culture and civilization under the labels of dynastic, hegemonic, economic, and ideational, while reserving the label ‘geological’ for the ice ages and extinction events, and ‘technological’ for “the stone age, the bronze age, the agricultural revolution, the industrial revolution” etc. (*The Ministry for the Future* 138). It also envisages the Roman Empire, the Arab Empire, European colonial powers, the post-colonial, and the neo-colonial as forming parts of the hegemonic power structures, while the imperial powers that ruled the ancient and medieval India and China, and also various parts of Medieval Europe, have been tagged as the dynastic powers (138). Also, it blames the neo-fascist and hegemonic power structures for their callousness towards the environmental crisis which often helps the crisis to inflate to catastrophic proportions. For

the Indian heatwave crisis, the novel describes how the ruling party BJP lost its power in India which it terms as a “good riddance to their RSS fake-traditional Hinduistic ethnic-nationalist triumphalism’ (*The Ministry for the Future* 140). The very phenomenon of the heatwave sweeping across India has been implicitly compared to the hyper-masculine-false-nationalistic sentiments that once swept the entire Indian populace, and as a result of which the tolerant, syncretic way of traditional Indian life fell prey to this ideological heatwave, again quite similar in spirit to how millions of people fell a prey to the onslaught of the actual heatwave. The novel seems to draw interesting parallels between the unsustainable power usage in the energy sector and the corrupt practices in the fields of political power play through which the parties aim to sustain themselves. Just as our mindless exploitation of energy resources and fossil fuels is harming nature, so are the practices of the corrupt politicians are harming the interests of the masses. In fact, in many of his works we see political unrest and ecological instabilities go hand-in-hand together as is evident in his novel *Red Mars*. In that novel, we see how when the oppressive authoritarian regime has fallen under maximum stress as a result of a series of ecological disasters, a section of the Martians rises in rebellion against the government in the year 2127 after a failed rebellion in 2061, often paralleling the spirit of the Russian Revolution of 1917.

The novel sarcastically remarks how the poorest are brainwashed and tricked into believing by the political propaganda machinery that they are being patriotic when they vote for some particular parties concerned when in reality, it is those powers which perpetuate the miseries of both the environment and the general populace: “...and indeed many of those harmed often vote for politicians who will increase their relative impoverishment. Thus the power of hegemony: we may be poor but at least we’re patriots” (*The Ministry for the Future* 86). The power of the hegemonic discursive practices also makes itself felt in the spheres of economics and framing of policies. The novel states that various indices like Bhutan’s Gross National Happiness index, are mere “attempts to portray civilization in our time using the terms of the hegemonic discourse, which is to say economics, often in the attempt to make a judo-like transformation of the discipline of economics itself, altering it to make it more human, more adjusted to the biosphere, and so on” (*The Ministry for the Future* 89). Unless and until we stop ignoring the human and social aspects of the problems, and strive to include them without getting trapped in the abstract and inhuman “realm of quantification” (89), no progress towards the realization of a sustainable future can be made. Here one may be tempted to recall the episode from Robinson’s *Forty Signs*



of *Rain* (2005) which is the first novel in his ‘Science in the Capital’ trilogy. In this episode from the novel, we see one Dr. Zacharius Strengloft, the newly appointed scientific advisor to the US President, trying his best to deny the reality of climate change, and berates various indices designed to measure the climate change as inherently unscientific and compares them to unconventional measures of a nation’s progress like Bhutan’s Gross Domestic Happiness (*Forty Signs of Rain* 161). Now, while the present novel employs extensive amounts of data and statistics to make its point strong, it always remains mindful of not losing track of the humane aspect of its narrative. The ecosophical concern remains palpably present in each of its passages as when the novel states, that the need of the hour is “to acknowledge the reality of other people, and of the planet itself” (*The Ministry for the Future* 89).

For the author, with his one eye forever fixed on the movement of history taking place against the backdrop of a geological scale, the ordering and structuring of our time have already begun to feel “unjust and unsustainable and yet massively entrenched” and now seems to be falling apart before our very eyes (*The Ministry for the Future* 139). In the absence of a sustainable future to look forward to, even mankind’s sense of history will no longer be able to support him in the wake of a wholesale dissolution of the environment. He borrows such concepts as Raymond Williams’ ‘structure of feelings’ and Freud’s theories of repression and suppression to equate and connect the movements taking place in the human psyche with those occurring in the natural world without. In his *New Yorker* essay titled ‘Coronavirus and our Future’, he uses Williams’ ‘structure of feelings’ to highlight the shifting phase we are currently undergoing: “We know we’re entering a new world, a new era. We seem to be learning our way into a new structure of feeling... we’ve been overdue for such a shift. In our feelings, we’ve been lagging behind the times in which we live ... the age of climate change... wrecking our one and only home in ways that soon will be beyond our descendants’ ability to repair” (*New Yorker*, 1 May 2020). Robinson has always emphasized the need for a coherent historical background for formulating the experiences of the present and for this purpose, the conservation of the natural world is a must. In the novel *Wild Shore*, we see how a teenager fabricates an imaginary past for himself and the survivors of a neutron bomb attack on the United States and intermixes his tales with semi-true historical facts. When there is no actual past available to connect to, we have to construct one and this is how the boy in the novel strives to present a vision of a future to his fellow survivors by embedding it in a fabricated past.

Since the inner spirit of man and nature is mutually interlinked, and the history of mankind is but an inscription of his biological, social, and cultural reflections onto the natural, if we really want to save the precious human nature from falling into utter chaos and dissolution, we have to find ways to address the problems that are plaguing our nature first. The author then points out the present dissociation between science and ideology and proposes that we must apply our scientific knowledge to not only improve and invent but also “put to use an ideology that explains in a coherent and useful way as much of the blooming buzzing inrush of the world as possible” (*The Ministry for the Future* 53). Even before this novel, in many of his interviews and writings, Robinson has pondered on the problematic relationship between science and ideology, and science and capitalism in particular. Science, Robinson (2010) feels, with its powers and promises of realizing an alternative utopian realm has always acted as an alterity to the hegemonic discursive practices. Also, he has brilliantly pointed out how science and capitalism have from the very beginning been engaged in a “giant struggle” (“Science, Justice, Science Fiction: An Interview with Kim Stanley Robinson”), where science, with its enormous creative potential, has always presented itself as a lucrative option for the capitalism to invest in, while capitalism, in the name of providing funding to the researches, has always sought to own science’s creative power, and in the process science itself.

While commenting on the manner in which the state machineries operate, the novel repeatedly emphasizes on the collusion between the rich private players and the state power, and explains how the state depends for its capitalization on the high net worth individuals who in turn receive states’ tacit approval for pursuing their inherently unsustainable and materialistic lifestyle: “...the capitalizing of state power now had its roots in private wealth; thus the rich and the state became co-dependents, two aspects of the same power structure” (*The Ministry for the Future* 224). In fact, in this regard, we can recall Piketty’s work *Capital and Ideology* (2020), where he states how by through institutional and ideological manipulations, economic inequalities are justified and encouraged to grow in an artificially constructed “inequality regime” where private wealth and state power continue to collude with each other and get mutually benefitted. Piketty also analyzes in detail the interrelationship between capital accumulation and modern economic growth and observes, “Capitalism can be seen as a historical movement that seeks constantly to expand the limits of private property and asset accumulation beyond traditional forms of ownership and existing state boundaries” (*Capital and Ideology* 154).

Now, the novel also seems to focus its attention on describing the notion of collective power in tackling the problems of unsustainable growth. When it comes to charting a course to a more sustainable future, any individual nation, no matter how mighty and powerful it is, is bound to fail, as the game is too big to play for any of them individually, and thus the only option available is to work collectively as a unit: “Even China, even the US; these were just the biggest Lilliputians, in terms of any given entity trying to tie down the global economy. It would take a gang of them” (*The Ministry for the Future* 227). The titular Ministry, born out of the Paris Agreement, finds it impossible to make any real, tangible progress unless the governments of the world actually join hands together in combating the growing threat of environmental degradation.

While the novel labels the histories of ancient expansionist powers as imperial and dynastic, at present, too, he opines that imperialism exists and continues to thrive by donning various ideological disguises. One such disguise that the present version of soft imperialism adopts is the notion of globalization. The novel maintains that any vision of a future if driven by the vision of one particular country is bound to fall into just another exercise in perpetuating hegemonic power: “Globalization was many things-including a reality, in that they all lived on one shared planet in which borders were historical fantasies-but it was also a form of Americanization, of soft power imperialism combined with economic dominance, in that the US still had seventy percent of the capital assets of the world secured in its banks and companies, even though it had only five percent of the world’s population” (*The Ministry for the Future* 232).

At present, the points of contention are no longer the expansive stretches of vast land and neither the battlegrounds are any ocean or land, rather it is the energy resources over which an endless struggle is being waged in which the victims are the poor, the destitute, the wild animals and last but not least, nature herself. The dynamics of the relation between the private individuals and the state powers and their mutually agreed acts of profiteering from the energy resources have been pointed time and again: “Civilization needed electricity, and it was citizens who had powered themselves on these fossil fuels for the last couple of centuries. The owners of these fuels were sometimes private individuals who had gotten fantastically rich, but many times they were nation-states that had claimed ownership of the fuels found within their boundaries as assets of the state and its citizenry” (*The Ministry for the Future* 251). The compensation that all the countries demand in return for not emitting more greenhouse gasses and thus ruining the

environment seems to be a cruel and insensitive joke or even worse, an act of pure extortion. US, China, Russia, Canada, Australia, the Arab states, Venezuela, Mexico, are some of the biggest players in the world, “And they all wanted compensation, even though all of them had agreed in the Paris Agreement to decarbonize. Pay us for not ruining the world! It was extortion” (*The Ministry for the Future* 252). The novel excoriates the people who deny the reality of climate change and insist on following their capitalist, consumerist lifestyle mindlessly even at the expense of putting the lives of the billions of people, and the planet’s ecosystem in danger: “But then also there were particular people, many still alive, who had worked all their lives to deny climate change, to keep burning carbon, to keep wrecking biomes, to keep driving other species extinct. That evil work had been their lives’ project, and while pursuing that project they had prospered and lived in luxury. They wrecked the world happily, thinking they were supermen, laughing at the weak, crushing them underfoot” (*The Ministry for the Future* 77). In the novel *Forty Signs of Rain*, we see one Charlie Quibler trying hard to defend the efficacies of the measurements of ecological footprints against the President’s scientific advisor, Dr. Zacharius Strengloft. Dr. Strengloft dismisses the statistics regarding the deterioration of climatic conditions as bad science and defends the current system based on the excessive use of Carbon on which the American economy stands. The President, referring to the measurements of environmental degradation even says, “we don’t know for sure if any of that is the result of human activity. Isn’t that a fact?” (*Forty Signs of Rain* 159), while Strengloft brands “the anticarbon-dioxide crowd” as “a special interest lobby in itself” (*Forty Signs of Rain* 161). Now, *The Ministry for the Future* makes it clear that the rich capitalists with their hedonistic lifestyle are not just polluting the environment but also contributing to the perpetuation of the miseries of millions of people. Bookchin aptly comments, “Any attempt to solve the ecological crisis within a bourgeois framework must be dismissed as chimerical. Capitalism is inherently anti-ecological” (*Post-Scarcity Anarchism* viii). The fate of nature and the people are inextricably interlinked, and any imbalance in one will inexorably cause an imbalance in the other. This is what a true ecosophical vision entails.

The narrative is most powerful and direct when it is sarcastically commenting on the evils of a pure capitalist, consumerist, and materialistic lifestyle where a handful of rich people seem to be accruing all the wealth to themselves while denying the majority of the world’s population even the basic amenities: “Possibly some of the richest two percent of the world’s population have decided to give up on the pretense that “progress” or

“development” or “prosperity” can be achieved for all eight billion of the world’s people” (*The Ministry for the Future*. 68). Thomas Piketty in his groundbreaking work *Capital in the Twenty-First Century* (2013) and in his papers titled “Income Inequality in France, 1901-1998” (2003) and “Income Inequality in the United States, 1913-1998” (2003), the latter being co-authored with Emmanuel Saez, has shown how income flowed only to the richest 1% of the world’s population.

The novel posits an equitable distribution of the world’s available resources among the entire population as a cure for the majority of the evils. The author’s insistence on the equal distribution of wealth among all calls for recognizing first and foremost the intrinsic value of the human life and the right of each and every the individual to have an optimum share in the resources of the world: “To be clear, concluding in brief: there is enough for all. So there should be no more people living in poverty. And there should be no more billionaires. Enough should be a human right, a floor below which no one can fall...” (*The Ministry for the Future* 70).

### **Powers and promises of the good Anthropocene**

A ‘good Anthropocene’, in short, believes that the quality of human life can be improved even while maintaining a constructive and cooperative relationship with the nature. In the face of ever increasing social-environmental challenges, certain visions of large-scale transformations can be realized through the collective efforts of the individuals, organizations, political leadership and comprehensive intergovernmental negotiations such as UN Sustainable Development Goals, in which the interlinked and interconnected nature of society, economy and ecology is recognized, integrity of an ecologically diverse world and its environmental quality are promised to be maintained and our choices and actions are oriented to make possible the emergence of a positive future world. In fact, from the novel, we can see that it is towards this aim of inspiring a noble vision of an alternative, positive future that the titular Ministry of the novel is constituted two years after the deadly Indian heatwave.

#### **i) Post-anthropocentric viewpoints**

One of the most important aspects of the good Anthropocene is to recognize and respect the agential realism of the non-human objects and phenomenon, and the novel employs it carefully as can be seen in the chapters where inanimate objects like the Sun, the carbon atom, and the photon seem to be describing the world from their unique perceptive. It also becomes clear that the realization of a good Anthropocene and the adoption

of an ecosophical approach go hand-in-hand. As Trexler remarks, “Agency allows an environmental critic to describe nonhuman things as actors in ecosystems, politics, and novels, while maintaining the sense of their categorical hybridity” (*Anthropocene Fictions* 23).

After describing the fury of the Sun in the opening chapter, the novel moves on to describe the godlike majesty of the Sun in the following chapter. This is where the Sun itself assumes the role of a narrator and the passage reminds one of the description of the Sun in his novel *2312* (2012). In the opening chapter of *2312*, we see the “sunwalkers” are avidly waiting to get a glimpse of the sunrise since they worship the Sun as their God: “You are a creature of the sun. The beauty and terror of it seen from so close can empty any mind, thrust anyone into a trance. It’s like seeing the face of God, some people say, and it is true that the sun powers all living creatures in the solar system, and in that sense is our god. The sight of it can strike thought clean out of your head” (*2312*, 4). The chapter in *The Ministry for the Future* reads, “I am a god and I am not a god. Either way, you are my creatures. I keep you alive. Inside I am hot beyond all telling, and yet my outside is even hotter. At my touch you burn, though I spin outside the sky. As I breathe my big slow breaths, you freeze and burn, freeze and burn. Someday I will eat you. For now, I feed you. Beware my regard. Never look at me” (25). This description affirms the agency of the Sun as the godlike entity capable of sustaining as well as destroying the lives of each and every creature on the planet in no uncertain terms. Besides the narration by the Sun in the second chapter, we see how a Carbon atom is also invested with an agency of its own as it narrates its own history of ‘life’. In a similar vein, in Robinson’s *Red Mars* novel, we see a character spiritualizes Mars, bestows it with a godlike dimension, and worships it as a god since he feels that Mars demands “fitting into it as it is, and worshipping it with our attention” (*Red Mars* 179). There emerges even a religion called “aerophany” centered around the godhood of Mars itself. The novel describes it as “a kind of a landscape religion, a consciousness of Mars as a physical space suffused with *kami*, which was the spiritual energy or power that rested in the land itself” (*Red Mars* 229). This recognition and appreciation of an innate spiritual agency in every object is one of the most defining features of an ecosophical outlook. As Raimon Panikkar explains, “Much more than a simple ecology, ecosophy is a wisdom-spirituality of the earth. ‘The new balance’ is not so much between man and Earth, but between matter and spirit, between spatio-temporality and consciousness” (“Ecosophy: Nature’s Guide to a Better World”).

The Carbon atom then recalls how it was born out of the death throes of its mother, i.e. the dying star as it went supernova: "...when she went supernova the heat of the detonation exceeded a hundred megakelvins and in that pressure three helium nuclei stripped of their two electrons were crushed together and there I was, as elegant as anything in the universe: carbon, the king of the elements..." (*The Ministry for the Future* 347). The Carbon atom recalls the event of the birth of Earth itself, the consequent formation of the land surfaces, and how the photon rain of sunlight that followed had attempted to soften it up, and then in the Jurassic era, how Dinosaurs tried to eat it, and after being knocked by the photons incessantly for millions of years, it was suddenly "caught underwater in a muddy clutch of my fellow carbon atoms, and down we went back into the Earth, crushed there to graphite, in this case a seam of coal, where I spent many millions of years" (*The Ministry for the Future* 348). Also, on another occasion, a photon is seen describing his life and journey. The photon proclaims, "I am visible, I embody light itself..." (249), and also states that it is immutable, immortal, massless, mysterious, and powerful and that "there are more of us than there are of anything else" (248). These scattered episodes narrated from the perspective of the non-living entities further reaffirm the need for adopting an ecosophical approach towards life and existence in general, and these post-anthropocentric modes of narration become a very powerful tool for entrenching our worldview in an ecosophical outlook.

Also, besides investing the inanimate objects with agencies of their own, the human characters have been compared with the natural objects and this is especially the case when the author intends to portray them as casting a positive influence on the environment. The female protagonist of the novel and head of the eponymous ministry, Mary Murphy is described as a representation "for these men any kind of stand-in for the Earth mother" (254). Mary is among the handful of such people who are genuinely concerned about the future of our world and so, she has been trying, to create "a way to invest in survival, to go long on civilization, as opposed to the many ingenious ways that finance had found to short civilization..." (*The Ministry for the Future* 304). In fact, we may say that Mary stands for an 'ecocentric' rather than an anthropocentric outlook towards life and nature in general. As Fox explains, "Whereas an anthropocentric orientation considers the nonhuman world as so many "resources" to be used as humans see fit, an ecocentric orientation attempts, within obvious kinds of practical limits, to allow all entities (including humans) the freedom to unfold in their own ways unhindered by the various forms of human domination" ("The meanings of Deep Ecology" 5).

In fact, in many of his other works we see non-human agencies play an even more important role in defining and directing the course of the plot. In *2312*, we come across the humanoids called Qubes, which are self-aware and super-sentient quantum computers that can connect with other intelligent entities across the vast stretches of space and time, and their communication power is only limited by the limits of quantum decoherence. A Qube also has a qube-implant named Pauline which is also a self-aware AI. In *Aurora*, we see several portions are described from the point of view of one self-aware AI narrator which refers to itself as the ship. The AI's narrative alternates between first and third-person narratives and the ship can gather information from a vast range of scales ranging from the "ever-foaming quantum surf, in which entangled quark-like particles appear and disappear, passing in and out of the ten suspected dimensions" to the level of the "complex manifold of overlapping universes" (*Aurora* 354). The AI even comments that "the self, the so-called I that emerges out of the combination of all the inputs and processing and outputs that we experience in the ship's changing body, is ultimately nothing more or less than this narrative itself" (*Aurora* 379).

## ii) **Geoengineering and terraforming**

In an interview (2014) given to Boom California, Robinson has said, "The idea that we're living in the Anthropocene is correct. We are the biggest geological impact now; human beings are doing more to change the planet than any other force, from bedrock up to the top of the troposphere" ("Planet of the Future"). One of the most prominent and powerful aspects of Robinson's climate fiction narratives is the description of the audacious geo-engineering feats and acts of terraforming which also feature prominently in the present novel. These feats of geoengineering and terraforming are the indispensable features of a good Anthropocene literature. Defining these two terms, i.e. 'terraforming' and 'geoengineering' is a very complex task as no single definition seems to be able enough to resolve all the paradoxical implications that inevitably arise from the use of such terms. Prucher has defined terraforming as our attempt to "modify a world's environment so that it can support earth life-forms, especially humans" (2007, 235). Now, commenting on the paradox that is inherent in this definition, the British physicist and geologist Matyn Fogg asks, "how does one make the earth more like itself?" (1995, 90). However, as Robinson himself has stated, the terraforming is a practice that is very much situated at present and is happening almost everywhere: "California is a terraformed space. I think we have accidentally become terraformer" ("Kim Stanley Robinson on science fiction and California"). While commenting on



geoengineering, Fogg explains it thus: “geoengineering is planetary engineering applied specifically to the earth. it includes only those macroengineering concepts that deal with the alteration of some global parameter, such as the greenhouse effect, atmospheric composition, insolation or impact flux” (90).

In his novels, Robinson describes time and again how humans are trying to counter the ice sheet loss in the Greenland ice caps, artificially salinating the Gulf Stream, attempting to convert the dry, shallow basins of the Sahara and Asia into salt seas by pumping more ocean water into them, diverting meltwater from Antarctica to be used as freshwater, genetically modifying photosynthetic bacteria to increase the carbon sequestration potential of plants, raising the State of Florida 30 feet above the sea level to prevent it from going underwater, etc. One of the characters in the novel *The Ministry for the Future* proposes pumping all the melted ice back on to the polar regions, while another feels it would not be economically feasible, as “the amount of electrical power needed to pump that much water up onto the east Antarctic ice cap came to about seven percent of all the electricity generated by all of global civilization” (93). While the problems and the challenges that Robinson describes here are definitely grounded in realities, an emphasis on the description of the nitty-gritty of the mechanisms seems to lend the work an unmistakable hard science fictional charm. Many researchers all over the world are involved in the research related to finding solutions to such problems as the melting of ice caps, rising seawater levels, global warming, etc to name a few. The novel also contains various geoengineering proposals, the most prominent being the proposal to drain the water from the bottom of the glaciers to stop them from slipping down into the sea: “Pump up the water from under the glaciers, and actually, the weight of the ice on it will cause that water to come up a well hole ninety percent of the way, just from pressure of all that weight. Then you pump it up the rest of the way, pipe it away from the glacier onto some stable ice nearby” (*The Ministry for the Future* 95). Robinson has always maintained that we indeed live on a terraformed planet, and terraforming should not only refer to the act of making other planets more habitable. A significant portion of the various chapters in the novel deals with the description of the minute details of the process of drilling holes in the glacial ice caps and pumping meltwater out from them. When Robinson really delves deep into the details it reads like this, “They shoot hot water at the ice through a thing like a giant shower head, and melt it. As the ice melts the drill head goes lower, and down it all goes. The meltwater gets pumped out, and the hole can be sleeved with a heated sleeve if you want to keep it open, which we did.

Some of the meltwater gets recycled into the drill head's feeder tank to be reheated. The rest gets piped away and dumped where it can spill out and freeze without messing anything up" (*The Ministry for the Future* 134). In his other novels, we find even more audacious descriptions of terraforming and geoengineering. In *2312*, we see Venus and Titan are being terraformed, as the human settlements have spread across the entire solar system – on Mercury, on the satellites of Jupiter, and on thousands of asteroids too. Here, the inhabitants of the asteroids are seen breeding endangered species in the caverns of the hollowed-out asteroids known as 'terraira', and these asteroids form parts of some greater federation system. In the novels belonging to the 'Mars Trilogy', we see the Martian human settlers have performed both geoengineering on massive scales to raise sea temperatures, to bring water to the surface of the lands, to increase atmospheric pressures, and also performed bio-engineering to create new species from existing life-forms.

### iii) Proposing alternate systems

Besides castigating the governments, nations, capitalism, and the hegemonic power structures for colluding with a handful of wealthy individuals at the cost of the lives and sustenance of billions of people, the novel also frequently questions the existing finance system and the inherently unsustainable world economy that keeps thriving on the exploitation of both the natural resources as well as the poor people. In one such section, he terms the tax system as "an ancient manifestation of the power of the state" (350), and calls for a targeted change in the taxation laws for bringing "rapid change in behavior and in wealth distribution" (*The Ministry for the Future* 352), and thus benefitting the masses.

In one place, the author makes clear the parallel that he has for so long been drawing indirectly between the exploitation of the nature and its resources and the exploitation of the poorer section of our society: "...all the young people on Earth, and all the generations of humans in the centuries to come, and all their cousin creatures on the planet who could never speak for themselves, especially in court—all these living beings added up to something like a poor and vulnerable developing nation, a huge one, appearing inexorably over the horizon of time" (*The Ministry for the Future* 372-373). This is highly ecosophical in its spirit since the philosophy clearly insists on treating the humans and non-humans alike as part of a greater and more inclusive ecosystem.

Robinson is primarily known for his ardent optimism and advocacy for a utopian future and this novel is too not an exception in this regard. The

author, despite dealing for the greater part of his work with the discontents of our present-day Anthropocene, he portrays a hopeful picture of the future in the end. The novel describes how the people are already beginning to see themselves as part of a great planetary civilization and acting responsibly with their technology: “Already a new internet; now its users may be turning into a new kind of citizen of the world. Gaia citizenship, or what have you. Earth citizen, commons member, world citizen. One Planet. Mother Earth. All these terms used by people who are coming to think of themselves as part of a planetary civilization. Main sense of patriotism now directed to the planet itself” (*The Ministry for the Future* 377). This seems to be the realization of the ecosophical vision projected by Naess (2008): “Every living being is connected intimately, and from this intimacy follows the capacity of identification and as its natural consequences, practice of non-violence” (*The Ecology of Wisdom* 90). Also, Latour, in his 2011 lecture titled *Is it Possible to Get Our Materialism Back? An Inquiry into the Various Idea/isms of Matter*, posits the need for engaging with the environmental discourse in terms of ‘Gaia’ and ‘Terrains’. He builds his theory based on the original ‘Gaia Hypothesis’ of Lovelock and Margulis (Lovelock & Lodge Jr 1972; Lovelock & Margulis 1974) but proposes the framework of Anthropocene for reformulating the new theory of Gaia. This also reminds one of Karen Barad’s theory of ‘intra-acting agencies’ in which she envisages all the sentient and non-sentient entities as entangled in a web of interaction and in which no entity can be said to be totally distinct and acting independently on its own, rather each exists only in relation to the others: “The neologism ‘intra-action’ signifies the mutual constitution of entangled agencies. That is, in contrast to the usual ‘interaction,’ which assumes that there are separate individual agencies that precede their interaction, the notion of intra-action recognizes that distinct agencies do not precede, but rather emerge through, their intra-action. It is important to note that the ‘distinct’ agencies are only distinct in a relational, not an absolute, sense, that is, agencies are only distinct in relation to their mutual entanglement; they don’t exist as individual elements” (33). Braidotti, too in his works (2006, 2011 and 2013) has put forward her vitalist approach through which she seeks to inspire us into acknowledging the agency of the non-human life, which she terms as *zoe*, along with the human life or ‘anthropos’ or ‘bios’. According to her, “*Zoe*-centred egalitarianism is...the core of the post-anthropocentric turn” (*The Posthuman* 60).

Recently researchers have also started acknowledging the model of ecology as a dynamic system made of socially interconnected agencies (Bennett *et al.* 2009; Ellis *et al.* 2018). This is what the Gaia 2.0 civilization

also envisages in which the entire human civilization is posited to be acting as geologically significant and technologically responsible agents to bring positive changes to their environment and ecosystem. Robinson in many of his works, whether they are set in the outer reaches of the solar system or in the imagined, alternative futures of our own planet, has striven to portray the complexities and challenges involved in the process of bringing change to human societies, as is evident from his ‘Mars Trilogy’.

Coming back to *The Ministry for the Future*, we see how even the power structures and discursive practices are described as undergoing reversals, as the people who for so long have been labeled as terrorists by the system, are now being hailed as resistance warriors who are fighting for the Earth itself: “Many attacks now were on carbon burners, especially those rich enough to burn it conspicuously. Car races and private jets. Yachts and container ships. So now the terrorists involved were perhaps saboteurs, or even resistance warriors, fighting for the Earth itself. Gaia’s Shock Troops, Children of Kali, Defenders of Mother Earth, Earth First, and so on” (*The Ministry for the Future* 390-391). This again reminds us of the Mars-first ecoterrorists and the highly radical Mars worshippers whom we come across in the novel *Red Mars*. Now, in *The Ministry for the Future*, the financial crisis that ensues as a result of the revolutionary change in the outlook of the people, “people, ordinary people en masse, as the material manifestation of “the public,” now seemed to hold the ultimate power” (402). Mary, first kidnapped by Frank May, the sole survivor of the Indian heatwave, later decides to cooperate with Frank and also collaborates with various illegal outfits since she realizes that the current system and its administrative machinery are too short-sighted and have too many vested interests to initiate works on a war footing for saving the Earth. In Michael Crichton’s *State of Fear*, we see the trope of ecoterrorism playing a really important role. In the novel, one young lawyer and environment sympathizer named Nicholas Drake is seen stealthily funding an ecoterrorist organization. Also, one Professor Hoffman, in this novel, exposes how all the political leaders, media houses, and legal institutions conspire together to whip up the fear in the public psyche regarding such terrorist outfits thus increasing their social and ideological hold over the masses. Also, in George Marshall’s novel *Earth Party*, we see how the ruling coalition government declares an environment sympathizing party named Earth Party as a terrorist organization thus forcing the latter to change its name to Peoples Earth Party (PEP). In Marshall’s work, however, following a large-scale popular uprising, the PEP wrests control from the coalition government and comes to power and then prepares to plan its responses to the eco-catastrophes.

Lenton and Latour have envisaged the Gaia 2.0 framework where through “deliberate self-regulation-from personal action to global geoengineering schemes” (Lenton and Latour), humans seem to constitute a fundamentally different Gaia framework from its predecessor. In the Gaia 2.0, the vision of a good Anthropocene can be realized with the help of responsible use of advanced technologies and the purposeful application of scientific knowledge, and here too, the author seems to advocate for the application of our technological prowess for establishing a framework for effecting a sustainable change. The novel states, that “We are Homo faber, man the maker, and our tools are the only thing that allow us to cope with the world. We even co-evolved with our tools...” (*The Ministry for the Future* 477), and as such it will be our tools that will ultimately help us in upgrading our present state to a whole new system based on deliberate self-regulation and an increased rate of global sustainability. Various researchers have begun to emphasize the need for engaging in the conjoined and collaborative efforts to realize the goal of “good Anthropocene” (Ellis 2011; Bennett *et al.* 2016; Pereira *et al.* 2018).

The author even terms the Paris Agreement as “the first big spark of planetary mind. The birth of a good Anthropocene” (*The Ministry for the Future* 494), since it is from this moment onwards that we have pledged to work collectively towards realizing our goal of achieving greater global sustainability. Thus, we see how the optimistic tone of the novel becomes even more prominent as the work draws towards its conclusion: “Ecosystems on every continent were therefore returning to some new kind of health, just as the result of the planetary ecology doing its thing, living and dying under the sun” (*The Ministry for the Future* 496). This picture of everyone coming together to contribute towards the creation of a new ecological practice brings to our mind Guattari’s proposition for building assemblages of subjectivities, and “organize new micropolitical and microsocial practices, new solidarities, a new gentleness, together with new aesthetic and new analytic practices regarding the formation of the unconscious” (*The Three Ecologies* 51). Guattari feels we should all be “working for humanity and not simply for a permanent reequilibration of the capitalist semiotic Universe” (52). In Robinson’s ‘Science in the Capital’ trilogy too, we see how scientists, politicians, individual volunteers all join hands together, in the end, to collectively fight the climate change.

Towards the end of the novel, we see the words from a song whose original has been written in Sanskrit and this song seems to be articulating the ecosophical vision of a good Anthropocene for the readers which stresses

on the need for all the entities of the planet to come together as a single unit: “We are the children of this planet, we are going to sing its praises all together, all at once, now is the time to express our love, to take the responsibilities that come with being stewards of this earth, devotees of this sacred space, one planet, one planet...” (*The Ministry for the Future* 558). The ecosophical vision that the novel upholds can be realized only if we attempt to join “with every sentient being on the planet, and found “a new Earth religion” where we, along with every other living being on Earth “that shares a crucial 938 base pairs of DNA” (*The Ministry for the Future* 560), would be seen to be constituting one single, planetary family. As Naess remarks, “Now is the time to share with all life on our maltreated Earth through the deepening identification with life forms and the greater units, the ecosystems, and Gaia, the fabulous, old planet of ours” (*The Ecology of Wisdom* 92).

## Conclusion

The study has endeavored to explicate the elements of ‘good’ and ‘bad’ Anthropocene in Kim Stanley Robinson’s *The Ministry for the Future* (2020) in order to show how the work advocates for the need of an ecosophical framework which might inspire us to see man and nature as forming parts of one singular family, and where the interest of one is always inextricably interlinked with the interest of the other. The novel also exhorts us to acknowledge the agency of the non-human and non-living others, and see ourselves as active agents in the act of bringing a revolutionary change in our attitude towards the climate change, environmental degradation and ecological harmony which will help move the society toward a most desirable future within the Anthropocene.

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The book cover features a dark background with a glowing blue globe in the upper right quadrant. The globe is covered in various white and blue icons representing technology, communication, and science, such as a smartphone, a globe, a star, a Wi-Fi symbol, and a mail icon. Below the globe, there are glowing blue circuit board traces. In the lower right, a hand is shown holding a glowing green circuit board. The overall aesthetic is futuristic and scientific.

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## INTRODUCTION

A wide variety of diabetes that occurs in the newborn babies within 6 months, is known as Neonatal diabetes mellitus. The main cause for the increase in blood glucose levels in the newborn is the failure of cells to produce insulin at the right time. A major cause and effect of the diabetes in newborn babies and it is caused by new genes with an autosomal recessive inheritance pattern. If any type of harmful mutation is present, the management should be done. The management of

## CHAPTER - 4

# DEVELOPMENT OF SKILLS AND COMPETENCIES BASED ON INDIGENOUS KNOWLEDGE: A SUSTAINABLE APPROACH FOR THE BENEFIT OF ALL

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### ABSTRACT

The basic component of any country's knowledge system is its Indigenous Knowledge (IK). Identifying and developing sustainability competencies that enhance the contributions of individuals to sustainability are crucial to deal with challenges of unsustainability. Among others, education has the potential to equip students and future professionals with skills and competencies. This can be better facilitated when education aims at meaningfully promoting skills and competencies and prepares learners to deal with social and ecological challenges. The need for education focusing on enhancing skills and competencies and promoting indigenous knowledge has been recognized by national and international organizations. Education for sustainable development (ESD) is a growing field of research in the scientific literature as well. 'Competence to utilize indigenous resources for sustainability' has also been identified as one of the competencies required to facilitate efforts towards a more sustainable life. This competence entails capabilities to recognize and utilize the

potential of IK for sustainability. The practice and potential of indigenous ecological knowledge and natural resource management has been documented.

## INTRODUCTION

Indigenous women in India have the highest levels of adult illiteracy, unemployment and poverty amongst Indian population of India (*Briefing Notes: Gender and Indigenous Women | United Nations For Indigenous Peoples, n.d.*). As a result of colonization, neoliberalism and development policy, indigenous women in India (and indeed globally) are struggling to preserve their traditional knowledge, education, livelihoods, and culture. The widespread loss of land and control of natural resources in indigenous areas have pushed these women away from previously productive activities. Adult education policies for indigenous women increasingly focus on vocational education and training (VET) to equip them with market-oriented skills to generate alternative livelihoods and increase their economic contribution. VET and skills development are considered an important tool for poverty reduction, supporting decent work, enhancing employability, and maximizing opportunities for disadvantaged groups across societies. The Indian government (GOI) launched the National Skills Development Mission in 2015 with the aim of skilling, up skilling or re-skilling 300 million people by 2022. The GOI's 2015 National Policy on Skill Development and Entrepreneurship (*Vikaspedia Domains, n.d.*) seeks to enhance the employability of disadvantaged groups, including women, scheduled tribes, scheduled castes, and people with disability. Under this policy, several non-governmental organizations (NGOs) and private institutions receive government funding for training programs in rural and indigenous areas.

However, there is limited research on indigenous women's experiences with VET programs in India (Dagar, 2021). Competency is the combined set of abilities, desire and knowledge required to be considered "competent" in performing or executing a particular function.

### INDIGENOUS KNOWLEDGE AND SUSTAINABILITY COMPETENCIES

Indigenous knowledge is a comprehensive system of a particular society that encompasses its worldviews, practices, laws, holistic know-how, and guidelines regarding interrelationships within the society and with the natural environment include the means of learning and perpetuating the knowledge (Owuor, 2007). 'Competence to utilize indigenous resources for sustainability' has also been identified as one of the competencies required to facilitate efforts towards a more sustainable life. This competence entails capabilities to recognize and utilize the potential of IK for sustainability. The practice and potential of indigenous ecological knowledge and natural resource management has been documented. The use of IK for wild fire management is another example out of several potential applications of IK for sustainability (McKemey et al., 2020)(Cunningham, 2010; Hiwasaki, L., Luna, E., Syamsidik, & Shaw, R. (2014). *Process for Integrating Local and Indigenous Knowledge with Science for Hydro-Meteorological Disaster Risk Reduction and Climate Change Adaptation in Coastal and Small Island Communities. International Journal of Disaster Risk Reduction*, 10, 15-27. - References - Scientific Research Publishing, n.d.)

It was revealed that indigenous knowledge has the potential to help students learn the ways that socio-ecological systems are integrated in specific cultures. Hence, exploring and integrating alternative worldviews and ways of knowing

is important to complement the dominant modern education (Lozano et al., 2017). Globally, Indigenous Knowledge Systems (IKSs), which have evolved through rigorously tested methods and practices, are a testimony of human intelligence and endurance. The diversity of goods such as food, beverages, herbs, etc., and its associated systems, which form an integral part of modern cuisine and healthcare systems, is deeply rooted in IKS and immensely contributing to overall well-being of mankind. The present study is an attempt to document and understand the contribution of indigenous and local knowledge to biodiversity conservation and management. Appreciation to the value of traditional and indigenous knowledge is globally recognized for their principles of coexistence and sustainable use practices. Past studies have also indicated a strong relationship between indigenous knowledge and sustainable development goals. This knowledge is valuable not only to dependent communities, but also to the modern world for ensuring food security and human well-being. The documentation of such valuable knowledge is therefore fundamentally essential for mainstreaming and strengthening the discourses on sustainable ecosystem management, and to address the preponderance of poverty among indigenous communities. Due to the changing scenario of consumption and the trend of revisiting nature-based solutions, the IKS hold a tremendous scope of engaging the community people in sustainable harvest and utilization of natural resources (Negi et al., 2021). Combining indigenous knowledge with scientific knowledge can help create solutions that are culturally acceptable, economically feasible and environmentally sustainable for the society being aided. The old notion of research & development (R&D), as an isolated process carried out in a laboratory, concerned with



generating new technologies and/or applications that are then transferred to the passive users, has now changed. Research and development is now widely seen as a learning process that follows inclusive, participatory, exploratory and experiential approach. Also termed as user-led approach, wherein the user becomes an integral constituent of the R&D team. It is therefore critical to create an enabling environment, for seamless fusion of indigenous and scientific knowledge by utilizing complimentary expertise and experience of people, and the one that is based on mutual respect. This will help stimulate and foster the culture of indigenous innovations in the country (Jena, 2013).

Instead it is "an adaptable, dynamic system based on skills, abilities, and problem-solving techniques that change over time depending on environmental conditions" integrating the traditional Indigenous perspectives of teaching and learning can also be immensely valuable in creating a more responsive education system for all students. In recent years, a requirement for a holistic understanding of sustainability aspect has regularly appeared, resulting as a need and condition for determining a current perspective education. The increase of awareness of the indigenous sustainability is filled by enthusiasm for nature conservation, social justice and the development of science in classes based on the cultural identity. Indigenous science describes how the local environment runs through a scientific process that includes objective observation of natural phenomena and classifies as well as solves problems that are encompassed in all perspectives of native culture.

#### ***Need for Competencies and Skill Development***

It is observed that the validation of IK as part of technology cannot be over emphasized. It represents an

important component of global knowledge on development issues. Technology for development is the extension of human capability in order to satisfy socio-economic needs or wants. It further denotes that it is the making, modification, usage, and knowledge of tools, machines, techniques, crafts, systems, and methods of organization, in order to solve a problem, improve a pre-existing solution to a problem, achieve a goal, handle an applied input/output relation or perform a specific function.

World Bank noted that IK is an under-utilised resource in the development process and therefore should be incorporated in the development planning processes. Learning from IK, by investigating first what local communities know and have, can improve understanding of local conditions and provide a productive context for activities designed to help the communities. IK accepts that diversity is the basis of creativity and adaptation.

Creation of an ecosystem of empowerment by skilling on a large scale at speed with high standards and promote a culture of innovation based entrepreneurship generating wealth and employment and ensuring sustainable livelihoods for all."

A big economic opportunity for India, lies in creating a competent and trained manpower. Of particular concern has been the skilling of the rural youth, who constitute nearly 68% of the country's total population. The penetration of vocational training in rural India is abysmally low- 93.7% (2017-18) of youth have not received any vocational training. Dearth of quality trainers, inadequacies in training programmes and high dropout rates remain hurdles to skill development. Most training institutes are located in the nearest small towns, inaccessible to most, especially women, due to the lack of public transport facilities. The Government-run Industrial Training Institutes (ITIs) have severely limited

capacity and offer outdated courses with limited placement options. In the absence of skills most literate rural youth end up working as unskilled migrant workers in the nearest towns and cities. Balanced human resource development will help in bringing about improvement in ensuring a quality of life. This balance can be brought in by various means. Education and skill-based training, along with the provision of credit and marketing assistance, will resolve the issue of unemployment. In India, skill development is broadly categorised as educational and vocational training. Skill development courses should be made available to the rural population because only proper education and skill-based training can be the engine of change needed to enhance income and employment opportunities for our rural youth. The lack of knowledge of job-oriented courses in rural areas has left many youths to remain unemployed.

India's strength lies in its villages. Rural areas contribute significantly to the overall growth and economic development of a country. The opportunity for India largely lies in the skilling of the youth in the country and the skill development in rural India is essential to ensure the equitable distribution of benefits of the development amongst all sections of the society. As responsible citizens, it is our duty to be a part of this mission.

In India majority of women and men residing both in rural and urban areas are unskilled. However, more number of women residing in the rural areas is unskilled compared to men living in both rural and urban areas. And these unskilled women workers are working in the informal sector facing many problems including lack of skills. The studies reveal that more than 90 per cent of women workers are concentrated in the informal sector. However, the condition of women in the informal sector is miserable, most of time they have to work in

extremely low wages and without any job security and social security benefits, apart from these working conditions also unsatisfactory. And for all these problem lack of skill among women is one of the main reasons.

Pedagogical approaches such as inquiry-based, project based and collaborative learning can help in the development of fundamental soft skills such as critical thinking, creativity, team work and communication.

The pedagogical approaches such as *Constructivist, Collaborative, Integrative, Reflective and Inquiry Based Learning* can be used as a tool for competencies and skill development based on Indigenous Knowledge.

#### PUTTING INDIGENOUS KNOWLEDGE (IK) INTO PRACTICE

- *Sustainable practices & land and resource management*

In every indigenous communities, social, economic, cultural and environmental activities take place. Sustainable production and consumption practices as well as resource conservation and management techniques are among these activities, mainly based on traditional knowledge and customary systems of governance (Cunningham, 2010; Hiwasaki, L., Luna, E., Syamsidik, & Shaw, R. (2014). *Process for Integrating Local and Indigenous Knowledge with Science for Hydro-Meteorological Disaster Risk Reduction and Climate Change Adaptation in Coastal and Small Island Communities. International Journal of Disaster Risk Reduction, 10, 15-27. - References - Scientific Research Publishing, n.d.*). For centuries, indigenous populations have been carrying out practices that are adapted to their lands. Among those that they have recognized as viable and sustainable and they perform rotational farming, shifting cultivation, pastoralism, fishing, agroforestry, and hunting

and gathering (DSD :: Areas of Work :: Major Groups - Indigenous Peoples - Declarations, n.d.) Sustainable and resilient ways of living are also promoted by the use of multiple resources and diversity of crops, as well as the development of specific techniques and technologies to carry out their activities in environmentally-friendly and cost-effective ways. These have allowed indigenous people to 'ensure food security while conserving the diversity of wild and domestic plants' (Nakashima, 2015). Indigenous communities also use cosmovision, which refers to the perspectives, conceptualizations and valorizations that determine their worldviews and relationships and spiritual practices to ensure biological diversity, ecological equilibrium and a healthy environment, as well as hunting and agricultural activities.

- ***Land and resource management: Community & women's role & new livelihood***

In indigenous societies, the community's central role transforms territories into collective spaces where fauna, flora and human beings live together in harmony. They maintain this harmony through social mechanisms and customary governance structures for the good functioning of relationships and land management (Nakashima, 2015). Indigenous women, because of their role as custodians of biodiversity, also play a very important role in environmental sustainability and in production, management, preservation and consumption practices (Resources, 2000). They play a special role in food security and sustainable resource management. For instance, in shifting cultivation practices, women are responsible for 70% of the work, from the initial selection of seeds, to weeding the fields, and gathering, processing, and managing the surplus products. They also play a key role in soil and water management (Rocheleau,

1991) and in household gardening. Studies carried out in various countries have demonstrated that these practices equip them with a deep knowledge about seeds, crops and plant varieties. This knowledge is then transferred to younger generations, which, once again, highlights the importance of women in the preservation of biodiversity (*Shifting Cultivation, Livelihood and Food Security New and Old Challenges for Indigenous Peoples in Asia*, n.d.). The communitarian way of living of indigenous people highlights concepts such as reciprocity and collectivity of the economic subject. Hence, for indigenous populations natural resources are not marketable. What they produce is generally used for their own consumption, whilst the surplus is redistributed equally among the community or used in exchanges with other communities. But the recent access to markets to sell products and buy goods has changed the way of living of many indigenous groups who now have more opportunities for cash income (*Shifting Cultivation, Livelihood and Food Security New and Old Challenges for Indigenous Peoples in Asia*, n.d.). This has affected their traditional livelihood, with changes in behaviour from community-oriented to individualize and the abandonment of traditional sustainable practices. In some countries, indigenous communities have begun to introduce complementary activities, such as ecotourism to increase their life opportunities, whilst at the same time respecting the environment and the cultural diversity of their territories.

#### DOCUMENTATION OF INDIGENOUS KNOWLEDGE

Indigenous Knowledge (IK) and practices are usually unwritten; relying on oral transmission and human memory. As a result, the documentation and dissemination of Indigenous Knowledge is very important for the conservation

of traditional knowledge. Knowledge practices can be disseminated through various means for example, video, library website, print media, direct mail, public lectures, exhibitions and displays, and exchange etc.

Knowledge has been affirmed as power which brings development in every human endeavour that is useful for decision making. Indigenous Knowledge is home-grown and cultural knowledge of a specific society. It is a way of life, skills, experiences, culture, insight and values embraced by people in local community. Every society or community has her local knowledge which cuts across all aspects of human living on which livelihood and survival depend. These include but are not limited to health, fashion, food preparation, education, agriculture, religion, festivals, recreation, norms and values, institutions, politics and technology. Consequently, knowledge, according to (Rowley & Farrow, 2017) is the integration of new information into previously stored information to form a large and coherent view of a portion of reality-a definition which fits both human and machine held knowledge, and describes the knowledge bases used in expert systems. Indigenous Knowledge is closely linked to maintaining the long-standing traditions from ancestors and its transfer to other generations in different forms. Hence, the term Indigenous Knowledge has different synonymms such as, traditional knowledge, local knowledge, community knowledge, rural peoples' knowledge, farmers' knowledge (Mahalik & Mahapatra, 2010).

Documenting traditional knowledge (TK) is now widely discussed as a way of guaranteeing the social, cultural and economic interests of indigenous peoples and local communities. It has emerged as a tool that can help impede further loss of TK, maintain TK over time, support benefit

sharing between holders of TK and those who use it, and ultimately protect TK from unwanted uses. Indeed, concerns have been raised regarding documentation and its potential effects on the rights, cultures and livelihoods of indigenous peoples and local communities. There are concerns that documenting TK may mean that communities lose control over it, make it widely available, compromise the secret nature of some TK, and so on. TK documentation is primarily a process in which TK is identified, collected, organized, registered or recorded in some way, as a means to dynamically maintain, manage, use, disseminate and/or protect TK according to specific goals (World Intellectual Property Organization, 2017).

With the emerging ICT tools and indigenous ICT expertise, much of the invaluable traditional knowledge can be saved, documented, improved upon, digitized and transmitted for the use of communities within and outside a particular country. This could aid the process of repackaging Indigenous Knowledge to ensure local suitability and relevance. In other words, for ICT to be an empowerment tool and a conveyor of the locally relevant messages and information, it has to provide opportunities for local people to interact and communicate with each other and with the outside world, expressing their ideas, knowledge and culture in their own languages (Adebayo, n.d.).

There is no hard and fast rule for the medium of information dissemination which is the most appropriate in the rural communities. This is because it varies considerably with the goal of the information source and the message content as it affects a given set of target audience.



### **LEVELS OF INDIGENOUS DEVELOPMENT PROCESS:**

*Local community:* It is obviously most important for the local community in which the bearers of such knowledge live and produce.

*Developmental agents:* Developmental agents (Government, NGOs, Local leaders and Private sector initiatives) need to recognise it, value it and appreciate it in their interaction with the local communities. Before incorporating it in their approaches, they need to understand it and critically validate it against the usefulness for the intended objective.

*Global knowledge:* Lastly, Indigenous Knowledge forms a part of it. It has a value and relevance in itself. It can be preserved, transferred or adopted and adapted elsewhere.

#### ***Significance of preservation of indigenous knowledge of textile craft***

The textile industry not only caters for the economic needs of the local populace, but supports a wider group for their livelihood. It also forms an important segment of Indian Prestige as an art and culture at the world forum. There are unlimited possibilities for export with adequate Government support; this industry can play an important role in earning foreign exchange at the national level. Restoring the different craft using various strategies is very crucial for the survival of the craft. The commitment to craft, innovative ideas and interventions of indigenous knowledge is a key factor for a viable livelihood at numerous production clusters across India. Preserving the textile craft of India will prove to be a cultural renaissance. Indigenous Knowledge respects tradition which is matched by realism, adaptability and entrepreneurial flair- characteristics that have led these artisans to embrace new opportunities and to seek support for their craft. It has become imperative to sustain craft as a viable form of

production in the digital age, bearing in mind its place in local cultures.

When faster methods of production are available, then it is important to support such antique technologies for the recognition of craft and providing a distinctive identity for the craft and region. Indigenous knowledge is a visual and material expression of a culture shaped by serendipity, human ingenuity, trade, conquest and colonization; these textiles and crafts embody the legacy of an ancient civilization and an ambitious modern state.

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Volume - 4

# Advances in Multidisciplinary Research and Development

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# Chapter - 3

## Occupational Health and Ergonomic Intervention in Handloom Industry: A Review

Dr. Sunita Dixit

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### Abstract

Handloom is a time honored skill in India. The handloom industry is basically a rural based cottage industry, where the processes are done basically by hand. Some handloom products like Banarasi Sari, Brocade, Zari textile etc. are appreciated worldwide. These are an extensive piece of art work exclusively done manually by the weavers. The product development involves extensive range of function such as manual sorting of raw materials, dyeing, cutting, starching and adjustment of loom, arrangement of thread and spindle insertion, etc. The handloom play very important role in the Indian economy. Handloom contributes in terms of exclusive production, export, employment and creation of an entrepreneurial base for the country. In handloom traditionally designed tools are used or manual work is performed. Long hours work with traditionally designed tools and un-ergonomic work places can cause musculoskeletal disorders (MSDs) and other occupational health problems among weavers. Weaves well-being is highly associated with the productivity and cost benefits of handloom. This review paper aims to identify various MSDs and occupational health problems among weavers in handloom industry. The effects of ergonomic interventions for improved occupational health as well as productivity enhancement and cost benefits of handloom are also reviewed in paper.

**Keywords:** Handloom, Ergonomic Intervention, Musculoskeletal Disorders, Productivity.

### Introduction

Weaving is oldest surviving traditional crafts in the world. It is a basically cottage industry, where spinning, weaving and other processes are done mainly manually. A large number of people are engaged in handloom sector in Varanasi as well as in other parts of India. Some handloom product of

Varanasi like Banarasi Sari, Brocade, Zari textile etc appreciated worldwide. "Banarasi Sari" is an extensive piece of art work exclusively done by hand weaving. The time taken to weave a sari depends on the degrees of art work. Production of weaving encompasses a wide range of tasks such as manual sorting of raw materials, dyeing, cutting, starching and adjustment of loom, arrangement of thread and spindle insertion, etc.

