

THE VISION OF NEP 2020:
Integrating Bharatiya Knowledge
System in Biology Textbooks

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Vidya Bharati Uchcha Shiksha Sansthan



VIDYA BHARATI
UCHCHA SHIKSHA SANSTHAN

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**The Vision of NEP 2020: Integrating Bharatiya Knowledge System in
Biology Textbooks**

Editor: Shweta Tiwari

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FOREWORD

This book, *The Vision of NEP 2020: Integrating Bhartiya Knowledge System in Biology Textbooks*, is an outcome of sustained efforts of Vidya Bharti Uchcha Shiksha Sansthan, IIT, BHU and Seed 2 Sapling towards implementation of various recommendations of NEP 2020 in School Curriculum. With the announcement of National Education Policy 2020, government agencies and pioneer organizations working in the field of education have come into action to work on National Curriculum Framework and State Curriculum Frameworks. These endeavours are seeing huge participation from intellectuals and stakeholders in the academic fields to prepare content and design school textbooks based on the mandate of NEP 2020. This research volume is a germane contribution in this direction and provides a strategic plan towards development of syllabi and new textbooks in Biology subject to be developed for all stages and classes.

In developing this volume, Vidya Bharti Uchcha Shiksha Sansthan has taken a pioneer initiative towards accomplishing the intent of NEP in re-connecting and re-establishing the foundations of age-old Indian Education System and connect it with global pedagogical developments. This work sheds powerful light on ways to assimilate the valued tenets of Bhartiya knowledge system in the biology syllabi of schools. The document highlights the specific aspects of Indian education and heritage that must be included under the ambit of the curriculum along with focus on imparting 21st century skills to the learners. In covering this facet, this book

also presents an extensive list of reference books and primary texts that can be used to re-design biology textbooks for different stages and classes in school. This judiciously written volume is an integral contribution to the countrywide efforts towards implementation of National Education Policy 2020. I am particularly pleased to provide an entry point to this volume and welcoming all policy makers, academics, scholars, authors and readers. Last but not the least, I would like to express our gratitude to all our partner institutions, collaborators and particularly IKS Division of MoE, AICTE, GoI for supporting us in this project.

Prof. Kailash Chandra Sharma

President, Vidya Bharati Uchcha Shiksha Sansthan

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This approach paper on Biology in the light of NEP 2020 and Indian Knowledge System owes its shape and form to the flurry of ideas generated through a series of intensive deliberations by eminent academicians, teachers, principals and other stakeholders of different universities, colleges, and schools of India at various levels.

We express our sense of gratitude to Honorable Shri Raghunandan (Sangathan Mantri, Vidya Bharti Uchcha Shiksha Sansthan), Shri Govind Mahant (Sangathan Mantri, Vidya Bharti Akhil Bhartiya Shiksha Sansthan), Dr. Sunil Kumar Mishra (convener, IIT-BHU) and the organizing team of IIT, BHU for their patronage, guidance, motivation and inspiration.

We are very much thankful to Professor Jai Prakash Lal, Distinguished Professor (Lifelong), Department of Genetics & Plant Breeding, Banaras Hindu University and Professor Rana Pratap Singh, School of Life Sciences, Jawaharlal Nehru University for their continuous guidance and support.

We are grateful to all the subject experts who contributed to the compilation of this book.



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PREFACE

The educational system in any diversified country, like India, is the most preferred way of spreading national ethos among millions of students so that they become good citizens and contribute to nation-building. The Indian Government issues the National Education Policy as and when need requires to retune the Indian education system according to changed situations. The National Education Policy-2020 (NEP 2020) is the latest that proposes the revision and revamping of all aspects of the education structure, including its regulation and governance, to create a new system that is aligned with the aspirational goals of 21st century education. NEP 2020 lays special emphasis on the development of the creative potential of each individual, which is based on the principle that education must develop not only cognitive, but also social, ethical, and emotional capacities and dispositions.

Additionally, NEP 2020 focuses on the Indian knowledge system and its incorporation into the current Indian education system that has been ignored or done half-heartedly, so far. According to NEP 2020, the elements of the Indian Knowledge system must be incorporated taking into account the local and global needs of the country, and with a respect for and deference to its rich diversity and culture. Instilling knowledge of India and its varied social, cultural, and technological needs, its inimitable artistic, language, and knowledge traditions, and its strong ethics in India's young people is considered critical for purposes of national pride, self-confidence, self-knowledge, cooperation, and integration.

The pursuit of knowledge (Jnan), wisdom (Pragyaa), and truth (Satya) was always considered in Indian thought and philosophy as the highest human goal. The aim of education in ancient India was not just the acquisition of knowledge as preparation for life in this world or life beyond schooling, but for the complete realization and liberation of the self. World-class institutions of ancient India such as Takshashila, Nalanda, Vikramshila, and Vallabhi, set the highest standards of multidisciplinary teaching and research and hosted scholars and students from across backgrounds and countries. The Indian education system produced great scholars such as Charaka, Sushruta, Aryabhata, Varahamihira, Bhaskaracharya, Brahmagupta, Chanakya, Chakrapani Datta, Madhava, Panini, Patanjali, Nagarjuna, Gautama, Pingala, Sankardev, Maitreyi, Gargi and Thiruvalluvar, among numerous others, who made seminal contributions to world knowledge in diverse fields such as mathematics, astronomy, metallurgy, medical science and surgery, civil engineering, architecture, shipbuilding and navigation, yoga, fine arts, chess, and more. Indian culture and philosophy have had a strong influence on the world. These rich legacies to world heritage must not only be nurtured and preserved for posterity but also researched, enhanced, and put to new uses through our education system.

Unfortunately, this traditional knowledge and wisdom have been undermined by the colonial mindset. The best way forward is to incorporate the Indian knowledge system and include Indian contributions in Indian textbooks to the possible extent with authenticity. However, present NCERT textbooks scarcely include the Indian contribution in various fields including science and technology. Therefore, it is a pertinent and opportune time to introduce the Indian knowledge system, particularly the contribution of Indian scientists in ancient, middle, and modern periods so that the disciples at the different levels (school to university education) of

the Indian education system may get sensitized and feel proud about their rich heritage. Further, it will encourage them to pursue research and innovation in the field of science and technology, especially those pertaining to the Indian knowledge system. Moreover, Indian scientists have been making path-breaking research in the fields of agriculture, medicine, biotechnology, cold region research, communications, environment, industry, mining, and nuclear power that must be included in textbooks.

This approach paper intends to provide a framework for the inclusion of the Indian knowledge system in biological sciences and has been developed based on the outcomes of a national symposium on ‘Biology in the light of NEP, 2020 and Indian Knowledge System’ held on June 3 and 4, 2022 at IIT, Banaras Hindu University. It was organized by Vidya Bharti Uchcha Shiksha Sansthan in collaboration with IIT, BHU and Seed 2 Sapling and attended by more than 120 participants representing different parts of India. There is ample scope for inclusion of Indian contributions in the various fields of Life Sciences viz. Ayurveda, Agriculture, Medicine and Surgery, Biotechnology, Plant and Animal Sciences in ancient India, and Indian Traditional Knowledge on Environmental Conservation in textbooks. Further, contributions of Nobel Laureates of Indian origin and other famous Indian scientists from various fields of biological sciences such as Sir Ronald Ross, Har Govind Khorana, Venkataraman Ramakrishnan, Sushruta, Birbal Sahni, Salim Moizuddin Abdul Ali, Panchanan Maheshwari, B.P. Pal, M.S. Swaminathan, Varghese Kurien, E.K. Janaki Ammal, etc., must be included in biology textbooks. Besides, this paper also focuses on various topics of biology that have either become obsolete or need more attention considering their scope in the current scenario.



Chapter–1

NATIONAL EDUCATION POLICY 2020: HIGHLIGHTS¹

Introduction

Education is fundamental for achieving full human potential, developing an equitable and just society, and promoting national development. Providing universal access to quality education is the key to India's continued ascent, and leadership. Universal high-quality education is the best way forward for developing and maximizing our country's rich talents and resources for the good of the individual, the society, the country, and the world.

The world is undergoing rapid changes in the knowledge landscape. With various dramatic scientific and technological advances, such as the rise of big data, machine learning, and artificial intelligence, many unskilled jobs worldwide may be taken over by machines, while the need for a skilled workforce, particularly involving mathematics, computer science, and data science, in conjunction with multidisciplinary abilities across the sciences, social sciences, and humanities, will be increasingly in greater demand.

Education thus, must move towards less content, and more towards learning about how to think critically and solve problems, how to be creative and multidisciplinary, and how to innovate, adapt, and absorb new material in novel and changing fields. Pedagogy must evolve to make education more experiential, holistic, integrated,

1. This chapter consists of extracts from NEP 2020 relevant to science curriculum

inquiry-driven, discovery-oriented, learner-centred, discussion-based, flexible, and, of course, enjoyable. The curriculum must include basic arts, crafts, humanities, games, sports and fitness, languages, literature, culture, and values, in addition to science and mathematics, to develop all aspects and capabilities of learners; and make education more well-rounded, useful, and fulfilling to the learner.

National Education Policy 2020 is the first education policy of the 21st century and aims to address the many growing developmental imperatives of our country. This Policy proposes the revision and revamping of all aspects of the education structure, including its regulation and governance, to create a new system that is aligned with the aspirational goals of 21st century education, including SDG4, while building upon India's traditions and value systems.

The rich heritage of ancient and eternal Indian knowledge and thought has been a guiding light for this Policy. The pursuit of knowledge (*Jnan*), wisdom (*Pragyaa*), and truth (*Satya*) was always considered in Indian thought and philosophy as the highest human goal. The aim of education in ancient India was not just the acquisition of knowledge as preparation for life in this world, or life beyond schooling, but for the complete realization and liberation of the self.

The Indian education system produced great scholars such as Charaka, Susruta, Aryabhata, Varahamihira, Bhaskaracharya, Brahmagupta, Chanakya, Chakrapani Datta, Madhava, Panini, Patanjali, Nagarjuna, Gautama, Pingala, Sankardev, Maitreyi, Gargi and Thiruvalluvar, among numerous others, who made seminal contributions to world knowledge in diverse fields such as mathematics, astronomy, metallurgy, medical science and surgery, civil engineering, architecture, shipbuilding and navigation, yoga, fine arts, chess, and more. Indian culture and philosophy have had a strong influence on the world. These rich legacies to world heritage must not only be nurtured and preserved for posterity but also researched, enhanced, and put to new uses through our education system.

Principles of NEP 2020

The purpose of the education system is to develop good human beings capable of rational thought and action, possessing compassion and empathy, courage and resilience, scientific temper and creative imagination, with sound ethical moorings and values. It aims at producing engaged, productive, and contributing citizens for building an equitable, inclusive, and plural society as envisaged by our Constitution.

The fundamental principles relevant to computer education that will guide both the education system at large, as well as the individual institutions within it are:

- Multidisciplinarity and a **holistic education** across the sciences, social sciences, arts, humanities, and sports for a multidisciplinary world in order to ensure the unity and integrity of all knowledge;
- **Creativity and critical thinking** to encourage logical decision-making and innovation;
- **Extensive use of technology** in teaching and learning, removing language barriers, increasing access for *Divyang* students, and educational planning and management;
- **Synergy in curriculum across all levels of education** from early childhood care and education to school education to higher education;
- **A rootedness and pride in India**, and its rich, diverse, ancient and modern culture and knowledge systems and traditions;

The Vision of NEP 2020

The National Education Policy envisions an education system rooted in Indian ethos that contributes directly to transforming India, that is Bharat, sustainably into an equitable and vibrant knowledge

society, by providing high-quality education to all, and thereby making India a global knowledge superpower.

SCHOOL EDUCATION

This policy envisages that the extant 10+2 structure in school education will be modified with a new pedagogical and curricular restructuring of 5+3+3+4 covering ages 3-18.

Early Childhood Care and Education

Para 1.1 of NEP 2020 states that Universal provisioning of quality early childhood development, care, and education must thus be achieved as soon as possible.

Foundational Literacy and Numeracy: An Urgent & Necessary Prerequisite to Learning

As per para 2.1 of NEP 2020 the ability to read and write, and perform basic operations with numbers, is a necessary foundation and an indispensable prerequisite for all future schooling and lifelong learning. Para 2.4 of NEP 2020 asserts that on the curricular side, there will be an increased focus on foundational literacy and numeracy - and generally, on reading, writing, speaking, counting, arithmetic, and mathematical thinking - throughout the preparatory and middle school curriculum, with a robust system of continuous formative/adaptive assessment to track and thereby individualize and ensure each student's learning. Specific hours daily - and regular events over the year-on activities involving these subjects will be dedicated to encourage and enthuse students. Teacher education and the early grade curriculum will be redesigned to have a renewed emphasis on foundational literacy and numeracy. Para 2.6 also recommends that A national repository of high-quality resources on foundational literacy and numeracy will be made available on the Digital Infrastructure for Knowledge Sharing (DIKSHA).

Technological interventions to serve as aids to teachers and to help bridge any language barriers that may exist between teachers and students, will be piloted and implemented.

Para 2.8 states that enjoyable and inspirational books for students at all levels will be developed, including through high-quality translation (technology assisted as needed) in all local and Indian languages, and will be made available extensively in both school and local public libraries.

Curtailling Dropout Rates and Ensuring Universal Access to Education at All Levels

As per NEP 2020 para 3.1, One of the primary goals of the schooling system must be to ensure that children are enrolled in and are attending school.

Curriculum and Pedagogy in Schools

Restructuring school curriculum and pedagogy in a new 5+3+3+4 design

As per para 4.1 of NEP 2020, the curricular and pedagogical structure of school education will be reconfigured to make it responsive and relevant to the developmental needs and interests of learners at different stages of their development, corresponding to the age ranges of 3-8, 8-11, 11-14, and 14-18 years, respectively. The curricular and pedagogical structure and the curricular framework for school education will therefore be guided by a 5+3+3+4 design, consisting of the Foundational Stage (in two parts, that is, 3 years of Anganwadi/pre-school + 2 years in primary school in Grades 1-2; both together covering ages 3-8), Preparatory Stage (Grades 3-5, covering ages 8-11), Middle Stage (Grades 6-8, covering ages 11-14), and Secondary Stage (Grades 9-12 in two phases, i.e., 9 and 10 in the first and 11 and 12 in the second, covering ages 14-18).

Para 4.2 also states that the Middle Stage will comprise three years of education, building on the pedagogical and curricular style of the Preparatory Stage, but with the introduction of subject teachers for learning and discussion of the more abstract concepts in each subject that students will be ready for at this stage across the sciences, mathematics, arts, social sciences, and humanities. Experiential learning within each subject, and explorations of relations among different subjects, will be encouraged and emphasized despite the introduction of more specialized subjects and subject teachers. The Secondary Stage will comprise of four years of multidisciplinary study, building on the subject-oriented pedagogical and curricular style of the Middle Stage, but with greater depth, greater critical thinking, greater attention to life aspirations, and greater flexibility and student choice of subjects.

Holistic development of learners

Para 4.4 asserts that the key overall thrust of curriculum and pedagogy reform across all stages will be to move the education system towards real understanding and towards learning how to learn - and away from the culture of rote learning as is largely present today.

Reduce curriculum content to enhance essential learning and critical thinking

Para 4.5 articulates that Curriculum content will be reduced in each subject to its core essentials, to make space for critical thinking and more holistic, inquiry-based, discovery-based, discussion-based, and analysis-based learning.

Experiential learning

Para 4.6 of NEP 2020 states that In all stages, experiential learning will be adopted, including hands-on learning, arts-integrated and sports-integrated education, story-telling-based pedagogy,

among others, as standard pedagogy within each subject, and with explorations of relations among different subjects. To close the gap in achievement of learning outcomes, classroom transactions will shift, towards competency-based learning and education. The assessment tools (including assessment “as”, “of”, and “for” learning) will also be aligned with the learning outcomes, capabilities, and dispositions as specified for each subject of a given class.

Empower students through flexibility in course choices

Para 4.9 claims that students will be given increased flexibility and choice of subjects to study, particularly in secondary school.

Multilingualism and the power of language

Wherever possible, the medium of instruction until at least Grade 5, but preferably till Grade 8 and beyond, will be the home language/mother tongue/local language/regional language. Thereafter, the home/local language shall continue to be taught as a language wherever possible. This will be followed by both public and private schools. High-quality textbooks, including in science, will be made available in home languages/mother tongue. All efforts will be made early on to ensure that any gaps that exist between the language spoken by the child and the medium of teaching are bridged. In cases where home language/mother tongue textbook material is not available, the language of transaction between teachers and students will still remain the home language/mother tongue wherever possible. Teachers will be encouraged to use a bilingual approach, including bilingual teaching-learning materials, with those students whose home language may be different from the medium of instruction. All languages will be taught with high quality to all students; a language does not need to be the medium of instruction for it to be taught and learned well. Para 4.12 states that extensive use of technology will be made for teaching and learning of different languages and to popularize language learning.

Para 4.17 frames that the importance, relevance, and beauty of the classical languages and literature of India cannot be overlooked. Sanskrit, while also an important modern language mentioned in the Eighth Schedule of the Constitution of India, possesses a classical literature that is greater in volume than that of Latin and Greek put together, containing vast treasures of mathematics, philosophy, grammar, music, politics, medicine, architecture, metallurgy, drama, poetry, storytelling, and more (known as ‘Sanskrit Knowledge Systems’), written by people of various religions as well as non-religious people, and by people from all walks of life and a wide range of socio-economic backgrounds over thousands of years. Sanskrit will thus be offered at all levels of school and higher education as an important, enriching option for students, including as an option in the three-language formula. It will be taught in ways that are interesting and experiential as well as contemporarily relevant, including through the use of Sanskrit Knowledge Systems, and in particular through phonetics and pronunciation. Sanskrit textbooks at the foundational and middle school level may be written in Simple Standard Sanskrit (SSS) to teach Sanskrit through Sanskrit (STS) and make its study truly enjoyable.

Curricular Integration of Essential Subjects, Skills, and Capacities

As per para 4.23, while students must have a large amount of flexibility in choosing their individual curricula, certain subjects, skills, and capacities should be learned by all students to become good, successful, innovative, adaptable, and productive human beings in today’s rapidly changing world. In addition to proficiency in languages, these skills include: scientific temper and evidence-based thinking; creativity and innovativeness; sense of aesthetics and art; oral and written communication; health and nutrition; physical education, fitness, wellness, and sports; collaboration and teamwork;

problem solving and logical reasoning; vocational exposure and skills; digital literacy, coding, and computational thinking; ethical and moral reasoning; knowledge and practice of human and Constitutional values; gender sensitivity; Fundamental Duties; citizenship skills and values; knowledge of India; environmental awareness including water and resource conservation, sanitation and hygiene; and current affairs and knowledge of critical issues facing local communities, States, the country, and the world.

