

Competency-Based  
**BD Chaurasia's**  
**Human Anatomy**

Regional and Applied | Dissection and Clinical

Ninth  
 Edition

Volume  
**1**

Volume 1 UPPER LIMB and THORAX  
 Volume 2 LOWER LIMB, ABDOMEN and PELVIS  
 Volume 3 HEAD and NECK  
 Volume 4 BRAIN-NEUROANATOMY

Widely acclaimed as a standard textbook in view of its simple language, comprehensive coverage, lucid presentation and neatly-drawn line diagrams, **BD Chaurasia's Human Anatomy** remains the most preferred textbook in India and abroad. This edition has been thoroughly revised and updated to make it extremely informative and much more student-friendly.

The ninth edition now features diagrams adapted from the first edition, originally prepared by Dr BD Chaurasia, which have been suitably redrawn, modified and colored appropriately. Many text chapters have citations to videos of osteology and soft parts which are accessible through CBSiCentral App. Clinically oriented FAQs and MCQs, and ECE cases have been included to make the volumes absolutely clinical in nature.

**Salient features of the four volumes**

- Text follows the **CBME Guidelines** and all topics are described as per the **Competency Based Undergraduate Curriculum for the Indian Medical Graduate** prescribed by the National Medical Commission.
- **Colour codes** used consistently in the drawings of various cells, tissues and organs are given at the beginning of each section.
- Impressive **line diagrams**, originally hand-drawn by Dr BD Chaurasia, adapted from the first edition of *BDC Human Anatomy*, have been incorporated in this edition to make drawing of illustrations easier for the students.
- **Videos of osteology and soft parts**, accessible from CBSiCentral App through scratch code, have been numbered and cited in the respective chapters in all the four volumes. The App also includes answers to FAQs.
- **Latest updates** on various topics have been provided from standard international publications.
- **Clinical orientation** has been enthused by structuring many FAQs and MCQs in 'clinical mode'. **Early Clinical Exposure (ECE)** has been provided in the form of signs, symptoms, investigations and treatment of a particular case.
- Important features like **viva voce questions, molecular regulation, clinicoanatomical problems, ossification, dissection (steps)** are continued from the previous editions.
- **This volume features**  
 Tables 43, Flowcharts 7, Illustrations 414, Ossification boxes 13, Dissection boxes 37, X-rays 5, Clinical Anatomy boxes 52, Facts to Remember 93, FAQs 99, MCQs 149, Viva Voce questions 259, Videos 47, Clinicoanatomical Problems 19.

Chief Editor

**Krishna Garg** MBBS, MS, PhD, FIMSA, FIAMS, FAMS, FASI is ex-Professor and Head, Department of Anatomy, Lady Hardinge Medical College (LHMC), New Delhi. She joined LHMC where she completed her MS and PhD and taught anatomy till her retirement. She has received fellowships of the Indian Medical Association, Academy of Medical Specialists, and the International Medical Science Academy. She was elected fellow of the Academy of Medical Sciences (FAMS) in 2005. She was honoured with Excellence Award in Anatomy in 2004 by Delhi Medical Association. She has received Life Time Achievement Award, Fellowship of Anatomical Society of India, and DMA Distinguished Services Award, in 2015. She is visiting faculty of DNB, MDS and a PhD examiner.

She is author of *Manual of Human Anatomy Dissection, Companion Pocketbook—BDC Human Anatomy (Vols 1–3)* and *BDC Human Anatomy for Dental Students 3/e*; coauthor of *Textbook of Histology 5/e, Textbook of Neuroanatomy 6/e, Anatomy and Physiology for Nurses, Anatomy and Physiology for Allied Health Sciences, Practical Anatomy Workbook, Practical Histology Workbook and Practical Anatomy Workbook for Dental Students*; and editor of *Human Embryology 2/e, Handbook of General Anatomy 6/e* and *BD Chaurasia's Applied Anatomy and Physiology for BSc Nursing Students*.

Editors

**PS Mittal** MBBS, MS is Professor, Department of Anatomy, Government Institute of Medical Sciences, Greater Noida, UP.

**Mrudula Chandrupatla** MBBS, MD is Additional Professor and Head, Department of Anatomy, and Associate Dean (Research), All India Institute of Medical Sciences, Bibinagar, Hyderabad, Telangana.



**CBS Publishers & Distributors Pvt Ltd**

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

E-mail: delhi@cbspd.com, customercare@cbspd.com; Website: www.cbspd.com

New Delhi | Bengaluru | Chennai | Kochi | Kolkata | Lucknow | Mumbai

Hyderabad | Jharkhand | Nagpur | Patna | Pune | Uttarakhand



Scan for the price of this book and catalogue

ISBN: 978-93-5466-473-1



Ninth  
 Edition



Competency-Based  
**Chaurasia's**  
**Human Anatomy**

Volume  
**1**

Competency-Based  
**BD Chaurasia's**

# Human Anatomy

Regional and Applied | Dissection and Clinical

As per the CBME Guidelines | Competency Based Undergraduate Curriculum for the Indian Medical Graduate

## Upper Limb Thorax

Scratch Code on Inside Front Cover for Accessing CBSiCentral App

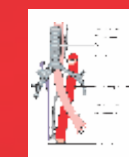


Available Free on CBSiCentral App

- Original Images from First Edition of BDC Human Anatomy (Vols 1–3) hand-drawn by Dr BD Chaurasia
- Videos on Osteology and Soft Parts
- Frequently Asked Questions & Answers



Wall Chart on Arterial Tree of Human Body



Many easily reproducible diagrams, originally hand-drawn by Dr BD Chaurasia, now modified and coloured suitably, are given at the relevant locations in the text



Dedicated to Education

**CBS Publishers & Distributors Pvt Ltd**



Ninth  
 Edition

Volume  
**1**

**Ninth Edition**

Volume



**1**

*Competency-Based*

**BD Chaurasia's**

**Human**

**Anatomy**

**Regional and Applied Dissection and Clinical**

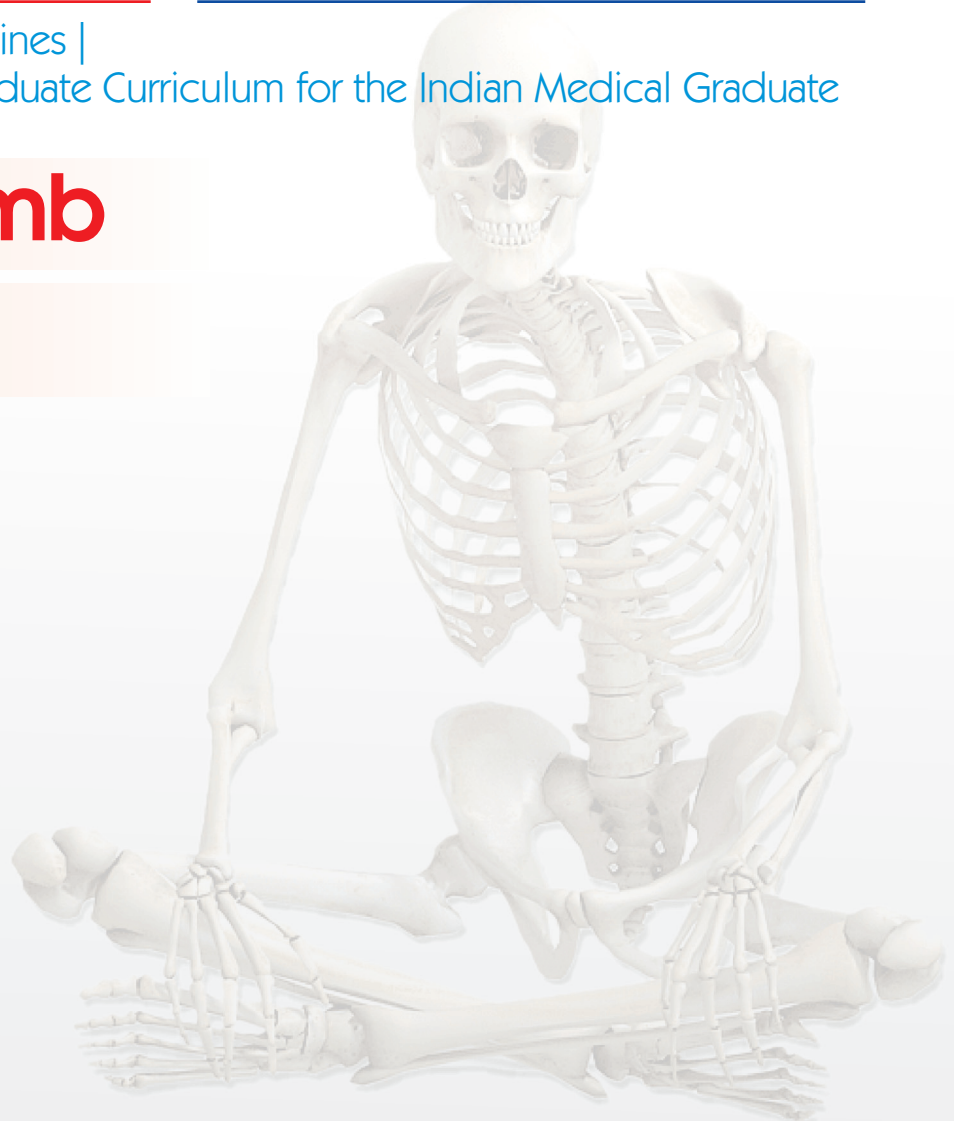
As per the latest CBME Guidelines |  
Competency based Undergraduate Curriculum for the Indian Medical Graduate



**Upper Limb**



**Thorax**







**Dr BD Chaurasia** (1937–1985)

was Reader in Anatomy at GR Medical College, Gwalior.

He received his MBBS in 1960, MS in 1965 and PhD in 1975.

He was elected fellow of National Academy of Medical Sciences (India) in 1982.

He was a member of the Advisory Board of the *Acta Anatomica* since 1981,

member of the editorial board of *Bionature*, and in addition

member of a number of scientific societies.

He had a large number of research papers to his credit.

**Ninth Edition**

**Volume**



**1**

*Competency-Based*

**BD Chaurasia's**

# **Human Anatomy**

**Regional and Applied Dissection and Clinical**

As per the latest CBME Guidelines |  
Competency based Undergraduate Curriculum for the Indian Medical Graduate



**Upper Limb**



**Thorax**

*Chief Editor*

**Krishna Garg**

MBBS MS PhD FIMSA FIAMS FAMS FASI  
Legend of Anatomy; Nation's Who's Who  
Fellow, Anatomical Society of India  
Lifetime Achievement Awardee  
DMA Distinguished Service Awardee  
Ex-Professor and Head, Department of Anatomy  
Lady Hardinge Medical College, New Delhi

*Editors*

**Mrudula Chandrupatla** MBBS MD

Additional Professor and Head, Department of Anatomy  
All India Institute of Medical Sciences  
Bibinagar, Hyderabad, Telangana

**Pragati Sheel Mittal** MBBS MS

Associate Professor, Department of Anatomy  
Government Institute of Medical Sciences  
Greater Noida, UP



**CBSPD**

**CBS Publishers & Distributors Pvt Ltd**

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



Ninth Edition Volume 1

Competency-Based

# BD Chaurasia's Human Anatomy

Regional and Applied Dissection and Clinical

As per the latest CBME Guidelines |  
Competency-based Undergraduate Curriculum for the Indian Medical Graduate

Upper Limb

Thorax



ISBN: 978-93-5466-473-1

Copyright © Publisher and author

**Ninth Edition: 2023**

First Edition: 1979

Reprint: 1980, 1981, 1982, 1983, 1984, 1985, 1986, 1987, 1988

Second Edition: 1989

Reprint: 1990, 1991, 1992, 1993, 1994

Third Edition: 1995

Reprint: 1996, 1997, 1998, 1999, 2000, 2001, 2002, 2003, 2004

Fourth Edition: 2004

Reprint: 2005, 2006, 2007, 2008, 2009

Fifth Edition: 2010

Reprint: 2011, 2012

Sixth Edition: 2013

Reprint: 2014, 2015

Seventh Edition: 2016

Reprint: 2017, 2018, 2019

Eighth Edition: 2020

Reprint: 2021, 2022

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 author, editors 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

Fax: 011-23243014

Website: www.cbspd.com

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: +033-256330055/56 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 Thomson Press (India) Ltd., Delhi, India

## Disclaimer

Science and technology are constantly changing fields. New research and experience broaden the scope of information and knowledge. The editors 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 editors will not be held responsible for any inadvertent errors, omissions or inaccuracies.

to

*my teacher*

*Shri Uma Shankar Nagayach*

— BD Chaurasia





Volume  
**1**

**UPPER LIMB and THORAX**

**LOWER LIMB, ABDOMEN and PELVIS**

Volume  
**2**

Volume  
**3**

**HEAD and NECK**

**BRAIN-NEUROANATOMY**

Volume  
**4**



*This human anatomy is not systemic but regional  
Oh yes, it is theoretical as well as practical  
Besides the gross features, it is chiefly clinical  
Clinical too is very much diagrammatical.*

*Lots of tables for the muscles are provided  
Even methods for testing are incorporated  
Improved colour illustrations are added  
So that right half of brain gets stimulated*

*Tables for muscles acting on joints are given  
Tables for branches of nerves and arteries are given  
Hope these volumes turn highly useful  
Editors' hardwork under Almighty's guidance prove fruitful*

# Preface to the Ninth Edition

This edition features a number of significant modifications which we have made in the light of the wide-ranging suggestions that we received in the recent months from students, teachers and also the well-wishers of this epic textbook. As the information explodes and knowledge multiplies, appropriate improvements, additions and changes are also required to be made in the contemporary literature. Latest research information sourced from the standard international publications has been selectively incorporated in these volumes.