### **Types of Handloom:**

There were different types of handloom and weaving products. Brief description is given below: Types of looms (based on their workstation) – Ground sitting handloom: This is a traditional work station used by the handloom weavers. In this workstation the weaver sits on the floor or on a plank on the center of a ditch with their leg hanging. They regulate the pedals placed at the ditch to control the movement of loom. Bench sitting hand loom weavers: Some of the weavers use bench type work station in this work.

Jacquard loom weaver: In 1801, Joseph Marie Jacquard produces a mechanical device, which could make the weaving production process with complex patterns such as brocade, damask. The loom is controlled by a "chain of cards", a number of punch cards, laced together into a continuous sequence. Multiple rows of holes are punched on each card with one complete card corresponding to one row of the design. In a wooden vertical-shaft loom, the heddles are fixed in place in the shaft. The warp threads pass alternately through a heddle, and through a space between the heddles (the shed), so that raising the shaft raises half the threads (those passing through the heddles), and lowering the shaft that lowers the same threads, the threads passing through the spaces between the heddles remain in place.

### **Weaving Condition**

Mostly handloom weavers were from poor socio-economic background. They had to work in an ill ventilated and poor illuminated room. During summer, the condition became worst due to increase in room temperature and humidity. In present times, the role of poor environmental conditions at the workplace, poor perception of work conditions, and presence of adverse health conditions in workers has received much attention.

### **Ergonomics**

Ergonomics is the scientific element concerned with the understanding of relation among humans and other discipline of a system, and the profession that applies theory, principles, data and methods to design in order to optimize



human well-being and mostly system implementation. Ergonomics is study of how people work in their environment.

### **Design**

Factors, as for the workplace, intended to grow productivity by diminish operator fatigue and discomfort. Five aspects of ergonomics are safety, comfort, ease of use, productivity and aesthetics.

Applying ergonomic solutions can make employees more comfortable and maximize productivity. Ergonomics is very important because doing a work and body is stressed by an awkward posture, extreme temperature, or repeated movement your musculoskeletal system is affected. Ergonomic interventions involve adapting a workers' environment, behaviour, and other long-term educational approaches to treat and prevent further damage.

### **Role of Ergonomics:**

- a) **Maximize productivity:** Best ergonomic solution increase the productivity. Ergonomic minimize the unwanted tension, awkward position of the body. Ergonomic is based in making the work easier and comfortable, reduces any kind of stress, risk and improve the satisfaction and productivity.
- b) **Minimize the cost:** Ergonomics can be advised as the one-time investment. As ergonomics is based about maintaining the better health of the worker it can further decrease the cost of compensation that would be made by the injured or unhealthy staffs. It also diminish the indirect and the opportunity cost that could have incurred due to injury.
- c) **Enhance the quality of the work:** Better ergonomics favors the favorable environment where the workers can work efficiently. As the ergonomics improves, level of satisfaction in the quality of the work rise.
- d) **Others:** Helps to minimize the absenteeism due to more comfort, safety and healthy working environment. Certainty to the worker as their workplace is safer (acts as the encouragement). More concentrated on the working environment and worker's health makes them feel valued and motivated.

### **Principles of Ergonomics**

There are 10 basic principles of ergonomics which are: Work in neutral postures: Proper posture maintenance is essential. Working too long with "C" curve can create strain. Keeping the proper alignment of neck hands wrist are also essential

Minimize extreme force: Intolerable pressure or force at the joints can cause injury. Better to reduce the work that needs more physical labor.

Keep everything in reach: keeping everything in reach would help in avoiding unnecessary stretching and strain. More or less this principle is affiliated with maintaining good posture.

Work at proper height: Working at right makes things way smooth and easy. Sometimes height can be maintained by adding extensions or avoiding extensions on the chair or tables. Minimize extreme motions: Repetitive motion necessarily avoided. This can produce disorder in long run. Motion scan be minimized through the use of power tools.

Reduce fatigue and static load: Fatigue is general in laborious work. Having to hold things for long term is example of static load. Fatigue can be minimized by the intervals and the breaks between the works.

Reduce pressure points: One needs to be conscious of pressure points. Everyone has to sit on chairs that had cushioning; one of the pressure point is behind knees, which happens if air is too high or when you dangle your legs. Pressure point is also created in between your thigh and the bottom of a table when you sit. Anti-fatigue mats can be used.

Give clearance: Work place should have proper clearance. Let the worker not worry about the bumps that they have to encounter every day.

Move, exercise and stretch: Move and stretch when possible. It is better to take intervals between the works and stretch and move along. Stretching technique may differ and depend on the work one does.

Maintain a comfortable environment: This principle is based on the other component of the working environment. It is concerned about the lightening, space, cool air and many more.

### **Ergonomic Injuries/Musculoskeletal Disorder (MSDs):**

- Ergonomic injuries or MSDs can influence the muscles, nerves, tendons, ligaments, joints, cartilage and spinal discs.
- Musculoskeletal disorder (MSDs) is also known as the repetitive motion injury.
- MSDs are the condition that can impact muscles, joints and bones.
- MSD are caused due to individual risk factor or ergonomic risk factor.
- MSDs are the single largest category of workplace injuries and are responsible for almost 30% of all worker's compensation costs

- Individual risk factor include age, nutrition, activity, etc. ergonomic risk factors includes:
- High task repetition
- Awkward body posture for longer period
- Sitting in same posture
- Lifting heavy weights. However, MSDs can be simply prevented as:
- Avoiding repetitive action.
- Use of machines for strenuous action.
- Maintaining the body posture.
- Use of cushion pads, lumbar support whiling sitting for the longer time.

### **Occupational Health Hazards of Handloom Weavers:**

Weaving process consist many occupational risk factors like awkward posture, high force, repetitive movement, long duration of work and high visual demand. Unfortunately, the traditional handloom approach to occupational health studies has tended to concentrate mainly on organized sectors and has neglected the occupational health problems in the informal sector where the mass populations of many developing countries live and works.

The handloom weaver's use hand operated looms that require the weaver to sit at the loom and operate foot pedals that hang down. Many studies on handloom weavers showed that pain in different body parts, respiratory problems, eye problems, problems of digestive system, and sleep disturbances was the main complaint among the weavers. Studies on the musculoskeletal disorders among handloom weavers showed that they suffered from pain in different body parts. The maximum discomfort felt in the lower back and knee, due to awkward sitting postures for long time, repeated movements of the limbs, altogether puts the workers into stress. Weaving processes are done on mainly two types of hand operated looms e.g., (i) desk-bench type workstation and (ii) sitting on floor with their legs hanging to operate the pedals at a lower level. The task of weaving demands repeated movement of upper and lower limbs to operate pedals and shuttles, with arms raised away from the body.

Weaving in textile units involves working with warping and weaving machines. The workers are exposed to vibration, cotton dust and noise. Standing work posture is maintained throughout the shift in operating power loom looms simultaneously. After raw materials are warped, the workers push and move iron beams weighing 75100 kg for a distance of about 2 m and this

kind of materials handling are performed 67 times per day. The job demands high attention in observing threads do not break off, mending the breaks and then change the beam after one is completed. The working environment and living conditions of the textile workers are poor and pathetic and even hazardous to their health.

They often do not have proper housing, ventilation, sanitation, water supply, proper electricity, natural and artificial lighting in working environment. There is no compensation for work stoppages by the employers. Many workers are Muslim by religion and weavers by caste. The textile work is a family affairs occupation and it is based on home industry.

Women and children are involved as co-supportive in weaving. Textile workers suffer many serious illnesses such as respiratory problems, musculoskeletal problems, mental disorders, stress, eye diseases, skin problem, gastritis and injuries. The ill health is compounded by various socio-economic factors such as poverty, lack of education, poor diet, addictions, poor working condition, excess working hours etc.

### **Handloom Industry in India**

India produced 95% of World's Hand-woven Fabric. Approx 15% of cloth production in India is from the handloom. Cloth production in 2019-20 (till January 2020) stood at 63,348 square meters.

Indian handloom industry demonstrates the richness and diversity of Indian culture. With over 4.3 million people are directly and indirectly involved in the handloom production.

Handloom industry is the second-largest employment provider for the rural population in India after agriculture. Indian handloom products are well known for their unique designs and finesse. The style is to mix old designs with new techniques and produce original products.

The industry has strong infrastructure, with about 2.4 million looms of various designs and construction, indicating substantial production capacity.

**Export Highlights:** The export of handloom products from India was valued at US\$ 343.69 million in FY2018-19. In FY20 (till September 2019), the exports stood at US\$ 178.04 million.

In 2018-19, the US was the major importer of Indian handloom products, with estimated purchases of US\$ 93.94 million, followed by the UK, Italy and Germany at US\$ 17.77 million, US\$ 16.47 and US\$ 14.65 million, respectively.

## Literature review

MSDs are very common health issue in all over world and also a major reason of workplace disability (Nur et al., n.d.; Punnett & Wegman, 2004). Maximum affected body regions are the low back, neck, shoulder, forearm and hand (Punnett & Wegman, 2004). Maximum of the work related MSDs are cumulative disorders which cause from exposures to high or low intensity repeated loads over a long period of time (Gangopadhyay & Dev, 2014; Sain &

Meena, 2016). Ergonomic interventions are the best solutions for the prevention of work related MSDs. For the handloom industries, it is compulsory to emphasis on quality and excellence through ergonomics. Ergonomics management is precious as a cost reduction, quality improvement, performance improvement and productivity-enhancing process (Mohd Makhbul et al., 2013). Work related MSDs, low back pain and other health issues result in maximized absenteeism and lost working time, adverse effects on labour relations, higher insurance and compensation costs, increased probability of accidents and errors, job transfer and higher turnover of workers, more scrap and decreased production, low-quality work and high administrative and personnel costs (Niu, 2010; Sain & Meena, 2016; Widanarko et al., 2012). Which ultimately minimizes productivity and increases cost to company. These problems can be minimized through ergonomic interventions which will develop better quality of life for workers and minimizes the financial losses and medical costs to companies and the economy (Ahasan & Imbeau, 2003; Roper & Yeh, 2007). A healthy worker is found nearly three times more constructive than a worker in poor health (Niu, 2010).

Studies show the risks in the textile sector exposure to noise and dangerous substances, to manual handling and working with dangerous machinery. Every processing stage from the production of materials to the manufacturing, finishing, coloring and occupational safety and health in the textile sector and packaging poses risks to workers and some of these are dangerous to health. These troubles have been classified as mechanical, physical, chemical, ergonomical and physiological hazards.

Unprotected working condition is a main problem observed in the handloom sector. It is also seen that handloom industry has been India's biggest cottage and labour intensive field, which has been playing major role in the country's economy by forming a part of India's rich heritage of weavers. Due to modernization and automation of the industries, handloom industry is

facing a tough competition. Above all unhealthy work atmosphere are all causing the decrease of this powerful sector.

According to (Sarkar, 2016) analyzed the health problems being faced by the weavers and suggested measures to uplift weavers in many aspects. Weavers are facing from many health issues like back pain, neck pain, foot pain, and joint pain. The reasons for health issues are poor ergonomic design at the workplace and no safety measures being followed at the work area. The researcher suggested that the government should take legislative measures to provide hygienic, clean and safe environments at the work area, the conduct of awareness programs on health issues and the conduct of regular health camps to monitor weaver's health status.

According to (Pandit et al., 2013) in Handloom area the four main problem are as causing MSDs were seating, treading, flying shuttle and cloth rolling operations. The weaving workers were found to work in uncomfortable posture for long time and repetitively. The force needed for shuttle operation was found  $6.67 \pm 1.39$  kg pulling with a repetition of  $94.67 \pm 13.59$  rpm constantly for 10 to 15 minutes which leads to disorder in trapezius muscles.

According to (Intervention of Ergonomics in Hand Driven Cotton Spinning Operation, n.d.) cotton spinning industry among hand driven cotton spinning operators, symptoms from knees, back and shoulders over the course of time were significantly more prevalent compared to other body parts. Any program for improving working condition should focus on reducing awkward posture of the body parts. Workers with uncomfortable posture, mostly suffer from MSDs particularly affecting the low back and neck area.

(Satheeshkumar & Krishnakumar, 2020) concluded in their studies that musculoskeletal disorder related to work is a major problem in most occupations. The objective of this research was to determine the prevalence, characteristics, and impacts of WMSDs in certain anatomical areas of the body among handloom industry workers in Kerala. This research was conducted with a modified Nordic Musculoskeletal Questionnaire (NMQ) to assess the prevalence of disorders that occurred. A self-administered questionnaire in regional language was prepared and distributed among 380 full-time handloom workers. (Ganguly & Ganguly, 2015) conducted research to study the dietary status, socio-economic status, and occupational health hazards of the Baluchari Shari weavers of Bishnupur. Sixty-two handloom weavers in the age group between 17-75 years willingly co-operated for the study and thus were selected by the convenient sampling procedure. The evaluation of their nutritional condition exhibited notable pervasiveness of malnutrition (53.22 %) in the weavers of Baluchari Sari.

(Bori & Bhattacharyya, 2020) conducted the study to assess the working posture of women workers involved in various handloom activities. Data were collected by interview method, photography, video recording, and observation of work practices. A total of 60 workers were taken for the study from the Lakhimpur district of Assam. The postural assessment was done by using ergonomic tools: RULA and Strain Index. Awkward postures were observed in the handloom workers. The mean RULA score was found highest in weaving activity with 6.

41±0.49 followed by warping, spinning. Strain Index was found highest in the right hand and left hand of weaving activity. The high occupational risk was found in the handloom activities. Therefore the application of ergonomics would help in reducing postural exertion.

(Muhamad Ramdan et al., 2020) conducted research on forty women weavers of Samarinda sarongs to ascertain the widespread and risk component of musculoskeletal disorders (MSDs). In this study, a Nordic body map, anthropometric equipment, and rapid upper limb assessment (RULA) were used to intrigue the MSD extremity, work posture, and anthropometric dimensions of the weavers, respectively.

Carpet weavers experienced musculoskeletal disorders mostly due to poor working postures.

The postures were mostly restricted due to the poor design of workstations. (Choobinch et al., 2007) explained that lengthy hours of constant work with inappropriate posture at old designed looms causes the extreme presence of musculoskeletal disorders among carpet weavers. The carpet industry possesses a central position in the economic strength of different countries. The weavers performing in the carpet industry agonize from a different kind of health risk component. The hazards in the carpet industry are exorbitant and the potential to control them is lower and more threatening. The predominance of the problems are due to poor ergonomics and designing of work station and prolonged hours of constant working atmosphere in the carpet industry (Ahmad Wani & Jaiswal, 2012).

The social and physical well-being of the weavers has not been much considered a priority in government policy. Musculoskeletal disorders (MSDs) are typically common to almost all the occupations and segments related to weaving, which leads to serious physical and economic aftermath for weavers, and their dependents. The Finnish Institute of Occupational Health (FIOH) identified musculoskeletal disorders as one of the most widespread work-related frailty, emphasizing that despite several parts of the

body being involved, the back experiences most of the discomfort (Gómez-Galán et al., 2017; Motamedzade, 2009).

Weaving is considered to be a highly labour-intensive task, with the labour cost accounting for up to an average of 65% of the production cost. Some of the MSDs that commonly occur are carpal-tunnel syndrome (CTS), tendonitis and lower-back pain, which are generally caused by repetitive motions, awkward and non-neutral postures, poor working conditions, among other things. There is a correlation between the MSDs and occupation. Therefore, there is a critical need to evaluate the occupational risk factors among the unorganized sector, particularly the weaving industry in India. The postures of workers also need to be modified, and corrective measures need to be introduced to minimize the risk of musculoskeletal disorders in the long term (Parida & Ray, 2012). The weaver has often been forced to adopt squatting posture to operate the traditional carpet looms and as the width of the carpet increase and they have to lean forward to complete the task (Banerjee & Gangopadhyay, 2003).

### **Conclusion**

The literature regarding MSDs and other occupational health problems in labour intensive handloom Industry has been reviewed in order to identify occupational health problems and benefits through ergonomic interventions, to develop a future research strategy. It is observed that MSDs and other occupational health problems are common in handloom weavers due manual work and un-ergonomic design of tools and work places. It is also observed that the ergonomic intervention improves wellbeing of workers which ultimately increases productivity, revenue, and reduces rejection cost. This review gives a quick overview of ergonomic issues of handloom weavers. In India a lot of work is required in the field of ergonomic intervention in handloom industry which would greatly help the economy of the country.

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# कौशल विकास भारतीय परम्परा के नेपथ्य से

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## Women Empowerment Through Apparel Based Training

**Mrs. Sunayana Kushwaha\***

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Women empowerment means that women should take part on an equal basis with men in economic, social, cultural and political decision-making at all levels and in all spheres of public and private life. Women, who now represent 48.2% of the population, are getting access to education, and then employment. From 5.4 million girls enrolled at the primary level in 1950-51 to 61.1 million girls in 2004-05. At the upper primary level, the enrolment increased from 0.5 million girls to 22.7 million girls. Today modern woman is so deft and self-sufficient that she can be easily called a superwoman, juggling many fronts single handedly. Women are now fiercely ambitious and are proving their metal not only on the home front, but also in their respective professions. Women in Indian are coming up in all spheres of life. They are

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joining the universities and colleges in large numbers. They are entering into all kinds of professions like engineering, medicine, politics, teaching, etc. A nation's progress and prosperity can be judged by the way it treats its women folk. There is a slow and steady awareness regarding giving the women their dues, and not mistreating them, seeing them as objects of possession. Women of India slowly started recognizing her true potential. She has started questioning the rules laid down for her by the society. As a result, she has started breaking barriers and earned a respectable position in the world. Today Indian women have excelled in each and every field from social work to visiting space station. There is no arena, which remains unconquered by Indian women. Despite progress, the very fact that women, along with being achievers, also are expected to fulfill their roles as wives or mothers, prioritizing home against anything else. The main objective of this study to find out the impact of apparel based training to empower the girl students. To enable employment ready workforce in the future, the youth need to be equipped with necessary skills and education. In this study 106 respondents were selected from B.A. second year and B.A. third year of V.K.M. and Arya Mahila P.G. college of Varanasi district. There was multi stage sampling method. Selection of college was purposive sampling method. Total Data were collected through self structured questionnaire. the average knowledge score about cutting of fabrics, drafting, seam, knowledge regarding paper 'pattern making, and knowledge about darts and tucks is found to be statistically highly significant between pre & follow up first follow up first and second and between pre and follow up second respectively.

**Malleswari (2014)** Revealed that through apparel making and embroidery training programme that there was about 142.5 per cent gain in knowledge among the trainees. It is evident from the study in apparel making and embroidery training given by BCT-KVK, every trainee is an earner. The beneficiaries got hands on experience during the training programme and started individual units in their respective villages and also got employment in the

nearby apparel companies. The KVK is offering necessary technical support during the follow up visits. There is good demand for Apparels. The apparel making and embroidery has given a boost to rural women and giving supplementary income and additional employment especially to house wives.

**Oppong (2014)** Revealed that most of the garment producers had the basic equipments that are just necessary to stay in business but not sophisticated machinery that can be used to produce to meet international standards. Three major problems confronting the garment producers were (a) inability to produce on a large scale (b) inability to produce at competitive prices and (c) inability to satisfy quality standards. Garment producers found in the Accra-Tema metropolis did not have much knowledge of computer technology.

**Maiyo, (2013)** Identify the contribution of Kenyan University undergraduate fashion and apparel design programs (UUGFADPs) towards manpower development for Kenyan FA industry. Descriptive survey was used to collect data. The target population was Kenyan university departments offering UUGFADPs as well as their graduates. Purposive and snowball sampling were employed to select 208 respondents. Data collection methods were questionnaires, in-depth oral interviews, and document analysis. Qualitative data were coded according to patterns and themes and presented descriptively. Quantitative data was analyzed and summarized using descriptive statistics then presented in tables. Findings indicate that Kenyan UUGFADPs contributed to FA industry through research, training for various roles, job creation and community development. This paper recommends that for the UUGFADPs to give maximum contribution to the apparel industry.

**Pani and Sharma (2012)** Focused that recent developmental trends in fashion marketing in India for promoting apparel retailing. This paper highlights the strategies implemented by Indian fashion retailers to achieve global competitiveness and win customers confidence. The study also evaluates the scopes and challenges of fashion retailing in India. The scope of the study is limited

to the area of Apparel retailing. Based on the data collected through secondary sources, this paper makes an assessment of the extent of innovativeness and responsiveness retail sector for marketing fashion. In the concluding section, limitations of the study have been discussed and recommendations provided for undertaking more detailed investigations in the area.

**Shanmugasundaram and Panchanatham (2011)** Discussed that Embracing Manpower for productivity in Apparel Industry. They analysed what are the Manpower related export problems disturbing the export performance in Madras Export processing Zone, Special Economic Zone and Export oriented units with the help of administering Questioner. The study is diagnosing factors of labour productivity in the Apparel Manufacturing Export Units. The paper Suggest, Labour productivity can be improved by imparting knowledge and skills to the workforce by arranging training programmes with experts both from India and abroad.

It is projected from the above table that knowledge score regarding fabric cutting during pre invention is found to be 3.12 among computerized C.D. and manual booklet provided students respectively. After giving specified educational material mean knowledge score increases and accounted to be 3.67 during follow up first as well as 4.11 during follow up second respectively. It is seen that the rate of increase in mean knowledge among is significantly higher regarded this matter in computerized C.D provided students during first and second follow up respectively.

Knowledge of the students regarding matter of drafting is assessed during pre and after invention. It is also observed that the mean knowledge score is found to be 2.21 in all the students before pre invention. After supplying specified training based educational material the mean knowledge score significantly increased to be 3.11 during first and second follow up and after application of practical training programme it significantly re-increase to be 3.81 during second follow up respectively among all the students. It is also seen that the rate of increase in knowledge is found to be significantly similar during follow-up first in all



Mean score ( $\pm SD$ ) of respondents knowledge regarding during pre & post intervention—

S. n.	Respondent's knowledge regarding	Pre	Follow up I <sup>st</sup>	Follow up II <sup>nd</sup>	T - test between		
		Mean $\pm$ S D	Mean $\pm$ S D	Mean $\pm$ S D	Pre & I <sup>st</sup> Follow up	I <sup>st</sup> & II <sup>nd</sup> Follow up	Pre & II <sup>st</sup> Follow up
1.	Cutting of fabric	3.12 $\pm$ .75	3.67 $\pm$ .90	4.11 $\pm$ .83	t=5.13	t=3.78	t=8.66
					P<0.001	P<0.001	P<0.001
2.	Knowledge about drafting	2.21 $\pm$ 1.04	3.11 $\pm$ 1.12	3.81 $\pm$ .98	t=6.38	t=5.80	t=11.41
					P<0.001	P<0.001	P<0.001

Paper pattern		t=4.13    t=2.46    t=6.11					
3.	making	3.22 $\pm$ 1.25	3.87 $\pm$ 1.16	4.21 $\pm$ 1.00	P<0.001	P<0.001	P<0.001
4.	Knowledge regarding seam	3.53 $\pm$ 1.08	3.93 $\pm$ .87	4.41 $\pm$ .86	t=2.96	t=4.64	t=6.73
					P<0.001	P<0.001	P<0.001
5.	knowledge about darts and tucks	2.92 $\pm$ 1.36	3.88 $\pm$ 1.02	4.24 $\pm$ .97	t=6.73	t=3.02	t=8.43
					P<0.001	P<0.001	P<0.001

the students.

It is seen that the mean knowledge score about paper pattern making is found to be 3.22 all the students respectively at the time of first survey but after providing necessary educational materials it is obtained to be 3.60 and the after practical training it is found to be 4.21 in all the student respectively. There is significant increase in knowledge of all the students between pre & follow up first, follow up first and follow up second between pre and follow up second respectively. The rate of increase in knowledge among all the student is found to be similar pattern because no significant difference in knowledge during pre, follow up first and second respectively. In the beginning of the survey the mean knowledge score about seam is found to be 3.53 among apparel construction training provided students about seam during pre invention but after application of specified training materials significant increase in mean knowledge score is seen which is counted to be 3.93 during first follow up respectively. The mean knowledge score was found to be 4.41 among students at the time of second follow up respectively.

The mean knowledge score found to be 2.92 among apparel construction training provided students about darts and tucks during pre invention but after application of specified training materials significant increase in mean knowledge score is seen which is counted to be 3.88 during first follow up respectively. The mean knowledge score was found to be 4.24 among students at the time of second follow up respectively. The rate of increase in mean knowledge score is found to be significantly higher during first follow up among all students at the time of pre intervention and second follow up respectively.

**Conclusion :** In present time women empowerment is demand of our society. The training about apparel construction is small try to empower the students. In this study assessment of the impact of apparel construction training programme and after supplying necessary educational material and practical training programme among girls, the average knowledge score about cutting of fabrics, drafting, seam, knowledge regarding

paper pattern making, and knowledge about darts and tucks is found to be statistically highly significant between pre & follow up first follow up first and second and between pre and follow up second respectively.

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**Chapter - 1**  
**Structure and Chemical Composition of Cellulose  
and Its Enzymatic Degradation: Pre-Treatment  
Process with Enzymes and Swelling Agents on  
Khadi Cotton Fabric**

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# Chapter - 1

## Structure and Chemical Composition of Cellulose and Its Enzymatic Degradation: Pre-Treatment Process with Enzymes and Swelling Agents on Khadi Cotton Fabric

Dr. Sunita Dixit and Dr. Sangita Deodiya

### Abstract

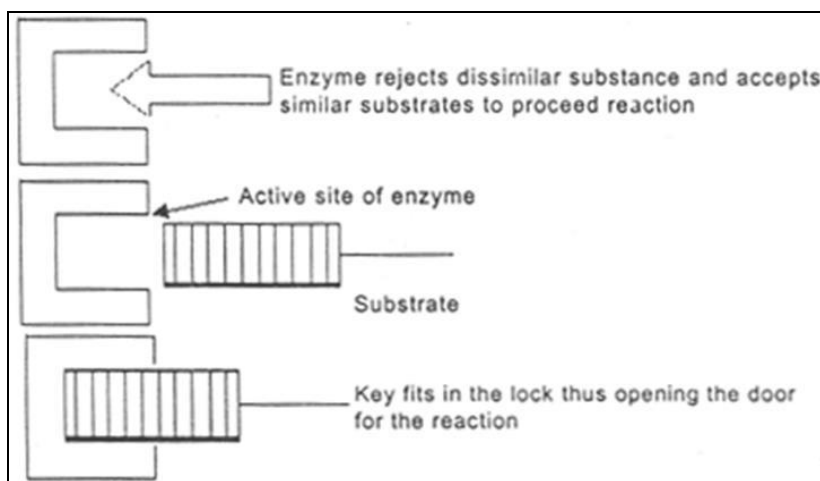
Handloom sector is known for its heritage and the tradition of excellent craftsmanship. But, the khadi cotton has some major shortcomings like higher maintenance costs for washing, ironing, rough texture, less dyeability and poor colourfastness. Nowadays the use of cellulases in the pretreatment process has found much broader acceptance as the effect of the treatment is long lasting and eco-friendly in nature. Due to increased environmental awareness the use of natural dyes are much preferred in dyeing of handloom fabrics, thus it has become imperative to revive the art of natural dyeing based on revised technology and scientific methodology. Thus, the present research was planned by keeping in view the emerging trend of bio-processing, use of swelling agents and dyeing with natural dyes. The present study was conducted to optimize the pre treatment process with acid (Americas Cellscos 450 AP) and neutral (Americos Cellucom 110 OM) cellulases and swelling agents (Sodium hydroxide, Ethylenediamine and Zinc chloride) on khadi cotton fabric. The dyeing of khadi cotton fabric with two natural dyes i.e. Tesu (*Butea frondosa*) and Sandalwood (*Pterocarpus santalinus*) using natural and metallic mordants was carried out. The comparison of colour strength (K/S) and colour fastness properties of untreated dyed sample and enzymatically and swelling agents treated and dyed sample was done. The economic feasibility of the process was also studied.

**Keywords:** Enzymes, cellulase, khadi fabric, swelling agents, colourfastness

### Introduction

The term “Enzyme” is derived from the Greek word “Enzymes” which means “in the cell or ferments.” They are complex protein ferments secreted by living organisms and are believed to be as old as life itself. Enzymes are

the naturally occurring high molecular weight proteins capable of catalyzing the chemical reactions of biological processes and hence are known as “Bio-catalysts”. Enzymes, being bio molecules, are susceptible to environmental conditions and, therefore, the rates of reaction catalyzed by enzymes also show a significant variation. They do not cause the reaction to take place, but can only accelerate the reaction at substrate surface. They contain true activity centres in the form of the three-dimensional structures. The “active site” is the part of the enzyme molecule that combines with the substrate. The number of active sites per molecule is very small, generally only one. In order to catalyze a reaction, the enzyme molecule has to form a complex with the substrate. The binding sites of the enzyme recognize corresponding domain of the molecule. This makes the enzyme specific towards the substrates and allows proper orientation of both the molecules so that the reactive sites of the enzyme molecules have to access to the appropriate part of the substrate molecule. Thus, enzyme catalysis operates first of all to form an enzyme-substrate complex. An enzyme is adsorbed into a substrate surface in “lock and key fashion” (Fig. 1).

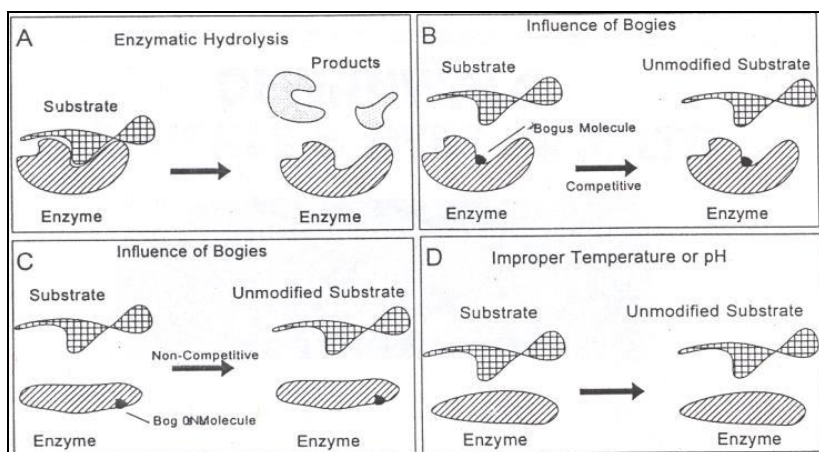


**Fig 1:** Lock and Key Mechanism

Bio-reaction takes place in the above mentioned enzyme-substrate complex through reduction of the activation energy to a multiple of the reaction speed. Finally, the complex disintegrates with the release of the reaction products and the original enzymes are once again available. The process continues until the enzyme is poisoned by a chemical bogie or inactivated by extremes of temperature, pH, or by other negative conditions in the processing environment. When the attack of enzyme on a specific

substrate takes place under proper conditions, the substrate breaks down to products releasing the original enzyme (Fig 2A).

A competitive bogie is a molecule that becomes attached to the active sites on the enzyme blocking it from being adsorbed by the substrate (Fig 2B). The bogie competes with the substrate for the enzyme. It need not cause the shape of the enzyme to change. A non competitive bogie is a molecule that become attached to the three dimensional shape of the enzyme to change (Fig 2C). Since the shape of the enzyme has changed, the substrate and enzyme can no longer approach each other to permit the lock and key mechanism to be operative. Both competitive and non-competitive bogies effectively poison the effectiveness of given enzyme system. The improper conditions of temperature or pH also do not allow action on enzyme on the substrate (Fig 2D) (Etters, 1998).



**Fig 2:** Factors affecting enzyme action

## Sources of Enzymes

According to Shukla *et al.* (2000) pancreatic enzymes are prepared from slaughter-house waste such as pancreas, clotted blood, liver, etc. whereas malt extracts are made from germinated barley. Bacterial enzymes are produced by growing culture of certain micro organisms in sterilized wort, proving an excellent supply of enzymes. Large population of microbial cells can be grown under controlled conditions and in a relatively short time to provide a uniform and inexpensive raw material for enzyme manufacture.

## Properties of Enzymes

According to Nalankilli (1998), some of the important properties of enzymes are as follows:

1. Physically, enzymes are colloidal in nature and chemically they are of the nature of proteins
2. Enzymes are complex and have high molecular weights
3. Enzymes are destroyed by high temperature because proteins get denatured. But upto 40 °C the enzymatic activity is rated double for every ten degrees in rise of temperature
4. Enzymatic reactions are reversible
5. The activity of enzymes is limited to a narrow range of pH
6. Enzymes are inhibited by cyanides, sulphides, azides etc
7. The range of specificity varies in different enzymes

## **Factor Influencing Enzymatic Activity**

### **Reaction temperature**

Enzymes, with increase in temperature, the activity increases due to increased possibilities of enzymes coming closer to substrate molecules. On the other hand, denaturation of enzyme protein due to heat is also accelerated. This diminution of activity is generally irreversible. The thermal inactivation is a logarithmic function of the time of exposure to the inactivation temperature. It is hence imperative that a thermostable enzyme must be used if the reaction temperature is higher. For lower reaction temperatures, less expensive enzymes, which are not thermostable, could be conveniently selected (Shukla *et al.*, 2000).

### **Reaction pH**

Enzymes have optimal activity at a particular pH. In order to achieve the high yield, it is important to keep pH at optimum value. Any change in pH, lower the reaction rate. A variation of the pH during the course of the reaction may cause the alteration in the enzyme protein structure with a denaturing effect on the enzymes or the ionization of the active sites. The suitability of the pH varies from enzyme to enzyme (Verma and Nishkam, 2002).

### **Presence of Inhibitors**

Certain chemicals such as alkalies, antiseptics, acid liberating agents tend to inhibit the enzyme activity, by blocking certain useful groups. The reaction products themselves may also inhibit the enzyme. The inhibitor possesses an affinity for the enzyme with which it is combined, thus actually creating competition between itself and the substrate, its action being reversible. (Shukla *et al.*, 2000).

## **Presence of Activators**

Some of the bivalent metallic cations activates certain enzymes. Metallic cations such as  $\text{Ca}^{++}$ ,  $\text{Sr}^{++}$ ,  $\text{Mg}^{++}$ ,  $\text{Zn}^{++}$ ,  $\text{Co}^{++}$  etc. sensitize the substrate to attack of the enzymes. Certain metals are capable of becoming part of the enzymes. They enter into the constitution of the prosthetic group and take part in the ion exchange. The activation can only be carried out indirectly (Verma and Nishkam, 2002).

## **Cellulase Enzymes**

Cellulases are derived from both fungal and bacterial sources and find extensive application on cellulosic materials and about 10% of the finishing of these materials is estimated to be performed by these enzymes to achieve various effects. Cellulases used in bio-finishing of cellulosic fabrics are derived from more than ten different fungal species which vary in their component composition, application pH and special effects produced. Cellulases derived from the fungus, *Trichoderma reesei* is widely used in textile finishing since it gives higher yield in industrial production. In addition to cellulases originating from the above fungus, those originating from *Humicola insolens* can also degrade cotton cellulose efficiently and they find extensive application in biostoning of denim fabric (Vardhini and Selvakumar, 2006).

Dyeing or finishing process performed in conjunction with the enzymatic treatment can therefore be of significant impact on the properties of the end-product. Especially dyes and finishing compounds that form covalent bonds with the cellulose strongly affect the substrate recognition of the enzymes. On the other hand, in case of a cellulase pretreatment, dye-or finishing-binding sites on fiber surfaces and in amorphous areas might be altered by the action of the enzymes (Buschle-Diller *et al.*, 1997).

According to Klahorst *et al.* (1996) acid cellulase is a type of cellulase enzyme that works best in the pH range of 4.5-5.5. Neutral cellulase is a different type of cellulase, so named because it is active from pH 6-8, but optimally at pH 6.

## **Swelling Agents**

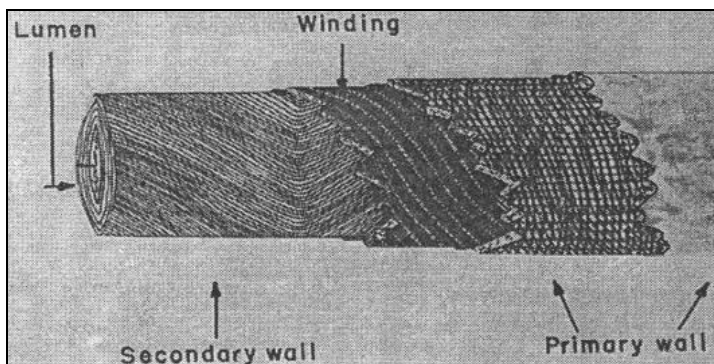
Swelling is perhaps the best tool to study the structure of cellulosic fibres. With cellulosic fibre substance, most of the reaction and chemical modification usually take place at the hydroxyl groups of the anhydro-D glucopyranose units, as the case of dyeing with reactive dyes. In order to achieve significant chemical modification of the fibre substance, it is

necessary to increase the accessibility of the cellulosic hydroxyl groups to the reagent, both in the readily accessible region as well as in the difficult-to-reach portion of the fibre.

All polymers, including cellulose, are non-compact and contain voids. When cellulose is brought into a fluid environment, for example, when it is totally immersed in a liquid containing a swelling agent, the molecules of the fluid penetrate into the voids of the fibre and are absorbed on the accessible surface. The opening of these voids depends largely on the nature of the swelling agents. Various agents like sodium hydroxide, zinc, chloride, zinc thiocyanate, sulphonic acid, phosphoric acid, barium hydroxide etc. are main inorganic swelling agents for cellulose. While mono-di-tri-triamines, quaternary ammonium compounds and cyclic aromatic compounds containing one or two nitrogen atoms are organic swelling agents. The swelling is possible in both aqueous as well as in non aqueous media (Thakare, 2006).

### Structure and Chemical Composition of Cellulose

The cotton fiber is a single biological cell and the layers in the cell structure are, from the outside of the fiber to the inside, cuticle, primary wall, secondary wall and lumen. These layers are different structurally and chemically. The primary and secondary wall have different degrees of crystallinity, as well as different molecular chain orientations. The cuticle, composed, of wax, proteins, and pectins, is 2.5% of the fiber weight and is amorphous. The primary wall is 2.5% of the fiber weight, has a crystallinity index of 30%, and is composed of cellulose. The secondary wall is 91.5% of the fiber weight, has a crystallinity index of 70% and is composed of cellulose. The lumen is composed of protoplasmic residues. A morphological structure of the cotton fibre is given in Fig. 3



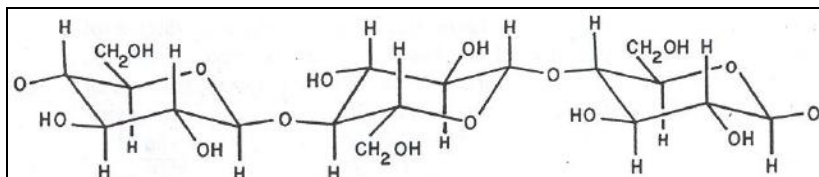
**Fig 3:** Morphological structure of the cotton fibre

The chemical composition of a nature cotton fiber is presented in the Table

### Typical Values for the Composition of a Mature Dry Cotton Fiber

Constituent	Composition of a Fiber			
	Typical %	Low %	High %	Composition of the Cuticle
Cellulose	94.0	88.0	96.0	-
Protein (N* 6.25)	1.3	1.1	1.9	30.4
Pectic substances	0.9	0.7	1.2	19.6
Wax	0.6	0.4	1.0	17.4
Mineral matters	1.2	0.7	1.6	6.5
Maleic, citric and other organic acids	0.8	0.5	1.0	-
Total sugars	0.3	-	-	-
Cutin	-	-	-	8.7

Table shows that a non cellulosic material accounts for only a very small amount of the fiber weight. These materials are amorphous and are located in the cuticle and the lumen. The cuticle forms a protective layer to shield the cotton from environmental attacks and water penetration. Waxy materials are mainly responsible for the non-absorbent characteristics of raw cotton. Pectins may also have an influence, since 85% of the carboxyl groups in the pectins are methylated. Natural pigment in the cotton and other matter picked up by a cotton substrate in yarn or fabric making responsible for the greyness of the substrate before bleaching (Li and Hardin, 1997).



**Fig 4:** Structure and conformational formula of cellulose

Cellulose, a high molecular weight linear polymer, is composed of D-glucose, building blocks, joined by  $\beta$ -1, 4-glucosidic bonds. In native cellulose, upto 10, 000  $\beta$ -anhydroglucose residues are linked to form a long chain molecule. This means that molecular weight of native cellulose is above 1.5 million. As the length of the anhydroglucose unit is 0.515nm (5.15  $\text{A}^0$ ), the total length of a native cellulose molecule is about 5 $\mu$ m. In a cellulose chain molecule, each anhydroglucose unit assumes the chair configuration with the hydroxyl groups in the equatorial and the hydrogen

atoms in the axial positions. The conformational formula (chair form) of cellulose (poly-1, 4-D-Glucosan) is shown in Fig.4, where it can be seen that alternate chain unit is rotated  $180^{\circ}$  around the main axis. This results in an unstrained linear configuration, with maximum steric hindrance. The glucosidic linkage acts as a functional group, and this along with the hydroxyl groups, mainly determines the chemical properties of cellulose. All significant chemical reactions occur at these locations (Fan *et al.*, 1987).

Cotton cellulose consists of crystalline fibrils varying in complexity and length and connected by less organized amorphous regions with an average ratio of about two-thirds crystalline and one-third non-crystalline material, depending on the method of determination. The crystalline part of cellulose can occur in different crystalline lattice types, called cellulose I, Cellulose II, Cellulose III, Cellulose IV or cellulose X, but only Cellulose I and Cellulose II are important in textile processing. The form that naturally occurs in nature is Cellulose I. Cellulose II is the thermodynamically stable form produced when cellulose I is destroyed by swelling with strong alkali (mercerization) or regenerated from solution in the viscose process.

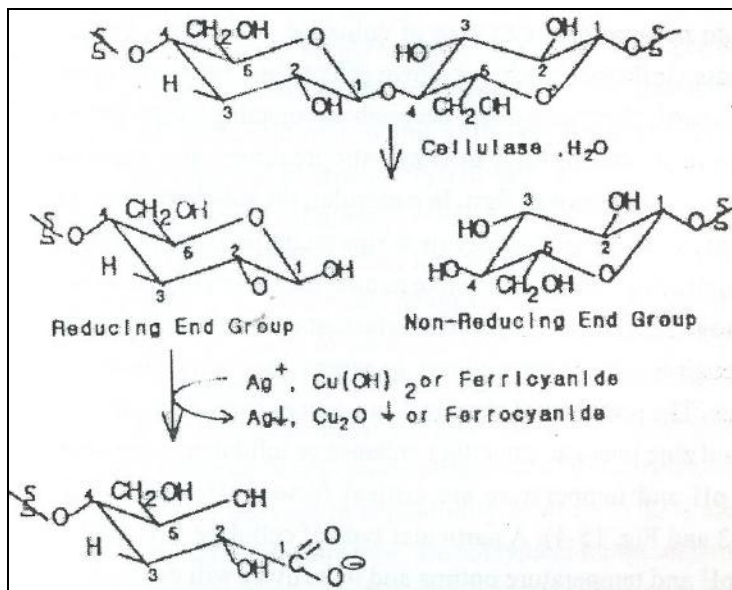
The chain length, or degree of polymerisation (DP), of a cotton cellulose molecular represents the number of anhydroglucose units connected together to form the chain molecule. DP of cotton may be as high as 14,000 but it can be reduced to 1000-2000 by different purification treatments with alkali. The individual chains adhere to each other along their lengths by hydrogen bonding and vander Waals forces. The physical properties of the cotton fibre as a textile material, as well as its chemical behaviour and reactivity, are determined by arrangements of the cellulose molecules with respect to each other and to the fibre axis (Heikinheimo, 2002).

### **Enzymatic Degradation of Cellulose**

Endoglucanases or endo-cellulases, hydrolyse cellulose polymers randomly along the chains, preferably attacking non-crystalline region. Cellobiohydrolases or exo-cellulases attack the polymer chain ends and produce cellobiose. Coupled with the binding domains associated with the enzyme, exo-cellulases may assist in degradation of cellulose by disrupting the local crystalline cellulose structure, which makes the region more susceptible to subsequent hydrolysis by endo-cellulases. The reducing and non-reducing end groups by the action of cellulase on 1, 4- $\beta$  glycoside bond of the cellulose molecule is represented in Fig. 5.  $\beta$ -glucosidase hydrolyze small chain oligomers, such as cellobiose into glucose. The three types of cellulase component act synergistically in degrading cellulose to glucose. Synergism of different components in the cellulase complex and inhibition



mechanisms further complicate the reaction. Enzyme diffusion plays a much more decisive role in the heterogeneous system of soluble enzyme and solid substrate. The kinetics of reaction therefore depends on the diffusion of enzyme to and into the solid phase of the substrate and the diffusion of the reaction products out of the solid phase into the liquor. For cotton the restriction of the enzyme to the fibre surface is easily achieved because cellulose is a highly crystalline material and possesses only small amorphous areas, making the diffusion of enzymes into the interior of the fibres nearly impossible. Thus by regulating enzyme dosage and choosing the right type of enzyme the catalytic action of the enzyme can be confined to the surface of cotton and to amorphous regions, leaving the fibres, as a whole, intact (Karmakar, 1999).



**Fig 5:** Enzymatic hydrolysis of cotton cellulose

### **Pre-Treatment Process with Enzymes and Swelling Agents on Khadi Cotton Fabric**

In the present day, handloom sector is known for its heritage and the tradition of excellent craftsmanship. But due to some inherent limitations, our handloom sectors are facing cut throat competition and ever growing challenges imposed by the low cost high end power loom products of various countries including our own especially in this age of globalization. One of the measures to revive our moribund handloom sectors is to produce articles through value addition with eco-friendly natural dyeing.

However, it is important to impart pre treatment to cotton to attain whiteness, uniform good absorbency, without chemically, damaging cotton. Efforts are being made in recent years to develop a mild and environment friendly process. Thus enzymatic pre treatment has assumed more importance due to present concern of clean and eco-friendly environment. It is also a known fact that crystalline region of cellulose is loosened by swelling agents and thus increasing the absorbency of the fabric towards water and dyes.

Due to increased environmental awareness the use of natural dyes are much preferred in dyeing of handloom fabrics, thus it has become imperative to revive the art of natural dyeing based on revised technology and scientific methodology. But, the khadi cotton has some major shortcomings like higher maintenance costs for washing, ironing, rough texture, less dyeability and poor colourfastness. Thus, the present research was planned by keeping in view the emerging trend of bio-processing, use of swelling agents and dyeing with natural dyes. The present study was conducted to optimize the pre treatment process with enzymes and swelling agents on khadi cotton fabric. The dyeing of khadi cotton fabric with two natural dyes using two natural and metallic mordants was carried out. The comparison of colour strength (K/S) and colour fastness properties of untreated dyed sample and enzymatically and swelling agents treated and dyed sample was done. The economic feasibility of the process was also studied.

Experiments were conducted to determine optimum values of four variables for acid and neutral cellulase enzyme treatment, namely, pH, concentration, treatment time and temperature. Concentration, treatment time and temperature were the three variables optimized for the swelling agents. Dyeing variables i.e. concentration of dye material, extraction time, dyeing time, mordant concentration and method of mordanting with natural and metallic mordants were optimized.

The colour strength (K/S) and colour fastness properties against washing, light, rubbing and perspiration of both the untreated and the enzymatically and swelling agents treated and dyed samples were evaluated and compared. Estimation of the cost effectiveness for the adoption of the pre treatments and dyeing was accomplished by conducting cost estimation. The cost of dyeing of one metre of untreated and pretreated khadi cotton with cellulases and swelling agents using Tesu and Sandalwood dye without mordant as well as with both natural and metallic mordants were calculated. The cost of dyeing and pretreatment process was calculated including cost of fabric, dye, mordants, cellulases, swelling agents, labour and electricity charges.

Commercial acid cellulase enzyme (Americos Cellscos 450 AP) and neutral cellulase enzyme (Americos Cellucom 110 OM) were selected for enzymatic pre treatment of khadi cotton.

Sodium hydroxide, Ethylenediamine and Zinc chloride were the three swelling agents used for the treatment of khadi cotton. Two natural dyes namely Tesu (*Butea frondosa*) and Sandalwood (*Pterocarpus santalinus*) were used for the study. The two natural (Babool and Harda) and two metallic mordants (Alum and Copper sulphate) were selected for Tesu dye. In case of Sandalwood dye, two natural mordants (Babool and Pomegranate) and two metallic mordants (Alum and Tartaric acid) were selected.

In the present study, various statistical tools were used particularly relevant to fulfill the specific objectives of the present study. The data were presented using mean and standard deviation and suitable tables were also made for the classified data as per analysis of different levels of pH, concentration, treatment time and temperature. Weighted mean score was calculated for quantifying the ratings of colourfastness. The fastness to washing was given highest weight 4 since it is most important followed by fastness to light, rubbing and perspiration which were given weight 3, 2 and 1, respectively.

The F-value, as obtained from the one way analysis of variance, was found to be statistically significant at 1% level of significance, which indicated that here was significant different in weight loss, tensile strength loss (warp and weft direction), moisture content, bending length (warp and weft direction), crease recovery angle (warp and weft direction), thickness and water absorption related to different levels of pH, concentration, treatment time and temperature of both acid and neutral cellulase enzyme.

The optimum pH, concentration, treatment time and temperature selected for the acid cellulase enzyme treatment were 5.5, 1.5% (owf), 45 minutes and 50 °C, respectively as significant differences in the mean values of all the physical parameters were found upto these levels by comparison of means at 1% level of significance.

In case of neutral cellulase enzyme, the optimum pH, concentration, treatment time and temperature selected were 7.5, 2.0% (owf), 70 minutes and 70 °C respectively, as it was proved statistically by comparison of means at 1% level of significance that significant difference in the mean values of all physical parameters occurred upto these levels.

The F-values, computed at 1% level of significance from one way analysis of variance confirmed that there was a significant difference in the

mean values of all the physical parameters due to different levels of concentration, treatment time and temperature of three swelling agents viz., Sodium hydroxide, Ethylenediamine and Zinc chloride.

The optimum concentration, treatment time and temperature selected for Sodium hydroxide treatment were 20% w/v, 60 minutes and 60 °C, respectively. In case of Ethylenediamine, 80% w/v, 60 minutes and 70 °C were selected as optimum concentration, treatment time and temperature, respectively. In case of Zinc chloride treatment, the optimum concentration, treatment time and temperature were selected as 80% w/v, 60 minutes and 70 °C, respectively. Significant differences in the mean values of all the physical parameters were found upto these selected level of concentration, treatment time and temperature in all the three swelling agents. Significant differences in the mean values of various physical parameters studied indicated significant improvements in the physical parameters.

It was found that 5 g Tesu dye extracted for 75 minutes gave best results on khadi cotton when dyeing was carried out for 90 minutes whereas 5 g Sandalwood dye extracted for 90 minutes gave best results on khadi cotton when dyeing was carried out for 75 minutes. It was observed that out of various concentrations of mordants used with Tesu dye, best shades of colour were obtained by using 0.04 g of Alum, 0.01 g of Copper sulphate, 5 g each of Babool bark and Harda whereas 0.05 g each of Alum and Tartaric acid, 5 g each of Babool bark and Pomegranate rind gave best shades of colour with Sandalwood dye. On optimizing the method of mordanting, best results were obtained with Tesu dye when samples were simultaneous mordanted and dyed with Alum, Babool bark and Alum. Pre-mordanting was selected for Copper sulphate. In case of Sandalwoods dye, Pre-mordanting was considered as best for both Alum and Tartaric acid. Pomegranate rind gave best shades with Post Mordanting and Simultaneous mordanting and dyeing was considered as best for Babool bark. The blank samples dyed with Tesu dye showed Light yellow colour whereas natural mordants Babool bark and Harda gave Daffodil colour and Golden yellow and Rust colour were obtained with metallic mordant Alum and Copper sulphate, respectively. In case of Sandalwood dye the natural mordant Babool bark and Pomegranate rind gave Bath stone and pale cream colour, respectively whereas metallic mordant Alum and Tartaric acid produced Honey and Bath stone colours respectively.

It was found that for all the enzyme treated (acid and neutral cellulase) as well as swelling agents treated (Sodium hydroxide, Ethylenediamine and Zinc chloride) samples, the K/S values, and thus the colour strength were increased in comparison to the untreated samples.

