

Biotechnology

Textbook for Class XII



(2150)

विद्यया ऽ मृतमश्नुते



एन सी ई आर टी
NCERT

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OFFICES OF THE PUBLICATION DIVISION, NCERT

NCERT Campus
Sri Aurobindo Marg
New Delhi 110 016

Phone : 011-26562708

108, 100 Feet Road
Hosdakere Halli Extension
Banashankari III Stage
Bengaluru 560 085

Phone : 080-26725740

Navjivan Trust Building
P.O. Navjivan
Ahmedabad 380 014

Phone : 079-27541446

CWC Campus
Opp. Dhankal Bus Stop
Panihati
Kolkata 700 114

Phone : 033-25530454

CWC Complex
Maligaon
Guwahati 781 021

Phone : 0361-2674869

Publication Team

Head, Publication Division : Anup Kumar Rajput

Chief Production Officer : Arun Chitkara

Chief Business Manager : Vipin Dewan

Chief Editor (In charge) : Bijnan Sutar

Production Assistant : Sunil Kumar

Cover and Layout

DTP Cell, DESM

Foreword

NCERT prepares quality curricular material for its stakeholders at all levels of school education. *Biotechnology* is a new addition in the series of textbooks for students at the higher secondary stage. It is always considered important that a smooth transition of students occur from the secondary stage to the higher secondary stage. At the secondary stage, children pursue science as an integrated subject, whereas specific subject disciplines are offered at the higher secondary stage.

Biotechnology being an applied subject, involves the understanding of fundamentals of the components of Biology, Chemistry and Physics. Keeping this in mind, basic principles of organisms, cell and molecules have been discussed in the textbook of *Biotechnology* at initial level in Class XI. Thus, the learner can appreciate the basic aspects and principles with a focus on its applications. The applied aspects are dealt with in Class XII, where children have been given good exposure to understand as to how the basic cellular and molecular processes can be used for diverse applications for the welfare of society in general.

Such applications touch almost all aspects of human activities, like agriculture, health, food and nutrition, industry, and environment conservation. Keeping in view the cognitive domain of higher secondary students, attempts have been made to keep various aspects of applications of biotechnology in such a way that a smooth transition occurs from higher secondary to higher and technical level. As per the recommendations of the National Education Policy-2020, attempts have also been made to develop critical thinking analysing societal needs.

Being an applied subject, it is extremely crucial that children must develop skills to cope up with technological content of the subject. I do hope that the textbook would be up to the expectations of the stakeholders. Biotechnological researches have a great potential for exploring and establishing various enterprises with the industrial and commercial applications, therefore, an appropriate understanding of entrepreneurial skills among children pursuing the course is relevant. A chapter has been dedicated to this aspect as well. It is expected that this course of Biotechnology would be a perfect bridge between the secondary stage science and similar disciplines at higher and professional level.

I am confident that the development team has taken due care while preparing the manuscript about correctness, accuracy and appropriateness of the content. However, NCERT believes in the continuous improvement of our curricular materials, therefore, feedback and suggestions provided by different stakeholders would be of great help for further improving its quality and utility.

New Delhi
September 2022

Director
National Council of Educational
Research and Training

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Preface

Biotechnology, by definition, is an applied science and its applications are widespread. It is becoming increasingly evident that the role of biotechnology is increasing day by day. In the field of agriculture, biotechnological applications have helped in improving many crop varieties from the perspective of increased productivity, pest resistance, drought and salinity tolerance. Production of human growth hormone and insulin, diagnosis of various diseases whether genetic or infectious and development of a number of vaccines including the one against COVID-19 have become possible only because of the advancements in the area of biotechnology. Even in the field of environment protection and conservation, biotechnological tools have tremendously contributed through bioremediation of toxic substance on one hand to detection of toxic substance through biosensor and elimination of toxic substances from soil on the other. Last but not the least, advancements in the area of bioinformatics provide a tool which has predictive potentialities from the point of view of prediction of disease a person is likely to suffer in future and drug discovery. It is worth mentioning that new researches are pouring in at a very fast speed and therefore, the understanding of the subject has to be fundamental and critical to address future challenges.

In Class XI, students of biotechnology have already been exposed to the basic understanding of biomolecules, cell organisation with cellular processes, fundamentals of genetic and molecular principles, and various tools and techniques employed in the biotechnological study. Course content of the subject for Class XII largely dwells around the application of molecular and cellular principles besides employing different microbes for various beneficial usage. Also, appropriate emphasis has been given on the aspect of recent innovations and development happening in the area. Another important feature of the book is the component on entrepreneurship which would develop an appropriate understanding as to how a biotechnology-based enterprise can be established.