Numerous unique line diagrams, originally hand-drawn by late Dr BD Chaurasia and used in the first edition of the book, after thoughtful moderation, have now been incorporated in the ninth edition. Our criteria for the selection and manipulation of these drawings were clearly based on the simplicity and lucidity of the anatomic description. These simply structured illustrations can be easily reproduced by the students in multitudes of tests and examinations, including university examinations.

Diagrams form the foundation of anatomy: The drawings create imprints on the brain. Figures, artwork and the dissection are recorded in the right half of the cerebrum while the text is learnt by using left half of cerebrum. Thus, learning by drawing diagrams and steps of dissection help in using both the halves of cerebrum, which is an ideal condition. This textbook lays stress on understanding anatomic structures and details through clear, neat and crisp diagrams.

Earlier, videos of the dissection of all regions had been given free access to the readers on [CBSiCentral App](#). These videos are now uploaded on the App after reorganization of the sequences, numeration and providing appropriate citations in the text. Readers can register on the App and access the enumerated videos through the scratch code given on the inside front cover of each volume. These videos adequately compensate the scarcity of the cadavers in medical institutions for conducting dissection.

The videos of the dissection give three-dimensional image descriptions of tissues and organs which get effectively registered in brain for a longer time.

Processes and steps of dissection given in blue boxes with dissection photographs have been retained as many students and teachers appreciate the same. However, no addition in dissection photographs has been made as a separate CBSPD publication *Manual of Human Anatomy Dissection* (ISBN: 978-93-89688-00-9) with numerous dissection photographs is available to the readers who aspire to learn and enjoy the dissection in a meticulous manner.

We have incorporated all the competencies prescribed by National Medical Commission under the [Competency Based Curriculum for the Indian Medical Graduate](#) for spirited implementation of [Competency Based Medical Education Guidelines](#).

Since National Medical Commission has laid stress on teaching and learning clinical aspects from the very beginning of the MBBS study period, the questions asked are mostly clinical. [Clinical aspects](#) have been explicitly given in the text such that the students are able to learn, recapitulate and answer the clinically-oriented questions in their examinations.

As NMC curriculum also lays emphasis on [Early Clinical Exposure](#), crisply written and well-presented [ECE Cases](#) have been given at the end of every section, which make the book clinical-savvy. These case studies will help the budding doctors in imbibing the salient clinical features, getting appropriate investigations done, and treating the patients satisfactorily once they are in clinical practice.

All the illustrations in the four volumes of this book have been prepared on a common colour scheme applicable to cells, tissues and organs. Colour codes employed in the preparation of the human anatomy illustrations are given in the beginning of each section. This characteristic feature will help the students in identifying the anatomic components clearly and draw appropriately coloured diagram in a schematic manner.



Extensive research by numerous scientists has decoded the molecular control of development of organ tissues of the body. Basics of this molecular control are given briefly in these volumes.

We have continued with the practice of giving one separate **wall chart** in each volume for easy comprehension of the topics.

Sincere attempt has been made to present all facets of theory and practical anatomy to make these volumes truly holistic. In addition to the descriptive text, the following rich features lend a high pedestal to the book in the context of the international literature.

	<i>Volume 1</i>	<i>Volume 2</i>	<i>Volume 3</i>	<i>Volume 4</i>	<i>Total</i>
Figures	414	653	462	210	1739
Flowcharts	7	4	12	9	32
Dissection Boxes	37	36	12	5	90
X-rays/MRI and CT Scans	5	5	4	16	30
Ossification Boxes	13	12	14	–	39
Tables	43	52	33	23	151
Clinical Anatomy Boxes	52	101	77	41	271
Mnemonics Boxes	22	15	8	4	49
Facts to Remember	93	229	114	67	503
FAQs	99	132	104	52	387
MCQs	149	232	135	72	588
Viva Voce Questions	259	508	227	125	1119
Clinicoanatomical Problems	19	35	20	14	88
Videos	47	50	32	9	138

Chief Editor

**Krishna Garg**

email: [dr.krishnagarg@gmail.com](mailto:dr.krishnagarg@gmail.com)

Editors

**Pragati Sheel Mittal**  
**Mrudula Chandrupatla**

# Preface to the First Edition (excerpts)



The necessity of having a simple, systematized and complete book on anatomy has long been felt. The urgency for such a book has become all the more acute due to the shorter time now available for teaching anatomy, and also to the falling standards of English language in the majority of our students in India. The national symposium on 'Anatomy in Medical Education' held at Delhi in 1978 was a call to change the existing system of teaching the unnecessary minute details to the undergraduate students.

This attempt has been made with an object to meet the requirements of a common medical student. The text has been arranged in small classified parts to make it easier for the students to remember and recall it at will. It is adequately illustrated with simple line diagrams which can be reproduced without any difficulty, and which also help in understanding and memorizing the anatomical facts that appear to defy memory of a common student. The monotony of describing the individual muscles separately, one after the other, has been minimised by writing them out in tabular form, which makes the subject interesting for a lasting memory. The relevant radiological and surface anatomy have been treated in separate chapters. A sincere attempt has been made to deal, wherever required, the clinical applications of the subject. The entire approach is such as to attract and inspire the students for a deeper dive in the subject of anatomy.

The book has been intentionally split in three parts for convenience of handling. This also makes a provision for those who cannot afford to have the whole book at a time.

It is quite possible that there are errors of omission and commission in this mostly single-handed attempt. I would be grateful to the readers for their suggestions to improve the book from all angles.

I am very grateful to my teachers and the authors of numerous publications, whose knowledge has been freely utilised in the preparation of this book. I am equally grateful to my professor and colleagues for their encouragement and valuable help. My special thanks are due to my students who made me feel their difficulties, which was a great incentive for writing this book. I have derived maximum inspiration from Prof. Inderbir Singh (Rohtak), and learned the decency of work from Shri SC Gupta (Jiwaji University, Gwalior).

I am deeply indebted to Shri KM Singhal (National Book House, Gwalior) and Mr SK Jain (CBS Publishers & Distributors, Delhi), who have taken unusual pains to get the book printed in its present form. For giving it the desired get-up, Mr VK Jain and Raj Kamal Electric Press are gratefully acknowledged. The cover page was designed by Mr Vasant Paranjpe, the artist and photographer of our college; my sincere thanks are due to him. I acknowledge with affection the domestic assistance of Munne Miyan and the untiring company of my Rani, particularly during the odd hours of this work.

**BD Chaurasia**





# Acknowledgements

The editors are thankful to Dr SN Kazi (Pune) for providing maximum updates from Gray's Anatomy, 42nd Edition.

Dr Vikas Verma (Lucknow) revised the chapters on Joints and Nerves of Limbs and gave very useful inputs. Dr Tripta Bhagat (Ghaziabad) edited clinical anatomy portions of the volumes.

We have the blessings and good wishes of Prof NA Faruqi (Aligarh); Dr DC Naik (Rewa); Dr SD Joshi and Dr SS Joshi (Indore); Dr (Brig) Rakesh Gupta (Greater Noida); Dr DR Singh (Lucknow); Dr M Kaul; Dr C Anand and Dr I Bahl (Delhi); Dr Mohsin Azmi (Kanpur); Dr Medha Joshi (Ghaziabad); Dr Surbhi Gupta (Delhi); and Dr Nitin Nagarkar (Raipur).

We are thankful to Dr Surjit Ghatak (Jodhpur); Dr Vinay Sharma (Muzzafarnagar); Dr Deepu Singh Kataria and Dr Anup Singh Gurjar (Pali); Dr Jagmohan Sharma; Dr Deepak Sharma; Dr Rajesh Arora and Dr Pooja Garg (Jaipur); Dr Sumit Gupta (Kota); Dr Gopal Sharma and Dr Manoj Sharma (Jhalawar); Dr Rekha Parashar (Chittorgarh); Dr Santosh Kumar (Dholpur); Dr BK Aghera (Sirohi), Dr Isha Srivastav; Dr Aprajita Raizada; Dr Sajjan Skaria; Dr Anjali Jain and Dr Kalpana Sharma (Udaipur); for giving feedback for various sections of the volumes.

We are grateful to Dr Hitant Vohra and Dr Anu Sharma (Ludhiana); Dr Anupma Mahajan (Amritsar); Dr Vanita Gupta (Jammu), for editing chapters to enhance the value of the volumes.

We are grateful to Dr Ravikant (Amritsar); Dr Sangeeta and Dr Nusrat Jabeen (Jammu); Dr Kalyan Singh and Dr Rajan Singla (Patiala); Dr Anjali Jain and Dr Aprajita Sikka (Ludhiana); Dr Bashir (Srinagar); Dr Seema and Dr Ritu (Rajouri); Dr Mubeen (Kathua); Dr RK Srivastava (Kanpur); Dr Punita Manik (Lucknow); Dr Binod Kumar; Dr Sunita Nayak and Dr Shambhu Prasad (Patna); Dr AK Dubey (Ranchi); Dr Satyam Khare; Dr Shilpi Jain and Dr Alok Tripathi (Meerut), for promoting the volumes.

We have been getting constant encouragement and support from Dr Ranjana Verma, Dr Muthukrishnan P, Dr Yogesh Yadav, Dr Pullimi Vineel and Dr Anupma Gupta (Greater Noida); Dr Nisha Kaul (Ghaziabad); Dr Vinay Singhal (Saharanpur); Dr RK Ashoka (Mathura); Dr Vineet Guha (Khandwa); Dr Manisha Sinha (Raipur); Dr Jahan Shirin (Kanpur); Dr Damyanti (Manipur); Dr Daisy Sahni (Chandigarh); and Dr MK Anand (Bhuj).

Our regards and affection to Dr Rewa Choudhry, Dr Shilpa Paul, Dr Smita Kakar, Dr Anita Tuli, Dr Gayatri Rath, Dr Shashi Raheja, Dr Shyama Rajdan, Dr Mangala Kohli, Dr A Sheriff, Dr SB Ray, Dr Vandana Mehta, Dr Sabita Mishra, Dr Renu Chauhan, Dr Jyoti Arora, Dr Sneha Aggarwal and Dr TS Roy (Delhi), for going through the volumes.

We would like to thank Dr Pritha Bhuiyan (Mumbai); Dr Brijendra Singh (Rishikesh); Col. Dr Sushil Kumar (Pune); Dr AK Srivastava (Lucknow); Dr MK Pant (Dehradun); Dr Shakuntala Pai (Manipal); Dr Simmi Mehra (Rajkot); Dr Fatima M De Souza (Goa); Dr Mukesh Mittal (Shivpuri); Dr Priti Sinha (Saharanpur); Dr Rakesh K Verma (Lucknow); Dr Rashmi Malhotra (Rishikesh); Dr Sandiya Kurup (Kalanchery); Dr Simmi Soni (Aziznagar); Dr Sunita Gupta (Ahmedabad) and many-many other teachers all over the globe, for giving us good wishes.

Videos of bones and soft parts of human body, prepared at Kathmandu University School of Medical Sciences, have now been added with the respective chapters and are available at our mobile App [CBSiCentral](#). I (chief editor) am grateful to Dr R Koju, CEO of KUSMS and Dhulikhel Hospital, for his generosity.