Among the three swelling agents, Sodium hydroxide treated sample obtained the highest colour strength (K/S) followed by Ethylenediamine and Zinc chloride treated samples in case of both Tesu and Sandalwood dye.

The K/S values of cellulase treated samples were enhanced in comparison with untreated samples. However, higher depth of dyeing was exhibited by neutral cellulase enzyme than acid cellulase enzyme treated samples in both Tesu and Sandalwood dye.

The swelling agent treatment followed by cellulase enzyme treatment showed higher depth in colour values (K/S) in both Tesu as well as Sandalwood dye. The maximum swelling caused by the Sodium hydroxide followed by cellulase enzyme treatment gave higher K/S value than Ethylenediamine and Zinc chloride treated samples followed by cellulase treatment. The swelling agents treated samples followed by neutral cellulase enzyme treatment showed higher depth of dyeing than acid cellulase enzyme treatment.

All the untreated and treated samples dyed without mordant and with natural and metallic mordants were subjected to colourfastness tests to light, washing, crocking and perspiration.

The light fastness grades for Tesu and Sandalwood dye were between poor to fair (2-3) to fairly good (4) for the untreated samples, but improved good (5) due to cellulases and swelling agents treatment and with their combinations.

The washing fastness test showed considerable (2) to slight (4) colour change for the untreated sample, which improved to negligible (5) change in colour when the samples were treated with cellulases and swelling agents and also with their combinations. Staining on wool and cotton was found to be considerable (2) to slight (4) in untreated sample, while it was increased to negligible (5), when the samples were treated with cellulases and swelling agents as well as with their combinations in case of both Tesu and Sandalwood dye.

In case of both dry and wet crocking tests, the untreated samples showed considerable (2) to slight (4) change in colour in both Tesu and Sandalwood dye. The treatment with cellulases and swelling agents and their combinations improved the colour change to negligible (5) in dry and wet crocking in case of both Tesu and Sandalwood dye. Staining on wool and cotton was considerable (2) to slight (4) for the untreated for Tesu and Sandalwood dye in both dry and wet crocking, whereas it improved to negligible (5) in both dry and wet crocking when the samples were treated with cellulases, swelling agents and with their combinations.

During perspiration fastness tests for Tesu dye, it was observed that the untreated sample showed noticeable (3) to slight (4) change in colour in both acidic and alkaline perspiration, which improved to negligible (5) when the sample were treated with cellulases, swelling agents and their combinations. In case of Sandalwood dye, considerable (2) to slight (4) colour change in untreated sample in acidic perspiration and noticeable (3) to slight (4) change in colour was observed in case of alkaline perspiration. Staining on wool and cotton in case of both Tesu and Sandalwood dye was found to be noticeable (3) to slight (4) in both acidic and alkaline perspiration, which was improved to negligible (5) in the samples treated with cellulases, swelling agents and with their combinations.

On the basis of weighted mean score, khadi cotton samples pretreated with cellulases, swelling agents as well as with their combinations and dyed with Tesu and Sandalwood dye without and with both natural and metallic mordants were given rank for their fastness.

In case of khadi cotton dyed with Tesu dye without mordant, samples treated with Neutral cellulase obtained first rank (3.05) whereas sample treated with Zinc chloride obtained seventh rank (2.47). The last rank was occupied by untreated sample (2.16).

In case of khadi cotton dyed with Tesu dye and mordanted with Babool bark, the first rank (4.00) was secured by samples treated with Acid cellulase, Neutral cellulase, Sodium hydroxide and Sodium hydroxide, Ethylenediamine and Zinc chloride combined with Acid cellulase and Sodium hydroxide, Ethylenediamine and Zinc chloride combined with Neutral cellulase. Sample treated with Zinc chloride occupied fourth rank (3.55). The last fifth rank (2.85) was occupied by untreated mordanted sample.

In case of khadi cotton dyed with Tesu dye and mordanted with Harda, it was found that the sample treated with Sodium hydroxide plus Neutral cellulase secured the first rank (4.43), whereas Zinc chloride and untreated mordanted sample occupied third rank (3.73). This showed that Zinc chloride treatment had no effect on the on the improvement of colourfastness property in case of Tesu dye mordanted with Harda.

In case of khadi cotton dyed with Tesu dye and mordanted with Alum, it was observed that the sample treated with Neutral cellulase secured first rank (4.73). Here, it was found that the samples treated with Acid cellulase, Sodium hydroxide, Ethylenediamine and Zinc chloride occupied eighth rank (4.00) whereas the untreated mordanted sample secured seventh rank (4.06).

This result showed that the treatment with Acid cellulase, Sodium hydroxide, Ethylenediamine and Zinc chloride had no improvement on the colourfastness property and untreated mordanted sample were more colour fast than these pretreated samples of khadi cotton dyed with Tesu dye.

In case of khadi cotton dyed with Tesu dye and mordanted with Copper sulphate, the first rank (5.00) was occupied by samples treated with Neutral cellulase and Sodium hydroxide, Ethylenediamine and Zinc chloride combined with Acid cellulase. Samples treated with Ethylenediamine and Zinc chloride secured seventh rank (4.16). The last seventh rank (4.00) was occupied by untreated mordanted sample.

In case of khadi cotton dyed with Sandalwood dye without mordant, it was observed that sample treated with Sodium hydroxide plus Neutral cellulase obtained first rank (3.05). Zinc chloride obtained sixth rank (2.21) whereas the untreated sample the seventh rank (2.20).

In case of khadi cotton dyed with Sandalwood dye and mordanted with Babool bark, sample treated with Sodium hydroxide plus Neutral cellulase secured first rank (4.07). Zinc chloride treated sample occupied eighth rank (3.60). The last rank i.e. ninth (2.83) was secured by untreated mordanted sample.

In case of khadi cotton dyed with Sandalwood dye and mordanted with Pomegranate rind, it was found sample treated with Sodium hydroxide plus Neutral cellulase secured first rank (4.23). Sample treated with Zinc chloride secured seventh rank (3.48). Untreated mordanted sample obtained the last rank i.e. eighth rank (2.83).

In case of khadi cotton dyed with Sandalwood dye and mordanted with Alum, the sample treated with Sodium hydroxide plus Neutral cellulase obtained first rank (4.72) whereas Zinc chloride treated sample secured the eighth rank (4.02). The untreated mordanted sample obtained the last ninth rank (3.67).

In case of khadi cotton dyed with Sandalwood dye and mordanted with Tartaric acid, it was observed that the first rank (5.00) was occupied by samples treated with Sodium hydroxide and Ethylenediamine combined with Acid cellulase and Sodium hydroxide, Ethylenediamine and Zinc chloride combined with Neutral cellulase as these samples got same score. Zinc chloride treated sample obtained sixth rank (4.48) whereas eighth rank (3.81) was occupied by untreated mordanted sample.

The cost of dyeing of one metre of untreated and treated khadi cotton with cellulases and swelling agents using Tesu and Sandalwood dye without

mordant as well as with both natural and metallic mordants were calculated. When the dyeing costs of Tesu and Sandalwood dye without pretreatment was compared with the cost of dyed pretreated cotton with cellulases and swelling agent, it was observed that the cost of the pretreatment process and dyeing was increased in both the cases i.e. without mordant as well as using natural and metallic mordants.

The conclusion can be drawn from the study on the basis of physical properties, colour strength (K/S), colourfastness as well as economic analysis that Neutral cellulase when used alone as well as its combination with Sodium hydroxide swelling agent gave best results on khadi cotton fabric. The combination of other two swelling agents i.e. Ethylenediamine and Zinc chloride also gave good results but not as good as like combination of Neutral cellulase with Sodium hydroxide swelling agent. Similarly, good results in terms of physical properties, colour strength (K/S), colourfastness and economic analysis was also obtained with Acid cellulase and combination of Acid cellulase with three swelling agents i.e. Sodium hydroxide, Ethylenediamine and Zinc chloride. In case of Acid cellulase also, the best result was observed with Sodium hydroxide followed by Ethylenediamine and Zinc chloride swelling agent. Although the results obtained with Acid cellulase and its combination with swelling agents in relation to physical properties, colour strength (K/S) and colourfastness were not better than those of Neutral cellulase and its combination with swelling agents, but it was also revealed by economic analysis that the dyeing costs of treatment with Acid cellulase and its combination with swelling agents were less than those obtained with Neutral cellulase and its combination with swelling agents. The swelling agents when used alone also showed improvement in physical properties, colour strength (K/S) and colourfastness, but not as good as cellulases and their combination with swelling agents. The cost calculated for treatment with Ethylenediamine and Zinc chloride were higher than the cellulases.

The weighted mean score of colourfastness has also revealed that in most of the cases samples treated with Neutral cellulase and its combination with swelling agents followed by Acid cellulase and its combination with swelling agents had secured higher ranks whereas samples treated with Ethylenediamine and Zinc chloride occupied lower ranks. The untreated samples have obtained last rank.

The enzymatic pretreatment of the textiles are not aggressive to fibres and environment. The 'clean chemistry' approaches is an advantage in comparison to the powerful alkalies, acids, oxidizers and reducers needed in



traditional processes tending to attack the textile material as well as causing considerable contamination in the environment. The residues of enzymes are present only in the form of primary structure and there are no chemical residues likely to affect the skin. Besides, they do not leave chemical residues on the processed materials and the colour change of the dyed is minimal. Although the dyeing costs increased with the pretreatment with cellulases, swelling agents as well as with their combinations, but nowadays the use of cellulases in the pretreatment process has found much broader acceptance as the effect of the treatment is long lasting and eco-friendly in nature. The pretreatment with swelling agents with optimized conditions enhances the physical properties as well as colour strength and colourfastness properties. Thus, some of the shortcomings of khadi cotton like rough texture, less dyeability and poor colourfastness can be minimized by chemical processing by an eco-friendly approach as well as using swelling agents in optimum conditions and can be recommended for handloom sectors as these sectors supports and strengthen the rural economy of our country.

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**Chapter - 2**  
**Recent Trends in Pre-Service Teacher Education  
Programme in India: A Study**

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# Chapter - 2

## Recent Trends in Pre-Service Teacher Education Programme in India: A Study

Subhashini Bada and R. Siva Prasadh

### Abstract

India is a country where the parents are giving the highest priority to quality education to their children and moreover many of them are spending the highest part of their earning on children education. Hence one cannot neglect the role of effective teachers in school education. Effective teaching is directly related to quality teacher training given in pre-service teacher education. The present work is based on the study of the recent trends in pre-service teacher education and integrated teacher education in India.

**Keywords:** Pre service-teacher education, effective teaching, integrated teacher education

### 1. Introduction

The national development of any country mainly depends on the quality of their education systems. The teacher has an import role in executing the proposed educational policies and reforms in the education system. The teacher education directly influences the teaching practice of a teacher and ultimately on the students' achievement. There are three types of teacher education programs in India.

Pre-service teacher education, In-service teacher education and distance teacher education program. Pre-service teacher education is related to the student teachers who will practice teaching the first time after their training, pre-service teacher education is nothing but the development of skills of teachers who are already practicing teaching through professional development courses and distance teacher education is just like other distance courses or open learning.

Over the last two decades all over the world, serious attention has been paid to improve teacher education. Many educational researchers produced theories and best practices for preparing the quality teachers through pre-

service teacher education programs. National Policy on Education 1986 highlights, “The status of the teacher reflects the socio-cultural ethos of the society; it is said that no people can rise above the level of its teachers”. Such exhortations are indeed an expression of the important role played by the teachers as transmitters, inspirers and promoters of man’s eternal quest for knowledge (NCFTE, 2010). Hence the researchers need to examine the issues related to the preparation of teachers as well as to prune the theory and practice of teacher education.

Status of school teachers is as shown in Table.1 and the demand for teachers from 1950 to 2010 is increasing for every decade as shown in Fig.1. The number of vacancies in government primary schools as on 31.03.2016 is shown in Fig.2. One can observe that about 9 lakhs teacher positions are vacant in government primary schools. Moreover, the percentage of vacancies should not go beyond 10% of sanctioned as per the right of children for free and compulsory education act (RTE Act, 2009). Therefore, the government agencies should look in to devise an appropriate mechanism to transfer of surplus teachers from zero enrolment schools and to fill teaching positions as many passed out students with D.Ed. or B.Ed. qualifications are available as shown in Table. 2.

**Table 1:** Growth in the number of teachers of School education in India from 1950-2010

Year	Primary			Upper Primary			Secondary		
	Male	Female	Total	Male	Female	Total	Male	Female	Total
1950-51	456	82	538	73	13	86	107	20	127
1960-61	615	127	742	262	83	345	234	62	296
1970-71	835	225	1060	463	175	638	474	155	629
1980-81	1021	342	1363	598	253	851	669	257	926
1990-91	1143	473	1616	717	356	1073	917	417	1334
2000-01	1221	675	1896	820	506	1326	531	225	756
2010-11	1194	905	2099	1048	839	1887	766	496	1262

**Source:** Educational Statistics at a glance, 2018

However, there is a huge shortfall in teachers in school education due to the delay in the recruitment of teachers. The percentage (%) vacancies of teachers in India in 2015-16 are given in Fig. 2. The government supported Elementary schools have a shortfall of 9.08 lakh teachers as on 31-03-2016. It is the highest percentage in the state of Jharkhand.

Further, the female teachers in India are significantly low as compared to other developed countries; one can observe the percentage of female

teachers in India is 49.49% as on 2014 in primary school education and is only 43.21% in secondary education. We all know that the female teachers can deal well with the children and reduce the absenteeism. Therefore all the developed countries are giving more preference to female teachers and their percentage is more as compared to male teachers.

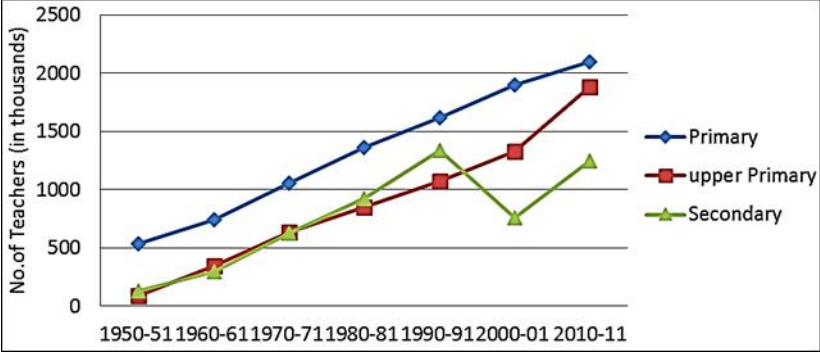


Fig 1: Number of teachers in School Education in India

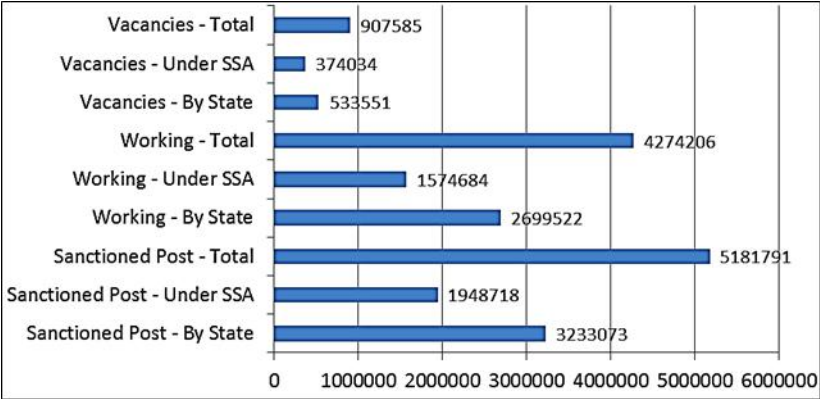


Fig 2: Status of teaching positions sanctioned, working, vacancies under State & SSA as on 31.03.2016 (From Annual Work Plan and Budget 2016-17)

Fig. 3 shows the percentage of Female Teachers in primary school Education in India where in our country has less than 50% and however in other developed countries female teachers share is more than 80%. Similarly one can observe that the percentage of female teachers in secondary school education.

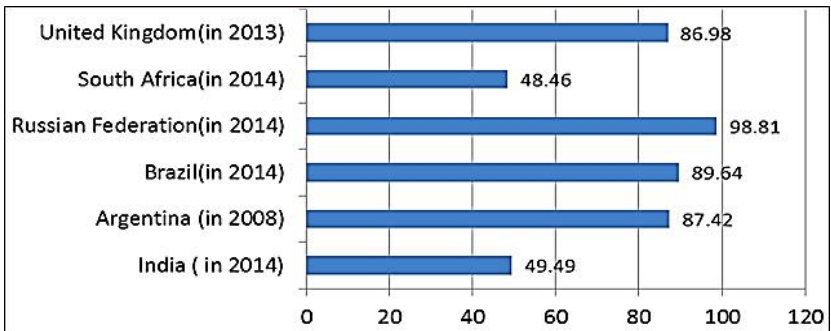
**Table 2:** Available manpower for teaching position with proper qualifications during 2015-16

No. of Persons	Male	Female	Total
D.Ed. or Equivalent pass-out	37,289	46,502	83,791
B.Ed. pass-out	1,89,795	3,38,354	5,28,149
Teachers with schools in zero enrolment			24,921
Total availability of school teachers			6,36,861
Demand for teachers at Elementary level	Approximately 4,00,000		

**Table 3:** Percentage of Female Teachers in India as compared to other countries

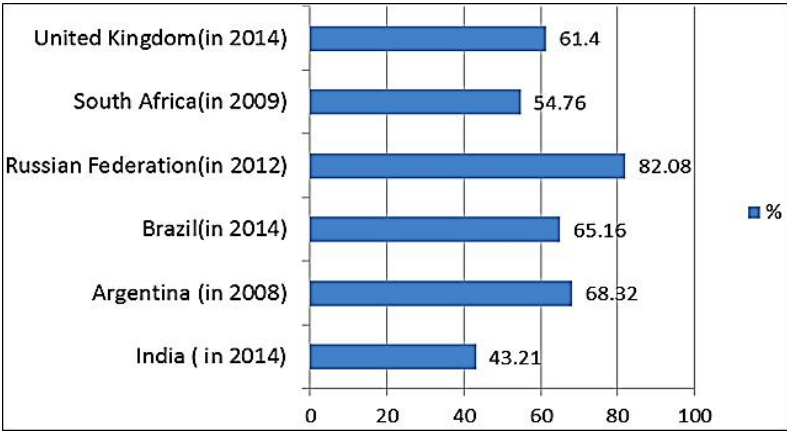
Country	% of Female Teachers			
	Primary		Secondary	
	Year	%	Year	%
India	2014	49.49	2014	43.21
Argentina	2008	87.42	2008	68.32
Brazil	2014	89.64	2014	65.16
Russian Federation	2014	98.81	2012	82.08
South Africa	2014	48.46	2009	54.76
United Kingdom	2013	86.98	2014	61.4

Source: Educational Statistics at a glance, 2018



**Fig 3:** Percentage of Female Teachers in primary school Education in India





**Fig 4:** Percentage of Female Teachers in Secondary school Education in India

There are many researchers across the globe who worked on the teacher education program, especially Darling-Hammond, L. (2006) worked on constructing 21<sup>st</sup>-century teacher education, Ashton; P. (1984) presented that the teacher efficacy is a motivational paradigm for effective teacher education. Bawane, J., & Spector, J.M. (2009) studied implications for competency-based teacher education programs in Distance Education. Further many people worked on integrated teacher education, Kim, M.M., Andrews, R.L., & Carr, D.L. (2004) discussed on Traditional versus integrated pre-service teacher education curriculum. Lesar, S., Benner, S.M., Habel, J., & Coleman, L. (1997) discussed the importance of preparing general education teachers for inclusive settings with a constructivist teacher education program. King, K.P., & Wiseman, D.L. (2001) highlighted science efficacy beliefs of elementary education majors in integrated and non-integrated teacher education coursework. Das, A.K *et al.* (2013) worked on Inclusive Education in India and their readiness for it. Sharma, U., & Deppeler, J. (2005), worked on integrated education in India. Neves de Jesus, S., & Lens, W. (2005) discussed integrated teacher education for teacher motivation. The present work is based on the study of the recent trends in pre-service teacher education and integrated teacher education in India.

**i) Organization of Teacher Education Programs in India**

Ministry of Human Resource Development (MHRD) is the apex body of pre-service teacher education in India. It executes different programs of teacher education through autonomous bodies such as the National Council for Teacher Education (NCTE), the National Council of Educational

Research and Training (NCERT), The National Institute of Educational Planning and Administration (NIEPA), etc.

## **2.1 The National Council for Teacher Education**

The National Council for Teacher Education initially an advisory body for the Central and State Governments on all matters pertaining to teacher education till 1973, with its Secretariat in the Department of Teacher Education of the National Council of Educational Research and Training (NCERT). The National Council for Teacher Education as a statutory body came into existence in pursuance of the National Council for Teacher Education Act, 1993 (No. 73 of 1993) on the 17th August 1995. The National Policy on Education (NPE, 1986) and its Programme of Action envisaged a National Council for Teacher Education with statutory status and necessary resources as a first step for overhauling the system of teacher education.

The main objective of the NCTE is to achieve planned and coordinated development of the teacher education system throughout the country, the regulation and proper maintenance of Norms and Standards in the teacher education system and for matters connected therewith. The mandate given to the NCTE is very broad and covers the whole gamut of teacher education programs including research and training of persons for equipping them to teach at pre-primary, primary, secondary and senior secondary stages in schools, and non-formal education, part-time education, adult education, and distance (correspondence) education courses.

## **2.2 The National Council of Educational Research and Training**

The National Council of Educational Research and Training (NCERT) is an autonomous organization set up by the Government of India in 1961. The main role of NCERT is to help and advise the Central and State Governments on policies and programs of school education for qualitative improvement. There are different constituent organizations under NCERT are as below

1. National Institute of Education (NIE), New Delhi
2. Central Institute of Educational Technology (CIET), New Delhi
3. Pandit Sundarlal Sharma Central Institute of Vocational Education (PSSCIVE), Bhopal
4. Regional Institute of Education (RIE) in Ajmer, Bhopal, Bhubaneswar, and Mysore
5. North-East Regional Institute of Education (NERIE), Shillong

The major objectives of NCERT and its constituent units are to:

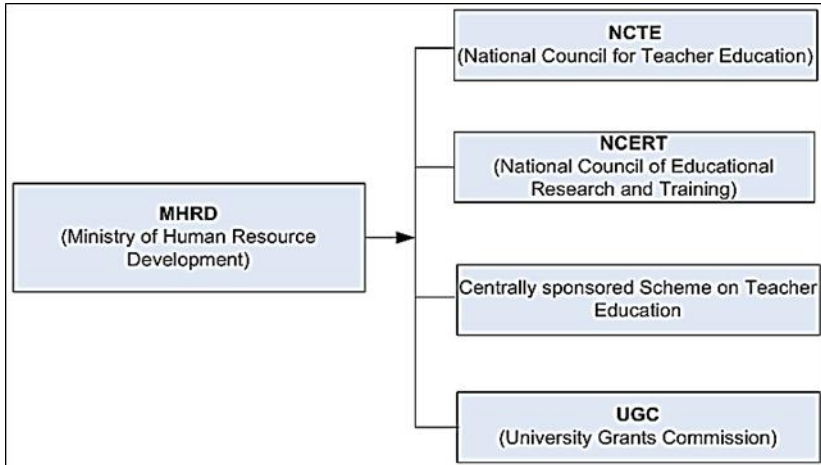
- Undertake, promote and coordinate research in areas related to school education
- Prepare and publish model textbooks, supplementary material, newsletters, and journals
- Develops educational kits, multimedia digital materials, etc.
- Organize pre-service and in-service training of teachers
- Develop and disseminate innovative educational techniques and practices
- Collaborate and network with state educational departments, universities, NGOs and other educational institutions
- Act as a clearinghouse for ideas and information in matters related to school education, and act as a nodal agency for achieving the goals of Universalization of Elementary Education

### **2.3 The National Institute of Educational Planning and Administration**

The National Institute of Educational Planning and Administration (NIEPA) established by the Ministry of Human Resource Development, Government of India, It is a deemed to be University and is dealing with capacity building and research in planning and management of education.

Like a central university, it is under Government of India and giving degrees in the field of educational planning and administration and has status deemed to be University in August 2006.

In 1962 UNESCO established the Asian Regional Centre for Educational Planners and Administrators which later became the Asian Institute of Educational Planning and Administration in 1965. Later, it was taken over by the Government of India and renamed as the National Staff College for Educational Planners and Administrators. Subsequently, with the increased roles and functions of the National Staff College, particularly in capacity building, research and professional support services to governments, it was again renamed as the National Institute of Educational Planning and Administration (NIEPA) in 1979.



The National Council for Teacher Education (NCTE) has defined teacher education as-A program of education, research, and training of persons to teach from pre-primary to higher education level. Teacher education is a program that is related to the development of teacher proficiency and competence that would enable and empower the teacher to meet the requirements of the profession and face the challenges therein. Initially, teacher education was called as teacher training till 1956 and it had narrow goals and limited scope for professional development. Later teacher education evolved into the professional development for teachers and consisting of

- i) Teaching Skills
- ii) Pedagogical theory
- iii) Professional skills

The NCTE recently in the year 2019 initiated the Integrated Teacher Education Programme in the similar lines of other professional courses like Engineering and Medicine etc.

#### **2.4 Centrally Sponsored Scheme on Teacher Education**

The National Policy on Education (NPE), 1986, and its Programme of Action (POA) envisaged a Centrally-Sponsored Scheme of Restructuring and Reorganization of Teacher Education in 1987. Its main focus is to create good institutional infrastructure for teacher training of elementary & secondary school teachers and for the provision of academic resource support to the schools. The Scheme involved the following

- Setting up of District Institutes of Education and Training (DIETs)

- Strengthening of Secondary Teachers Education Institutions into Colleges of Teacher Education (CTEs) and Institutes of Advanced Study in Education (IASEs)
- Strengthening of State Councils of Educational Research and Training (SCERTs)
- Central assistance is provided to the State Governments as resource support to the DIETs, CTEs, IASEs and SCERTs

The Department has initiated the process of revision of the Teacher Education Scheme. The main components of the revised scheme are as under:

- Modification in Centre-State financial sharing pattern, from the existing 100% central assistance to sharing pattern in the ratio of 75:25 for all States/UTs (90:10 for NER States, including Sikkim)
- Continuation of support to SCERTs/SIEs
- Strengthening and re-structuring of SCERTs
- Training for Educational Administrators, including Head Teachers
- Orientation/Induction Training to Teacher Educators
- Continuation of support to CTEs and establishment of new CTEs
- Continuation of support to IASEs and establishment of new IASEs
- Continuation of support to and restructuring of DIETs
- Establishment of Block Institutes of Teacher Education (BITEs) for augmenting Teacher Education capacity in SC/ST and minority concentration areas
- Professional Development of Teacher Educators
- Technology in Teacher Education
- Public-Private Partnership (PPP) in teacher education
- Monitoring mechanism

In the state level, there are different organizations that are taking care of teacher education

- State Institute of Education (SIE)
- State Council of Educational Research and Training (SCERT)
- State Board of Teacher Education (SBTE)

### **State Institute of Education (SIE)**

The State Institute of Education (SIE) is an apex Institute in some states that looks over teacher training, pedagogy, methodology, planning, and

management of the Education Department. The mandate of SIE is to advise and assist the State Education Department in formulating and implementation of policies and programs in the field of education. Initially, they looked after primary education and later evolved as an institution like NCERT.

### **State Council of Educational Research and Training (SCERT)**

The state council is the apex institute of the state. In Andhra Pradesh, it was established in 1967 and has been amalgamating the State Institute of Education, the State Bureau of Educational and Vocational Guidance, the State Science Education Unit and the State Evaluation Unit. Some of the important functions of SCERT in are listed below

- Preparation of curricula, syllabi and instructional material for all levels of school education
- Development of evaluation procedures and material, for the benefit of practicing teachers. Bridging gaps between the methods and techniques advocated in training and the actual classroom practices
- Dissemination of knowledge relating to improved methods and techniques to be followed by educational institutions
- Co-ordination with the national and international organizations in academic programs
- Organization of orientation programs for the professional growth of teachers, teacher-educators, supervisor's, etc
- Publication of journals, Periodicals, Books
- To develop new courses in Teacher Education. To frame and revise the curriculum of teacher Education courses periodically

Kothari Commission for the first time in 1966 recommended for establishing SBTE, whose main function was to develop teacher education in the state to be administered by the state board

### **Programs Recognized by NCTE**

NCTE notified revised Regulations and Norms and Standards on November 28, 2014, for the following Teacher Education Programmes:

- DPSE

Diploma in an early childhood education program leading to a Diploma in Preschool Education (DPSE).

- D.El.Ed

Elementary teacher education programme leading to Diploma in Elementary Education

- B.El.Ed.

Bachelor of elementary teacher education programme leading to a Bachelor of Elementary Education (B.El.Ed.) degree.

- B.Ed.

Bachelor of education programme leading to a Bachelor of Education (B.Ed.) degree.

- M.Ed.

Master of education programme leading to Master of Education (M.Ed.) degree.

- D.P.Ed

Diploma in a physical education programme leading to a Diploma in Physical Education (D.P.Ed.).

- B.P.Ed.

Bachelor of physical education programme leading to a Bachelor of Physical Education (B.P.Ed.) degree.

- M.P.Ed.

Master of physical education programme leading to Master of Physical Education (M.P.Ed.) degree.

- D.El.Ed

Diploma in elementary education programme through Open and Distance Learning System leading to Diploma in Elementary Education (D.El.Ed.).

- Bachelor of education programme through Open and Distance Learning System leading to Bachelor of Education (B.Ed.) degree.
- Diploma in arts education (Visual Arts) programme leading to a Diploma in Arts Education (Visual Arts).
- Diploma in arts education (Performing Arts) programme leading to a Diploma in Arts Education (Performing Arts).
- Bachelor of education programme 3-year (Part Time) leading to a Bachelor of Education (B.Ed.) degree.

## **Integrated programmes recognized by NCTE**

- A 4-year integrated programme leading to B.A. B.Ed./B.Sc. B.Ed. Degree
- 3-year Integrated programme leading to B.Ed., M.Ed. (Integrated) Degree

### **ii) Integrated Teacher Education**

Now NCTE started the following four years Integrated Teacher Education Programme (ITEP) in Arts Stream and Science Stream (The regulations of integrated teacher education, Gazette of India, 2018)

- Four years Teacher Education Programme (ITEP) for Pre-Primary to Primary
- Four years Teacher Education Programme (ITEP) Upper-Primary to Secondary

This course is offered from Senior Secondary (+2) with the objectives of preparing committed, responsible and professional teachers. The curriculum is designed with the world's best practices to bring the paradigm shift in Teacher education. It is a specialized course with liberal disciplines of knowledge with integration pedagogy and content.

This programme integrates general studies comprising Mathematics and Science, Social Sciences and Humanities and also professional studies comprising perspectives in education, other core education courses, curriculum and pedagogy of school subjects and the tasks and functions of a school teacher. It maintains a balance between theory and practice and ensures coherence and integration among the various components of the programme.

This programme is intended to result in a paradigm shift in teacher preparation. The curriculum of this four years integrated programme is designed inculcating the world's best practices in the field of teacher education sector. This is a specialized course with intrinsic integration of pedagogy and content, along with sustained engagement with liberal disciplines of knowledge and field of education. The opportunity for the vertical mobility of teachers is also visualized through this programme. This programme integrates general studies comprising Mathematics and Science, Social Sciences and Humanities and also professional studies comprising perspectives in education, other core education courses, curriculum and pedagogy of school subjects and practicum related to the tasks and functions of a school teacher. It maintains a balance between theory and practice and



ensures coherence and integration among the various components of the programme. It is expected to equip the aspirant school teacher with the requisite attitude, skill, and knowledge to address the challenges of becoming an effective school teacher.

**Table 3:** Staff pattern and qualifications specified by NCTE for one unit

S. No	Designation	Science Stream	Arts Stream
1	Head of the Department in the rank of Professor or Associate Professor in Education	01	01
2	Assistant Professors	09	08
3	Health and Physical Education	01 (part-time)	01(part-time)
4	Arts Education	01 (part-time)	01(part-time)
5	Career Guidance and Counseling	01 (part-time)	01(part-time)

**Table 4:** Qualifications specified by NCTE for teachers

Assistant Professor (Liberal Discipline and Pedagogy)	Assistant Professor (in Educational Studies)	Head of the Department
Post-Graduate degree		Postgraduate degree
B.Ed. degree with a minimum of 55% marks	M.Ed. with minimum 55% marks	M.Ed.
National Eligibility Test (NET) or State Level Eligibility Test (SLET) or Ph.D.	NET or SLET or Ph.D.	Ph.D. in Education
M.Ed. (Master of Education)-desirable qualification	Master's degree in Psychology or Philosophy or Sociology or their allied subjects-desirable qualification	10 years for Professor or 08 years for Associate Professor of teaching experience in a Teacher Education Institution

**Source:** The regulations of integrated teacher education, Gazette of India, 2018

The model curriculum has been developed by NCTE and the institutes which are conducting can adapt or modify based on their requirements, however with prior approval from the NCTE. The institution should have a minimum of 3000 sq.m well-demarcated land with 2000 sq.m built-up area for one unit consist of 50 students. However, the addition of one unit requires a land of 500 sq.m with a built-up area of 400 sq.m. Advantages of Integrated course are as below.

- Student can obtain two degrees with nearly a fee of one course
- Less time consuming as compared with two individual degrees
- Achieve more knowledge and advantages as compared with their peers

- Immediacy end of the course can practice the teaching profession
- Problems associated with conventional teacher education can be avoided
- Opportunity for vertical mobility of teachers is also visualized through this programme

## **Conclusions**

The concept of integrated teacher education has a better scope for a paradigm shift in teacher education. It also provides teacher education with the world's best practices of teacher education. The present work deals with the study of recent trends in teacher education and its importance in the present scenario.

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**Chapter - 3**  
**India's Approach towards Bangladesh: Recent  
Trends and Future Prospects**

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# Chapter - 3

## India's Approach towards Bangladesh: Recent Trends and Future Prospects

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### Abstract

India's dealings with Bangladesh are human progression, social, financial etc. A mutual history and normal legacy, semantic and social ties, writing and expressions of the human experience connects these two neighborhood nations. With Bangladesh, India shares not just a distinctive history of battle for flexibility and freedom yet in addition persisting sentiments of friendly ties. These shared characteristics are reflected in multi-dimensional relations with Bangladesh at a few levels of collaboration. There had been many misshape in the past between the two nations especially in the course of 1975-90, which has been particularly imperative to know. The target of this paper is to feature India's policy towards Bangladesh and examining the recent trends, as well as the issue based relation between the two nations. Along with these, forecasting possible future prospects of India's relation with Bangladesh is also a major aim of the paper.

**Keywords:** India, Bangladesh, issues, recent trends, future prospects

### Introduction

India and Bangladesh share a common border of 4,096 km running through five Indian states, West Bengal, Assam, Meghalaya, Tripura and Mizoram. India's relations with Bangladesh are traditionally cultural, social and economic. There is a much that brings them together-a shared history and common heritage, linguistic and cultural ties, passion for music, literature and the arts. India shares not only a common history of struggle for freedom and liberation but also lasting feeling of both fraternal as well as familial ties. This cohesion is reflected in the multi-dimensional relations with Bangladesh at several levels of interface. While India played a critical role in 1971 in the birth of Bangladesh, this does not however result in close bilateral ties. The paper seeks to provide a framework of recent trends in the

relations between the two nations. Currently, both nations are enjoying extremely good quality relations.

India's connections with Bangladesh are human improvement, social, political and economic etc. There is much that joins the two nations a mutual history and normal legacy, social ties, intensity for music, writing and expressions of the human experience. With Bangladesh, India shares not just a distinctive history of battle for flexibility and freedom yet in addition enduring sentiments of both friendly and familial ties. This shared characteristic is reflected in multi-dimensional relations with Bangladesh at a few levels of collaboration. Be that as it may, there had been many curves in the past between the two nations especially amid 1975-90, which has been particularly necessary to know. The target of this investigation is to feature the real moves, issue based relation between the two nations, both the neighbouring nations approach towards the issues as well as the future course of connections between these two nations.

### **Objectives**

Centre of Attention of the study is to observing the issue based relations between the two neighbors i.e. India and Bangladesh. However, main objective of the paper is to-

1. Trace the real moves of relation between the two nations
2. Investigating the issues influencing the relation between the two nations
3. Examining India's policy towards Bangladesh
4. Analyzing possible future course of relation between the two nations

### **Research Methods**

Analytical and descriptive methods are used in preparation of the paper based on secondary sources. Secondary sources are collected from different books, articles published in newspapers, research papers published in different journals.

### **Approach towards the Issues and Their Relations**

The relation between the two neighboring nations, that is, India and Bangladesh are determined by various issues such as water issue, insurgency issue, transit issue, migration issue, maritime boundary demarcation issue, border issue etc. In those issues both the nations have been showing different approach from their own perspective which always been influencing their reciprocal relations-



## Approach towards Water Issue

India and Bangladesh share 54 trans-limit streams, of all shapes and sizes. In 1996, the sharing of the Ganga waters was effectively settled upon between the two countries. In any case, the real debate has been India's development and operation of the Farakka Dam. The point of development of the Farakka Dam was to expand the lean time frame stream of the Bhagirathi-Hooghly branch of Ganga to build the water a profundity at the Kolkata port which was undermined by siltation. As water system withdrawals expanded in Bangladesh, question emerged amongst India and Bangladesh over the sharing of the lean season stream at Farakka. The insufficiency of water amid the lean season to meet the evaluated requests in the two nations is the underlying driver of the contention (Raja Mohan, 2004). The Bangladesh government feels that the decrease in stream made harm agribusiness, industry and nature in the sink in Bangladesh. Due to the powerlessness of the concerned governments to go to any enduring ascension in the course of the most recent couple of decades on sharing the stream water, this issue has developed and now it is additionally seen as an instance of upstream-downstream debate. The other explanation behind water debate is Teesta Stream-which has its source in Sikkim – moves through the northern piece of West Bengal in India before entering Bangladesh, where subsequent to intersection through around 45km of irrigable land, converges with the Brahmaputra Waterway (or Jamuna when it enters Bangladesh). In 1983, a specially appointed water sharing ascension was come to amongst India and Bangladesh, whereby the two nations were distributed 39% and 36% of the water stream separately (Karim, 2009). The new respective arrangement develops this understanding by proposing an equivalent designation of the Teesta Stream. Be that as it may, the arrangement fell through when the then recently chose Boss Clergyman of West Bengal, Ms. Mamata Banerjee, declined to affirm the arrangement, expecting that the loss of higher volume of water to the lower riparian would cause issues in the northern area of state, particularly amid drier months. Development of the Tipaimukh Dam is another petulant issue amongst India and Bangladesh. Tipaimukh Dam is a hydel control venture proposed on the waterway Barak in Manipur. Bangladesh's protest is that it would have unfriendly natural impacts in its eastern Sylhet region. Notwithstanding India's emphasis that no dam would be built disregarding Bangladesh's protests, the contention is a long way from being done. The famous contentions in Bangladesh against the Tipaimukh venture are:

- a) India ought not to choose what is useful for individuals of Bangladesh without taking them into certainty

- b) No think about has been attempted in Bangladesh to evaluate the effect of the environments that exist and rely upon the characteristic stream of the water in Surma Kushiya-Meghna and their tributaries. India and Bangladesh have concurred on a joint report gathering to look at the focuses raised by Bangladesh

### **Approach towards Transit Issue**

One of the biggest causalities India and Bangladesh not Seeing Eye to eye and the water sharing issue has been the issue of the transit rights for India. The two countries were supposed to sign an agreement in 2011 allowing transit access to India. However, with India was holding back on the Teesta issue. Bangladesh decided not go forward and sign the agreement. Transit access through Bangladesh would hugely beneficial for India and significantly reduce transit time and costs between India and its Northeastern states, with Bangladesh profiting millions of dollars through transit fees.

The issue granting transit rights to India has been a controversial affairs in Bangladesh, with way in the country arguing that India will take advantage of transit access to more easily transport its military persons to its far flung border across Arunachal Pradesh. Such indirect support to India which is actively trying to contain the Chinese threat, they believe, would also result in reprisal from China. They also assume that India will exploit the transit access to put down the insurgency in the Northeast. Military affairs aside, transit rights would also harm Bangladeshi exports to India's North-east which is presently dependent on Bangladeshi manufactured products due its isolated geographic position.

Having reached an impasse on certain interconnected issues and unable to fashion solution in single domains' relations between India and Bangladesh that it has invested equally in the relationship (Karim, 2004).

### **Approach towards the Issue of Insurgency**

Over the years the war against terrorism and its causes have come to be viewed as a collective effort of all members of international community. International terrorism cannot fought unless we corporate. With terror groups acquiring transitional networks, they now possess the ability to cross national lines and establish sanctuaries in that nations that they perceives to the weakest link. Once they exploit the differences between nations and cultures. Facing an evolving terror threat and with Indian investigative agencies encountering several difficulties, while following up terror related cases, Indian counter-terrorism efforts were provided a major boost, when Sheikh Hasina responded to Indian security concerns and began claiming

down on to work together on security issues and reaffirmed their unequivocal and uncompromising position against terrorism in all its forms manifestation, including insurgency. As a commitment towards this groups had formed close connections with militant's networks in Bangladesh on account of its proximity to India and porous nature of their shared border. Sheikh Hasina and Awami League have been true to their word and have severely restricted the activities of Indian insurgent group such as United Liberation Front of Assam (ULFA) and terror groups let and Harkat-ul-Mujahideen. In this context that Bangladesh Handed over ULFA leader Anup Chetia and reported Chittagong arms haul case of 2004. Soon after the Mumbai terror attacks the Indian government conveyed to Dhaka its concerns about Bangladeshi Link to the terror outfits. On Indian concerns, Bangladesh arrested Abdul Rouf Daud Merchant on operative of the mafia gang headed by Dawood Ibrahim. On 30 November 2009, Bangladesh police arrested Arabinda Rajkhowa, the Chairman and handed over to the Indian authorities. On December 5, 2009, Rajkhowa along with his body gourd Raja Boruah was produced before Rabin Phukan, the Chief judicial magistrate of Kamrup.

It is time for India to reciprocate has been largely been a gesture of good will on Bangladesh's part; the progress that India and Bangladesh have jointly made on counter terrorism must now transcend the narrow bounds of security co-operation and permeate other bilateral issues in the relationship(Mir, 2018).

### **Border Management and Land Boundary Agreement**

The India-Bangladesh border that for over 4094 km and is extremely porous facilitates the illicit flow of good across the border and illegal migration from Bangladesh into India. In fact, illegal trade and smuggling has led to violent incidents in the past with Bangladesh accusing Indian Border Security Force (BSF) of shooting innocents. India, which has always maintained that the supposed innocents were in fact gangs of cattle smugglers, has now issued strict guidelines for the use of non-lethal weapons against illegal trespassers. With the majority of the trespassers evading security forces are being allocated to the borders.

India's great focus on the India-China and Indo-Pak borders has neglected. Central government has been giving much more attention in the last decade only due to rapidly escalating security concerns. While the both the countries recognize the significance of checking cross border crime they also acknowledge that the border guarding forces must exercise restraints. In

July 2011 both the nations signed the coordinated Border Management Plan to effectively control cross border illegal activities. Both the governments directed the concerned co-ordination efforts, share information and identify the vulnerable areas.

With the termination of Illegal Migrants Determination by Tribunal Act (IMDT), the government took an important step in detecting and deporting illegal immigrants. However, in order for the Indian government to make considerable headway with the migration issue it needs the supports of the sending country, in this case Bangladesh, many European countries that are faced with the same migration problems are increasingly resorting to re-admission agreements in order to tackle the problems. Whether India should enter into a similar re-admissions unclear, yet it is evident that it needs to engage with Bangladesh on this issue (Arora, 2015).

The Land Boundary Agreement signed on the 6<sup>th</sup> September 2011 was meant to mark a watershed in India-Bangladesh relation and resolve a decade old boundary dispute between the two nations. This along overdue exchange of territory concentrated over 200 enclaves would give India a clear demarcated border with Bangladesh and would bring these enclaves which are like islands of Indian Bangladesh territory surrounded by the each other land, out of isolation abject poverty.

Trinamool Congress and section of NDA voiced against the historic deal, arguing that the deal gives away to much territory to Bangladesh.

In the breakthrough in Indo-Bangladesh ties, Prime Minister Narendra Modi signed the Land Boundary Agreement with his Bangladesh counterpart Sheikh Hasina. With this agreement in place India has control of 510 acres of land while Bangladesh will have control 10,000 acres of land at the India-Bangladesh border thereby setting the border dispute. In this regard Modi tweeted, "History is made as the instrument of ratification of land boundary Agreement is exchanged". The exchange of documents paves way for the operationalisation of the 1974 India-Bangladesh Land Boundary Agreement that provides for exchange of 161 enclaves between the two countries. A total 111 border enclaves will be transferred to Bangladesh in exchange for 51 acres that will become a part of India (Mir, 2018).

Earlier in the day, Modi along with West Bengal Chief Minister Mamata Banerjee Flagged of the bus service between Kolkata and Agartala via Dhaka, Shillong-Guwahati bus service. The Prime Minister has a tight schedule during his two- day Bangladesh visit as besides holding detailed talks with Hasina, he attended several programmes and a visit to Memorial of 1971 liberation war.

## **Approach towards Maritime Boundary Demarcation**

Another confrontational issue amongst India and Bangladesh is the sea fringe division. Bangladesh guarantees an enormous mainland rack, since the ocean isn't impressively profound as observed from its benchmark. Bangladesh is stressed that it may get ocean or zone-bolted by the two India and Myanmar if the two forces demand settling the issue in light of the rule of equidistance rather than value. There are uncertain issues, for example, the acknowledgment of a Bangladeshi estimate, and the obsession of control focuses with its neighboring countries from where both of these neighbors would draw the sea limit. Connected to it is the argument about the responsibility for island in the Stream Haribhanga, in the south-western piece of Bangladesh, flanking India, and bordering the Straight of Bengal. Settling the issue of South Talpatti/New Moore (the names, separately, that the island is given by Bangladesh and India) has "more to do with the degree of the sea zone to be conceivably obtained in the oil rich delta of the Cove of Bengal than the island itself. Accordingly the island holds the possibility to wind up plainly the center combative issue between the two countries." The Hindu of India reports that India-Bangladesh sea limit talks stay uncertain. The question were basically finished the Talpatti/New Moore Island and the claim on selective monetary zones in the slender of Bengal (Mir, 2018).

## **Recent Trends and Future Prospects**

Prime Minister Narendra Modi's fruitful two-day visit to Dhaka (June 6-7 2015) saw the marking of a huge number of 22 understandings covering the whole extent of political, monetary and social relations. During the visit, five issues that are a piece of the 60-point Notice of Comprehension (MOU) emerge and guarantee a period. Thus the issue may must be alluded to the certainly Bangladesh has as of late disagreed with the Assembled Countries for assertion. Keeping the issue uncertain would keep on vitiating the relations with spiraling questions. There is, be that as it may, a case of the Worldwide Court giving a model decision for value rule, considering the area of the two neighboring nations and form of the shoreline.

As Sheik Hasina took on the position of Executive in 2009, the two sided connection amongst Dhaka and New Delhi was changed. Once chose again with a more grounded order, she rapidly start changing the Bangladesh-India relationship in what has been named an "India-Positive" approach. Executive of Bangladesh Ms. Sheik Hasina joined by a 123-part appointment including a business landmass paid a state visit to India. At this summit, the two sides consented to construct an "irreversible" agreeable

connection between the two neighbors. On her visit, PM Sheik Hasina was given the esteemed Indira Gandhi Prize for Peace, Demilitarization and Advancement for 2009. Amid Hasina's visit to India, the then Finance Minister Pranab Mukherjee marked a \$1 billion advance manage the Hasina government, the biggest credit extension got by Bangladesh under a solitary ascension. India's Exim Bank consented to the arrangement with Bangladesh's financial relations division and the advance was be utilized to create railroads and interchanges foundation in Bangladesh. The arrangement conveyed a 1.75 percent yearly loan fee and would be repayable in 20 years, including a five-year effortlessness period. India and Bangladesh marked 3 agreements on a) common legitimate help with criminal issues, b) fighting universal fear based oppression, sorted out wrongdoing and illegal medication trafficking; and c) exchange of condemned individual amid the Hasina's visit. It was likewise concurred that Bangladesh will permit utilization of Mongla and Chittagong Ocean ports for development of merchandise to and from India through street and rail. Bangladesh additionally passed on its aim to give Nepal and Bhutan access to these ports. This was trailed by the two nations marking a 35-year power transmission bargain under which India will send out up to 500 megawatts of energy to Bangladesh. Dhaka likewise marked a \$1.7 billion agreement with the National Warm Power Enterprise for the development of two coal-let go plants in southern Bangladesh. Bangladesh consented to give travel office to India to access its landlocked 7 north-Eastern States through Bangladesh. Enhanced rail connections would profit both Bangladesh and India's eastern locale. Not just trucks from Nepal would approach the Bangla bandha arrive port in Bangladesh; Bangladeshi trucks would likewise approach Nepal through India. Dhaka had given its assent for laying the cross-limit rail tracks. In spite of these activities, India neglected to expand on the force furnished by Hasina's visit with its inability to execute two noteworthy two-sided understandings: a conclusion of land limit boundary and the sharing of the waters of the Teesta Stream.

Political issues between the two states have secured all fields of arrangement, from monetary and exchange, outskirt security and limit lines, sharing of normal and trans-limit waters, correspondence and travel, lastly, local and national security against extremist systems.

Advance on a considerable lot of these issues was slowed down from 1975 until 2009; be that as it may, changes in the reciprocal relations have as of late prompted impressive development on all issues of conflict. Amid the previous couple of years, Sheik Hasina's Administration has enough tended

to India's security related worries; there has been a recognition in Bangladesh that Bangladesh has not of more prominent helpful relationship, best reflected in the title of the joint revelation-Notun Projonmo-Nayi Disha (Fresh start New Beginning). These understandings are identified with network- a need region for the Narendra Modi Government-and incorporate lattice interconnection and age of energy, enhancing the adjust of exchange, better coordination among the fringe guarding powers and individuals to-individuals contact. While the initial two issues are to be progressed inside a sub-local system, different issues are solely reciprocal in nature. Be that as it may, in a noteworthy advance towards ties, India and Bangladesh traded the instruments of approval of the Land Limit Ascension, Promising a conclusion to the "stateless presence" of more than 50,000 individuals in 162 enclaves on the two sides of the outskirts.

Cooperation between the two countries is a continuous process. The relationships of mistrust and hostility between India and Bangladesh cost both countries billions of dollars in missed opportunities. Transit and transshipment facilities would save for India potentially billions of dollars in transportation costs while it would generate substantial revenues and employment for Bangladesh every year. It is argued that greater cross-border investments could produce significant benefits for both countries. The economic growth and development of both Bangladesh and Indian North East can benefit immensely through the development and expansion of trade and economic cooperation between the two geographically contiguous parts of the sub-continent. Thus, the issue of developing economic cooperation between Bangladesh and Indian North East has become an important issue in determining the future of Bangladesh-India relations. Bangladesh can provide a whole range of consumer products to the North East at competitive prices taking advantage of its geographical proximity and can also serve as a good market for products from the North East. Modi inherited a solid base of strong Bangladesh-India partnership from the Congress led United Progressive Alliance (UPA). Indian thinking was dominated by the security-centric approach instead of seeking to build a long-term state-state relationship. Reluctance to address issues like the Land boundary Agreement (LBA), sharing of waters of common rivers of the Ganges and Teesta and trade deficit showed that India did not view Bangladesh as an equal partner. It is arguable that India's troubled relationships with the neighbours were a result of its own hegemonic posture. However, this perception with political leaders has been changing gradually in the last few years. Manmohan Singh, during his visit to Bangladesh seeks to build a new future relation with Bangladesh. He also added that the time has come to plan a new path and

pursue a bold vision for good relations based on mutual respect and benefits. However, three years have passed but India has not made any remarkable change to the Singh's statement. If India fails to address the disputed issues properly, relation with China will weaken India's regional super power. India's relations with Bangladesh will restrict its sea connectivity and expansion of 'East Look' policy. It is opined that Bangladeshi and Indian political leaders both in power or opposition must consider their options carefully.