Para 4.24 proclaims that concerted curricular and pedagogical initiatives, including the introduction of contemporary subjects such as Artificial Intelligence, Design Thinking, Holistic Health, Organic Living, Environmental Education, Global Citizenship Education (GCED), etc. at relevant stages will be undertaken to develop these various important skills in students at all levels. Para 4.25 claims that mathematics and mathematical thinking will be very important for India's future and India's leadership role in the numerous upcoming fields and professions that will involve artificial intelligence, machine learning, and data science, etc. Thus, mathematics and computational thinking will be given increased emphasis throughout the school years, starting with the foundational stage, through a variety of innovative methods, including the regular use of puzzles and games that make mathematical thinking more enjoyable and engaging. Activities involving coding will be introduced in Middle Stage.

Para 4.26 enunciates that every student will take a fun course, during Grades 6-8, that gives a survey and hands-on experience of a sampling of important vocational crafts, such as carpentry, electric work, metal work, gardening, pottery making, etc., as decided by States and local communities and as mapped by local skilling needs. A practice-based curriculum for Grades 6-8 will be appropriately designed by NCERT while framing the NCFSE 2020-21. All students will participate in a 10-day bagless period

sometime during Grades 6-8 where they intern with local vocational experts such as carpenters, gardeners, potters, artists, etc. Similar internship opportunities to learn vocational subjects may be made available to students throughout Grades 6-12, including holiday periods. Vocational courses through online mode will also be made available. Bagless days will be encouraged throughout the year for various types of enrichment activities involving arts, quizzes, sports, and vocational crafts. Children will be given periodic exposure to activities outside school through visits to places/monuments of historical, cultural and tourist importance, meeting local artists and craftsmen and visits higher educational institutions in their village/ Tehsil/District/State.

Para 4.27 determines that “Knowledge of India” will include knowledge from ancient India and its contributions to modern India and its successes and challenges, and a clear sense of India’s future aspirations with regard to education, health, environment, etc. These elements will be incorporated in an accurate and scientific manner throughout the school curriculum wherever relevant; in particular, Indian Knowledge Systems, including tribal knowledge and indigenous and traditional ways of learning, will be covered and included in mathematics, astronomy, philosophy, yoga, architecture, medicine, agriculture, engineering, linguistics, literature, sports, games, as well as in governance, polity, conservation. Specific courses in tribal ethno-medicinal practices, forest management, traditional (organic) crop cultivation, natural farming, etc. will also be made available.

Para 4.29 reveals that all curriculum and pedagogy, from the foundational stage onwards, will be redesigned to be strongly rooted in the Indian and local context and ethos in terms of culture, traditions, heritage, customs, language, philosophy, geography, ancient and contemporary knowledge, societal and scientific needs, indigenous and traditional ways of learning etc. – in order to ensure

that education is maximally relatable, relevant, interesting, and effective for our students. Stories, arts, games, sports, examples, problems, etc. will be chosen as much as possible to be rooted in the Indian and local geographic context. Ideas, abstractions, and creativity will indeed best flourish when learning is thus rooted.

National Curriculum Framework for School Education (NCFSE)

Para 4.30 states that the formulation of a new and comprehensive National Curricular Framework for School Education, NCFSE 2020-21, will be undertaken by the NCERT - based on the principles of this National Education Policy 2020, frontline curriculum needs.

Transforming Assessment for Student Development

Para 4.34 asserts that the aim of assessment in the culture of our schooling system will shift from one that is summative and primarily tests rote memorization skills to one that is more regular and formative, is more competency-based, promotes learning and development for our students, and tests higher-order skills, such as analysis, critical thinking, and conceptual clarity. The primary purpose of assessment will indeed be for learning; it will help the teacher and student, and the entire schooling system, continuously revise teaching-learning processes to optimize learning and development for all students. This will be the underlying principle for assessment at all levels of education. Para 4.35 expresses that AI-based software could be developed and used by students to help track their growth through their school years based on learning data and interactive questionnaires for parents, students, and teachers, in order to provide students with valuable information on their strengths, areas of interest, and needed areas of focus, and to thereby help them make optimal career choices.

Equitable and Inclusive Education: Learning for All

Para 6.15 states that capacities of teachers in the teaching of science, mathematics, language, and social studies will be developed including orientation to new pedagogical practices.

HIGHER EDUCATION

Quality Universities and Colleges: A New and Forward-looking Vision for India's Higher Education System

Para 9.1 specifies that Higher education plays an extremely important role in promoting human as well as societal well-being and in developing India as envisioned in its Constitution - a democratic, just, socially-conscious, cultured, and humane nation upholding liberty, equality, fraternity, and justice for all. Higher education significantly contributes towards sustainable livelihoods and economic development of the nation. Para 9.1.1 describes that according to 21st century requirements, quality higher education must aim to develop good, thoughtful, well-rounded, and creative individuals. It must enable an individual to study one or more specialized areas of interest at a deep level, and also develop character, ethical and Constitutional values, intellectual curiosity, scientific temper, creativity, spirit of service, and 21st century capabilities across a range of disciplines including sciences, social sciences, arts, humanities, languages, as well as professional, technical, and vocational subjects. A quality higher education must enable personal accomplishment and enlightenment, constructive public engagement, and productive contribution to the society. It must prepare students for more meaningful and satisfying lives and work roles and enable economic independence. Para 9.1.2 states that for the purpose of developing holistic individuals, it is essential that an identified set of skills and values will be incorporated at each stage of learning, from pre-school to higher education.

Some of the major problems currently faced by the higher education system in India presents in para 9.2 are

- Less emphasis on the development of cognitive skills and learning outcomes;
- A rigid separation of disciplines, with early specialization and streaming of students into narrow areas of study;
- Limited access particularly in socio-economically disadvantaged areas, with few HEIs that teach in local languages
- Lesser emphasis on research at most universities and colleges, and lack of competitive peer-reviewed research funding across disciplines;

Towards a More Holistic and Multidisciplinary Education

Para 11.1 describes that India has a long tradition of holistic and multidisciplinary learning, from universities such as Takshashila and Nalanda, to the extensive literatures of India combining subjects across fields. Ancient Indian literary works such as Banabhatta's *Kadambari* described a good education as knowledge of the 64 Kalaas or arts; and among these 64 'arts' were not only subjects, such as singing and painting, but also 'scientific' fields, such as chemistry and mathematics, 'vocational' fields such as carpentry and clothes-making, 'professional' fields, such as medicine and engineering, as well as 'soft skills' such as communication, discussion, and debate. The very idea that all branches of creative human endeavour, including mathematics, science, vocational subjects, professional subjects, and soft skills should be considered 'arts', has distinctly Indian origins. This notion of a 'knowledge of many arts' or what in modern times is often called the 'liberal arts' (i.e., a liberal notion of the arts) must be brought back to Indian education, as it is exactly the kind of education that will be required for the 21st century.

As per para 11.2 NEP 2020, assessments of educational approaches in undergraduate education that integrate the humanities and arts with Science, Technology, Engineering and Mathematics (STEM) have consistently showed positive learning outcomes, including increased creativity and innovation, critical thinking and higher-order thinking capacities, problem-solving abilities, teamwork, communication skills, more in-depth learning and mastery of curricula across fields, increases in social and moral awareness, etc., besides general engagement and enjoyment of learning. Research is also improved and enhanced through a holistic and multidisciplinary education approach.

Para 11.3 describes that a holistic and multidisciplinary education would aim to develop all capacities of human beings -intellectual, aesthetic, social, physical, emotional, and moral in an integrated manner. Such an education will help develop well-rounded individuals that possess critical 21st century capacities in fields across the arts, humanities, languages, sciences, social sciences, and professional, technical, and vocational fields; an ethic of social engagement; soft skills, such as communication, discussion and debate; and rigorous specialization in a chosen field or fields. Such a holistic education shall be, in the long term, the approach of all undergraduate programmes, including those in professional, technical, and vocational disciplines. Para 11.4 states that a holistic and multidisciplinary education, as described so beautifully in India's past, is indeed what is needed for the education of India to lead the country into the 21st century and the fourth industrial revolution. Even engineering institutions, such as IITs, will move towards more holistic and multidisciplinary education with more arts and humanities. Students of arts and humanities will aim to learn more science and all will make an effort to incorporate more vocational subjects and soft skills. As per para 11.5, Imaginative and flexible curricular structures will enable creative combinations of

disciplines for study, and would offer multiple entry and exit points, thus, removing currently prevalent rigid boundaries and creating new possibilities for life-long learning.

Para 11.7 asserts that Departments in Languages, Literature, Music, Philosophy, Indology, Art, Dance, Theatre, Education, Mathematics, Statistics, Pure and Applied Sciences, Sociology, Economics, Sports, Translation and Interpretation, and other such subjects needed for a multidisciplinary, stimulating Indian education and environment will be established and strengthened at all HEIs. Credits will be given in all Bachelor's Degree programmes for these subjects if they are done from such departments or through ODL mode when they are not offered in-class at the HEI.

Optimal Learning Environments and Support for Students

According to para 12.1, effective learning requires a comprehensive approach that involves appropriate curriculum, engaging pedagogy, continuous formative assessment, and adequate student support. The curriculum must be interesting and relevant, and updated regularly to align with the latest knowledge requirements and to meet specified learning outcomes. High-quality pedagogy is then necessary to successfully impart the curricular material to students; pedagogical practices determine the learning experiences that are provided to students, thus directly influencing learning outcomes. The assessment methods must be scientific, designed to continuously improve learning and test the application of knowledge. Last but not least, the development of capacities that promote student wellness such as fitness, good health, psycho-social well-being, and sound ethical grounding are also critical for high-quality learning.

Catalysing Quality Academic Research in All Fields through a new National Research Foundation

As per para 17.1, Knowledge creation and research are critical in growing and sustaining a large and vibrant economy, uplifting society,

and continuously inspiring a nation to achieve even greater heights. Para 17.2 states that a robust ecosystem of research is perhaps more important than ever with the rapid changes occurring in the world today, e.g., in the realm of climate change, population dynamics and management, biotechnology, an expanding digital marketplace, and the rise of machine learning and artificial intelligence. If India is to become a leader in these disparate areas, and truly achieve the potential of its vast talent pool to again become a leading knowledge society in the coming years and decades, the nation will require a significant expansion of its research capabilities and output across disciplines. Para 17.4 describes that The societal challenges that India needs to address today, such as access for all its citizens to clean drinking water and sanitation, quality education and healthcare, improved transportation, air quality, energy, and infrastructure, will require the implementation of approaches and solutions that are not only informed by top-notch science and technology but are also rooted in a deep understanding of the social sciences and humanities and the various socio-cultural and environmental dimensions of the nation. Facing and addressing these challenges will require high-quality interdisciplinary research across fields that must be done in India and cannot simply be imported; the ability to conduct one's own research also enables a country to much more easily import and adapt relevant research from abroad.

Para 17.5 states that in addition to their value in solutions to societal problems, any country's identity, upliftment, spiritual/intellectual satisfaction and creativity is also attained in a major way through its history, art, language, and culture. Research in the arts and humanities, along with innovations in the sciences and social sciences, are, therefore, extremely important for the progress and enlightened nature of a nation.

Para 17.7 describes that India has a long historical tradition of research and knowledge creation, in disciplines ranging from science

and mathematics to art and literature to phonetics and languages to medicine and agriculture. This needs to be further strengthened to make India lead research and innovation in the 21st century, as a strong and enlightened knowledge society and one of the three largest economies in the world. Para 17.8 explains that this Policy envisions a comprehensive approach to transforming the quality and quantity of research in India. This includes definitive shifts in school education to a more play and discovery-based style of learning with emphasis on the scientific method and critical thinking. This includes career counselling in schools towards identifying student interests and talents, promoting research in universities, the multidisciplinary nature of all HEIs and the emphasis on holistic education, the inclusion of research and internships in the undergraduate curriculum, faculty career management systems that give due weightage to research, and the governance and regulatory changes that encourage an environment of research and innovation. All of these aspects are extremely critical for developing a research mindset in the country.

Professional Education

As per para 20.6 of NEP 2020 India must also take the lead in preparing professionals in cutting-edge areas that are fast gaining prominence, such as Artificial Intelligence (AI), 3-D machining, big data analysis, and machine learning, in addition to genomic studies, biotechnology, nanotechnology, neuroscience, with important applications to health, environment, and sustainable living that will be woven into undergraduate education for enhancing the employability of the youth. Para 22.2 describes that the promotion of Indian arts and culture is important not only for the nation but also for the individual. Cultural awareness and expression are among the major competencies considered important to develop in children, in order to provide them with a sense of identity, belonging, as well

as an appreciation of other cultures and identities. It is through the development of a strong sense and knowledge of their own cultural history, arts, languages, and traditions that children can build a positive cultural identity and self-esteem. Thus, cultural awareness and expression are important contributors both to individual as well as societal well-being. Para 22.15 asserts that due to its vast and significant contributions and literature across genres and subjects, its cultural significance, and its scientific nature, rather than being restricted to single-stream Sanskrit Pathshalas and Universities, Sanskrit will be mainstreamed with strong offerings in school - including as one of the language options in the three-language formula - as well as in higher education. It will be taught not in isolation, but in interesting and innovative ways, and connected to other contemporary and relevant subjects such as mathematics, astronomy, philosophy, linguistics, dramatics, yoga, etc. Thus, in consonance with the rest of this policy, Sanskrit Universities too will move towards becoming large multidisciplinary institutions of higher learning. Departments of Sanskrit that conduct teaching and outstanding interdisciplinary research on Sanskrit and Sanskrit Knowledge Systems will be established/strengthened across the new multidisciplinary higher education system. Sanskrit will become a natural part of a holistic multidisciplinary higher education if a student so chooses. Sanskrit teachers in large numbers will be professionalized across the country in mission mode through the offering of 4-year integrated multidisciplinary B.Ed. dual degrees in education and Sanskrit.

Technology Use and Integration

Para 23.1 describes that India is a global leader in information and communication technology and in other cutting-edge domains, such as space. The Digital India Campaign is helping to transform the entire nation into a digitally empowered society and knowledge economy.

While education will play a critical role in this transformation, technology itself will play an important role in the improvement of educational processes and outcomes; thus, the relationship between technology and education at all levels is bi-directional. Para 23.2 states that given the explosive pace of technological development allied with the sheer creativity of tech-savvy teachers and entrepreneurs including student entrepreneurs, it is certain that technology will impact education in multiple ways, only some of which can be foreseen at the present time. New technologies involving artificial intelligence, machine learning, block chains, smart boards, handheld computing devices, adaptive computer testing for student development, and other forms of educational software and hardware will not just change what students learn in the classroom but how they learn, and thus these areas and beyond will require extensive research both on the technological as well as educational fronts.

Para 23.5 of NEP 2020 explains that the thrust of technological interventions will be for the purposes of improving teaching-learning and evaluation processes, supporting teacher preparation and professional development, enhancing educational access, and streamlining educational planning, management, and administration including processes related to admissions, attendance, assessments, etc. Para 23.6 acknowledges that a rich variety of educational software, for all the above purposes, will be developed and made available for students and teachers at all levels. All such software will be available in all major Indian languages and will be accessible to a wide range of users including students in remote areas and *Divyang* students. Teaching-learning e-content will continue to be developed by all States in all regional languages, as well as by the NCERT, CIET, CBSE, NIOS, and other bodies/institutions, and will be uploaded onto the DIKSHA platform.

Para 23.7 claims that Particular attention will need to be paid to emerging disruptive technologies that will necessarily transform

the education system. When the 1986/1992 National Policy on Education was formulated, it was difficult to predict the disruptive effect that the internet would have brought. Our present education system's inability to cope with these rapid and disruptive changes places us individually and nationally at a perilous disadvantage in an increasingly competitive world. For example, while computers have largely surpassed humans in leveraging factual and procedural knowledge, our education at all levels excessively burdens students with such knowledge at the expense of developing their higher-order competencies. Para 23.8 states that this policy has been formulated at a time when an unquestionably disruptive technology -Artificial Intelligence (AI) 3D/7D Virtual Reality - has emerged. As the cost of AI-based prediction falls, AI will be able to match or outperform and, therefore, be a valuable aid to even skilled professionals such as doctors in certain predictive tasks. AI's disruptive potential in the workplace is clear, and the education system must be poised to respond quickly. Para 23.9 declares that in response to MHRD's formal recognition of a new disruptive technology, the National Research Foundation will initiate or expand research efforts in the technology. In the context of AI, NRF may consider a three-pronged approach: (a) advancing core AI research, (b) developing and deploying application-based research, and (c) advancing international research efforts to address global challenges in areas such as healthcare, agriculture, and climate change using AI.

Para 23.10 describes that HEIs will play an active role not only in conducting research on disruptive technologies but also in creating initial versions of instructional materials and courses including online courses in cutting-edge domains and assessing their impact on specific areas such as professional education. Once the technology has attained a level of maturity, HEIs with thousands of students will be ideally placed to scale these teaching and skilling efforts, which will include targeted training for job readiness.

Disruptive technologies will make certain jobs redundant, and hence approaches to skilling and deskilling that are both efficient and ensure quality will be of increasing importance to create and sustain employment. Para 23.11 states that Universities will aim to offer Ph.D. and Masters programmes in core areas such as Machine Learning as well as multidisciplinary fields “AI + X” and professional areas like health care, agriculture, and law. They may also develop and disseminate courses in these areas via platforms, such as SWAYAM. For rapid adoption, HEIs may blend these online courses with traditional teaching in undergraduate and vocational programmes. HEIs may also offer targeted training in low-expertise tasks for supporting the AI value chain such as data annotation, image classification, and speech transcription. Efforts to teach languages to school students will be dovetailed with efforts to enhance Natural Language Processing for India’s diverse languages.

As per para 23.12, As disruptive technologies emerge, schooling and continuing education will assist in raising the general populace’s awareness of their potential disruptive effects and will also address related issues. This awareness is necessary to have informed public consent on matters related to these technologies. In school, the study of current affairs and ethical issues will include a discussion on disruptive technologies such as those identified by NETF/ MHRD. Appropriate instructional and discussion materials will also be prepared for continuing education. Para 23.13 explains that data is a key fuel for AI-based technologies, and it is critical to raise awareness on issues of privacy, laws, and standards associated with data handling and data protection, etc. It is also necessary to highlight ethical issues surrounding the development and deployment of AI-based technologies. Education will play a key role in these awareness raising efforts. Other disruptive technologies that are expected to change the way we live, and, therefore, change the way we educate students, include those relating to clean and renewable energy, water

conservation, sustainable farming, environmental preservation, and other green initiatives; these will also receive prioritized attention in education.

