



A TEXT BOOK OF

# BIOTECHNOLOGY

CLASS - XII



**CENTRAL BOARD OF SECONDARY EDUCATION**  
**PREET VIHAR, DELHI - 110092**

## **Biotechnology : Class - XII**

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# Foreword To The First Edition

The Central Board of Secondary Education has been constantly striving for a qualitative improvement of education at school level for the past many years. It has to its credit many educational innovations. Introduction of new contemporary areas to school curriculum and updation of its syllabi in different subjects from time to time in the form of 'Frontline Curriculum' is one of the examples of many such innovations. The subject of Biotechnology has been introduced as an elective subject at senior secondary level from the academic session 2002-2003 as a follow up of this approach.

The Board has already published its own textbook as well as laboratory manual in the subject for Class XI during the preceding academic session. The present document aims at meeting the requirements of different content areas included in Class XII syllabus. Some of the major areas discussed in this publication include Protein Structure and Engineering, Recombinant DNA Technology, Genomics and Bioinformatics, Microbial Culture, Plant Cell Culture, Animal Cell Culture and their applications. Every care has been taken to lay due emphasis on applications of basic concepts in the subject to daily life situations, particularly in relation to agriculture, medicine, industry and environment. The complete set of instructional package also includes another document on laboratory manual for Class XII.

Eminent subject experts from Guru Gobind Singh Indraprastha University, University of Delhi, International Centre for Genetic Engineering and Biotechnology, All India Institute of Medical Sciences, National Institute of Immunology and Institute of Genomics and Integrative Biology have contributed to the writing of the original manuscript. The writing group, under the leadership of Prof. K. Kannan, Dean, School of Biotechnology, GGSIP University has worked overtime to develop the material in stipulated time. I would like to record my deep appreciation and sincere thanks to all the members of the writing group for their invaluable contribution in development of this material. I shall also thankfully acknowledge the untiring efforts put in by Prof. K. Kannan and Dr. K. Nirmala in editing the whole material and making it print worthy.

Shri G. Balasubramanian, Director (Academic), CBSE, deserves special appreciation for his innovative ideas and intellectual perception of the whole project. Deep appreciation is also due to Shri R.P. Sharma, Education Officer (Science) for his total involvement and commitment in coordinating different activities related to this publication.

Suggestions from users for further improvement of the document will be highly appreciated.

**Ashok Ganguly**  
**Chairman, CBSE**



# Foreword To The Second Edition

*T*he Central Board of Secondary Education, in its intent to facilitate growth through education at school level endeavours to update curriculum in various emerging areas of study. In this light Biotechnology was introduced as an elective subject at senior secondary school level in the academic session 2002- 2003.

Text book is an extension of the curriculum initiatives. It serves as a ready-to-access resource material, both for the teachers and the students.

This edition of Biotechnology text book for class XII has been revised in order to keep pace with the galloping advancement in technology on one front and increasing role of Biotechnology to manipulate and promote a productive and healthy life.

The demand from the teachers and the students through the website of the Board provided important feedback and need to revise the text book. In the present edition, though the scheme of chapters remains the same, there are inclusions that have a certain edge over the previous work for better conceptual connections, some of these are in terms of diagrammatic presentations and explanations.

The team of experts under the convenor Prof. M. V. Rajam, Department of Genetics, South Campus, University Of Delhi, invested their expertise, experience and willingness to revise the book. The effort of each member: Prof M.V. Rajam, Prof. J.S. Viridi, Dr. K. Nirmala and Dr. S. Ramachandran is appreciatively acknowledged by the Board. The work once taken up was efficiently owned up and zestfully completed.

The efforts of Sh. P. V. Sai Ranga Rao, former Education Officer (Science) for the inception of the whole idea and providing the necessary impetus and Dr. Rashmi Sethi, Education Office (Science) to coordinate and give final shape to the manuscript to its worthwhile completion, deserve a special mention as a team work.

The Board invites observations and suggestions from the readers to further upgrade the content and presentation of the text book in future as well.

**VINEET JOSHI**

CHAIRMAN

# Preface To The First Edition

A modern Biotechnologist does simple mathematical operations such as addition, subtraction, multiplication or division of bio-molecules in a cell to produce products of commercial value. One adds, subtracts, multiplies or divides a gene, which in turn changes the levels of a protein, which may in turn change the level of carbohydrates and lipids. A classical biotechnologist first used natural bio-factories (cells) to make products such as Curd, Ethanol, Penicillin, Insulin etc. Modern biotechnology on the contrary is making cells-do jobs which they have never done before. An instance being bacteria producing human insulin. Should biotechnology teaching-learning be incorporated at the senior secondary school level? Recall the impact created by the automobile industry in the 20th century. Till about 1930, most of the day to day used products were derived from plants, animals or microbes. Every new technological development brings about a change in life style. The advent of automobile industry brought in a sea of change in our life styles leading to the discovery of better and cheaper fuel such as petrol from oil fields. We saw the growth of the petroleum industry. This consequently produced several byproducts from oil. These petroleum-derived byproducts being cheaper, led to the development of technologies from these byproducts as raw materials during the period 1930's to 1960's. Chemical Engineers and Technologists created a whole range of synthetic products for daily use from petroleum byproducts. By the end of 20th century, 95% of the products of daily use were derived from petroleum byproducts and hardly 1 % from plants, animals or microbes. The reason was that the raw materials derived from nature were not economically viable to make products. Further no efforts were made to develop cheaper technologies from natural raw materials.