The moral support of my (chief editor) family members, Late Dr DP Garg, Dr Suvira Gupta, Dr JP Gupta, Mr Manoj, Ms Rekha, Mr Sanjay, Ms Meenakshi, Dr Manish, Dr Shilpa Garg, Dr Naveen Garg, Dr Manoj, Dr Nalini Shukla, Dr Vikas Verma and Dr Swati Gupta, is appreciated.

The magnanimity shown by Mr SK Jain (Chairman) and Mr Varun Jain (Director), CBS Publishers & Distributors, has been always forthcoming. The unquestionable support of Mr YN Arjuna (Senior Vice President—Publishing, Editorial and Publicity) and his entire team comprising Ms Ritu Chawla (GM—Production), Mr Sanjay Chauhan, Mr Neeraj Prasad and Mr Rohan Prasad (Graphic Artists); Mr Surendra Jha and Mr Prasenjit Paul (Copy Editors); Ms Jyoti Kaur and Mr Tarun Rajput (DTP Operators) has made an excellent contribution to bring out this edition. We are really obliged to them and pray for their prosperity.

*Chief Editor*

**Krishna Garg**

email: [dr.krishnagarg@gmail.com](mailto:dr.krishnagarg@gmail.com)

*Editors*

**Pragati Sheel Mittal**  
**Mrudula Chandrupatla**

## *Thus spoke the cadaver*

*Handle me with little love and care  
As I had missed it in my life affair  
Was too poor for cremation or burial  
That is why am lying in dissection hall*

*You dissect me, cut me, section me  
But your learning anatomy should be precise  
Worry not, you would not be taken to court  
As I am happy to be with the bright lot*

*Couldn't dream of a fridge for cold water  
Now my body parts are kept in refrigerator  
Young students sit around me with friends  
A few dissect, rest talk, about food, family and movies  
How I enjoy the dissection periods  
Don't you? Unless you are interrogated by a teacher*

*When my parts are buried post-dissection  
Bones are taken out for the skeleton  
Skeleton is the crown glory of the museum  
Now I am being looked up by great enthusiasm*

*If not as skeletons as loose bones  
I am in their bags and in their hostel rooms  
At times, I am on their beds as well  
Oh, what a promotion to heaven from hell*

*I won't leave you, even if you pass anatomy  
Would follow you in forensic medicine and pathology  
Would be with you even in clinical teaching  
Medicine line is one where dead teach the living*

*One humble request I'd make  
Be sympathetic to persons with disease  
Don't panic, you'll have enough money  
And I bet, you'd be singularly happy*

*—Krishna Garg*



# Contents



<i>Preface to the Ninth Edition</i>	vii
<i>Preface to the First Edition (excerpts)</i>	ix
<i>Index of Competencies</i>	xix

## Section 1 UPPER LIMB

### 1. Introduction 3

Parts of the Upper Limb	3
Evolution of Upper Limbs	4
Study of Anatomy	5
Frequently Asked Questions	5

### 2. Bones 6

Introduction	6
Clavicle	6
Ossification	8
Clinical Anatomy	8
Scapula	8
Ossification	12
Clinical Anatomy	13
Humerus	13
Ossification	16
Clinical Anatomy	17
Radius	18
Ossification	21
Clinical Anatomy	21
Ulna	22
Ossification	24
Clinical Anatomy	24
Ossification of Humerus, Radius and Ulna	25
Importance of Capsular Attachments and Epiphyseal Lines	25
Clinical Anatomy	25
Carpal Bones	26
Ossification	27
Clinical Anatomy	27
Metacarpal Bones	27
Ossification	31
Clinical Anatomy	31
Phalanges	32
Ossification	33
Clinical Anatomy	33
Sesamoid Bones	33
▶ Video 1.2.1 Clavicle	
▶ Video 1.2.2 Scapula	
▶ Video 1.2.3 Humerus	
▶ Video 1.2.4 Radius	
▶ Video 1.2.5 Ulna	
▶ Video 1.2.6 Hand	
Mnemonics	33
Facts to Remember	33
Clinicoanatomical Problem	34
Further Reading	34
Frequently Asked Questions	34

Multiple Choice Questions	34
Viva Voce	35, 36

### 3. Pectoral Region 37

Introduction	37
Surface Landmarks	37
Dissection	38
Superficial Fascia	38
Mammary gland/Breast	39
Lymphatic Drainage	42
Clinical Anatomy	44
Deep Fascia	46
Muscles of the Pectoral Region	46
Serratus Anterior	49
Dissection	50
▶ Video 1.3 Pectoral Region	
Mnemonics	50
Facts to Remember	50
Clinicoanatomical Problem	50
Further Reading	51
Frequently Asked Questions	51
Multiple Choice Questions	51
Viva Voce	52

### 4. Axilla 53

Introduction	53
Dissection	53
Boundaries	54
Contents of Axilla	55
Clinical Anatomy	57
Axillary Artery	57
Relations of Axillary Artery	57
Axillary Vein	60
Clinical Anatomy	60
Axillary Lymph Nodes	60
Clinical Anatomy	61
Spinal Nerve	61
Brachial Plexus	61
Dissection	64
Clinical Anatomy	64
▶ Video 1.4 Axilla	
Mnemonics	66
Facts to Remember	66
Clinicoanatomical Problem	66
Further Reading	66
Frequently Asked Questions	67
Multiple Choice Questions	67
Viva Voce	68



**5. Back**

69

- Introduction 69
- Surface Landmarks 69
- Skin and Fasciae of the Back 69
- Dissection 70
- Muscles Connecting the Upper Limb with the Vertebral Column 70
- Dissection 70
- Additional Features of Muscles of the Back 72
- Trapezius 72
- Latissimus Dorsi 73
- Dissection 74
- Facts to Remember 74
- Clinicoanatomical Problem 74
- Further Reading 74
- Frequently Asked Questions 75
- Multiple Choice Questions 75
- Viva Voce 75

**6. Scapular Region**

76

- Introduction 76
- Surface Landmarks 76
- Muscles of the Scapular Region 76
- Deltoid 76
- Dissection 80
- Clinical Anatomy 80
- Rotator Cuff 81
- Intermuscular Spaces 81
- Dissection 82
- Axillary or Circumflex Nerve 83
- Anastomoses Around Scapula 84
- Clinical Anatomy 84
- ▶ **Video 1.6 Muscles of the Back and Scapular Region**
- Mnemonics 84
- Facts to Remember 84
- Clinicoanatomical Problem 84
- Further Reading 85
- Frequently Asked Questions 85
- Multiple Choice Questions 85
- Viva Voce 86

**7. Cutaneous Nerves, Superficial Veins and Lymphatic Drainage**

87

- Introduction 87
- Cutaneous Nerves 87
- Dissection 89
- Dermatomes 90
- Clinical Anatomy 91
- Superficial Veins 92
- Individual Veins 92
- Clinical Anatomy 94
- Lymph Nodes and Lymphatic Drainage 94
- Clinical Anatomy 95
- Facts to Remember 96
- Clinicoanatomical Problems 96
- Further Reading 96
- Frequently Asked Questions 97
- Multiple Choice Questions 97
- Viva Voce 97

**8. Arm**

98

- Introduction 98
- Surface Landmarks 98

- Compartments of the Arm 99
- Anterior Compartment 99
- Muscles 99
- Nerves 99
- Musculocutaneous Nerve 99
- Median Nerve 103
- Ulnar Nerve 103
- Radial Nerve 103
- Dissection 103
- Clinical Anatomy 103
- Brachial Artery 104
- Dissection 105
- Clinical Anatomy 106
- Changes at the Level of Insertion of Coracobrachialis 106
- Cubital Fossa 107
- Dissection 108
- Clinical Anatomy 109
- Posterior Compartment 109
- Triceps Brachii Muscle 109
- Dissection 111
- Clinical Anatomy 111
- Radial Nerve or Musculospiral Nerve 111
- Clinical Anatomy 113
- Profunda Brachii Artery 113
- ▶ **Video 1.8 Arm**
- Mnemonics 114
- Facts to Remember 114
- Clinicoanatomical Problem 114
- Further Reading 114
- Frequently Asked Questions 115
- Multiple Choice Questions 115
- Viva Voce 115, 116

**9. Forearm and Hand**

117

- Introduction 117
- Surface Landmarks of Front of Forearm 117
- Muscles of Front of Forearm 118
- Superficial Muscles 119
- Deep Muscles 120
- Dissection 123
- Arteries of Front of Forearm 123
- Radial Artery 123
- Ulnar Artery 124
- Dissection 125
- Nerves of Front of Forearm 126
- Median Nerve 126
- Ulnar Nerve 127
- Radial Nerve 127
- Dissection 128
- Palmar Aspect of Wrist and Hand 128
- Dissection 128
- Flexor Retinaculum 129
- Clinical Anatomy 130
- Intrinsic Muscles of Hand 131
- Testing of Some Intrinsic Muscles 136
- Dissection 137
- Arteries of Hand 137
- Ulnar Artery 137
- Clinical Anatomy 138
- Radial Artery 138
- Dissection 140
- Nerves of Hand 140
- Ulnar Nerve 140
- Clinical Anatomy 141
- Median Nerve 142

**Clinical Anatomy** 143  
 Fascial Spaces of Hand 145  
**Clinical Anatomy** 147  
 Back of Forearm and Hand 147  
 Surface Landmarks 147  
 Dorsum of Hand 148  
 Anatomical Snuffbox 149  
 Extensor Retinaculum 149  
**Dissection** 149  
 Muscles of Back of Forearm 150  
 Superficial Muscles 150  
 Deep Muscles 152  
 Dorsal Digital Expansion/Extensor Expansion 152  
**Dissection** 153  
 Posterior Interosseous Nerve 153  
**Dissection** 155  
 Posterior Interosseous Artery 155  
 Arches of Hand 155  
 ▶ **Video 1.9.1 Forearm**  
 ▶ **Video 1.9.2 Palm**  
 Mnemonics 156  
 Facts to Remember 156  
**Clinicoanatomical Problems** 157  
 Further Reading 157  
**Frequently Asked Questions** 157  
**Multiple Choice Questions** 158  
**Viva Voce** 159

## 10. Joints of Upper Limb 160

Introduction 160  
 Shoulder Girdle 160  
 Sternoclavicular Joint 160  
**Dissection** 161  
 Acromioclavicular Joint 161  
 Movements of Shoulder Girdle 161  
**Dissection** 163  
 Shoulder Joint 163  
 Movements of Shoulder Joint 165  
**Dissection** 166  
**Clinical Anatomy** 167  
 Elbow Joint 169  
 Dancing Shoulder 169  
 Carrying Angle 171  
**Dissection** 171  
**Clinical Anatomy** 171  
 Radioulnar Joints 173  
 Interosseous Membrane 173  
 Middle Radioulnar Joint 173  
 Supination and Pronation 174  
**Dissection** 174  
**Clinical Anatomy** 175  
 Wrist (Radiocarpal) Joint 175  
**Dissection** 177  
**Clinical Anatomy** 177

Joints of Hand 178  
 Intercarpal, Carpometacarpal and  
 Intermetacarpal Joints 178  
 First Carpometacarpal Joint 178  
**Dissection** 180  
**Clinical Anatomy** 180  
 Metacarpophalangeal Joints 180  
 Interphalangeal Joints 181  
 ▶ **Video 1.10 Joints of Upper Limb**  
 Mnemonics 182  
**Facts to Remember** 182  
**Clinicoanatomical Problem** 182  
 Further Reading 182  
**Frequently Asked Questions** 183  
**Multiple Choice Questions** 183  
**Viva Voce** 184

## 11. Surface Marking, Radiological Anatomy and Comparison of Upper and Lower Limbs 185

Introduction 185  
 Surface Marking 185  
 Mammary Gland 185  
 Arteries and Nerves in Arm 185  
 Joints 189  
 Retinacula 190  
 Synovial Sheaths of the Flexor Tendons 190  
 Radiological Anatomy of Upper Limb 190  
 Comparison of Upper and Lower Limbs 193  
 Further Reading 196  
**Frequently Asked Questions** 196

## Appendix 1: Nerves, Arteries and Clinical Terms 197

Introduction 197  
 Musculocutaneous Nerve 197  
 Axillary or Circumflex Nerve 197  
 Radial Nerve 198  
 Median Nerve 200  
 Ulnar Nerve 200  
**Clinical Anatomy** 202  
 Arteries of Upper Limb 204  
 Sympathetic Innervation 206  
 Embryology of the Upper Limb 206  
 Molecular Regulation of Limb Development 206  
 Clinical Terms 206  
 Further Reading 208  
**Frequently Asked Questions** 208  
**Multiple Choice Questions** 208  
**Early Clinical Exposure (ECE) Cases** 210  
**Spots on Upper Limb** 211  
**Answers: Spots on Upper Limb** 212