Present political situation both in India and Bangladesh must allow both sides an opportunity to rethink and re-envision the relationship. As cultural relations, Indira Gandhi Cultural Center of Indian Council was inaugurated at Dhaka on March 11, 2010. Again, the AL Government, on March 27, 2012 "conferred the Liberation War Honor to 45 Indian friends and institutions for their contribution to the 1971 Liberation War". All these speak about the generosity and priority placed by Bangladesh to India. India must modify its attitude and be more cooperative to Bangladesh to settle all the unresolved issues. Bangladesh must also assist India to make the new beginning. Both countries must compromise their political issues and value the national interests. "Sheikh Hasina government has shown considerable courage and conviction to free its soil from anti-India activity". Bangladesh hopes for suitable reciprocal gestures from India to strengthen the polity. Bangladesh-India relationships started improving significantly with the visit of the Bangladesh Prime Minister Sheikh Hasina to India in January 2010 and the then Indian Prime Minister Manmohan Singh to Bangladesh in September 2011. These visits have shifted the perceptions of relations between the two countries. However, these relationships between the two countries have been amplified with the visit of the Indian Prime Minister Narendra Modi to Bangladesh in June 2015.

## **Conclusion**

More prominent local collaboration, particularly in the field of financial improvement to destroy the neediness trap, might be a definitive objective of every single South Asian. Be that as it may, unless some remedial and brilliant measures are embraced right now, the circumstance may move the other way. That would be amazingly unsettling for the large number of destitution stricken South Asians. They may need to go past the geopolitical impulses and move towards more concrete provincial collaboration like what the Europeans and Southeast Asians are doing. Something else, improvement as such will just evade the South Asians. Lastly, the MOU emphasized the significance of people to people contact in carrying the



relationship forward, not only the two bus services were flagged off and more bus and train services were agreed upon, India and Bangladesh also announced the opening of new consulates in Sylhet and Khulna for India and in Guwahati for Bangladesh, Similarly since the Dhaka Kolkata Mitree Express is currently very popular and India has also agreed to construct a modern international passenger terminal to mitigate the grievances of travelers between the two cities. The two nations likewise have huge interests in proceeding to work together in battling fear based oppression. In the event that India will expand its control over its immature upper east, financial network and improved combination with other territorial on-screen characters like Bangladesh, Bhutan, and China is basic. India will have a significantly more noteworthy shot of achievement at keeping up peace in its northeastern states while creating them financially with Bangladesh's proceeded with collaboration, however Bangladesh likewise has a solid motivating force to help India. Precariousness along the fringe areas of Bangladesh can serve to stop Indian venture, as well as indications of instability may likewise take away from other advancement and undermine the possibilities of Bangladesh turning into a local center point.

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**Chapter - 4**  
**Producer Organization (s): An Institutional  
Mechanism for Improving Farmers' Income**

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# Chapter - 4

## Producer Organization (s): An Institutional Mechanism for Improving Farmers' Income

Deepak Pal and Laveena Sharma

### Abstract

Bharat (India), as a new and youngest <sup>[1]</sup> rising economy in Asia, puts strong emphasis on strengthening its institutional capacities in the widest sense. When it came to Institutional Mechanism for Improving Farmers' Income, integration are going to be very demanding and it will be the biggest challenge Indian farmers community has to face. There is no doubt: new challenge in Producer Organization(s): An Institutional Mechanism for Improving Farmers' Income will have clear and strong reflections in agriculture as a very important sector for the economy and rural society. Full harmonization with farmers' community would mean many changes in the sector and reshaping of it. Experiences of developing countries show that even a well-developed agricultural sector needs to be supported. Institutional support is one of the most important and crucial aspect. Very often, institutional support is a pre-requisite for other supports: direct support to the farmers; setting & implementation of quality standards, support to investments & Insurance, implementation of new concepts of rural development policy and so on. As it was the case in many other schemes/programme of Government of India, building appropriate institutional capacities that could meet all developmental needs was not taken so seriously in the past. Process of transition opened and sharpened necessity for building up institutional capacities in agriculture as a real precondition for its further sustainable development.

In the meantime, Ministry of Agriculture & Farmer Welfare, GoI <sup>[2]</sup> has already made some important steps within the institutional reforms & un-curtained the concept of 'Producer organization' <sup>[3]</sup> with the help of SFAC <sup>[4]</sup>

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<sup>1</sup> In terms of availability of young employee(s)

<sup>2</sup> Government of India

<sup>3</sup> Producer Company Act, A sub-clause under Companies Act 2013

<sup>4</sup> Small Farmers' Agribusiness Consortium

& NABARD <sup>[5]</sup> throughout the country. The work carried out here is all about the Concept, definition, approaches, budgets, accountability systems, technical capacity and investment and infrastructure of Producer Organization in India & its comparability with other legal form of entity apparently with the expectation to institutions serve the needs of the well-off and powerful strategy in farmer's communities.

**Keyword:** Farmer producer organization, institutional mechanism & farmers' income

## Introduction

Historically, India has been a farming based country. But it was only after we attained independence that the future of the sector brightened. One of the golden period in the history of Indian agriculture was between the 1950 and the late 1960s-the Green Revolution resulted in incremental increase in production of food grains, especially wheat and paddy.

It is a matter of concern that the 76 percent (approx) of farmers surveyed during a recent study said they would prefer to search something less riskier. The Government has set a target of doubling of farmers' income by the year 2022. Parallely, the Government is aiming to reorient agriculture sector by focusing on income centeredness. In order to realise net positive returns for the farmer are being promoted and implemented in a major way through the States/UTs. State government of Madhya Pradesh are also supporting doubling the farmer's income by tagline of "कृषि को लाभ का धंधा बनाने की योजना".

No nation can afford to compromise with its farming and farmers. And much less India, wherein the absolute number of households engaged in agriculture in 2011 (119 million) outpaced those in 1951 (70 million). Then, there are the landless agricultural labour who numbered 144.30 million in 2011 as against 27.30 million in 1951. The welfare of this elephantine size of India's population is predicated upon a robust agricultural growth strategy that is guided by an income enhancement approach. (Doubling Farmers' Income-Volume XIII).

This explains the rationale behind adopting income enhancement approach to farmers' welfare. It is hoped, that the answer to agrarian challenges and realization of the aim of farmers' welfare lies in higher and steady incomes. It is in this context, strategy for development of the

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<sup>5</sup> National Bank for Agriculture and Rural Development

agriculture sector in India has focused primarily institutional mechanisms & Development initiatives including infrastructure. These pressing issues have led to the evolution of “Producer Organization”. It is the best fit for targeted issue with full of customization.

### **Concept of Producer Organisation (PO)**

A Producer Organisation (PO) is a legal entity formed by primary producers, viz. farmers, milk producers, fishermen, weavers, rural artisans, craftsmen. A Producer Organisation can be a producer company, a cooperative society or any other legal form which provides for sharing of profits/benefits among the members. In some forms like producer companies, institutions of primary producers can also become member of Producer Organisation. The evolution of Producer Companies brought in by the Ministry of Corporate Affairs, based on the report of a high powered committee under the chairmanship of Dr. YK Alagh, through a bill for the amendment of the Companies Act, 1956 by inserting Part IX A.

### **Producer Company as Per the Companies Act, 2013**

In generic terms, producer companies can be said to be a way to improve the standard of living of those involved in the agricultural sector. Such companies are deemed to possess the goodness of co-operatives and the dynamicity of companies. The Companies Act, 2013 holds no provision with regards to the Producer Companies and with the enactment of the new act, the former act stands repealed. However, as per the provision of the said Act, Part IX A of the Companies Act, 1956 shall be applicable to a Producer Company in a manner as if the Companies Act, 1956 has not been repealed until a special Act is enacted for Producer Companies. A producer company is a company incorporated under Companies Act 2013 (formerly the Companies Act 1956) and shall carry on prescribed activities as mentioned in Section 581B of Companies Act 1956, to name few.

- Production, harvesting, procurement, grading, pooling, handling, marketing, selling, export of primary produce of the Members or import goods for their benefit
- Processing including preserving, drying, distilling, brewing, venting, canning and packaging of produce of its members
- Manufacture, sale or supply of machinery, equipment or consumables mainly to its Members
- Promoting mutual assistance, financial services and welfare measures of producers or their primary produce

Producer Organisation can be registered under any of the following legal provisions:

- Cooperative Societies Act/ Autonomous or Mutually Aided Cooperative Societies Act of the respective State
- Multi-State Cooperative Society Act, 2002
- Producer Company under Section 581(B) of Indian Companies Act, 1956, as amended in 2013
- Section 25 Company of Indian Companies Act, 1956, as amended as Section 8 in 2013
- Societies registered under Society Registration Act, 1860
- Public Trusts registered under Indian Trusts Act, 1882

Out of mentioned above, most adopted is producer Company under Section 581(B) of Indian Companies Act, 1956, as amended in 2013

### **Purpose of Producer Organization**

The main aim of PO is to ensure better income for the producers through an organization of their own. Small producers do not have the volume individually (both inputs and produce) to get the benefit of economies of scale. Besides, in agricultural marketing, there is a long chain of intermediaries who very often work non-transparently leading to the situation where the producer receives only a small part of the value that the ultimate consumer pays. Through aggregation, the primary producers can avail the benefit of economies of scale. They will also have better bargaining power vis-à-vis the bulk buyers of produce and bulk suppliers of inputs.

### **Producer Organization for Non-Farmers**

The PO is an organization of the primary producers. If the produce in question is a non-farm item (for example, handloom or handicraft), then the PO will be that of non-farmers. The objective of the PO is to ensure better income realization to its members (who are producers) through aggregation and, if feasible, value addition.

### **Essential Features of a Producer Organization**

- a) It is formed by a group of producers for either farm or non-farm (Allied) activities
- b) It is a registered body and a legal entity
- c) Producers are shareholders in the organization
- d) It deals with business activities related to the primary produce/product



- e) It works for the benefit of the member producers
- f) A part of the profit is shared amongst the producers
- g) Rest of the surplus is added to its owned funds for business expansion

### **Ownership of the Producer Organization**

The ownership of the Producer Organization is with its members. It is an organization of the producers, by the producers and for the producers. One or more institutions and/or individuals may have promoted the Producer Organization by way of assisting in mobilization, registration, business planning and operations. However, ownership control is always with members and management is through the representatives of the members.

### **Legal form(s)**

Institutions registered as cooperative societies and producer companies have legal provisions for sharing of profit earned by the Producer Organization by way of dividend. Other legal forms do not explicitly provide for profit sharing. However, the Producer Organization can offer better price for the produce it procures from the members, thus, benefiting the latter. Similarly, it can procure inputs/raw material in bulk and sell to members with low margin. Such activities are permissible for Producer Organizations under all legal forms. A comparative chart of important features of Cooperative Society and Producer Company is given below:

### **Key Differences between Producer Companies and Cooperative Societies**

<b>Parameter</b>	<b>Cooperative Society</b>	<b>Producer Company</b>
Registration	Cooperative Societies Act	Indian Companies Act
Objectives	Single object	Multi-object
Area of Operation	Restricted, discretionary	Entire Union of India
Membership	Individuals and cooperatives	Any individual, group, association, producer of goods or services
Share	Non tradable	Not tradable but transferable; limited to members at par value
Profit sharing	Limited dividends on shares	Commensurate with volume of business
Voting rights	One member, one vote, but Government and Registrar of Cooperatives hold veto power	One member, one vote. Members not having transactions with the company cannot vote

Government control	Highly patronized to the extent of interference	Minimal, limited to statutory requirements
Extent of Autonomy	Limited in “real world scenario”	Fully autonomous, self-ruled within the provisions of Act
Reserves	Created if there are profits	Mandatory to create every year
Borrowing Power	Restricted as per bye-law. Any amendment to bye-law needs to be approved by the Registrar and time consuming.	Borrowing limit fixed by Special Resolution in general meeting. Companies have more freedom to raise borrowing power.
Relationship with other corporate/business houses/NGOs	Transaction based	Producers and corporate entity can together float a producer company

### **Producer Organization as Registered Non-Profit Organization (NPO)**

Institutions can be built for promoting common interests of members/producers. The limitation is that surplus generated by such a Producer Organization cannot be divided among members by way of dividend etc. The Producer Organization can re-invest the surplus to grow the business. Comparison of Producer Organization registered under different Acts governing non-profit institutions is given below:

### **Comparative Chart for Non-Profit Legal Forms**

<b>Objectives</b>	<b>Non-Profit Activities</b>	<b>Charitable, Literary, Scientific, etc.</b>	<b>Charitable, Socially Beneficial</b>
Statute/Law	Indian Companies Act, 1956 (Sec 8)	Societies Registration Act 1860	Indian Trust Act, 1882 or Bombay Public Trusts Act
Alternation of objects	Complex legal procedure	Simple procedure	Normally only Settle or can modify
Formation	Complex procedure, 3-6 months	Simple and easy	Simple and easy
Management	Formalities of Company law have to be observed	Few restrictions imposed under the Act	Very few restrictions imposed under the Act
Meetings	To be held as per provisions of law which are quite extensive.	Annual meeting as per law and Rules of the society	No provisions laid down
Penalties	Various offences and lapses attract severe penalties.	Few offences and penalties have been prescribed	Very negligible
Legal Status	Full legal status	Legal status with certain limitations	Legal status with limitations

Statutory Regulation	Exhaustive but mature	Very limited	Nominal
Removal of members	Not possible without consent	Possible without consent	Not applicable
Dissolution or takeover by state	Very difficult	Possible	Possible

### **Importance of Registration**

It is preferable for the Producer Organization to work as a legal entity. Only such an entity can enter into legally valid contracts including mobilization of funds from other institutions. There are specific Acts under which the Producer Organization could be registered. It is also possible for a Producer Organization to migrate from one legal form to another. While choosing a legal form, the following factors may be kept in view:

- a) Primary producers should benefit from the surplus generated by the Producer Organization
- b) Process of Registration should not be too demanding in terms of time and resources
- c) The legal form needs to fit into its business needs, organizational priorities, social capital and management capacity

### **Important Activities of a Producer Organization**

The primary producers have skill and expertise in producing. However, they generally need support for marketing of what they produce. The Producer Organization will basically bridge this gap. The Producer Organization will take over the responsibility of any one or more activities in the value chain of the produce right from procurement of raw material to delivery of the final product at the ultimate consumers' doorstep. In brief, the Producer Organization could undertake the following activities:

- Processing (processing also includes, preserving, brewing, vinting, drying, distilling, canning and packaging) of the produce of its members
- Manufacture, sale or supply of equipment, machinery or consumables to its producer members
- To provide education on the mutual assistance principles to the producer members of the producer company and others
- To render consultancy services, technical services, training, R & D and all other required activities for promoting the interests of producer members

- Insurance of the primary produce and its producer
- To promote the techniques of mutuality and mutual assistance
- The welfare of members as may be decided by the Board
- Financing of procurement, marketing, processing or other activities such as extending of credit facilities or any other financial assistance to its producer members
- Any other activity (ancillary or incidental to the main objectives of the producer company) in order to promote the mutual assistance amongst the producer members and the lines of principles of mutuality
- Procurement of inputs, Disseminating market information, Dissemination of technology & innovations and Facilitating finance for inputs Aggregation and storage of produce
- Primary processing like drying, cleaning and grading, Brand building, Packaging, Labeling and Standardization, Quality control, Marketing to institutional buyers, Participation in commodity exchanges and Export

A Producer Organization will support the members in getting more income by undertaking any/many/all of the activities listed above. By aggregating the demand for inputs, the Producer Organization can buy in bulk, thus procuring at cheaper price compared to individual purchase. Besides, by transporting in bulk, cost of transportation is reduced. Thus reducing the overall cost of production. Similarly, the Producer Organization may aggregate the produce of all members and market in bulk, thus, fetching better price per unit of produce. The Producer Organization can also provide market information to the producers to enable them hold on to their produce till the market price become favourable. All these interventions will result in more income to the primary producers. A Producer Organization is a collective of farmers (and non-farmers) who are the primary producers of a product (an agricultural produce or a manufactured product). It, therefore, can work as a platform to facilitate better access to government services, like PDS, MNREGA, Scholarships and Pensions, etc. It can liaison with the Government Departments for convergence of programmes, like drinking water, sanitation, health and hygiene.

### **Role of Central Government Institutions in Supporting FPOs**

- Department of Agriculture and Cooperation (DAC), Ministry of Agriculture, Govt. of India will act as the nodal agency for the development and growth of FPOs.

- Small Farmers' Agribusiness Consortium (SFAC), a Society under DAC, will be the designated agency of DAC to act as a single-window for technical support, training needs, research and knowledge management and to create linkages to investments, technology and markets. SFAC will provide all-round support to State Governments, FPOs and other entities engaged in promotion and development of FPOs. In particular, SFAC will create sustainable linkages between FPOs and inputs suppliers, technology providers, extension and research agencies and marketing and processing players, both in the public and private sectors.
- The mandate of National Cooperative Development Corporation (NCDC) will be expanded to include FPOs in the list of eligible institutions which receive support under the various programmes of the Corporation.
- NAFED will take steps to include FPOs in the list of eligible institutions which act on its behalf to undertake price support purchase operations.
- DAC will work with Food Corporation of India (FCI) and State Governments to encourage them to include FPOs as procurement agencies under the Minimum Support Price (MSP) procurement operations for various crops.
- DAC and its designated agencies will work with NABARD and other financial institutions to direct short and medium term credit for working capital and infrastructure investment needs of FPOs. DAC will also work with all relevant stakeholders to achieve 100% financial inclusion for members of FPOs and link them to Kisan Credit Cards.
- DAC will work with Ministry of Corporate Affairs and other stakeholders to further clarify and strengthen provisions of the law relating to the registration, management and regulation of FPOs with a view to fostering fast paced growth of FPOs.

### **Role of State Government Institutions in Supporting FPOs**

Besides encouraging State Governments to take up formation of FPOs on a large scale through centrally sponsored and State-financed programmes and schemes, DAC suggests the following steps to be taken by State Governments to support and strengthen FPOs:

- By declaring FPOs at par with cooperatives registered under the relevant State legislation and self-help groups/federations for all

benefits and facilities that are extended to member-owned institutions from time to time

- By making provisions for easy issue of licenses to FPOs to trade in inputs (seed, fertilizer, farm machinery, pesticides etc.) for use of their members as well as routing the supply of agricultural inputs through FPOs at par with cooperatives
- By using FPOs as producers of certified seed, saplings and other planting material and extending production and marketing subsidies on par with cooperatives
- By suitable amendments in the APMC Act to allow direct sale of farm produce by FPOs at the farmgate, through FPO owned procurement and marketing centres and for facilitating contract farming arrangements between FPOs and bulk buyers
- By appointing FPOs as procurement agents for MSP operations for various crops
- By using FPOs as implementing agencies for various agricultural development programmes, especially RKVY, NFSM, ATMA etc. and extending the benefits of central and State funded programmes in agriculture to members of FPOs on a preferential basis
- By linking FPOs to financial institutions like cooperative banks, State Financial Corporations etc. for working capital, storage and processing infrastructure and other investments
- By promulgating state level policies to support and strengthen FPOs to make them vibrant, sustainable and self-governing bodies

### **Prerequisite to Become a Member**

PO is an organization of the producers, specifically the primary producers. All primary producers residing in the relevant geography, and producing the same or similar produce, for which the Producer Organization has been formed, can become member of the Producer Organization. Membership is voluntary. The procedure for obtaining Producer Organization membership depends on the bye-laws of the Producer Organization. The founder-members are those who were there at the time of formation of the Producer Organization. Other members join the Producer Organization later. However, all members enjoy equal rights. A primary producer can become member of a Producer Organization by submitting an application and a nominal membership fee. Some Producer Organizations also charge annual membership renewal fee. Although primary producers

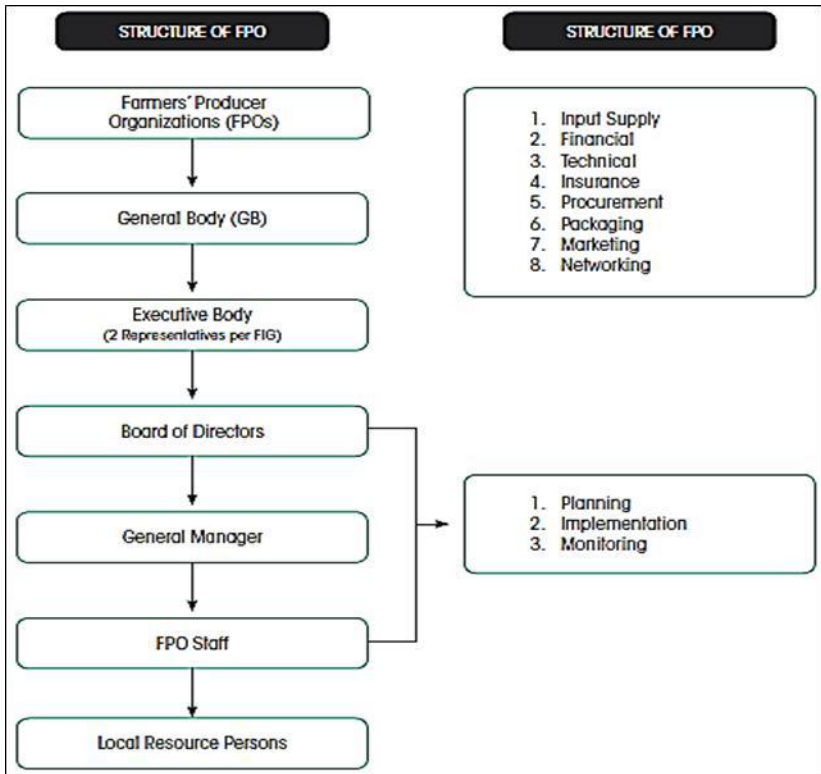
obtain membership of Producer Organization voluntarily, the promoting institution should make efforts to bring all producers into the Producer Organization, especially the small producers.

### **Primary Producer**

Any person engaged in any activity connected with or related to any primary produce will be treated as producer. Primary produce means the produce of farmers from agriculture and allied activities or produce of persons engaged in handloom, handicrafts and other cottage industries, including any by-product and product resulting from ancillary activities thereof. Primary produce also includes any activity intended to increase the production or quality of aforementioned products or activities. Persons engaged in agriculture, horticulture, animal husbandry, fishery, sericulture, apiary, handloom, handicrafts, etc., can become members of appropriate Producer Organization. Persons engaged in collection of minor forest produce are also eligible for membership of Producer Organization although they gather these from forests and strictly are not producers. FPO as Lehman language “Group of farmers (producer) on the basis of symmetry in geographical conditions, Crop, land holding & living status etc. to get the optimum return or not for profit objective through conjoint effort.”

Family is the unit of production in rural areas. Benefits from the Producer Organization will accrue to members in proportion to the volume/value of produce given to the Producer Organization. Therefore, one person from a family can provide the whole produce of the family to the Producer Organization and get the same amount of benefit as multiple members providing the same volume/value. If however there are two different Producer Organizations in the vicinity, each for a different type of produce, say vegetables and milk, one person can become member of both these Producer Organizations, if the family produces both milk and vegetables. Each Producer Organization will have an elected Board of Management/Board of Directors as per the bye-laws. The Board can engage professionals to manage its affairs. In the initial years, professional and managerial assistance is usually extended by the Producer Organization. As the leaders of the Producer Organization gain experience, they should take over the affairs of the Producer Organization completely.

## FPO Service Model <sup>[6]</sup>



### Engagement of Professionals

All legal forms provide for engaging professional and other employees by the Producer Organization. Such persons should be paid out of the income of the Producer Organization. As far as Producer Organization, the income should come from value addition to the produce and not from price paid to members. If members get price less than the market, they will gradually move away from the Producer Organization. The professionals and other employees should be paid at par with the prevailing market to ensure that they remain for long with the Producer Organization. Compensation will also depend upon the business plan, ensuring a positive surplus.

The objective of the Producer Organization is to ensure better income to the member-producers through aggregation and value addition. Therefore, procurement from non-members is usually not undertaken. However, market exigencies at times may necessitate such procurement. There should be

<sup>6</sup> Source-Policy & Process Guidelines for Farmer Producer Organizations



provision in the by-laws of a Producer Organization to enable procurement from non-members during such exigencies. The Producer Organization can aggregate the produce of its members, and sell it using the commodity exchanges. The produce needs to meet the quality standards specified by the commodity exchanges, and be stored scientifically in approved warehouses. The Producer Organization can become a member of the Commodity Exchanges to do trading directly, or else it can sell through the exchange-approved brokers.

For exporting agricultural produce, all the members will have to follow Good Agricultural Practices (GAP). There are also other specific quality parameters that the importing countries impose for different produce which need to be complied with. For non-farm produce (handloom, handicrafts etc.), there are other quality specifications and other stipulations against using child labour, etc.

Expenditure towards registration of a Producer Organization viz. registration fee, stamp duty, preparation of documents and facilitation charges etc., will depend on the legal structure of the Producer Organization. In general, establishment of a producer company is more expensive than other legal forms. The estimated cost of incorporating a producer company is about forty thousand INR. It may vary with time.

### **Size of FPO**

Normally about 800-1000 producers are a good size to form agriculture based Producer Organization, however this would change depending upon the products to be handled. Normally selection of the area and the members is done on the basis of the commonalities like produce, farmers' need and common problems they are facing in terms of production and marketing.

### **Benefits for Producer Companies**

The following are the benefits enjoyed by a Producer Company:

- The members of the producer company initially will receive the value for the produce pooled and supplied as determined by the directors. This amount will be given out later in the form of cash/ kind/ equity shares.
- The members of the producer company will be entitled to get bonus shares in the same proportion to the shares held by them.

The surplus (after providing provision for payment of limited return and

reserves) may be given as patronage bonus <sup>[7]</sup> to the members of the producer company.

## Loans and Investments

As mentioned above the Producer Company consists of individuals who are primary producers, and thus, are in need of financial support from time to time. Hence, a special provision under the companies acts 1956 was passed for giving loans to producer members. A Producer Company can provide financial assistance to its members through:

- **Credit Facility:** This is available to any member for a period not exceeding six months (such facility must be in connection with the business of the Company).
- **Loans and Advances:** These are provided to the producer member against security, repayable within a period not exceeding seven years from the date of disbursement of such loans or advances.
- **NABARD Loan:** NABARD provides support and financial assistance to meet the needs of Producer Companies. In 2011, NABARD set up a Rs. 50 crore Producer Organisation Development Fund (PODF), out of its operating surplus.
- **SFAC (Small Farmers' Agribusiness Consortium):** a Society under DAC, will be the designated agency of DAC to act as a single-window to create linkages to investments.

## Taxability of Producer Company

The Income Tax Act, 1961 under section 10(1) exempts the agricultural income. However, the exemption provided under section 10(1) for the agricultural income sometimes vary on the basis of the agricultural activity carried out.

The Income Tax Act does not specify any specific tax benefit which essentially provides special tax benefits or exemptions to producer companies by its definition. But subject to the agricultural activity carried out by the producer company, certain tax benefits and exemption can be availed.

For example, income derived from selling the grown green tea leaves is an agricultural income under the Income Tax Act and it is 100% tax-free.

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<sup>7</sup> Signifies a distribution of the surplus income to the members of the producer company in proportion to their respective patronage. Patronage, on contrary, is the participation by members in their business activities by using the services offered by Producer Company

However, if the tea leaves are further processed for the manufacturing of tea, only 60% of such income will be considered as agricultural income and 40% of such income will be taxed.

Thus, it is apparent that the tax benefit and exemption to a producer company is totally depending upon the activity it carries on.

### State wise Summary <sup>[8]</sup> of Registered and under the Process of Registration FPOs Promoted by SFAC

S. No.	State	No. of FPOs			
		Total Targeted Farmer	Registered	Under the Process of Registration	Total
1	Andhra Pradesh	13000	7	6	13
2	Arunachal Pradesh	4750	2	4	6
3	Assam	10500	12	6	18
4	Bihar	35000	29	7	36
5	Chhattisgarh	29000	26	2	28
6	Delhi	3500	4	0	4
7	Goa	1750	2	0	2
8	Gujarat	24000	20	5	25
9	Haryana	12750	23	0	23
10	Himachal Pradesh	6850	6	1	7
11	Jammu & Kashmir				
	Jammu (Division)	3981	1	0	1
	Srinagar (Division)	4080	1	0	1
12	Jharkhand	12000	10	0	10
13	Karnataka	127500	119	6	125
14	Madhya Pradesh	149000	143	5	148
15	Maharashtra	104500	99	6	105
16	Manipur	6950	6	2	8
17	Meghalaya	3750	3	1	4
18	Mizoram	2700	1	1	2
19	Nagaland	3750	2	2	4
20	Odisha	38900	41	0	41
21	Punjab	6000	7	0	7
22	Rajasthan	60500	48	2	50
23	Sikkim	15750	30	0	30
24	Tamil Nadu	17000	11	6	17

<sup>8</sup> as on 30.04.2019 <http://sfacindia.com>

25	Telangana	28998	20	5	25
26	Tripura	2750	4	0	4
27	Uttarakhand	6000	7	0	7
28	Uttar Pradesh	56000	49	8	57
29	West Bengal	90500	80	9	89
Total		881709	813	84	897

In addition of SFAC promoted FPOs i.e. 897, in our country 339 FPOs (Non-SFAC promoted) have also promoted by ATMA Directorate and SAMETI, Department of Agriculture Pondicherry, Directorate of Horticulture and Farm Forestry Chhattisgarh, NABARD & MSAMB.

## Conclusion

The absence of well conceived institutional mechanism in our country is the core reason behind the disability of Indian farmer in case of low level of farmers return on farming. Distress agrarian is resulting curse of low level of farmer's income and year-to-year fluctuations. This distress is spreading and getting severe over time because of the farmers zero interest toward farming. Today stark reality is that, the farming is the last choice of farmers and in present scenario even we can say, The Farmer is a farmer until/unless s/he has a alternate to quit it. Being a father (farmer), he never suggests his children to go for farming. This is the situation in era of globalization where we consider human resource as assets for organization. Therefore, the major problem is to conversion of traditional farming to farming as an enterprise. The term enterprise defined<sup>9</sup> as '*an organization, especially a business, or a important plan, especially one that will earn money*' so here, the prime motto behind the aforesaid conversion is to earn money from farming to make it sustainable. In traditional farming, it is not possible to calculate the status of return at end because of 'Non- Enterprising approach' and in absence of this approach we cannot assume management related to Human Resource, Finance, Marketing & Sales. Without managing these factors hardly are we earning something, even we get some earning then it is not possible to quantify the return from it. So until/unless we don't go for 'legal entity' it is not easy to support the government's aim to doubling the farmers' income. It is the reason to un-curtained the term 'Farmer producer Organization' for farmer<sup>10</sup> community of country. It the best fit for improve the welfare of farmers, raise agricultural income & supporting the farmers voice. Achieving this goal will reduce persistent disparity between farm and

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<sup>9</sup> Cambridge-dictionary

<sup>10</sup> Involved in agriculture and allied practices

non-farm income, alleviate agrarian distress, promote inclusive growth and infuse dynamism in the agriculture sector. Respectable income in farm sector will also attract youth towards farming profession and ease the pressure on non-farm jobs, which are not growing as per the expectations. There is a need to liberalise agriculture to attract responsible private investments in production and market. Similarly, FPOs and FPC<sup>11</sup>s can play big role in promoting small farm business. Ensuring MSP alone for farm produce through competitive market or government intervention will result in sizeable increase in farmers' income in many states.

Most of the development initiatives and policies for agriculture are implemented by the States. States invest much more than the outlay by the Centre on many development activities, like irrigation. Progress of various reforms related to market and land lease are also State subjects. Therefore, it is essential to mobilise States and UTs to own and achieve the goal of doubling farmers' income. If concerted and well-coordinated efforts are made by the policy makers, the Country can achieve the goal of doubling farmers' income by the year 2022.

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**Chapter - 5**  
**Health Benefits and Applications of Microbial**  
**Pigments**

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# Chapter - 5

## Health Benefits and Applications of Microbial Pigments

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### Abstract

The demand for natural colors is increasing day by day due to harmful effects of some synthetic dyes. Microbial pigments provide a readily available alternative source of naturally derived pigments. In contrast to other natural pigments, they have enormous advantages including rapid growth, easy processing, and independence of weather conditions. The various microorganisms such as *Micrococcus*, *Bacillus*, *Rhodotorula*, *Monascus*, *Phaffia*, *Sarcina*, *Sporobolomyces* and *Achromobacter* have the capability to produce different pigments. These colors have number of beneficial properties like anti-cancerous, immunosuppressive, antibiotic, anti-proliferative, bio-degradability etc. Further, they have broad area of application mainly in food, dairy, printing, textile and pharmaceutical industries etc. Use of microbial pigments in processed food is another promising area with large economic potential.

**Keywords:** Pigments, synthetic, natural, microorganisms, significance, applications

### 1. Introduction

Humans are naturally attracted to colorful foods and have historically tried to improve and preserve the appearance and nutritive value of foods. This led to the traditional practice of adding colorants to foods during processing. However, achieving this goal with synthetic colorants has raised health concerns due to potential mutagenic and carcinogenic side effects. Interest in the use of natural colorants in food and pharmaceuticals opened the vista for interest in the production and use of microbial colorants. Natural pigments are extracted from fruits, vegetables and microorganisms. Colour is a key organoleptic attribute that provides clues for many food qualities such as flavour, sanity, naturalness or maturity. Based on these clues, consumers make their choices <sup>[21]</sup>.

Beyond just adding color to food, these microbial colorants may also have potential beneficial properties as antioxidants and anticancer agents,

and therefore they have received considerable scientific and industrial interest. Microbial sources of colorants have significant advantages over other natural sources including improved production, predictability of yield, and the ability to manipulate the color and physiological value through genetic and metabolic engineering. So, the use of food colorants in the food industry is a significant factor for both food manufacturers and consumers in determining the acceptability of processed food [3].

## **2. Classification of Colourants**

For consumers the colourants may appear to be either natural or synthetic, but it is definitely more than that and is worthwhile to take a look at it. Based on chemistry, colourants can be divided into organic or inorganic both of which are mostly synthesized chemically in the lab. The simple examples of which are carotenoids and titanium dioxide respectively. Most of the naturally occurring colourants that are currently in use are typically organic colourants. Furthermore, organic colourants can be classified as pigments and dyes based on their solubility in the media; if they are insoluble and require a fixative to adhere to the surface of the substrates, they are termed as pigments while the dyes are almost soluble in the media to which they are added and do not require any fixatives.

As per the origin and legislation is concerned, food colourants can be categorized into natural, nature-identical and synthetic. Natural colourants are pigments produced, accumulated or excreted by living organisms. They also include colourants made by the modification of materials from living organisms, such as caramel, vegetable carbon and copper chlorophyllin. Ironically, they are (except for carbon) not found in nature. Nature identical colourants are chemically synthesized man-made pigments which are also found in nature. Examples include,  $\beta$ -carotene, canthaxanthin, and riboflavin. Synthetic colourants are man-made colourants that are not found in nature; these are mostly azo-dyes. Consumers, however, perceive only natural and synthetic classes of colourants. Thus, it can be inferred that natural colours are regarded as safe and have a healthy image for the consumers [3].

### **2.1 Synthetic Food Colours**

The first synthetic organic dye, a purplish lilac colour, was discovered in 1856 by William Henry Perkin and called “mauve.” Over the next 50 years, scores of similar organic aniline dyes, representing every colour and tint of the rainbow, were developed, and many were used to colour food with little thought or testing regarding their safety. Significant toxicity of many early

aniline and coal-tar based colours prompted regulators to examine exactly what was being used to colour food [30].

Of the 80 synthetic food colourants sold in 1907, only 16 were deemed to be “more or less” harmless. By 1907, this list was pared to seven synthetic colourants, which eventually were subjected to “batch certification” to detect and limit toxic impurities [5, 36]. The list of “certified” colours had expanded and contracted over the decades to the current group of nine certified colours chemically classified into four chemical families: azo, xanthenes or fluorescein, triphenylmethane and sulfonated indigoid.

### **2.1.1 Health Hazards of Synthetic Food Colours**

The potential adverse health effects through exposure to synthetic agents in foods is evaluated by risk analysis. Among the synthetic agents, food colours are of major concern in India. In the mid-1980s, there was a growing concern among consumers about the possible adverse effects of additives such as colours, for example, the purported link between tartrazine and hyperactivity in children. A possible link between the ingestion of foods containing synthetic food flavourings and colours and the presence of hyperactive behaviours in children had been suggested [13].

Permitted colours like ponceau, tartrazine and sunset yellow have provoked allergic reactions in several individuals even at low levels of intake. The allergic responses vary from urticaria to dermatitis, angioedema and exacerbation of asthmatic patients (WHO, 1991). It has also been reported that the consumption of a particular brand of aniseed having very high levels of ponceau 4R, exhibited symptoms of glossitis of tongue in children. Tartrazine was associated with irritability, restlessness and sleep disturbance in atopic or hypertensive children aged between 2 and 14 years. Rowe and Rowe (1994) found that behavioural changes in relation to irritability, restlessness, and sleep disturbance were associated with the ingestion of tartrazine in some children, and reported that those effects were dose-related (1-50 mg per child).

The potential adverse effects of erythrosine (ER, FD & C Red No. 3) on the spermatogenesis in adult mice. The sperm count as well as the percentage of motile sperms were significantly reduced by about 50 per cent and 57 per cent respectively [11]. These findings indicated that ER in the used doses had a potential toxic effect on spermatogenesis in mice and in turn, it might affect its testicular function and reproductive performance. Many synthetic colours have been widely used as food additives in various processed foods for economic reasons and for their bright colour and

stability <sup>[25]</sup>. The Prevention of Food Adulteration (PFA) Act in India prescribes a level of 100 ppm of tartrazine, sunset yellow, ponceau 4R, carmoisine, erythrosine, brilliant blue, fast green FCF and indigo carmine to be added to specified food items and a level of 200 ppm in canned foods, jams and jellies.

Permitted colours usage had also evoked concern because they were being used in excess of the statutory limit (100 ppm) or in foods in which they were not permitted <sup>[31]</sup>. The safety of repeated exposure to the permitted synthetic colours were often questioned.

### **2.1.2 Natural Vs Synthetic Colourants**

Use of dyes to colour the food stuff have been used historically, however the detrimental effect of such food dyes became more prominent only after the invention of synthetic dyes. For example, it has been reported that synthetic colourant, fuchsine, was used as early as in 1860 in France as a wine additive <sup>[46]</sup>. Arsenic acid (toxic) was used as a reagent for its manufacture. Today, consumers are concerned about the eventual harmful effects of synthetic colourants; Fast Green dye has been shown to be an immunotoxic agent <sup>[4]</sup>. Despite the fact that synthetic colourants are relatively more stable, have higher colour strength per mole of a compound and cheaper to produce. Natural colourants are preferred due to their safe and healthy image and the fact that they can be produced by eco-friendly means. Global sales of natural colours reached an estimated \$600 million in 2011, up by almost 29 per cent from 2007 and demonstrating annual growth in excess of 7 per cent. The share of the total food colours market taken by natural sources has increased from 34 per cent in 2007 to nearly 39 per cent in 2011, according to a new report from Mintel and Leatherhead Food Research. Thus, it can be said that naturally derived colorants look set to overtake synthetic alternatives in market value due to the rising demand for the clean label ingredients.

## **2.2 Legislative Issues and Food Regulations on Food Colourants**

To evaluate the safety of food colours, the Joint FAO/WHO Expert Committee of Food Additives (JECFA) has set an Acceptable Daily Intake (ADI) for each of the permitted colours based on toxicological studies on experimental animals and data from human clinical studies. The ADI has been defined as the amount of a substance that can be consumed everyday throughout the life time of an individual without any appreciable adverse health effects <sup>[44]</sup>. The ADI for permitted colours varies from 0.1 mg kg<sup>-1</sup> body weight for erythrosine to 25 mg kg<sup>-1</sup> body weight for fast green FCF.

The more toxic the food colour, the lower is the ADI. It becomes extremely important to monitor the total daily intake of all food colours since the ADI level of any food colours should not be exceeded the level prescribed by JECFA, 1996. The International Life Sciences Institute (ILSI) suggested that special ADIs should be established for infants and children as the use of food colours represents a higher risk for infants and children than for adults. The maximum permitted limit in foods is 0.1g per kg of food or one g in 10 kg. In food category, the maximum limit is 0.2 g per kg of food, but even in these, the limit should not exceed 0.1 g per kg at the time of serving or consumption. (Pratima and Sudershan, 2008).

In general, children are more susceptible to chemical dyes or colours and the patterns of consumption are different from adults. There are various factors which can influence the intake of food colours, such as the type and quantity of foods consumed and the socio-economic status of individuals. In India, most of the studies were focussed on the usage of colours in foods while there have been limited studies focused on the exposure of individuals to synthetic food colours. Thus, the safety of repeated exposure to synthetic colours were questioned and there was a need to evaluate total exposure of individuals to colours. The Prevention of Food Adulteration Act (PFA) regulates the usage of colour. At the state level, the implementing authority is the State Food Health Authority and at the local level, municipalities, municipal corporations or Local Health Authorities are responsible [33].

In most countries, only certain dyes are permitted as food colours, and compound-specific purity standards are governed by strict regulation. The legislation specifies which colourants may be used; the sources of the colourants, the purity of the colourant, to which foods the colourant may be added, and at what level the colourant may be added to a specific food. The European Union (EU) directive, EU Directive 94/36/EC, often referred to as the Colours Directive, is implemented throughout the members state. Here the colours are listed together with conditions for their use. In the United States (US), the use of colours is outlined in Code of Federal Regulations, Title 21 (21CFR). A number of countries also follow the US legislation. The Australian and Japanese legislations on colours in food are also used as the basis for local regulation in a number of other Asian countries.

Legislation is often influenced by local, traditional usage of colorants as in case of *Monascus* colourants (pigments of an ascomycetous fungus *Monascus* used as fermentative produced red rice powder), lac, and gardenia based colourants. None of these are permitted to be used in the EU and the

US, partly due to the fact that their sources are too alien for these societies. There are many similarities between the EU and US legislations about the colourants that are allowed, however, there are striking differences when it comes to the sources of the colorants and the foods in which the colorants can be applied. For example, in the USA, sodium copper chlorophyllin may only be made from alfalfa (*Medicago sativa*) and only be used in citrus-based dry beverage mixes, whereas in the EU, allowed sources are alfalfa, grass, nettle, and edible plant material, and a wide range of foods may be coloured <sup>[21]</sup>.

### **2.3 Quality Control Issues**

The extent of quality control depends on the type of colour product, the information available on the certificate of analysis, the expected processing conditions, the finished product and the standard quality control procedures of the food or beverage manufacturer. In some cases the colour strength or colour hue and intensity may be the most important parameter. In others, the microbiological standard and absence of pathogens are also important. For powder formulations to be used in dry blends, the particle size is relevant, whereas density can be a key point if the colour is volumetrically measured by flow meter during the production process <sup>[24]</sup>.

### **2.4 Merits Vs Demerits of Natural Food Colorants Currently in use**

Since natural colorants are extracted from natural sources, they are in most cases mixtures of varying composition and, therefore, not easy to characterize with respect to purity and contaminants. Anthocyanins and flavonoids form one such an example that is derived from many fruits and vegetable sources. Their use in a pure form as food additives is limited mainly for three reasons:

1. They are expensive to isolate in pure form and large quantities from natural sources
2. They are difficult to synthesize
3. The colour is often pH dependent as in case of anthocyanins. An increase of pH enhances blue hues, whereas, under acidic conditions, an orange to red colour is observed <sup>[46]</sup>

The issue of stability of pigments is not to be overlooked. Pigments are highly unsaturated compounds and are prone to light, heat, and oxygen disintegration. However, there exists a large difference in the stability of different classes of existing natural food colorants. Vegetable carbon and caramel are very stable towards heat, light, and oxygen. Carminic acid and



carmines are also quite stable but not as stable as vegetable carbon and caramel. On the other hand, turmeric is rapidly bleached by light and beet root pigments turn brownish even under mild heating conditions <sup>[21]</sup>. This provides a large incentive to identify alternative ways in which natural colours can be produced in the future.

## 2.5 Status of Permitted Food Colours in India

The type and extent of colours added to ready-to-eat (RTE) foods prepared in the non-industrial sector of India was investigated. Of the 545 RTE foods analysed, 90 per cent contained permitted colours, 2 per cent contained a combination of permitted and non-permitted colours and 8 per cent contained non-permitted colours <sup>[16]</sup>. However in RTE foods with permitted colours, 73 per cent exceeded the 100 ppm, as prescribed by the Prevention of Food Adulteration Act of India and 27 per cent were within the prescribed levels. Among the permitted colours, tartrazine was the most widely used colour followed by sunset yellow. The maximum concentration of colours was detected in sweetmeats (18767 ppm), non-alcoholic beverages (9450 ppm), miscellaneous foods (6106 ppm) and hard-boiled sugar confectioneries (3811 ppm). Among the non-permitted colours found, rhodamine was most commonly used. Some of the foods, such as savouries and miscellaneous foods like sugar coated aniseed is not supposed to contain colours as per the Prevention of Food Adulteration Act, but were found to contain colours (Pratima and Sudershan, 2008). The studies on permitted and non-permitted colours are presented in Table 1.

**Table 1:** Studies in India on usage of added colours in various foods

Food Items	Permitted Colours	Non-Permitted Colours	Reference
Milk products (ice cream, khoya, chenna), non-milk products (sweets, namkeens), pulses, miscellaneous (confectionery, soft drinks, spices, condiments and tea)	Tartrazine, sunset yellow, carmoisine, ponceau 4R, amaranth, erythrosine, fast red and indigo carmine	Metanil yellow, auramine, rhodamine B, blue VRS, malachite green, Sudan II, III, congo red	Khanna <i>et al.</i> (1973)
Sweets, confectionery, namkeens	Tartrazine, sunset yellow, brilliant blue, carmoisine, indigo carmine, erythrosine, ponceau 4R, amaranth	Metanil yellow, orange II, malachite green, Rhodamine B, blue VRS, auramine	Dixit <i>et al.</i> (1995)
Pulses ( <i>Cajanus cajan</i> , <i>Cicer arietinum</i> , <i>Phaseolus</i> )	-	Metanil yellow, orange II, sudan II,	Khanna <i>et al.</i> (1987)

<i>mungo</i> ), powdered spices (turmeric, chili powder), non-hydrogenated oils		III, IV and V, auramine, blue VRS, Malachite green, rhodamine B	
Sweetmeats, turmeric, ice candies	-	Metanil yellow, lead Chromate	Kiple and Ornelas (2000)
Sweets, confectionery, soft drinks, ice candies, fruit sweetened juices, edible oils, turmeric, pulses, tea and coffee	Tartrazine, sunset yellow, carmoisine, ponceau 4R, brilliant blue	Rhodamine, auramine, orange II	Babu and Shenolikar (1995)
Jilebi	-	Metanil yellow	Toledo <i>et al.</i> (1992)
Dried ginger, confectionery, pulses, edible oils, potatoes, pickles, prepared foods <i>viz.</i> , Biryani	Tartrazine, ponceau 4R, sunset yellow	Rhodamine, orange II, Metanil yellow, ultramarine blue	Biswas <i>et al.</i> (1994)
Confectionery, sweets, biscuits, beverages, jam, jelly, custard powder	Tartrazine, sunset yellow, carmoisine, ponceau 4R, brilliant blue	Amaranth, orange II, Metanil yellow, rhodamine B, congo red, blue VRS, unidentified chocolate brown	Biswas <i>et al.</i> (1994)
Flattened rice, fish, fresh vegetables and cut-fruits		Auramine, congo red, Malachite green, rhodamine B	Dixit <i>et al.</i> (1995)
Sweets, savoury products, powdered spices (turmeric, red chilli)	Tartrazine, sunset yellow, indigo carmine, amaranth, brilliant blue FCF	Metanil yellow, orange II, sudan I, III, IV, Rhodamine B, blue VRS, auramine	Dixit <i>et al.</i> (1995)

## 2.6 Natural Colours

Natural colourants are considered to be safer than synthetic ones, and their applications in foods, cosmetics and pharmaceuticals are growing rapidly. There are a number of natural pigments, but only a few are available in sufficient quantities for industrial production. Production of pigments from microorganisms is advantageous over other sources because microorganisms can grow rapidly which may lead to a high productivity of the product<sup>[18]</sup>.

### 2.6.1 Important Chemical Classes of Natural Food Colourants

The use of food colourants as additives in the food industry is a significant factor for both food manufacturers and consumers in determining the acceptability of processed food<sup>[29]</sup>. Currently, the European Union has

authorized approximately 43 colourants as food additives, whereas approximately 30 colour additives are approved for use in the United States. These legislations do not distinguish between synthetic and natural colour additives; however, in both Europe and US several of the listed colour additives are derived from natural sources by physical and/or chemical extraction.

Although structurally quite diverse and derived from a variety of sources, natural food colourants can be grouped into five important classes [22]; tetrapyrrole derivatives, isoprenoid derivatives, benzopyran derivatives, artefacts, and others. Chlorophylls belong to the class tetrapyrroles which is a characteristic photosynthetic green plant pigment and is ubiquitous. Other members of photosynthetic apparatus include carotenoids that belong to the pigment class of isoprenoid derivatives. They impart characteristic yellow-orange-red colour to many fruits. Anthocyanins are a group of flavonoids that provide the red-purple shade to many fruits such as strawberries, elderberries, and black currants. They are an example of benzopyran derivatives.

Melanins, melanoidins and caramels are grouped together since they are all complex polymeric molecules, with some similarity in structural units comprising the polymers. The distinction between the melanins and melanoidins and caramels is that melanins occur naturally and are responsible for many of the black, grey and brown colours found in plants and animals, Melanoidins and caramels, however, are formed by non-enzymatic browning reactions, usually during the heat processing of foods, melanoidins are produced as a result of Maillard reactions, essentially a reaction initiated between a reducing sugar and a primary or secondary amine, while caramelization reactions result from the effect of heat on sugars. The pigments of scale insects such as lac and cochineal belong to anthraquinone subclass. For example, carminic acid, which imparts orange-red-purple colour shade; the colour depends on the pH. Beet root is a major source of betalains which comprises of the red-purple betacyanins and the yellow betaxanthins. Curcumin belongs to the subclass pantalones. The major source of which is the rhizome of the plant *Curcuma longa*. It imparts a characteristic greenish yellow colour. Another less widely used colorant that belongs to the subclass flavin is riboflavin [45].

**2.7 History of Bio-Colorants:** Trends of coloring the processed food is an old tradition, but isolation of pigment from micro-organisms is a recent approach. Man has always been interested in colors. The dyeing process is an old practice which was practiced in Europe

during Bronze Age. According to the earliest records i.e. 2600 BC these natural dyes were used in china for the first time 8. In Indian Subcontinent, the use of natural dyes is reported during Indus Valley Civilization (2500 BC), which is proved by the presence of traces of madder dye in the colored garments of cloth found in the ruins of Mohenjo-Daro and Harappa civilization (3500 BC). In Egypt, mummies wrapped with colored clothes and presence of Alizarin, a pigment isolated from madder in the tomb of King Tutankhamen also confirms the use of natural dyes. The Aztec and Maya culture period people of Central and North America used cochineal dye. The dyes such as woad, madder, weld, Brazil wood, indigo and reddish-purple were recognized until 4th Century AD, even Brazil got its name from the dye woad found there. Bible has the mention of saffron, whereas the usage of Henna is dated even before 2500 BC. The previous record also states the consumption of colored processed food by people of some sections according to the text in shosoin of the Nara period of 8th century from Japan.

**2.7.1 Source of Biocolors:** There are different sources of natural pigments. Some of these have been summarized in later sections. These have been extracted from fruits, vegetables, seeds roots and even microorganisms [14].

**2.7.1.1 Plant Pigments:** Any type of colored substance produced by the plants is called as “Plant Pigment”. Photosynthesis is the primary function of pigments in plant, which uses the green pigment chlorophyll. Carotenoids are also essential for their functions in photosynthesis [20]. There are different types of plant pigments, found in different classes of organic compounds. Plant pigments can give color to leaves, flowers and fruits.



