

# Textbook of Anatomy and Physiology

Second Edition

for Health Professionals

This textbook on human anatomy and physiology covers the syllabi for paramedical and allied health sciences in a thorough, yet concise manner. The text matter has been systematically organized into eleven sections. Each section begins with a brief overview highlighting the topics covered and has been further divided into various chapters. It is hoped the book will be useful in laying a strong foundation for paramedical and allied health sciences undergraduate students.

#### Salient Features

- Unique compendium with an integrated approach of studying anatomy and physiology developed and updated as per the syllabus of Paramedical and Allied Health Sciences.
- Fundamentals of anatomy and physiology covered in concise yet comprehensive manner in simple and easy-to-understand language making it an essential asset for every student.
- 'A picture is worth more than a thousand words.' Hence, this book incorporates 600+ four-color diagrams to make the learning and reading experience more engaging. All diagrams are easy to reproduce in the examinations.
- A new chapter, "Introduction to Chemistry of Life" has been added.
- Histology of important structures has been added as "Histology Plates" along with histological photomicrographs to provide a new dimension for an integrated learning.
- Clinical correlations and applied anatomical and physiological concepts have been separately highlighted as clinical aspects boxes to help the students in understanding the correlations of basic sciences with clinical scenarios.

**Indu Khurana MD** is presently Dean-cum-Principal, and Professor of Physiology, World College of Medical Sciences and Research, Jhajjar. Formerly she was Senior Professor and Head, Department of Physiology at Pt. BD Sharma Post Graduate Institute of Medical Sciences (PGIMS), and Dean, Faculty of Pre-clinical Sciences, University of Health Sciences (UHS), Rohtak. She is Founder President of Association of Physiologists of Haryana and possesses a rich teaching experience of about 40 years. She has published extensively in national and international journals with discovery of a new reflex, the 'Oculodepressor Reflex' (ODR) and three distinct patterns of Oculorespiratory reflex (ORR) to her credit. For her valuable contribution in the physiology of oculo-visceral reflexes, she has been bestowed with excellence awards by American Academy of Ophthalmology (AAO) and Strabismological Society of India (SSI). She has also been honored with excellence award by Association of Physiologists of Haryana for her exemplary contribution in the field of physiology.



She is an established author having published many successful books, mainly *Textbook of Medical Physiology for Postgraduates*, *Medical Physiology for Undergraduate Students*, *Textbook of Anatomy and Physiology of Eye*, *Essentials of Medical Physiology*, *Textbook of Human Embryology*, and *Fundamentals of Anatomy and Physiology for Diploma Nursing*. She has also contributed many chapters for *Modern System of Ophthalmology*, a postgraduate reference book.

**Arushi Khurana MD** is presently Fellow in Hematology-Oncology, Massey Cancer Center, Virginia Commonwealth University (VCU), Richmond, VA. Earlier, she has worked as Chief Medical Resident at Department of Internal Medicine, University of Connecticut, USA. She is a graduate from Maulana Azad Medical College, New Delhi, India, and has been a dedicated student of physiology. During her Internal Medicine Residency Program, she has been honored with Harold N. Willard, MD, Award for Excellence in Ambulatory Care. She has presented many papers at international and national conferences and has bagged 'Best Poster Award' for 'Quality Improvement Initiatives'. She has published scientific papers in journals of repute. She is author of *Human Embryology* and coauthor of *Textbook of Medical Physiology*, *Textbook of Anatomy and Physiology for Nurses and Allied Health Sciences*, *Textbook of Anatomy and Physiology for Health Professionals* and *Fundamentals of Anatomy and Physiology for Nursing and Allied Health*, published by Oxford University Press, Malaysia. She has also contributed four chapters on physiological aspects in postgraduate level textbooks.



Second Edition

Textbook of Anatomy and Physiology  
Indu Khurana  
Arushi Khurana



# Textbook of Anatomy and Physiology

Second Edition

for Health Professionals



#### Exclusive Features

- International Standard Colored Edition
- 600+ Illustrations and Photographs
- Written by Most Senior Subject Expert (40+ yrs' teaching exp.)