With the sudden increase in oil prices from 1973 onwards, natural products became cheaper as raw materials than oil based byproducts. Further, it was realized that oil is an unsustainable source in the long run whereas plants, animals and microbes (PAM) are everlasting. Thus in the scheme of sustainable development, plants, animals and microbes acquired special importance as well as helped in better environment management. USA has taken a policy decision that 20% of the products of daily use will be made from raw materials derived from PAM by 2020 and 50% by 2050. Indian economy heavily relies on oil and we incur billions of dollars in foreign exchange. Our nation has been bestowed with a rich biodiversity waiting to be explored for sustainable economic prosperity. Biotechnology holds the greatest promise for sustainable economic growth and make India a developed nation.

A Textbook of Biotechnology for class XII has been written with the hope that we will create a new breed of Biotechnologist, who is sensitive to the issue of economic slavery. The Textbook has been divided into two units and is a continuation of class XI Textbook.

We sincerely hope that the units covered in this book will enthuse the young minds who read them to think differently about Biology and the role it will play in fostering a new Biotechnology Culture.

Any textbook requires meticulous and painstaking efforts by all its contributors. We are grateful to all the contributors who have cheerfully revised and re-revised their sections to keep the subject level interesting and readable at the class XII level. In addition, several other have made contributions in reading and recommending changes wherever necessary and these include students from the School of Biotechnology, GGSIPU. Special thanks are due to Anjana, Neeraj, Bhavana, Shruti, Ritu, Nitika, Amit, Yasha, Archana, Aditya and Deepak Grover. We would like to acknowledge the assistance of Mr Sanjeev Kumar and Mr Amreesh Kumar in preparation of the book.

The Convener and the Resource team are ever so grateful to Mr. Ashok Ganguly, Chairman CBSE, Mr. G Balasubramanian, Director Academic and Mr. R P Sharma, Education Officer (Science), CBSE whose complete faith in the team has had an undoubted influence on much of the content. Without the help of these people, the book could not have seen the light of the day. I can only hope that they will all look upon the results of the influence and endeavor with pleasure. Wherever possible, credit has been given and if I have failed to acknowledge the source of an idea or a technique, it is because the source for some reason is unknown to me. In the rapidly expanding world of biotechnology, it is often impossible to know where the idea really originated.

We hope that all the budding biotechnologists will fulfill our dream and convert India into a sustainable developed nation.

**Prof. K. Kannan**

**Convener**

**CBSE Committee of Courses in Biotechnology**





# Preface To The Second Edition

The text book of Biotechnology was first introduced to the Senior Secondary School students to provide an overview of many of the fundamentals of Biology and Biotechnology as well as the potential applications of biotechnology in industry, health-care and agriculture, and to make them understand the impact of biotechnology on human welfare. This text book of Class XII Biotechnology was first published in March 2003. It has been nearly eight years since the first edition of this book appeared and since then much has happened in biotechnology in these intervening years. In fact, the developments in this area have radically altered our concepts of health-care and agriculture and this has been the main reason to bring out the second edition of this book. A collaborative effort has been made to present as updated content along with visual presentation for a better comprehension by the readers. We have condensed, improved and elaborated here and there, improved or replaced the existing diagrams and photos and added some new pictures, and done overall improvement of the book. Even though the various units and chapters remain, more or less, the same as in the first edition.

In preparing this second edition, I am grateful to the authors, Prof. J. S. Virdi, Dr. K. Nirmala, Dr. Vijay Kumar and Dr. S. Ramachandran for their academic contributions and support. I would also like to thank all the contributing authors of the first edition of this book, and a special thanks to Prof. K. Kannan, the former Convenor of the CBSE Committee of Courses in Biotechnology for his initiative and active participation in the first edition of this book. My sincere thanks are due to the former Chairman (Ashok Ganguly), Director (Dr. G. Balasubramanian) and Education Officer (Mr. R. P. Sharma) and the present Chairman (Mr. Vineet Joshi), Director (Mrs. Chitralkha Gurumurthy) and Education Officers (Science), Mr. P.V. Sai Ranga Rao and Dr. Rashmi Sethi, CBSE, New Delhi for constant support to bring out this book. I thank the Multigraphics for their meticulous work in producing this book.

I am indebted to some Biotechnology school teachers, particularly Ms. Vaishali Aggarwal, SLS DAV Public School, Mausam Vihar, Delhi-51, Ms. Shalu Bajaj and Dr. Supriya Sharma, Manav Sthali School, New Rajendra Nagar, New Delhi, for reviewing the chapters and providing valuable suggestions, which were important for the improvement of the book. Special thanks to Ms. V. Vineela for her help in preparing some diagrams for a chapter on rDNA technology.