**Turmeric Powder**



**Beet Root Powder**



**Carrot Powder**

**2.7.1.2 Animal Pigments:** Even animals produce bichrome or biological pigments, as mentioned earlier. In most of the plants chlorophyll is the primary biological pigment, and in mammals melanin is the main biochrom that is found. However, melanin is responsible for the color of hair and fur of an animal. A small parasitic insect i.e. *Cochineal beetle*, Latin name *Dactylopius Confucius* that lives and dines on the prickly pear cactus, or *nopal*, in Spanish. Cactus is a plant from which the insects or, *grana* are harvested and ground into a red pulp color. A brilliant red liquid pigment produced from their blood is used by the ancient Mesoamericans to make a beautiful steadfast dye. Through the world, *Cochineal* is still used in many products. It is commonly used in red lipsticks, and is one of the few red pigments allowed to be used in eye shadow. Further, the color additive used in Cherry Coke is also made from *cochineal*<sup>18</sup>.

## **2.8 Microbial Pigments**

The pigments from microbial sources are a good alternative that could easily be produced in high yields and capability of producing different coloured pigments. Pigment producing microorganisms and microalgae are quite common in nature. Pigment produced by microorganisms includes carotenoids, melanins, flavins, quinones and more specifically monascus, violacein, phycocyanin or indigo. However, there is a long way to go from the Petri dish to the market place as only five productions are operated on an industrial scale. List of some pigment producing microorganisms presented in Table 2.

The microbial colours have the advantage of being climate independent, do not require large area for their growth and can be produced in any quantity in shorter period. Microorganisms produce a variety of pigments that includes polyketides, carotenoids, phenazines, alkylphenols, pyrones, scleritis, anthraquinones but most of these pigments are toxic to humans except for carotenoids and polyketides<sup>[40]</sup>. Further, the carotenoids possess nutraceutical properties which gain more importance in food

industries. Among microalgae, two successful stories yield to efficient production of carotenoids such as  $\beta$ -carotene using *Dunaliella salina* or astaxanthin using *Haematococcus*. The phycobiliproteins or phycocyanin, researchers should first carry out toxicological studies which could allow the use as food colours [6].

Bacterial sources of food colourants such as zeaxanthin by *Flavobacterium*, canthaxanthin (mostly used in aqua feed) from the photosynthetic bacterium *Bradyrhizobium* spp., and *Halobacterium* spp. have been investigated. Astaxanthin production by *Agrobacterium* and *Paracoccus carotinifaciens* have been investigated. Case of aryl carotenoids such as isorenieratene and hydroxyl derivatives production by *Brevibacterium aurantiacum*; a bacterium associated with red-smear ripened soft cheeses, forms an interesting avenue to be explored further. This is because the pigments produced by this bacterium, thus, have been consumed for a long time. Apart from carotenoids, rubrolone is known to be produced by *Streptomyces echinoruber* [6].

Fungi, particularly ascomycetous and basidiomycetous (mushrooms) fungi, and lichens (symbiotic association of a fungus with a photosynthetic partner usually either a green alga or cyanobacterium) are known to produce extraordinary range of colours that include several chemical classes of pigments. Mushrooms and lichens have a rich history as sources of pigments for textile colouring. Mycelial extracts of some promising mushrooms such as *Chroogomphus vinicolor* gives red tints, *Bankera violascens* gives greens and *Collybia iocephala* gives blues. They have a tremendous potential for dyeing wool and silk fabrics [19]. Carotenoids such as  $\beta$ -carotene and lycopene have been known to be produced by fungal cell factories. The successful industrial production of  $\beta$ -carotene by *Blakeslea trispora* is the best example to be given. DSM (The Netherlands) was the first company to produce  $\beta$ -carotene from this fermentative source. Today, there are two other industrial productions of *B. trispora* fungal  $\beta$ -carotene, the first in Russia and Ukraine, the second in Leon (Spain). Another explored fungal sources of  $\beta$ -carotene are *Mucor circinelloides* (zygomycota fungus), and *Phycomyces blakesleeanus*. Widely known vitamin, riboflavin (vitamin B2) is a yellow food colorant that is fermentative produced by the fungi *Eremothecium ashbyii* and *Ashbya gossypii* [6]. As far as polyketide class of fungal pigment from *Monascus* have been utilized for making Oriental foods, especially in Southern China, Japan and Southeastern Asia, such as red rice wine, red soya bean cheese and anka (red rice). Anka was traditionally produced by inoculating moistened rice with *Monascus*, and the product contained

various pigments linked to proteins, peptides, and amino acids). The new isolate *Penicillium* strain produced violet, red, orange and yellow pigments and these pigments exhibit the monascorubramine components. Pigments synthesized by micromycetes *Aspergillus* sp. are true melanins. The pigment obtained from mycelial biomass of *Aspergillus* sp. is a safe food colour [35].



**Chromobacterium Violaceum**



**Rhodotorula Glutinis**



**Monascus Purpureus**

**Penicillium Purpurogenum**

**Table 2:** List of some pigment producing microorganisms (Gupta *et al.*, 2011)

S. No	Pigment	Microorganisms	Color
1.	Prodigiosin	<i>Serratia marcescens</i>	Red
2.	Indigoidine	<i>Corynebacterium insidiosum</i>	Blue
3.	Zeaxanthin	<i>Staphylococcus aureus</i>	Yellow
4.	Canthaxanthin, Ankaflavin, Monascorubramin, Rubric Punctuation	<i>Monascus</i> spp.	Orange, pink, Yellow, red, Orange
5.	Prodigiosin like pigment	<i>Rugamonas rubra</i>	Red
6.	Prodigiosin like pigment	<i>Streptoverticillium rubriretricoli</i>	Red
7.	Pyocyanin blue	<i>Pseudomonas aeruginosa</i>	Green
8.	Astaxanthin	<i>Haematococcus pluvialis</i>	Red

9.	$\beta$ carotene	<i>Dunaliella salina</i>	Orange
10.	Canthaxanthin	<i>Bradyrhizobium</i> sp.	Orange/Dark red
11.	Xanthomonadin	<i>Xanthomonas oryzae</i>	Yellow
12.	Astaxanthin	<i>Phaffia rhodozyma</i>	Red
13.	Prodigiosin like pigment	<i>Serratia rubidaea</i>	Red
14.	Prodigiosin like pigment	<i>Vibrio gaogenes</i>	Red
15.	Prodigiosin like pigment	<i>Alteromonas rubra</i>	Red
16.	Violacein	<i>Janthinobacterium lividum</i>	Purple
17.	Anthraquinone	<i>Penicillium oxalicum</i>	Red
18.	Astaxanthin	<i>Xanthophyllomyces dendrorhous</i>	Pink-red
19.	Lycopene, $\beta$ -carotene	<i>Blakeslea trispora</i>	Red, Yellow-orange
20.	Melanin	<i>Saccharomyces neoformans</i>	Black
21.	Naphthoquinone	<i>Cordyceps unilateralis</i>	Deep Blood red
22.	Riboflavin	<i>Ashbya gossypii</i>	Yellow
23.	Rubrolone	<i>Streptomyces echinoruber</i>	Red
24.	Torularhodin	<i>Rhodotorula</i> spp.	Orange-red
25.	Zeaxanthin	<i>Flavobacterium</i> spp.	Yellow

## 2.9 Applications of Pigments

**2.9.1 Pigments in Textile Industry:** The textile industry uses approximately 1.3 million tons of dyes and dye precursors, which are synthesized synthetically. Dyeing to textile is a simple process; involve dipping the textile in the pigment extract. Variation in color texture is achieved by changing the dipping time and the temperature of the dye bath. The textile produces large amount of waste which mainly consist of synthetic dyes. These synthetic dyes are used in industries, due to their easy and cheap synthesis, stability towards light, temperature and advanced colors covering whole color spectrum. However, these synthetic dyes have many drawbacks like toxicity, mutagenicity and carcinogenicity properties leading to various health problems like skin cancer and allergies <sup>[10]</sup>. Hence, consumers demand for dyes of natural origin as colorants.

Microbial colorants, especially anthraquinone type compounds, have shown remarkable antibacterial activity in addition to providing bright colors which could serve as functional dyes in producing colored antimicrobial textiles Pigment like prodigiosin from *Vibrio* spp. suggests that, it could be used to dye many fibers including wool, nylon, acrylics and silk. Pigment from *Serratia marcescens* can color five types of fabric, namely acrylic, polyester microfiber, polyester, silk and cotton using tamarind as a mordant



[39]. In the view of the vast availability of the microbial pigment, their affinity towards different textile, cost effectiveness and non-toxic nature of microbial pigments may increase their market trend and could replace the synthetic colors which are toxic to mankind and nature.

**2.9.2 Pigments as Food Grade Colorant:** The development of foods with an attractive appearance is an important goal in the food industry. To attract the food, many colors either synthetic or natural are added. In recent days, food producers are turning from synthetic color to natural colors, since synthetic color has demonstrated negative health issues. Many natural colors are available, in which microbial colorants play important role as food coloring agent as its production and down streaming process is easy. *Penicillium oxalicum* is a fungus which produces red color used in cosmetic and food industry [37]. These colors are useful in different products like baby foods, breakfast cereals, pastas, sauces, processed cheese, fruit drinks, vitamin-enriched milk products, and some energy drinks and so on. Therefore, natural colors are environment friendly and moreover serve as the dual need for visually attractive colors and health benefits in food colorants of probiotic [23]. Therefore, pigments from microbial sources are good alternative.

Many pigments from microbial sources such as red pigment from *Monascus* sp., astaxanthin from *Xanthophyllomyces dendrorhous*, arpink red from *Penicillium oxalicum*, riboflavin from *Ashbya gossypii*,  $\beta$ -carotene from *Blakeslea trispora* and lycopene from *Erwinia uredovora* and *Fusarium sporotrichioides* are added to the food to increase its appeal. Similarly, canthaxanthin an orange yellow pigment produced by *Haematococcus lacustris* is used in poultry for the appearance of color shade of the yolk. Further, canthaxanthin is also used in cosmetics and foods, particularly in dairy products such as cheese, confectionery in soft and hard candy, fish products, meat products, fruit products, beverages, snacks, beer and wine. The use of natural pigment as a food grade colorant not only increased the appeal of the food, but also used as a preservative for maintaining the good quality of the food which makes it superior than synthetic color.

**2.9.3 Pigments as Antimicrobial Agent:** The development of drug resistance in human pathogenic microorganisms prompted researchers to look for better antimicrobial agents. In current scenario, the treatment of infectious diseases has become difficult due to the emergence of multidrug resistance pathogens [15]. Such evolutionary changes in pathogenic microorganisms necessitate for the development of a newer generation of

antimicrobial agent. Therefore the question of investigations into the natural antimicrobial agents is a valid one to tackle such problems <sup>[42]</sup>. Pigments like carotenoids, melanins, flavins, quinones, monascus, violacein, and indigo are good antimicrobial agents. The antibacterial activity of yeast carotenoid pigment was studied on several organisms like *Bacillus Subtilis*, *Streptococcus faecalis*, *Escherichia coli*, *Staphylococcus aureus*, *Pseudomonas aeruginosa* and *Enterococcus* sp. The pigment showed excellent antibacterial activity than the standard chloramphenicol. Among this, pigment showed maximum inhibition against *Bacillus subtilis* and *Staphylococcus aureus*. The observed results suggest that the potential therapeutic drug could be developed from yeast pigment in future to treat human pathogenic microbes <sup>[25]</sup>.

However with the emergence of antimicrobial resistant microbial strains, there is a need to search for new and novel antibiotics and the pigments are required to be investigated further based upon their promising bioactivities. The need is to improve ways to produce, purify and characterize such antimicrobial agents (pigments).

#### **2.9.4 Pigments as Antioxidant**

An antioxidant is a molecule that delay or inhibit cellular damage by donating electrons to a rampaging free radical and neutralize through their free radical scavenging property. The chronic diseases such as cancer, diabetes, cardiovascular and autoimmune disorders are known to associate with free radicals. Microbial pigments like Carotenoid, naphthoquinone and Violacein have been shown to have a potent antioxidant activity due to their biological functions <sup>[7]</sup>. Bacterial pigment Xanthomonadin showed antioxidant activity by inhibiting photodynamic lipid peroxidation in liposome and offered protection against photodamage. An antioxidant pigment naphthoquinone from *Comamonas testosteroni* and were successfully produced and they proposed its protective role against superoxide free radicals <sup>[28]</sup>.

#### **2.9.5 Pigment as Anticancer Agent**

Pigments like carotenoids have good anticancer activity on human T-cell leukemia, which causes fatal malignancy due its free radical scavenging. These have many properties like antibiotic, anticancer and immune-suppressive properties <sup>[43]</sup>. The property of bacteria to produce biopigments, is used to produce medically important products. *Adonirubin* and *astaxanthin* are the xanthophylls, which also act as nutraceuticals. These xanthophylls by the process of antioxidation, anti-free radical or other mechanisms help to prevent carcinogenesis. The nutraceuticals functions of these xanthophylls

and carotenes also help to prevent problems like heart attacks and strokes. A red pigment, astaxanthin is important carotenoids which has great commercial value, and is also used as pharmaceuticals feed. Further, the *Monascus purpureus* produce pigments which help in the inhibition of hepatitis virus replication by interfering with viral RNA polymerase activity property <sup>[11]</sup>. In the view of the above, microbial pigment could be potential useful therapeutic agents against cancer cells in the near future.

**2.9.6 Dairy Industry:** *Monascus species* are known to produce nontoxic pigments, which can be used as food colorants, flavour enhancers and as a food preservative. *Monascus ruber* is used to prepare flavoured milk by utilizing rice carbohydrate for its metabolism and produces pigment as a secondary metabolite <sup>[27]</sup>. The solid state fermentation of rice produces red, orange and yellow pigments.

**2.9.7 Nutritional Supplements:** Chemical compounds in the biocolor are produced by plant cells known as vegetal active principles. These compounds are the means for obtaining biological active substances and many other natural compounds which are used in food, pharmaceuticals and cosmetics industries with having important commercial value. As  $\beta$ -carotene is the precursor of Vitamin A, so carotenoids can be used as Vitamins supplements. Rice is the main food in under developed countries, so there is possibility of deficiency of vitamin A which causes night blindness and in serious cases to xerophthalmia. Another example of natural food grade biocolorant is Riboflavin which is also a source of vitamins, available in milk, several leafy vegetables, meat and fish <sup>[12]</sup>. Yellow  $\beta$ -xanthines are used as biocolorants and can also be used as biocolorant and for introducing essential dietary amino acids into food stuffs.

**2.9.8 Printing Industry:** To conserve the forest resources and reduction of wastes it's important to reuse and recycle the papers in offices etc. The reuse of papers is important but it's also important to disappear the prints from paper. Decolorable ink contains *Monascus* pigments used for inkjet printing. These pigments from *Monascus* when exposed to irradiation of visible or ultraviolet light get discolored <sup>[41]</sup>.

## Conclusion

Biocolors are natural, prepared from renewable sources that are easily degradable and without production of recalcitrant intermediates when they enter in the environment. Natural dyes and colours have growing importance not only in dyeing but also because of their medicinal properties. The awareness among people towards natural dyes and their therapeutic uses are

increasing because of their nontoxic or less toxic properties, with fewer side effects. On the other hand, synthetic colours are based on toxic raw materials. The continuous use of synthetic colours not only causes considerably environmental pollution but also many health related problems in human beings i.e. carcinogenic effects etc. It is therefore, essential to explore various natural sources of food grade colorants and their potential uses. Hence, natural products produced by microorganism as pigments are safer and better than synthetic products.

**Future Perspective:** Microbial pigment production can be increased in huge amount through genetic engineering. Production of colours by fermentation has several advantages i.e. cheaper production, probably easier extraction, higher yields, and no seasonal variations with adequate raw material. Many microbial pigments not only used as colouring agents in food and cosmetic industry but also act as anticancer, anti-inflammatory, anti-microbial and anti-oxidant. Isolation of new microorganisms producing colouring pigment can be an alternate source of colorants used in foods, textile, pharma industry etc.

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**Chapter - 6**  
**A Concise Aspect of Kashtartava**  
**(Dysmenorrhea) with It's a Etiopathogenesis and**  
**Management**

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# Chapter - 6

## A Concise Aspect of Kashtartava (Dysmenorrhea) with It's a Etiopathogenesis and Management

Dr. Sunita Temhunna, Dr. Sangram Mishra and Dr. Nalinikant Parida

### Abstract

The science of Ayurveda is well recognized system of medicine, which have unique speciality in the field of Prasuti & Stri Rog. In Ayurveda, diseases related to the female reproductive system i.e. gynaecological disorders are described under the caption of Yoni Vyapad. Most of the classics have given the number of Yonivyapad as twenty with difference lies in their terminology from one text to other. According to classics when a women having ruksha sharir (dry body) or else a weak body or very young physique women do excessive coitus with abnormal bodily posture, uses of objects made of iron are most probably cause abnormalities of Artava & Bija (a portion of which responsible for development of Yoni during embryonic life). One of the type of yonivyapad Udavritta or Udavartini resembles the description of almost all type of dysmenorrhoea. Madhukosh commentary has explained as inordinate or irregular contraction of all the myometrial muscle fibres as all around movement of vayu' in pelvic area. The vitiated vata spreads through rasavaha srotas & leads to rasavaha, raktavaha & artavavaha srotodusti. In the disease Kashtarva, all the three doshas are involved with predominance of vata. According to acharya charak main causative factor of Udavarta is vata, so it should be treated first. Shoshan & shaman chikitsa principles are described by all Acharyas for the successful management of kashtartava symptoms along with other therapeutic procedures like Oleation, sudation, purgation which has been proved to be beneficial for Udavarta and its associated kastartava complaints. Uttarbasti, as one of the basti procedure is most important treatment procedure for fruitful combat of Yonivyapad along with its associated complaints.

**Keyword:** Dysmenorrhea, etiopathogenesis, yonivyapad, kashtartav

## Introduction

### Nirukti

The word Kashtartav (dysmenorrhoea) can be expressed as-“Kashtena muchyati iti kashtartav (dysmenorrhoea)” i.e. the condition where Artava is shaded with great difficulty and pain is termed as “Kashtartav (dysmenorrhoea)”.

The term Kashtartav (dysmenorrhoea) is made of two words- “Kashta” and “Artava”.

Kashta-Painful, Difficult, troublesome, ill, forced, wrong, unnatural, a bad state of thing.

Artava-Rutau bhavam arthavam (A.H./sha./01/01-Arunadatta commentary).

Kashta-with great difficulty.

Ritu-Particular period Bhavam-to happen/to occur

A substance of the body which flows out at the specific period of time is called as Artava. In another way, artava means belonging to reasons, period of time, menstruation.

In Ayurveda, diseases related to the female reproductive system i.e. gynaecological disorders are described under the caption of Yoni Vyapad and 20 diseases are there in the classical literature. Udavarta Yoni Vyapad is one of them where painful menstruation is the cardinal feature of the disease and the discomfort is relieved after establishment of menstruation, which may be foamy in appearance.

Not less than 50% of women are said to experience some discomfort in relation to menstruation. Studies suggest 10-45% of young women reported missed or reduced time at work places and schools. The incidence is affected by social status, occupation and age. So group of school girls, college students, factory workers and women members of the armed forces each provide different statistics.

In Ayurvedic literature dysmenorrhoea is explained in terms of ‘Kastartava/Kukshi Shoola, Vatala Yoni, Udavartini Yonivyapad (Ayurvedic names of disease under Striroga). The causative factors, pathogenesis, symptoms and treatment are also described in Ayurveda and based on that the increased ‘Vata dosha in the body is responsible for disease creation. The aim of management should be by equilibrating vitiated Doshas, especially Vata (as it is main causative factor of all Yonivyapads) or managing Avrita

Apana Vayu (pathology of one of the type among five Vata dosha) through Agni Deepika (Improving appetite), Grahi (controlling of excessive outflow), Vata Anulomana (normalizing any type of abnormal flow) and Pakvashaya Shuddhikaran (purification of large intestine) methods.

Ayurveda advocates that selection of any medicine should be purely based on the Individualized/Personalized features of sufferings. According to Charaka Samhita a best physician should know the science of administration of drugs with due reference to climate and season, and who applies it only after examining each and every patient individually. Moreover while commenting on the role of diet, Charaka recommends planning of opposite properties of vitiated Doshas in the form of diet to maintain the health. Habitual intake of balanced diet with all Rasas (tastes) in proportionate quantity is recommended for equilibrium of doshas. The Ayurveda system does not stress on the naming of the disease but a proper diagnosis related with the vitiation is more important than the labeling of the disease. It explains that the diseases are innumerable being divided on the basis of trouble, colour, etiology, site, symptoms and name. However in other cases general principle may be followed. Ultimately, applying knowledge and common sense one should plan the management. Moreover, the treatment should be continued till the patient regains health. While describing the state of normalcy Ayurveda screened many points to identify healthy individual. Some of these parameters like person having good built, has balanced proportion of muscles, compactness of the body, possess very strong sensory and motor systems, etc. Also healthy individual can withstand hunger, thirst, the heat of the sun, cold and physical exercise. They can digest and assimilate the food properly. In total all these factors make the concept of Individualized/Personalized features of an individual and help in assessment of personalized treatment plan. In the present paper we adopted some methods to achieve the target through literature review.

**Primary Dysmenorrhoea:** The pain which is of uterine origin and directly due to menstruation. This is true dysmenorrhoea and is also described as primary, spasmodic, intrinsic and functional. It is essentially a first day pain. Identifiable pelvic pathology usually absent in primary dysmenorrhea.

Causes of Primary Dysmenorrhoea includes Environmental factors causing nervous tension, general ill health, faulty outlook, hormonal imbalance, Psychogenic cause, usage of Intrauterine contraceptive device (IUCD), Stenosis at internal Os, Unequal development of mullerian ducts, Uterine hypoplasia, effect of Vasopressin and Prostaglandins.

**Premonitory Symptoms:** This may be accepted as pre-menstrual syndrome with symptoms like retention of water, emotional instability and headache.

### **Secondary Dysmenorrhoea**

Secondary dysmenorrhoea is the pain associated with ovulatory cycles caused by a demonstrable pathology. This menstrual pain is generally related to some kind of gynaecologic disorder. Secondary dysmenorrhea is more likely to affect women during adulthood. The main symptom of dysmenorrhea is pain concentrated in the lower abdomen, in the umbilical region or the supra-pubic region of the abdomen. It is also commonly felt in the right or left abdomen. It may radiate to the thighs and lower back. Symptoms often co-occurring with menstrual pain include nausea and vomiting, diarrhoea or constipation, headache, dizziness, disorientation, hypersensitivity to sound, light, smell and touch, fainting, and fatigue. Symptoms of dysmenorrhea often begin immediately following ovulation and can last until the end of menstruation.

**Clinical Features of Dysmenorrhea:** In true dysmenorrhoea the pain sensation arises in the uterus and is related to muscular contraction. It is experienced within few hours before and after the onset of menstruation and rarely lasts for longer than 12 hours. The pain is of spasmodic type and confined to lower abdomen, may radiate to the back and medial aspect of thighs. Associated systemic discomforts like nausea, vomiting, fatigue, diarrhoea and headache may be associated. Any abnormal findings are not seen upon abdominal or pelvic examination. It reaches its maximum peak with the age of 18 and 24 years. After the age of 25 years it rarely occurs and rarely persists beyond 30 years.

Dysmenorrhea, also known as painful periods or menstrual cramps, is pain during menstruation. Its usual onset occurs around the time that menstruation begins. Symptoms typically last less than three days. The pain is usually in the pelvis or lower abdomen. Other symptoms may include back pain, diarrhoea or nausea. A systematic review of studies in developing countries performed by Harlow and Campbell (2002) has revealed that about 25-50% of adult women and about 75% of adolescents experience pain during menstruation with 05-20% reporting severe dysmenorrhoea or pain.

### **Possible Aetiology of Pain in Dysmenorrhea**

- a) **Hormonal Imbalance:** Spasmodic dysmenorrhoea has some connection with the hormone stimulus to the uterus. If the uterus has not been exposed to progesterone, as in the cases of all forms on

anovular bleeding, pain is never experienced. Progesterone stimulates myometrial contraction of the smooth muscle of the cervix and causes narrowing of the cervical canal. It further stimulates the production of prostaglandin F<sub>2</sub> alpha which in turn accentuates pain.

- b) **Myometrial Activity Theory:** It is not adequately explained that myometrial contraction produces pain, as all myometrial contraction are not found painful. However, as Reynold (1949) has pointed out that when painful contraction is produced, the pain can be increased by giving such a drug which increases the strength of the contraction of myometrium and can be relieved by such a drug which reduces the same as progesterone.
- c) **Myometrial Ischaemic Theory:** Rapid distention of the uterus due to any cause, increases muscular activity and metabolism and decreases blood circulation to it. Lack of blood supply causes myometrial ischaemia thus producing painful stimuli. This type of pain is cured by child birth, because blood supply of the myometrium will be improved (Noir 1933-34, Knaus 1929, Schultze 1931). Contrary to this myometrium of a multiparous uterus shows vascular degeneration but they don't suffer from dysmenorrhoea which do not support the ischaemic theory (Shaw, 1956).
- d) **Psychogenic Causes:** Psychogenic causes are the most common and important in cases of primary dysmenorrhoea. There is little wonder that this is true since there are so many misconceived ideas, traditions and opportunities for such factors to exert their influence on a young girl approaching and experiencing her first period of bleeding. A dysmenorrhoea mother or sister or friend will misdirect her by telling menstruation is a period of being unwell, that she must be very careful, avoid all sorts of physical activities, must rest, and keep herself excessively clean. All these actually produce fear on immature young mind. Fear lead to anxiety and depression which may be presented as pain.
- e) **Anovulatory Cycle:** Despite the fact that anovulatory cycles are painless, some women with anovulatory cycle to have dysmenorrhoea.
- f) **Prostaglandins (PGs):** The most favoured view is that dysmenorrhoea is associated with an excess of prostaglandins especially (PG F<sub>2</sub>α) or of their activity in the uterus. It has been

demonstrated that secretory endometrium contains more PGs than proliferative. PGs are known to increase myometrial contractions and constrict small endometrial blood vessels to produce ischaemia and breakdown of the endometrium, bleeding and pain.

- g) **Muscular In-Coordination:** It may be due to muscular in-coordination of the uterus as a whole. If so, it could be explained by an imbalance in the autonomic nervous control of muscle, one in which an overactive sympathetic system leads to hypertonus of the circular fibers of the isthmus and internal Os.
- h) **Vasopressin:** This increases PG synthesis and also increases myometrial activity directly. This further causes uterine hyperactivity and dysrhythmic contractions to produce ischaemia and pain.
- i) **Systemic Disease and General Ill Health:** Severe malnutrition, acute and chronic illness may be associated with dysmenorrhoea. As pain threshold is decreased by ill health of any kind.
- j) **Abnormal Anatomical and Functional Aspects of Uterus:** In Unequal development of mullerian ducts (separate or bicornuate uterus) pain is produced due to unequal muscular contraction. In hypoplastic uterus myometrium contains an excessive amount of fibrous tissues and less muscle in myometrium which disturbs the normal contraction pattern which leads to inadequate expulsive force and acute pain. Cervical obstruction such as Pinhole Os and conical cervix are comparatively rare conditions, which partially obstruct the menstrual passage. Frequently cramping like pain is found along with menses. Often colour of the menstrual blood is black or dark. In deficient polarity when the body of the uterus contracts, the cervix normally dilates, this is normal phenomenon. The polarity denotes its co-ordination. When this polarity is disturbed, painful or difficult menstrual discharge through the Os occurs.
- k) **Poor Posture:** Due to poor posture, the normal body mechanism also suffers, like the loss of tone of nerves supplying blood vessels and muscle tissues. Poor posture leads to primary dysmenorrhoea in poor asthenic women whose pain threshold is low and generative organs are functionally faulty.
- l) **Inadequate Liquefaction of The Menstrual Clot:** Due to deficiency of thrombolysis, menstrual blood becomes clotted. Due to failure of liquefaction, clotted blood obstructs the passage of the



cervical canal. To expel out those clots uterus contracts vigorously thus painful menstruation initiates.

**Table 1:** Terminology used for Kashtartav (dysmenorrhea) in various disorders

<b>Kashtartav (Dysmenorrhea) as a Symptom with Main Samhita with Related Terminology</b>	<b>References</b>
<b>Charaka Samhita</b>	
Saruk	Vataki Yonivyapad (Ch./chi./30/10-11)
Sashoola	Sannipatika Yonivyapad (Ch./chi./30/14,15)
Sarati	Paripluta and Mahayoni (Ch./chi./30/23-24, 36)
Rajah Krichchha	Udavartini Yonivyapad (Ch./chi./30/25-26)
Saruja	Vataja Asrigdara (Ch./chi./30/211-213)
Manda Rujakarma	Kaphaja Asrigdara (Ch./chi./30/219)
<b>Sushruta Samhita</b>	
Rajah Krichchha	Udavarta Yonivyapad (Su./utt./38/9-11)
Vedana	Artava Dushti (Su./sha./2/5)
<b>Ashtanga Sangraha</b>	
Rajah Krichchha	Udavarta Yonivyapad (A.S./utt./38/36)
Sarujam	Vataja Artava Dushti (A.S./sha./01/24)
<b>Ashtanga Hridaya</b>	
Rajah Krichchha	Udavarta Yonivyapad(B.P./chi.70/7)
Sarujam	Vataja Artava Dushti (A.H./sha./01/10)
<b>Harita Samhita</b>	
Saruja	Vataja Artava Dushti (H.S./tri./48/13)
<b>Mādava Nidan</b>	
Rajah Krichchha	Udavarta Yonivyapad (M.N./62/2)
<b>Bhavaprakasha</b>	
Rajah Krichchha	Udavarta Yonivyapad(B.P./chi.70/7)
<b>Yogaratanakara</b>	
Rajah Krichchha	Udavarta Yonivyapad (Y.R./Yoni Roga.)

Kashtartav i.e. dysmenorrhea is not separately described as a disease anywhere in Ayurvedic classics. But there are many other diseases in which Kashtartav (dysmenorrhea) is considered and described as a symptom. There are several diseases in ayurvedic texts where Kashtartav (dysmenorrhea) mentioned as specific Symptom. In samhitas, Kashtartav (dysmenorrhea) has explained as primary or secondary symptoms with relation to the many yonivyapad diseases.

## **Kashtartav (Dysmenorrhea) Mentioned as Specific or Non-Specific Symptom in the following Disease**

1. Vatala Yonivyapad
2. Vataja Artava Dushti
3. Pittala yonivyapad
4. Udavartini Yonivyapad
5. Paripluta Yonivyapad
6. Kushina Artava Dushti
7. Mahayoni yonivyapad
8. Artava kshaya
9. Suchimukhi yonivyapad
10. Sannipatika yonivyapad

### **1) Vatala Yonivyapad**

According to all Acharyas have described painful menstruation as main complain along with other pains and stiffness, in this condition. Acharya Charaka mentioned that Vatala yonivyapad only related with Kahtartava. Kashtartav is specific symptom of vatala yonivyapad along with other Vataja Lakshana.

### **2) Vataja Artava Dushti**

In case of Vataja Artava Dushti all the text have mentioned only the clinical findings of menstrual flow related to Vata dosha along with pain. All the features of condition resemble typical Vata Kapha condition. Other than that it is difficult to find a systemic or local feature of pathological condition. So this condition more nearer to Primary dysmenorrhoea.

### **3) Pittala yonivyapad**

Here Acharya Charaka (Ch./chi./30) and Vagbhata (A.S./utt./38/44) have mentioned menstruation with burning (Daha) sensation. This Daha can also be considered as a type of pain caused by vitiation of Pitta Dosha. So in this condition Kashtartava can be correlated with menstruation with pain of burning sensation. Kashtartava which is associated with fever, vaginal bleeding with different colours and odours can be consider as dysmenorrhea due to acute infective condition related to reproductive organs. Hence it can be correlated with secondary dysmenorrhoea.

#### **4) Udavartini Yonivyapad**

Udavarta suggests the primary dysmenorrhoea. Charaka says that the uterus is seized with pain, pushes the Raja (menstrual blood) upwards and then discharges with great difficulty and pain. The lady feels comfort after discharging the menstrual blood. Sushruta has described it to be characterized by painful frothy menstruation, associated with other Vātika pain. Yogaratnakara has added the discharge of frothy menstrual blood associated with Kapha with difficulty.

Udavarta or Udavartini suggests mainly the primary dysmenorrhoea. On the basis of the symptom of difficulty of menstruation at the beginning and immediate relief of pain following discharge of menstrual blood given by Charaka, is the identical symptom of primary/ Spasmodic dysmenorrhoea (Cha./chi./30/26). In Madhukosh commentary, it has been mentioned this pain is of Varti (colicky) type (M.N./62/2). Discharge of clotted blood mentioned by Indu may be the description of special form of spasmodic dysmenorrhoea characterized with expulsion of big clots of blood (A.S./utt./38/36 Indu commentary) has compared Udavartini with membranous dysmenorrhoea also on the basis of reference from Yoga Ratnakara where the association of Kashta is taken as association of mucous membrane or endometrium. But according to the explanation given by Acharya Charaka, sushruta and Vagbhata it is more reasonable to correlate with primary dysmenorrhoea.

#### **5) Paripluta Yonivyapat**

While describing its signs and symptoms, Acharya Charaka has mentioned painful menstruation as primary symptom. (Ch./chi./30/24) Other than that he has also included tenderness, backache and fever as additional symptoms. With this signs and symptoms, it indicates acute inflammatory condition. Sushruta in this context, has added dyspareunia (Su./utt./38/10) as a symptom. Dyspareunia is a sign mostly associated with the Salpingitis or Oophoritis. All these denote inflammatory condition of genital tract. So here we can comment Paripluta is a stage of secondary dysmenorrhoea due to Pelvic inflammatory disease (PID).

#### **6) Kshina Artava Dushti**

All the Acharyas have described Kshina Artava as Vata Pitta dominant condition. Again in this condition menstruation is delayed, scanty and painful. Dalhana in his commentary has mentioned added colours like yellow and blue with peculiar odours in menstrual flow due to Pitta Dosha (Su./sha./2/4). Again bodyache, heat and burning sensation also can taken as

general symptoms. All these factors give idea of inflammatory condition related to genital tract and vitiation of Vata and Pitta Doshas. So Kshina artava more resembles to secondary dysmenorrhoea.

### **7) Mahayoni Yonivyapad**

It is hard to correlate with pain in menstruation. Because Mahayoni is congruence with uterine prolapse and it is a disease related to age of menopause. Another factor is in this condition blood stained vaginal discharge is commonly seen which is rarely accompanied with pain.

### **8) Artava Kshaya**

Artava Kshaya is a condition with several features of Vata vitiation i.e. Yathochit Kala Darshana, Alpartava, Yoni Vedana etc. (Su./su./14/12). It has being mentioned that disease causes by Dhatu Kshaya again it proves the association of Vata Dosha. Deficiency of nutritional factors is a one of the cause of painful menstruation. Though it has not mentioned directly, by considering whole the clinical picture Kashtartava also must be there as a symptom. It can be correlated with a stage of primary dysmenorrhoea due to nutritional deficiency.

### **9) Suchimukhi Yonivyapad**

Acharya Charaka (Ch./chi./30/31) described it as a congenital diseases while Sushruta (Su./utt./38) explain same condition by the term of Suchivaktra. By the name given, this can compare with either stenosed internalos, or narrowed cervical cavity. Even Though it has not clearly mention pain in menstruation according to the facts it can be understand as a stage of primary dysmenorrhoea due to any type of stenosis of the cervix.

### **10) Sannipata Yonivyapad**

It is a condition with vitiation of all the three Doshas. Though dysmenorrhoea is not mentioned directly as a symptom but as Acharya Sushruta (Su./utt./38/17) and Vagbhata (A.S./utt./38/42) say that it contains clinical features of all three doshas. According to it pain in menstruation must be present as a symptom. Acharya Charakahas added Daha, with yellowish and white unctuous vaginal discharge (Ch./chi./30/14). Again since this condition associated with features of all the three doshas (i.e. Daha, Paka, Jvara) it may be considered as a secondary Dysmenorrhoea due to acute inflammatory condition of reproductive tract.

**Table 2:** Difference between Primary and Secondary Dysmenorrhoea

Features	Primary	Secondary
Age	Generally after 6-10 months of onset of menarche with establishment of ovulatory cycle. Peak at 18-24 years, decreases with child birth and advancing age.	Appears in the late twenties and thirties, progressively.
Nature of pain	Cramp like pain.	Usually dull steady, bearing down sensation.
Location of pain	Main site is hypogastrium, low back radiating towards inner and front aspect of thighs	Lower abdomen sometimes unilateral
Relation of pain to flow	Usually precedes the flow and tends to subside as the flow becomes free	Begins before or at the onset of bleeding. May persist throughout flow and even beyond.
Parity	Usually encountered in nullipara often disappears with pregnancy.	Encountered in both nullipara and multipara not relieved by pregnancy
General symptoms	Nausea, vomiting, diarrhoea, bladder tenesmus, feverish, tired etc. appears	Usually absent
Pelvic findings	Uterus is normal. No pelvic lesion found, but hypoplasia, acute ante flexion and cervical stenosis are uncommon	Pelvic lesion is found with pelvic tenderness.

### Nidan (A Etiopathogenesis)

According to particular diseases in which the Kshatriya is present as a symptoms

#### 1) Vatala Yoni Vyapad-(Cha./chi./30/11)

According to Charaka, women of Vatika constituents, taking Vayu aggravating diets and behaviours in excessive amount is the cause for Vatala.

#### 2) Udavarta Yoni Vyapad-(Cha./chi./30/25)

Due to movement of flatus etc. natural urges in reverse direction, the aggravated Vayu moving in reverse direction fills the Yoni. (M.N./62/2/ Madhukosh).

In Madhukosh commentary all around movement of Vayu is said to be the course. When considering all of these references Nidana (aetiological factors) of Kashtartav (dysmenorrhea) can be categories under the following headings.

Mithya Achara-this factor can be discussed under two broad headings as mentioned. Hence Kashtartav (dysmenorrhea) which is primarily a Vata predominant Vyadhi, food and life style that causes aggravating the particular Dosh should be taken into consideration.

Abnormal diet-excessive intake of food which are vitiating especially Vata Dosha like Katu rasa, Ruksha, Sheeta, Khara Guna Ahara, inadequate intake of food (Anashana), improper meal times (Vishamashana) are comes on abnormal diet (Mithya Ahara). Abnormal mode of life-improper life style including either excessive exercises or sedentary life, addictions like smoking, alcohol etc., which increase to Chala, Ruksha, Khara Guna of the body. Consumption of Vata Vardhaka Nidanans, including Vegadharana (control of natural urges), Ati Vyayama.

**Table 3:** Explanation of hetu involvement in the manifestation of dysmenorrhea

<b>Major Dusti Involvement</b>	<b>Explanation of the Dushti and Hetu</b>
Pradushan Artava	Here the word Artava can be understood as reproductive hormones or ovum. Because ovum is described separately under Bija Dosha, this should be understood as vitiation of reproductive hormones.
Bija-Dosha	Abnormalities at the level of genetic factors which can causes functional abnormalities of reproductive tract, especially uterus and Kulaja Hetu also correlated.
Daiva (idiopathic)	Diseases due to Purvajanmika Karma or etiological factor where not known
Manasika Hetu	Vata vitiating-Chinta, Shoka, Bhaya etc., and Pitta vitiating Krodha, Irshya etc., and all the psychological condition including stress.

### **Samprapti (Pathogenesis)**

According to acharya Vagbhata, the pathogenesis of any disease in Ayurveda can be explained as such-when the nidanic factors vitiate the doshas, they undergo specific mode of vitiation leading to disease production. Another word Samprapti can be defined as the path of pathogenesis, through which Doshas exhibit their sequential steps of pathogenesis. In the disease 'kashtartav (dysmenorrhea) all the three doshas are involved with predominance of vata. The probable mode of pathogenesis may be viewed as follows-

Vata Dosha which is the leading Dosha is the disease may be vitiated or aggravated by three ways;

- a) Due to indulgence of vata vitiating Ahar-Vihara
- b) Due to Dhatu Kshaya
- c) Due to marga Avarna

Due to consumption of Vata Prakoaka Ahara-Vihara, the Vata gets aggravated leading to Dhatu Kshaya starting from Rasa and then rakta. Thus there will be Alpata in updhatu nirman i.e., Artava will be produced in less

quantity then normal which will further vitiate vata dosha which further will produce shobha in Garbhashaya the stage resembling to ischaemic condition of the uterus resulting in pain. This will lead to Toda and Vedana. This will continue as Vata Vriddhi causes Dhatu Kshaya and vice versa. Acharya Charaka says that by occupying different seats, Vata produces various disorders with respect to its various etiological factors.

The vitiated Vata by Ruksha, Sheeta, Sukshma properties spread through Rasavaha Srotasa and leads to Rasavaha, Raktavaha and Artavavaha Sroto Dushti. Dosha-Dushya Sammurchana takes place in Garbhashay. Here due to vitiation of Vyvan and apana vayu the Suchana and Prasaran Kriya of Garbhashay does not take place properly, the state exactly that of dysrhythmia of uterine muscles, which will hinder in proper flow of menstrual blood leading to Kashtartav (dysmenorrhea).

### **Treatment as Explained by Different Authors in Their Text**

#### **1) Upashaya**

##### **a) Aharaja**

Madhura, Amla and Lavana Rasa prominent food

Tridosha Shamak food especially Vata Shamaka

Ushna, Laghu and Snigdha food

Yava (Barley)

Yawaka (meal made of barley and milk)

Lashuna as Rasayana Sevana (Ka./kalpa./2)

Sura, Asava and Arishta Sevana as per Dosha. (Su./ut./38/29)

Ksheera, Mamsa Rasa (Su./ut./38/30)

##### **b) Viharaja**

Bath with Luke warm water (A.S./ut./39/29)

Kumbhi Sweda (B.P./chi./70/37)

Sneha, Sweda

#### **2) Anupashaya**

##### **a) Aharaja**

Manda (secum of boiled rice) (Ka./kalpa./7)

Vatala food-brinjal, ladies finger, potato, chick pea etc.

Tikshna, Ushna, Katu, lavana food

Ruksha food

## b) Viharaja

Divaswapna

Excessive exercises

Sheeta Udaka Snana

Udvardhana

### Principles of Treatment

- 1) As Vata is main causative factor off all Yonivyapads, so it should be treated first (ch.chi.30/115)
- 2) For Artava Shuddhi, after applying oleation and sudation, emesis and purgation, five Shodhana measures should be used, after this Uttarbasti should be given repeatedly (Su. Sa. 2/21-16; A. S. Sa. 1/39). Acharya Charaka has explained the same but in mild form
- 3) Purgation is beneficial for Yoni Rogas and artava Rogas
- 4) In menstrual disorders caused by Vāta Doshā, the specific treatment prescribed for suppressing that particular Doshā should be used. Recipes prescribed for Yoni Rogas and Uttarbasti etc. should also be used after giving due consideration to the vitiated Doshā. (A. H. Sa. 1/12-17)
- 5) Unctuous, hot, sour and salty articles should be used for the relief from menstrual disorders due to Vata. Sweet, cold and astringent substances for the purification of Pitta and hot, dry and astringent for Kapha (A. H. Sa. 1/12)
- 6) For Avrita Apana Vayu, treatment should be Agni Deepika, Grahi, Vāta, Anulomana and Pakvashaya Shuddhikaran. (Ch. Chi. 28/243)

### View of Acharya Charak

1. All vataj yonivyapad and also in udavartini yonivyapad use snehan and sweden by trivita kalk and kwatha
2. Gramya, aanup, jaliya mansar and milk cooked by Dashamoola drugs kalk give to the patient in as preparation of uttarvasti
3. Anuvasan vasti and uttarvasti by nishoth kalk siddha oil

### View of Acharya Sushrut

1. Uttarvasti
2. Kumbhi Sweda in yoni by audak and aanupmansa
3. Pichu Dharan



## **View of Acharya Bhavmishra**

1. Vasti, abhyanga, parisheka, prilep and pichdharan.

## **View of Bhaishajya Ratnavali**

1. Vatnashak karma, uttarbasti, abhyang, parishek, pichu dharan
2. Vachadi churna
3. Yoni parishechana by guduchi, Triphala, Danti kwath.
4. Tagaradi pichu.
5. Rajahpravartini vati
6. Shishu Kalpdrum Ghrit
7. Hingwadi tail

## **View According to Siddha Yog Sangrah**

1. Rajodosh har vati 2-2 tab. Anupan water

## **View According to Rasendra SAR Sangrah**

Prakshalana Sweden and lep by triphala kashaya.

## **Concept of Uttarbasti in General as Explained by Different Acharyas:**

### **a) Type**

- i) Mutra Marg Agata
- ii) Garbhashay Agata

### **b) Uttarbasti Netra Pramana**

It should be of 12 Angular according to patient's finger.

In married women Basti Netra should be inserted up to four fingers in length.

### **c) Time Period of Uttarbasti Application**

Uttarbasti should be given in Ritukala (up to 16 days of menses) as the mouth of uterus is open at that time and it readily receives the drug injected. But in emergency conditions like Ashrigdara, Yoni Bhransh etc. it is indicated in other days also (Ch. Si. 9/62-64).

### **d) Duration**

According to Acharya Charaka and Vagbhata the Uttarbasti should be given consecutively for three days. But in this context, it has been said that Sneha should be increased day by day for three days. Therefore it should be

stopped for 3 days then again the Uttarbasti should be repeated for 3 days continuously.

#### e) **Dosage of Uttarbasti**

Quantity of decoction taken should be one Prastha. Two Prastha for an adult women for cleaning the uterus. According to patient and disease, the physician can also decide the dose.

#### **According to Different Acharya, Matra of Uttarbasti**

**Vagbhata:** 1 Pala for 1st day then gradually increases.

**Bhavaprakasha & Sharangadhara:** 2 Pala

**Charaka:** ½ Pala

#### f) **Dravya**

Uttarbasti can be given with Sneha or Kwatha. Sneha is more useful in most of the diseases of Garbhāshaya. Because Sneha is beneficial for Vāta Shamana.

#### g) **Dose of Sneha in Uttarbasti**

Amount of medicine should be ½ Pala. The maximum dose of oily substance in Uttarbasti is one Prakuncha for person below 25 years of age. The dose should be fixed by the physician as he consider appropriate.

#### h) **Position for Uttarbasti**

Patient should lie in lithotomy position. Same opinion is given in Su. Chi. 37/114 i.e. after flexing the knee and lying in supine position, Uttarbasti should be given very slowly.

#### i) **Paschatap Karma**

After giving Uttarbasti, the Netra should be withdrawn slowly. Afterwards, when oily substances has been returned the wise physician should give her meals along with milk, soup or meat juice as appropriate in the evening.

#### j) **Action of Uttarbasti**

Though the scope of action of Uttarbasti have been mainly indicated for urinary, vaginal and uterine disorders but its generalized action has been stated all over the body. It acts on all the Tridoshas but its specific action has been stated to be on Vata Dosha.

#### k) **Importance of Uttarbasti in the Treatment**

There is no cause greater than Vata in the manifestation of disease especially in Kashtartava. Basti Chikitsa is the best treatment for Vatika

ailments. The Vatanulomaka and Satyashodhak effect of Basti is well known.

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## **Chapter - 7**

# **Emerging Diagnostic Techniques for Lung Cancer Detection**

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# Chapter - 7

## Emerging Diagnostic Techniques for Lung Cancer Detection

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### Abstract

Cancer continues to be common reason of mortality worldwide. Among the different types of cancer, Lung cancer is a common reason for high mortality rate. The cases of lung cancer can be reduced by the early detection of cancer in the initiation state of cancer. For cancer therapeutics, biosensors have provided a great opportunity to detect and analyze cancer. Nanotechnology with biosensor applications provided the breakthrough in the prevention of cancer by rapid and convenient detection of cancer biomarkers, even in very low concentration of biomarkers. Several nanobiosensors have been designed and are under the clinical study stages. Here in this chapter, we have lightened the nanobiosensors for lung cancer. Nanobiosensors are the device which can be rapidly used to cancer biomarker identification and given an effective way in cancer diagnosis and screening. Although by wide application of nanotechnology has given way to design highly efficient biosensors. Different types of nanoparticles can be used of biosensing platform with their important properties like larger surface area, high conductance. We have discussed the different nanomaterials employed in nanobiosensors and cancer biomarkers and different challenges associated with biosensors. Futuristically, cancer biomarkers according to their cutoff value can be used to design the multianalyte detection biosensors for more specific detection of cancer in early stages.

**Keyword:** Lung cancer detection, nanobiosensors, diagnostic techniques

### Introduction

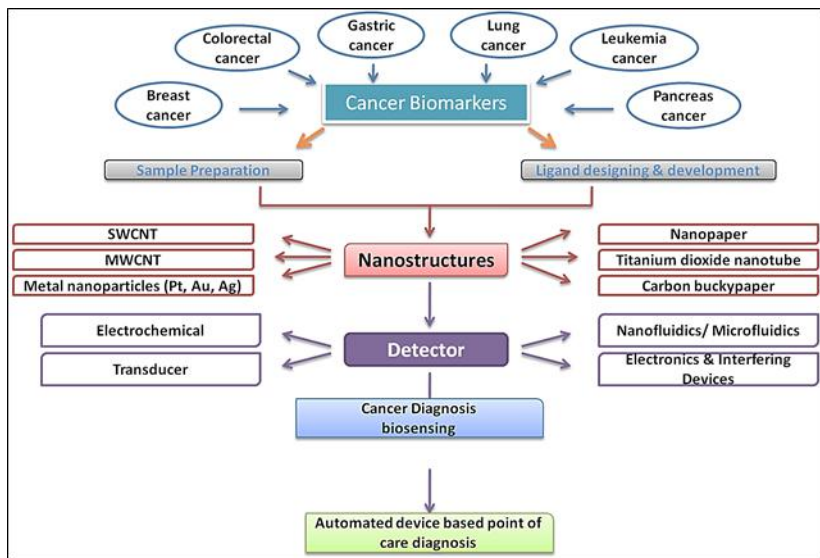
Lung cancer is observed as the major cause of cancer death worldwide. The high mortality rate is reported in lung cancer patients due to smoking, which is around 80-90%. Lung cancer is mainly divided into two subclasses

by world health organization; one is non-small cell lung cancer (NSCLC) and small cell lung cancer (SCLC). NSCLC is reported to be the reason of more than 85% cases of lung cancer, and on the other hand, SCLC has been known to cause of 15% cases (Siegel *et al.* 2017; Gatta *et al.* 2013). NSCLC types include the cases of lung adenocarcinoma, lung squamous carcinoma, and other large cell cancer subtypes. Among the different types of cancer, the survival rate of lung cancer has been reported to be the lowest. Lung cancer has only 18% survival rate, and prostate cancer has 99%, breast cancer 90% and colorectal cancer has 65% survival rate in a five-year survival analysis report (Sun *et al.* 2007; Couraud *et al.* 2012). Prevention therapy for lung cancer is complex, and time taking process with minimal survival rate. Hence, it is always suggested to identify and treat cancer in preliminary stages (early stages). Now a days, several techniques are being used to detect the cancer state, including the magnetic resonance imaging, chest X-ray, computerized tomography, sputum cytology analysis, positron emission tomography, and biopsy. However, many of these approaches are associated with certain other pathological conditions and so restricted to be used (Travis *et al.* 2015). Likewise, biopsy is painful approach and can also cause severe pain; and other diagnostic techniques are time-consuming, laborious, and required expertise. With the advancement of science avenues and modern technology, new rapid and sensitive lung cancer detection technique was needed to treat cancer. Sensing approaches proved to be remarkable technology for identification and detection of many diseases. These sensor technologies have shown good results via rapid and fast detection with minimal invasiveness. By employing biosensing approaches, biomarkers of any specific disease can be detected from any of sample types (blood, urine, saliva, body wastes, etc) in early stages with easy detection and with minimal pain (non- invasive) (Franier B *et al.* 2013). In present times, Biosensors are widely used to diagnose the different types of cancer. Biosensors are the platform formed with a chemical reaction and which signals the biological response into the detectable response. The biosensor can be employed to determine the defined concentration of target substances to assess the cutoff values in a biological process. Biosensors have wide applications in biomedical detection, drug homing analysis, environmental monitoring, etc (Peng *et al.* 2014).