Online and Digital Education: Ensuring Equitable Use of Technology

As per para 24.4 of NEP 2020, Given the emergence of digital technologies and the emerging importance of leveraging technology for teaching-learning at all levels from school to higher education, this Policy recommends the following key initiatives:

- Pilot studies for online education: Appropriate agencies, such as the NETE, CIET, NIOS, IGNOU, IITs, NITs, etc. will be identified to conduct a series of pilot studies, in parallel, to evaluate the benefits of integrating education with online education while mitigating the downsides
- Digital infrastructure: There is a need to invest in creation of open, interoperable, evolvable, public digital infrastructure in the education sector that can be used by multiple platforms and point solutions, to solve for India's scale, diversity, complexity and device penetration.
- Online teaching platform and tools: Appropriate existing e-learning platforms such as SWAYAM, DIKSHA, will be extended to provide teachers with a structured, user-friendly, rich set of assistive tools for monitoring progress of learners.
- Content creation, digital repository, and dissemination: A digital repository of content including creation of coursework, Learning Games & Simulations, Augmented Reality and Virtual Reality will be developed, with a clear public system for ratings by users on effectiveness and quality. For fun based learning student-appropriate tools like apps, gamification of Indian art and culture, in multiple

languages, with clear operating instructions, will also be created. A reliable backup mechanism for disseminating e-content to students will be provided.

- Addressing the digital divide: Given the fact that there still persists a substantial section of the population whose digital access is highly limited, the existing mass media, such as television, radio, and community radio will be extensively used for telecast and broadcasts.
- Virtual Labs: Existing e-learning platforms such as DIKSHA, SWAYAM and SWAYAMPURABHA will also be leveraged for creating virtual labs so that all students have equal access to quality practical and hands-on experiment-based learning experiences. The possibility of providing adequate access to SEDG students and teachers through suitable digital devices, such as tablets with pre-loaded content, will be considered and developed.
- Training and incentives for teachers: Teachers will undergo rigorous training in learner-centric pedagogy and on how to become high-quality online content creators themselves using online teaching platforms and tools.
- Online assessment and examinations: Appropriate bodies, such as the proposed National Assessment Centre or PARAKH, School Boards, NTA, and other identified bodies will design and implement assessment frameworks encompassing design of competencies, portfolio, rubrics, standardized assessments, and assessment analytics.
- Blended models of learning: While promoting digital learning and education, the importance of face-to-face in-person learning is fully recognized. Accordingly, different effective models of blended learning will be identified for appropriate replication for different subjects.

- Laying down standards: As research on online/digital education emerges, NETF and other appropriate bodies shall set up standards of content, technology, and pedagogy for online/digital teaching-learning.



**EXTRACTS OF 331st REPORT:
REFORMS IN CONTENT AND DESIGN OF
SCHOOL TEXT BOOKS¹**

Department-Related Parliamentary Standing Committee on Education, Women, Children, Youth and Sports has presented the “Three Hundred and Thirty First Report of the Committee on “Reforms in Content and Design of School Text books”. The report focuses on:

- Removing references to un-historical facts and distortions about our national heroes from the text books;
- Ensuring equal or proportionate references to all periods of Indian History;
- Highlighting the role of great historic women achievers.

The relevant highlights of the report are given below

- The report elaborates upon National Curriculum Framework that will provide roadmap for the development of new generation of textbooks providing more space to experiential learning for bringing in students the conceptual clarity and motivate students

1 This report was presented by Dr. Vinay P. Sahasrabudde, Chairman Department-related Parliamentary Standing Committee on Education, Women, Children, Youth and Sports on 26th November, 2021

for self-learning and self-assessment to improve not only cognitive skills but also the social -personal qualities.

- New NCF for School Education will guide the development of new generation textbooks across the subject areas. The new generation textbooks across subject areas will take care of the thematic, inter-disciplinary and multi-disciplinary approaches to highlight Indian culture and traditions, national heroes including women achievers and great regional personalities besides providing coverage to different phases of Indian history.
- NCF must focus on restructuring of stages of curriculum and pedagogy as 5+3+3+4, more focus is on Early Childhood Care and Education and Foundational Literacy and Numeracy, Integration of Pre-vocational Education from classes 6 to 8, Integration of Knowledge of India across the stages, focus on the holistic development through experiential learning, flexibility in choice of subjects etc.
- The report further informs about new ways for promotion of experiential learning, art integrated learning, sports integrated learning and competency-based learning, including internships, 10 bag less days, peer tutoring, interdisciplinary and multidisciplinary projects and development of fun-based student appropriate learning tools to promote and popularize Indian arts and culture etc.
- It also highlights different pedagogies such as group discussions, mock drills, excursion trips, visits to various places, such as zoo, museum, local store or restaurant; field study, classroom interactions, etc. were also being used to support experiential learning. Also, opportunities were provided to break subject boundaries by integration of art forms (visual or performing arts, such as dance, design, painting, photography, theatre, writing, etc.), stories, pictures, fun activities or games, sports,

etc. for holistic learning of concepts of science and mathematics without burden.

- It further states that the future syllabi and textbooks will be based on goals and competencies which will lead towards mapping of core essentials with competencies hence lessening the curriculum burden and focusing on holistic learning and development. The curriculum and syllabi should provide lots of space for experiential learning and textbooks will be based on competencies rather than content.
- NEP, 2020 recommends integration of knowledge of India across the stages and subject areas in the curriculum. Under this concern, as per the directions of new National Curriculum Framework for school education, various activities including development of digital and audio-video materials will be taken up.
- Thematic, interdisciplinary and multidisciplinary approaches to highlight Indian Culture and Traditions, our National Heroes including women achievers and great personalities from different regions of the country and perspective of equity, integrity, gender parity, constitutional values and concern for environment and other sustainable development goals.
- Experiential Learning through projects and age-appropriate activities, simple language, glossary, more in-text and end-text assessment questions and reduction of curriculum load to core essentials.
- All textbooks will be visually rich with illustrations, photographs, maps, etc., the illustrations and activities will be age/class appropriate. Local flavor will be added to the core essentials in textbooks of the States, to showcase the diversity of the country.
- Local flavor will be added to the core essentials in textbooks of the States, to showcase the diversity of the country. NCERT

has been working towards bringing dictionary on Indian sign language, which will help in developing material in sign language. The upcoming books and other materials based on the new NCFSC will follow the same pursuit in future.

- More emphasis on role of women: Role of women as rulers, their role in knowledge sector, social reforms, Bhakti movement, art and culture, freedom struggle (**Jnana Prabodhini, Pune**). Coverage of great historic women heroes belonging to different periods of Indian History including Gargi, Maitreyi, rulers like Rani of Jhansi, Rani Channamma, Chand Bibi, Zalkari Bai etc. will be taken up in the new textbooks, supplementary materials and e-content.
- National initiatives such as Swachh Bharat, Digital India, 'Beti Bachao Beti Padhao', 'Demonetization', GST etc. were integrated in the new textbooks in the review of syllabi and textbooks in 2017-18. Contents were added in history textbooks regarding knowledge, traditions and practices of India. For example, addition of material on Vikram Samvat, Metallurgy, Shivaji Maharaj, Paika revolt, Subhash Chandra Bose, Swami Vivekanand, Ranjeet Singh, Rani Avantibai Lodhi and Sri Aurbindo Ghosh.
- The objective of teaching history was to instil high self-esteem in students, National Renaissance, National unity, Social Inclusion and establish links with cultural roots. Thus following points are to be kept in mind while writing text books:
 - Depicting cultural unity
 - Linguistic heritage- importance of Sanskrit, Prakrit and Pali for national unity and international spread.
 - Linking Indian languages.
 - Civilization development -Vedic to present.

- Comparison of scientific temper with other civilizations on scientific and objective ground.
- History of sacrifices of various segments of Indian society for saving cultural values.
- Social inclusion.
- India and its cultural boundaries.
- Civilization proofs of India in other countries of the world.
- Religio-cultural emissaries from India should have proper place.
- Local, national as well as international influence of any event or thought should be highlighted. (**Bharatiya Shikshan Mandal, New Delhi**)
- The representatives of **Vidya Bharti** also put forth their views on the subject and pointed out certain factual distortions about vedic tradition, incompatibility of certain facts with constitutional ideals and values in the school textbooks. They suggested a thorough review and removing of such distortions/ discrepancies from the school textbooks. They also mentioned about 'My NEP' programme launched to reach non-academic people and to make them learn about the things in the National Education Policy in a nutshell.
- Inclusion of History of North East India: Bhakti and social movements in Assam and Manipur, tribal heroes who fought against British, contribution of Arunachal and Manipur with reference to Azad Hind Fauj and 1962 war, dynasties in Assam, Manipur, Tripura, Meghalaya. (**Jnana Prabodhini, Pune**)
- Post-independence History of Indian pride also needs to be stressed: Story of ISRO, story of BARC, story of cooperative movement (Story of Amul), story of restorations (Somnath, Hampi, archaeological sites such as Lothal) etc. (**Jnana Prabodhini, Pune**)

- The Design of textbooks should be:
 - Curriculum of history can be organized in an ascending order. The scope of curriculum grows with the growth of experience sphere of students from local to global.
 - Digitization of textbooks to make them attractive and dynamic document to go beyond text/ printed form: need to add audio-visuals with QR codes.
 - Inclusion of intellectual games, simulations. VR Games modeled to let students experience the historical times (for example ‘Real lives’) (**Jnana Prabodhini, Pune**).
- As far as the Modern period is concerned, some leaders have received more weightage as compared to others. The role of Subhash Chandra Bose, Sardar Patel, Bhagat Singh, Ram Prasad Bismil, Lala Lajpat Rai, Khudiram Bose, Surya Sen, and even the women revolutionaries must be highlighted. The contribution of Veer Savarkar needs to be given enough weightage. (**Public Policy Research Centre, New Delhi**)
- The representatives pointed out that proportionate representation across Region, Time Period, and Events should be given in the Textbooks. South and East Indian dynasties have been highly under-represented. The history of great kingdoms like the Marāthas, Coḷas, and Vijayanagara as well as the early Kāśmīra dynasties, Kalingas, Gangas, Gajapatis, Kākatiyas, Ahoms, Ceras, Pallavas, Pāṇḍyas, Pālas, Senas, and Pratihāras either get a passing mention or not even that. The crucial role they played in our history must be elaborated. They further added that we must include these dynasties, which represent the very spirit of Bhāratīya Civilization that the Radhakrishnan Committee wanted every student to imbibe. (**Samvit Research Foundation, Bengaluru**). The following points were further added:

- Bhāratīya saṃskṛti has been widespread from Mesopotamia in the West to Japan in the East, from the Himalayas in the North to Indonesia in the South
- The Zend Avesta has significant relationship with the late R̥gvedic period
- Our Itihāsas and Purāṇas, particularly the Rāmāyaṇa, have been an integral part of the culture of many regions of Southeast Asia.
- The representatives also added that the history curriculum hardly emphasizes the role played by women in our history. It is important for students to learn –
 - the importance our civilization has given to women and how women participated in all aspects of life over the centuries
 - the freedom and opportunities available to women in public life
 - the great achievements of women from ancient times until the present day
 - the temporary changes in status of women in the wake of invasions
 - to progressively appreciate that our paramparā has a beautiful and holistic perspective of strīva that is far beyond modern formulations.
- They further suggested that this can best be accomplished by exposing the children to factual information from the past:-
 - Introduce the three great goddesses of the Vedas – Bhāratī, Ilā, Sarasvatī. Introduce a few Veda-suktas for which women are the mantra-draṣṭārīṇīs. In the Vedic period, mention woman scholars, brahmavādinīs, and mantra-draṣṭārīṇīs, including instances of where women learnt the Vedas.

- Present the dynamic role played by women in the Rāmāyaṇa and Mahābhārata. Give a complete picture of women-related references in the smṛtis.
- Portrayal of women in various classical literary accounts (e.g. Kālidāsa's Mālavikāgnimitra) that indirectly shows how the society was shaping up at that time.
- The critical contributions of queens in every century and every region across communities. Prominent rājamātas who played a role in shaping their children as rulers; important women warriors, scholars, poetesses, philanthropists, public personalities, sanyāsinīs, philosophers, saints, and freedom fighters
- The Committee is of the view that there should be an appropriate comparison of the portrayal of women heroes like Rani Laxmi Bai, Zalkari Bai, Chand Bibi etc vis-a-vis their male counterparts. The Committee observes that the women heroes from different regions and eras should be given equal weightage highlighting their contributions in the history textbooks.
- The Committee also observes that notable women in all fields, and their contributions, like that of Ahilyabai Holkar, Abala Bose, Anandi Gopal Joshi, Anasuya Sarabhai, Arati Saha, Aruna Asaf Ali, Kanaklata Deka, Rani Ma Guidinglu, Asima Chatterjee, Captain Prem Mathur, Chandraprabha Saikini, Cornelia Sorabji, Durgavati Devi, Janaki Ammal, Mahasweta Devi, Kalpana Chawla, Kamaladevi Chattopadhyay, Kittur Chennamma, M. S. Subbulakshmi, Madam Bhikajji Cama, Rukmini Devi Arundale, Savitribai Phule and many others have not found adequate mention in NCERT textbooks.
- The Committee observes that generally Women are underrepresented in school textbooks, many a times shown through images in traditional and voluntary roles, leading to

formation of gender stereotypes in the impressionistic minds of students and feels that there is a need to undertake an analysis of the textbooks from the Gender perspective as well.

- The Committee observes that in the suggestions received regarding updation of NCERT books, emphasis was laid on providing equal representation to the North-East Indian States and the History. It was suggested that developmental models and economic policies should have sections dealing with and talking about the complex realities and demographics of the North-East along with the history of civilizations and tribal communities of the North-eastern region. Furthermore, the textbook content should also ensure adequate balance in representing Hill areas and Plains areas so as to recognise both communities adequately.

Subject Experts

Prof. J.S. Rajput, Former Director, NCERT in his submission before the Committee stated that Reforms in the content and design of Textbooks should focus on the following aspects:

- a. Distortion of historical facts where one ruler is remembered and other equally prominent one's finds no mention.
- b. Not only periods, history must be just and objective to considerations of regional imbalances, historical contributions of the communities, people and practices.
- c. Social and cultural distortions must not be presented by those bound by prejudices and biases.

He stated that the content and design of textbooks is a product of Policy on Education, Curriculum Framework to be developed after its sensitive comprehension, followed by the process of preparing detailed syllabus for each textbook; for each grade /class. The quality

and content of the textbook shall depend on the quality of the authors; that include depth, seriousness, professional competence and commitment of individuals and institutions assigned the task. A good textbook can be authored only by those who are lifelong learners.

It was emphasized that National level textbooks are essential for several reasons, but it must be remembered that local element of curriculum also cannot be ignored. A class three textbook on environmental education just cannot be same in Tripura and Thiruvananthapuram. Hence, it is necessary to strengthen expertise and institutions at the State level. We need high level experts in textbook writing, evaluation, assessment, growing up, guidance, and all that children could need. now education is not only about/through textbooks, but textual materials for online learning, self-learning, digital learning, open and distance learning, and a couple of other terms that are in vogue. It has to be hybrid teaching and learning in future. Things have changed drastically in 2020, and some of the impacts shall continue in future as well.

New discoveries are taking place, new facts are coming up, and textbooks just cannot remain the same. This is worsened if the history is written with certain pre-conceived biases resulting out of politically-constrained ideological bindings. History writing in India has suffered on these unacceptable considerations, and it must be extracted - and liberated -out of gross subjectivity and ideological bias to transparent objectivity, and openness of mind, willingness to enter into dialogue with those holding diametrically opposite views. New facts have emerged around us; say; Aryan Invasion theory, Saraswati River, Ram Setu, and so many more solely because of new scientific advancements and new tools that have led to new researches. These just cannot be ignored in preparing new textbooks. Indian history writing needs a thorough professional review. As it was determined to highlight certain individuals, regimes and eras, it suffers from

serious imbalances of every possible type. He further pointed out the British tried to downgrade the great contributions of ancient India in philosophy, science, mathematics, spirituality, medicine and other fields and it was continued to be neglected in our textbooks. While considerable initiatives were taken for removing gender bias and caste discriminations, history writing remained confined to the hegemony of a select group of few academics for over five decades. The post- independence history books are deficient on 'linking Indians to India'; and this includes history, heritage and culture. In fact, this aspect needs serious informed and scholarly deliberations before textbooks are prepared in response to the NEP-2020.

The second most important aspect that no textbook writer could ignore pertains to the need for strengthening social cohesion and religious amity. Racial discrimination and caste considerations - in varied connotations – have not vanished fully even in what are known as most advanced societies. We must accept that these challenges still exist even before us; and these require an attitudinal transformation. Our Children must know that different religions are a reality, that no religion could claim superiority over any other.

Shri Hukmdev Narayan Yadav, Ex-MP, Lok Sabha emphasized the importance of the subject and suggested for detailed discussion with more stakeholders and eminent educationists. The focus should not 'be only on facts and figures while writing Indian history but it should focus on the deep essence of the nature of Indian history in order to make it more understandable.

Shri Shankar Sharan, Eminent Educationist so deposed before the Committee on the above subject and highlighted various topics for inclusion/ exclusion in NCERT text-books. He drew the attention of the Committee Members as to why the text-books had references to unhistorical/ distorted facts and why a section of intellectuals insisted on keeping it. Focusing on this will only help in removing such discrepancies.

Recommendations

In view of the evidences gathered throughout the process, the Committee strongly recommends that:

- While creating the content for textbooks, inputs from experts from multiple disciplines should be sought. This will ensure balance and diversity of views. It should also be ensured that books are free of biases. The textbooks should instill commitment to values enshrined in the constitution and should further promote national integration and unity.
- There is a pressing need to develop high-quality textbooks and effective teaching methods. Thus mandatory standards related to text-book content, graphics and layout, supplementary materials, and pedagogical approaches should be developed. Such standards are needed for printed as well as digital textbooks.
- There is a need to have more child-friendly textbooks. This is possible through enhanced use of pictures, graphics, QR codes, and other audio-visual materials. Children should be taught through enhanced used of games, plays, dramas, workshops, visits to places of historical importance, museums etc. as such approaches will ignite their inquisitiveness and analytical abilities.
- The initiative of Maharashtra State Bureau of Textbook Production & Curriculum Research known as Ekatmik Pathya Pustak conceived in 2018-19 to lighten the school bag is appreciable. Towards this, the Bureau has created quarter-specific integrated material for Marathi, English, Mathematics and 'Play, Do, Learn' for Class I students into a single book. A similar approach may be adopted by others. Such initiative will be aligned to the School Bag Policy of New Education Policy (NEP), 2020 as laid out in Section 4.33.