## Section 2 THORAX

### 12. Introduction 215

Surface Landmarks of Thorax 215  
 Skeleton of Thorax 216  
 Formation 216

**Clinical Anatomy** 218  
 Shape 218  
**Clinical Anatomy** 218  
 Superior Aperture/Inlet of Thorax 219  
**Clinical Anatomy** 221

Inferior Aperture/Outlet of Thorax 221

Facts to Remember 223

Clinicoanatomical Problem 223

Further Reading 223

Frequently Asked Questions 223

Multiple Choice Questions 223

Viva Voce 224

### 13. Bones and Joints of Thorax 225

Introduction 225

Bones of Thorax 225

Ribs or Costae 225

Ossification of a Typical Rib 227

Ossification 228

Ossification 229

Costal Cartilages 229

Clinical Anatomy 230

Sternum 230

Development and Ossification 232

Clinical Anatomy 232

Vertebral Column 233

Ossification 237

Clinical Anatomy 237

Joints of Thorax 237

Respiratory Movements 240

Clinical Anatomy 242

▶ Video 1.13.1 Sternum

▶ Video 1.13.2 Ribs

▶ Video 1.13.3 Thoracic Vertebra

Mnemonics 243

Facts to Remember 243

Clinicoanatomical Problem 244

Further Reading 244

Frequently Asked Questions 245

Multiple Choice Questions 245

Viva Voce 245

### 14. Walls of Thorax 246

Introduction 246

Thoracic Wall Proper 246

Intercostal Muscles 246

Intercostal Nerves 248

Dissection 249

Clinical Anatomy 250

Typical Intercostal Spaces 251

Intercostal Arteries 251

Intercostal Veins 253

Lymphatics of an Intercostal Space 253

Internal Thoracic Artery 253

Azygos Vein 255

Hemiazygos Vein 256

Accessory Hemiazygos Vein 256

Thoracic Sympathetic Trunk 256

Clinical Anatomy 259

▶ Video 1.14 Thoracic Cage

Facts to Remember 259

Clinicoanatomical Problem 259

Further Reading 259

Frequently Asked Questions 260

Multiple Choice Questions 260

Viva Voce 260

### 15. Thoracic Cavity and Pleurae 261

Thoracic Cavity 261

Dissection 261

Pleurae 263

Nerve Supply of the Pleura 267

Clinical Anatomy 267

Mnemonics 268

Facts to Remember 268

Clinicoanatomical Problem 268

Further Reading 269

Frequently Asked Questions 269

Multiple Choice Questions 269

Viva Voce 270

### 16. Lungs 271

Introduction 271

Dissection 271

Fissures and Lobes of the Lungs 272

Root of the Lung 274

Bronchial Tree 276

Dissection 276

Development of Respiratory System 279

Molecular Regulation 280

Histology 280

Clinical Anatomy 281

▶ Video 1.16 Lungs

Mnemonics 282

Facts to Remember 282

Clinicoanatomical Problems 282

Further Reading 283

Frequently Asked Questions 283

Multiple Choice Questions 284

Viva Voce 284

### 17. Mediastinum 285

Introduction 285

Superior and Inferior Mediastina 285

Dissection 285

Superior Mediastinum 286

Inferior Mediastinum 286

Anterior Mediastinum 286

Middle Mediastinum 286

Posterior Mediastinum 286

Clinical Anatomy 287

Facts to Remember 288

Clinicoanatomical Problem 288

Frequently Asked Questions 289

Multiple Choice Questions 289

Viva Voce 289

### 18. Pericardium and Heart 290

Introduction 290

Pericardium 290

Fibrous Pericardium 291

Serous Pericardium 291

Dissection 292

Clinical Anatomy 292

Heart 293

External Features 293

Clinical Anatomy 293

Right Atrium 295

Dissection 295	
Right Ventricle 297	
Dissection 299	
Left Atrium 299	
Dissection 299	
Left Ventricle 299	
Dissection 300	
Clinical Anatomy 301	
Structure of Heart 301	
Valves 301	
Clinical Anatomy 302	
Fibrous Skeleton 302	
Musculature of the Heart 303	
Conducting System 303	
Clinical Anatomy 304	
Arteries Supplying the Heart 304	
Right Coronary Artery 305	
Dissection 306	
Left Coronary Artery 306	
Dissection 307	
Cardiac Dominance 307	
Clinical Anatomy 307	
Veins of the Heart 308	
Lymphatics of Heart 309	
Nerve Supply of Heart 310	
Clinical Anatomy 310	
Developmental Components 311	
Molecular Regulation of Cardiac Development 311	
Foetal Circulation 311	
▶ Video 1.18.1 Pericardium and Heart	
▶ Video 1.18.2 Chambers of the Heart	
Mnemonics 314	
Facts to Remember 314	
Clinicoanatomical Problems 314	
Further Reading 315	
Frequently Asked Questions 315	
Multiple Choice Questions 316	
Viva Voce 316	
<b>19. Superior Vena Cava, Aorta and Pulmonary Trunk</b>	<b>317</b>
Introduction 317	
Dissection 317	
Superior Vena Cava 317	
Clinical Anatomy 318	
Aorta 319	
Ascending Aorta 319	
Arch of Aorta 319	
Descending Thoracic Aorta 321	
Phrenic Nerve 323	
Clinical Anatomy 323	
Pulmonary Trunk 324	
Development of Arteries 324	
Development of Superior Vena Cava 325	
Mnemonics 325	
Facts to Remember 325	
Clinicoanatomical Problem 326	
Frequently Asked Questions 327	
Multiple Choice Questions 327	
Viva Voce 327	
<b>20. Trachea, Oesophagus and Thoracic Duct</b>	<b>328</b>
Introduction 328	
Trachea 328	
Histology of Trachea 329	
Clinical Anatomy 330	
Oesophagus 330	
Dissection 330	
Histology of Oesophagus 332	
Clinical Anatomy 333	
Thoracic Duct 334	
Facts to Remember 335	
Clinicoanatomical Problem 335	
Further Reading 335	
Frequently Asked Questions 336	
Multiple Choice Questions 336	
Viva Voce 336	
<b>21. Surface Marking and Radiological Anatomy of Thorax</b>	<b>337</b>
Introduction 337	
Surface Marking 337	
Parietal Pleura 337	
Lungs 338	
Borders of the Heart 339	
Arteries 340	
Veins 341	
Trachea 342	
Right Bronchus 342	
Left Bronchus 342	
Oesophagus 342	
Thoracic Duct 342	
Radiological Anatomy 342	
Tomography 344	
Numericals 344	
Further Reading 344	
<b>Appendix 2: Autonomic Nervous System, Arteries, Nerves and Clinical Terms</b>	<b>345</b>
Introduction 345	
Autonomic Nervous System 345	
Sympathetic Nervous System 345	
Thoracic Part of Sympathetic Trunk 346	
Nerve Supply of Heart 347	
Nerve Supply of Lungs 347	
Typical Intercostal Nerve 348	
Atypical Intercostal Nerves 348	
Arteries 348	
Clinical Terms 348	
Frequently Asked Questions 351	
Multiple Choice Questions 352	
Early Clinical Exposure (ECE) Cases 353	
Spots on Thorax 355	
Answers: Spots on Thorax 356	
<b>Index</b>	<b>357</b>





# Ethical Aspects of Cadaveric Dissection

The cadaver, the dead body, that we dissect, plays an important role in the teaching of anatomy to medical students. The cadaver and the bones become an important part of our life as medical students as some academics have even referred to the cadaver as the 'first teacher' in the medical school.

We must pay due respect to the cadavers and bones kept in the dissection hall or museum. In some medical schools it is mandatory to take an 'oath' before beginning the cadaveric dissection which aims to uphold the dignity of the mortal remains of the departed soul while other medical schools help the student to undertake dissection in a proper manner and empathise with the families of the donor. During the course of dissection the student is constantly reminded of the sanctity of the body he/she is studying so that the noble donation of someone's body is used only as a means of gaining scientific knowledge/progress. Each and every dissected part afterwards is disposed or cremated with full dignity.

Honour of the donor and his/her family is the prime responsibility of the health professional. 'The dead teach the living', and the living pledge to use this knowledge for the upliftment of humankind.

Three-dimensional models and computer simulations cannot replace the tactile appreciation achieved by cadaveric dissection and we should always be grateful to those who have donated their bodies and strive to respect them. We have the privilege to study the human being through a body of a fellow human and have to be humble and carry forward the legacy of nobility and selflessness in our careers.

*(Contributed by Dr Puneet Kaur)*

# Index of Competencies



## Competency based Undergraduate Curriculum for the Indian Medical Graduate

<i>Code</i>	<i>Competency</i>	<i>Chapter</i>	<i>Page no</i>
AN 8.1	Identify the given bone, its side, important features and keep it in anatomical position	2	6
AN 8.2	Identify and describe joints formed by the given bone	2	6
AN 8.3	Enumerate peculiarities of clavicle	2	6
AN 8.4	Demonstrate important muscle attachments on the given bone	2	7, 8
AN 8.5	Identify and name various bones in articulated hand, specify the parts of metacarpals and phalanges and enumerate the peculiarities of pisiform	2	25
AN 8.6	Describe scaphoid fracture and explain the anatomical basis of avascular necrosis	2	27
AN 9.1	Describe attachment, nerve supply and action of pectoralis major and pectoralis minor	3	46
AN 9.2	Describe the location, extent, deep relations, structure, age changes, blood supply, lymphatic drainage, microanatomy and applied anatomy of breast.	3	39
AN 9.3	Describe development of the breast	3	43
AN 10.1	Identify and describe boundaries and contents of axilla	4	53
AN 10.2	Identify, describe and demonstrate the origin, extent, course, parts, relations and branches of axillary artery and tributaries of vein	4	57
AN 10.3	Describe, identify and demonstrate formation, branches, relations, area of supply of branches, course and relations of terminal branches of brachial plexus	4	61
AN 10.4	Describe the anatomical groups of axillary lymph nodes and specify their areas of drainage	3, 4	42, 60
AN 10.5	Explain variations in formation of brachial plexus	4	61
AN 10.6	Explain the anatomical basis of clinical features of Erb's palsy and Klumpke's paralysis	4	64
AN 10.7	Explain anatomical basis of enlarged axillary lymph nodes	3, 4	42, 60
AN 10.8	Describe, identify and demonstrate the position, attachment, nerve supply and actions of trapezius and latissimus dorsi	5	70
AN 10.9	Describe the arterial anastomosis around the scapula and mention the boundaries of triangle of auscultation	5, 6	73, 84
AN 10.10	Describe and identify the deltoid and rotator cuff muscles	6	76, 81
AN 10.11	Describe and demonstrate attachment of serratus anterior with its action	3	49
AN 10.12	Describe and demonstrate shoulder joint for—type, articular surfaces, capsule, synovial membrane, ligaments, relations, movements, muscles involved, blood supply, nerve supply and applied anatomy	10	163
AN 10.13	Explain anatomical basis of injury to axillary nerve during intramuscular injections	6	80, 83, 84
AN 11.1	Describe and demonstrate muscle groups of upper arm with emphasis on biceps and triceps brachii	8	99, 109
AN 11.2	Identify and describe origin, course, relations, branches (or tributaries), termination of important nerves and vessels in arm	8	99, 104
AN 11.3	Describe the anatomical basis of venepuncture of cubital veins	7	93
AN 11.4	Describe the anatomical basis of Saturday night paralysis	8	112
AN 11.5	Identify and describe boundaries and contents of cubital fossa	8	106
AN 11.6	Describe the anastomoses around the elbow joint	8	105
AN 12.1	Describe and demonstrate important muscle groups of ventral forearm with attachments, nerve supply and actions	9	118
AN 12.2	Identify and describe origin, course, relations, branches (or tributaries), termination of important nerves and vessels of forearm	9	123

