

Biology

Textbook for Class XI



11080



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

2019-2020

ISBN 81-7450-496-6

First Edition

February 2006 Phalguna 1927

Reprinted

October 2006 Kartika 1928

November 2007 Kartika 1929

January 2009 Pausa 1930

January 2010 Magha 1931

January 2011 Pausa 1932

January 2012 Magha 1933

December 2012 Pausa 1934

December 2013 Agrahayana 1935

December 2014 Pausa 1936

May 2016 Vaishakha 1938

March 2017 Phalguna 1938

December 2017 Magha 1939

January 2019 Magha 1940

PD 450T BS

© National Council of Educational
Research and Training, 2006

₹ 230.00

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
Vishwa Printers, VII Tarhiya, Mubarakpur
Road, Chhatha Meel Sitapur Road,
Lucknow - 226 001

ALL RIGHTS RESERVED

- No part of this publication may be reproduced, stored in a retrieval system or transmitted, in any form or by any means, electronic, mechanical, photocopying, recording or otherwise without the prior permission of the publisher.
- This book is sold subject to the condition that it shall not, by way of trade, be lent, re-sold, hired out or otherwise disposed of without the publisher's consent, in any form of binding or cover other than that in which it is published.
- The correct price of this publication is the price printed on this page. Any revised price indicated by a rubber stamp or by a sticker or by any other means is incorrect and should be unacceptable.

**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
Bangalore 560 085

Phone : 080-26725740

Navjivan Trust Building
P.O. Navjivan
Ahmedabad 380 014

Phone : 079-27541446

CWC Campus
Opp. Dhankal Bus Stop
Panhati
Kolkata 700 114

Phone : 033-25530454

CWC Complex
Maligaon
Guwahati 781 021

Phone : 0361-2674869

Publication Team

Head, Publication Division : M. Siraj Anwar
Chief Editor : Shweta Uppal
Chief Business Manager : Gautam Ganguly
Chief Production Officer : Arun Chitkara
Assistant Editor : Shashi Chadha
Production Assistant : Mukesh Gaur

Cover and Layout

Shweta Rao

Illustrations

Lalit Maurya



FOREWORD

The National Curriculum Framework (NCF) 2005, recommends that children's life at school must be linked to their life outside the school. This principle marks a departure from the legacy of bookish learning which continues to shape our system and causes a gap between the school, home and community. The syllabi and textbooks developed on the basis of NCF signify an attempt to implement this basic idea. They also attempt to discourage rote learning and the maintenance of sharp boundaries between different subject areas. We hope these measures will take us significantly further in the direction of a child-centred system of education outlined in the National Policy on Education (1986).

The success of this effort depends on the steps that school principals and teachers will take to encourage children to reflect on their own learning and to pursue imaginative activities and questions. We must recognise that, given space, time and freedom, children generate new knowledge by engaging with the information passed on to them by adults. Treating the prescribed textbook as the sole basis of examination is one of the key reasons why other resources and sites of learning are ignored. Inculcating creativity and initiative is possible if we perceive and treat children as participants in learning, not as receivers of a fixed body of knowledge.

These aims imply considerable change in school routines and mode of functioning. Flexibility in the daily time-table is as necessary as rigour in implementing the annual calendar so that the required number of teaching days are actually devoted to teaching. The methods used for teaching and evaluation will also determine how effective this textbook proves for making children's life at school a happy experience, rather than a source of stress or boredom. Syllabus designers have tried to address the problem of curricular burden by restructuring and reorienting knowledge at different stages with greater consideration for child psychology and the time available for teaching. The textbook attempts to enhance this endeavour by giving higher priority and space to opportunities for contemplation and wondering, discussion in small groups, and activities requiring hands-on experience.

The National Council of Educational Research and Training (NCERT) appreciates the hard work done by the textbook development committee responsible for this book. We wish to thank the Chairperson of the advisory group in science and mathematics, Professor J.V. Narlikar and the Chief Advisor for this book, Professor K. Muralidhar, Department of Zoology, University of Delhi, Delhi for guiding the work of this committee.