- Education must be provided in the light of values enshrined in the constitution which cannot be taught by mere delivery of information. The pedagogy woven around textbooks has a lasting impact on the minds of the student and hence learning-by-experiment methodology should be compulsorily used by all teachers. Such an approach will enhance positive attitude towards learning amongst students.
- The prioritization of development of foundational skills amongst primary students is required by the NEP-2020, and therefore necessitates the use of information technology and digital devices. Therefore, digital content should be created and disseminated using satellite technology to enhance our students' capabilities and potentials. Such approaches will further curriculum reform and will also help develop more effective operational models for content delivery, and learning. Introduction of modern technologies/methodologies for the dissemination of information as part of teaching strategies should be undertaken preferably after enabling the possibility of the same uniformly in every part of the country. Schools in remote corners of the country should be suitably equipped for the same.
- The primary school textbooks should serve two purposes; provide strong foundation in core areas such as reading, writing and arithmetic, and provoke curiosity so that students can rapidly expand their knowledge in later years. This is also in alignment with NEP 2020's goal of promoting competency-based learning.
- The NCERT and SCERTs should primarily focus on providing core content through their textbooks. Detailed information and supplementary materials may be provided

through other texts, videos, reference books, A/V files, etc. Further, textbooks should be anchored in facticity. Any presentation of data or survey results should be appropriately referenced. Textbooks should be designed to provoke curiosity and analytical abilities, should be tuned to cognitive capability of the student, and should employ simple language. Further, efforts should be made to design textbooks in ways such that project-based, art-integrated, and experiential learning models can be deployed for effective education. In this way, our textbooks will promote scientific temper, innovation, and also the four Cs; Communication, Collaboration, Creativity, and Critical Thinking.

- The Ministry should explore the possibility of developing a core class-wise common syllabus for various subjects for implementation by CBSE, CICSE and various other State education Boards as this will go a long way in maintaining uniformity in educational standards of school students across the country.
- Our textbooks should highlight the lives of hitherto unknown men and women from different states and districts who have positively influenced our national history, honour, and one-ness. This may require content production teams to dig deeper into local sources of knowledge, including oral ones, and identify linkages between the local and the national. In this way, our textbooks should elicit “Unity in Diversity” of India emphasizing that diversity in India is in fact diverse manifestation of the innate one-ness or intrinsic unity.
- The textbooks should include content on world history and India’s place in the same. In this regard, special emphasis must be placed on the histories of other countries of the

world. This is aligned with international guidelines which argue for study of history through a multi-perspective approach. Further, sufficient emphasis must also be placed on the connects between histories of South-East Asia and India. This would be very useful in the context of India's Look East policy.

- Our history textbooks should be continually updated, and account for post-1947 history as well. In addition, an option of conducting review of National Curricular Framework at regular intervals should be kept.
- The Department of School Education & Literacy and NCERT should carefully study how other ancient civilizations/ countries teach their own histories to their respective citizens through textbook content, and areas of emphasis. The results of such a study should be used to improve our own history textbooks and teaching methods taking into consideration history at the grassroots level preferably at the district levels. Further, the State Boards may prepare district-wise history books that will impart knowledge about local historical figures to the students.
- The NCERT should consider the suggestions received by this Committee, while framing the NCF and syllabus of the textbooks. For avoiding content overload on students, NCERT in collaboration with SCERT should identify State-specific historical figures for inclusion in respective SCFs. Efforts may also be made to incorporate and highlight the contributions of the numerous local personalities in various fields in State curriculum.
- The NCERT and SCERT should incorporate the ancient wisdom, knowledge and teachings about life and society from Vedas and other great Indian Texts/ Books in the school

curriculum. Also, educational methodologies adopted in the ancient Universities like Nalanda, Vikramshila and Takshila should be studied and suitably modified to serve as a model reference for teachers so as to benefit them in improving their pedagogical skills for imparting education in the present day context.

- Contributions of ancient India in the fields of Philosophy, Science, Mathematics, Medicine, Ayurveda, Epistemology, Natural sciences, Politics, Economy, Ethics, Linguistics, Arts, etc may also be included in the textbooks. The traditional Indian knowledge systems should be linked with modern science and presented in the contemporary context in NCERT textbooks.
- New technologies should be adopted for better pedagogy for the education of History. Further a permanent mechanism to make suitable rectifications through additions or deletions in the textbooks in a structured manner needs to be established.
- All books especially history books other than published by Government agencies used for supplementary reading may be in consonance with the structure/ content of NCERT books to avoid discrepancies. Also, Ministry of Education should develop a monitoring mechanism for ensuring the same.
- There is a need for discussing and reviewing, with leading historians, the manner in which Indian freedom fighters, from various regions/parts of the country and their contributions get place in History textbooks. This will result in more balanced and judicious perception of the Indian freedom struggle. This will go a long way in giving due and proper space to the freedom fighters hitherto

unknown and oblivious in the freedom movement. Review of representation of community identity based history as of Sikh and Maratha history and others and their adequate incorporation in the textbooks will help in a more judicious perspective of their contribution.

- In order to address the underrepresentation of Women and girls in school textbooks or them being depicted only in traditional roles, a thorough analysis from the view point of gender bias and stereotypes should be undertaken by NCERT and efforts be made to make content portrayal and visual depiction gender inclusive. The textbooks should have greater portrayal of women in new and emerging professions, as role models with a focus on their contributions and pathway of achieving the same. This will help in instilling self-esteem and self confidence among all, particularly girls. Also, while examining the textbooks, other issues like environment sensitivity, human values, issues of children with special needs etc can also be looked up for adequate inclusion in the School textbooks.
- The significant role played by women in the freedom movement and in various other fields needs adequate representation in the textbooks as it would go a long way in understanding the issues in a better way for the next generation of students.
- One of the major social ills afflicting our society in the present times is the malaise of drug addiction cutting across the class divide. It has far-reaching adverse effects on the socio-economic structure of the country, and that concerted efforts are required to be made by the government agencies as well as the civil society to combat this menace. As part of these efforts, the ill effects of such addiction must be

adequately and suitably highlighted in strong words, in the content of school text books to caution the impressionable young minds of students against falling prey to luring tactics of anti-social elements and resulting in waywardness. Similarly, the textbooks should have separate elements spreading awareness against internet addiction and other such aspects that are harmful to the society.

- Taking into account the voluminous number of suggestions received from teachers, students, Institutions for updating the syllabus of NCERT textbooks incorporating various subjects, an internal Committee be set up by Ministry of Education and NCERT to examine the suggestions so received and incorporate the same in curriculum as deem fit.
- All NCERT and SCERT textbooks must be published in all Eighth Schedule languages of the Constitution of India, besides Hindi and English. Further, efforts for developing textbooks in local languages (those not part of the Eighth Schedule) be also made. These will help the children in understanding the subjects better as the content will be in their mother tongue.
- To supplement the textbook content, field visits/ excursions should be introduced as a compulsory part of learning experience. As an initiative in this regard, textbooks can introduce a “Box Format” near the name of the place being mentioned stating the importance of that place whether religious, historical, etc. promoting the readers to visit it. This would further promote North-South and East-West integration.



Chapter–3

NEP & DEVELOPING NEW TEXT BOOKS¹

Prof. Chand Kiran Saluja

Director, Sanskrit Promotion Foundation, New Delhi

Prof. Chand Kiran Saluja emphasizes upon the various aspects of New Education Policy- 2020 such as building a culture of reading across the country. NEP-2020 has focused upon the development of curriculum, syllabus and textbook and it envisions a new way of learning which is not merely text book focused. Earlier, NCF 2005 had also mentioned that learning should be active rather than textbook centric only. Textbooks as a single source of education are not enough; they are important but are not only a teaching material. Therefore, a large number of packages should be developed at State and District levels with adequate provision for cluster and school level modifications and supplementary materials. To understand a textbook one needs to understand the curriculum and the aims of education. The present-day classroom practices

1 Based on the Keynote Address delivered by Prof. Chand Kiran Saluja in the Preparatory Workshop on Textbooks: Indian Knowledge System and Languages organized by VBUSS on 3rd & 4th February, 2022 and Keynote Lecture in the Two-day National Workshop on Sanskrit in the light of NEP 2020 & Indian Knowledge Systems organized by Central Sanskrit University, Delhi and Shri Lal Bahadur Shastri National Sanskrit University, Delhi on 4th & 5th June 2022.

are, in almost all schools of the country, totally dominated by the textbook. As a result, it has acquired an aura and a standard format. What is needed is not a single textbook but package of teaching learning method and material that could be used to engage the child in active learning. The textbook thus becomes a part of this package and not just a teaching learning material e.g., it connects the past with the present and should lead to experiential learning which means taking classroom to the field and vice versa. Therefore, a large number of packages should be developed at state and district levels with adequate provision for cluster and school level modifications and supplementary materials. This essentially means establishing proper coordination between the textbook designing committees at national and regional levels. The establishment of NCERT and SCERT are the part of this purpose only. The cluster system envisaged in the NEP, 2020 is also a part of this exercise. The availability of a number of alternative TLM packages of approved quality to the increased choice of the teachers may go a long way in introduction of IKS. To understand the textbook, one must understand the relationship between the curriculum and aims of education. There is a difference between curriculum and syllabus. The syllabus is something that is taught to the student in the classroom but curriculum involves vast level of activities including the syllabus. In simple terms, the curriculum starts from the moment a student enters the school environment and continues to be involved into till the end of the school hours and thereafter too in the form of doing various activities given by the teachers. Part I of the NEP, 2020 document outlays various objectives of education.

Textbooks are to be prepared based on certain pre-suppositions in relation to imparting of education and these presuppositions are guided by social, physical and psychological aspects of learners.

- The presentation of the textbook should be organized keeping certain things in mind such as what should be the topic of a lesson, how should study be conducted, how should vocabulary related to the lesson be organized etc.
- The objective of the textbook should not aim at merely addressing the curiosity in the minds students alone but also to create more curiosity among them. Therefore, the preparation of the textbooks should aim at invoking curiosity in the minds of learners.
- Textbook is an instructional material. It is not only for teaching but for learning as well. Therefore, textbooks should be designed keeping teaching-learning textual material based on a teaching model in mind.
- We must collect material for the preparation of textbooks first. As envisaged in the NEP, 2020, such material useful for the preparation of textbooks should be able to establish proper explanation of the idea to be taught, should be able to invoke thinking process among children, the textbook should be able to develop critical faculty among students and they should highlight Indianness or Indian values embedded in them.
- A Teaching Model essentially means designing educational activities and situations (classroom situations to learn).
- Constructive Teaching Learning Situation: NEP 2020 in its part 4 maintains that textbooks should not be an exercise of merely providing answers to the questions but students should be enabled to find out answers to the questions in their minds. Constructive approach used in NEP document means students should be equipped to find out answers that are already in their minds through the means of textbooks. NEP document says education should move towards less content and more towards learning about how to think critically and solve problems, how

to be creative and multidisciplinary, and how to innovate, adapt and absorb new material in novel and changing fields.

- Pedagogy must evolve to make education more experiential, holistic, integrated, inquiry driven, discovery oriented, learner-centric, discussion based, flexible and of course, enjoyable.
- Education should evolve into a process that recognizes, accepts and develops the potential of the learner.
- This must also be born in mind that while teaching, a teacher is not merely teaching in the classroom but he/she is also learning from the experiences of his/her students which he/she can bring in use for teaching the next batch of students. Part 4 of the NEP 2020 also emphasizes on art oriented and play oriented ways of teaching-learning process. Art cannot be understood only in terms of narrow understanding like drawing but seeing and perceiving things with different aspects associated with a particular issue is also an art.
- Textbooks should be prepared by drawing connections between cause and effect related to a particular issue as well.
- Activities prescribed for students should not be merely individual student centric but they should also develop group behavior among them. The NEP too has said that such activities will help students to keep in tune with the developments of the 21st century and should imbibe constitutional values among students, e.g., fundamental duties, environmental concerns etc.
- Approach to preparing textbooks should not be followed in isolation but must have an inter-disciplinary approach for example, textbook preparing committees on science, social sciences and languages should come together and device strategies in this regard.

- Textbooks for students should enable them not to learn what's being taught in the classroom for that moment or year alone but they should develop the sense of learning things continually.
- Thus, textbook should inculcate the thoughts and ideas on social justice, equality, scientific development, and national unity, cultural preservation of India, developing wholesome personality, developing resources to their fullest and using them in sustainable ways.
- Section 4.31 of the NEP provides for developing textbooks at national level keeping local issues and local aspects in the center stage. It lays emphasis on the constructive approach based on the discussions, explanations and utility of the learnt knowledge in practical life. It also talks of including supplementary material in the textbooks. It also talks of including bunch of books derived from the national and local sources.
- The reduction in content and increased flexibility of school curriculum renewed emphasis on constructive rather than rote learning. This must be accompanied by parallel changes in school textbooks. All textbooks shall aim to contain the essential core material (together with discussion, analysis, examples and applications) deemed important on a national level, but at the same time contain any desired nuances and supplementary material as per local contexts and needs. Wherever possible schools and teachers will also have choices in the textbooks they employ from among a set of textbooks that contain the requisite national and local material - so that they may teach in a manner that is best suited to their own pedagogical styles as well as to their students and communities' needs.
- Section 4.32 of the NEP provides for coordination between NCERT and SCERT to develop textbooks in various

languages spoken in India. They must derive from the sources across regions in India. “The aim will be to provide such quality textbooks at the lowest possible cost -namely, at the cost of production/printing - in order to mitigate the burden of textbook prices on the students and on the educational system. This may be accomplished by using high-quality textbook materials developed by NCERT in conjunction with the SCERTs; additional textbook materials could be funded by public-philanthropic partnerships and crowd sourcing that incentivize experts to write such high-quality textbooks at cost price.

- States will prepare their own curricula (which may be based on the NCFSE prepared by NCERT to the extent possible) and prepare textbooks (which may be based on the NCERT textbook materials to the extent possible), incorporating State flavour and material as needed. While doing so, it must be borne in mind that NCERT curriculum would be taken as the nationally acceptable criterion. The availability of such textbooks in all regional languages will be a top priority so that all students have access to high-quality learning. All efforts will be made to ensure timely availability of textbooks in schools. Access to downloadable and printable versions of all textbooks will be provided by all States/UTs and NCERT to help conserve the environment and reduce the logistical burden.”
- Section 4.33 provides for “Concerted efforts, through suitable changes in curriculum and pedagogy, will be made by NCERT, SCERTs, schools, and educators to significantly reduce the weight of school bags and textbooks.
- In this regard, it’s important to look at 1992 Committee Recommendations on how should the textbooks be also the 2005 NCF recommendation on the curriculum.

- Textbooks should include topic, role of the concerned topic, syllabus, self-study material, pictorial representations, structuralism, experiential learning, communication, students' participation, empowering teachers, culture, constitutional values, skills required for the 21st century, research aptitude, supplementary books etc.
- Education should be the process of humane learning presupposing a specific social nature and a process by which children grow into the intellectual life for those around them.
- Education should enable the child to look at the environment around her/ his in a holistic manner and does not compartmentalize any topic into science and social science.
- Therefore, an attempt should be made in the textbook so that it will help a child to locate every theme in physical, social and cultural contexts critically so that the child can make informed choices in his/her life.
- The challenge in relation to writing a textbook at national level lies in the fact that it should reflect the multicultural dimensions of the Indian society. Every effort should be made to include every community in the country giving due space to their culture and way of life so that all of them feel important.
- The position paper by the textbook preparation committees previously constituted had observed that- While writing textbooks.....“who is the child we are addressing was the big question. Does a child study in the big of school of the metro city or the school in the slums, a small-town child, one in village school or one in the remote mountainous areas? One also needed to tackle the difference of gender, class, culture, religion, language, geographical locations etc. These are some of the issues addressed in the book, which the teacher will also

have to handle sensitively in her own ways.” While preparing textbooks these issues of concern must be deliberated over.

- There is need to inculcate the habit of reading among our students and for that to happen the books must be prepared in a way that they become attractive for them.
- We need to pay attention to the section 4.35 of the NEP in this regard. It says, “The progress card of all students for school-based assessment, which is communicated by schools to parents, will be completely redesigned by States/UTs under guidance from the proposed National Assessment Centre, NCERT, and SCERTs. The progress card will be a holistic, 360-degree, multidimensional report that reflects in great detail the progress as well as the uniqueness of each learner in the cognitive, affective, and psychomotor domains. It will include self-assessment and peer assessment, and progress of the child in project-based and inquiry-based learning, quizzes, role plays, group work, portfolios, etc., along with teacher assessment. The holistic progress card will form an important link between home and school and will be accompanied by parent-teacher meetings in order to actively involve parents in their children’s holistic education and development. The progress card would also provide teachers and parents with valuable information on how to support each student in and out of the classroom. AI-based software could be developed and used by students to help track their growth through their school years based on learning data and interactive questionnaires for parents, students, and teachers, in order to provide students with valuable information on their strengths, areas of interest, and needed areas of focus, and to thereby help them make optimal career choices.” These issues must be kept in mind while preparing textbooks.