<i>Code</i>	<i>Competency</i>	<i>Chapter</i>	<i>Page no</i>
AN 12.3	Identify and describe flexor retinaculum with its attachments	9	128
AN 12.4	Explain anatomical basis of carpal tunnel syndrome	9	143
AN 12.5	Identify and describe small muscles of hand. Also describe movements of thumb and muscles involved	9	134
AN 12.6	Describe and demonstrate movements of thumb and muscles involved	10	178
AN 12.7	Identify and describe course and branches of important blood vessels and nerves in hand	9	137
AN 12.8	Describe anatomical basis of claw hand	9	143
AN 12.9	Identify and describe fibrous flexor sheaths, ulnar bursa, radial bursa and digital synovial sheaths	9	120
AN 12.10	Explain infection of fascial spaces of palm	9	145
AN 12.11	Identify, describe and demonstrate important muscle groups of dorsal forearm with attachments, nerve supply and actions	9	150
AN 12.12	Identify and describe origin, course, relations, branches (or tributaries), termination of important nerves and vessels of back of forearm	9	153
AN 12.13	Describe the anatomical basis of wrist drop	8	112
AN 12.14	Identify and describe compartments deep to extensor retinaculum	9	149
AN 12.15	Identify and describe extensor expansion formation	9	152
AN 13.1	Describe veins of upper limb and its lymphatic drainage	7	92
AN 13.2	Describe dermatomes of upper limb	7	90
AN 13.3	Identify and describe the type, articular surfaces, capsule, synovial membrane, ligaments, relations, movements, blood and nerve supply of elbow joint, proximal and distal radioulnar joints, wrist joint and first carpometacarpal joint	10	169
AN 13.4	Describe sternoclavicular joint, acromioclavicular joint, carpometacarpal joints and metacarpophalangeal joint	10	160, 178
AN 13.5	Identify the bones and joints of upper limb seen in anteroposterior and lateral view radiographs of shoulder region, arm, elbow, forearm and hand	11	190
AN 13.6	Identify and demonstrate important bony landmarks of upper limb: Jugular notch, sternal angle, acromial angle, spine of the scapula, vertebral level of the medial end, inferior angle of the scapula	3	37
AN 13.7	Identify and demonstrate surface projection of: Cephalic and basilic vein, palpation of brachial artery, radial artery, testing of muscles: Trapezius, pectoralis major, serratus anterior, latissimus dorsi, deltoid, biceps brachii, brachioradialis	11	185
AN 13.8	Describe development of upper limb	Appendix 1	206
AN 21.1	Identify and describe the salient features of sternum, typical rib, 1st rib and typical thoracic vertebra	13	225
AN 21.2	Identify and describe the features of 2nd, 11th and 12th ribs, 1st, 11th and 12th thoracic vertebrae	13	227
AN 21.3	Describe and demonstrate the boundaries of thoracic inlet, and outlet	12	219
AN 21.4	Describe and demonstrate extent, attachments, direction of fibres, nerve supply and actions of intercostal muscles	14	246
AN 21.5	Describe and demonstrate origin, course, relations and branches of a typical intercostal nerve	14	248
AN 21.6	Mention origin, course and branches/ tributaries of: 1. Anterior and posterior intercostal vessels 2. Internal thoracic vessels	14	250
AN 21.7	Mention the origin, course, relations and branches of: 1. Atypical intercostal nerve 2. Superior intercostal artery, subcostal artery	14	248
AN 21.8	Describe and demonstrate type, articular surfaces and movements of manubriosternal, costovertebral, costotransverse and xiphisternal joints	13	237
AN 21.9	Describe and demonstrate mechanics and types of respiration	13	240

<i>Code</i>	<i>Competency</i>	<i>Chapter</i>	<i>Page no</i>
AN 21.10	Describe costochondral and interchondral joints	13	238
AN 21.11	Mention boundaries and contents of the superior, anterior, middle and posterior mediastinum	17	285
AN 22.1	Describe and demonstrate subdivisions, sinuses in pericardium, blood supply and nerve supply of pericardium	18	290
AN 22.2	Describe and demonstrate external and internal features of each chamber of heart	18	295
AN 22.3	Describe and demonstrate origin, course and branches of coronary arteries	18	304
AN 22.4	Describe anatomical basis of ischaemic heart disease	18	307
AN 22.5	Describe and demonstrate the formation, course, tributaries and termination of coronary sinus	18	308
AN 22.6	Describe the fibrous skeleton of heart	18	302
AN 22.7	Mention the parts, position and arterial supply of the conducting system of heart	18	303
AN 23.1	Describe and demonstrate the external appearance, relations, blood supply, nerve supply, lymphatic drainage and applied anatomy of oesophagus	20	330
AN 23.2	Describe and demonstrate the extent, relations tributaries of thoracic duct and enumerate its applied anatomy	20	333
AN 23.3	Describe and demonstrate origin, course, relations, tributaries and termination of superior venacava, azygos, hemiazygos and accessory hemiazygos veins	14, 19	255, 317
AN 23.4	Mention the extent, branches and relations of arch of aorta and descending thoracic aorta	19	319
AN 23.5	Identify and mention the location and extent of thoracic sympathetic chain	14	256
AN 23.6	Describe the splanchnic nerves	14	256
AN 23.7	Mention the extent, relations and applied anatomy of thoracic duct	20	334
AN 24.1	Mention the blood supply, lymphatic drainage and nerve supply of pleura, extent of pleura and describe the pleural recesses and their applied anatomy	15	263
AN 24.2	Identify side, external features and relations of structures which form root of lung and bronchial tree and their clinical correlate	15	274
AN 24.3	Describe a bronchopulmonary segment	15	277
AN 24.4	Identify phrenic nerve and describe its formation and distribution	19	322
AN 24.5	Mention the blood supply, lymphatic drainage and nerve supply of lungs	16	275
AN 24.6	Describe the extent, length, relations, blood supply, lymphatic drainage and nerve supply of trachea	20	328
AN 25.1	Identify, draw and label a slide of trachea and lung	20	329
AN 25.2	(a) Describe development of pleura, lung and heart (b) Describe development of respiratory system and heart	16 18	279 310
AN 25.3	Describe fetal circulation and changes occurring at birth	18	311
AN 25.4	Describe embryological basis of: 1. Atrial septal defect 2. Ventricular septal defect 3. Fallot's tetralogy 4. Tracheo-oesophageal fistula	18, 20	313
AN 25.5	Describe developmental basis of congenital anomalies, transposition of great vessels, dextrocardia, patent ductus arteriosus and coarctation of aorta	19	319
AN 25.6	Mention development of aortic arch arteries, SVC, IVC and coronary sinus	19	324
AN 25.7	Identify structures seen on a plain X-ray chest (PA view)	21	342
AN 25.8	Identify and describe in brief a barium swallow	21	344
AN 25.9	Demonstrate surface marking of lines of pleural reflection, lung borders and fissures, trachea, heart borders, apex beat and surface projection of valves of heart	21	337



Competency-Based  
**BD Chaurasia's**  
**Human Anatomy**

Regional and Applied | Dissection and Clinical

Ninth  
 Edition

Volume  
**2**

- Volume 1 UPPER LIMB and THORAX
- Volume 2 LOWER LIMB, ABDOMEN and PELVIS
- Volume 3 HEAD and NECK
- Volume 4 BRAIN-NEUROANATOMY

Widely acclaimed as a standard textbook in view of its simple language, comprehensive coverage, lucid presentation and neatly-drawn line diagrams, **BD Chaurasia's Human Anatomy** remains the most preferred textbook in India and abroad. This edition has been thoroughly revised and updated to make it extremely informative and much more student-friendly.

The ninth edition now features diagrams adapted from the first edition, originally prepared by Dr BD Chaurasia, which have been suitably redrawn, modified and colored appropriately. Many text chapters have citations to videos of osteology and soft parts which are accessible through CBSiCentral App. Clinically oriented FAQs and MCQs, and ECE cases have been included to make the volumes absolutely clinical in nature.

**Salient features of the four volumes**

- Text follows the **CBME Guidelines** and all topics are described as per the **Competency Based Undergraduate Curriculum for the Indian Medical Graduate** prescribed by the National Medical Commission.
- **Colour codes** used consistently in the drawings of various cells, tissues and organs are given at the beginning of each section.
- Impressive **line diagrams**, originally hand-drawn by Dr BD Chaurasia, adapted from the first edition of *BDC Human Anatomy*, have been incorporated in this edition to make drawing of illustrations easier for the students.
- **Videos of osteology and soft parts**, accessible from CBSiCentral App through scratch code, have been numbered and cited in the respective chapters in all the four volumes. The App also includes answers to FAQs.
- **Latest updates** on various topics have been provided from standard international publications.
- **Clinical orientation** has been enthused by structuring many FAQs and MCQs in 'clinical mode'. **Early Clinical Exposure (ECE)** has been provided in the form of signs, symptoms, investigations and treatment of a particular case.
- Important features like **viva voce questions**, **molecular regulation**, **clinicoanatomical problems**, **ossification**, **dissection (steps)** are continued from the previous editions.
- **This volume features**  
 Tables 52, Flowcharts 4, Illustrations 653, Ossification boxes 12, Dissection boxes 36, X-rays 5, Clinical Anatomy boxes 101, Facts to Remember 229, FAQs 132, MCQs 232, Viva Voce questions 508, Videos 50, Clinicoanatomical Problems 35.

**Chief Editor**

**Krishna Garg** MBBS, MS, PhD, FIMSA, FIAMS, FAMS, FASI is ex-Professor and Head, Department of Anatomy, Lady Hardinge Medical College (LHMC), New Delhi. She joined LHMC where she completed her MS and PhD and taught anatomy till her retirement. She has received fellowships of the Indian Medical Association, Academy of Medical Specialists, and the International Medical Science Academy. She was elected fellow of the Academy of Medical Sciences (FAMS) in 2005. She was honoured with Excellence Award in Anatomy in 2004 by Delhi Medical Association. She has received Life Time Achievement Award, Fellowship of Anatomical Society of India, and DMA Distinguished Services Award, in 2015. She is visiting faculty of DNB, MDS and a PhD examiner.

She is author of *Manual of Human Anatomy Dissection*, *Companion Pocketbook—BDC Human Anatomy (Vols 1–3)* and *BDC Human Anatomy for Dental Students 3/e*; coauthor of *Textbook of Histology 5/e*, *Textbook of Neuroanatomy 6/e*, *Anatomy and Physiology for Nurses, Anatomy and Physiology for Allied Health Sciences*, *Practical Anatomy Workbook*, *Practical Histology Workbook* and *Practical Anatomy Workbook for Dental Students*; and editor of *Human Embryology 2/e*, *Handbook of General Anatomy 6/e* and *BD Chaurasia's Applied Anatomy and Physiology for BSc Nursing Students*.

**Editors**

**PS Mittal** MBBS, MS is Professor, Department of Anatomy, Government Institute of Medical Sciences, Greater Noida, UP.

**Mrudula Chandrupatla** MBBS, MD is Additional Professor and Head, Department of Anatomy, and Associate Dean (Research), All India Institute of Medical Sciences, Bibinagar, Hyderabad, Telangana.



**CBS Publishers & Distributors Pvt Ltd**  
 4819/XI, Prahlad Street, 24 Ansari Road, Daryaganj, New Delhi 110 002, India  
 E-mail: delhi@cbspd.com, customercare@cbspd.com; Website: www.cbspd.com  
 New Delhi | Bengaluru | Chennai | Kochi | Kolkata | Lucknow | Mumbai  
 Hyderabad | Jharkhand | Nagpur | Patna | Pune | Uttarakhand



Ninth  
 Edition



Competency-Based  
**Chaurasia's**  
**Human Anatomy**

Volume  
**2**

Competency-Based  
**BD Chaurasia's**  
**Human Anatomy**

Regional and Applied | Dissection and Clinical

As per the CBME Guidelines | Competency Based Undergraduate Curriculum for the Indian Medical Graduate

**Lower Limb**  
**Abdomen and Pelvis**

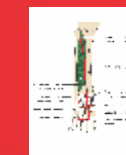
Scratch Code on Inside Front Cover for Accessing CBSiCentral App



Available Free on CBSiCentral App

- Original Images from First Edition of BDC Human Anatomy (Vols 1–3) hand-drawn by Dr BD Chaurasia
- Videos on Osteology and Soft Parts
- Frequently Asked Questions & Answers

Wall Chart on Veins of Human Body



Many easily reproducible diagrams, originally hand-drawn by Dr BD Chaurasia, now modified and coloured suitably, are given at the relevant locations in the text