Indu Khurana  
Arushi Khurana



CBS Dedicated to Education  
CBS Publishers & Distributors Pvt Ltd



**CBS Publishers & Distributors Pvt Ltd**

4819/XI, Prahlad Street, 24 Ansari Road, Daryaganj, New Delhi 110 002, India  
E-mail: delhi@cbspd.com, cbspubs@airtelmail.in; Website: www.cbspd.com  
New Delhi | Bengaluru | Chennai | Kochi | Kolkata | Lucknow | Mumbai  
Hyderabad | Jharkhand | Nagpur | Patna | Pune | Uttarakhnad



QR code to  
access online  
CBS Catalogue

ISBN: 978-93-5466-209-6





Second Edition

Textbook of  
**Anatomy and  
Physiology**  
*for Health Professionals*

**Indu Khurana** MD

Dean-cum-Principal

World College of Medical Sciences and Research

Jhajjar, Haryana, India

*Former Professor and Head*

Department of Physiology

Pt BD Sharma Postgraduate Institute of Medical Sciences

Rohtak, Haryana, India

**Arushi Khurana** MD

Fellow, Hematology-Oncology

Massey Cancer Center

Virginia Commonwealth University

Richmond, VA



**CBS Publishers & Distributors** Pvt Ltd

New Delhi • Bengaluru • Chennai • Kochi • Kolkata • Lucknow • Mumbai  
Hyderabad • Jharkhand • Nagpur • Patna • Pune • Uttarakhand

#### Disclaimer

Science and technology are constantly changing fields. New research and experience broaden the scope of information and knowledge. The authors have tried their best in giving information available to them while preparing the material for this book. Although, all efforts have been made to ensure optimum accuracy of the material, yet it is quite possible some errors might have been left uncorrected. The publisher, the printer and the authors will not be held responsible for any inadvertent errors, omissions or inaccuracies.

Textbook of  
**Anatomy and  
Physiology**  
for Health Professionals

Second Edition

ISBN: 978-93-5466-209-6

Copyright © Publisher

**Second Edition 2022**

First Edition 2009

Reprint 2010, 2014, 2015, 2017, 2019

All rights reserved. No part of this book may be reproduced or transmitted in any form or by any means, electronic or mechanical, including photocopying, recording, or any information storage and retrieval system without permission, in writing, from the authors and the publisher.

Published by Satish Kumar Jain and produced by Varun Jain for

**CBS Publishers & Distributors Pvt Ltd**

4819/XI Prahlad Street, 24 Ansari Road, Daryaganj, New Delhi 110 002, India

Ph: 011-23289259, 23266861, 23266867 Website: www.cbspd.com

Fax: 011-23243014 e-mail: delhi@cbspd.com;

cbspubs@airtelmail.in.

*Corporate Office:* 204 FIE, Industrial Area, Patparganj, Delhi 110 092, India

Ph: 011-4934 4934 Fax: 011-4934 4935 e-mail: publishing@cbspd.com;