- The interdisciplinary approach of seeking knowledge is not new to us in India. The Sushrutsamhita has quite elaborately spoken about it in the following words-

एकंशास्त्रमधियानो न विद्याछास्त्रनिश्चयं
 तस्माद् बहुश्रुताः शास्त्रंविजनीयचिकित्स्काः
 शास्त्रंगुरुमुखोदीर्णमादायोपास्य चासकृत
 यः कर्मकुरुतेवैद्यः स वैद्योन्य तू तस्कराः
 (सुश्रुत संहिता सूत्रस्थानम् 4. 6-8)

- Our education should make students competent, experienced and capable enough to expand their knowledge on their own. While writing books, the interests of all students of society belonging to different gender, class, culture, religion and geographic locations should be kept in mind.
- The textbooks should be structured primarily in the five parts, viz. 1. Curriculum or syllabus as per our educational needs and objectives. 2. Collection of the material and its sequencing or sorting for the intended purpose, for example, the collected material can be used for designing syllabus of various classes. 3. Evaluation of the utility of the syllabus or curriculum. 4. Presentation of the collected material in the textbooks and 5. background checking meaning whether there is any need for further improvement in the designed books and its syllabus (पतिपृष्टि). It has been very beautifully said in the Indian knowledge traditions in the following shloka of Shukarhasyopanishad-

श्रवणं तु गुरोः पूर्वं मननं तदनन्तरम् ।
 निदिध्यासनमित्येतत् पूर्णबोधस्य कारणम् ॥
 (शुकरहस्योपनिषद्)

श्रवण > मनन > निदिध्यासन



**NATIONAL SYMPOSIUM ON
BIOLOGY IN THE LIGHT OF NEP 2020
AND INDIAN KNOWLEDGE SYSTEM:
A REPORT**

The two days national symposium on Biology in the light of NEP 2020 and Indian knowledge system was organized by Vidya Bharti Uchcha Shiksha Sansthan in collaboration with IIT- BHU and Seed 2 Sapling, Bengaluru on June 3-4, 2022 at IIT, Banaras Hindu University, Varanasi. It was attended by more than 120 participants representing different parts of India and was highly enlightening and insightful for all the participants.

The opening ceremony of the symposium was graced by distinguished guests, namely Professor Vikas Dubey (Dean, Research and Development, IIT, BHU), Dr. Pankaj Jain, (founder, Seed 2 Sapling, Bengaluru), Professor Rana Pratap Singh, (School of Life Sciences, JNU) and Shri Govind Chand Mahant (Sangathan Mantri, Vidya Bharti Akhil Bhartiya Shiksha Sansthan).

The distinguished resource persons and participants from different parts of the country sit together for two days to brainstorm on different thrust areas of Biology. The active discussions undertaken during this consortium were not only interactive but also result-oriented in terms of valuable inputs received at the end of the Symposium. The focus of the Symposium was to discuss the

modalities of the subject Biology, currently being taught in XI and XII classes; to suggest modifications in the course content as per the spirit of the National Education Policy, 2020; and to discuss the need for including Indian knowledge system in the Biology curriculum.

The inaugural session conducted on the first day (3rd June) in the forenoon was started with the lighting of a lamp by the invited guests followed by welcome addresses by Professor Vikas Dubey, Dean, Research and Development, IIT, BHU and Dr. Pankaj Jain, founder, Seed 2 Sapling. In subsequent sessions, invited resource persons enriched the knowledge of the delegates through their thought-provoking presentations related to new developments in the field and suggested some of the focus areas which must be readdressed to make Biology textbooks more informative as well as student-centric. The important points highlighted during the symposium by different invited speakers are undermentioned.

- 1. Professor Rana Pratap Singh, School of Life Sciences, JNU, New Delhi:** as the keynote speaker of the Inaugural Session, put forth a very brief but overall account of the vision of the NEP 2020 and stressed on the redesigning of the school textbooks according to National Education Policy 2020. He discussed the importance of Biology in day-to-day life and elaborated on the means under different sections of NEP 2020 that can make the Biology teaching-learning process interesting. He pointed out that textbooks must be made student-centric and written keeping in the mind the current scenario and needs of learners. The books must highlight and support the teaching-learning process. The content of the subject should be free from all ambiguities and written in such a way that students may be encouraged to explore the subject on their own
- 2. Dr. Pankaj Jain, founder, Seed 2 Sapling, Bengaluru:** focused his presentation on inquiry-based learning

pedagogy. In inquiry-based teaching-learning, a teacher rather than acting as know it all must act as a facilitator and encourage students to self-explore the problem by making keen observations and finding the solution by raising relevant questions related to the problem. He stressed that the inquiry-based teaching-learning pedagogy will help in inculcating the scientific temperament and prepare them for problem-solving.

3. **Professor Yukti Sharma, CIE, University of Delhi, Delhi:** discussed the basic components of the curriculum, policies and assessment policies in light of NEP 2020. As per the recommendations of NEP 2020, she suggested shifting the teaching-learning process/curriculum from an objective-based to a competency-based curriculum, focusing on learning outcomes, which must be holistic, enjoyable and engaging based on conceptual understanding, experiences and experiments through awareness, knowledge, attitude, skills and participation.
4. **Professor Jai Prakash Lal, Former Head, Department of Genetics and Plant Breeding:** talked about the importance of agriculture and animal husbandry in fulfilling the basic needs of humankind from the dawn of human civilization. Indian Vedic Agriculture, which is a natural/organic way of farming keeps soil, water, air, and overall ecosystem, completely free from toxic chemicals including fertilizers, pesticides and other harmful elements and protects the farm biodiversity. This system is sustainable as well as eco-friendly because it consumes less energy and combats the effects of global warming, and maintains soil health by reducing run-off-induced pollution. Therefore, as a part of the introduction of the Indian knowledge system, Vedic Agriculture must be included in the curriculum of Biology.

- 5. Professor Parameswarappa S. Byadgi, Department of Vikriti Vigyan, Faculty of Ayurveda, Institute of Medical Science, BHU:** highlighted the need of introducing Ayurveda, one of the oldest systems of medicine in the world and a gift of India to the humanity, in Biology textbook. Ayurveda is a well-established science, which is supported by several medical texts and glossaries created by the ancient Indians. Ayurveda predicts that life exists as a union of the body, mind, soul, and senses and its importance is immense due to its natural and holistic approach toward physical and mental health. Ayurvedic texts mention a wide range of plant species full of minerals and useful biochemical having medicinal properties. The introduction of Ayurveda in textbooks shall sensitize the learners about the Ayurvedic sciences and encourage them to explore biodiversity and work for its conservation and sustainable utilization.
- 6. Professor Y. Vimla, Pro-Vice Chancellor, CCS University, Meerut:** threw light on plant ecology and ethnobotany through her presentation. She stressed the need to make Indian traditional knowledge and the role of tribal people in enriching it the part of Biology curriculum. India has a very rich indigenous knowledge related to biodiversity and its applications as mentioned in Indian ancient texts. The physical geography in these texts has been defined through different names like Jangala, Aanoopa, and Sadharana, each listing the trees, vegetables, lakes and rivers, birdlife, and animals. Many of the drugs mentioned in these texts are according to the area of their origin (e.g., Maghadi from Maghada and Kashmarya from Kashmir). Ayurbotany or banausadhi Vigyan must be taught with the incorporation of knowledge from the pharmacognosy of local and readily available yet medically high-value herbs and plants.

- 7. Professor Kavita Shah, Dean & Head, Institute of Environment & Sustainable Development, BHU:** suggested through her lecture to make environmental education more relevant. It is often noticed that students are unable to correlate various environmental issues with their own life problems and therefore they remain unconcerned about environmental problems. Over-consumption lies at the heart of the environmental crisis, and education must teach consumption control. We can contribute towards biodiversity conservation and environmental welfare by changing our consumption patterns. This must be included in the biology textbooks.
- 8. Dr. M. Raghavan, IIT Hyderabad:** deliberated on the importance of the central nervous system (CNS) and suggested redesigning the topic given in Biology textbooks so that it may become central to the animal/human system. The musculoskeletal system, the brain, and the nervous system are extremely central to essential everyday functions like seeing, hearing, moving, walking, running, cognition, fear, memory and many more. The Indian knowledge system, especially Saankhya, Yoga and Ayurveda also believes in the central position of CNS. Both our current understanding of the functioning of CNS and the one mentioned in the Indian knowledge system are similar, but pedagogy adapted to describe CNS in the Biology textbooks is limiting and must be relooked at.
- 9. Dr. P. N. Ravindra, Associate Professor, NIMHANS, Bengaluru:** discussed the importance of epigenetics, altruistic behavior, circadian rhythm, etc. It is the need of the hour to study human biology so that students may understand the physiological functioning of the body, and derive inspiration towards implementing certain measures

related to emotional state and sleep patterns in day-to-day life to enhance health and well-being.

- 10. Dr. Kishore Chand Mohanty, Retired Academic Officer BSE, Odisha:** discussed the importance of health sciences and various practices, namely, diagnosis, treatment and prevention of diseases adopted for proper health or health care. Current medical practices developed to maintain and restore health based on prevention and cure strategy need people from multiple disciplines such as medical and health service managers, biomedical engineers, radiation therapists, dental hygienists, dieticians and nutritionists, occupational therapists, etc. Students must be given information related to all these disciplines as a part of their curriculum so that they may pursue their interests. Students must also be taught about the alternative systems of medicine, especially Ayurveda.
- 11. Dr. M. S. Chaitra, Head & Senior fellow, Indian Studies Unit, CESS, Bengaluru:** emphasized research-based methodologies be incorporated in the curriculum where a lot of free flow of inquiry should happen. He further emphasized if we want to see science flourishing to its full capacity, all stakeholders must work together for its strengthening and the state or any other similar body must have the least possible interference. The indigenous knowledge and practices in various fields particularly agriculture and medicine must be narrated to students through storytelling or similar interesting methods so that they develop an aptitude for biological sciences.
- 12. Dr. Sunil Kumar Srivastava, Associate Professor, SSN College, University of Delhi, Delhi:** delivered his lecture on various aspects of microbiology particularly the importance of microbes in human life and emphasized the need of strengthening various concepts of microbiology in

textbooks so that learners may be encouraged to explore the microbial world.

13. Dr. Rahul Kumar Singh, Assistant Professor, Department of Zoology, BHU: enlightened the audience with various ecological concepts and his work on the river Ganga. He gave a detailed account of the various components of the ecosystem and their functioning. He deliberated on the hazards of water pollution on aquatic life, especially fish of the river Ganga. He suggested the inclusion of various important environmental issues that have relevance in Indian context in Biology textbooks.

14. Dr. Ragav Kumar Mishra, Associate Professor at Department of Zoology, BHU: focused his lecture and discussion on how to promote research and innovation aptitude in students. He suggested that research-based inquiry should be introduced and textbooks must be written in such a way that the text must generate curiosity in the learners and encourage them to explore the topic on their own.

The last session on the second day of the symposium was the valedictory session that was graced by Professor Kailash C. Sharma, President, VBUSS, Dr. Jay Prakash Lal Ji, Institute of Agricultural Sciences, BHU, Professor S. P. Dwivedi, Dean of Academics, IIT, BHU, Dr Pankaj Jain, Founder, seed 2 Sapling and Shri Govind Chand Mahant, Vidya Bharti Akhil Bhartiya Sangathan Mantri.

The Symposium had been attended by more than 120 participants. The feedback given by the participants was very positive and insightful. The Symposium provided the requisite platform where brilliant minds met and brainstormed to discuss various issues related to Biology. The organizing core committee for the symposium made the event a grand success.



**DEVELOPMENT OF NEW TEXT
MATERIAL IN BIOLOGY TEXTBOOKS
IN THE LIGHT OF NEP 2020:
AN APPROACH PAPER**

Reforms in content writing and design of school textbooks in the light of National Education Policy-2020.

5.1. Introduction

Education is considered the foundation of any nation as it provides the necessary framework for the development of an equitable and just society towards the promotion of national development through utilizing full human potential. The world over new changes especially as a result of globalization and advancement in information technology are continuously changing the employment landscape that has necessitated a shift in the purpose of education from being totally content driven to being the vehicle for enhancement of critical thinking and problem-solving ability of the learners together with encouraging creativity. All this requires a multi-disciplinary approach, which helps learners to innovate, adopt and adapt to new ideas and skills. Education must build character, and bring change in the learners to be ethical, rational, compassionate, and caring while simultaneously preparing them for gainful employment.

The primary pedagogical tool available for educating students at the school level is textbooks. In our educational system, school

textbooks happen to be the easiest way of sharing a single narrative with millions of students coming from diverse cultural diversity occurring in India. Thus, textbooks are a very effective tool for ensuring standardized education amongst students, regardless of the location or economic status of the school. In India, the textbooks are developed based on the National Curriculum Framework (NCF). The framing of the new NCF is undergoing to implement National Education Policy (NEP) 2020 in letter and spirit. The preparation of NCF is a national task where various stakeholders that include the Central Government, different State Governments through their State Curriculum Frameworks (SCFs), and people are consulted. Further, this exercise has to essentially include a widespread public discourse on the content and design of school textbooks, fueled with discussions in academic circles and the public at large. The future syllabi and textbooks will be based on goals and competencies which will lead towards mapping core essentials with competencies, hence appropriately reducing the curriculum burden and focusing on holistic learning and development.

The present NCERT textbooks scarcely include the Indian contribution to science and technology. There is a need and an apt time to introduce the contribution of Indian scientists in the Indian education system who have contributed prominently in the field of Biology in the ancient, middle, and modern periods. This will help in sensitization of the disciples at the different levels of school as well as the university and make them proud of their rich heritage, and inspire them to take up similar activities. Indian scientists are doing path-breaking research in the fields of agriculture, medicine, biotechnology, cold region research, communications, environment, industry, mining, nuclear power, space, and transportation. Further, we have experts of global repute in the fields of astronomy and astrophysics, liquid crystals, condensed matter physics, molecular biology, virology, crystallography, software technology, and nuclear power, including defense research and development.

National Education Policy 2020 looks at an education system with Indian roots that would directly contribute to the transformation of India into a self-sustained developed country. The long-term sustainability of traditional economic and cultural systems is the result of traditional educational programs that established human nature and the environment completely in harmony with each other. Unfortunately, Indian traditional knowledge and wisdom have been undermined by colonial, industrial, and global mindsets. In general, this neglect led to the loss of knowledge, values, and skills of sustainable living in contemporary education which play a major role in regenerating the social and environmental values of our modern, wealthy, consumer-centered society. The best way forward is to incorporate the Indian knowledge system and include the contribution of Indian scientists in Indian textbooks to the possible extent with authenticity.

This approach paper compiles views and suggestions of renowned academicians, representatives of various organizations, and experts from across the country for the requisite reforms in content writing and design of school textbooks.

5.2. Areas of Focus

As per the recommendations of NEP 2020, related to the understanding about the relevance of the Indian knowledge system and its incorporation in the biology curriculum to make teaching-learning process holistic, enjoyable as well as engaging following areas are suggested for the consideration:

1. Contributions of India in the multidisciplinary fields of Life Sciences viz Ayurveda, Agriculture, Medicine and Surgery, Biotechnology, Plant and Animal Science in ancient India, and Indian Traditional Knowledge on Environmental Conservation should be compiled. Contributions of Nobel Laureates and other famous scientists of Indian origin in

the different fields of biological sciences viz. Sir Ronald Ross, Har Govind Khorana, Venkataraman Ramakrishnan, Sushruta, Birbal Sahni, Dr. Salim Moizuddin Abdul Ali, Panchanan Maheshwari, B. P. Pal, M. S. Swaminathan, Varghese Kurien, E. K. Janaki Ammal, etc. should be incorporated in biology textbooks.

2. India has a long history of traditional medicine that is well established and integrated to cater to the needs of the human mankind including healthy and diseased. The Indian health system has perhaps the world's largest community-based indigenous system of medicine deals with a holistic approach. Indian system of Medicine comprises Ayurveda, Unani medicine, Siddha, Yoga, and Naturopathy. Ayurveda is one of the oldest systems of medicine that adopts a holistic approach towards physical and mental health. It treats various ailments of human body and mind using natural products which are mainly plant based. The medicinal texts and glossaries penned by the ancient Ayurvedic experts and great physicians are of immense value as they contain valuable information gathered over the centuries of study and practice. This treasure of knowledge must be researched and validated as per the standards of modern science. The important principles of the Ayurveda must be included in the biology textbooks.
3. Health and well-being are the most essential for individual and societal progress. The yoga and yoga science and philosophy, which are promoted world over. The new findings related to the effect of yoga on the body and mind must be taught to students so that students may know the benefits as well as take up yoga research as their future endeavour.

Understanding human biology helps students to learn about the physiological functioning of the body, and to get inspired to implement certain measures in a day-to-day life to enhance health and well-being. The musculoskeletal system, the brain, and the nervous system are extremely central to essential everyday body functions like seeing, hearing, moving, walking, running, cognition, feelings, and memory. This topic is also central in Indian knowledge system, specifically in the Samkhya, Yoga, and Ayurveda indicating a unanimity between the modern understanding and the Indian knowledge system. However, this approach is absent in current pedagogy and must be incorporated in the biology textbooks.

Furthermore, in human physiology in the chapter -Endocrine health and well beings'- details of chakra glands should be correlated with endocrine glands as they are responsible for regulating a range of bodily functions viz. metabolism, growth, development, reproductive functions, heart rate, blood pressure, appetite, sleeping and waking cycle, body temperature, depression, obesity, decrease in concentration, etc. The correlation between the Indian diet, lifestyle, yoga, exercise, meditation, and medicine should be compiled.

4. Agriculture has been the basic need of humankind from the dawn of civilization. For the last 50 years, farmers have been dependent on synthetic pesticides and fertilizers to maximize crop yield. While on the other hand harmful agrochemicals decrease the quality of the produce and damage the soil, environment, and overall ecosystem. Contrary to this Vedic Agriculture or Natural/ Organic Farming makes soil, water, air, and overall, the ecosystems completely free from toxic chemicals, pesticides, and other harmful elements and protect the biodiversity, and maintains long-term

sustainability. The system also consumes less energy and reduces runoff-induced pollution. It also facilitates healthy soil formation and combats the effects of global warming. The fundamentals of the organic farming which are similar to Indian traditional agriculture mentioned in the ancient Indians literature must be taught to students along with modern agriculture.

Further, India has a huge potential in Aquaculture due to its vast coastline area, which is an important source of food and nutrition, and revenue for India. Fish and fish products are one of the largest groups of agricultural exports in the Indian basket. A brief paragraph should be added on Aquaculture to promote entrepreneurship and to make awareness about its potential in the Indian economy.

5. Indian region is one of the greatest emporia of ethnobotanical wealth & a storehouse of traditional knowledge. This profound traditional knowledge can provide solutions to some of the current and future problems and is a source of unparalleled opportunities for research and product development. Added to this, the Indian region supports an enormous biodiversity of ancient lineage. A section related to ethnobiology should be added to the curriculum.
6. The correction in NCERT textbooks on controversial points should be focused on. e.g., the Wrong diagram of monocot root in plant anatomy, mint is considered as an example of stolon in Morphology of flowering plants, etc.