Several teachers contributed to the development of this textbook. We are grateful to their principals for making this possible. We are indebted to the institutions and organisations which have generously permitted us to draw upon their resources, material and personnel. We are especially grateful to the members of the National Monitoring Committee, appointed by the Department of Secondary and Higher Education, Ministry of Human Resource Development under the Chairpersonship of Professor Mrinal Miri and Professor G.P. Deshpande, for their valuable time and contribution.

As an organisation committed to systemic reform and continuous improvement in the quality of its products, NCERT welcomes comments and suggestions which will enable us to undertake further revision and refinement.

New Delhi
20 December 2005

Director
National Council of Educational
Research and Training

NBCampus





TEXTBOOK DEVELOPMENT COMMITTEE

CHAIRPERSON, ADVISORY GROUP FOR TEXTBOOKS IN SCIENCE AND MATHEMATICS

J.V. Narlikar, *Emeritus Professor*, Chairman, Advisory Committee, Inter University Centre for Astronomy and Astrophysics (IUCAA), Pune University, Pune

CHIEF ADVISOR

K. Muralidhar, *Professor*, Department of Zoology, University of Delhi, Delhi

MEMBERS

Ajit Kumar Kavathekar, *Reader* (Botany), Sri Venkateswara College, University of Delhi, Delhi

B.B.P. Gupta, *Professor*, Department of Zoology, North-Eastern Hill University, Shillong

C.V. Shimray, *Lecturer*, Department of Education in Science and Mathematics, NCERT

Dinesh Kumar, *Reader*, Department of Education in Science and Mathematics, NCERT

J.S. Gill, *Professor*, Department of Education in Science and Mathematics, NCERT

K. Sarath Chandran, *Reader* (Zoology), Sri Venkateswara College, University of Delhi, Delhi

Nalini Nigam, *Reader* (Botany), Ramjas College, University of Delhi, Delhi

Pratima Gaur, *Professor*, Department of Zoology, University of Allahabad, Allahabad

Ratnam Kaul Wattal, *Reader* (Botany), Zakir Hussain College, University of Delhi, Delhi

R.K. Seth, *UGC Scientist C*, Department of Zoology, University of Delhi, Delhi

R.P. Singh, *Lecturer* (Biology), Rajkiya Pratibha Vikas Vidyalaya, Kishan Ganj, Delhi

Sangeeta Sharma, *PGT* (Biology), Kendriya Vidyalaya, JNU, New Delhi

Savithri Singh, *Principal*, Acharya Narendra Dev College, University of Delhi; *Former Fellow*, Centre for Science Education and Communication, University of Delhi, Delhi

S.C. Jain, *Professor*, Department of Education in Science and Mathematics, NCERT

Sunaina Sharma, *Lecturer* (Biology), Rajkiya Pratibha Vikas Vidyalaya, Dwarka, New Delhi

Tejinder Chawla, *PGT* (Biology), Guru Harkrishan Public School, Vasant Vihar, New Delhi

T.N. Lakhanpal, *Professor* (Retd.), Department of Bio Sciences, Himachal Pradesh University, Shimla

U.K. Nanda, *Professor*, Regional Institute of Education, Bhubaneswar

MEMBER-COORDINATOR

B.K. Tripathi, *Reader*, Department of Education in Science and Mathematics, NCERT.





ACKNOWLEDGEMENTS

National Council of Educational Research and Training (NCERT) gratefully acknowledges the contribution of the individuals and organisations involved in the development of the Biology textbook for Class XI. The Council is grateful to Arvind Gupte, *Principal (Retd.)*, Government Collegiate Education Services, Madhya Pradesh; Shailaja Hittalmani, *Associate Professor* (Genetics), University of Agricultural Sciences, Bangalore; K.R. Shivanna, *Professor (Retd.)*, Department of Botany, University of Delhi, Delhi; R.S. Bedwal, *Professor*, Department of Zoology, University of Rajasthan, Jaipur; P.S. Srivastava, *Professor*, Department of Biotechnology, Hamdard University, New Delhi and Pramila Shivanna, *former Teacher*, D.A.V. School, Delhi, for their valuable suggestions. The Council is also thankful to V.K. Bhasin, *Professor and Head*, Department of Zoology, University of Delhi, Delhi; P.P. Bakre, *Professor and Head*, Department of Zoology, University of Rajasthan, Jaipur and Savithri Singh, *Principal*, Acharya Narendra Dev College, New Delhi for their support. The Council is also grateful to B.K. Gupta, *Scientist*, Central Zoo Authority, New Delhi for providing pictures of zoological parks and Sameer Singh for the pictures on the front and back cover. All the other photographs used in the book provided by Savithri Singh and taken at either at NCERT, IARI Campus or Acharya Narendra Dev College is gratefully acknowledged.

