Biotechnology

Textbook for Class XII

12150

विद्यया ऽमृतमश्नुते

एन सी ई आर टी
NCERT

राष्ट्रीय शैक्षिक अनुसंधान और प्रशिक्षण परिषद्
NATIONAL COUNCIL OF EDUCATIONAL RESEARCH AND TRAINING

12150 – BIOTECHNOLOGY
Textbook for Class XII

ISBN 978-93-5292-402-8

First Edition
February 2023 Magha 1944

PD 5T BS

₹ 435.00

OFFICES OF THE PUBLICATION DIVISION, NCERT

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Cover and Layout
DTP Cell, DESM

Printed on 80 GSM paper with NCERT watermark

Published at the Publication Division by the Secretary, National Council of Educational Research and Training, Sri Aurobindo Marg, New Delhi 110 016 and printed at Chandra Prabhu Offset Printing Works (P.) Ltd., C-40, Sector-8, Noida - 201 301 (U.P.)

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

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.

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Acknowledgements

The National Council of Educational Research and Training (NCERT) gratefully acknowledges the contribution of the individuals and organisations involved in the development of *Biotechnology* textbook for Class XII. The Council is grateful to Binay Panda, *Professor*, School of Biotechnology, Jawaharlal Nehru University, Delhi; Pawan K. Dhar, *Professor*, School of Biotechnology, Jawaharlal Nehru University, Delhi; Mohammad Mahfuzul Haque, *Professor*, Department of Biotechnology, Jamia Millia lslamia, Delhi; Vinod Kumar Srivastava, *Former Associate Professor*, Indira Gandhi Government College, Tezu, Arunachal Pradesh, for their contribution in the review of the manuscript.

The NCERT is highly thankful to Shweta Singh, *Joint Director*, Central Board of Secondary Education, Delhi; Anjulika Joshi, *PGT*, Mount Carmel School, Anand Niketan, Delhi; Sushil Kumar Dwivedi, *PGT*, Kendriya Vidyalaya, Aliganj, Lucknow; Payal Priyadarshini, *PGT*, Kendriya Vidyalaya, Delhi Cantt-3, Delhi; Pratibha Sharma, *PGT*, Kendriya Vidyalaya, JNU, Delhi and Ambika Nagrath, *PGT*, Army Public School, Dhaula Kuan; Upasna Chopra, *PGT*, Apeejay School, Panchsheel Park, Delhi; Dinesh Kumar Jamwal, Air Force Bal Bharti School, Lodhi road, Delhi; Ankit, *PGT*, Ahlcon International School, Mayur Vihar Phase 1, Delhi; Neva, *PGT*, Delhi Public School, R.K. Puram, Delhi; for their valuable suggestions.

The NCERT is also thankful to Bharat Biotech Pvt. Ltd., Dr. Banwarilal of The Energy and Resources Institute (TERI), for providing relevant information that was required for finalising a few chapters.

The Council also acknowledges the academic contributions of Ritika Gupta and Preeti Sharma, *Junior Project Fellows*, in finalising the manuscript. Contributions of Shilpi Singh, *Lab Assistant*; Suman Prajapati and Pooja Sharma, *Graphic Designers* and Rekha Sharma, *DTP Operator* for typesetting are also acknowledged. Without their effort, it would not have been possible to bring out the manuscript. Cooperation from Rajendra Singh, *Assistant Program Coordinator*, and his staff for their help in organising workshops and office logistics for the same is especially thanked.

The efforts of Soumma Chandra, *Editor* (Contractual), Chanchal Chauhan, *Assistant Editor* (Contractual), Surender Kumar, (Incharge, DTP Cell, NCERT), and Mohammed Aariz *DTP Operator* (Contractual) of the Publication Division, NCERT, in bringing out the first edition of this book are also highly appreciated.

Contents