Chapter – 6

THEMATIC HIGHLIGHTS

Integration of the Indian knowledge System in the Biology Curriculum

India is one of the most diverse countries with multiple languages, traditions, religions, and practices. However, we have failed to appreciate our Indigenous knowledge, diversity, and wisdom which has resulted in the alienation of our youth from the Indian knowledge system, which is richer in its discourses than any other knowledge system. One of the reasons for alienation was the colonial system of education adopted during British rule in India. The colonial system of education disregarded the Indian knowledge system as the colonial education had the agenda to civilize and enculture the masses rather than develop them as leaders or independent beings. Even after 75 years of independence, the Indian education system is heavily based on the colonial education system. Globalization has yet again geared the shift towards a single global converging curriculum which may further lead to the marginalization of indigenous knowledge systems and the exclusion of learners coming from that context. Thus, it is important to understand the relevance of the Indian knowledge system and locate it in the present curriculum appropriately. Indigenous knowledge includes a local community's traditional technology; social, economic, and philosophical learning grounded in spirituality, skills, practices, and ways of being in nature. It encompasses many areas from farming

to law and psychology to mathematics. Efforts to integrate this knowledge into formal schooling via the biology curriculum should focus on the environment, living in nature, agriculture, technology, food, plant uses biodiversity, ayurvedic medicine, etc. With the integration of the Indian knowledge system in the education system, Indian children will find education easy and interesting to correlate better and practice in their day-to-day life as the Indian knowledge system is an integral part of their culture. Hence, there is a dire need to include Indian knowledge in the school curriculum. NEP 2020 strongly recommends the inclusion of the Indian knowledge system in the curriculum. At the same time, it focuses on competency-based learning to have pace with the fast-changing world. Competency-Based Education (CBE) is an outcome-based approach to education in order to ensure proficiency in learning by students through the demonstration of the knowledge, skills, values, and attitudes required for dealing with real-life situations at the age and grade-specific levels. The ultimate aim of civilization is the progress of humankind instead of science and machinery.

Contribution of Indian Scientists to Biological Sciences

Sushruta: commonly called the “Father of Plastic Surgery”, was a great physician and surgeon in ancient India around 2500 years ago. He developed several surgical procedures, including the procedure for reconstruction of the lost nose popularly known as the Indian method of rhinoplasty. His work on the subject, the Sushruta Samhita (Sushruta's Compendium) is considered one of the oldest texts in the world on plastic surgery. This book in addition to all aspects of general medicine has a detailed description of more than 300 surgical procedures, which used to be performed with the help of various surgical instruments numbering around 120, and has classified human surgery into seven categories namely, excision, scarification, puncturing, exploration, extraction, evacuation and suturing. The

Sushruta Samhita is one of the most important surviving ancient treatises on medicine, which is considered a foundational text of Ayurveda.

Some of Sushruta's contributions include various surgical techniques of making incisions, probing, extraction of foreign bodies, alkali and thermal cauterization, tooth extraction, and excisions. He also described the removal of the prostate gland, and urethra, hernia surgery, and caesarian section. He described different bones and their reaction to injuries and mentioned six types of dislocations and 12 varieties of fractures. He wrote about 76 signs of various eye diseases, symptoms, prognosis, medical/surgical interventions, and cataract surgery. There is also a description of a method of stitching the intestines by using ant heads as stitching material. He even introduced the use of wine to minimize the pain of surgical incisions. Sushruta provided details of almost 650 drugs of animal, plant, and mineral origin. Sushruta Samhita emphasizes the well-being of children and expectant mothers. Sushruta had also written in detail about the types of poisons and methods of poisoning, the symptoms of poisoning, first-aid measures, and long-term treatment. The Sushruta Samhita was translated into Arabic and later into Persian. These translations helped to spread the science of Ayurveda far beyond India.

Sir Ronald Ross: a Nobel laureate born on May 13, 1857, in Almora (Uttarakhand), was a British medical doctor. As a kid, he saw many people including his father suffering from malaria which left an impression in his mind. As an army doctor, a large part of his work was to treat malaria patients. Ronald Ross studied malaria between 1882 and 1899 and established the complete life cycle of the malaria parasite. In 1897, he proved that the spread of malaria takes place through mosquitoes and confirmed the hypotheses previously put forward independently by scientists Alphonse Laveran and Sir Patrick. Till that time, it was believed that malaria was caused by breathing in bad air and living in a hot, humid, and

marshy environment. In the medical school of Osmania University, Secunderabad, he discovered the presence of the malaria parasite within a specific species of mosquito of the genus *Anopheles*. Ross made his crucial discovery by dissecting the stomach of a mosquito feeding on the blood of a malaria victim. He found the previously observed parasite. He contributed majorly to the epidemiology of malaria and brought a method to its survey and assessment. Most importantly, he made mathematical models for further study. In 1902, Ross was awarded the Nobel Prize in Medicine for his remarkable work on malaria and was conferred Knighthood as a mark of his great contribution to the world of medicine. In India, Ross is remembered with great respect and love. The Regional Infectious Disease Hospital at Hyderabad was named after him as the -Sir Ronald Ross Institute of Tropical and Communicable Diseases- in recognition of his services. The building where he worked and actually discovered the malaria parasite, located in Secunderabad near the old Begumpet airport, is now a heritage site and the road leading up to the building is named Sir Ronald Ross Road.

Jagadish Chandra Bose: born on November 30, 1858, in Mymensingh (now in Bangladesh) was the nationalist Indian scientist known for his contribution to physics and plant physiology. He obtained his BSc degree from Christ College, Cambridge in 1885. He joined as Lecturer at Presidency College, Kolkata at half of the salary of his English colleagues. He protested this discrimination and refused to draw the salary on such terms. Ultimately, the college administration conceded his demands and he was paid his full salary. He was an outstanding teacher and engaged the interest of his students by making extensive use of scientific demonstrations. Many of his students such as S.N. Bose and Meghnad Saha later became famous scientists. He was the first to prove that plants too have feelings. He invented an instrument (crescograph) to record the pulse of plants to demonstrate his findings.

Birbal Sahni (1891-1949): born on 14 November 1891 at Bhera in Shahpur district (now in Pakistan), was a renowned paleobotanist. He worked as a professor of botany at Lucknow University, Lucknow, and studied the fossils of the Indian subcontinent. He was the founder of Birbal Sahni Institute of Palaeobotany, Lucknow. Palaeobotany is a subject that requires knowledge of both botany and geology. Birbal Sahni was the first botanist to study extensively the flora of the Indian Gondwana region. He also explored the Raj Mahal hills in Bihar, which is a treasure house of fossils of ancient plants. He discovered many new genera of fossil plants, especially *Williamsonia seawardiana*, *Sahnioxylon rajmahalense*, *Glossopteris angustifolia* Brongniart, and *Palmoxyylon sundram*. Sahni died on 10 April 1949, less than a week after laying the foundation stone of the Institute of Palaeobotany, which is the first of its kind in the world. This institute is now known as the Birbal Sahni Institute of Palaeobotany.

S.R. Kashyap (1882-1934): called the Father of Indian Bryology, was born on November 6, 1882, in Punjab. He obtained his M.Sc. degree in Botany from Punjab and went to Cambridge University for further studies. After completing his research degree he joined Government College, Lahore. Professor Kashyap was the first Secretary of the Indian Botanical Society and was elected its President in 1925. He was elected President of the Botany section of the Indian Science Congress in 1919 and a Fellow of the Indian Academy of Sciences in 1934. Although he did some work on Pteridophyta, he is known mainly for his work on Bryophyta. Two of his books are very famous- 'Liverworts of Western Himalayas and Punjab Plains Part I (1929) (S.R. Kashyap) and Part II (1932) (Kashyap and Chopra). He discovered 4 new genera and 30 new species of Liverworts. His theory of Retrogressive Evolution in Liverworts (Marchantiales) is well-accepted by bryologists around the world.

K.C. Mehta (1892-1950): a plant pathologist, was born in Amritsar in 1892. He was famous for his research regarding the recurrence of rust in the plains of India. He obtained his M.Sc. degree in 1914. He was appointed Assistant Professor of Botany at Agra College in 1915. In 1920 he went to Cambridge University where he worked on the Black Rust of Cereals. On the basis of his research on the recurrence of Black rust in the plains of India, he concluded that the infection (uredospores) spreads from the Himalayas in the North and Nilgiri and Puleny Hills in the south. He presided over the session of the Indian Botanical Society in 1939.

M O P Iyengar (1886–1963): was a prominent Indian phycologist, who is called the Father of Indian Phycology. He was born on 15th December 1886 in Madras (Chennai). After completing his education, he became a Professor of Botany at the Presidency College, Chennai in 1920. He did his Ph.D. under the supervision of Professor F.E. Fritsch, a doyen of algae in 1930. He pioneered algal research in India and was elected as the first President of the Phycological Society of India. He worked extensively on the algal flora of India and discovered many new genera such as *Ecballocystopsis*, *Fritschiella*, *Gilbertsmithia*, and *Characiosiphon*. Several taxa have been named after him including *Iyengaria*, *Iyengarina*, *Iyengariella*, and *Parthasarathiella*.

Ram Nath Chopra (1882–1973): called as the 'Father of Indian Pharmacology' was born on August 17, 1882 at Gujranwala, Punjab (now in Pakistan). He went to the Downing College, Cambridge in 1903 for higher studies after completing his studies at the Government College, Lahore. He was selected for the Indian Medical Services in 1908 and became the first Professor of Pharmacology at the Calcutta School of Tropical Medicine in 1921. The expertise of his work was the experimental pharmacology. He carried out varied kinds of studies pertaining to general pharmacology and chemotherapy. The indigenous drugs constituted an important

segment of his research, and gave an impetus to research on Indian medicinal plants. Consequently, several indigenous drugs, such as ispaghula, kurchi, rauwofia, psoralea, and cobra venom became official in the Indian Pharmacopoeial List 1946 and Pharmacopoeia of India (1955). Chopra and associates carried out a pioneering work on *Rauwolfia serpentina*, a plant that gained prominence two decades later as a source of reserpine. In 1933, it was reported that an alkaloid obtained from the plant on experimental studies in animals showed central depressant properties and lowered the blood pressure. He authored several books, for instance, *Indigenous Drugs of India*, *Glossary of Medicinal Plants of India*, and *Poisonous Plants of India* which became the most enduring and popular encyclopedia of Indian medicinal plants. His efforts toward promotion of Indian systems of medicine were noteworthy. The recommendations of the Committee on Indigenous Systems of Medicine at which he presided brought focus on the Indian systems and the process for their consolidation started and a beginning was made for preparing the Ayurvedic and Unani pharmacopoeias through the respective committees chaired by him. He was conferred the Knighthood in the 1941 and was nominated the general president of the Indian Science Congress (1948). The Indian Pharmaceutical Association elected Sir Chopra as an honorary member and conferred on him the Dr. E. R. Squibb award for his outstanding contributions.

Dr. Hargovind Khorana: received the Nobel Prize in Physiology or Medicine in 1968 along with M.W. Nirenberg and R.W. Holley for the interpretation of the genetic code, its function, and protein synthesis. Till his death, he was the Alfred P. Sloan Professor of Biology and Chemistry Emeritus at MIT. The Government of India honored him with Padma Vibhushan in 1969. He won numerous prestigious awards, including the Albert Lasker award for medical research, the National Medal of Science, the Ellis Island Medal of Honor, and so on. But he remained modest throughout his life and

stayed away from the glare of publicity till 95. In a note after winning the Nobel Prize, Dr. Khorana wrote: 'Although poor, my father was dedicated to educating his children and we were practically the only literate family in the village inhabited by about 100 people. Following in his father's footsteps, Dr. Khorana imparted education to thousands of students for more than half a century. He was more interested in the next project and experiments than cashing in on his fame. He was born into a poor family in a small village in Punjab, and by dint of sheer talent and tenacity rose to be one of science's immortals.

Venkataraman Ramakrishnan: born on April 1, 1952, in Chidambaram (Tamil Nadu), deciphered the complex function and structure of the ribosome, which fetched him the Nobel Prize for Chemistry in 2009, along with Thomas E. Steitz, USA, and Ada E. Yonath, Israel. He became the fourth scientist of Indian origin to win a Nobel Prize after Sir C.V. Raman, Har Gobind Khurana, and Subrahmanyam Chandrasekhar. After graduating from the Maharaja Sayajirao University of Baroda, Vadodara, Venkataraman Ramakrishnan went to the United States for further studies and completed his Ph.D. from Ohio University in 1976. He began his career as a Postdoctoral Fellow with Peter Moore at Yale University, where he worked on ribosomes and continued to work on ribosomes from 1983 to 1995 in Brookhaven National Laboratory. Later, he moved to the Medical Research Council Laboratory of Molecular Biology, England, where, he began detailed research on ribosomes. In 1999, his team published a 5.5-angstrom resolution structure of the 30S subunit of the ribosome and subsequently submitted the complete structure of the 30S subunit of the ribosome that created a sensation in the field of structural biology. Venkataraman earned a fellowship from Trinity College, Cambridge, and the Royal Society. He is also an honorary member of the US National Academy of Sciences. In 2007, he was awarded the Louis-Jeantet Prize for his

contribution to Medicine. In 2008, he was presented with the Heatley Medal of the British Biochemistry Society. For his contribution to science, he was conferred with India's second-highest civilian award, the Padma Vibhushan in 2010.

Lalji Singh (1947-2017): popularly known as the "Father of Indian DNA fingerprinting", was born on 5Th July 1947 in the Jaunpur district of Uttar Pradesh. He completed his education at Banaras Hindu University, Varanasi, and joined the Centre for Cellular and Molecular Biology (CCMB), Hyderabad as Senior Scientist in 1987. At CCMB, he developed and established DNA fingerprinting technology for the forensic investigation of crime and civil disputes. He served as the Director of the Centre for Cellular and Molecular Biology (CCMB) from 1998 to 2009. He also worked in the areas of the molecular basis of sex determination, wildlife conservation forensics and evolution and migration of humans, and DNA-based molecular diagnosis and treatment of genetic disorders. In 2004, the Indian Government conferred him the Padma Shri in recognition of his contribution to Indian science and technology. He founded various institutes and laboratories in India, including the Centre for DNA Fingerprinting and Diagnostics in 1995, the Laboratory for the Conservation of Endangered Species (LaCONES) in 1998, and the Genome Foundation in 2004, aiming to diagnose and treat genetic disorders affecting the Indian population, in particular the under-privileged people residing in rural India. He also served as the Vice Chancellor of Banaras Hindu University (BHU) and Chairman of the Board of Governors of the Indian Institute of Technology (BHU), Varanasi.

Dr. Salim Moizuddin Abdul Ali (1894-1987): the famous ornithologist-naturalist, was born on 12th November 1896, in Mumbai. He is also known as the 'Birdman of India'. He pioneered a systematic survey of birds in India. His research work has shaped the course of ornithology in India to a great extent. Ali failed to get an

ornithologist's position at the Zoological Survey of India due to a lack of a proper university degree (He was a college dropout). Therefore, he decided to study further after he was hired as a guide lecturer in 1926 at the newly opened natural history section in the Prince of Wales Museum in Mumbai. He went on study leave in 1928 to Germany, where he got trained under Professor Erwin Stresemann at the Zoological Museum of Berlin University. On his return to India, in 1930, he was unable to find a suitable job, so shifted to Kihim, a coastal village near Mumbai, where he began making his first observations of the Baya or the Weaver bird. The publication of his findings on the bird in 1930 brought him recognition in the field of Ornithology. Salim Ali was very influential in ensuring the survival of the Bombay Natural History Society (BNHS) and managed to save the 200-year-old institution. Dr. Ali's influence helped save the Bharatpur Bird Sanctuary and the Silent Valley National Park. In 1990, the Salim Ali Centre for Ornithology and Natural History (SACON) was established at Anaikatty, Coimbatore, aided by the Ministry of Environment and Forests (MoEF), Government of India. He was honoured with a Padma Vibhushan in 1976. He died at the age of 90, on 20th June 1987.

Panchanan Maheshwari: He was born in November 1904 in Jaipur, Rajasthan, Panchanan Maheshwari is a famous biologist. During his college days, he was inspired by Dr. W. Dudgeon, an American missionary teacher. Maheshwari invented the technique of test-tube fertilization of angiosperms. Till then no one thought that flowering plants could be fertilized in test tubes. Maheshwari's technique immediately opened up new avenues in plant embryology and found applications in economic and applied botany. Cross-breeding of many flowering plants which cannot cross-breed naturally can be done now. The technique is proving to be of immense help to plant breeders. Maheshwari's teacher once expressed that if his student progresses ahead of him, it will

give him great satisfaction. These words encouraged Panchanan to enquire what he could do for his teacher in return. Dudgeon had replied, Do for your students what I have done for you. Meticulously following his teacher's advice, he did train a host of talented students. He pursued his postgraduate university education in Botany at Allahabad University. He went on to establish the Department of Botany at the University of Delhi as an important centre of research in embryology and tissue culture. The department was recognized by the University Grants Commission as the Centre of Advanced Studies in Botany. Maheshwari was assisted by his wife in the preparation of slides in addition to her household duties. Way back in 1950, he talked about contacts between embryology, physiology, and genetics. He also emphasized the need for the initiation of work on the artificial culture of immature embryos. These days, tissue culture has become a landmark in science. His work on test tube fertilization and intra-ovarian pollination won worldwide acclaim. He founded an international research journal *Phytomorphology*, which he continued editing till his death in May 1966, and a popular magazine *The Botanica* in 1950. He was honoured with the Fellowship from the Royal Society of London, the Indian National Science Academy, and several other institutions. He also wrote books for schools to improve the standard of teaching life sciences. In 1951, he founded the International Society of Plant Morphologists.