publicity@cbspd.com

#### Branches

- **Bengaluru:** Seema House 2975, 17th Cross, KR Road, Banasankari 2nd Stage, Bengaluru 560 070, Karnataka, India  
Ph: +91-80-26771678/79 Fax: +91-80-26771680 e-mail: bangalore@cbspd.com
- **Chennai:** 7, Subbaraya Street, Shenoy Nagar, Chennai 600 030, Tamil Nadu, India  
Ph: +91-44-26680620, 26681266 Fax: +91-44-42032115 e-mail: chennai@cbspd.com
- **Kochi:** 42/1325, 1326, Power House Road, Opp KSEB, Power House, Ernakulum Kochi 682 018, Kerala, India  
Ph: +91-484-4059061-65.67 Fax: +91-484-4059065 e-mail: kochi@cbspd.com
- **Kolkata:** 147, Hind Ceramics Compound, 1st Floor, Nilgunj Road, Belghoria, Kolkata-700056, West Bengal, India  
Ph: +91-9096713055/7798394118, 9836841399 e-mail: kolkata@cbspd.com
- **Lucknow:** Basement, Khushnuma Complex, 7 Meerabai Marg (Behind Jawahar Bhawan), Lucknow-226001, UP, India  
Ph: +0522-4000032 e-mail: tiwari.lucknow@cbspd.com
- **Mumbai:** PWD Shed, Gala no 25/26, Ramchandra Bhatt Marg, Next to JJ Hospital Gate no. 2, Opp. Union Bank of India, Noorbaug, Mumbai-400009, Maharashtra, India  
Ph: 022-66661880/89 e-mail: mumbai@cbspd.com

#### Representatives

- Hyderabad 0-9885175004
- Jharkhand 0-9811541605
- Nagpur 0-9421945513
- Patna 0-9334159340
- Pune 0-9623451994
- Uttarakhand 0-9716462459

Printed at Magic International Pvt. Ltd., Greater Noida, UP, India



# Preface

---

This book has been conceptualized by keeping in view the syllabi of Allied Health Sciences courses. The book contains concise exposition of the basic and applied text on human anatomy and physiology, which has proved to be a boon for understanding the fundamentals of the subject by the students of nursing and other Allied Health Sciences. The text matter is aimed at providing an insight into how the body is structured, how it functions and how the alterations in normal structure and functioning result in disease. To achieve this aim, the text on core and applied aspects of human anatomy and physiology has been skillfully intermingled and presented in an adorned form. It is hoped, that the book will fulfill its aim of laying a strong foundation for students of Allied Health Sciences.

The book has been organized into 11 sections and each has been subdivided into various chapters. Section one is on 'Introduction to Anatomical terms; Organization of the Body' and rest ten sections are devoted to the various organ systems of human body.

The *salient features* of the book are as follows:

- The text has been organized in such a way that students can easily understand, retain and reproduce it. Various levels of headings, subheadings, bold face and italics given in the text will be helpful in quick revision of the text.
- The exposition of the text is such that every student will find it easy to conceptualize it.
- A brief list of contents given in the beginning of each chapter provides a clear layout of the text.
- The text has been well illustrated with high quality colored line diagrams, which provide vivid and lucid details.
- The important information has been highlighted with the help of plenty of tables and flowcharts.
- To emphasize the clinical significance of anatomy and physiology, the relevant applied aspects have been covered adequately in each chapter and have been highlighted separately as "Clinical Aspects".
- The histological features of various structures have been highlighted as 'Histology Plates' to help the students in getting acquainted with its importance in the study of anatomy and physiology.
- "Also know" boxes contain additional important information.

I would like to thank all faculty members and students who helped me with healthy criticism during the making of this book. Having Dr. Arushi Khurana, MD, former Chief Resident, Department of Internal Medicine, University of Connecticut, USA and Fellow, Hematology - Oncology, Massey Cancer Center, Virginia Commonwealth University, Richmond, VA, as coauthor has been very useful while composing the applied aspects. I bow with reverence to my teachers for grooming me for this task. I wish to express indebtedness to my husband Dr. AK. Khurana, Sr. Professor Regional Institute of Ophthalmology, PGIMS, Rohtak; my son, Aruj K Khurana, Vitreo Retinal Surgeon, NEI, Rishikesh; daughter-in-law, Dr. Bhawna Piplani Khurana, Oculoplastic Surgeon, Rishikesh; and Son-in-law Dr. Gurukripa Kowli, MD Internal Medicine, University of Connecticut, USA and Fellow, Cardiovascular Diseases Pauley Heart Center, Virginia Commonwealth University Richmond, VA.