To develop a Biosensor, first, it needs to select the type of cancer among the different type since priority is to identify potential biomarkers. Biomarkers are of different types (Protein, DNA, Nucleic acids, etc). Biomarkers should be specific and precise. Now a day, wide research is going employing various types of nanostructures (Figure 1). Biosensors are



associated with issues in early cancer detection since in early stages biomarkers are present in very low concentration. Which give raise the application of nanotechnology to improve and modify the detection techniques. Using the nanotechnology, minute level of biomarkers can be detected and help to detect in early-stage cancer named them as nanobiosensors. Nanobiosensors are now a problem-solving approach to sensitivity, velocity, selectivity, and cheapness. Electrochemical nanobiosensors are one of the significant techniques of medical analytics (Roointan *et al.* 2019). In electrochemical biosensors, signal transduction is based on an electrochemical reaction, which is occurring at an electrode surface. The occurrence of an electrochemical reaction at the electrode surface with a target molecule will result in a change in the electrical signal.



**Fig 1:** Overview of Biosensor designing and development

## Nanobiosensors at a Glance

A nanobiosensor can be spelled as a sensing/probing machine which is devised specifically for estimation of material by employing the biological interactions and then evaluating these interactions into a readable form through transduction and electromechanical interpretation. These measurement systems are used to quantitatively measure a biological or biochemical event, utilizing numerous technologies (electronic, optical, or magnetic technology) through a compact probe. Advancement in nanotechnology and fabrication technology in electronics recently have developed or formulated a new set of biosensors spelled as

“Nanobiosensors,” and these sensors have marshaled in a new era of bionanotechnology for disease prognosis and therapy. The main purpose of a nanobiosensor is to sense a biologically specific material. Often, these materials are antibodies, proteins, enzymes, immunological molecules, and so on.

Most importantly, nanobiosensors also plays a decisive role in identifying biological agents such as nucleic acids, antibodies, pathogens, and metabolites for the further detection of pathological outcomes associated with these agents. In terms of the conceptual and fundamental mode of operation, there are mainly three components of a nanobiosensor. These components are, namely, bioreceptor, transducer, and the detector (Touhami *et al.* 2014). The working principle of nanobiosensor comprises of binding bioanalytes of interest onto bioreceptors to control the physicochemical signal linked to the binding bioanalytes. Further, a transducer afterward captures and translates the physicochemical signal into an electrical signal to detect the variation in the signal such as electric potential, current, impedance, and conductance.

Additionally, differences in the phase of electromagnetic radiation, intensity, temperature, and viscosity are also monitored through this technology. Interestingly, analysis of the differences in these parameters determines the presence or absence of biological agents. Nanostructure materials have been employed as a layer support in between the biomolecules/biomaterial and physicochemical agents along with transducer to form the biosensor.

### **Functional Implications of Nanomaterial in Electrodes**

The specificity of biomolecules can be improved with the help of NPs/nanomaterials for providing specific and precise targeting. These features are further helpful in incorporating nanomaterials in biosensors for any crucial function and developing the application of nanomaterials in nanobiosensors (Doria *et al.* 2012). Furthermore, the alliance between nanotechnology and bio-electronic may also provide novel feasibilities to miniaturize the settings and to advance biological tools for sample detection or measurement. This synergy indeed provides the accuracy and precision of the diagnosis owing to an increase in the surface-to-volume ratio of nanomaterials, which further makes electrical sensors more responsive to exterior influences (Zhang *et al.* 2014b). The nanomaterial integration usually can be helpful in various improvements such as immobilization support, signal generating probe, signal amplifier, enzyme mimics, and

nanohybrids/composite (Saha *et al.* 2011). Nanomaterials not only advance the immobilization process of biomolecules but also stop biological changes including, denaturation and loss of bioactivity (Chinen *et al.* 2015). Although, effects associated with nanomaterials on attaining high responsiveness and selectivity should be carefully considered (Doria *et al.* 2012).

Nowadays, nanomaterials play a fundamental role in enzyme mimetic research because of having plenty of reactive groups on their surface and associated catalytic activity (Panraksa *et al.* 2018). In this context, oxidase, catalase, and peroxidase activities have been validated and confirmed for different kinds of nanomaterials (Sapountzi *et al.* 2017). The usages of these nanomaterial-based enzyme mimetics are having benefits of cheap and high constancy activities (Doria *et al.* 2012). Similarly, one of the considerable advantages of enzymatic nanomaterials is their high significance as signal amplifying nanoprobe for electrochemical cytosensing. These types of nanobiosensors are competent to measure low numbers of cancer cells in the blood (Liu and Liu 2017). For instance, CTCs cells that are crucially engaged in the metastasis process and used as precious biomarkers for early cancer detection are measured by the help of this technique.

Moreover, the detection of CTCs has been a significant challenge due to their lower availability in the blood (1-10 CTCs per 1 billion blood cells). Interestingly, a cytosensitive based on Fe<sub>3</sub>O<sub>4</sub> NPs and AuNPs are able to identify breast cancer at a concentration of 5 cells/mL of blood (Zheng *et al.* 2014; An *et al.* 2018). The most common nanomaterials that are used in current research are metal NPs like Au or magnetic nanomaterials and carbon nanostructures such as nanotube and graphene (Hayat *et al.* 2014; Pingarron *et al.* 2008). Further, the hybrid combinations of metal-nanotube, NPs-silica, metal chitosan, etc are being used in nanobiosensors as an important factor to identify cancer prognosis markers (Choi *et al.* 2010).

There are various procedures that have been established to construct AuNPs. These procedures include both chemical and physical procedures ranging from co-precipitation, vapor deposition to laser ablation. However, electrodeposition of AuNPs through HAuCl<sub>4</sub> solution in steady potential is the simplest way to develop AuNP-modified electrodes. The impact of numerous carbon nanomaterials such as CNTs, graphene, carbon nanosphere, and reduced graphene oxide (GO) have attained much consideration these days in the field of nanobiosensors, as these NMs are having their specific physical and chemical properties (Choi *et al.* 2010). Further, the usage of carbon nanostructures is suggested as electrode

substances, signaling elements, catalysts, and mediators as this creates diverse signal amplification routes in electrochemical nanobiosensors (Balasubramanian and Burghard 2006).

Additionally, carbon nanostructures work as potential candidates for medical settings despite being toxic compared to AuNPs. The reasons behind such functionalities are having their large surfaces, chemical stability, lightweight, mechanical strength, and compatibility. Nanomaterials also work as perfect carriers for signal transduction due to their high capacity to trigger rapid transmit electron. Hence, electrochemical nanobiosensors are normally advocated as GCE or metal electrode for analyte detection (Yáñez-Sedeño *et al.* 2017).

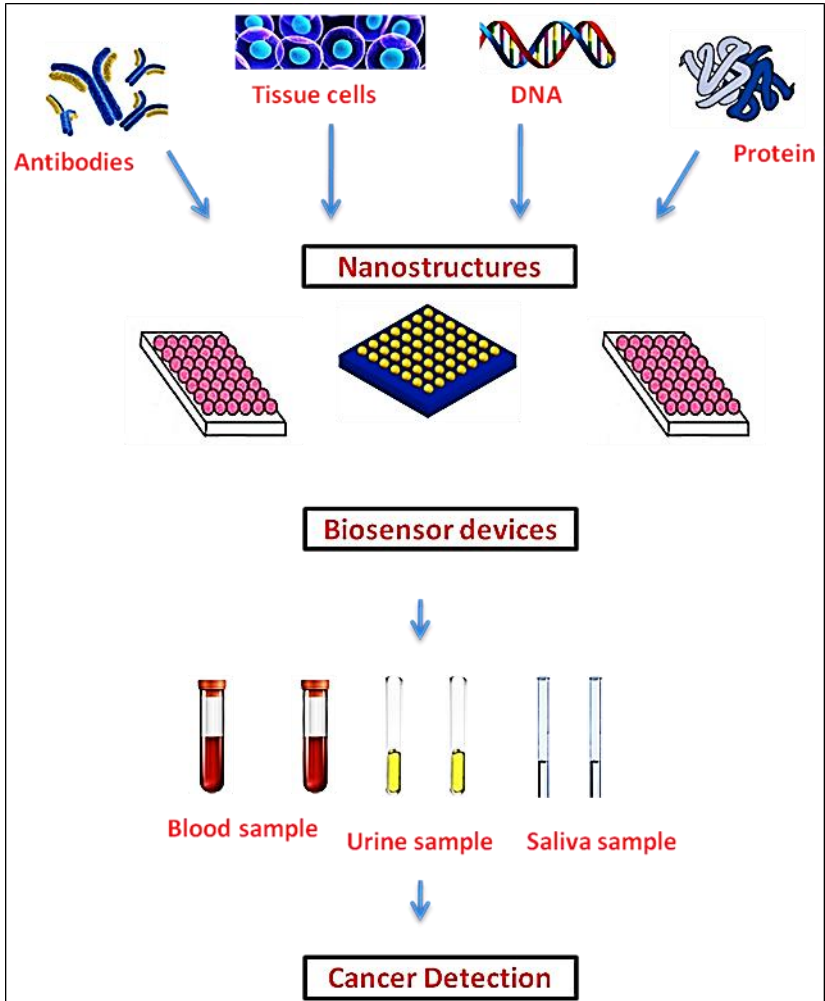
There are various methods to construct carbon-based nanobiosensors, but electrochemical nanobiosensors are generally being formulated by casting method of carbon nanostructure like nanotubes onto an electrode. This method causes nanobiosensor to be free from impurities affected by surfactants or connectors, despite ameliorating the electrical connection between active sensing and conducting substrate, and accelerating the transfer of electrons (Yáñez- Sedeño *et al.* 2017). Likewise, the chemical vapor deposition method is also used for direct growth of Carbon nanotubes (CNTs), and CNTs developed by this method have shown the best output. However, di-electrophoresis compare to the chemical vapor deposition method is simpler, cost-effective, and does not need any special materials and high temperature for the growth of CNTs (Balasubramanian and Burghard 2006). CNTs are cylindrical molecules, having rolled-up sheets of single-layer carbon atoms (graphene). They can be classified as single-walled with a diameter of <1 nm or multi-walled consisting of numerous concentrically interlinked nanotubes, with diameters reaching >100 nm. Their length can reach several micrometers or even millimeters. Similar to CNTs, graphene sheets that are supposedly made in the form of 2-D crystals with a range of flaws (both chemical and physical) are also formulated by virtue of chemical vapor method. However, flaws can destroy the 2-D electron conduction, but can also be advantageous to electrochemistry as the electron transfer in the electrochemistry of CNTs occurs at the edge planes and flaws (Ambrosi *et al.* 2011). The simplest manner to persuade extra sensing capacity to graphene after its construction can be achieved via reforming its physical-chemical structure by hydrogenation, oxygenation, and fluorination processes (Guy *et al.* 2012). Now a days Graphene oxide has considered as a favorite material in the advancement of electrochemical nanobiosensors as this oxide is inexpensive and requires easy processing for its formulation.

Moreover, solubility, dispersibility, and the existence of the active edge of Graphene oxide make it more demanding in the field of nanobiosensors. Equally, carbon nanosphere (CNS) has also been considered as a preferred material for designing electrochemical nanobiosensors because of their convenient structure, great mass transport, and biocompatibility. Hence, a type of PdNPs decorated nitrogen-doped graphene quantum dots (NGQDs) based CNSs has been developed recently. These modified CNSs are further integrated into nitrogen-doped carbon (NC) for their better detecting performance. The structure of these CNSs works as dual signal-amplifying nanoprobes in H<sub>2</sub>O<sub>2</sub> released from living cancer cells. This bio-sensing system also demonstrates its ability to differentiate a trace amount of H<sub>2</sub>O<sub>2</sub> released from various living cancer cells and also determines the therapeutic potential of radiotherapy and chemotherapy towards cancer (Xi *et al.* 2016).

Further, nanocomposites of CNTs and AuNPs along with platinum and propyl gallate molecules are frequently used in research nowadays as these composites have the potentiality to accelerate electron transfer and sensor sensitivity. The detection limit of these nanocomposites is as low as 2.51Å~10<sup>-8</sup> mol/L, and a wide linear range from 7Å~10<sup>-8</sup> to 1Å~10<sup>-5</sup> mol/L (Cui *et al.* 2015). Also, microelectrode of AuNPs/GQDs/ACF is being utilized in the sensitive detection of H<sub>2</sub>O<sub>2</sub> as a cancer biomarker in human breast cancer cells and tissues (Xu *et al.* 2018). AuNPs decorated graphene QDs and modified activated carbon fiber (ACF) microelectrode was earlier developed as a part of electrochemical sensing machines.

### **Biomarkers for Lung Cancer Detection**

Lung cancer is a formidable disease. Its proliferation and different stages are associated with the marked references named as a biomarker. A biomarker may be a protein, hormone, peptide, nucleic acid change in cancerous state (Jianrong *et al.* 2004; Luo *et al.* 2006). These biomarkers are diagnosed and identified by different biological techniques to screen cancer using various type of patient sample (Figure 2). Some of the potential biomarkers for lung cancer have been discussed here.



**Fig 2:** Depiction of cancer detection employing different types of samples from patients employing nanostructures based biosensors

### **Carcinoembryonic Antigen**

Carcinoembryonic antigen (CEA) is proteinous in nature and founds at a low level in adults. It was first demonstrated in human colon cancer tissues. CEA has a range of 2.5 to 5ng/ml, and its concentration is found more in smokers. It is used as an indicator of colorectal cancer and widely employed for identification of cancer states. CEA test is performed mostly for gastrointestinal cancers.

## **Neuron-Specific Enolase**

Neuron-specific Enolase (NSE) is reported to be the most consistent biomarker for lung cancer. It is an enzyme present in the neuronal tissues and involved in the energy metabolism in the brain and releases during injury. It is considered to be a precise marker for neurons and peripheral neuroendocrine cells. It is most used biomarker used by the doctors using the electrochemiluminescence immunoassay to monitor and identify the small cell lung cancer. It is acidic in nature and involved in the regulation of the glycolytic cycle.

## **CYFRA 21-1**

CYFRA 21-1 (Cytokeratin fragment 9) is an epithelial protein and considered as a potential biomarker for lung cancer detection. It is reported to present in all lung cancer patients. CYFRA 21-1 is also used widely in design and development of cancer biosensors. It has an optimal range of 3.3 ng/ml in serum, and it is tested with some other cancer biomarker.

## **Annexin A2**

Annexin A2 (ANXA2) is another important biomarker reported to identify lung cancer. This proteinous biomarker is present in macrophages and endothelial cells to regulate the membrane transport. It has been found to be an efficient biomarker for lung cancer and liver cancer. It is also detected along with heat shock protein 60 (HSP60) to assess lung cancer in the early diagnosis of lung cancer.

## **Serum Amyloid**

Serum amyloid A1 (SAA1) high level is also associated with lung cancer stages. Usually, it is known as an acute phase protein and found at a high level in injury or infections. Several studies have confirmed its direct linkage with cancer initiation and progression. Hence it is widely used in the design and development of biosensors and microfluidics systems.

## **P53**

P53 is tumor protein and involved directly for cell cycle regulation and its expression at different stages of cancer. It is known as tumor suppression protein that functions in cell regulations, including the apoptosis (programmed cell death), DNA repair, etc. Its accumulation or deregulation or any mutation in the P53 gene leads to the development of a tumor. P53 cell check point is reported to an important biomarker for lung cancer in several studies.

## **Epidermal Growth Factor Receptors**

Epidermal growth factor receptors (EGFR) are known as transmembrane protein receptors. These proteins bind to ligands and start cascade signaling resulting in cell development and metastasis. Any mutation in its promoter region leads to its high expression result in a tumor. Scientists have reported over expression of its mutated forms is an effective biomarker for lung cancer.

## **RAS Genes**

RAS proteins are a group of a gene family of K-RAS, H-RAS, and N-RAS. These proteins have a direct role in regulations, cell signaling, and cell progression. Any mutation to this family is linked to lung cancer. It is reported in 30% of lung cancers are associated with this protein dysfunctions. Mutated K-RAS protein is well studied and a potential biomarker for lung cancer.

## **Micro RNAs**

MicroRNAs are small noncoding RNAs. These have a role in gene regulations in transcription level as these are directly involved in the RNA silencing and also post-transcriptional regulations of genes. These have a significant role in silencing of tumor proteins hence plays a very important role in cancer initiation and progression. Among different microRNAs, miRNA-21 is found to be associated with lung cancer. Its high expression is reported in lung cancer patients

## **Nanobiosensors for Lung Cancer Detection**

With the advancement of research and development, the modified electrochemical nano-biosensors have given a promising diagnostic process. It has multiple advantages, including rapid detection, fast response, lesser time consuming, combatively less laborious, and high specificity.

Nanoparticles are immobilized on to the device to perform the chemical and reaction and to provide the detectable biological response in the form of current. For lung cancer detection, several diverse biomarkers have been reported; for them, scientists have developed the many nano-biosensors. Biosensor consisted of an electrode based on grapheme, which is modified with gold nanoparticles and chitosan for lung cancer and liver cancer detection was reported. It has a high identification limit of 0.1 ng.ml and 0.05 ng.ml, respectively (Chen *et al.* (2013). Similarly in another study electrochemical immunosensor was reported based on MAGE proteins (Protein reported in lung cancer) by using the carbon nano tube and chitosan



mixture with very high detection limits for lung cancer (Choudhary *et al.* 2014).

In another study, the graphene oxide and carbon oxide based nanowires composite were employed in electrochemical sensor development for CYFRA 21-1 cancer biomarker with improved sensitivity and rapid process with a low concentration of biomarkers (Chen *et al.* 2015). Similarly, another group designed the electrochemical biosensor. It is developed based on microRNAs and gold nanoparticles for efficient lung cancer detection (Liu *et al.* 2015). In another study, Aptamer-based nano biosensor was designed with gold nanoparticles and benzoic acids for the detection of human non-small cell lung cancer cells (Mir *et al.* 2015). Similarly, protein biomarker-based electrochemical biosensor was reported for the CYFRA21-1, squamous cell carcinoma antigen, CEA biomarker and NSE (neuron-specific enolase) biomarker with gold composites. Recently, an electrochemical sensor for CYFRA biomarker has been designed and developed for lung cancer detection with an enhanced detection limit of biomarker (Chen *et al.* 2018). These are on the list of biosensors designed and developed for cancer detection. With the ongoing time, more advanced biosensors have been proposed. Notably, more specific detection of lung cancer multianalyte biosensor for multiple biomarkers is under investigations.

### **Constraints and Challenges in Cancer Detection**

Cancer diagnosis requires a specific, fast, accurate, and convenient approach for cancer detection at every stage of cancer. Till date, multiple studies have been done for cancer diagnosis concerning nanobiosensors. With the advent of nanobiosensors, instant caring, real-time caring, and monitoring to medical therapeutics have been enhanced; however, in clinical studies, lung cancer detection is not reported successful approach. Cancer detections are liked with issues of the presence of very less concentration of biomarkers, and multiple biomarkers are responsible for cancer development. So it is required to develop the nanobiosensors to reduce these issues for detection of a low range of biomarkers and multianalyte biomarkers. Another major concern is sample withdrawal since current techniques are invasive and needed expertise, this can be reduced by designing the minimally invasive or noninvasive biosensor by using the easily available sampler like urine, saliva, blood, etc.

Moreover, Nano-biosensors are associated with challenges including the less stability of nanobiosensors electrodes, sustainably, reusability, different

effects and impacts of medical stages and environmental factors, the biocompatibility of nanobiosensors materials, simple patient sample analysis and other mechanistic clarity of binding and interaction nanomaterials used and its interactions with biomolecules. To overcome the mentioned issues, scientists are working on designing and developing good quality nanomaterials and nano scale combinations on electrodes. Moreover, to analyze the patient sample, it is advised to develop the noninvasive electrochemical nanobiosensors for the detection of lung cancer. To resolve the nanomaterials is suggested to use biocompatible, biodegradability with high speculated properties made from different nanomaterials.

## **Conclusion**

Nanotechnologies have provided the advancement to design and develop the molecular diagnosis which has enable the early cancer detection, point of care diagnosis, and development of biosensors. Clinically nanotechnology has extended the limit to prevent and treat the in cancer therapeutics. Biosensors developments with nanotechnology avenues have shown a clear indication for the future development of potential cancer diagnostics. As discussed in the chapter, with nanotechnology employment to the biosensors, nanobiosensors have shown the good results in the detection of very low range (concentration) of cancer biomarkers. That has helped in the determination of cancer symptoms in the early stages, which will be helping in effective cancer treatment. Importantly, by using nanobiosensors doctors will be able to check the patient sample with a minute sample that will also overcome the issue of laborious processing and large sample collection. With the advancement in nanotechnology to biosensing application have significantly enhanced the diagnostics approaches to detect cancer in a convenient and efficient way and also shown the positive outputs to the future for cancer diagnosis.

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## Conflict of Interest

The authors have no conflict of interest with the publication of the paper.

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**Chapter - 8**  
**Pathophysiology of Type 2 Diabetes Mellitus**

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# Chapter - 8

## Pathophysiology of Type 2 Diabetes Mellitus

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### Abstract

Diabetes Mellitus (DM) is a clinical syndrome characterized by hyperglycemia due to absolute or relative deficiency of insulin. This can arise in many different ways. Lack of insulin affects the metabolism of carbohydrate, protein and fat and causes a significant disturbance of water and electrolyte homeostasis. Death may result from acute metabolic decompensation while long standing metabolic derangement is frequently associated with permanent and irreversible functional and structural changes in the cells of the body, with those of the vascular system being particularly susceptible.

**Keywords:** Diabetes mellitus, pathophysiology

### Introduction

**Development of Pancreas:** Pancreas develops as an outgrowth of the endoderm of the small intestine and ultimately becomes hollowed out to form the alveoli or acini. The islets of Langerhans develop as buds from the ducts and remain as solid clumps of cells. During development in most cases, the connections with the duct vanishes and the islets become completely isolate. But in a few cases the connections persist as solid chords.

**Physiology of Pancreas:** The pancreas is both an endocrine as well as exocrine gland. It is devoid of distinct connective tissue capsule and is covered by a fine layer of the loose tissue which passes into the gland as septa and subdivides the gland into many lobules in the lower animals [cat] the lobules are completely separated from one another by the connective tissue <sup>[1]</sup>.

### Mechanism of Pancreatic Secretion

### Experiments

Most of our knowledge regarding pancreatic secretion has been derived from experiments on animals. Some direct evidences in man have been

obtained from cases of accidental or postoperative duodenal fistula, through which pancreatic juice could be collected outside. In dog the process is studied by establishing a pancreatic fistula by cutting out the duodenal papilla [through which the duct opens] which is brought to the surface and sutured to an opening in the abdominal wall. The duodenum wound is stitched up. Pancreatic juice is collected by a cannula inserted into the duct. In man some information may be obtained with the help of a duodenal tube [ryle's tube swallowed upto the third mark.

With these experiments it is seen that during fasting there may not be any secretion for long periods. Occasionally a little secretion takes place. The rate of secretion actually starts 1-2 minutes after taking food. The rate of secretion steadily rises, lasts for above 3 hours and then gradually declines. Greatest increase of secretion is observed at the time when gastric contents enter duodenum. This indicates that the acid chyme of the gastric juice exerts a stimulant effect on pancreatic secretion <sup>[2, 3]</sup>.

On closer study it is found that pancreatic secretion consists of 2 phases.

Nervous phase and chemical phase.

### **Nervous Phase**

Pancreatic secretion starts 1-2 minutes after taking food. When the vagi are cut, the secretion is abolished. This proves that the initial phase of pancreatic secretion is a reflex response. The stimulus for this reflex arises in the mouth during mastication as well as in the stomach when food enters the later [gastro pancreatic reflex]. It is to be noted that this reflex is purely unconditioned. There is no conditioned stimulus here. This stands in great contrast with the nervous phase of gastric secretion. That the vagi are the motor nerves of pancreas is proved by the fact that when they are stimulated, increased pancreatic secretion takes place. This vagal secretion is rich in enzymes but has very little effect on bicarbonate concentration. In addition there is a local cholinergic reflex mechanism independent of vagal innervation. Thus, the vagal juice has got a greater digestive power. Acetylcholine is the mediator and parasympathomimetic drugs, example pilocarpine are also effective. The response is blocked by atropine. Inhibition of secretion may also be obtained by stimulating adrenergic nerves producing vasoconstriction and constriction of ducts. Thus stimulation of sympathetic nerves may decrease secretion of pancreatic juice by reducing the blood flow through the organ and flow of juice through the duct <sup>[4-9]</sup>.

## **Chemical Phase**

There are many controversial opinion regarding the cell responding to a stimulus with a characteristic type of functional activity regardless of the nature of stimulus. It is known through the cells of intralobular ducts secrete water and bicarbonate and the enzymes are secreted by acinus cells. It has already been noted that the rate of secretion of pancreatic juice raises shortly when the gastric contents enter duodenum. This is the onset of chemical phase. Bayliss and starling isolated a loop of jejunum maintaining its vascular supply intact but destroying all possible nerve connections. When acid was introduced into this loop, pancreas was found to secrete. Since there is no nervous connection between this loop and the pancreas, it is evident that the stimulus must be carried to pancreas through blood streams. That HCl itself is not the stimulus is proved by the fact that injection of the acid into the portal vein did not produce any effect. But when acid extracts of intestinal mucosa were injected into the portal vein, pancreatic secretion was stimulated <sup>[10-13]</sup>.

This proves that acid liberates some substances from the mucus membrane which act as the real stimulus. This substance is called secretin originally by Bayliss and starling. Recently this has been separated into the following different components.

- Secretin
- Pancreozymin
- Hepatocrinin stimulates liver to secrete bile
- Cholecystokin causes contraction of gall bladder
- Enterokinin stimulates release of intestinal juice

### **The First Two which are related to the Pancreas are Described Below**

#### **Nature and Action of Secretin**

It can be extracted from the mucus membranes of the duodenum and upper part of the small intestine with water, 0.4% HCl, soap solution or alkali. From the nature of the solvents it is obvious that during normal process of digestion secretin can be extracted by the HCl of the gastric chyme as well as by the alkali of bile. Secretin has been isolated by various workers and is believed to be a polypeptide containing, 27 amino acid residues. Its molecular is about 5000. It is rapidly destroyed by pepsin and trypsin in alkaline or neutral medium. It remains stable in acid solution. Recently secretin has been synthesized when secretin is injected

intravenously, the flow pancreatic juice increases. This juice is watery, rich in bicarbonate but poor in enzyme <sup>[14]</sup>.

### **Pancreozymin**

It is a polypeptide containing 33 amino acids. This causes release of zymogen granules from the pancreatic acinus cells resulting in release of a pancreatic juice rich in enzymes but poor in bicarbonates.

### **Influence of Various Food Stuffs on Pancreatic Secretion**

It has been observed that pancreatic secretion remains high for about 3 hours and then declines. This is due to the fact that stomach is completely emptied within 3 hours when mixed meal is injected so contact of gastric chyme is lost with the mucosa of proximal part of the small intestine. Pancreatic juice is found to vary in quality and quantity with different types of food. Meat stimulates a secretin type of response, that is large volume, more alkali and less enzyme. Fat elicits a vagal type of response that is moderate volume, low alkali and rich in enzyme. Bread produces a mixed type of response <sup>[15]</sup>.

The exocrine component portion of the pancreas is compound tubular gland. The terminal secretory portions of this gland are known as acini or alveoli which are tubular and somewhat and convoluted and secrete pancreatic juice. These acini resemble those of serous [Sero Zymogenic] alveoli of salivary glands and do not contain myoepithelial cells. The main excretory duct of the gland is the duct of Wirsung, which extends the entire length of the gland, giving out several intralobular ducts or intercalated ducts. The duct of Wirsung opens in company with the common bile duct into the ampulla of Vater, which opens into the second part of the duodenum <sup>[16]</sup>.

An accessory pancreatic duct, duct of Santorini is often present within the lumina of many acini, one or more cubical cells are lying in contact with the apices of the secretory cells. These cells are known as centro acinus [acinar] cells. The cytoplasm of this cell does not possess any secretory granules. In each secretory cell, there are two well-marked granules—an inner apical zone towards the lumen and outer basal zone towards the basement membrane. In the inner zone there are numerous coarse zymogen granules and their number are varying with the functional activity of the cell. Their number are diminished during the digestion but increased during rest. The basal zone contains the nucleus as well as the basophilic or chromophilic substance <sup>[17]</sup>.

Electron microscope structure shows highly developed rough walled endoplasmic reticulum and a supranuclear golgi apparatus. Surface membranes are studded with ribosome granules which give basophilic staining. In resting stages the granular zone gradually increases upto  $\frac{3}{4}$ <sup>th</sup> of the cell, but during activity the granular zone gradually diminishes in size. The pancreatic excretory duct is also similar to that of the salivary gland. Larger ducts contain elastic fibers and plain muscles which, when contract, may prevent the flow of juice into the duodenum. Near the duodenum small mucus glands are seen in the lamina propria.

Zymogen granules contain pro enzymes. The pro enzymes become activated on secretion to form enzymes. These enzymes are responsible for later stages of digestion of proteins, carbohydrates and fats.

Between acini or alveoli there are found groups of solid cells, termed as interacinous [interalveolar] cells, islets [or islets of Langerhans]. Which is the endocrine component portion of the pancreas. These islets are scattered throughout the pancreas but from the exocrine tissue by a thin basement membrane <sup>[18]</sup>.

The endocrine pancreatic tissue cells are formed with much less cytoplasm than those of the ex-more numerous in the tail than elsewhere. These are main two types of cells in the islets: alpha and beta cells. The B cell contains numerous insulin granules and secrete insulin.

Recent studies by Steiner and his colleague over showed the existence of biosynthetic precursor of insulin termed proinsulin. The concept of proinsulin is supported by the following evidences.

- Oxidative degeneration of reduced proinsulin is much more efficient than that of reduced insulin
- Pancreas slice incorporate labeled aminoacids into proinsulin fraction 1
- Low concentration of trypsin readily cleave sensitive bonds in proinsulin giving a insulin like product

The alpha cells contain glucagon granules and secrete glucagon. A few gamma and delta cells scattered in the islets. According to Hellerstrom *et al.* it reveals that alpha cells can be classified as alpha 1 which is argyrophilic and alpha 2, argyrophilic but rich in protein bound tryptophan.

### **Insulin Biosynthesis, Secretion and Action** <sup>[19]</sup>

#### **Biosynthesis**

Insulin is produced in the beta cells of the pancreatic islets. It is initially synthesized as single-chain 86-amino-acid precursor polypeptide,

preproinsulin. Subsequent proteolytic processing removes the amino-terminal single peptide, giving rise to preproinsulin. Proinsulin structurally related to insulin-like growth factors I and II, which bind weakly to the insulin receptor. Cleavage of an internal 31-residue fragment from proinsulin generates the C peptide and the A (21 amino acids) and B (30 amino acids) of insulin, which are connected by disulfide bonds. The mature insulin molecule and C peptide are stored together and co-secreted from secretory granules in beta cells. Because C peptide is clearly more slowly than insulin, it is a useful maker of insulin secretion and allows discrimination of endogenous and exogenous sources of insulin in the evaluation of hypoglycemia. Pancreatic beta cells co-secrete islet amyloid polypeptide or amylin, a 37-amino-acid peptide, along with insulin. The role of IAPP in normal physiology is incompletely defined, but it is major component of the amyloid fibrils found in the islets of the patients with type 2 diabetes, and an analogue is sometimes used in training type 1 and type 2 DM. Human insulin is produced by recombinant DNA technology, structural alterations at one or more amino acids residues modify its physical and pharmacologic characteristics [20].

## **Secretion**

Glucose is the key regulator of insulin secretion by the pancreatic beta cell, although amino acids, ketones, various nutrients, gastrointestinal peptides and neurotransmitters also influence glucose secretion. Glucose levels more than 3.9mmol/L [70mg/dl] stimulate insulin synthesis, primarily by enhancing protein translation and processing.

Glucose stimulation of insulin secretion begins with its transport into the beta cell by a facilitative glucose transporter. Glucose phosphorylation by glucokinase is the rate limiting step that controls glucose regulated insulin secretion. Further metabolism of glucose -6- phosphate via glycolysis generates ATP, which inhibits the activity of ATP sensitive K<sup>+</sup> channel. This channel consists of two separate proteins: one is the binding site for certain oral hypoglycemic; the other is an inwardly rectifying K<sup>+</sup> channel protein. Inhibition of this K<sup>+</sup> channel induces beta cell membrane depolarization, which opens voltage dependent calcium channels [leading to an influx of calcium], and stimulates insulin secretion.

Insulin secretory profiles reveal a pulsatile pattern of hormone release, with small secretory bursts occurring about every 10minutes, superimposed upon greater amplitude oscillations of about 80-150min. Incretions are released from neuroendocrine cells of the gastrointestinal tract following food ingestion and amplify glucose stimulated insulin secretion and suppress

glucagon secretion. Glucagon like peptide 1 [GLP1], the most potent incretin, is released from L cells in the small intestine and stimulates insulin secretion only when the blood glucose is above fasting level. Incretin analogues, are used to enhance endogenous insulin secretion <sup>[21]</sup>.

### **Action**

Once insulin is secreted into the portal venous system, about 50% is removed and degraded by the liver. Unextracted insulin enters the systemic circulation where it binds to receptors in target sites. Insulin binding to its receptor stimulates intrinsic tyrosine kinase activity, leading to receptor, auto phosphorylation and the recruitment of intracellular signaling molecules, such as insulin receptor substrates [IRS]. IRS and other adaptor proteins initiate a complex cascade of phosphorylation and dephosphorylation reactions, resulting in the widespread metabolic and mitogenic effects of insulin <sup>[17]</sup>.

As an example, activation of the phosphatidylinositol-3-kinase pathway stimulates translocation of a facilitative glucose transporter ex: GLUT4, to the cell surface an event that is crucial for glucose uptake by skeletal muscle and fat. Activation of other insulin receptor signaling pathways induces glycogen synthesis, protein synthesis, lipogenesis and the regulation of various genes in insulin responsive cells.

Glucose homeostasis reflects a balance between hepatic glucose production and peripheral glucose uptake and utilization. Insulin is the most important regulator of this metabolic equilibrium, but neural input, metabolic signals and other hormones [ex: glucagon] result in integrated control of glucose supply and utilization. In the fasting state, low insulin levels increase glucose production by promoting hepatic gluconeogenesis and glycogenolysis and reduce glucose uptake in insulin sensitive tissues [skeletal muscle and fat], there by promoting mobilization of stored precursors such as aminoacids and free fatty acids [lipolysis]. Glucagon, secreted by pancreatic alpha cells when blood glucose or insulin levels are low, stimulates glycogenolysis and gluconeogenesis by the liver and renal medulla. Postprandially, the glucose load elicits a rise in insulin and fall in glucagon, leading to a reversal of these processes. Insulin, an anabolic hormone, promotes the storage of carbohydrate and fat and protein synthesis. The major portion of postprandial glucose is utilized by skeletal muscle, an effect of insulin stimulated glucose uptake. Other tissues, most notably the brain, utilize glucose in an insulin dependent fashion <sup>[7]</sup>.

Type 2 diabetes mellitus is characterized by impaired insulin secretion, insulin resistance, excessive hepatic glucose production and abnormal fat

metabolism. Obesity, particularly visceral or central [as evidenced by the hip- waist ratio], is very common in type 2 diabetes mellitus [80% or more are obese]. In the early stages of the disorder, glucose tolerance remains near normal, despite insulin resistance, because the pancreatic beta cell compensate by increasing insulin output. As insulin resistance and compensatory hyperinsulinemia progress, the pancreatic islets in certain individuals are unable to sustain the hyperinsulinemic state. IGT, characterized by elevations in postprandial glucose, then develops. A further decline in insulin secretion and an increase in hepatic glucose production lead to overt diabetes with fasting hyperglycemia. Ultimately beta cell failure ensues.

## **Metabolic Abnormalities**

### **Abnormal Muscle and Fat Metabolism**

Insulin resistance, the decreased ability of insulin to act effectively on target tissues [especially muscle, liver and fat], is a prominent feature of type 2 diabetes mellitus and results from a combination of a genetic susceptibility and obesity.

Insulin resistance is relative, however since supra normal levels of circulating insulin will normalize the plasma glucose. Insulin-dose response curves exhibit a right ward shift, indicating reduced sensitivity and a reduced maximal response, indicating an overall decrease in maximum glucose utilization [30-60% lower than in normal individuals]. Insulin resistance impairs glucose utilization by insulin-sensitive tissues and increases hepatic glucose output; both effects contribute to the hyperglycemia. Increased hepatic glucose output predominantly accounts for increased FPG levels, whereas decreased peripheral glucose usage results in post prandial hyperglycemia. In skeletal muscle, there is greater impairment in nonoxidative glucose usage [glycogen formation] than in oxidative glucose metabolism through glycolysis. Glucose metabolism in insulin dependent tissues is not altered in type 2 diabetes mellitus [7].

The precise molecular mechanism leading to insulin resistance in type 2 diabetes mellitus has not been elucidated. Insulin receptor levels and tyrosine kinase activity in skeletal muscle are reduced, but these alterations are most likely secondary to hyperinsulinemia and are not primary defect. Therefore, postreceptor defects in insulin regulated phosphorylation/dephosphorylation appear to play the predominant role in insulin resistance. For example, a PI-3 kinase signaling defect might reduce translocation of GLUT4 to the plasma membrane. Other abnormalities include the accumulation of lipid within



skeletal myocytes, which may impair mitochondrial oxidative phosphorylation and reduce insulin stimulated mitochondrial ATP production. Impaired fatty acid oxidation and lipid accumulation within skeletal myocytes also may generate reactive oxygen species such as lipid peroxides. Of note, not all insulin signal transduction pathways are resistant to the effects of insulin [e.g.: those controlling cell growth and differentiation using the mitogenic-activated protein kinase pathway]. Consequently, hyperinsulinemia may increase the insulin action through these pathways, potentially accelerating diabetes- related conditions such as atherosclerosis.

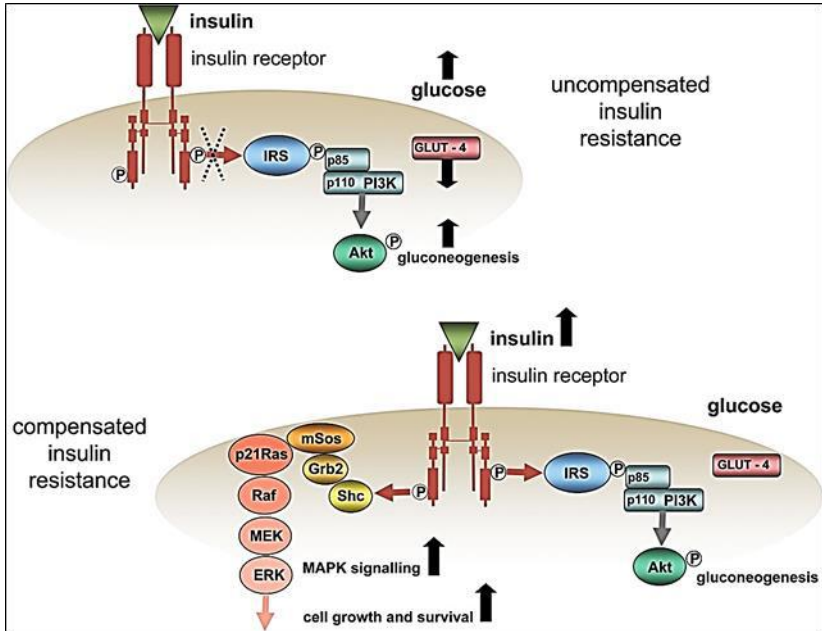
The obesity accompanying type 2 diabetes mellitus, particularly in a centrally or visceral location, is thought to be a part of pathogenic process. The increased adipocyte mass leads to increase levels of circulating free fatty acids and other fat cell products. For example adipocytes secrete a number of biologic products [non esterified free fatty acids, retinol binding protein 4, leptin, TNF-alpha, resistin and adiponectin]. In addition to regulating body weight, appetite and energy expenditure, adipokines also modulate insulin sensitivity [22].

The increased production of free fatty acids and some adipokines may cause insulin resistance in skeletal muscle and liver. For example, free fatty acids impair glucose utilization in skeletal muscle, promote glucose production by the liver and impair beta cell function. In contrast the production by adipocytes of adiponectin, an insulin sensitizing peptide is reduced in obesity and this may contribute to hepatic insulin resistance. Adipocyte products and adipokines also produce an inflammatory state and may explain why markers of inflammation such as IL-6 and C-reactive protein are often elevated in type 2 diabetes mellitus. In addition inflammatory cells have been found infiltrating adipose tissue. Inhibition of inflammatory signaling pathways such as the nuclear factor kB [NF-kB] pathway appears to reduce insulin resistance and improve hyperglycemia in animal model [22].

### **Impaired Insulin Secretion**

Insulin secretion and sensitivity are interrelated. In type 2 diabetes mellitus, insulin secretion initially increases in response to insulin resistance to maintain normal glucose tolerance. Initially, the insulin secretory defect is mild and selectively involves glucose stimulated insulin secretion. The response to other non-glucose secretagogues, such as arginine is preserved. Abnormalities in proinsulin processing is reflected by increased secretion of

proinsulin in type 2 diabetes mellitus. Eventually, the insulin secretory defect progresses to a state of inadequate insulin secretion.



**Fig 1: Insulin resistance**

The reason for the decline in insulin secretory capacity in type 2 diabetes mellitus is unclear. The assumption is that a second genetic effect is superimposed upon insulin resistance—leads to beta cell failure. Beta cell mass is decreased by approximately 50% in individuals with longstanding type 2 diabetes. Islet amyloid fibrillar deposit found in the islets of individuals with longstanding type 2 diabetes mellitus. Whether such islet amyloid deposits are primary or secondary event is unknown. The metabolic environment of diabetes may also negatively impact islet function. For example chronic hyperglycemia paradoxically impairs islet function [glucose toxicity] and leads to worsening of hyperglycemia. Improvement in glycaemic control is often associated with improved islet function. In addition, elevation of free fatty acid levels [lipotoxicity] and dietary fat Amy also worsen islet function [23].

### **Increased Hepatic Glucose and Lipid Production**

In type 2 diabetes mellitus, insulin resistance in the liver reflects the failure of hyperinsulinemia to suppress gluconeogenesis, which results in fasting hyperglycemia and decreased glycogen storage by the liver in the

postprandial state. Increased hepatic glucose production occurs early in the course of diabetes, though likely after the onset of insulin secretory abnormalities and insulin resistance in skeletal muscles.

As a result of insulin resistance in adipose tissue, lipolysis and free fatty acid flux from adipocytes are increased, leading to increased lipid [very low density lipoprotein [VLDL, triglyceride] synthesis in hepatocytes. This lipid storage of steatosis in the liver may lead to nonalcoholic liver disease and abnormal liver function tests. This is also responsible for the dyslipidemia found in type 2 diabetes mellitus [elevated triglycerides, reduced high density lipoprotein [HDL] and increased small dense low density lipoprotein [LDL] particles].

### **Insulin Resistance Syndromes**

The insulin resistance condition comprises a spectrum of disorders, with hyperglycemia representing one of the most readily diagnosed features. The metabolic syndrome, the insulin resistance syndrome, or syndrome X are the terms used to describe a constellation of metabolic derangements that includes insulin resistance, hypertension, dyslipidemia (decreased HDL and elevated triglycerides), central or visceral obesity, type 2 diabetes or IGT/IGF, and accelerated cardio-vascular disease.

Mutations in the insulin receptor that interfere with binding or signal transduction are a cause of insulin resistance. Acanthosis Nigricans and signs hyperandrogenism (hirsutism, acne and oligomenorrhea in women) are also common physical features. Two distinct syndromes of severe insulin resistance have been described in adults:

- 1) Type A, which affects young women and is characterized by severe hyperinsulinemia, obesity and features of hyperandrogenism
- 2) Type B, which affects middle-aged women and is characterized by severe hyperinsulinemia, obesity, and features of hyperandrogenism, and autoimmune disorders

Individuals with the type A insulin resistance syndrome have an undefined defect in the insulin-signaling pathway; individuals with the type B insulin resistance syndrome have antibodies may block insulin binding or may stimulate the insulin receptor, leading to intermittent hypoglycemia <sup>[22]</sup>.

Polycystic ovary syndrome (PCOS) is a common disorder affects premenopausal women and is characterized by chronic anovulation and hyperandrogenism. Insulin resistance is seen in a significant subset of women with PCOS, and the disorder substantially increases the risk for type 2 diabetes mellitus, independent of the effects of obesity.

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**Chapter - 9**  
**Foundations of Data Base and Mapping to Data  
Warehouse**

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# Chapter - 9

## Foundations of Data Base and Mapping to Data Warehouse

Dr. Reena Hooda

### Abstract

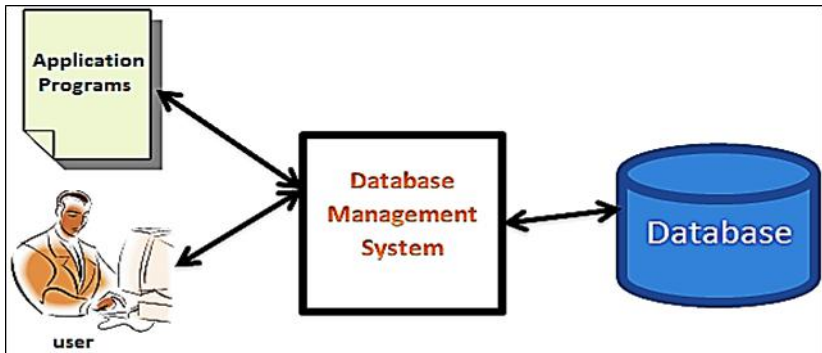
Data is major concern for a business or an organization to take knowledge based actionable decisions. All data is stored in databases with predefined formats & constraints to validate the data integrity and consistency. Data is increasing rapidly in terms of size, structure and nature of change. Therefore, it is obligatory to map the dispersed databases to data warehouse that is single large repository of heterogenous data. Before mapping, understanding the databases and data warehouse paradigm can support in data handling systematically. The present chapter elaborates the notion of databases, ACID Properties, database management system, different types of database, mapping of database to data warehouse, star schema and materialization significance.

**Keywords:** Database, data warehouse, star schema, materialization, database management system

### Introduction to Database and Database Management System

Database is grouping of similar kind of data at one place; all entities of same type i.e. share common attributes are gathered in single repository called database that contain one or more tables depending upon the requirements of user or the size of organization. Database is a well-structured, systematized organization of collected data, stored in a system so that it can be accessed easily when required, can be manipulated, modified and managed through database management system. In simple terms, it is a collection of data that is well ordered and manageable. It is a set of data items which can be accessed easily and can be updated as required. Database is subject oriented it means it only stores the related data, for instance if there is student database, it contain only the student related information. Data can be anything that can be stored in electronic form, it can be a raw data, facts, files, figures, text, media, images, pdfs, audio, video, images and CSV type files etc., all are considered as data. Database management system

act as mediator between database and user, user or other applications accessed database through data base management system which provide an interface between these as shown in Figure 1 [3, 4].



**Fig 1:** Shows Interface between User & Applications and Database

Database management system is a software or a set of system programs that are written specifically for the purpose of managing database and enable the user to query the database, extract data, load data, modify or update data and draw results. It is the system software through which data tables are created in database, extracted, deleted, renamed, copied, and transformed while maintaining the accuracy & consistency in data [1] using ACID properties. ACID properties of a database specified that a transaction is atomic; maintaining consistent state of database before and after transaction is fired or carried out. I stands for isolation means no transaction should effect the other transaction while executing simultaneously. Transactions must be independent of each other. Durability specifies that the data must stay safe, consistent and durable i.e. data remain unchanged for a period of time so that can retain its faith. Data must be reliable, even if the system fails, data cannot be lost at all. Even if it is partially modified, it can be resumed back either in previous state or in the current state along with the information about data modified [4].

Elements of database management system [1] are:

- **Databases Engine:** It helps in manipulating data like create, add, delete, update, rename, and commit, rollback; all functions are handled by the engine.
- **Database Schema:** It defines the logical structure of database i.e. the tabular form in which data is stored in database or defined that how the data is laid down.

- Data itself that to be stored in Database
- **Database Manager:** Database manager control access to database by defining various privileges, specifying grants. The privileges can be read or write, read & write or read only or write only. Databases manager monitors the databases and database usage.

## Types of Databases on the Basis of Structures

**Relational Database:** It is a database in which data is presented in form of tables. It is most basic, oldest and popular form of databases as well as can be easily comprehensible.

Tables have a name, rows & columns. Table name specify the entity type as set of an entities sharing common attributes for example student is entity type containing 6 records called entity set in Figure 2. Columns are called attributes, data element or the data field; these are used to specify the features of an entity. For example student data table contains the roll no. as primary key to uniquely (duplicate values are not allowed) identify the records, other attributes like name, father name, class and marks. Row is drawn horizontally called tuple and column in vertical bars is called an attribute.

Student					
Roll No.	Name	Father name	Class	Marks	Row/Tuple
1	Sonal	Ompraksh	MCA	66	or record
2	Monika	Satya	MCA	76	
3	Sumit	Rampanuj	MCA	68	
4	Poonam	Pankaj kumar	MCA	88	
5	Megha	Rishikant	MCA	56	
6	Gaurav	sundar	MCA	78	

Column

Attribute value

Roll No., Name, Fsther name, Class and marks are the attributes of Student table

**Fig 2:** Shows the Relational Structure of a Student Database

It is not mandatory that all the tables must have a primary key, however primary key is beneficial to maintain accuracy in data and data consistency as well as validate the table while entering data or modify data or delete data. Table must have two or more columns on which other integrity constrains can also be applied. UNIQUE key constraint specify that the column must have unique (different) values, NOT NULL indicate that column value can't be left blank and Primary Key constraint is the combination of UNIQUE key constraint and NOT NULL Constraint.

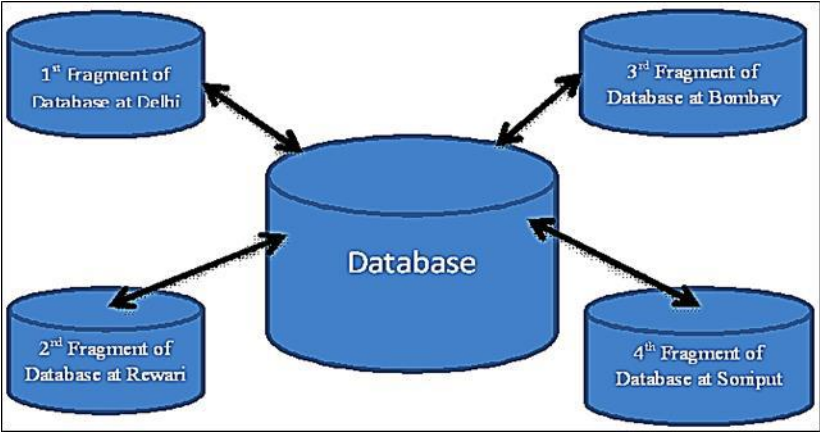
Relational database properties were specified by Edgar F. "Ted" Codd who shaped 12 codd's rules to make sure whether a database is relational

databases or not. Relational databases accessed by the query language for example SQL, a Structured Query language (a non-programming language) that has predefined set of data types, commands and functions [4].

**Distributed Database:** In these types of databases, data is fragmented, stored at different locations that are independent of each other in place of storing data at a centralized location. A single copy of data is maintained or a duplicate copy is stored as a backup for the failure or breakdown of a system or to make the processing fast and handling of a query on local sites avoiding the networking overhead in fetching data from remote sites. Organization of distributed database is shown in Figure 2.

Though database is dispersed and stored at different locations, it provides a single, abstract view to the user. User fired a single query and gets the results without being worried about internal operations that how the query is divided into sub-queries. The results are executed, combined and presented to user in desired format, all task are handled by the database management system [5].

Distributed database can be considered as homogeneous repository if each of the fragmented databases has same operating system, same DBMS version, same hardware and software support otherwise database can be considered as heterogeneous with dissimilarities between operating system, hardware or software [4].



**Fig 2:** Shows Distributed Database

Network connectivity between the distributed systems is mandatory to connect disseminated databases and give access as a single repository to the user.

Problem of security is one of the major issues in distributed database as data may be theft, altered online or communication failure between devices may break down the whole system.

**Cloud Database:** Cloud is the virtual storage space that now a days offered by various telecommunication or mobile companies. Even various free cloud providers are in the market where data can be stored along with the services of security and privacy. Further, storage is independent of the hardware or software so any type of data can be stored without any concern about hardware or hardware purchase. Hardware can be used as a second option as a backup and keeping primary copy on the cloud. Cloud service providers give space up to 50 GB free of cost and can be used for business as well as personal purpose <sup>[9]</sup>. Free cloud service providers are Google Drive, Dropbox, Media fire, pCloud, Mega, OneDrive, Apple iCloud and Amazon cloud, each of these have their own space offering of different sizes in which pCloud is on the top to provide a storage up to 2TB <sup>[9]</sup>. Cloud organization is shown in Figure 3.