Attempt has been made to keep a continuity of the content of biotechnology for Class XII with that of the fundamentals studied in earlier class. There are five units in the book divided into thirteen chapters. Unit I with four chapters deals with the details of recombinant DNA (rDNA) technology and gene cloning in which the role of host and vector for transfer of gene or a segment of DNA for various applications have been detailed first. In Chapter 4, a few of the common and important applications of rDNA technology have been described. Unit II focusses on the aspect of genome engineering in which various advancements of DNA sequencing technology, genome editing, comparative genomics and protein engineering have been described. Unit III has five chapters in which the fundamentals and application of various culture techniques, be it culture of microbes, plant and animal tissues or stem cells have been prescribed. The usage of microbial and cell culture in most of the cases lead to the bioprocessing of various products. Accordingly, Chapter 10 of the Unit III deals

with this applied technology of bioprocessing and biomanufacturing. Unit IV with one chapter emphasises on the applied aspect of microorganisms and technology for the treatment of wastewater and sewage besides bioremediation of toxic substances especially pesticides. Unit V has two chapters, one on recent innovations in the field of Biotechnology and the other on various aspects about entrepreneurship skill and its development.

It is expected that the entire course of Biotechnology would be helpful for students in developing a critical understanding of the subject, its application, future prospects besides developing entrepreneurial skills.

I express my deep sense of gratitude and appreciation to U. N. Dwivedi, *Former Professor*, Department of Biochemistry and *Former Vice Chancellor* of University of Lucknow, for providing leadership in this endeavour of NCERT. This task would not have been accomplished without the contribution of the entire development team and their efforts are highly appreciated.

The department welcomes the comments as well as suggestions for bringing out further improvement in the textbook.

DINESH KUMAR
Professor and Member Co-ordinator
Department of Education in Science and
Mathematics

Textbook Development Committee

CHAIRPERSON

U. N. Dwivedi, *Former Professor and Former Vice Chancellor*, Department of Biochemistry, University of Lucknow, Lucknow

MEMBERS

Akash Ranjan, *Scientist*, Centre for DNA Fingerprinting and Diagnostics [CDFD], Hyderabad

Amit Dinda, *Professor*, Department of Pathology, All India Institute of Medical Sciences, Delhi

Animesh Kumar Mohapatra, *Professor*, Regional Institute of Education, Bhubaneswar

Anita K. Verma, *Professor*, Kirori Mal College, University of Delhi, Delhi

Chochong Vareichung Shimray, *Associate Professor*, Department of Education in Science and Mathematics, NCERT

G.B.N. Chainy, *Professor*, Department of Zoology and Biotechnology, Utkal University, Utkal

Indrakant K. Singh, *Associate Professor*, Department of Zoology, Deshbandhu College, University of Delhi, Delhi

Kusum Yadav, *Associate Professor*, Department of Biochemistry, University of Lucknow, Lucknow

Manoj K. Sharma, *Assistant Professor*, School of Biotechnology, Jawaharlal Nehru University, Delhi

Poonam Sharma, *Associate Professor*, Gargi College, University of Delhi, Delhi

Pushp Lata Verma, *Associate Professor*, Department of Education in Science and Mathematics, NCERT

Sarmistha Sarma, *Professor*, Institute of Innovation in Technology and Management, Delhi

Sunita Farkya, *Professor*, Department of Education in Science and Mathematics, NCERT

Veda Prakash Pandey, *CSIR Pool Scientist*, Department of Biochemistry, University of Lucknow, Lucknow

MEMBER CO-ORDINATOR

Dinesh Kumar, *Professor*, Department of Education in Science and Mathematics, Head, PMD and Dean (Research) NCERT

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THE CONSTITUTION OF INDIA

PREAMBLE

WE, THE PEOPLE OF INDIA, having solemnly resolved to constitute India into a ¹**[SOVEREIGN SOCIALIST SECULAR DEMOCRATIC REPUBLIC]** and to secure to all its citizens :

JUSTICE, social, economic and political;

LIBERTY of thought, expression, belief, faith and worship;

EQUALITY of status and of opportunity; and to promote among them all

FRATERNITY assuring the dignity of the individual and the ²[unity and integrity of the Nation];

IN OUR CONSTITUENT ASSEMBLY this twenty-sixth day of November, 1949 do **HEREBY ADOPT, ENACT AND GIVE TO OURSELVES THIS CONSTITUTION.**

1. Subs. by the Constitution (Forty-second Amendment) Act, 1976, Sec.2, for "Sovereign Democratic Republic" (w.e.f. 3.1.1977)
2. Subs. by the Constitution (Forty-second Amendment) Act, 1976, Sec.2, for "Unity of the Nation" (w.e.f. 3.1.1977)