Last but not least, I am grateful to my wife Padma for her loving support.

Suggestions for the improvement of this book would be gratefully acknowledged.

**Prof. M. V. Rajam**

**Convenor**

**CBSE Committee of Courses in Biotechnology**

# THE CONSTITUTION OF INDIA

## PREAMBLE

**WE, THE PEOPLE OF INDIA**, having solemnly resolved to constitute India into a **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 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)

# THE CONSTITUTION OF INDIA

## Chapter IV A

### Fundamental Duties

## ARTICLE 51A

### Fundamental Duties - It shall be the duty of every citizen of India-

- (a) to abide by the Constitution and respect its ideals and institutions, the National Flag and the National Anthem;
- (b) to cherish and follow the noble ideals which inspired our national struggle for freedom;
- (c) to uphold and protect the sovereignty, unity and integrity of India;
- (d) to defend the country and render national service when called upon to do so;
- (e) To promote harmony and the spirit of common brotherhood amongst all the people of India transcending religious, linguistic and regional or sectional diversities; to renounce practices derogatory to the dignity of women;
- (f) to value and preserve the rich heritage of our composite culture;
- (g) to protect and improve the natural environment including forests, lakes, rivers, wild life and to have compassion for living creatures;
- (h) to develop the scientific temper, humanism and the spirit of inquiry and reform;
- (i) to safeguard public property and to abjure violence;
- (j) to strive towards excellence in all spheres of individual and collective activity so that the nation constantly rises to higher levels of endeavour and achievement.

# भारत का संविधान

## उद्देशिका

हम, भारत के लोग, भारत को एक '[ सम्पूर्ण प्रभुत्व-संपन्न समाजवादी पंथनिरपेक्ष लोकतंत्रात्मक गणराज्य ] बनाने के लिए, तथा उसके समस्त नागरिकों को:

सामाजिक, आर्थिक और राजनैतिक न्याय,  
विचार, अभिव्यक्ति, विश्वास, धर्म  
और उपासना की स्वतंत्रता,  
प्रतिष्ठा और अवसर की समता

प्राप्त कराने के लिए, तथा उन सब में, व्यक्ति की गरिमा और '[ राष्ट्र की एकता और अखण्डता ] सुनिश्चित करने वाली बंधुता बढ़ाने के लिए दृढ़संकल्प होकर अपनी इस संविधान सभा में आज तारीख 26 नवम्बर, 1949 ई० को एतद्वारा इस संविधान को अंगीकृत, अधिनियमित और आत्मार्पित करते हैं।

1. संविधान ( बयालीसवां संशोधन ) अधिनियम, 1976 की धारा 2 द्वारा ( 3.1.1977 ) से "प्रभुत्व-संपन्न लोकतंत्रात्मक गणराज्य" के स्थान पर प्रतिस्थापित।
2. संविधान ( बयालीसवां संशोधन ) अधिनियम, 1976 की धारा 2 द्वारा ( 3.1.1977 से ), "राष्ट्र की एकता" के स्थान पर प्रतिस्थापित।

## भाग 4 क मूल कर्तव्य

51 क. मूल कर्तव्य - भारत के प्रत्येक नागरिक का यह कर्तव्य होगा कि वह -

- (क) संविधान का पालन करे और उसके आदर्शों, संस्थाओं, राष्ट्रध्वज और राष्ट्रगान का आदर करे;
- (ख) स्वतंत्रता के लिए हमारे राष्ट्रीय आंदोलन को प्रेरित करने वाले उच्च आदर्शों को हृदय में संजोए रखे और उनका पालन करे;
- (ग) भारत की प्रभुता, एकता और अखंडता की रक्षा करे और उसे अक्षुण्ण रखे;
- (घ) देश की रक्षा करे और आह्वान किए जाने पर राष्ट्र की सेवा करे;
- (ङ) भारत के सभी लोगों में समरसता और समान भ्रातृत्व की भावना का निर्माण करे जो धर्म, भाषा और प्रदेश या वर्ग पर आधारित सभी भेदभाव से परे हों, ऐसी प्रथाओं का त्याग करे जो स्त्रियों के सम्मान के विरुद्ध हैं;
- (च) हमारी सामाजिक संस्कृति की गौरवशाली परंपरा का महत्त्व समझे और उसका परीक्षण करे;
- (छ) प्राकृतिक पर्यावरण की जिसके अंतर्गत वन, झील, नदी, और वन्य जीव हैं, रक्षा करे और उसका संवर्धन करे तथा प्राणिमात्र के प्रति दयाभाव रखे;
- (ज) वैज्ञानिक दृष्टिकोण, मानववाद और ज्ञानार्जन तथा सुधार की भावना का विकास करे;
- (झ) सार्वजनिक संपत्ति को सुरक्षित रखे और हिंसा से दूर रहे;
- (ञ) व्यक्तिगत और सामूहिक गतिविधियों के सभी क्षेत्रों में उत्कर्ष की ओर बढ़ने का सतत प्रयास करे जिससे राष्ट्र निरंतर बढ़ते हुए प्रयत्न और उपलब्धि की नई उंचाइयों को छू ले।

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