B.P. Pal (1906-1989): He has been ever known as a famous agricultural scientist, born in Punjab on 26 May 1906. His family later moved to Burma (presently known as Myanmar), then a British colony, to work as a medical officer. Pal studied at St. Michael's School in Maymyo, Burma. Apart from being a brilliant student, Pal was fond of gardening and painting. In 1929, Pal qualified for Masters in Botany at Rangoon University where he also won the Matthew Hunter Prize for topping all science streams at the

University. He was awarded a scholarship that permitted him to pursue his postgraduate education at Cambridge. Dr. Pal worked with Sir Frank Engledow on hybrid vigour in wheat at the famous Plant Breeding Institute. This provided the basis for the design of the Green Revolution, essentially based on the commercial exploitation of wheat hybrids. In March 1933, Dr. Pal was appointed Assistant Rice Research Officer in the Burmese Department of Agriculture. In October, of the same year, he moved to Pusa, Bihar, to become the Second Economic Botanist at the Imperial Agricultural Research Institute, which was renamed the Indian Agricultural Research Institute (IARI) in 1947. IARI was earlier located in Pusa, Bihar, but after a severe earthquake that damaged its main building, the institute was shifted to New Delhi in 1936. Dr. Pal was the first Indian Director of the IARI in New Delhi, and the institute was named Pusa in 1950. He continued to serve in that capacity until May 1965, when he became the first Director General of the Indian Council of Agricultural Research (ICAR). He held this position from May 1965 to January 1972, during which period the Green Revolution was launched with outstanding success. Dr. Pal's major contribution to the scientific aspects of the Green Revolution was in the area of wheat genetics and breeding. He observed that rust disease was largely responsible for low yields of wheat and, therefore, developed a systematic breeding method to develop varieties with resistance to rust disease. Then India was reeling under a severe food crisis and was known in the world as a country of starving people. Dr. Pal was instrumental in changing India's global image and it soon became an exporter of food grains. Dr. Pal was also a rose breeder of distinction and created several varieties. He was the founder and President of the Rose Society and Bougainvillea Society. He also founded the Indian Society of Genetics and Plant Breeding and edited the Indian Journal of Genetics and Plant Breeding for 25 years. He was elected as a Fellow of the Royal Society in 1972. He

was awarded the Padmashri in 1959, the Padma Bhushan in 1968 and the Padma Vibhushan in 1987. He died on 14 September 1989

Varghese Kurien (1921-2012): known as the ‘Milk Man of India’, was born on 26th November 1921 in Kozhikode, Kerala. He is famously known as the architect of Operation Flood, the largest dairy development programme in the world. He engineered the White Revolution in India through the Anand model of cooperative dairy development, which turned India into the largest milk producer in the world. He is the founder of the Gujarat Cooperative Milk Marketing Federation, the cooperative organization that manages the Amul food brand, a globally recognized Indian brand. Kurien and his team were pioneers in inventing the process of making milk powder and condensed milk from buffalo milk. Quality-packed milk, which is pasteurized, packaged, branded, and owned by farmers, is now available throughout the length and breadth of India. He was awarded the Padma Vibhushan in 1999. He passed away in September 2012.

Mankombu Sambasivan Swaminathan: was born on 7th August, 1925 in Kumbakonam, Tamil Nadu. He successfully executed the ‘Green Revolution, a programme that made India self-sufficient in cereal production by adopting modern agriculture techniques such as high-yielding crop varieties, fertilizers and pesticides, and water. The Time magazine placed him in the Time’s 20 list of the most influential Asian people of the twentieth century. He is the Founder and Chairman of the M.S. Swaminathan Research Foundation. He nurtured a vision to see a world devoid of hunger and poverty and advocated the cause of sustainable development. He also emphasized the preservation of biodiversity. Swaminathan brought to India the wheat grains developed in Mexico by Norman Borlaug. After crossbreeding them with local varieties, developed new high-yielding wheat varieties. Today, India grows over 100 million tons of wheat a year, compared to 12 million tons in the early 60s. He served as the Director General of the Indian Council

of Agricultural Research from 1972–79 and became Union Minister for Agriculture from 1979–80. He also was the Director General of the IRRI and became President of the International Union for the Conservation of Nature and Natural Resources. He received the Ramon Magsaysay Award for Community Leadership in 1971 and Indira Gandhi National Integration Award.

E. K. Janaki Ammal: was an Indian botanist who conducted scientific research in cytogenetics and phytogeography. Her most notable work involves those on sugarcane and eggplant. She had collected various valuable plants of medicinal and economic value from the rain forests of Kerala. Janaki Ammal was born in 1897, in Thalassery, Kerala. From 1934–39, she worked as a geneticist at the Sugarcane Breeding Institute, Coimbatore. Ammal made several intergeneric hybrids: *Saccharum* x *Zea*, *Saccharum* x *Erianthus*, *Saccharum* x *Imperata*, and *Saccharum* x *Sorghum*. The Chromosome Atlas of Cultivated Plants which she wrote jointly with C.D. Darlington in 1945 was a compilation that incorporated much of her own work on many species. She was appointed as Officer on Special Duty to the Botanical Survey of India (BSI) in 1952. She served as the Director General of the BSI. Following her retirement, Ammal continued to work focusing special attention on medicinal plants and ethnobotany. She settled down in Madras in November 1970, working as an Emeritus Scientist at the Centre for Advanced Study in Botany, University of Madras. She lived and worked in the Centre's Field Laboratory at Maduravoyal near Madras until her demise on 7 February 1984. Ammal was elected Fellow of the Indian Academy of Sciences in 1935, and of the Indian National Science Academy in 1957. The University of Michigan conferred an honorary LL.D. on her in 1956. The Government of India conferred the Padmashri on her in 1977. In 2000, the Ministry of Environment and Forestry of the Government of India instituted the National Award of Taxonomy in her name.

Ayurveda

Ayurveda (Ayur means life, Veda means knowledge) is probably the oldest structured system of medicine in the world. Ayurveda predicts life as a union of the body, mind, soul, and senses. The human body is seen as a complex integrated network of interconnected systems namely the humors, the structural components, the tissues, and the excretions, or waste materials. Proper knowledge about various ailments, diseases, symptoms, diagnoses, and cure is the basis of Ayurveda. Ayurveda has eight branches: General Medicine (Kaya Chikitsa), Surgery (Salyatantra), Ophthalmology-ENT-Dentistry (Salakatantra), Paediatrics (Kaumar bhrtya), Psychiatry (Bhutavidya), Toxicology (Agadatantra), Rejuvenative Medicine (Rasayantantra) and Reproductive Medicine (Vajikarantantra).

The Charaka Samhita is one of the two Ayurvedic fundamental treatises, the other being the Sushruta Samhita. This foundational text of the ancient science of Ayurveda was authored by Charaka, long before the birth of Hippocrates. Charaka organised the treatise into eight sections or *ashtanga sthanas*, namely, Sutra, Nidana, Vimana, Sarira, Endriya, Chikitsa, Kalpa, and Siddha. Each section comprised many chapters. Later, the author, Dhabala added seventeen chapters to the Charaka Samhita. According to this book, there are four key components to medical practice, i.e., patient, physician, nurse, and medication. All four components are necessary for rehabilitation and restoring health.

Charaka, referred to as the Father of Indian Medicine was the first physician to present the concept of digestion, metabolism, and immunity in his book. The Charaka Samhitā gives the earliest reference to the genetic basis of diseases. Further, it points out that the reproductive element is composed of seeds (bīja), having further parts (bījabhāga) and subparts (bījabhāgāvayava). Each part or subpart of a seed represents a particular organ of the body and damage to any part can damage the organ.

Medical ethics penned by Charaka are universal and are equally relevant in the current scenario. He had been an early proponent of the “Prevention is better than cure” doctrine. Charaka’s ancient manual on preventive medicine remained a standard work on the subject for two millennia and was translated into many foreign languages, including Arabic and Latin.

The surgical method known as Shalya tantra in Ayurveda is one of the ancient techniques known to Indians. The Indian surgery flourished and reached its acme at Suśhruta’s time, around the 2nd century BCE. Suśhruta is now revered as the father of surgery and advocated a thorough study of anatomy by dissecting the dead body. He introduced the method of sterilizing surgical instruments to prevent sepsis after surgical procedures. Suśhruta Saṃhitā, the compendium of Suśhruta, describes more than a hundred types of surgical instruments and many of them resemble instruments used by modern surgeons. Suśhruta is recognized for having developed innovative surgical procedures like reconstruction of the nose or rhinoplasty (plastic surgery), use of a specific species of ants as dissolvable sutures to close the intestines, surgical removal of the cataract, and surgical management of urinary calculi.

The Indian rhinoplasty technique was re-discovered by Western medicine in the 18th century when the East India Company surgeons Thomas Cruso and James Findlay witnessed Indian rhinoplasty procedures at the British Residency in Poona. The surgeons published photographs of the procedure and its nasal reconstruction outcomes in the October 1794 issue of the Gentleman’s Magazine of London.

Suśhruta Saṃhitā also describes communicable diseases and epidemics, explaining that disease can be transmitted from one person to the other by close contact, through the air, sharing of clothes, sleeping together, etc. Fumigation is mentioned as a measure to prevent infectious diseases from spreading. Charaka Saṃhitā devotes an entire chapter to epidemiology and prescribes

methods to prevent and manage the outbreak of epidemics. During the period of King Aśhoka, an efficient public healthcare system was established.

The Ayurvedic pharmacopoeia represents a continuous and unfinished quest for discovering new medicines from natural resources. About 1,500 medicinal plants have been described and formulated into thousands of medicines in the tradition of Ayurveda. Hundreds of animals and animal products have also been mentioned in the texts. Around the 6th century in the Common Era, the branch of medicine specializing in the use of minerals and metals known as Rasaśāstra developed and established itself, especially in the North of India. The older tradition of herbal medicines continued to be practiced in India's southern states.

Ayurveda nurtured a pluralistic approach to healthcare in India. From ancient times, healthcare in India developed in the two streams of folk and classical expressions. India has a rich tradition of folk medicine, which was organized into a paramedical force of health practitioners, bonesetters, poison healers, and birth attendants who delivered primary healthcare to the people. Many of these traditions are still practiced, especially in remote rural India.

Today, India is perhaps the only country in the world that officially recognizes a pluralistic healthcare system patronizing medical systems like Ayurveda, Yoga and Naturopathy, Unani, Siddha and Homoeopathy. Ayurveda benefited from cross-cultural interactions and spread out of India into neighboring countries like China, Sri Lanka, Tibet, Thailand, and Indonesia. Buddhism played a major role in the spread of Ayurveda outside India. When Alexander the Great invaded India in 325 BCE, he was so impressed by the snakebite healers and Ayurvedic physicians that he invited them to Greece.

Important textbooks of Ayurveda like Charaka Saṃhitā, Suśruta Saṃhitā and Aṣṭāṅga Hṛdaya were translated into Tibetan,

Persian and Arabic languages in the Middle Ages. Travelers from China and the Middle East narrated in their accounts the advanced state of medical practice in India. It is evident that the textbooks of Ayurveda like Charaka Saṃhita (General Medicine), Sushruta Saṃhita (Surgery), and Kasyapa Saṃhita (Paediatrics) were edited and revised several times over one thousand years and attained their current form in the first few centuries of the Common Era.

The history of Ayurveda reveals the evolution of a vibrant and dynamic medical tradition with compendia, medical lexicons, pharmacopoeias, handbooks, and manuals of treatment being composed at important chronological and geographical landmarks. For example, in the 8th century CE, a treatise devoted exclusively to diagnostics was composed by Mādhava known as Mādhava Nidāna. In the 11th century, a new treatise was composed on dietetics by Viśvanātha Sena called Pathyāpathyaviniścaya. In the 13th century the Śārngadhara Saṃhitā was composed on the subject of pharmacy and pharmaceuticals, providing the first description of the physiology of respiration. When pulse diagnosis was introduced in Ayurveda, independent treatises were composed on the subject. This tradition of constant updating and documentation of medical knowledge continued uninterrupted right up to the colonial period.

In the 19th century, Ayurveda suffered a setback when unfavourable policies and regulations were enforced by the colonial rulers. However, with the publication of the main Ayurvedic texts, a revival set in around the turn of the 20th century, with a few leading Indian scholars coming out in defence of the discipline. In the post-independence period, Ayurveda's resurgence continued, and in recent years it has been gaining prominence as a whole system approach to healthcare under the banner of Complementary and Alternative Medicine. Ayurveda is taught and practiced in many countries including Germany, Italy, the United Kingdom, Austria, and the Netherlands.

Ayurveda must be introduced in the secondary stages of modern education so that one may learn about the ideal mindset of a medical practitioner from an early age. Nursing and caring for people and personal health must be valued in the general sense.

Yoga

Yoga is the precious gift of India to humanity whose innumerable benefits have not only been validated but also accepted globally. Consequently, the United Nations has declared the 21st of June as World Yoga Day. The practice of yoga brings harmony among the body, mind, and consciousness (soul), and, hence, contributes immensely to the wellbeing of the physical, mental, and spiritual health of a person.

Since antiquity, yoga is being practiced in India, and lord Shiva is considered the first yogi (adi yogi) as well as the first guru (adi guru) of yoga in Hindu mythology. The foundational text of yoga philosophy is Yog-Sutra which was written by Patanjali, perhaps in the first century CE. Yoga-Sutra contains 194 sutras (aphorisms) and proposes eight elements (astangas), namely, yama (abstinences), niyama (observances), asana (yoga postures), pranayama (breath control), pratyahara (withdrawal of the senses), dharana (concentration of the mind), dhyana (meditation) and samadhi (absorption) of yoga.

Yoga is based on Samkhya philosophy. A central question in the study of nervous systems revolves around the interaction of the world as understood by us. This also happens to be a central question in the Samkhya and Yoga shastras. Samkhya describes a taxonomy of self, based on sense organs, motor organs, and the distinct roles of Manas as a hypothesis generator, Buddhi as a decision-making faculty, and Ahankara as the 'Self' that is sought to be preserved and continued through evolution. It makes clear distinctions between the structural and functional aspects of organs, once again an important step that

modern science also recognizes. Yoga further takes the study of the functioning of the brain a step ahead in describing the different modes such as cognition, sleep, memory, etc., and also describes the calm state of Yoga that abolishes all these modes. The design of the Astangas or eight steps in Yoga is a very fine construction that recognises the interactions between body and mind. Similarly, the system of Yoga asanas even from a physical perspective demonstrates a very good understanding of the musculature and joints of the body and their use in various tasks.

The ultimate goal of yogic sciences is not only to attend to optimum physical and mental health but also to elevate the level of unconsciousness of an individual practicing it. The pathway of mechanism for attaining such goals may be vivid but one thing is very much clear for attaining such goals one has to understand follow and nourish the body and mind simultaneously. In that way, the psychology of yoga has its importance. Its basic principles need to be documented in terms of modern physiology and psychology. It is the need of today.

The linkage between the mind and body, particularly about Yogic sciences, was widely accepted in ancient wisdom, but later on, an artificial dichotomy between these two components was created. Modern medical science focuses, only on the body as something which is apart from the mind. However, the psychosomatic linkage has now got its due importance by both modern medicine practitioners and therapists of Indian tradition. It has now been proved by scientific research beyond doubt that yoga practices bring in better balance equilibrium in the autonomic function and metabolic rate on one hand and neurohumoral functions on the other hand so that the state of both physical and mental wellbeing is achieved.

Yoga and meditation practice contribute to health and well-being in three important ways. First, it changes Neural plasticity;

second, it reduces stress, and third, it increases the activity of the vagus nerve. Through regular practice of yoga/meditation, various networks in the brain get modulated and strengthened, and the mechanism is termed neural plasticity. For example, yoga/meditation practice is known to reduce mind wandering and increase attention because a reduction in mind wandering increases attention. This happens because the suppression of areas associated with mind wandering which is the default mode of neural networking in the brain strengthens neural networking responsible for attention or concentration. With this process, the time taken to get into a focused state lowers down, and the attention span increases. Skill to enhance attention is considered to be the basic brain process that is involved in enhancing memory, reducing stress, increasing good mood, and also resilience (capacity to overcome negative mood). Yoga and meditation practice is also known to increase vagal activity. The Vagus nerve is an important cranial nerve that supplies all the organs including the lungs and heart. Enhanced vagal activity is known to improve the health of the heart, lungs as well as brain. This will also help in improving cognition and emotion. Enhanced vagus activity is also one of the basic mechanisms associated with the capacity to effectively handle stressful situations. Thus, yoga is known to enhance overall cognition, emotion, physical and psychological health, and well-being.

Agriculture

Regarding agriculture, it is a generally perceived notion that 'India is an agrarian country' even after 75 years of independence. Agriculture is still considered the backbone of India's economy because agriculture and related activities generate maximum employment, although the service sector contributes the maximum to our national income. Most Indians still make their livelihoods from the country's farmland. Two aspects make the agricultural sector important to

our country. One is the need to feed our ever-growing population without depending on food imports. And, second is to support the basic strength of any economy. While short-term growth spurts can be achieved by economic activities based on value addition (like the services sectors), for the long-term health of an economy and for it to have strong basics, primary sectors that generate products (such as agriculture) need to be strong.

Post-independence, our agricultural sector was suffering from many ills, including a lack of irrigation facilities, inequitable distribution of land, and almost zero use of technology to improve production. We were heavily dependent on importing grains to feed our population. The introduction of the Green Revolution is supposed to have saved the lives of the Indian population. That was the turning point for our agriculture and we have been moving ahead from there. Several measures were introduced to improve agricultural production along with the use of high-yielding crop varieties. In this task, Dr. M.S. Swaminathan and his team played a major role. The other steps taken include the development of irrigation facilities, use of chemical fertilizers, pesticides, and insecticides, land reforms and consolidation of land holdings under chakabandi, use of mechanized instruments in land tilling, harvest and post-harvest functions, easier and smoother availability of agricultural loans and rural electrification to facilitate running of farm machinery. Simultaneously, the government also invested in opening agricultural universities and research laboratories to develop indigenous technologies. This led to the development of wheat and paddy crop varieties that are typically suited to our climate and the vagaries of the monsoon—flooding or droughts—are pest resistant and have better yields, thereby lowering the risks for farmers. Unfortunately, post-Green Revolution, there were very few changes made in our approach to agriculture and as a result, production suffered. This occurred despite the high-yield crops we talked about previously.

What we have realized is that over the last couple of decades, the total land area under production has decreased, our population has kept increasing as ever and our agricultural productions have been forced to cope with the growing demand. Unfortunately, this had caused long and indiscriminate use of chemicals in our farms. Farmers no longer depend on any natural manures or crop rotation to revitalize their fields. Long use of synthetic chemicals leads to fields reaching their maximum capacity of production while the weeds, pests, and insects grow resistant. Now is the ideal time for a second Green Revolution.

For the past decade, agricultural scientists have been focusing on finding organic alternatives to chemical fertilizers and insecticides and there has been some considerable success. Irrigation facilities have also been improved and people are getting more conscious of maintaining a stable underground water table. The plans are to make our fields less dependent on the monsoons, thus eliminating a highly variable factor from production. Initiatives are concentrating on completing rural electrification with a dependable power supply and recycling groundwater through techniques like rainwater harvesting. By consulting agricultural scientists, farmers can better determine the specifics of when to use what kind of chemical aids, and the precise quantum to be used precisely and as organic supplements to use so that they can give better yields without over-stressing the land. This has decreased the indiscriminate use of chemicals in our farms and, hence, the contamination of neighboring areas and water resources too. There is a growing trend of soil testing and field evaluations of local conditions, which has enabled the researchers to provide better suggestions to the farmers. This has made the process of farming much more scientific and has also reduced the expenses of the farmers as now they have to use specific amounts of fertilizers or pesticides.