Ninth  
 Edition

Volume  
**2**



Dedicated to Education

**CBS Publishers & Distributors Pvt Ltd**

**Ninth Edition**

Volume



**2**

*Competency-Based*

**BD Chaurasia's**

# **Human Anatomy**

**Regional and Applied   Dissection and Clinical**

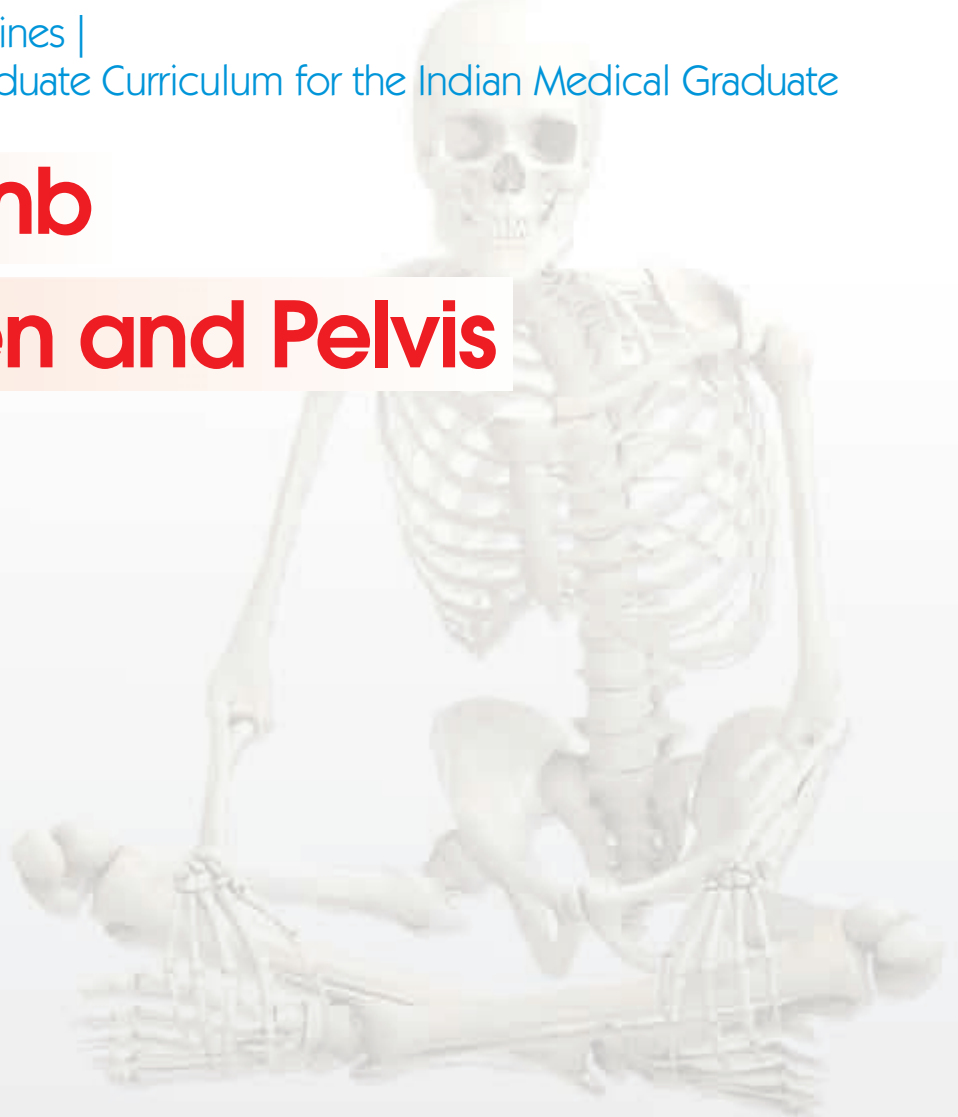
As per the latest CBME Guidelines |  
Competency based Undergraduate Curriculum for the Indian Medical Graduate



**Lower Limb**



**Abdomen and Pelvis**





**Dr BD Chaurasia** (1937–1985)

was Reader in Anatomy at GR Medical College, Gwalior.

He received his MBBS in 1960, MS in 1965 and PhD in 1975.

He was elected fellow of National Academy of Medical Sciences (India) in 1982.

He was a member of the Advisory Board of the *Acta Anatomica* since 1981, member of the editorial board of *Bionature*, and in addition member of a number of scientific societies.

He had a large number of research papers to his credit.



**Ninth Edition**

**Volume**

**2**

*Competency-Based*

**BD Chaurasia's**

# **Human Anatomy**

**Regional and Applied** **Dissection and Clinical**

As per the latest CBME Guidelines |  
Competency based Undergraduate Curriculum for the Indian Medical Graduate



**Lower Limb**



**Abdomen and Pelvis**

*Chief Editor*

**Krishna Garg**

MBBS MS PhD FIMSA FIAMS FAMS FASI

Legend of Anatomy; Nation's Who's Who  
Fellow, Anatomical Society of India  
Lifetime Achievement Awardee  
DMA Distinguished Service Awardee

Ex-Professor and Head, Department of Anatomy  
Lady Hardinge Medical College, New Delhi

*Editors*

**Mrudula Chandrupatla** MBBS MD

Additional Professor and Head, Department of Anatomy  
All India Institute of Medical Sciences  
Bibinagar, Hyderabad, Telangana

**Pragati Sheel Mittal** MBBS MS

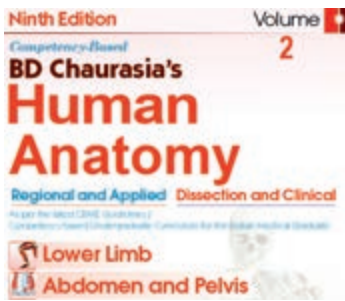
Associate Professor, Department of Anatomy  
Government Institute of Medical Sciences  
Greater Noida, UP



**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 editors 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 editors will not be held responsible for any inadvertent errors, omissions or inaccuracies.

**ISBN:** 978-93-5466-476-2

Copyright © Publisher and author

**Ninth Edition:** 2023

First Edition: 1979

Reprint: 1980, 1981, 1982, 1983, 1984, 1985, 1986, 1987, 1988

Second Edition: 1989

Reprint: 1990, 1991, 1992, 1993, 1994

Third Edition: 1995

Reprint: 1996, 1997, 1998, 1999, 2000, 2001, 2002, 2003, 2004

Fourth Edition: 2004

Reprint: 2005, 2006, 2007, 2008, 2009

Fifth Edition: 2010

Reprint: 2011, 2012

Sixth Edition: 2013

Reprint: 2014, 2015

Seventh Edition: 2016

Reprint: 2017, 2018, 2019

Eighth Edition: 2020

Reprint: 2021, 2022

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 author, editors 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

Fax: 011-23243014

Website: www.cbspd.com

e-mail: delhi@cbspd.com; cbspdubs@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: +033-256330055/56 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, Noorbau, 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 Thomson Press (India) Ltd., Delhi, India

to

---

*my teacher*

*Shri Uma Shankar Nagayach*

— BD Chaurasia



Volume

1

UPPER LIMB and THORAX

Volume

2

LOWER LIMB, ABDOMEN and PELVIS

Volume

3

HEAD and NECK

Volume

4

BRAIN-NEUROANATOMY



*This human anatomy is not systemic but regional  
Oh yes, it is theoretical as well as practical  
Besides the gross features, it is chiefly clinical  
Clinical too is very much diagrammatical.*

*Lots of tables for the muscles are provided  
Even methods for testing are incorporated  
Improved colour illustrations are added  
So that right half of brain gets stimulated*

*Tables for muscles acting on joints are given  
Tables for branches of nerves and arteries are given  
Hope these volumes turn highly useful  
Editors' hardwork under Almighty's guidance prove fruitful*

# Preface to the Ninth Edition

This edition features a number of significant modifications which we have made in the light of the wide-ranging suggestions that we received in the recent months from students, teachers and also the well-wishers of this epic textbook. As the information explodes and knowledge multiplies, appropriate improvements, additions and changes are also required to be made in the contemporary literature. Latest research information sourced from the standard international publications has been selectively incorporated in these volumes.

Numerous unique line diagrams, originally hand-drawn by late Dr BD Chaurasia and used in the first edition of the book, after thoughtful moderation, have now been incorporated in the ninth edition. Our criteria for the selection and manipulation of these drawings were clearly based on the simplicity and lucidity of the anatomic description. These simply structured illustrations can be easily reproduced by the students in multitudes of tests and examinations, including university examinations.

Diagrams form the foundation of anatomy: The drawings create imprints on the brain. Figures, artwork and the dissection are recorded in the right half of the cerebrum while the text is learnt by using left half of cerebrum. Thus, learning by drawing diagrams and steps of dissection help in using both the halves of cerebrum, which is an ideal condition. This textbook lays stress on understanding anatomic structures and details through clear, neat and crisp diagrams.

Earlier, videos of the dissection of all regions had been given free access to the readers on [CBSiCentral App](#). These videos are now uploaded on the App after reorganization of the sequences, numeration and providing appropriate citations in the text. Readers can register on the App and access the enumerated videos through the scratch code given on the inside front cover of each volume. These videos adequately compensate the scarcity of the cadavers in medical institutions for conducting dissection.

The videos of the dissection give three-dimensional image descriptions of tissues and organs which get effectively registered in brain for a longer time.

Processes and steps of dissection given in blue boxes with dissection photographs have been retained as many students and teachers appreciate the same. However, no addition in dissection photographs has been made as a separate CBSPD publication *Manual of Human Anatomy Dissection* (ISBN: 978-93-89688-00-9) with numerous dissection photographs is available to the readers who aspire to learn and enjoy the dissection in a meticulous manner.

We have incorporated all the competencies prescribed by National Medical Commission under the [Competency Based Curriculum for the Indian Medical Graduate](#) for spirited implementation of [Competency Based Medical Education Guidelines](#).

Since National Medical Commission has laid stress on teaching and learning clinical aspects from the very beginning of the MBBS study period, the questions asked are mostly clinical. [Clinical aspects](#) have been explicitly given in the text such that the students are able to learn, recapitulate and answer the clinically-oriented questions in their examinations.

As NMC curriculum also lays emphasis on [Early Clinical Exposure](#), crisply written and well-presented [ECE Cases](#) have been given at the end of every section, which make the book clinical-savvy. These case studies will help the budding doctors in imbibing the salient clinical features, getting appropriate investigations done, and treating the patients satisfactorily once they are in clinical practice.

All the illustrations in the four volumes of this book have been prepared on a common colour scheme applicable to cells, tissues and organs. Colour codes employed in the preparation of the human anatomy illustrations are given in the beginning of each section. This characteristic feature will help the students in identifying the anatomic components clearly and draw appropriately coloured diagram in a schematic manner.

Extensive research by numerous scientists has decoded the molecular control of development of organ tissues of the body. Basics of this molecular control are given briefly in these volumes.

We have continued with the practice of giving one separate **wall chart** in each volume for easy comprehension of the topics.

Sincere attempt has been made to present all facets of theory and practical anatomy to make these volumes truly holistic. In addition to the descriptive text, the following rich features lend a high pedestal to the book in the context of the international literature.

	<i>Volume 1</i>	<i>Volume 2</i>	<i>Volume 3</i>	<i>Volume 4</i>	<i>Total</i>
Figures	414	653	462	210	1739
Flowcharts	7	4	12	9	32
Dissection Boxes	37	36	12	5	90
X-rays/MRI and CT Scans	5	5	4	16	30
Ossification Boxes	13	12	14	–	39
Tables	43	52	33	23	151
Clinical Anatomy Boxes	52	101	77	41	271
Mnemonics Boxes	22	15	8	4	49
Facts to Remember	93	229	114	67	503
FAQs	99	132	104	52	387
MCQs	149	232	135	72	588
Viva Voce Questions	259	508	227	125	1119
Clinicoanatomical Problems	19	35	20	14	88
Videos	47	50	32	9	138

*Chief Editor*

**Krishna Garg**

email: [dr.krishnagarg@gmail.com](mailto:dr.krishnagarg@gmail.com)

*Editors*

**Pragati Sheel Mittal**  
**Mrudula Chandrupatla**



# Preface to the First Edition (excerpts)

The necessity of having a simple, systematized and complete book on anatomy has long been felt. The urgency for such a book has become all the more acute due to the shorter time now available for teaching anatomy, and also to the falling standards of English language in the majority of our students in India. The national symposium on 'Anatomy in Medical Education' held at Delhi in 1978 was a call to change the existing system of teaching the unnecessary minute details to the undergraduate students.

This attempt has been made with an object to meet the requirements of a common medical student. The text has been arranged in small classified parts to make it easier for the students to remember and recall it at will. It is adequately illustrated with simple line diagrams which can be reproduced without any difficulty, and which also help in understanding and memorizing the anatomical facts that appear to defy memory of a common student. The monotony of describing the individual muscles separately, one after the other, has been minimised by writing them out in tabular form, which makes the subject interesting for a lasting memory. The relevant radiological and surface anatomy have been treated in separate chapters. A sincere attempt has been made to deal, wherever required, the clinical applications of the subject. The entire approach is such as to attract and inspire the students for a deeper dive in the subject of anatomy.