NCERT sincerely acknowledges the contributions of the members who participated in the review of the manuscripts – M.K. Tiwari, *PGT* (Biology), Kendriya Vidyalaya, Mandasaur, Madhya Pradesh; Maria Gracias Fernandes, *PGT* (Biology), G.V.M.S. Higher Secondary, Ponda, Goa; A.K. Ganguly, *PGT* (Biology), Jawahar Navodaya Vidyalaya, Roshnabad, Haridwar; Shivani Goswami, *PGT* (Biology), The Mother's International School, New Delhi and B.N. Pandey, *Principal*, Ordinance Factory Sr. Sec. School, Dehradun.

The Council is highly thankful to M. Chandra, *Professor and Head*, DESM; Hukum Singh, *Professor*, DESM, NCERT for their valuable support throughout the making of this book.

The Council also gratefully acknowledges the contribution of Deepak Kapoor, *Incharge*, Computer Station; Mohd. Khalid Raza and Arvind Sharma, *DTP operators*; Saswati Banerjee and Hari Darshan Lodhi, *Copy Editor*; Archana Srivastava, *Proof Reader* and APC office and administrative staff of DESM, NCERT.

The efforts of the Publication Department, NCERT in bringing out this publication are also appreciated.





A NOTE FOR THE TEACHERS AND STUDENTS

Biology is the science of life. It is the story of life on earth. It is the science of life forms and living processes. Biological systems, often appear to challenge physical laws that govern the behaviour of matter and energy in our world. Historically, biological knowledge was ancillary to knowledge of human body and its function. The latter as we know, is the basis of medical practice. However, parts of biological knowledge developed independent of human application. Fundamental questions about origin of life, the origin and growth of biodiversity, the evolution of flora and fauna of different habitats, etc., caught the imagination of biologists.

The very description of living organisms, be it from morphological perspective, physiological perspective, taxonomical perspective, etc., engaged scientists to such an extent that for sheer convenience, if not for anything else, the subject matter got artificially divided into the sub-disciplines of botany and zoology and later into even microbiology. Meanwhile, physical sciences made heavy inroads into biology, and established biochemistry and biophysics as new sub-disciplines of biology. Mendel's work and its rediscovery in the early twentieth century led to the promotion of study of genetics. The discovery of the double-helical structure of DNA and the deciphering of three dimensional structures of many macromolecules led to the establishment of and phenomenal growth in the dominating area of molecular biology. In a sense, functional disciplines laying emphasis on mechanisms underlying living processes, received more attention, support, intellectual and social recognition. Biology, unfortunately, got divided into classical and modern biology. To the majority of practising biologists, pursuit of biological research became more empirical rather than a curiosity and hypothesis driven intellectual exercise as is the case with theoretical physics, experimental physics, structural chemistry and material science. Fortunately and quietly, general unifying principles of biology were also being discovered, rediscovered and emphasised. The work of Mayr, Dobzhansky, Haldane, Perutz, Khorana, Morgan, Darlington, Fisher and many others brought respect and seriousness to both classical and molecular biological disciplines. Ecology and Systems biology got established as unifying biological disciplines. Every area of biology began developing interface with not only other areas of biology but also other disciplines of science and mathematics. Pretty soon, the boundaries became porous. They are now on the verge of disappearing altogether. Progress in human biology, biomedical sciences, especially the structure, functioning and evolution of human brain brought in respect, awe and philosophical insights to biology. Biology even stepped out of laboratories, museums and natural parks and raised social, economic and cultural issues capturing the imagination of general public and hence political attention. Educationists did not lag behind and realised that biology should be taught as an interdisciplinary and integrating science at all stages of educational training especially at school and undergraduate levels. A new synthesis of all areas of basic and applied areas of biology is the need of the hour. Biology has come of age. It has an independent set of concepts which are universal just like physics and chemistry and mathematics.