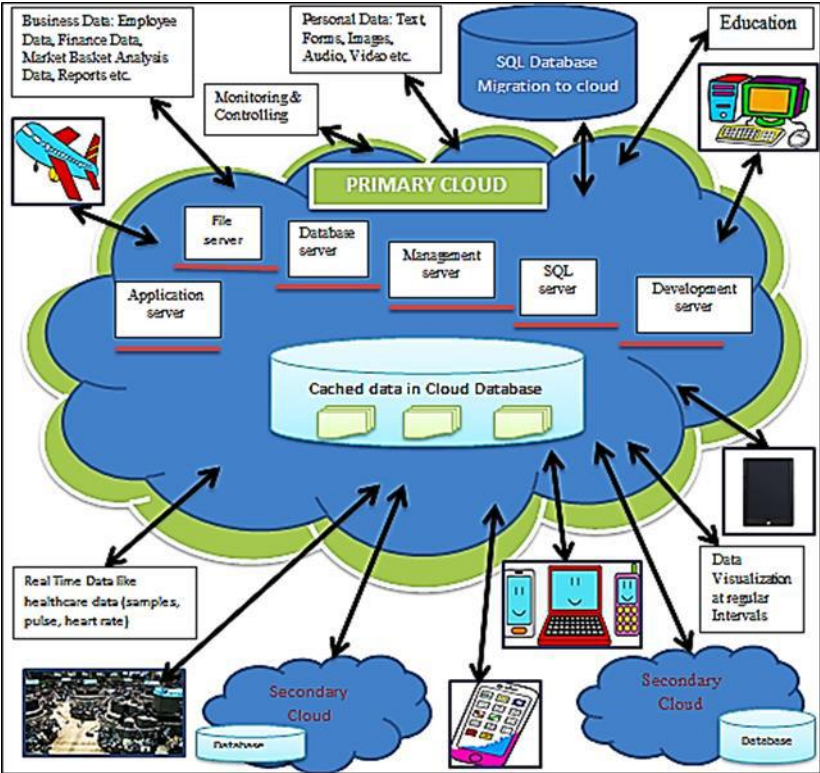


Fig 3: Shows Cloud Database Environment

Cloud is a not a physical location, it's a virtual environment that offers storage services to users in virtual area that is unlimited and can be extended as per the request for the increased space as shown in Figure 3. Single requirement is to create a profile, sign in and download the App or work online to upload the data. Cloud make the file accessible from everywhere, any time with an internet connection and login id further it is secure and safe where the privacy is maintained, data that a user upload & not make public is kept private furthermore authenticated user is only allowed to sign. The login profile or the preferences may be changed by the users [6].

**No SQL Database:** This kind of databases are used to store Big data that is too vast, heterogeneous, raw as well and stored at discrete locations and are independent of the other databases. There is no fixed format; in fact files are in different formats. No SQL stand for not only SQL that means now data in data bases is flexible and not consistent though data is stored still in well-designed schema independent of each other. With different schemas, types, data is collected from its raw form and analyzed as per the application requirements. Data is not in a fixed format or not converted in standardized format. This makes quick access to data in cloud or distributed locations. There are various methods and tools of data analytics which have own format and designing methodologies so raw data is kept and loaded for the further processing. A key item is required for the connection between the data bases and mappings between different data sets stored at different locations. To make relationships between data and facilitation of fast searching along with the merging of data records for quick exploration is possible with NO SQL type databases [7].

With the advent of Internet and Networking, No SQL databases got its existence when typical relational model is not suitable to store & handling massive data with varieties of formats. So relational model is scaled up to No SQL in which data is at different locations in different formats and considered as non-relational databases, designed with web data & applications, dispersed & stored at several host over the network including cloud data [3]. Sometimes data gathered from even unexpected sources, different formats that upshot the big data analytical scenarios.

Therefore the basic ACID properties are not followed in NO SQL databases and no data security is guaranteed. However still, relational data model has its own importance, all traditional and major data is still utilizing relational data model for its data integrity, security, accuracy & consistency features [3].

**Document Databases:** Document databases is used a storage for the semi-structured data along with the descriptions or the details about data. It is used in content or the text mining over web & mobiles to handle data by providing common format for transaction data or data exchange between different applications or devices. Data stored in descriptive form ignoring the relational database rules. Like relational databases, data in document databases also contain field, values however, with range of data types. Primary key is must to identify the records uniquely. Data is stored in one collection (same format) of documents at a single location, other collections at different locations.

**Graph Databases:** Graph database was created by a mathematician named Leohard Euler in 18<sup>th</sup> century. It is another NO SQL type databases that represents data in the form of graph. Graph is collection of nodes and links or edges. Nodes represent the entity and edges are used to show relationships between entities. These databases are best suited to represent social media data & other business data having dynamic schema and relationships. Graph databases are used to find associations between unrelated dispersed data, <sup>[6, 7]</sup> examples are IBM Graph, Titan etc.

**Object Oriented Databases:** Object oriented databases are used to store objects for example multimedia records and these are created using object oriented paradigm, inheritance, concept of classes, persistent and non-persistent object, object oriented notations to represent data.

### **Mapping of Database Schema to Data Warehouse Schema**

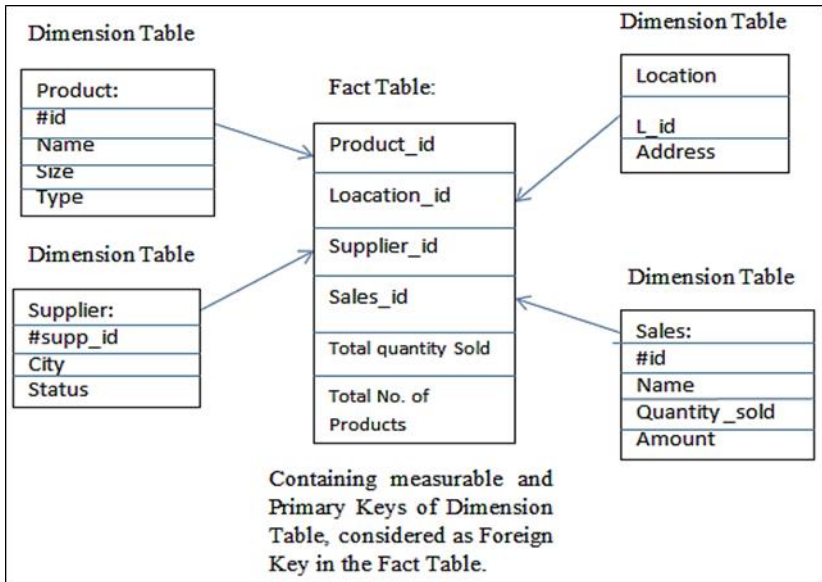
A relational model that contain the table, primary key, other constraints, views, indexes are mapped to star schema of data warehouse. Generally, schema is the designing of the databases or the data warehouse that shows how the entities or objects will be stored in the database or data warehouse. Schema contains all table structure, indexes, alias names or the synonyms and objects to be stored excluding the values. Key constraints which are used to validate the database are also included in the schema <sup>[16]</sup>. Star schema or 3NF schema can be used to map the databases to data warehouse more easily <sup>[16]</sup>. 3NF (third normal form) of normalization states that table should be in 2<sup>nd</sup> normal form that means every non-key (non-primary) attribute/column is fully functionally dependent on primary key. In short there should be no partial dependency. Second condition is that there should not be any transitive dependency in the table that means a non-primary key column/attribute should not depend on the other non-key attribute for example:

#ID	City	Status
-----	------	--------

City is dependent on primary key #Id and Status is dependent on City. Mathematically if City is dependent on ID (Primary Key) and Status dependent on City, that means Status transitively dependent on Id. This should not be allowed in normalization. That means table is not in 3NF. Every non-key attribute must dependent on only primary key so that there should not be transitive dependency <sup>[17]</sup>. So to reduce the data redundancy & maintain the integrity constraint, normalization split the table in to two or more table resultant in normalized table in 3NF. Integrity maintains the accuracy and consistency to validate the data. Integrity is maintained by referential integrity, UNIQUE key constraint, and PRIMARY key constraint, NOT NULL, FOREIGN key constraint that also applied to data warehouse and can be easily mapped to data warehouse <sup>[18]</sup>. For this reason star schema and 3NF are the simplest way to map data into data warehouse. Various constraints are also applied for data cleanness in ETL Process (Preprocessing tasks like Extract, Transform and Load), query optimization, accuracy and validations etc. <sup>[18]</sup> In star schema, Foreign key constraint is used for mapping between dimensional table and fact table as shown in Figure 4 <sup>[17, 18]</sup>.

Dimension tables also called reference tables are used to describe the entities like product, suppliers, locations, sales descriptions etc. as shown in Figure 4. Dimension tables are not dynamic that means descriptions in dimension tables are not change rapidly. Every dimensional table has a primary key that is referenced by the fact table. Further generally, the size of dimension table is smaller than that fact table. Fact table also called detail table describe the transactions, not the entities or the objects that means generally, they contain measurable units which are used to fetch the information from the dimension table. Size of fact table is larger as compared to dimension as they contain the summary data also besides the primary keys of the dimension table. In star schema there is only one fact table for all dimension tables so the Fact table size is bigger. The keys in fact tables must be UNIQUE and NOT NULL so that can refer to primary keys of the dimension table. Dimension table can be further divided in to sub-dimensions for more detailed descriptions through referential integrity <sup>[20]</sup>.



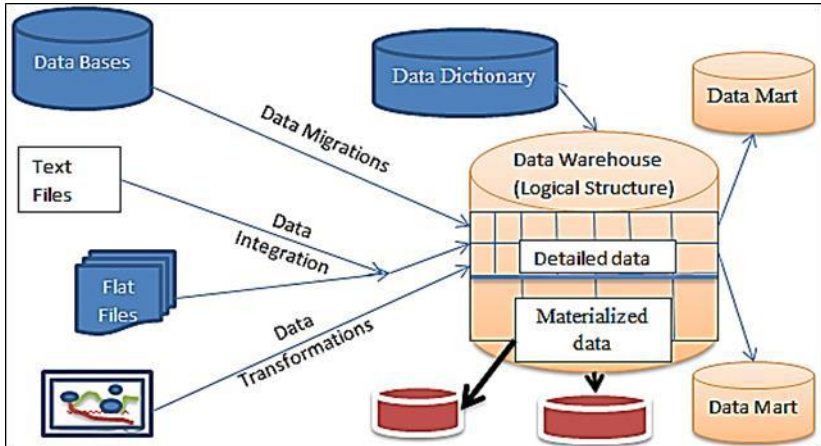


**Fig 4:** Define Star Schema containing Fact Table and Dimension Tables

Data from databases are mapped to data warehouse i.e. data integrated from different sources are migrated from data bases to data warehouse. Therefore, during migration data accuracy or validity may halt, incomplete data may also break the consistency or reliability therefore, transformations or data cleanness are required before transferring and loading data into data warehouse as shown in Figure 5.

**Data Detail and Data Materialization:** Data from various sources are integrated, migrated or transformed before loading in to data warehouse. All this is done under ETL process of data warehouse. After loading data, warehouse is created, it can be created bottom to top by merging different data marts or can be top to bottom by creating small data marts from a single large repository. This single large repository is called detailed data. To make the processing fast, achieving quick results for the queries, the most accessed data is fetched and computed in advance and stored as materialized data as shown in Figure 5. This data is actually precompiled for example monthly sales, yearly purchased, yearly sales, total quarterly expenditure etc. The most asked questions as a query are computed in advance and put in the separate areas of the data warehouse. This materialized data is also known as summary data that can be directly called with materialized views or as sub-queries in the detailed data, the purpose of this summary data is just to save the time of query execution from the detailed repository. Data dictionary is

maintained to describe the data, schemas and other useful information to help in understanding the data warehouse architecture. Materialized views represented the summaries so may be one or two or more materialized view may be there in data warehouse architecture, depending upon the type of query fired for different summaries. Reducing the overhead of time spend in fetching and getting quick results is the main target of materialization <sup>[20]</sup>.



**Fig 5:** Shows the Data from different sources to be loaded into Data Warehouse

### Conclusions and Further Scope

The present chapter described the database notions, significance of database management system and different types of databases that are even enhancing to meet the current market requirements. The chapter presented an overall view of the database, elements of database management system, ACID properties and significance of mapping databases to data warehouse. Further star schema and 3NF forms are described that can be used to map the data into data warehouse effectively. In star schema, relation between fact table and dimension table are elaborated. The chapter also highlighted the requirement of preprocessing and significance of materialization in data warehouse. All this are helpful for the novice users to understand the databases and data warehouse conceptions more clearly. The further scope of the idea is vast that may include the preprocessing methodologies, other data warehouse schemas and management of data warehouse & data mining techniques.

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**Chapter - 10**  
**Phylogeny of Meghalayan *Dioscorea* Species**  
**Assessed by Morphology and ITS Sequences**  
**Analysis**

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# Chapter - 10

## Phylogeny of Meghalayan *Dioscorea* Species Assessed by Morphology and ITS Sequences Analysis

Nilofer Sheikh and Yogendra Kumar

### Abstract

The present study deals with morphological characterization and analysis of the internal transcribed spacer (ITS) region of nuclear ribosomal DNA to investigate the phylogeny of *Dioscorea* species of Meghalaya. Phylogenetic reconstruction was performed by analysis of separate morphometric and molecular data. Two separate topologies baselines were evaluated. *Trichopus zeylanicus*, a species of the genus *Trichopus*, an allied genus of *Dioscorea* from Dioscoreaceae was used as out group to validate the findings. The test confirms the congruence between morphometric and molecular data. In summary, the findings show an approach towards considering both morphological and molecular data for taxonomic evaluation and identification of species. The study also confirms that the analyzed species are descended from a common ancestor. The main goal of this study is to provide a robust tool for showing the phylogeny of *Dioscorea* species utilizing distinct characters.

**Keywords:** Traits of *Dioscorea* spp., cluster analysis, ITS region, phylogeny

### Introduction

*Dioscorea* L., the largest genus of the family Dioscoreaceae included 602 species (Coursey, 1967) with about 70 sections mainly distributed in Southeast Asia, Africa, Central America, South America and other tropical or subtropical regions. The family Dioscoreaceae is considered as the most primitive monocots because of its morphological characteristics that resembles similar to the paleoherb dicots, such as presence of reticulated venation and heart shaped or highly lobed leaves (Dahlgren, 1981). Hence this family is regarded as the pivotal taxon in the evolution of monocotyledonae and occupies a basal position among all extant monocotyledonous plants (Chase *et al.*, 2006; Dahlgren, 1989). *Dioscorea*, being the largest genus of Dioscoreaceae is devoid of proper systematic study due to its great

morphological diversity, dioecy and small flowers. Several workers (Ayensu, 1972; Burkill, 1960; Coursey, 1967; Knuth, 1924) have classified this genus based on seed morphology, floral characters, underground organs and anatomical characters, yet the systematic of the genus is confusing and not completely resolved. Other systematists who studied on the floristic of the genus were Miege (1968), Milne-Redhead (1975), Tellez and Schubert (1994), N'Kounkou (1993), Miege and Sebsebe (1998) and Ding and Gilbert (2000). Despite of the considerable attention made by various systematists towards the taxonomy and phylogeny of the genus yet no proper conclusion was derived for evaluating the natural classification of the genus.

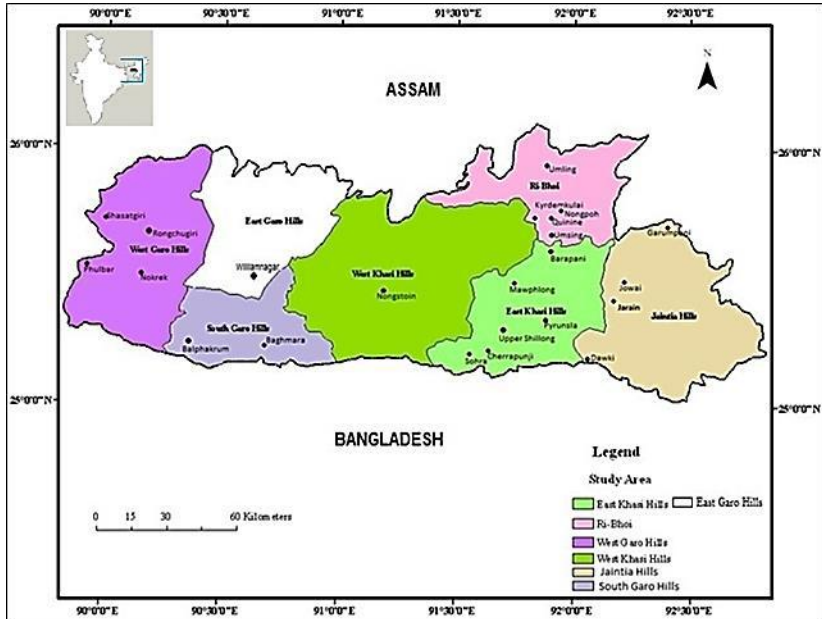
Germplasm characterization based on molecular phylogeny can also contribute to a better understanding of the evolutionary process and genetic divergence of accessions. Over the years, studies have been carried out to examine the phylogenetic relationships within the genera. Studies have reported attempts to clearly demarcate the species of the genus *Dioscorea* using mainly chloroplast DNA (Wilkin *et al.*; 2005; Hsu *et al.*, 2013).

The internal transcribed spacer (ITS) region has been used in phylogenetic studies of many angiosperm families. The two internal transcribed spacer DNA sequences have evolved rapidly and are therefore useful for comparing closely related taxa. In some genera, variations in ITS sequences have proven useful for studies at the species level (Alvarez and Wendel, 2003). The ITS region is also flanked by well-conserved rRNA genes that can be used to differentiate plant species (Calonje *et al.*, 2009). But the ITS regions have not been used to assess the phylogeny of the genus *Dioscorea*. At lower levels, the use of an arbitrary selection of morphological characteristics to delimit genera has yielded conflicting results. More information is needed to address evolutionary questions at the interspecies relationship in subgenus level. Accessing molecular analysis at the species level also contributes to the acquisition of knowledge that can be useful for identification and classification of complex genus like *Dioscorea*. Therefore, in the present study both morphological and molecular dataset were assessed for phylogenetic evaluation.

## Materials and Methods

In this study, plant samples were collected from wild habitat of Meghalaya, North East India (Fig. 1), one of the 8 states of North- Eastern region of India lying between 25°5'N and 26°10'N latitude and 89°47' E and 92 °47'E longitudes with an area of 22,429 sq. km. A total of eight species viz., *D. pentaphylla* L. (NEHU-11946), *D. alata* L. (NEHU-11944), *D.*

*belophylla* (Prain) Haines (NEHU-11950), *D. glabra* Roxb. (NEHU11937), *D. pubera* Bl. (NEHU-11949), *D. oppositifolia* L. (NEHU-11941), *D. lepcharum* Prain ET Burk. (NEHU-11942) and *D. bulbifera* L. (NEHU-11935) were collected from wild habitats of Meghalaya. Voucher specimens were deposited in the Herbarium of Botany Department, North Eastern Hill University, Shillong.



**Fig 1:** Location map of the study area

### Morphological Analysis

A complete and detailed morphological investigation of the species was carried out. For each of the species at least 10 samples (individual plants) were analyzed. About 90 morphological characters were selected for the present study (Table 1). The morphological investigation was done with the help of magnifying glass and binocular stereomicroscope. The ranges of variation present in a character within and between the species were recorded. 54 qualitative and 36 quantitative characters were scored as binary state (present/absent) or unordered multistate characters were selected as Operation Taxonomic Units (OUT), as suggested by Sneath and Sokal (1973). All the data were standardized and then subjected to PCA and cluster analysis using XLSTAT ver. 2013.

**Table 1:** Morphological traits of taxonomic importance

No.	Traits Acronym	Characters/Descriptors	Score Code/Descriptor Code
<b>Qualitative Stem</b>			
1	STD	Twinning direction	1-clockwise (left); 2-
2	STR/A	Stem ridged/angled	anticlockwise (right)
3	STC	Stem colour	1-ridged; 2-angled
4	STA/U	Stem armed/unarmed	1-Green; 2-purplish green; 3-
5	STG/P	Stem glabrous/Pubescent	brownish green 1-armed; 2-unarmed 1-glabrous;2-pubescent
<b>Leaves</b>			
6	POL	Position of leaves	1-alternate; 2-opposite; 3-mixed
7	LT	Leaf type	1-simple; 2-compound
8	NoL	Number of leaflets in	1-mainly 3; 2-mainly5
9	LC	compound leaf	1-yellowish; 2-pale green; 3-
10	LD	Leaf colour	dark green
11	LS	Leaf lobation	1-shallowly lobed; 2-deeply
12	DL	Leaf shape	lobed; 0-no lobe
13	LAN	Distance between lobes	1-ovate; 2-cordate; 3-elliptic
14	LAS	Leaf nerves	oblong
15	LG/P	Leaf apex shape	0-no measurable distance; 1-
16	PC	Leaf glabrous/pubescent	intermediate; 2-very distant
17	PL/LF	Petiole colour	1-5n; 2-7n; 3-9n; 0-others
18	PG/P	Petiole length in correlation to leaf length Petiole glabrous/pubescent	1-obtuse; 2-acute; 3-emarginate; 0-others 1-glabrous; 2-pubescent 1-brownish green; 2-purplish green; 3-green 1-short; 2-median; 3-long 1-glabrous; 2-pubescent
<b>Male Inflorescence</b>			
19	InfS	Inflorescence smell	0-absent; 1-present
20	NoInf/INT	Number of inflorescence	1-One or two; 2-many
21	InfG/P	InfPo per internode	1-glabrous; 2-pubescent
22	MFC	FLBS Inflorescence	1-upward; 2-downward
23	FLBrS	glabrous/pubescent	1-whitish purple; 2-pale green;
24	OTS ITS TG/P	Inflorescence position	3-yellow
25	STA STAMA/P	Male flower colour	1-ovate acuminate; 2-orbicular;
26		Floral bract shape	3-ovate
27		Floral bracteoles shape	1-broadly lanceolate; 2-ovate
28		Outer tepal shape	acuminate; 0-others
29		Inner tepal shape	1-ovate; 2-obovate; 3-
30		Tepal glabrous/pubescent	lanceolate; 0-others
		No of stamen	1-linear oblong; 2-oblong
		staminode absent/present	obovate; 3-ovate 1-glabrous; 2-pubescent 1-3stamens; 2-6 stamens 0-absent; 1-present

<b>Female Inflorescence</b>			
31	FNoInf/IN	Number of inflorescence	1-One or two; 2-many
32	FInfG/P FInfPo	per internode	1-glabrous; 2-pubescent
33	FFC FFLBS	Inflorescence	1-upward; 2-downward
34	FFLBrS FOTS	glabrous/pubescent	1-greenish brown; 2-white; 3-yellowish
35	FITS FSTAM	Inflorescence position	
36	STYLS	Female flower colour	1-ovate acuminate; 2-orbicular;
37		Female Floral bract shape	3-ovate
38		Female Floral bracteoles	1-broadly lanceolate; 2-ovate
39		shape	acuminate
40		Female Outer tepal shape	1-ovate; 2-obovate; 3-lanceolate
		Female Inner tepal shape	1-linear oblong; 2-oblong
		No of staminode	obovate; 3-ovate
		Style shape	1-3nos; 2-6nos
			1-fanshaped; 2-hookshaped
<b>Fruiting</b>			
41	FF FP FS SS	Fruit formation	0-no; 1-yes
42	SWP	Fruit position	1-upward; 2-downward
43		Fruit shape	1-<3cm; 2-<3cm
44		Seed shape	1-elongated; 2-circular
45		Seed wing position	1-circular; 2-apical; 3-basal
<b>Aerial Tubers</b>			
46	BA/P	Absence/presence of	0-absent; 1-present
47	BS	bulbil	0-round; 1-oval; 2-irregular; 3-ellongated
48	BST	Aerial tuber shape	
49	B ab/P	Surface texture	1-smooth; 2-wrinkled; 3-rough
50	BSC	Bulbil abundant/less	1-abundant; 2-less
51	TUS	Bulbil skin colour	1-greyish; 2-light brown; 3-dark brown
52	RTTU	Underground tuber	
53	TUSC	Tuber shape	0-round; 1-cylindrical; 2-oval-
54	TUFC	Number of roots on the tuber surface	oblong; 3 -other
		Skin colour of tuber	1-few; 2-many
		Tuber flesh colour	1-off-white; 2-black; 3-dark brown
			1-off-white; 2-orange; 3-light purple; 0-others
<b>Qualitative</b>			
55	STH	Stem Height Leaves	1-(1-5cm); 2-(6-10cm); 3>10cm
56	LML WML	Length of a mature leaf	1-(1-10cm); 2-(11-20cm); 3->20cm
57	PL	width of mature leaf	1-(1-10cm); 2-(11-20cm); 3->20cm
58		petiole length	1-(1-5cm); 2-(6-10cm); 3->10cm
<b>Male Inflorescences</b>			
59	LMspk MFL	Average length of spike	1-(1-10cm); 2-(11-20cm); 3->20cm
60	MFP	Male flower length	
61	MFPe	Male flower peduncle	1-(2mm); 2->2mm

62	FLBL	length	1-(1.1-2cm); 2-(2.1-3cm); 3-
63	FLBW	Male flower pedicle length	(3.1-4cm); 4-(4.1-5cm)
64	FLBrL	floral bract length	1-(0.6-1.5mm); 2-(1.6-2.5mm);
65	FLBrW	floral bract width	3-(2.6-3.5mm)
66	OTL	floral bracteoles length	1-(1mm); 2->1mm
67	OTW	floral bracteoles width	1-(1mm); 2->1mm
68	ITL	outer tepal length	1-(0.1-1.0mm); 2->1mm
69	ITW	outer tepal width	1-(0.1-1.0mm); 2->1mm
70		inner tepal length	1-(1.5-3mm); 2->3mm
		inner tepal width	1-(0.1-1.0mm); 2->1mm
			1-(0.1-3.1mm); 2->3.1mm
			1-(0.1-1.0mm); 2->1mm
<b>female Inflorescence</b>			
71	LFspk	average length female	1-(1-20cm); 2-(21-40cm)
72	feFL	spike	1-(5.5-6.5mm); 2->6.5mm
73	feFBL	flower length	1-(1.6-2.5mm); 2-(2.6-3.5mm)
74	feFBW	floral bract length	1-(1mm); 2->1mm
75	feFBrL	floral bract width	1-(0.6-1.5mm); 2-(1.6-2.5mm)
76	feFBrW	floral bracteoles length	1-(1mm); 2->1mm
77	feOTL	floral bracteoles width	1-(1.5mm); 2->1.5mm
78	feOTW	outer tepal length	1-(1mm); 2->1mm
79	feITL	outer tepal width	1-(1.5mm); 2->1.5mm
80	feITW	inner tepal length	1-(1mm); 2->1mm
81	STL	inner tepal width	1-(1-5mm); 2-(6-10mm)
82	feSTAL	Style length	1-(0.8mm); 2-(0.9mm)
83	fePL	staminode length	1-(1-5cm); 2-(6-10cm)
84	fePeL	peduncle length	1-(1.1-2mm); 2-(2.1-3mm)
		pedicel length	
<b>Fruiting</b>			
85	FrL	fruit length	1-(1.1-2cm); 2-(2.1-3cm)
86	FrW	fruit width	1-(0.6-1.5cm); 2-(1.6-2.5cm)
87	SL	seed length	1-(0.1-1.2cm); 2->1.2cm
88	SW	seed width	1-(1-10mm); 2->10mm
89	SWL	Seed wing length	1-(2.5-3.5mm); 2->3.5mm
90	SWW	Seed wing width	1-(1-1.5mm); 2->1.5mm

\*cm= centimeter; mm=millimeter.

## Molecular Analysis

Total genomic DNA was isolated from fresh leaves following Doyle and Doyle (1987) method of DNA extraction with the addition of the saturated phenol extraction step prior to ethanol precipitation. Polymerase chain reaction was used to amplify ITS regions. PCR primers were designed using DS GENE version 1.1 software. Sequencing was done utilizing these primers (SITS-F5'-GGAAGGAGAAGTCGTAACAAG-3'; SITS-R5'-GATATGCTTAAGTTCAGCGGG-3'). DNA amplification was performed in Applied Biosystems® Gene Amp® PCR System 9700. Amplified PCR products were pureed and sequence at Bangalore Genei, India and Axygen

Scientific Pvt. Ltd. India. The nucleotide sequences for the ITS regions have been submitted to the GenBank databases ([www.ncbi.nlm.nih.gov](http://www.ncbi.nlm.nih.gov)). Gene bank accessions of Meghalayan *Dioscorea* species viz. *D. oppositifolia* (KX774425); *D. lepcharum* (KX774426); *D. glabra* (KX774427); *D. alata* (KX774428); *D. pentaphylla* (KX774429); *D. bulbifera* (KX774430) *D. pubera* (KX774431); *D. belophylla* (KX774432). Phylogenetic trees of targeted regions were drawn using MEGA ver. 5.1 (Tamura *et al.*, 2011). Maximum Likelihood (ML) methods were used to analyze the aligned sequence data matrix of all the four genes. The distance matrix was estimated following the Kimura 2-parameter model (Kimura, 1980) with a bootstrap analysis of 1000 replication.

### Out Group Selection

*Trichopus zeylanicus* belonging from the genus *Trichopus*, an allied genus of *Dioscorea* from Dioscoreaceae was selected as the out group for the present study. Data for morphometric as well as molecular study for the out group was taken from available literature viz. Caddick *et al.* (1998, 2000, 2002a, 2002b); Huber (1998); Knuth (1924) and Wilkin *et al.* (2005).

### Result and Discussion

The result of cluster analysis based on unweighted pair-group average method produced four main clusters at 0.37 level of similarity (fig. 2). The first cluster (A) represented by the out group *Trichopus zeylanicus*, a species of the genus *Trichopus* of Dioscoreaceae which is also an allied genus of *Dioscorea*. The second cluster (B) is again subdivided into two sub clusters including *D. glabra*, *D. pubera* and *D. lepcharum* in one sub cluster and *D. alata*, *D. belophylla* and *D. oppositifolia* in another sub cluster. Species belonging to cluster (B) were characterized by right twining direction of stem, position of leaves, leaves apex shape, petiole color, male flower color, circular fruit shape and presence of wing all around the seed. The third cluster (C) includes *D. pentaphylla* which is characterized by left twinning direction of stem, alternate position of leaves, elongated fruit shape and presence of wings at the proximal end of the seed. The fourth cluster (D) also consist of a single species i.e. *D. bulbifera* which is characterized by the presence of left twinning direction of stem, alternate position of leaves, whitish purple color of male flower, color of petiole, elongated fruit shape and presence of wings at the proximal end of the seed. The dendrogram obtained from unweighted pair-group average method shows good clustering patterns that reflect the natural relationship among the taxa. Grouping of the species into various sections based on similarity method of cluster analysis correlates with the existing

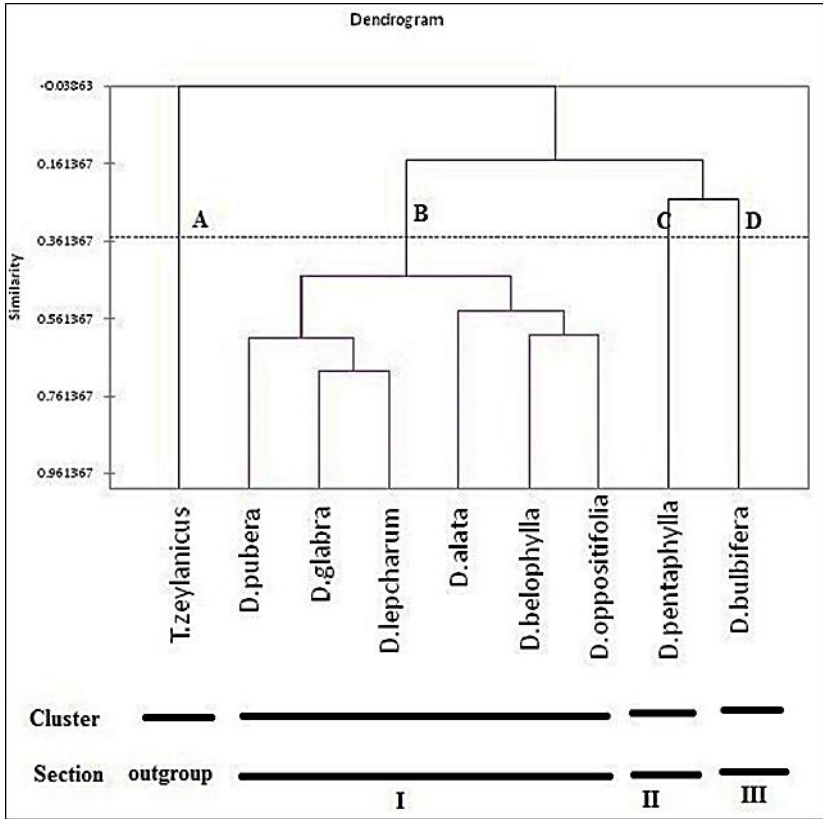
classification of the species of *Dioscorea* at the subgenera level (Knuth, 1924; Burkill, 1960). According to the classification system, the eight taxa which were analyzed in the present study falls under three sections viz. *Eriophyllum* Uline (1897), *Botryomycosis* (Hochstetter) Uline (1897) and *Opsophyton* Uline (1897). Section *Eriophyllum* is represented by species such as *D. alata*, *D. belophylla*, *D. oppositifolia*, *D. glabra*, *D. pubera* and *D. lepcharum* which were grouped together in Section I in unweighted pair-group average method of cluster analysis. Similarly *D. pentaphylla* of section *Botryomycosis* and *D. bulbifera* of section *Opsophyton* were also found to group together in Section II and Section III respectively in cluster analysis based on unweighted pair-group average method.

The sequence analysis of ITS region revealed 566 characters of which 47.97% are of conserved sites, 39.38% are of variable sites and 20.9% is parsimony informative sites. The number of indels estimated is 54 and percentage of GC content was accounted for 49.8%. High percentage of variable sites and parsimony informative sites suggests that this region is rapidly evolving. The phylogeny based on maximum likelihood analysis of ITS sequences reveals that clade 1 of *D. oppositifolia* and *D. lepcharum* possesses a bootstrap value of 70%, clade2 with *D. pentaphylla* and *D. bulbifera* with bootstrap of 99% whereas *D. alata* and *D. glabra* of clade 3 and *D. pubera* and *D. belophylla* of clade4 with a bootstrap value of 97% and 99% respectively (Fig. 3). Gandawal *et al.* (2015) analyzed on few *Dioscorea* species based on ITS2 sequence data revealed that *D. oppositifolia* and *D. belophylla* under the Cluster-I but from our present analysis based on similar sequence revealed that *D. belophylla* form group with *D. pubera* in one clade and *D. oppositifolia* form group with *D. lepcharum* in another clade. Moreover in the present molecular analysis *D. pentaphylla* and *D. bulbifera* was placed in one group. But in Gandawal *et al.* (2015) experiment similar case was not observed instead *D. hispida* and *D. bulbifera* were placed closer to each other under Cluster-I and *D. pentaphylla* was out grouped.

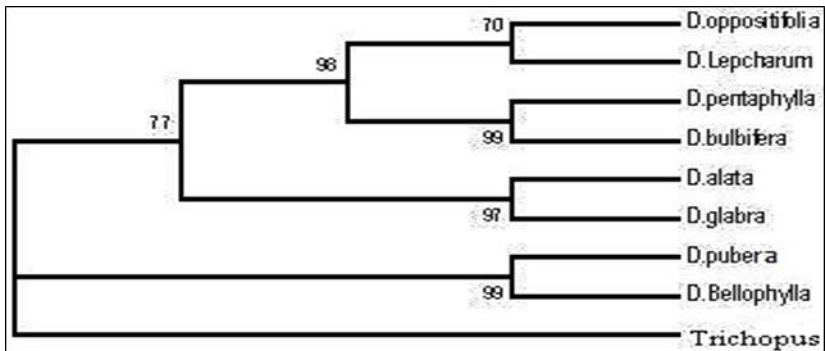
The present study showed, *D. bulbifera* and *D. pentaphylla* was grouped together in one clade in the Maximum likelihood tree analysis based on ITS sequences and also in unweighted pair group hierarchy cluster analysis based on morphological characters analysis. Though *D. bulbifera* and *D. pentaphylla* belongs to separate sections of the genus *Dioscorea* were grouped together. Morphologically, *D. bulbifera* and *D. pentaphylla* differ in leaf type such as *D. bulbifera* has simple, cordate leaves and *D. pentaphylla* has compound, lanceolate leaflets. But both the species has left twinning habit and seed morphology is also same that is wing is attached to the seed at only one side.



Hence, the present work provides a better integration of morphological data and ITS sequences to understand the relationship within subgenus *Dioscorea*.



**Fig 2:** Dendrogram based on Unweight pair group average method for 8 species of *Dioscorea* based on morphological data



**Fig 3:** Maximum likelihood tree constructed from ITS sequences. Value at the node indicates bootstrap value

## Conclusion

The study shows that the molecular phylogenetic analysis of ITS region were congruent with the morphology-based phylogenetic analysis. Hence from the present study we can conclude that not only molecular analysis but also detailed morphological analysis could be used as a better tool for phylogenetic study.

## Acknowledgement

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**Chapter - 11**  
**Jallianwala Bagh Massacre & Rowlatt Act: A  
Historical Understanding of the Colonial Mindset**

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# Chapter - 11

## Jallianwala Bagh Massacre & Rowlatt Act: A Historical Understanding of the Colonial Mindset

Dr. Surinder Kaur

### Abstract

The Jallianwala Bagh massacre of 1919 is considered one of the most important and contentious actions of British rule in India. Coinciding with extensive disturbances in Ireland and in Egypt, the Jallianwala Bagh massacre is usually examined in terms of the radically transformed political landscape of the British Empire following the First World War. The Massacre is thus commonly seen to mark the beginning of the process that came to its conclusion with Indian independence in 1947. This annoyance among people about the massacre gave a authoritative impetus to the path of Indian national movement and sharpen the psyche of national leaders in particular and served as the basis of encouragement to freedom fighters in general devoted to the cause of freedom of the country. Mahatma Gandhi, the co-operator to the British government during First World War, became non co-operator, the fuming incident threw up Mahatma Gandhi as a authoritative leader and the Congress, under the unquestioned commandership of a changed Gandhi, accentuated the movement for national independence. The Satyagraha of Mahatma Gandhi was drastically changed suddenly by the chaotic event held at Jallianwala Bagh at Amritsar in Punjab. The paper would map out the trajectories of the implementation of Rowlatt act and the Jallianwala Bagh incident against the framework of colonial rule. The nationalist historiography points towards a tacit understanding between the implementation of the Act and in its aftermath the resultant bloodbath. There has been a wide ranging debate in media and academia about the true intent of General Dyer actions bordering on from an error of judgment to a barbaric premeditated plan. The paper would borrow from different archival sources to establish the major contours of massacre within the narrative of freedom struggle. The major thrust of this paper would be to chronicle the responses of the national leaders like Gandhi and other prominent leaders.

**Keywords:** Rowlatt act, Jallianwala Bagh, general dyer, colonial politics, Udham Singh, Mahatma Gandhi

## **Introduction**

The Jallianwala Bagh massacre took place in Amritsar a century ago, on 13 April 1919. It is a blemish on the British government as it was carried out by the British army in British Indian State. Jallianwala Bagh's significance lies not in the figures killed but in what paved the way and in what follow. The Anarchical and Revolutionary Crimes Act of 1919, better known as the Rowlatt Act, came into force a month before the massacre in Jallianwala Bagh. It shocked most Indians who had expected to be rewarded, not penalized, for voluntarily fighting together with the British in the First World War. The massacre was a turning point in Indo-British relations and inspired the people to provide a more unrelenting fight for freedom.

In 1919, the world scenario had been changing. Many new nations sprang up with the collapse of the Ottoman and Austro-Hungarian empires. The outbreak of world war had given rise to the spirit of nationalism all over the world. Indian nationalism also moved ahead with great pace during the war and expressed itself through various movements. The Ghadar movement, the Pan-Islamic movement, and armed rebellion, etc. But all these movements proved futile due to unsuitable time which was not ripe for them. Later the Home rule movement (peaceful mass movement) started by Lokmanya Tilak and Annie Besant forced the British Government to make August Declaration of 1917 making promises for political consciousness etc. With this declaration, Indians realized the strength of peaceful mass movement.

Since the beginning of the World War I, there had been increasing resentment and civil unrest throughout the country especially in Punjab and West Bengal due to the terrible repercussions of the war like-inflation, and heavy taxation. Even then, numerous Indian national leaders besides Mahatma Gandhi helped the British during the world war, taking them as friends of India and hoping that the incredible assistance given by India to them in its hour of hazard would be correctly rewarded by the British and after the termination of war, Home Rule would be provided to Indians. So Indians had made huge contribution in men, material, blood and money.

British Government had been watching the tide of growing Indian Nationalism with great concern. They could have struck terror in the mind of people even during the war but in the face of German's menace, they tactfully allured the nationalists infrequently by promises. After the war, the



circumstances had changed. The danger of German moved out and they were now not ready to carry on with the policy of conciliation. The British now determined to demolish the nationwide arousing and awakening among Indians before it became powerful enough to move them out of country. At this juncture, all hopes of Indians were dashed to ground and British announced the dishonest Montagu-Chelmsford “reforms” and imposed the punitive Rowlatt Act.

The Rowlatt Act was a legislative act that allowed certain political cases to be tried without the presence of a jury and permitted internment of suspects without any trial. The Rowlatt Act also known as the “Black Act” or “Black Bill” was strongly opposed by the people of India. This is the time when Mahatma Gandhi came to limelight as a revolutionary. The Act resulted in furious protests throughout the country. Freedom of the press and expressions were also prohibited. Indians realized that British had enacted new acts just in order to give themselves greater power over the people of India. When they comprehended that there was no chance of getting self-government from the British, they started opposing the British Government tooth and nail. The situation in Punjab became most worst because people had been suffering a lot as hundreds of them were put behind bars for minor mistakes or crime under this act.

Mahatma Gandhi showed his resentment over the passing of Rowlatt Act by launching *Satyagraha* movement (a time of fasting and suspension of work). Other Indian leaders also expressed their discontentment by joining movement as they all believed that British could not punish a group of people for a single crime. The Rowlatt Act infused the National leaders and common people of India with a large amount of anger. This however did not greatly affect the British as they were still able to keep control over the people. The *Satyagraha* movement was quickly called to an end by Gandhi when riots and violence broke out which went against *Satyagraha*, one of Gandhi’s major principles.

The *Satyagraha* movement was started on an All- India level, but it found its current on the soil of the Punjab. In Punjab, people rallied peacefully at various places in March and April 1919, to protest the Rowlatt Acts. They showed their anger and their dissatisfaction at the British betrayal through empty streets and shuttered shops. This was a form of Gandhian non-violent non-cooperation movement. But to curb down their movement, Sir Michael O’Dwyer- Lieutenant Governor of Punjab strategically provoked people of Punjab to commit violence somehow, and then make that a pretext to pounce upon them and crush them through force.

In Amritsar, various political rallies and anti-British activities were going on. In an opened peaceful agitation against the issue relating to the Railway Platform Tickets, British opened fire on peaceful protestors, and killed many people and arrested the two nationalist leaders of Punjab-Dr. Saifudin Kitchlew and Dr. Satyapal from Amritsar. Meanwhile the issue of Rowlatt Act further enthused the people. As a result, mass meetings were held and riots broke out and people held demonstration at the abode of Deputy Commissioner of Amritsar to insist the release of their cherished leaders of the Indian Independence movement. There were aggressive protests in Amritsar which led to the burning of the Town Hall and Railway station. Protestors had disrupted telegraphs and communication system. In the riots five Englishmen (European government officials) as well as some civilians were killed. Angry mob didn't spare to thrash even a woman missionary. However, she was rescued, and carried to safety, by some Indians.

Owing to all these events, there was stillness in the city of Amritsar whereas in other parts of Punjab, there prevailed unrest and chaos. The British quickly appointed Brigadier General Reginald Dyer with large number of troops to restore peace in Punjab. Dyer, enjoyed the liberal support of the lieutenant-governor of Punjab, who gave General Dyer full liberty and power to deal with Indian people. First of all General Dyer curtailed the Civil liberties of the people by prohibiting public gatherings and assembly of more people together.

On the day of Baisakhi i.e. 13th April, 1919, General Dyer issued a public statement in Amritsar under which people can't leave the city without a pass, and they can't organize and take part in any processions or demonstrations. He even prohibited a group of 4 or more people to meet publicly. In the noontime, Dyer received secret information about the get-together of people at Jallianwala Bagh. By twelve noon, thousands of people including devotees of Golden temple, and traders, farmers or merchants visited Amritsar to attend the meeting and to enjoy the Baisakhi festival. Jallianwala Bagh was an enclosed walled public garden stretched over an area of 7 acres with wall covering of all its sides and it is a popular spot for public events in Amritsar. It is equipped with thin doorways, most of which were locked. It is situated very near to Golden temple. Judging the number of people presented there and the undisclosed get-together that was going to take place, General Dyer decided to go there with armed British Indian troops to punish people as they had disobeyed his orders.

Some courageous people of Punjab in fact had gone to Jallianwala Bagh to attend the meeting, without knowing the probable consequences. Actually the meeting was held in the Jallianwala Bagh as a part of the *Satyagraha* movement and in open insolence of Dyer's proclamation made at Amritsar during the day, prohibiting assembly of more than four persons. Majority of the people were well aware of the possible result of holding a meeting in defiance of military orders though not to that acute level to which General Dyer had gone. In their earlier rallies, people had already tasted the shooting by troops. The truth is that they were not ready to give up themselves to the official orders. A spirit of disobedience of foreign power had overtaken them. They had become bold, fearless and courageous. They were actually *Satyagrahi* soldiers, whose very presence in the Jallianwala Bagh seemed to be an open challenge to the British power in India.

But some people like pilgrims, traders and farmers etc. living outside Amritsar were not aware about this public statement of General Dyer. Every year many Sikh followers used to visit Golden temple on *Baisakhi* festival to pay obeisance to their Guru. This year on 13th April, 1919, their destiny was very terrible. Uninformed of the statement, around 10,000 to 15,000 people from far-flung districts had assembled in the city on the same day. While going to Golden Temple, as usual they took halt at Jallianwala Bagh to rest for a while. They all were unarmed civilians.

On the other side, General Dyer had reached there with his armed troops to spread terror in the mind of people. The main opening and exits were shielded by his troops with armoured cars carrying machine guns and explosives. At first, General Dyer instructed his troops to surround the brick walls of garden and then without ordering the assembled unarmed civilians to go away, General Dyer ordered his troops to fire. Firing was opened from some 150 yards away on the unaware crowd. The horde of thousands of unarmed men, women and children who had assembled serenely in a cramped space, started blaring and running in panic alongside the closed gate. Many wished to jump into the well built in the site of Jallianwala Bagh. The troops started shooting on the most thickly congested spot where they could harm the highest number of people. This atrocious act of violent behavior resulted in numerous killings. The firing went about 10 minutes, and it only stopped when the bullets provisions were nearly exhausted. When it was over and the deceased and injured lay in pools of blood, grousing on the ground, General Dyer forbade his soldiers to provide any help to the wounded. He ordered all Indians to refrain themselves to enter the roads of Amritsar for 24 hours, avoiding

family members or friends from bringing even a cup of water to the injured, who were crying in pain on the ground calling for aid. He made no effort to provide medical aid to the wounded, saying it was not his duty and left the sight of desolation.

How many people killed due to the firing had been a cynical issue till now. According to British official report, the troops had used 1,650 rounds, killed around 379 people but the Indian figures are considerably higher) and wounded 1,137. Hardly a bullet was wasted, General Dyer noted down with contentment.

I fired and continued to fire until the crowd dispersed and I consider this is the least amount of firing which would produce the necessary moral, and widespread effect it was my duty to produce, if I was to justify my action. If more troops had been at hand the casualties would be greater in proportion. It was no longer a question of merely dispersing the crowd; but one of producing a sufficient moral effect, from a military point of view, not only on those who were present but more specially throughout the Punjab. There could be no question of undue severity.

This is how Dyer explained the reasoning behind his order to shoot at straight on a large crowd of Indian civilians gathered in Jallianwala Bagh, Amritsar.

The natural reaction of the massacre amongst the British bureaucrats was obviously that of jubilation and triumph. General Dyre had not acted on his own, but had just played the part assigned to him by the British Bureaucracy which had plotted the design. On receiving the first report on the 14<sup>th</sup> April of what Dyre had done in Amritsar his military superior, General Beynon, immediately got into touch with Michael O' Dwyer on telephone and soon sent a congratulatory message to Dyre by aeroplane: Your action correct and Lt. Governor approves. Both Michael O' Dwyer and General Beynon were expecting good news. For more than a year, The Government of Indian, Army headquarter, and the secretary of state for India supported Dyer' action In fact they strained every nerve to justify the action in the great debate of September 1919 session of the Imperial Council at Shimla.

The massacre was followed by the announcement of martial law in those provinces of India where the people had responded freely to the call of Mahatma Gandhi. As the governor of the Punjab province supported the massacre at Amritsar and, on April 15, placed the entire province under the martial law. Sensing the gravity of situation, British Government made all

efforts not to spread the news of this bloody massacre beyond Amritsar. But all their efforts proved futile, the news of cruel act of General Dyer reached silently throughout the subcontinent. There was feeling of anguish and pain all over India. National leaders started questioning the reasons behind the cruel act of General Dyer. The Bengali poet and Nobel laureate Rabindranath Tagore abandoned the knighthood that he had received in 1915. Gandhi was firstly undecided to act, but he soon began organizing his first nonviolent protest-the non cooperation movement. Resentment against Government went on mounting to such an extent that the British Government changed its official stand to the great outcry against the bloody massacre and had to formulate commission to enquire about Jallianwala Bagh massacre. The Indian National Congress set up an Enquiry committee to report about the massacre.

Indian affairs had never drawn much interest in Parliament, but, quite unusually, the Jallianwala Bagh atrocity and its aftermath were debated vigorously both in the Commons and among the Lords. Viceroy Chelmsford, however, considered the act as “an error of judgment,” and, when Secretary of State, Edwin Montagu came to know about butchery, he appointed a commission of inquiry, headed by Lord Hunter. The Hunter Commission found General Dyer guilty only of an error in judgment, exercising excessive force, and having a somewhat mistaken conception of his duties. The Hunter Commission in 1920 censured Dyer for his actions and ordered him to resign from the military. General Dyer was held responsible for wrong doing by the British Government which he had sought to serve on 13th April 1919, and he had to fight a single-handed battle before the Army council in England. The latter further condemned him for committing an “error of judgement”.

Though Dyer was then relieved of his command, he returned as a hero to many in Britain, especially conservatives and in Parliament members of the House of Lords. Renowned poet and novelist Rudyard Kipling winner of the Nobel Prize for Literature called slayer of Jallianwala Bagh, General Dyer, as “the man who saved India”. For years, it has been supposed that he also started a profit fund for him. A British right-wing conservative newspaper “Morning Post”, also stood in favour of act of General Dyer, and raised a large sum of "26,000 pounds" for the benefit of General Dyer. The ‘Morning Post’ had supported Dyer’s deed on the ground that he “did his duty, not considering the cost and consequences”. On General Dyer’s judgment, and his judgment alone, the future of the Punjab, and it may well be of India, was placed, and fearlessly he did his duty.

The Jallianwala Bagh butchery was a conscientious, purposeful nuisance of colonial will. It represented the most terrible face of British colonialism.

The massacre made Indians out of millions of people to think consciously of their political identity. It turned millions of moderate Indians from patient and loyal supporters of the British Government into nationalists who would never again place trust in British “fair play.” Many loyalists and constitutionalists turned into nationalists and protesters. The intolerable atrocities in the Punjab transformed Mahatma Gandhi too from a “staunch loyalist” and “co-operator” to an “uncompromising disaffection” who was convinced that British rule had made “India more helpless than it ever was before, politically and economically.” The massacre left a permanent scar on Indo-British relations and was the prelude to Mahatma Gandhi’s full commitment to the cause of Indian nationalism and independence from Britain. It marked the beginning of the process that came to its conclusion with Indian independence in 1947.