The book has been intentionally split in three parts for convenience of handling. This also makes a provision for those who cannot afford to have the whole book at a time.

It is quite possible that there are errors of omission and commission in this mostly single-handed attempt. I would be grateful to the readers for their suggestions to improve the book from all angles.

I am very grateful to my teachers and the authors of numerous publications, whose knowledge has been freely utilised in the preparation of this book. I am equally grateful to my professor and colleagues for their encouragement and valuable help. My special thanks are due to my students who made me feel their difficulties, which was a great incentive for writing this book. I have derived maximum inspiration from Prof. Inderbir Singh (Rohtak), and learned the decency of work from Shri SC Gupta (Jiwaji University, Gwalior).

I am deeply indebted to Shri KM Singhal (National Book House, Gwalior) and Mr SK Jain (CBS Publishers & Distributors, Delhi), who have taken unusual pains to get the book printed in its present form. For giving it the desired get-up, Mr VK Jain and Raj Kamal Electric Press are gratefully acknowledged. The cover page was designed by Mr Vasant Paranjpe, the artist and photographer of our college; my sincere thanks are due to him. I acknowledge with affection the domestic assistance of Munne Miyan and the untiring company of my Rani, particularly during the odd hours of this work.

**BD Chaurasia**

# Acknowledgements

The editors are thankful to Dr SN Kazi (Pune) for providing maximum updates from Gray's Anatomy, 42nd Edition.

Dr Vikas Verma (Lucknow) revised the chapters on Joints and Nerves of Limbs and gave very useful inputs. Dr Tripta Bhagat (Ghaziabad) edited clinical anatomy portions of the volumes.

We have the blessings and good wishes of Prof NA Faruqi (Aligarh); Dr DC Naik (Rewa); Dr SD Joshi and Dr SS Joshi (Indore); Dr (Brig) Rakesh Gupta (Greater Noida); Dr DR Singh (Lucknow); Dr M Kaul; Dr C Anand and Dr I Bahl (Delhi); Dr Mohsin Azmi (Kanpur); Dr Medha Joshi (Ghaziabad); Dr Surbhi Gupta (Delhi); and Dr Nitin Nagarkar (Raipur).

We are thankful to Dr Surjit Ghatak (Jodhpur); Dr Vinay Sharma (Muzzafarnagar); Dr Deepu Singh Kataria and Dr Anup Singh Gurjar (Pali); Dr Jagmohan Sharma; Dr Deepak Sharma; Dr Rajesh Arora and Dr Pooja Garg (Jaipur); Dr Sumit Gupta (Kota); Dr Gopal Sharma and Dr Manoj Sharma (Jhalawar); Dr Rekha Parashar (Chittorgarh); Dr Santosh Kumar (Dholpur); Dr BK Aghera (Sirohi), Dr Isha Srivastav; Dr Aprajita Raizada; Dr Sajjan Skaria; Dr Anjali Jain and Dr Kalpana Sharma (Udaipur); for giving feedback for various sections of the volumes.

We are grateful to Dr Hitant Vohra and Dr Anu Sharma (Ludhiana); Dr Anupma Mahajan (Amritsar); Dr Vanita Gupta (Jammu), for editing chapters to enhance the value of the volumes.

We are grateful to Dr Ravikant (Amritsar); Dr Sangeeta and Dr Nusrat Jabeen (Jammu); Dr Kalyan Singh and Dr Rajan Singla (Patiala); Dr Anjali Jain and Dr Aprajita Sikka (Ludhiana); Dr Bashir (Srinagar); Dr Seema and Dr Ritu (Rajouri); Dr Mubeen (Kathua); Dr RK Srivastava (Kanpur); Dr Punita Manik (Lucknow); Dr Binod Kumar; Dr Sunita Nayak and Dr Shambhu Prasad (Patna); Dr AK Dubey (Ranchi); Dr Satyam Khare; Dr Shilpi Jain and Dr Alok Tripathi (Meerut), for promoting the volumes.

We have been getting constant encouragement and support from Dr Ranjana Verma, Dr Muthukrishnan P, Dr Yogesh Yadav, Dr Pullimi Vineel and Dr Anupma Gupta (Greater Noida); Dr Nisha Kaul (Ghaziabad); Dr Vinay Singhal (Saharanpur); Dr RK Ashoka (Mathura); Dr Vineet Guha (Khandwa); Dr Manisha Sinha (Raipur); Dr Jahan Shirin (Kanpur); Dr Damyanti (Manipur); Dr Daisy Sahni (Chandigarh); and Dr MK Anand (Bhuj).

Our regards and affection to Dr Rewa Choudhry, Dr Shilpa Paul, Dr Smita Kakar, Dr Anita Tuli, Dr Gayatri Rath, Dr Shashi Raheja, Dr Shyama Rajdan, Dr Mangala Kohli, Dr A Sheriff, Dr SB Ray, Dr Vandana Mehta, Dr Sabita Mishra, Dr Renu Chauhan, Dr Jyoti Arora, Dr Sneha Aggarwal and Dr TS Roy (Delhi), for going through the volumes.

We would like to thank Dr Pritha Bhuiyan (Mumbai); Dr Brijendra Singh (Rishikesh); Col. Dr Sushil Kumar (Pune); Dr AK Srivastava (Lucknow); Dr MK Pant (Dehradun); Dr Shakuntala Pai (Manipal); Dr Simmi Mehra (Rajkot); Dr Fatima M De Souza (Goa); Dr Mukesh Mittal (Shivpuri); Dr Priti Sinha (Saharanpur); Dr Rakesh K Verma (Lucknow); Dr Rashmi Malhotra (Rishikesh); Dr Sandiya Kurup (Kalanchery); Dr Simmi Soni (Aziznagar); Dr Sunita Gupta (Ahmedabad) and many-many other teachers all over the globe, for giving us good wishes.

Videos of bones and soft parts of human body, prepared at Kathmandu University School of Medical Sciences, have now been added with the respective chapters and are available at our mobile App [CBSiCentral](#). I (chief editor) am grateful to Dr R Koju, CEO of KUSMS and Dhulikhel Hospital, for his generosity.

The moral support of my (chief editor) family members, Late Dr DP Garg, Dr Suvira Gupta, Dr JP Gupta, Mr Manoj, Ms Rekha, Mr Sanjay, Ms Meenakshi, Dr Manish, Dr Shilpa Garg, Dr Naveen Garg, Dr Manoj, Dr Nalini Shukla, Dr Vikas Verma and Dr Swati Gupta, is appreciated.

The magnanimity shown by Mr SK Jain (Chairman) and Mr Varun Jain (Director), CBS Publishers & Distributors, has been always forthcoming. The unquestionable support of Mr YN Arjuna (Senior Vice President—Publishing, Editorial and Publicity) and his entire team comprising Ms Ritu Chawla (GM—Production), Mr Sanjay Chauhan, Mr Neeraj Prasad and Mr Rohan Prasad (Graphic Artists); Mr Surendra Jha and Mr Prasenjit Paul (Copy Editors); Ms Jyoti Kaur and Mr Tarun Rajput (DTP Operators) has made an excellent contribution to bring out this edition. We are really obliged to them and pray for their prosperity.

*Chief Editor*

**Krishna Garg**

email: [dr.krishnagarg@gmail.com](mailto:dr.krishnagarg@gmail.com)

*Editors*

**Pragati Sheel Mittal  
Mrudula Chandrupatla**

## *Thus spoke the cadaver*

*Handle me with little love and care  
As I had missed it in my life affair  
Was too poor for cremation or burial  
That is why am lying in dissection hall*

*You dissect me, cut me, section me  
But your learning anatomy should be precise  
Worry not, you would not be taken to court  
As I am happy to be with the bright lot*

*Couldn't dream of a fridge for cold water  
Now my body parts are kept in refrigerator  
Young students sit around me with friends  
A few dissect, rest talk, about food, family and movies  
How I enjoy the dissection periods  
Don't you? Unless you are interrogated by a teacher*

*When my parts are buried post-dissection  
Bones are taken out for the skeleton  
Skeleton is the crown glory of the museum  
Now I am being looked up by great enthusiasm*

*If not as skeletons as loose bones  
I am in their bags and in their hostel rooms  
At times, I am on their beds as well  
Oh, what a promotion to heaven from hell*

*I won't leave you, even if you pass anatomy  
Would follow you in forensic medicine and pathology  
Would be with you even in clinical teaching  
Medicine line is one where dead teach the living*

*One humble request I'd make  
Be sympathetic to persons with disease  
Don't panic, you'll have enough money  
And I bet, you'd be singularly happy*

*—Krishna Garg*





<i>Preface to the Ninth Edition</i>	vii
<i>Preface to the First Edition (excerpts)</i>	ix
<i>Index of Competencies</i>	xxv

## Section 1 LOWER LIMB

### 1. Introduction 3

Development of Lower Limb	3
Molecular Regulation of Limb Development	4
Parts of the Lower Limb	4
Related Terms	4
Frequently Asked Questions	6
Viva Voce	6

### 2. Bones 7

Introduction	7
Hip Bone	7
Ilium	7
Pubis	9
Ischium	12
Acetabulum	14
Obturator Foramen	15
Ossification	15
Clinical Anatomy	15
Femur	15
Ossification	21
Clinical Anatomy	21
Patella	23
Ossification	23
Clinical Anatomy	24
Tibia	24
Ossification	28
Clinical Anatomy	29
Fibula	29
Ossification	32
Clinical Anatomy	32
Bones of the Foot	33
Tarsus/Tarsals	33
Talus	33
Ossification	35
Clinical Anatomy	35
Calcaneus or Calcaneum	35
Ossification	37
Clinical Anatomy	37
Navicular Bone	37
Ossification	37
Cuneiform Bones	37
Medial Cuneiform	38
Intermediate Cuneiform	38
Lateral Cuneiform	39
Ossification	39
Cuboid	39
Ossification	40
Metatarsus	40
Ossification	41

Phalanges	41
Ossification	41
Clinical Anatomy	41
Sesamoid Bones	42
▶ Video 2.2.1 Hip Bone	
▶ Video 2.2.2 Femur	
▶ Video 2.2.3 Patella	
▶ Video 2.2.4 Tibia	
▶ Video 2.2.5 Fibula	
▶ Video 2.2.6 Tarsus	
▶ Video 2.2.7 Metatarsals and Phalanges	
▶ Video 2.2.8 Joints of the Foot	
Mnemonics	42
Facts to Remember	42
Clinicoanatomical Problem	42
Further Reading	43
Frequently Asked Questions	43
Multiple Choice Questions	43
Viva Voce	44

### 3. Front of Thigh 46

Introduction	46
Surface Landmarks	46
Skin and Superficial Fascia	47
Cutaneous Nerves	47
Cutaneous Arteries	48
Great or Long Saphenous Vein	48
Superficial Inguinal Lymph Nodes	49
Subcutaneous Bursae	49
Dissection	50
Clinical Anatomy	50
Deep Fascia	50
Dissection	52
Clinical Anatomy	52
Femoral Triangle	52
Boundaries	52
Contents	53
Femoral Sheath	54
Femoral Canal	55
Clinical Anatomy	55
Femoral Artery	57
Clinical Anatomy	58
Femoral Vein	59
Femoral Nerve	59
Branches and Distribution	59
Clinical Anatomy	60
Muscles of the Front of the Thigh	60
Iliacus and Psoas Major	61
Clinical Anatomy	61