I am highly thankful to Dr. (Mrs.) Ritu Singh, Trustee, and Dr. Narender Singh, Chairman, World College of Medical Sciences and Research, Jhajjar for encouragement and infusing academic atmosphere.

Finally and perhaps most importantly, I would like to express my special appreciation to **Mr Satish Kumar Jain** (Chairman) and **Mr Varun Jain** (Managing Director), M/s CBS Publishers and Distributors Pvt Ltd for their wholehearted support in publication of this book. I have no words to describe the role, efforts, inputs and initiatives undertaken by **Mr Bhupesh Arora**, Vice-President, Nursing for helping and motivating me.



I would like to thank Dr Mrinalini Bakshi (Sr. Content Developer and Editor) for her editorial support on this project. I personally thank Ms Nitasha Arora (Project Manager), Ms Neetu Jindal (Asst Production Manager), Mr Nitish K Dubey (Sr. Editor) and all the production team members Mr Ashutosh Pathak, Mr Chaman Lal, Mr Phool Kumar, Mr Bunt Kashyap, Mr Prakash Gaur, Mr Prabhat Ranjan, Ms Tahira Parveen, Ms Babita Verma, Mr Raju Sharma, Mr Vikram Chaudhary and Manoj Chaudhary for devoting laborious hours in designing and type-setting of the book.

Sincere efforts have been made to verify correctness of the text. However, inspite of best efforts, some inaccuracies, ambiguities and typographical mistakes are likely to be noticed by the readers. Therefore, feedback and suggestions from the teachers and students are invited for improving the future editions. Feedbacks received will be highly appreciated and duly acknowledged.

**Indu Khurana**

# Contents

## Section I: Introduction to Anatomical Terms; Organization of the Body

<b>Chapter 1</b>	Introduction to Human Body .....	3
<b>Chapter 2</b>	Introduction to Chemistry of Life .....	16
<b>Chapter 3</b>	The Cell .....	22
<b>Chapter 4</b>	Tissues, Glands and Membranes .....	37

## Section II: Skeletal System

<b>Chapter 5</b>	Human Skeleton .....	51
<b>Chapter 6</b>	Joints .....	74

## Section III: Muscular System

<b>Chapter 7</b>	Muscles of Human Body .....	83
<b>Chapter 8</b>	Neuromuscular Junction and Muscle Physiology .....	102

## Section IV: Nervous System

<b>Chapter 9</b>	Organization of Nervous System and Nerve Physiology .....	115
<b>Chapter 10</b>	Central Nervous System .....	130
<b>Chapter 11</b>	Peripheral Nervous System .....	162
<b>Chapter 12</b>	Autonomic Nervous System .....	179

## Section V: Sensory Organs

<b>Chapter 13</b>	Integumentary System: Skin and Fascia .....	191
<b>Chapter 14</b>	Special Senses .....	204

## Section VI: Circulatory and Lymphatic System

<b>Chapter 15</b>	Blood .....	231
<b>Chapter 16</b>	Cardiovascular System .....	262
<b>Chapter 17</b>	Lymphatic System and Immunity .....	324

## Section VII: Respiratory System

<b>Chapter 18</b>	Anatomy, Organization and Functions of Respiratory System .....	341
<b>Chapter 19</b>	Physiology of Respiration .....	355

**Section VIII: Digestive System**

<b>Chapter 20</b> Anatomy and Physiology of Digestive System .....	379
<b>Chapter 21</b> Digestion and Absorption .....	420

---

**Section IX: Urinary System**

<b>Chapter 22</b> Anatomy and Physiology of Urinary System .....	429
<b>Chapter 23</b> Physiology of Acid-Base Balance .....	453

---

**Section X: Endocrine System**

<b>Chapter 24</b> Anatomy and Physiology of Endocrine Organs .....	461
--	-----

---

**Section XI: Reproductive System**

<b>Chapter 25</b> Male and Female Reproductive System .....	503
<b>Chapter 26</b> Contraception.....	537

<b>Index</b> .....	543
--------------------	-----