The Jallianwala Bagh tragedy changed the course of British Indian history. It served as a biggest source of warmth and inspiration to freedom fighters devoted to the cause of Indian Independence for the next 28 years when India attained freedom from foreign yoke. It quickened the pace of freedom struggle for independence. Jallianwala Bagh made Mahatma Gandhi as a powerful leader and Congress under leadership of new Gandhi, accentuated the movement for national freedom. All the nationalist leaders and forces gathered around the flag of Congress and struggle for India’s emancipation from foreign rule was now carried forward with grim determination and downright earnestness. The boom of the guns which fired at the crowd in the park proved to be rumbling of earthquake which shook the grand structure of British kingdom in India to its foundations. All national leaders intensified their demands for compensation to the families of victims of bloody Jallianwala Bagh massacre from British Government.

After many months of fighting for justice, the families of the victims of the Jallianwala Bagh massacre were given 500 rupees each in compensation by the British government-at the prevailing exchange rate, approximately £37 (or some £1,450 in today’s money) for each human life.

But all these compensations could not fill the internal wound of the people, bitterness still wedged in the minds of people. Sardar Udham Singh who had witnessed the events in Jallianwala Bagh and had himself been wounded, shot and killed Michael O’Dwyer whom he considered the master mind behind that bloody massacre on 13 March 1940, at Caxton Hall in London.

Some, such as the nationalist newspaper *Amrita Bazar Patrika* made statements supporting the killing. The common people and revolutionaries

glorified the act of Udham Singh. Much of the press globally recalled the story of Jallianwala Bagh, and assumed O'Dwyer to have been accountable for the massacre. Udham Singh had been called as "fighter for freedom" and his deed was referred to in *The Times* newspaper as "an expression of the confined ferocity of the subjugated Indian People". After that an American reporter and historian William L. Shirer wrote the next day, "Most of the other Indians I know [other than Gandhi] will feel this is divine retribution. Michael O'Dwyer bore a share of responsibility in the 1919 Amritsar massacre, in which Gen. Dyer shot 1,500 Indians in cold blood. When I was at Amritsar eleven years after [the massacre] in 1930, the bitterness still stuck in the people there" .. Sardar Udham Singh was caught and hanged for the murder on 31 July 1940.

In retrospect, we can say that it's a British imperialism and widespread national ideas amongst people of Punjab were the main reasons behind the Jallianwala Bagh Tragedy. It was the entire imperial system behind this naked barbarity. General Dyer performed his duty with thoroughness according to the directions given by his superiors. The truth is that the great massacre was the result of an inevitable clash between completely opposed forces i.e., those of imperialism and nationalism. Circumstances at Amritsar had been heading steadily towards a disaster since March 1919. People began defying authority openly in the beginning of April. The masses had become bold and fearless, whereas a foreign rulers, in their passion to preserve their realm unharmed, were strong-minded to punch fear in the people's mind. This clash resulted in Jallianwala Bagh massacre. It was the audacious and daring stand of the people of Amritsar against the awful might of the British on that fateful day, people all over India got inspired and became ready to sacrifice their life for the freedom of country. And then with united efforts, people of India would be able to gain freedom within a generation afterwards.

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**Chapter - 12**  
**संस्कृतब्याकरणे सिद्धान्तकौमुद्याः बैशिष्ट्यम**

**Author**

**डॉ बिश्बेशबर पाणिग्रह**

संस्कृतबिभागाध्यक्षः प्रभातकुमारमहाबिद्यालयः, काँथिः, पूर्वमेदिनीपुरम

पश्चिम बंगाल, भारत



## Chapter - 12

### संस्कृतव्याकरणे सिद्धान्तकौमुद्याः बैशिष्ट्यम्

डॉ बिशवेश्वर पाणिगृही

#### ब्रह्मण

आरभ्य अद्ययावत् समुपलब्धस्य व्याकरणशास्त्रस्य पठनपाठनकर्मस्य सुब्यबस्था बैज्ञानिकप्रकारश्च यथा पाणिनीयव्याकरणशास्त्रेऽनुमीयते बिद्वद्भिर्नतथाऽन्येषु व्याकरणेषु। अतः बिबिधव्याकरणशास्त्रकर्तृमहर्षिमणिमालायां मध्यमः सुमेरूरिब महर्षिः पाणिनिरेव चिराय जागर्ति। तमधिकृत्य पाक् पाणिनिः पश्चात् पाणिनिरिति ऐतिह्यं द्विधा बिभवतम्। अनेन बयं व्याकरणशास्त्रपथसुखेन प्रशस्तीकरणे समर्थाः। महामतिः पाणिनिः शब्दागमनिधिं जगदगुरुं साम्बं शिबं प्रसाद्य व्याकरणज्ञानं लेभे इत्यनुशूयते, अनुशूयते च तस्य अष्टाध्यायी, यस्याः रचनायाः बैज्ञानिकं निरूपणमद्याप्यखिलं जगन्मोहयति। अनेन महर्षिणा स्वपागबर्तिनां समेषामपि बिदुषां रचनाः परिशील्य समग्रेषु देशेषु परिभ्रम्य तत्तदेशबिदेशेषु प्रचलितशब्दानां साधुत्वप्रतिपादनाय स्वकीया रचना बिहितेति तस्य परिशीलनेन स्पष्टं ज्ञायते। पाणिनिना अष्टाध्यायीग्रन्थः बिरचितः। सूत्रात्मकेऽस्मिन् ग्रन्थे अष्टौ अध्यायाः बर्तन्ते। अतएव कृतिरियंमष्टाध्यायी अष्टकमिति वा कथ्यते। प्रत्यध्यायं चत्वारः पादाः। प्रतिपादं च बहुनि सूत्राणि बर्तन्ते। संकलनेन सूत्रसंख्या ३९९६ अथवा ३९९५ भवति। तथा च उवतम् -

त्रीणिसूत्रसहस्राणि तथा नबशतानि च ।

षण्णवति च सूत्राणां पाणिनिः कृतवान् स्वयम् ॥

अपि च चतुः सहस्रीसूत्राणां पञ्चसूत्रबिबर्जिता ।

अष्टाध्यायी पाणिनीया सूत्रैमहिश्वरैः सह ॥

ग्रन्थेऽस्मिन् बिशालतां क्मबद्धतां सूक्ष्मेक्षिकां च दृष्ट्वा पौरस्तैः पाश्चात्यैश्च बिद्वद्भिरस्य गौरवं मुहुर्मुहुर्गीतम्। अस्य ग्रन्थस्य प्रणयनादनन्तरं सूत्रजगति महत् परिबर्तनं जातम्। पाणिनिना अत्यन्त सरलया मनोरमया च शैल्या सूत्राणां रचना कृतास्ति। अथापि अस्य निर्माणं

दूरुहमस्ति। अनेन पूर्वपिक्षया शुद्धप्राञ्जलसूत्राणामुद्भाबना कृता। पाणिनिना सूत्राणां लघुकरणं कृतम्। सूत्राणां लघुकरणे पाणिनेः प्रत्याहारसूत्रैः महत् साहाय्यमबाप्तम्। अनुबन्धानां साहाय्येन अच्-हल् प्रभृति प्रत्याहारनिर्माणे महत् कौशलं प्रदर्शितम्। गणानां साहाय्येन पाणिनिना व्याकरणस्य संक्षिप्तकरणे सफलता जाता। पाणिनेः टि-घु-घ-भेत्यादयः पारिभाषिकशब्दाः महत् साहाय्यं कृतवन्तः। पाणिनिना अष्टाध्यायां विशिष्टः सूत्रकर्मोऽनुसृतः। लाघवार्थं पाणिनिः पूर्वसूत्रवर्तिनां शब्दानां उत्तरत्राबृतिं नेच्छति। उत्तरवर्तिसूत्रेष्वदृष्टाः शब्दाः बावयपरिपूरणाय पूर्वसूत्रेभ्योऽनुवर्त्तनीया भवन्ति। तथा चावश्यकानां शब्दानामावृत्तिपरिहाराय ससूत्रेण पुष्पाण्येव अनुवृत्त्या सूत्राण्येकत्र बध्नाति। तानीमानि सूत्राणि भिन्नभिन्नलक्ष्यानुगाह्यामपि एकस्मिन् प्रकरणे पठितव्यानि भवन्ति। पुनः पुनस्तेषां शब्दानामावृत्तिपरिहाराय प्रकरणानुसारेण सूत्राणां विभागः समाश्रयणीयो भवति, सर्वाणि णत्वविधायकानि सूत्राण्येकत्र इत्येव कर्म आश्रितः तेन। किं च परबलीयस्थापनार्थं त्रिपाद्याः सपादसप्ताध्यायीदृष्ट्या असिद्धत्वस्थापनार्थं च विशिष्टकर्मः पाणिनिना अनुसर्त्तव्यो भवति अष्टाध्यायाम्। अस्याः नूतनायाः वर्णनात्मकपद्धतेरेतद् वैशिष्ट्यं यदिदमाश्रित्य कोऽपि अधितिः पाणिनीयव्याकरणे सूत्रसाहाय्येन महतो महतः शब्दौघान् उत्पादयितुं शक्नोति। यन्त्रं यथा बहुनि वस्तुनि निर्मातुं शक्नोति। तथैव अष्टाध्यायीसूत्रैः नैकान् संस्कृतभाषाशब्दान् यान्त्रिकपद्धत्या व्युत्पादयितुं शक्नोति। आधुनिकाः भाषाशास्त्रज्ञाः पाणिनीयव्याकरणस्य शब्दनिर्मितसामर्थ्यं मनसि कृत्वा पृच्छन्ति यत् कथं पुनरिदमाचार्यपाणिनेर्लक्षणं प्रवृत्तमिति। कीदृशी स्वल्पस्य शास्त्रस्य प्रवृत्तिर्यया महान् शब्दराशिं निर्मातुं शक्यते। कथं स मुनिः संस्कृतभाषया वाक्यविश्लेषणे प्रवृत्तोऽभवदिति। पाणिनेः शब्दशास्त्रप्रवृत्तिं जिज्ञासव इदानीन्तनाः विद्वांसो न केवलं व्याकरणस्य शब्दपराशब्दविवेकसामर्थ्येन सन्तुष्टाः, परन्तु शब्दराशिनिर्माणार्थं या पाणिनिना शास्त्रप्रवृत्तिरनुसृता तां ज्ञातुमतीव समुत्सुकाः। अनेनैवाभिप्रायेण भगवान् पतञ्जलिर्बदति-अनभ्युपाय शब्दानां प्रतिपत्तौ प्रतिपदपाठः। कथं तर्हि इमे शब्दाः प्रतिपत्तव्याः। किञ्चित् सामान्यविशेषलक्षणं प्रवर्त्तव्यम्। येनाल्पेन यत्नेन महतो महतः शब्दौघान् प्रतिपद्येरन्, किं पुनस्तत्। उत्सर्गापवादौ। कश्चिदुत्सर्गः, कश्चिदपवादः। कथं जातीयकः पुनरुत्सर्गः कर्त्तव्यः। कथं जातीयकोऽपवादः। सामान्येनोत्सर्गः कर्त्तव्यः। तद्यथा कर्मण्यण् तस्य विशेषणापवादः। तद्यथा आतोऽनुपसर्गे कः इति।

**कात्यायनः** अथेदमपि पाणिनीयव्याकरणसम्पूर्णमिदं मन्यमानो भगवान् कात्यायनः उक्तानुक्तद्विरुक्तचिन्तनात्मकं बार्तिकं विरच्य सम्पूर्णमकरोत्। यदष्टाध्यायाः पूर्त्तये कात्यायनेन

बार्तिकानि प्रणितानि । ततः प्रभृत्येव बार्तिकद्वारेण शब्दानां निष्पादनस्य रीतिरस्मिन् सम्प्रदाये प्राचलत् । नूनं बार्तिकानां सन्निवेशेनेदं शब्दशास्त्रं ज्ञानगौरवं अद्भुतं वैभवं च समुद्धरति । कात्यायनः बार्तिकं पाणिनीयव्याकरणस्यातीव महनीयमङ्गमिति बोध्यम् । बार्तिकरहितस्य व्याकरणस्याध्ययनं नैव पूर्णता मर्हति । अतीव दुःखकरोऽयं विषयो यदिदानीं कात्यायनबार्तिकानां कश्चन स्वतन्त्रः ग्रन्थो नोपलभ्यते । प्रकियाकौमुद्यामपि द्वितीयमुपजीव्य महर्षेः कात्यायनस्य बार्तिकान्येवेति मन्तव्यम् । कात्यायनेन विरचितेषु प्रायः ४२६३ बार्तिकेषु ४४८ बार्तिकान्यत्राचार्य्यपादैस्तत्सूत्रेषूपन्यस्तानि यद्यपि प्रकियाकौमुदीकारेण काशिकाकाररीत्या बहूनां बार्तिकानां समावेशः सूत्रेष्वेव कृतः । किं च कतिपयबार्तिकानि अपि सूत्ररूपेण पठितानीत्यादि विषये विशदरूपेण अत्र विचारयिष्यते । मुनित्रये कात्यायनस्य द्वितीयस्थानमिति स्वीक्रियते सबैः विद्वद्भिः । अयं खलु बररुचिः इत्यपरनाम्नापि प्रसिद्धः आसीत् । कात्यायनः न केवलं वैयाकरणः अपि तु कविकर्मप्यपि ख्यातिमवाप । तथा च कृष्णचरितस्य मुनिकविबर्णनप्रसङ्गे महाकविसमूद्रगुप्तेनोक्तं यत्-

यं स्वर्गारोहणं कृत्वा स्वर्गमानीतवान् भूवि ।

काव्येन रुचिरेणैव ख्यातोबररुचिः कविः ॥

अपि च न केवलं व्याकरणं पुषोष दाक्षीसुतस्येति बार्तिकैर्यः ।

काव्येऽपि भूयोऽनुचकार तं वै कात्यायनऽसौ कविकर्मदक्षः ॥ एतेषां देशकालविषये न किमपि ज्ञायते । ऐतिहासिकैरपि एतद्विषये किमपि स्फुटं निश्चेतुं न शक्यते । शीयुधिष्ठिरमीमांसकेन कात्यायनस्य पाणिनेः उत्तरवर्तित्वं स्वीकृतम् । शीपदकृष्णबेल्बलकरेण कथासरितसागरमधिकृत्य कात्यायनस्य समयः ख्रीष्टाब्दतः पूर्वं ५००-३०० ईशबीयवर्षः स्वीकृतः । एतद् विषये सबैरैतिहासिकैरङ्गीक्रियते । कैश्चित्तु कथासरितसागरमधिकृत्य पाणिनिः कात्यायनयोः समकालिकत्वं कल्प्यते । तत्तु ऐतिहासिकदृष्ट्या पोषकप्रमाणाभावात् नैव सम्यक् । तथा च उभययोः मुन्योः प्रतिस्पर्द्धित्वकल्पनमप्ययुक्तम् । शबरस्वामिनोक्तम्-सद्वादित्वाच्च पाणिनेर्बचनं प्रमाणम् । असद्वादित्वान्न कात्यायनस्य इत्यादि । बस्तुतस्तु कात्यायनः-अष्टाध्यायाः प्रतिभापूर्णो योग्यतमो वैज्ञानिकस्य व्याख्याता बभूव । एवं च कालान्तरे प्रकाशमागतानां नवनवानां प्रयोगाणां सिद्धये पाणिनिसूत्रैः सह बार्तिकानि संयोजयितुं यत्न एवाभ्युपयितः ।

**भाष्यकारः** मुनित्रये महर्षेः पतञ्जलेः तृतीयस्थानमवसीयते । प्रकियाकौमुद्यां महाभाष्यस्य बहवः श्लोकाः बहूनि वाक्यानि चाविकलत्वेनोपन्यस्तानि । एतदतिरिक्तं सूत्राणामर्थव्याख्याने,

साधुत्वनिर्बचने, सिद्धान्तसंस्थापने चाचार्य्यर्बगैः सर्बदैब महाभाष्यस्य अनुकरणं कृतम् । प्रकियाकौमुद्याः टीकाकारैरपि प्रकियाप्रसादे प्रकाशे चाक्षेपसमाधानादिबिधौ प्रायो महाभाष्यमेवानुदितम् । तत्र बहुषु स्थलेषु एतन्नमहाभाष्यादेरबगन्तव्यम् उत बा अस्मिन् सूत्रे आक्षेपसमाधानादिकं महाभाष्यादेरबगन्तव्यम् फलितमेवास्वाभिरुक्तम् अथवा अत्र पक्षे पाठार्थे सूत्राक्षरैरेकपात्तौ बिचारबिशेषादर्थबिशेषो ज्ञेयः इत्यादि बहुधा प्रपञ्चितम् । पतञ्जलेः समयबिषये नेतिहासबिदां बिभिन्नाः मतयः । महाभाष्ये पुष्पमित्रं याजयामहे इत्यादि उदाहरणादयं पुष्पमित्रसमकालिक इति स्वीक्रियते सर्बैः । पुष्पमित्रस्य कालः इ. द्वितीयशताब्दीति सुबिदितमेव । अतः ख्रीष्टाब्दतः पूर्बे द्वितीयशतके पतञ्जलेः समयो निर्णेतुं शक्यते । तत्र नास्ति कश्चन बिबादाबसर इति । बिभिन्नेषु प्राचीनग्रन्थेषु पतञ्जलेः गोनर्दीयः, गोणिकापुत्रः, नागनाथः, अहिपतिः, चूर्णिकार इत्यादीनि नामान्युपलभ्यन्ते । तत्र गोनर्दीयपदं गोनर्दे भव इत्यर्थे एङ् प्राचां देशे इत्यनेन छ प्रत्यये सिद्धति । अतो देशस्य प्रागभागे स्थितत्वादुत्तरप्रदेशस्य बर्त्तमानगोण्डाजनपदमेतेषां जन्मस्थानमिति गृहीतुं शक्यते । गोणिकापुत्रः, इत्यनेनास्य मातुर्नाम गोणिकेत्यनुमीयते । एतेषां जीबनेतिबृत्तबिषये न किमपि स्फुटमुपलभ्यते । महाभाष्यं न केबलं व्याकरणनिबन्धः, अपि तु सर्बाण्यपि ज्ञातव्यानि बिषयजातानि स्थाने स्थानेत्र सपरिकरं बिबेचितानि । तथा चोक्तमपि भर्तृहरिणा-कृतेऽथ पतञ्जलिना गुरुणातीर्थदर्शिना

सर्बेषां न्यायबीजानां महाभाष्ये निबध्यते ।।

तत्र सर्बेऽपि लौकिकव्यबहारा, प्राक्तनेतिहासाः, आबश्यकधर्माः, दर्शनानां सिद्धान्ताश्च स्थले स्थले उपबर्णिताः । बिज्ञानस्यापि गूढतमाः सिद्धान्ताः महाभाष्ये यत्र तत्र प्राप्यन्ते । यथा स्थानेऽन्तरतमः इति सूत्रे उक्तम्-अचेतनेष्वपि तद्यथा लोष्टः क्षिप्त बाहुबेगं गत्वा नैब तिर्यग् गच्छति नोर्ध्वमारोहति । पृथिबीबिकारः पृथिबीमेव गच्छत्यान्तर्यतः । यथा या एता आन्तरीक्ष्याः सूक्ष्मा आपस्तासां बिकारो धूमः स धूम आकाशे निबाते नैब तिर्यग्गच्छति । नार्बामबरोहति, ज्योतिषो बिकारो ज्योतिरेव गच्छत्यान्तर्यतः । महाभाष्ये यादृशी गम्भीरा सरलाभाषा, न तथा कस्मिन्नप्यन्यस्मिन् ग्रन्थे परिलक्ष्यते । महाभाष्यस्य बहुषु स्थलेषु पतञ्जलिना पाणिनिसूत्राणां, सूत्रांशानां वा प्रत्याख्यानमकारि इत्युच्यते कैश्चित्, किन्तु न तत् समीचीनम् । यतो हि बृद्धिरादैच् सूत्रे महाभाष्ये उक्तम्-प्रमाणभूत आचार्यो दर्भपबिन्नपाणिः शुचाबकाशे प्राङ्मुख उपबिश्य महता यत्नेन सूत्राणि प्रणयति स्म । तत्रैकेन बर्णेनाप्यनर्थकेन भबितुं किं पुनरियता सूत्रेण, अपि च इकोयणचि सूत्रे भाष्ये उक्तम्-सामर्थ्ययोगान्नहि किंचिदस्मिन् पश्यामि शास्त्रे यदनर्थकं स्यात् । इत्यादि सर्बे दृष्टया पाणिनिसूत्राणां सम्बन्धे महाभाष्यकारस्य महान् श्रद्धाभावः प्रतीयते ।



तत्रोपन्यस्तस्य प्रत्याख्यानस्यैव भासमानस्य प्रकारस्यायमाशयो यत् भाष्यकाराः बुद्धिचातुर्येण प्रकारान्तरेणापि प्रयोगनिष्पादनोपायान् निर्दिशन्ति। न तु तत्र सूत्रस्य सूत्रांशस्य वा प्रत्याख्याने तेषां तात्पर्यमिति ज्ञेयम्। नागेशभट्टेन तत्

प्रत्याख्यानपरभाष्यस्येदृग्भिप्राय उदघोषितो यत् व्याकरणस्य बेदाङ्गत्वेन तदध्ययने न केवलं प्रयोगसाधुत्वसम्पादनमेव फलम्। अपि तु बेदाध्ययनजन्यं यत् पूण्यं तदप्यस्य फलं भवितुमर्हति। एवं च महर्षिपाणिनिबिरचितायाः अष्टाध्यायाः सर्वाशेनादृष्टरूपफलस्य जनकत्वे कुत्रचित् प्रयोगसाधुत्वबोधनरूपफलस्य प्रकारान्तरेणापि सम्भवप्रदर्शनाय तत्तत्प्रत्याख्यानपरं भाष्यम्। तथा चोक्तं लघुशब्देन्दुशेखरे- किञ्चित् दृष्टादृष्टार्थत्वं सर्वथाऽनर्थकं न किञ्चिदिति तदर्थः। बृद्धिसूत्रस्थे बर्णेनाप्यनर्थकेन न भवितव्यमिति भाष्यग्रन्थेऽनर्थकत्वं बोधार्थराहित्यरूपमिति। न निष्प्रयोजनत्वं रूपानर्थक्येन तत्र। तत्र प्रत्याख्यानपरभाष्यसंगतिरित्यादि प्रपञ्चितम्।

काशिका-पुरा खलु पाणिनिसूत्राणां व्याख्यानाय बहुनां वृत्तिग्रन्थानां रचना जाता। अद्योपलब्धेषु प्रक्रियाकौमुद्यामाचार्यपादैःसूत्राणां पाठ्यभेदप्रसङ्गे सर्वथा काशिकाकारस्येवानुसरणं कृतम्। सूत्रार्थज्ञाने प्रयोगसाधुत्वे प्रत्युदाहरणादिनां च बिबेचनादिबिधौ आचार्यचरणैर्बामिनजयादित्य बिरचितायाः अस्याः काशिकायाः आश्रयणं बहुधा कृतम्। प्रक्रियाकौमुद्याटीकाकारैः बिठुलादिभिरपि तत्र तत्रोपदर्शितानां मतानां प्रामाण्योपबृंहणाय काशिकायाः उपस्थापनं कृतम्। यदप्यस्यां प्रक्रियाकौमुद्यां केषांचित् सूत्राणामर्थाः काशिकातो भिन्नाः उपपादिताः किं तु एवं विधानां सूत्राणां संख्या स्वल्पीयस्येवेति। एतद्विषये सूत्रार्थबिमर्शे मया बिस्तरेण बिबेचयिष्यते। काशिकायाः रचना ख्रीष्टाब्दस्य सप्तमशतके एवाजायतेति चीनयात्रिणः झात्सिंगस्ययात्राबणनोद्धरेण परिलक्ष्यते। डाः बेल्बलकरेणाऽपि तदपि समर्थितम्। पाणिनीयसूत्राणां विषये काशिकाकारस्यातीव श्रद्धाभावः संसूच्यते। यथोक्तम्- उदक्यबिपाशः इति सूत्रे महति सूक्ष्मेक्षिका वर्तते सूत्रकारस्य। अस्यां काशिकायां प्रतिसूत्रमनुवृत्तिरर्थोदाहरणानि शङ्कासमाधानपुरःसरमुपलभ्यते। अत्र प्रौढतयैतत्सर्वं प्रतिपादितं वर्तते। अस्याः वृत्तिविषये एषा जनशुतिर्यत् काश्यां बिरचनादेषा काशिकेति नाम्ना ख्यातेति। पदमञ्जर्या हरदत्तमिश्रेणाप्युक्तम्-काशिकादेशतोऽभिधानम् काशीषु भवा इति। ऐतिहासिकसामग्रीदृष्टाप्ययं ग्रन्थोऽतीव मूल्यवानित्यैतिहासिकानां बिदुषामभिप्रायः।

प्रक्रियाकर्मः-कस्यामपि कार्यपद्धतौ शनैः शनैः परिवर्तनमिति मानवस्य सहजः स्वभावः। अनयैव प्रवृत्त्या कालक्रमेण परिवर्तमानेस्मिन् जगत्यध्ययनाध्यापनादिक्रमेऽपि

परिबर्तनं स्वाभाविकी क्रियो। समये समये अध्ययनाध्यापनादिपरम्परायां न जाने कतिचित् परिबर्त्तनानि संजातानि, ख्रीष्टाब्दस्य द्वितीयशतकात् प्राक् व्याकरणानन्तरं वेदाध्ययनस्य परम्परा आसीत्। किं तु पतञ्जलेः समये सा रीतिः परिबर्त्तता। यथोक्तं पस्पशाह्निके महाभाष्ये-पुराकल्प एतदासीत् संस्कारोत्तरं ब्राह्मणाः व्याकरणं स्माधीयते। तेभ्यस्तत्तत्स्थानकरणानदानुप्रदानज्ञेभ्यो बैदिकाः शब्दाः उपदिश्यन्ते। तत् अद्यत्वे न तथा। वेदमधीत्य त्वरिता बक्तारो भवन्ति। वेदान्न बैदिकाः शब्दाः सिद्धाः लोकाश्च लौकिकाः अनर्थकं व्याकरणमित्यादि इति। इत्थमारम्भात् सहस्रेभ्योऽप्यधिकवर्षपर्यन्तं पाणिनीयव्याकरणाध्यायनाध्यापनामष्टाध्यायाः क्रमेणैवजायत। इत्सिद्धेन स्वीये भारतयात्रावर्णनप्रसङ्गे उल्लिखितम्-चीनदेशीयया जनाः यदाध्ययनाय भारतमुपयान्ति तदा तैरष्टाध्यायाः अध्ययनं प्रथमतः कर्तव्यं भवति। तदनन्तरं तेषां कृते अन्येविषयाः पाठ्याः भवन्ति। तदित्यं न स्यात्तदा तेषां सर्वः श्रम एव व्यर्थः स्यात्। अनेनेदं सिद्धति यदित्सिद्धस्य भारतागमनपर्यन्तं अत्राष्टाध्यायाः क्रमेणैवाध्ययनाध्यापनस्य रीतिरासीत्। इत्सिद्धस्य यात्राकालः सप्तमशताब्द्याः उत्तरार्द्धमिति सुबिदितमेव। अतः सप्तमशताब्द्याः पर्यन्तमष्टाध्यायाः क्रमोऽक्षुण्णः अबिशृङ्खलितश्चासीत्। कस्मिन्नपि कार्ये कार्यपूणाल्यां वा परिबर्त्तनं स्वसभाविकमिति तु मया प्रागेबोक्तम्। किन्तु तत्रेदमपि किञ्चिदबधेयं यत् कुत्रापि परिबर्त्तनं नाहेतुकी क्रिया। प्रायः परिबर्त्तने सारल्यानुसन्धानस्य संक्षिप्तीकरणस्य च प्रवृत्तिरपि नितरां स्वाभाविकी। अष्टाध्यायाः क्रमेण शब्दशास्त्रस्य ज्ञानाय महानायासः कर्तव्यः। प्रथमाध्यायादारभ्याष्टमाध्यायपर्यन्तं अधीत्येव कश्चन राम इत्येकस्यापि प्रयोगस्य साधुत्वनिर्बचने न क्षमः। अथ चाष्टाध्यायां सूत्राणां महती संख्या चासीत्। तत्रापि तत्तत्सूत्रेषु स्वल्पाक्षरैरेव शब्दैरितिगूढतमानां भावानां सन्निवेशेन सरलरीत्या स्वल्पनैव च कालेन व्याकरणज्ञानमिच्छद्भिस्तात्कालिकैरध्यैतृभिस्तास्मिन् क्रमे विशेषणासौबिध्वमन्वभावि। फलतः शनैः शनैरध्येतारः पाणिनीयव्याकरणात् पराङ्मुखाः बभूवुः। अतोऽस्यां परिस्थित्यां उपर्युक्तकाठिन्यस्य दूरीकरणायैव प्रक्रियाक्रमस्यारम्भो जातः।

**रुपावतारः** पाणिनीयव्याकरणेऽस्याः प्रक्रियापूणाल्याः सर्वप्रथमो ग्रन्थो बौद्धधर्माबलम्बिना धर्मकीर्तिना विरचितो रुपावतार इति। पाणिनीयसूत्राणां प्रक्रियाक्रमेण पुनः संघटनेनाध्ययनादिपरम्परायां महत् परिबर्त्तनं जातम्। अस्मिन्क्रमे रुपावतारस्य निर्माणं दशमशताब्द्यामभूदिति रुपावतारसंपादकैः श्रीरङ्गाचार्यैः संशोधितम्। बौद्धधर्माबलम्बिना निर्मितेप्यस्मिन् ग्रन्थेऽन्यनास्तिकादीनां ग्रन्थबदत्र मङ्गलाभावो न दृश्यते। अपि तु ग्रन्थादौ

ग्रन्थमध्ये च मङ्गलं दृश्यते एव। ग्रन्थादौ निवेशितेन तद्विरचितेनैव सर्वज्ञप्रमाणपूर्वकप्रतिज्ञाश्लोकेन ज्ञायते यदयं सौगतमतानुयायी आसीत्।

सर्वज्ञमनन्तगुणं पूणम्य बालप्रबोधनार्थमिमम् ।

रुपाबतारमल्पं सुकलापमृजुं करिष्यामि ।

भारतीयबौद्धविद्याप्ररोहवृन्तज्ञाः केचिन्नबिनपण्डिताः अपि सौगतसमयाचार्यं तन्मतानुयायिनं च मन्यन्ते। अस्याः प्रक्रियापद्धतेरध्ययनप्रसङ्गे मया पृथमस्यास्य ग्रन्थस्यादितोऽन्तर्पर्यन्तमध्ययनमासादितम्। यद्यपि प्रक्रियाकौमुद्यामस्य ग्रन्थस्य कश्चन विशेषो प्रभावो नाबलोक्यते। तथापि प्रक्रियाग्रन्थेषु पृथमतया अस्मिन् विषये किञ्चिदुपबर्णनं न तावदनावश्यकम्। अपि च प्रक्रियाकौमुद्याष्टीकारैः शीबिट्टलाचार्यस्य ग्रन्थस्योद्धरणमसकृत् दत्तम्। सम्पूर्णेऽयं ग्रन्थः पूर्वाद्धोत्तराद्धे इति भागद्वयेन विभक्तः। तत्र पूर्वाद्धे प्रत्येकं प्रकरणमबतार इति नाम्ना अभिहितम्। संज्ञाबतारः, सन्ध्यबतारः, विभक्त्याबतारः, अब्ययाबतारः, स्त्रीप्रत्ययाबतारः, कारकाबतारः, समासाबतारः तद्धिताबतारश्चेति। उत्तराद्धेस्तु धातुप्रत्ययपञ्चकेति नाम्ना अभिहितः। तत्रादाबुक्तम् -

पूणम्य शिरसा देवीं बालानां हितकारिणीम् ।

यथासारं प्रबक्ष्यामि धातुप्रत्ययपञ्चिकाम्।। तत्र पञ्चिकाशब्दप्रयोगेण मयैवमनुमीयते यत् तस्मिन् प्रकरणे पञ्चधा प्रत्ययाः निहिताः सन्ति। तद्यथा शुद्धधातुभ्यः तिङ्कृत्भेदेन प्रत्ययानां प्रकारद्वयम् एवं सप्रत्ययधातुभ्यो ण्यन्तसन्नन्तयङन्तभेदेन च त्रैधमित्येवं रीत्यात्र पञ्चानां प्रत्ययानां निर्देशेन धातुप्रत्ययपञ्चिकेत्युक्तम्। तत्राबान्तरप्रकरणे परिच्छेदशब्दस्य व्यबहारो दृश्यते। अत्र २६६४ पाणिनिसूत्राणि प्रक्रियाक्रमेण व्याख्यातानि। रुपमालाबिमलसरस्वत्याः चतुर्दशशताब्द्यामस्य पाणिनीयप्रक्रियाग्रन्थस्य रचना कृता। डाः बेल्बलकरेणापि उक्तं यद्यत्र पाण्डुलिप्यां लिखिता तिथिः सत्या तर्ह्यस्य समयः १३५० ईशबीयवर्षेभ्यः पश्चान्नैव भवितुमर्हति। के. पि त्रिबेदिना प्रक्रियाकौमुदीसमकालिकोऽयं ग्रन्थः इत्युपात्तम्। यद्यपि प्रक्रियाकौमुद्याः रचनापद्धतिरस्मात् ग्रन्थात् भिन्नैव दृश्यते। तथापि प्रक्रियाकौमुद्याः प्रकाशटीकायां यत्र कुत्रचित् रुपमालायाः उद्धरणं प्राप्यते। तत्र प्रकरणानामेषः क्रमः- संज्ञामाला, स्वरसन्धिः, प्रकृतिभावः, व्यञ्जनसन्धिः, बिसर्गसन्धिः, अजन्तमाला, हलन्तमाला, सर्वनाममाला, संख्यामाला, नियतलिङ्गमाला, च्छान्दस्यमाला, स्त्रीप्रत्ययमाला, कारकाभागः, समासश्च। अत्यल्पसूत्राणामत्र व्याख्यानतयाऽतीव लघुकलेबरकोऽयं ग्रन्थः। उत्तरकालेस्य

ग्रन्थस्य विशेषप्रसारो नैबजायत। अतएव ग्रन्थोऽयमिदानीं याबदमूद्रित एबाबसीयते। पाण्डुलिपिरपि पायो दुर्लभैव। मया तु पुनास्थितभण्डारकर ओरियेन्टाल् रिसर्च इन्स्टियट् इति संस्थातः ग्रन्थस्य पाण्डुलिपिरुपलब्धेति।

प्रक्रियाकौमुदी-इदानीं याबत् मया पाणिनीयकृमिको बिकाशः अपाणिनीयव्याकरनानामुद्भवः प्रक्रियाकौमुद्या सह तेषां सम्बन्धश्च सम्यग् बिचारिताः। तत्रैव चेदमप्युपादि यदेकस्यापि शब्दस्य व्याकृतिमार्गणेऽनेकस्थलाबलोडने पूर्वपद्धतौ गौरवमबधार्य जनाः प्रक्रियाप्रणाल्यां प्रवृत्ताः। दशमशताब्द्यां रूपाबतारः इति प्रक्रियाग्रन्थस्य निर्माणेऽपि तत्र काश्चन एतादृश्यस्त्रुटयः आसन्। यथा नारायणभट्टेनोऽक्तम्-बृतौ चारु न रुपसिद्धिकथना रूपाबतारे पुनः इति। तेन तस्य सार्वदेशिकःसार्वभौमिकश्च प्रचारो नैबाजायत। परिणामतो ग्रन्थोऽयमेकदेशीयो जातः। रुपमालात्वतीब लध्वाकारतया प्रक्रियाज्ञानेऽपर्याप्ता ततोऽपि स्वल्पं प्रचारमलभत। अत एबेदानीमपि कस्यचन युक्ततमस्य पाणिनीयप्रक्रियाग्रन्थस्यापेक्षा उदपद्यत। अस्यामपेक्षायां शाब्दीं प्रक्रियां सुखेन प्रतपित्सुनां बिद्यार्थिनामत्यन्तोपकृतये सकलन्यूनतानिरासबद्धिकरणेन मनिषिणा श्रीरामाचार्येण व्याकरणार्णबपारगमनसेतुरूपः प्रक्रियाकौमुदीग्रन्थः संजगन्थे। बहुषु पूर्वबर्तिषु ग्रन्थेषु सत्स्वपि प्रक्रियाकौमुद्याः किं प्रयोजनमित्यस्मिन् बिषये प्रसादकृता बिठुलाचार्येणोऽक्तम्-यथा कौमुदी सुखरूपा सती सकलानर्थानभिब्यनक्तेबमियं सुखं जनयन्ती स्वल्पैरेब शब्दैः सकलान् शब्दार्थान् प्रकाशयति। अन्ये हि ग्रन्थाः महान्तोऽतिगहनास्तैः सहसा शब्दाः न प्रकाशयन्त इत्यबान्तरप्रयोजनमस्याः इति। एवं केनचित् शब्दान्तरेण प्रक्रियाप्रकाशकृता श्रीशेषकृष्णेनाप्ययमेब भाबः प्रकटीकृतः। तद्यथा-पूर्वप्रक्रियायामतिगहनबिस्तृतत्वादिदोषेन बालब्युत्पादनयोग्यात् कुमुदानामियं कौमुदी इति ब्युत्पत्या तरणिकिरणसहिष्णुनां कुमुदानां चन्द्रिका यथा बिकाशमाधते। तापं चापयास्यति तद्बदियमलसप्रायाणां ब्युत्पत्तिमाधते इति। प्रक्रियाकौमुद्याः निर्माणेन तादृश्यापेक्षयाः पूर्तिः कथं जाता इत्यस्य ग्रन्थस्य कृमिकबिमर्शेन स्फुटीभबति।

सिद्धान्तकौमुदी-सुप्रचीनकालादारभ्य पाणिनीयाष्टकसूत्राणि सारयुक्तान्यपि अल्पाक्षरत्वात् असन्दिग्धान्यपि,बिश्बतोमुखत्वात् मन्दबुद्धीनां कृते दुरुहाणि च संजातानि। इमामेब बुद्धिमबलोक्य भगबान् पतञ्जलिः तानि तानि सूत्राण्यादाय महाभाष्यं प्रणीनाय। तदनन्तरं महाभाष्यस्यास्य गूढाशयत्वात् तत्रत्यानामपि निगुढबादानां सिद्धान्तानां च अतिशयदुरूहत्वात् मन्दबुद्धिनामिष्टसिद्धौ कृणि-स्वोभूमि-देबानन्दि-चूर्णिप्रभृतिभिः बृत्तिकारैः तानि सूत्राणि ताभिः ताभिः बृत्तिभिरलंकृतानि। परन्तु अद्यत्वे बामनः जयादित्यबिरचिता काशिकाबृत्तिरेब

अष्टाध्यायाः समुपपासकानुपकरोति। इयं चाष्टाध्यायाः उपलब्धासु बृत्तिषु प्राचीनतमेति सर्वैः संस्कृतसाहित्यिकबिभर्शकैः स्वीक्रियते। अस्यां बृत्तौ प्रतिसूत्रमनुबृत्तिः, बृत्युदाहरण-प्रत्युदाहरणानि शंकासमाधानपुरःसराणि प्राप्यन्ते। परिबर्तमानेऽस्मिन् संसारे पठनपाठनकृमेऽपि परिबर्तनं स्वाभाविकम्। लाघवेनाध्ययनाय प्रक्रियाक्रमस्योत्पत्तिः जाता। सत्सु अपि बहुषु प्रक्रियाग्रन्थेषु सिद्धान्तकौमुदी अतीव लोकप्रिया सर्वोत्कृष्टा जाता। ग्रन्थसंक्षेपस्याः प्रधानं बैशिष्ट्यम्। ग्रन्थेऽस्मिन् समाश्रिताः विषयप्रतिपादनशैली प्रकरणक्रमश्च प्रशंसार्हो वर्तते। सिद्धान्तानुगुणसूत्रार्थविबरणमपि अतीव समीचीनम्। अतएव ग्रन्थोऽयं सर्वान् प्रक्रियाग्रन्थानतिशेते। यद्यपि प्रक्रियाग्रन्थस्य पूर्वार्धोत्तराद्धोरूपेण विभाजनं प्रक्रियाकौमुद्यां प्रथमतया प्राप्यते, तथापि सिद्धान्तकौमुद्यां कानिचित् प्रकरणानि पूर्वप्रक्रियाग्रन्थापेक्षया परिबर्तनं कृत्वा संग्रहितानि। एवञ्च उणादिसूत्र लिङ्गानुशासन-गणपाठानामन्तर्भावः प्रथमतया सिद्धान्तकौमुद्यां कृतः। सर्वेषु प्रक्रियाग्रन्थेषु सर्वाणि सूत्राणि न व्याख्यातानि। परं सिद्धान्तकौमुद्यां सर्वाण्येव पाणिनिः सूत्राणि विवेचितानि सिद्धान्तकौमुद्यां सूत्रार्थः संक्षिप्ततया व्याख्यातः। तत्र केषुचित् स्थलेषु सूत्रव्याख्यानाबसरे काशिकावृत्तेःरुपाबतारस्य प्रक्रियाकौमुद्याश्च प्रभावो परिलक्ष्यते। किन्तु बहुषु स्थलेषु पूर्वं सूत्रार्थं व्याख्यानपरम्परां परित्यज्य नवीनमेव सूत्रार्थं प्रदर्शयति दीक्षितः। अष्टाध्यायामेतादृशानि बहूनि सूत्राणि विद्यन्ते, येषां स्वरूपैव अर्थबोधो भवति। अतः एतादृशानां सूत्राणां बृत्तिः नैव प्रदर्शिता। तत्र कुत्रचित् स्पष्टं लिखितमस्ति, वचिच्च केवलं उदाहरणमात्रं दत्तम्। प्रक्रियाकौमुद्यामपि बहुनां सूत्राणां बृत्तिः नैव प्रदर्शिता। अतः सिद्धान्तकौमुदीस्था एषा शैली प्रक्रियाकौमुदीभ्यः एवानसृता लौकिकानां बैदिकानां च शब्दानां साधनविषये अष्टाध्यायी कृममबलमव्य सूत्रव्याख्या नैव प्रदर्शिता सिद्धान्तकौमुद्याम्। बैदिकव्याकरणं विहाय अन्येषु प्रकरणेषु बैदिकप्रयोगान् साधयितुं प्रयासो नैव कृतः। यानि यानि अधिकारसूत्राणि केवलमुत्तरसूत्रे पठितान्यष्टाध्यायां तानि सर्वाणि रुपाबतारे व्याकृतानि, किन्तु प्रक्रियाकौमुद्यां कानिचित् अधिकारसूत्राणि नाममात्रेण पठितानि। किन्तु सिद्धान्तकौमुद्यां सर्वाण्येव सूत्राणि व्याख्यातानि। न कस्यापि सूत्रस्य परित्यागो दृश्यते। रुपाबतार-प्रक्रियाकौमुद्यादिषु ग्रन्थेषु एकैकस्य सूत्रस्य बारं बारं व्याख्यानं कृतम्। परं सिद्धान्तकौमुद्यां कुत्रापि पूर्वव्याख्यानं सूत्रस्य पुनः व्याख्यानं नोपलभ्यते। रुपाबतारे बहुत्र प्रकरणस्थापनात् वा तत् पूर्वं तद्विषये प्रश्नः, शङ्का बोधस्थाप्यते। तदनन्तरं तद्विषयकसूत्रं संस्थाप्यते। किन्तु ग्रन्थसंक्षेपहेतुना एतादृशी शैली सिद्धान्तकौमुद्यां नैव समाश्रिता। ग्रन्थविषये सिद्धान्तकौमुद्यां यादृशो यत्नो विहितः, न तादृशः अन्येषु प्रक्रियाग्रन्थेषु। सिद्धान्तकौमुद्यां बहुषु स्थलेषु पृथक् पृथक् रूपेण सूत्राणि संस्थाप्य अन्ते तेषां सूत्राणां बृत्तिः एकत्रैव प्रदर्शिता। अतएव

बिषयेऽस्मिन् बालमनोरमाकारेणोच्यते यत्-ब्याख्यासौकर्याय सूत्रद्वयमुपात्तम्। भाष्य-बार्तिक-काशिका-प्रक्रियाग्रन्थादिसारांशसंग्रहेण मतान्तरप्रदर्शनेन नूतनानां शब्दानां संकलनेन च कौमुदीयं प्रशंसार्हा वर्तते। अद्यत्वे व्याकरणजगति सिद्धान्तकौमुदी गीतारूपेण गीयते। अतएव सिद्धान्तकौमुदी अन्वर्थसंज्ञिका भवति। यथा कौमुदी तमो निरस्यति, सुखं च प्रकाशयति। दिनकरकिरणसम्पर्कजनितं सन्तापमपगमयति। तथैव इयमपि ग्रन्थरूपवाक्याबलिः अज्ञानात्मकं तमो निरस्यति। मुनित्रयग्रन्थभाबान् त्वनायासेन प्रकाशयति। अतीव दुरूहभाष्यकैयटादिमहाग्रन्थ-परिशीलनजनितं चित्तंसन्तापं च शमयति।

**सिद्धान्तकौमुद्याः टीकाग्रन्थाः** परिबर्तमानेऽस्मिन् सर्वेषां परिबर्तनं समयानुकूलेन सम्भवति। बिलयबिकाशामार्गेण बस्तुस्थितानां बिकाशनं प्रकाशनं च जायते। एतत् कृते लोकोऽभिरुचिः किल कारणम्। अनेन क्रमेण व्याकरणनिकाये पठनपाठनेऽपि परिबर्तनमासादितम्। प्रतिपदोक्तपाठादारभ्य इदानीन्तनप्रक्रिया यावत् पाठनकाले शिष्यः गुरुमुखात् श्रुत्वा शास्त्राणि अधीतवान्। श्रुतिक्रमेण व्याकरणस्यापि परम्परा सन्निहिता आसीत्। ऐतिह्यादबगम्यते यत् पतञ्जलिकालात् प्राक् व्याकरणध्ययनादनन्तरमेव बेदाध्ययनप्रवृत्तिरासीत्। इयं च परम्परा पतञ्जलिकाले समाप्ता जाता। पुराकाले अष्टाध्यायाः पठनपाठनपरम्परा सूत्रकृमानुसारेण एवासीत्। ख्रीष्टाब्दस्य सहस्रेभ्योऽपि अधिर्बर्षपर्यन्तं सेयं परम्परा प्रचलिता। चीन्यात्रिणा हुएन्साङ् इत्यनेनापि भारतयात्रानुबन्धनेन इदमेव निगदितम्। अनेनानुमीयते यत् हुएन्साङ्गस्य भारतगमनसमयेऽयमध्ययनकर्मः प्रचलितः। तदुत्तरवर्तिकाले इमां परम्परां परित्यज्य एका नूतना परम्परा समागता। सा किल प्रक्रियाक्रमान्ना विशुता। प्रक्रियाक्रमस्याभिर्भावे बहुनि कारणानि सन्ति। अष्टाध्यायीक्रमेण प्रयोगसाधुत्वप्रतिपादनाय महत्काठिन्यं समनुभूयते स्म। सम्पूर्णायाः अष्टाध्यायाः अध्ययनादनन्तरं मध्ये वा प्रयोगाणां साधने समर्थः भवति। प्रथमाध्यायादारभ्य अष्टमाध्यायं यावत् सूत्राणि नाल्पानि। संज्ञाबिधायकं सूत्रं प्रथमाध्याये वर्तते येन प्रयोगं यथाकालं नितरामायासाध्यम्। अतः सारल्येन पाणिनिव्याकरणध्ययनार्थं प्रक्रियाग्रन्थानामुत्पत्तिः जाता इति स्थलतः प्रतिपादयितुं शक्यते। भाष्यकृता उक्तम्-पुराकल्प एतदासीत् संस्कारोत्तरकालं ब्राह्मणं स्माधीयते। तेभ्यस्तत्स्थानं करणादानुप्रदानज्ञेभ्यो वैदिकाशब्दाः उपदिश्यन्ते। तदद्यत्वे न तथा। बेदमधित्य त्वरिता बत्तारो भवन्ति। प्रक्रियाग्रन्थेषु यद्यपि कातन्त्रव्याकरणं प्रथम्येन दृष्टिपथमायाति तथापि तत्र प्रक्रियाक्रमस्य परिपूर्णतया जनैः समादृतं नाभूत्। पाणिनीयव्याकरणपरम्परायां प्रक्रियाक्रमे रूपावतारः प्रथमप्रक्रियाग्रन्थः। यद्यप्यत्र बिषयाः प्रश्नमुखेन उपस्थापिताः तथापि सर्वेषां

सूत्राणामत्र व्याख्यानाभावात् इदमपि जनानां समादरं न प्राप्तवत्। अत्र केवलं १६६४ सूत्राणि व्याख्यातानि वर्तन्ते। तदनन्तरं प्रक्रियारत्नं बिमलसरस्वतेः रूपमाला, रामचन्द्राचार्यस्य प्रक्रियाकौमुदी इत्याख्यानां प्रक्रियाग्रन्थानामाभिर्भावः अभूत्। परन्तु यदा षोडशशताब्द्यां भट्टोजीदीक्षितेन सिद्धान्तकौमुदी विरचिता तदा एतेषां प्रभावो निर्गतः। अत्र महाभाष्याभिमतम्-सूत्रार्थं परिज्ञानाय भाष्याभिमते सूत्रस्वरूपस्य रक्षणाय प्रयत्नो विहितः। सर्वाणि सूत्राणि सरलया भाषया व्याख्यातानि सन्ति। कानिचित् प्रकरणानि सन्ति यानि प्रक्रियाग्रन्थापेक्षया परिबर्त्य संगृथितानि। अनेनक्रमेण उणादिसूत्राणि लिङ्गानुशासन-गणपाठानामन्तर्भावः प्रथमतया सिद्धान्तकौमुद्यां विहितः। भाष्य-वार्तिक-काशिका-प्रक्रियाग्रन्थानां सारांशो संग्रहणेन मतान्तरप्रदर्शनेन नूतनानां शब्दानां संकलनेन च कौमुदीयं प्रशंसाहं वर्तते। सर्वपृष्ठ्या अस्याः कौमुद्याः वैशिष्ट्यं सातिशयमिति अनुभवेन प्रकटीकर्तुं शक्यते। अस्याः उपरि बह्व्यः व्याख्याः निर्मिताः। तासु प्रमुख्याः व्याख्याः अत्र प्रस्तुयन्ते। सिद्धान्तकौमुद्याः टीकाग्रन्थेषु भट्टोजीदीक्षितेन विरचितः पौढमनोरमा इत्याख्यः टीकाग्रन्थोऽन्यतमः। असौ महाराष्ट्रीयः ब्रह्मणः आसीत्। तस्य समयः २५३०-१६५० ख्रीष्टाब्द इत्यनुमीयते स्वयं सिद्धान्तकौमुदी विरच्य तत्र अपरितुष्य तस्य टीकाग्रन्थरूपेण पौढमनोरमां विरचितवान्। यत्र दीक्षितस्य गूढाशयः समुपलभ्यते। सिद्धान्तकौमुद्याः अपरा एका टीका भवति तत्त्वबोधिनी इति। इयं ज्ञानेन्द्रसरस्वतीमहोदयेन विरचिता। तस्य समयः १५५०-६०० ख्रीष्टाब्दः। सुखबोधिनी-नीलकण्ठबाजपेयी, तत्त्वदिपीका-रामानन्दः, रत्नाकरः-रामकृष्णभट्टः, पूर्णिमा-यज्वा, बालमनोरमा-बासुदेवबाजपेयी, रत्नाकरः-कृष्णमित्रः, सुमनोरमा-तिरूमल्लद्वादशाहयाजी, प्रकाशः-तोपलदीक्षितः। एवमनेकानि व्याख्यानानि विश्रुतानि सन्ति। साम्प्रतमेते टीकाग्रन्थाः समुपलभ्यन्ते। अस्मात् सिद्धान्तकौमुद्याः प्रसिद्धः लोकादरः अनुमीयते। समयः आसीत् यदा कौमुद्याः प्रशंसायाः शतमुखाः जनाः बदन्ति स्म यत्-

कौमुदी यदि कन्ठस्था बृथा भाष्ये परिश्रमः ।

कौमुदी यद्य कन्ठस्था बृथा भाष्ये परिश्रमः ॥ इति ॥