

# Biotechnology

Textbook for Class XII



12150

विद्यया ऽ मृतमश्नुते



एन सी ई आर टी  
NCERT

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Textbook for Class XII

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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

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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

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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

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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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# Contents

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<i>Foreword</i>	<i>iii</i>
<i>Preface</i>	<i>v</i>
<b>Unit I: Recombinant DNA Technology</b>	<b>1–110</b>
<b>Chapter 1: An Overview of Recombinant DNA Technology</b>	<b>3</b>
1.1 An Overview of Recombinant DNA Technology	3
<b>Chapter 2: Host–Vector System</b>	<b>9</b>
2.1 Two Key Components of Recombinant DNA Technology	9
2.2 Host	10
2.3 Vector	10
2.4 Eukaryotic Host Vector System	20
2.5 Expression Vectors	22
2.6 Shuttle vectors	23
<b>Chapter 3: Gene Cloning</b>	<b>27</b>
3.1 Identification of Candidate Gene	27
3.2 Isolation of Nucleic Acids	28
3.3 Enzymes used for Recombinant DNA Technology	34
3.4 Modes of DNA Transfer	40
3.5 Screening and Selection	44
3.6 Blotting Techniques	48
3.7 Polymerase Chain Reaction (PCR)	52
3.8 DNA Libraries	59
<b>Chapter 4: Applications of Recombinant DNA Technology</b>	<b>67</b>
4.1 DNA Fingerprinting	67
4.2 Transgenic Organism	71
4.3 Gene Therapy	85
4.4 Recombinant Vaccines	90
4.5 Therapeutic Agents/Molecules: Monoclonal Antibodies, Insulin and Growth Hormone	98

**Unit II: Genome Engineering** **111–140**

**Chapter 5: Genome Technology and Engineering** **113**

5.1 Mapping of the Genome: Genetic and Physical	113
5.2 High-Throughput DNA Sequencing	118
5.3 Other Genome-related Technology	124
5.4 Genome Engineering	126
5.5 Structural, Functional and Comparative Genomics	130
5.6 Protein Engineering	132

**Unit III: Microbial, Plant, Animal Cell,  
Organ Culture and Bio processing** **141–252**

**Chapter 6: Microbial Culture** **143**

6.1 Historical Perspective	143
6.2 Nutritional Requirements and Culture Media	148
6.3 Sterilisation Methods	153
6.4 Pure Culture Techniques	156
6.5 Factors Affecting Microbial Growth	159
6.6 The Growth Curve	161

**Chapter 7: Plant Tissue Culture** **167**

7.1 Historical Perspective	167
7.2 Plant Cell and Tissue Culture Techniques	170
7.3 Nutrient Media	173
7.4 Culture Types	174
7.5 Applications of Plant Cell and Tissue Culture	176

**Chapter 8: Animal Cell Culture** **185**

8.1 Historical Perspective	186
8.2 Culture Media	187
8.3 Physical Environment for Culturing Animal Cells	190
8.4 Equipment Used for Cell Culture	193
8.5 Types of Animal Cell Cultures and Cell Lines	196
8.6 Cell Viability Determination	200
8.7 Advantages of Animal Cell Culture	202
8.8 Applications of Animal Cell Culture	202

<b>Chapter 9: Stem Cell Culture and Organ Culture</b>	<b>209</b>
9.1 Stem Cell Culture	209
9.2 Organ Culture	221
<b>Chapter 10: Bioprocessing and Biomanufacturing</b>	<b>231</b>
10.1 Historical Perspective	232
10.2 Instrumentation in Bioprocessing: Bioreactor and Fermenter Design	233
10.3 Operational Stages of Bioprocess	236
10.4 Bioprocessing and Biomanufacturing of Desired Products	246
<b>Unit IV: Bioremediation</b>	<b>253–288</b>
<b>Chapter 11: Bioremediation</b>	<b>255</b>
11.1 Waste Water Treatment	255
11.2 Solid Waste Management	265
11.3 Management and Disposal of Bio-medical Waste	272
11.4 Bioremediation of Pesticides	275
<b>Unit V: Recent Innovations in Biotechnology and Entrepreneurship</b>	<b>289–342</b>
<b>Chapter 12: Recent Innovations in Biotechnology</b>	<b>291</b>
12.1 Environmental Biotechnology	291
12.2 Plant Biotechnology	298
12.3 Regenerative Medicine	304
12.4 Nanobiotechnology	308
12.5 Synthetic Biology	315
12.6 Future Prospects	317
<b>Chapter 13: Entrepreneurship</b>	<b>323</b>
13.1 Concept of Entrepreneurship	323
13.2 Sources of Funds	328
13.3 Entrepreneurship in Biotechnology	329
13.4 Concept of IPR	332
13.5 Biopiracy	336

# THE CONSTITUTION OF INDIA

## PREAMBLE

**WE, THE PEOPLE OF INDIA**, having solemnly resolved to constitute India into a <sup>1</sup>**[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 <sup>2</sup>[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)