In Indian agriculture, indigenously developed farming techniques and fertilizers were invented much ahead of time. It

included soil testing techniques, crop rotation methods, irrigation plans, the application of eco-friendly pesticides and fertilizers, and storage methods for crops. It is believed that agriculture was developed at least 10000 years ago and since then it has undergone significant changes. Further, the majoritarian view is that agriculture was developed independently in northern and southern China, Africa's Sahel region, New Guinea, and several regions of America, and later on in India. But ancient literature of India such as Bhagavat-Gita, Rig Veda, and Atharveda contain very specific details on agriculture like crop cultivation, manuring, classification of herbs, and different varieties of plants suggesting a very rich knowledge of agriculture. It is also evident that agriculture (Krishi) finds extensive mention in the text, such as Krishi Parashar, Kautilya-Arthshastra, Sangam literature of early Tamil, Manu smriti, Varahamihira's Brihat Sanhita, Amarakosha, Kashyapiya-Krishisukti and Surapala's Vriksh Ayurveda. These texts provide information about agriculture, horticulture arboriculture, and plant biodiversity. In Rig-Veda, there is a sloka- “पृथीयदवावैच्य” (8.9.10), means Prithi (Prithu) the son of king Vainy was the first inventor of Krishi Vidya. Therefore, more systematic and historical evidence is needed to substantiate who was the first to start agriculture and where it started.

Ethnobotany, Ecology and Biodiversity in Traditional Indian Knowledge

Topics taught under plant sciences are well documented in ancient Indian literature. Discussions on plant science can be seen in Vedic literature, the epics, and various compendia. Sources like Arthasastra of Kautilya contain very interesting passages relating to the harvesting and management of crops, crop diseases, and many other aspects of agroforestry. Some of the concepts of Ecology and biodiversity were composed by Maharshi Ved Vyas at the end of Dwapara Yuga (~4th Century BC). Puranas contain sufficient

information on many avenues of knowledge explored by Indians of the Puranic times. Thus, a student of biology can neither avoid nor overlook the Puranas and other texts.

Our ancestors used to live in harmony to the nature and realized the importance of natural resources including plants. Plants have been the close natural associates of humans as the source of food, drug, shelter, and cloths since the early days of human civilization. Consequently, different plants based on their importance were considered as the “Tree of Life or Existence”. Various Indian texts such as Vedas, Puranas, Upanisadhas, etc., mention a number of trees of existence such as asvattha (*Ficus religiosa*), vata (*Ficus benghalensis*) udumbara (*Ficus glomerata*), bael (*Aegle marmelos*), ashoka (*Saraca asoca*), coconut (*Cocos nucifera*), mango (*Mangifera indica*), and sandalwood (*Santalum album*). In Indian literature, asvattha (peepal tree) and vata (banyan tree) are two prominent trees of existence. Atharva Veda mentions of asvattha tree as the abode of the gods. The asvattha tree is considered the abode of the Trimurti (Brahma, Vishnu and Mahesha). The roots of asvattha tree are the form of Brahma, trunk is the form of Vishnu and other aerials parts as the form of Shiva. In Bhagvad Gita, Krsna (an incarnation of Lord Vishnu) proclaims himself to be the asvattha tree. In Vedic literature asvattha tree is considered to be the tree of knowledge (brahma taru) as well as the tree of life (jivana taru). Skanda Purana declares the asvattha tree “the most sacred of all trees” and its worshiping destroys all misfortune, and leads to the achievement of ultimate liberation (moksha). In contrast, cutting an asvattha tree ends up in hell. Vata (nyagrodha) is another sacred tree which is considered the tree of immortality in Indian knowledge system. According to Matsya Purana, when the great dissolution of the world (pralya) occurs, among all life forms akshya vata alone survives and Lord Vishnu stays at this tree during the period of the state of dissolution.

Barhat Samhita of Varahamihira composed in the 6th Century CE has an entire chapter devoted to Vrksayurveda. Agni Purana also includes a chapter on the topic. Cakrapanidatta puts forth the theory that plants have feelings and cognitive abilities. There are also independent works on the subject like Surapala's Vrksayurveda and Upavana Vinoda of Sarngadhara. The legacy of Vrksayurveda has also been preserved through folk traditions in oral form. The farming and tribal communities constitute the largest repository of the working knowledge of plant science in India. Surapala applied the dosa theory to plants to provide several recipes for plant protection and treatment, depending on the particular dosa imbalance affecting the plants. Many of the ingredients he lists have been shown to possess antimicrobial properties. Among them are milk (elephant milk at times!), ghee, honey, licorice, cow urine, and dung, various liquid manures, mustard, pastes made of various barks and roots, asafetida, turmeric, sesame oil, salt, and ash; the flesh, fat or marrow from various animals (mammals and fish) that were also recommended in specific cases.

Further, Ayurvedic literature refers to plants and their classification into forest trees, other trees, shrubby plants, and herbs. Shrubby plants are either climbers or shrubs and herbs are flowering and non-flowering. Flowering and non-flowering trees are also distinguished. Vrksayurveda includes topics like collection, selection, and storage of seeds, germination, and sowing, various techniques of plant propagation and grafting, nursing and irrigation, testing and classification of soil, selection of soils suitable for various plants, types of plants, manuring, pest and disease management, nomenclature and taxonomy, description and classification of plants to get varied purposes, favourable and unfavourable meteorological conditions. Use of plants as indicators of weather, water, and minerals as well as botanical marvels.

The Indian Council of Agricultural Research (ICAR) has documented 4,879 indigenous practices in the field of traditional

plant science. A set of 111 indigenous technical practices were selected and subjected to experimental testing and validation in efforts that were conducted by several ICAR institutes and state agricultural departments and universities across the country. These pertain to various topics such as pest control, crop protection, farm implements, weather forecasting, etc. It was shown that around 80% of these practices were valid and about 6% were partly valid. Vrksayurveda promises many new areas for fresh research initiatives like the study of meteorological conditions (tithi, nakshatra) that are suitable for various agricultural operations in the cultivation of crops, increasing plant growth and yield, testing and classification of soil and use of plants as indicators for water, minerals and weather. The Indian knowledge system is a valuable source of ethnobotanical, ecological, and biodiversity-related information, which must be introduced to students so that they may get acquainted with Indian flora and its importance.

Other aspects that may be incorporated in the Biology Curriculum

It is the need of the hour to understand the application of biology to achieve optimal health and well-being. Health and well-being are the most essential for individual and societal progress. The study of neurophysiology as a part of human biology can be helpful in implementing certain measures in day-to-day life to enhance health and well-being. The gut-brain axis (GBA) consists of bidirectional communication between the Gastro-intestinal tract and the Brain influencing emotion, cognition, and the immune system. Microbes in the gut are the modes of communication with the brain. Microbes are known to influence mood, anxiety, cognition; most importantly memory as well. The nutritive value and contents of food determine the type of microbes that will be developed in the gut. Highly nutritious food and probiotics are known to enhance good microbes

that will bring good psychological effects. These good microbes are known to increase the turnover of serotonin, GABA, and trophic factors in the brain which are responsible for reducing anxiety, depression, and mood swings and enhancing cognition. Further, these good gut microbes also enhance the health of gastrointestinal system by protecting the intestinal barrier, enteric nervous system, and gut mucosal immune regulation. Thus, the type of food that we consume will determine to enhance good microbes.

In the digestive process, oral digestion is the first and most important step. In this process, the enzyme 'salivary amylase' present in saliva helps in the breakdown of carbohydrates. However, the stimulus for the secretion of saliva is touch, the smell of food, and the mental state of an individual while having food. Therefore, a proper way of eating food with a calm mind is important for digestion.

Sleep is one of the important aspects of life for health and well-being. Sleep is divided into two categories, non-rapid eye movement (NREM) and rapid eye movement (REM) sleep. NREM sleep is further divided into light sleep (stages N1 and N2) and deep sleep (stage N3). REM sleep is the sleep stage where most of the dreams occur with a higher degree of. 6-7 hours of sleep is needed every day for optimal physical and mental functions. Either sleep restriction or deprivation leads to many immediate, short-term and long-term adverse effects. Adequate sleep is important for repair and rejuvenation, rewiring of the brain, memory consolidation, enhanced immunity and have balanced mood. The following are the factors that need to be followed to have proper sleep:

1. The timing of sleep and wake should be constant.
2. Avoid screen time, and texting, at least one hour before sleep time.
3. Avoid the consumption of coffee, and tea, in the late evening.
4. Early dinner is better for sleep.

5. Avoid heavy exercise late in the evening (however, walking is good).
6. Tobacco and alcohol are not good for sleep.
7. Follow any relaxation technique (light music, deep breathing) before going to sleep.

The current texts have a disproportionate emphasis on the anatomy of the Musculoskeletal and Nervous systems. As against this, a physiological approach is advocated, which helps answer very relevant questions, such as, how do we see, how do we hear, how do we remember, how do we move, how do we grasp, how do we eat, and many more such questions.

We, indeed, need to move away from giving out facts to focus on developing knowledge - an aggregated interlinked set of facts. In the current text cherry-picked facts are presented, but do not leave the reader with a coherent understanding of how the brain or musculoskeletal system works. Modern biology has embraced mathematics in a big way, especially systems biology. However, our textbooks still rely on very verbose text to describe systems. We need to move to a concise description of systems in biology using mathematical expressions.

Aquaculture is the farming of aquatic animals, including finfish, crustaceans, molluscs, *etc.* and aquatic plants, mostly algae, using the wide-ranging freshwater, seawater, brackish water and inland saline water. Fish and fish products have emerged as the largest group in agricultural exports in India, with 10.5 lakh tonnes in terms of quantity and 33,442 crores in value. More than 50 different types of fish and shellfish products are exported to 75 countries around the world. This accounts for around 10% of the total exports of the country and nearly 20% of the agricultural export. Indian Fisheries and aquaculture are important sectors of food industry, providing nutrition.

In the budget of 2018-2019, the facility of Kisan Credit Card was extended to the farmers engaged in fisheries, aquaculture and animal husbandry, and a dedicated fund of Rs. 10,000 crores to develop the sector was allocated. Fish production also contributes around 1% to India's gross domestic product and over 5% to the agricultural GDP. Aquaculture resources in India include 2.36 million ha of ponds and tanks, 0.798 million ha of floodplain lakes, in addition to 195210 km of rivers and canals, and 2.907 million ha of reservoirs, that could be utilized. So, a brief paragraph should be added on Aquaculture to promote entrepreneurship and to apprise the students of the huge potential of the Indian economy in this field.

Futuristic Agenda as per NEP-2020

NEP-2020 asks to reclaim, re-articulate, and restructure the Bhartiya self for becoming a global leader (Vishwaguru), where equity, equality, and fraternity will be celebrated. The vision of NEP 2020 is to incorporate the Indian knowledge system (IKS) into the curriculum. Specifically, in the Biology curriculum, there are a lot of scopes to infuse Indian knowledge and rather it should be the foundation of the curriculum. Biology is the science of the living world and the role of human beings in developing and discovering knowledge through interactions with the environment is based upon real experiences. The Vedas, Upanishads, and other texts should be referred to for including the concepts related to environmental sustainability, agriculture, medicine, conservation, *etc.* and their significance for the present times should be discussed. Also, the importance of our IKS for addressing many of the environmental issues in contemporary times should be deliberated in the textbooks. Also, there are different methods for collecting information on IKS, depending upon the type of information, situation, people, social system, cultural values, and other aspects which should also be

given in textbooks. Along with this, the curriculum should focus on specific competencies and learning outcomes that should be identified/ developed for Biology at the senior secondary level.

As advocated by NEP, textbooks should encourage experiential learning. For instance, instead of pouring out facts and expecting the student to digest the same, questions need to be constructed that lead the student to the intended state of understanding. For instance, to motivate the fact that skeletal muscles move bones at joints, one may ask the question “How do we move our hands”? Are there places where they bend? What happens when you feel your biceps and triceps as you do different exercises? When is the biceps taut? When is it lost? Can you create a model with sticks and ropes that mimic the way your muscles pull the bones? What is the role played by joints? To promote an experientialist theme in the true sense, one needs to move away from the sole reliance on textbooks to actively using videos, and multimedia over mobile phones and tablets as experiential textbooks.

Science can be taught based on the science of nature (srushti gyan), the science of health (ayur-vigyan), the science of sound (Vaani vigyan) science of materials (Padartha vigyan), the science of building (Vaastu-vigyan) in a gradually structured way from the foundational to higher secondary stages of 5+3+3+4 NEP knowledge system.

In the curriculum, multiple sets of well-translated textbooks in local contexts across India must be prepared to emphasize the wider context of the learner’s relevance to the subject matter. India’s ancient and cultural scientific and knowledge systems must be interwoven with the text appropriately.

Philosophy of operation and contribution to humanity of AYUSH system and their perception of well-being and falling ill.

- Introducing Charak and Sushruta and their medical-surgical advances.

- Considering the diet, seasonal foods, natural produce and culinary habits as medicine.
- The related banasthali vigyan is to identify the habits, tastes, chemical constituents, and actions in the local indigenous method. Naturally, this is in order to use it in diseases and treatment in Ayurved.
- Local knowledge about the use and worship of flora and fauna will be understood along with the scientific principle underlying. The social and geographical communities have to be studied in the project.
- Analysis and critical appreciation of nature and science.
- Prevocational skills with local Vaidya and use of herbs as medicine.
- Testing of chemicals occurring in the leaves, stems, flowers, and fruits of the different plants.
- For the ethnobotany, plants used by different tribal populations of India be recorded to save their eco-knowledge of less economic investment and high medicinal value.
- Concept of sacred groves and ecosystem conservation.

The entire school education curriculum will be reoriented to develop holistic learners with higher-order skills of critical thinking, creativity, logical deduction, collaboration, social responsibility, multilingualism, quantitative reasoning and digital literacy. This all will be accompanied by context and motivation, and the post accompanied by analysis, discussion, and application

Ayurveda involves evidence-based learning and incorporates different complex scientific techniques in a simple manner. This will inculcate scientific temperament in students regarding useful herbs and plants. Evidence-based thinking and a scientific temper are the considerable key ingredient in teaching students to “learn how to learn” and it will lead to establishing them as lifelong learners.

Today's students knowing the usefulness and applications of various plants will lead to a society living in harmony with nature.

With a long civilization history, India has a rich body of knowledge and experience captured through a variety of literary works on various subjects including Ayurveda. Capacity-building and professional development of Biology teachers to impart this ancient Indian knowledge lucidly to the next generation through the usage of new-age information technology tools.

Pedagogical Innovations and Presentation

The Indian knowledge system is a unique cumulative body of knowledge and practices related to the natural environment of a specific geographical area in India, developed by people over generations. It is embedded in the culture as well as spirituality and is expressed in stories, songs, proverbs, and language. It has been passed through generations but now there are fewer opportunities, especially for children, to spend time with and learn from parents, grandparents, and others who are knowledgeable. Developing a cooperative learning environment with an equal role of learners and community members is vital for incorporating indigenous knowledge into the formal education system. There is a need to develop a self-sustaining model of learning and knowledge generation at the community level. These models should be able to adapt according to the needs of the local community. Project-based work and activities will be the most important pedagogical strategy for incorporating indigenous knowledge into the science curriculum. At the senior secondary level, students may take up the task of analysis and interpretation of the collected data. Also, Indigenous knowledge incorporation will require the development of specific local teaching-learning material (TLM). Problem-solving and inquiry-based methods can be used as a pedagogical strategy. The learners should be given a problem or instructed to look for a

problem related to agriculture, medicine, sanitation, water scarcity, etc. ICT can also be an interesting and innovative pedagogy for incorporating indigenous knowledge into the science curriculum. Preparing videography, photography, and PowerPoint presentation of rare medicinal plants, indigenous water management practices, different indigenous irrigation methods, etc., so that everyone can experience the diversity.

The currently used pedagogical methods for teaching-learning are largely based on detailing and description of facts. This makes it monotonous and kills the curiosity that is the driving force in science. Instead, an inquiry-based approach where students are encouraged to find solutions through a series of observations is recommended. The outcomes of these experiments are an appreciation or discovery of the working principles. For instance, instead of describing the different bones and muscles in the body, the student may be encouraged to touch, feel and identify the muscles in the body responsible for different actions and movements. Once they physically locate the same, the names may be given out. Extensive use of storytelling style in textbook writing is advocated. For instance, in the case of the description of hearing, the process can be described as a story starting from the arrival of sound waves at the ear. Only as many details as is required to understand the processing of the auditory signal at each stage may be given, taking the student through Malleus, Incus, Stapes, conversion of frequencies into spatial activation along the cochlear membrane, mechanism of spatial localization of sound by inter-aural time and intensity differences in superior Olive, spatial maps of the inferior colliculus, representation in primary and secondary auditory cortices. The processing through successive stages constitutes the story of sound as it passes from the ear to the brain. Excessive details more than just required to understand the processing may be eschewed at each step. “Less is more” should be the key philosophy of textbook writing.

The project activity-based learning should involve preparing the herbarium seeds and their study of different plants. Experience should be collected through case studies. The learning outcomes of the students should be achieved through collaborative approaches. Stories should be related to medicine and food habits in the local cultural context.

Experiential learning should provide hands-on learning by reflecting on the experience of local professional persons in various fields like farmers, gardeners, electricians, vaidyas, etc.

Ayurveda Curriculum must focus on the ICT based information about the composition of medicines and mapping of the medicinal herbs:

- Experiential learning, hands-on exposure to herbs, and tools essential for making medicine.
- Interdisciplinary coursework with the use of modern gadgets and techniques.
- 3D movies, interactive mobile and computer applications regarding various sections of studies of Ayurveda like – herbs glossary, Sushruta's anatomical models and surgical tools, *etc.*
- Schools must partner with local community members and Vaidyas to provide integrated support and diverse knowledge to the students
- Project-based examinations for identification and preparation of herbs and herbal medicines.
- The use of local language and culture and the inclusion of indigenous practices shall make the curriculum more engaging and relevant.

Thus, a fundamental reorientation now needs to occur with the development of new assumptions in education which treat the

interactions of ecological processes, market forces, cultural values, equitable decision-making, government actions, and environmental impacts of human activities in a holistic, interdependent manner.



Chapter - 7

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