The present volume is the first time presentation of the integrated biology for the school level children. One of the lacunae in biology teaching and study is the absence of integration





with other disciplinary knowledge of physics, chemistry etc. Further many processes in plants, animals and microbes are similar when looked from physico-chemical perspective. Cell biology has brought out the unifying common cellular level activities underlying apparently diverse phenomena across plants, animals and microbes. Similarly, molecular science (e.g. biochemistry or molecular biology) has revealed the similar molecular mechanisms in all these apparently diverse organisms like plants, animals and microbes. Phenomena like respiration, metabolism, energy utilisation, growth, reproduction and development can be discussed in a unifying manner rather than as separate unrelated processes in plants and animals. An attempt has been made to unify such diverse disciplines in the book. The integration achieved however, is partial and not complete. Hopefully along with changes in the teaching and learning context, to be brought out in the next few years, the next edition of this book will reveal more integration of botany, zoology and microbiology and truly reflect the true nature of biology – the future science of man by man and for man.

This new textbook of Biology for class XI is a completely rewritten book in view of the syllabus revision and restructuring. It is also in accordance with the spirit of the National Curriculum Framework (2005) guidelines. The subject matter is presented under twenty-two chapters which are grouped under five thematic units. Each unit has a brief write up preceding the unit highlighting the essence of the chapters to follow under that unit. Each unit also has a biographical sketch of a prominent scientist in that area. Each chapter has, on the first page, a detailed table of contents giving sub-headings within the chapter. Decimal system using arabic numerals has been employed to indicate these sub-headings. At the end of each chapter a brief summary is provided. This brings to the notice of the student, what she/he is supposed to have learnt by studying the chapter. A set of questions is also provided at the conclusion of each chapter. These questions are essentially to enable the student to test herself/himself as to how much she/he has understood the subject matter. There are questions which are purely of information recall type; there are questions which need analytical thinking to answer and hence test true understanding; there are questions which are problems to solve and finally there are questions which need analysis and speculation as there is no one to answer to such questions. This tests the critical understanding of the subject matter in the mind of the student.

Special emphasis has been given on the narrative style, illustrations, activity exercises, clarity of expression, coverage of topics within the available time in school. A large number of extremely talented and dedicated people including practising teachers helped in bringing out this beautiful book. Our main purpose was to make sure that school level biology is not a burden for students and teachers. We sincerely wish that teaching biology and learning biology would become an enjoyable activity.

Professor K. Muralidhar
Department of Zoology
University of Delhi





CONTENTS

FOREWORD	iii
A NOTE FOR THE TEACHERS AND STUDENTS	vii

UNIT I

DIVERSITY IN THE LIVING WORLD 1-62

Chapter 1 : The Living World	3
Chapter 2 : Biological Classification	16
Chapter 3 : Plant Kingdom	29
Chapter 4 : Animal Kingdom	46

UNIT II

STRUCTURAL ORGANISATION IN PLANTS AND ANIMALS 63-122

Chapter 5 : Morphology of Flowering Plants	65
Chapter 6 : Anatomy of Flowering Plants	84
Chapter 7 : Structural Organisation in Animals	100

UNIT III

CELL : STRUCTURE AND FUNCTIONS 123-172

Chapter 8 : Cell : The Unit of Life	125
Chapter 9 : Biomolecules	142
Chapter 10 : Cell Cycle and Cell Division	162



UNIT IV

PLANT PHYSIOLOGY

173-254

Chapter 11 : Transport in Plants	175
Chapter 12 : Mineral Nutrition	194
Chapter 13 : Photosynthesis in Higher Plants	206
Chapter 14 : Respiration in Plants	226
Chapter 15 : Plant Growth and Development	239

UNIT V

HUMAN PHYSIOLOGY

255-343

Chapter 16 : Digestion and Absorption	257
Chapter 17 : Breathing and Exchange of Gases	268
Chapter 18 : Body Fluids and Circulation	278
Chapter 19 : Excretory Products and their Elimination	290
Chapter 20 : Locomotion and Movement	302
Chapter 21 : Neural Control and Coordination	315
Chapter 22 : Chemical Coordination and Integration	331