Adductor/Hunter's/Subsartorial Canal 63

Dissection 65

▶ **Video 2.3 Front of Thigh**

Facts to Remember 65

Clinicoanatomical Problem 65

Further Reading 65

Frequently Asked Questions 65

Multiple Choice Questions 65

Viva Voce 66

#### 4. Medial Side of Thigh

67

Introduction 67

Adductor Compartment 67

Boundaries 67

Dissection 67

Muscles of Adductor/Medial Compartment of Thigh 68

Relations of Adductor Longus 68

Obturator Nerve 69

Clinical Anatomy 70

Accessory Obturator Nerve 71

Obturator Artery 71

Medial Circumflex Femoral Artery 71

Clinical Anatomy 72

▶ **Video 2.4 Medial Side of Thigh**

Facts to Remember 72

Clinicoanatomical Problem 72

Further Reading 72

Frequently Asked Questions 73

Multiple Choice Questions 73

Viva Voce 73

#### 5. Gluteal Region

74

Introduction 74

Surface Landmarks 74

Dissection 75

Superficial and Deep Fascia 75

Superficial Fascia 75

Cutaneous Nerves 75

Cutaneous Vessels and Lymphatics 76

Deep Fascia 76

Muscles of Gluteal Region 76

Structures under Cover of Gluteus Maximus 78

Structures Deep to the Gluteus Medius 80

Structures Deep to the Gluteus Minimus 80

Dissection 80

Clinical Anatomy 80

Sacrospinous and Sacrotuberous Ligaments 82

Nerves of the Gluteal Region 82

Superior Gluteal Nerve 82

Inferior Gluteal Nerve 82

Sciatic Nerve 82

Clinical Anatomy 82

Posterior Cutaneous Nerve of the Thigh 83

Nerve to Quadratus Femoris 83

Pudendal Nerve 83

Nerve to the Obturator Internus 83

Perforating Cutaneous Nerve 83

Arteries of Gluteal Region 84

Superior Gluteal Artery 84

Inferior Gluteal Artery 84

Internal Pudendal Artery 84

Trochanteric Anastomosis 84

Cruciate Anastomosis 84

Structures Passing through the Greater Sciatic

Foramen (Gateway of Gluteal Region) 85

Structures Passing through the Lesser

Sciatic Foramen 85

▶ **Video 2.5 Gluteal Region**

Facts to Remember 85

Clinicoanatomical Problem 85

Further Reading 85

Frequently Asked Questions 86

Multiple Choice Questions 86

Viva Voce 86

#### 6. Popliteal Fossa

87

Introduction 87

Surface Landmarks 87

Dissection 87

Location 87

Boundaries 87

Contents 89

Popliteal Artery 89

Clinical Anatomy 90

Popliteal Vein 90

Tibial Nerve in Popliteal Fossa 91

Clinical Anatomy 91

Common Peroneal Nerve 91

Posterior Cutaneous Nerve of Thigh 92

Genicular Branch of Obturator Nerve 92

Popliteal Lymph Nodes 92

Clinical Anatomy 92

Anastomoses Around the Knee Joint 92

▶ **Video 2.6 Popliteal Fossa**

Mnemonics 93

Facts to Remember 93

Clinicoanatomical Problem 93

Further Reading 93

Frequently Asked Questions 94

Multiple Choice Questions 94

Viva Voce 94

#### 7. Back of Thigh

95

Introduction 95

Muscles and Nerves 95

Muscles of the Back of Thigh 95

Dissection 95

Clinical Anatomy 95

Sciatic Nerve 99

Clinical Anatomy 100

Arteries of the Back of Thigh 101

Anastomoses on the Back of Thigh 102

▶ **Video 2.7 Back of the Thigh**

Facts to Remember 103

Clinicoanatomical Problem 103

Further Reading 103

Frequently Asked Questions 104

Multiple Choice Questions 104

Viva Voce 104

#### 8. Front of Leg with Dorsum of Foot; Lateral and Medial Sides of Leg

105

Introduction 105

Surface Landmarks 105

Superficial Fascia 106

Superficial Veins 106

Cutaneous Nerves 107

Dissection 107  
 Clinical Anatomy 107  
 Deep Fascia 107  
 Superior Extensor Retinaculum 108  
 Inferior Extensor Retinaculum 109  
 Dissection 109  
 Clinical Anatomy 109  
 Muscles of Front of Leg 109  
 Muscles of Anterior Compartment of the Leg 109  
 Anterior Tibial Artery 109  
 Deep Peroneal Nerve 113  
 Dissection 114  
 Clinical Anatomy 115  
 Dorsum of Foot 115  
 Dorsalis Pedis Artery (Dorsal Artery of the Foot) 115  
 Dissection 116  
 Clinical Anatomy 116  
 Fascia and Muscles of Lateral Side of the Leg 116  
 Peroneal Retinacula 116  
 Dissection 117  
 Clinical Anatomy 117  
 Peroneal Muscles 117  
 Clinical Anatomy 117  
 Superficial Peroneal Nerve 117  
 Dissection 118  
 Clinical Anatomy 118  
 Tendons on Medial Side of the Leg 118  
 Dissection 119  
 Clinical Anatomy 119  
 📺 **Video 2.8 Front of Leg**  
 Mnemonics 119  
 Facts to Remember 120  
 Clinicoanatomical Problem 120  
 Further Reading 120  
 Frequently Asked Questions 121  
 Multiple Choice Questions 121  
 Viva Voce 121

## 9. Back of Leg

123

Introduction 123  
 Superficial Fascia 123  
 Small or Short Saphenous Vein 123  
 Great or Long Saphenous Vein 123  
 Cutaneous Nerves 123  
 Dissection 124  
 Clinical Anatomy 124  
 Deep Fascia 124  
 Boundaries and Subdivisions 124  
 Flexor Retinaculum 125  
 Dissection 125  
 Clinical Anatomy 126  
 Muscles 126  
 Superficial Muscles 126  
 Deep Muscles 128  
 Dissection 129  
 Clinical Anatomy 129  
 Posterior Tibial Artery 130  
 Peroneal Artery 131  
 Tibial Nerve 131  
 Clinical Anatomy 132  
 📺 **Video 2.9 Back of Leg**  
 Mnemonics 133  
 Facts to Remember 133  
 Clinicoanatomical Problem 133  
 Further Reading 133

Frequently Asked Questions 134  
 Multiple Choice Questions 134  
 Viva Voce 134

## 10. Sole of Foot

135

Introduction 135  
 Skin 135  
 Dissection 136  
 Fasciae 136  
 Superficial Fascia 136  
 Dissection 136  
 Deep Fascia 136  
 Plantar Aponeurosis 136  
 Deep Transverse Metatarsal Ligaments 137  
 Fibrous Flexor Sheaths 137  
 Clinical Anatomy 137  
 Muscles of Sole 137  
 Muscles and Tendons of the First and Second Layers 137  
 Dissection 138  
 Muscles and Tendons of Third and Fourth Layers 139  
 Dissection 139  
 Plantar Vessels and Nerves 142  
 Medial Plantar Nerve 142  
 Lateral Plantar Nerve 144  
 Dissection 144  
 Clinical Anatomy 144  
 Medial Plantar Artery 144  
 Lateral Plantar Artery 144  
 Plantar Arch 145  
 Clinical Anatomy 145  
 📺 **Video 2.10 Foot/Sole**  
 Facts to Remember 146  
 Clinicoanatomical Problem 146  
 Further Reading 146  
 Frequently Asked Questions 147  
 Multiple Choice Questions 147  
 Viva Voce 147

## 11. Venous and Lymphatic Drainage; Segmental and Sympathetic Innervation; and Comparison of Lower and Upper Limbs

148

Introduction 148  
 Venous Drainage 148  
 Factors Helping Venous Return 148  
 Veins of Lower Limb 148  
 Long Saphenous Vein 149  
 Small or Short Saphenous Vein 150  
 Perforating Veins 150  
 Clinical Anatomy 151  
 Lymphatic Drainage 152  
 Classification 152  
 Superficial Inguinal Lymph Nodes 152  
 Deep Inguinal Lymph Nodes 153  
 Superficial Lymphatics 153  
 Deep Lymphatics 153  
 Clinical Anatomy 154  
 Segmental Innervation 154  
 Dermatomes 154  
 Myotomes 155  
 Clinical Anatomy 155  
 Sympathetic Innervation 156  
 Comparison of Lower and Upper Limbs 156

Facts to Remember 159  
 Clinicoanatomical Problem 159  
 Further Reading 159  
 Frequently Asked Questions 159  
 Multiple Choice Questions 160  
 Viva Voce 160

## 12. Joints of Lower Limb

161

Introduction 161  
 Hip Joint 161  
 Type 161  
 Ligaments 161  
 Relations of the Hip Joint 163  
 Blood Supply 164  
 Nerve Supply 164  
 Movements 164  
 Dissection 164  
 Clinical Anatomy 165  
 Knee Joint 166  
 Type 166  
 Ligaments 166  
 Dissection 169  
 Synovial Membrane 170  
 Bursae around the Knee 170  
 Relations of Knee Joint 170  
 Blood Supply 171  
 Nerve Supply 171  
 Dissection 171  
 Movements at the Knee Joint 171  
 Locking and Unlocking of the Knee Joint 172  
 Dissection 172  
 Clinical Anatomy 173  
 Ankle Joint 174  
 Ligaments 174  
 Relations of the Ankle Joint 176  
 Movements 176  
 Blood Supply 177  
 Nerve Supply 177  
 Dissection 177  
 Clinical Anatomy 177  
 Tibiofibular Joints 177  
 Superior Tibiofibular Joint 177  
 Middle Tibiofibular Joint 177  
 Inferior Tibiofibular Joint 178  
 Dissection 178  
 Clinical Anatomy 178  
 Joints of the Foot 178  
 Subtalar or Talocalcanean Joint 179  
 Movements 179  
 Talocalcaneonavicular Joint 179  
 Movements 180  
 Calcaneocuboid Joint 180  
 Transverse Tarsal or Midtarsal Joint 181  
 Inversion and Eversion of the Foot 181  
 Joints Taking Part 181  
 Muscles Producing Movements 181  
 Dissection 182  
 Smaller Joints of Forefoot 182  
 Joint Cavities of Foot 182  
 Metatarsophalangeal and Interphalangeal Joints 183  
 Dissection 183  
 Gait/Walking 183  
 Clinical Anatomy 183  
 Video 2.12 Joints of Lower Limb  
 Facts to Remember 184

Clinicoanatomical Problems 184  
 Further Reading 185  
 Frequently Asked Questions 185  
 Multiple Choice Questions 185  
 Viva Voce 186

## 13. Arches of Foot

187

Introduction 187  
 Formation or Structure of Arches 187  
 Medial Longitudinal Arch 187  
 Lateral Longitudinal Arch 188  
 Anterior Transverse Arch 188  
 Posterior Transverse Arch 188  
 Factors Responsible for Maintenance of Arches 188  
 Functions of Arches 190  
 Summary 190  
 Comparison of Medial and Lateral Longitudinal Arches 190  
 Clinical Anatomy 191  
 Facts to Remember 192  
 Clinicoanatomical Problem 192  
 Frequently Asked Questions 193  
 Multiple Choice Questions 193  
 Viva Voce 193

## 14. Surface and Radiological Anatomy

194

Palpable Parts of the Bones 194  
 Surface Marking 195  
 Arteries 195  
 Femoral Artery 195  
 Profunda Femoris Artery 195  
 Popliteal Artery 195  
 Superior Gluteal Artery 195  
 Inferior Gluteal Artery 195  
 Anterior Tibial Artery 196  
 Posterior Tibial Artery 196  
 Dorsalis Pedis Artery 196  
 Medial Plantar Artery 197  
 Lateral Plantar Artery 197  
 Plantar Arch 197  
 Veins 197  
 Femoral Vein 197  
 Great Saphenous Vein 197  
 Small Saphenous Vein 198  
 Nerves 198  
 Femoral Nerve 198  
 Sciatic Nerve 198  
 Tibial Nerve 198  
 Common Peroneal Nerve 198  
 Deep Peroneal Nerve 199  
 Superficial Peroneal Nerve 199  
 Medial Plantar Nerve 199  
 Lateral Plantar Nerve 199  
 Miscellaneous Structures 199  
 Saphenous Opening 199  
 Femoral Ring 199  
 Superior Extensor Retinaculum 199  
 Inferior Extensor Retinaculum 199  
 Flexor Retinaculum 200  
 Radiological Anatomy 200  
 Hip 200  
 Knee 201  
 Foot 201  
 Further Reading 202

**Appendix 1: Nerves, Arteries and Clinical Terms**

203

Nerves of Lower Limb 203  
 Femoral Nerve 203  
 Obturator Nerve 203  
 Accessory Obturator Nerve 204  
 Superior Gluteal Nerve 204  
 Inferior Gluteal Nerve 204  
 Nerve to Quadratus Femoris 204  
 Nerve to Obturator Internus 205  
 Sciatic Nerve 205

Tibial Nerve 206  
 Common Peroneal Nerve 206  
 Deep Peroneal Nerve 206  
 Superficial Peroneal Nerve 207  
 Plantar Nerves 208  
 Arteries of Lower Limb 210  
 Clinical Anatomy 211  
 Clinical Terms 212  
 Multiple Choice Questions 213  
**Early Clinical Exposure (ECE) Cases** 214  
**Spots on Lower Limb** 215  
**Answers: Spots on Lower Limb** 216

**Section 2 ABDOMEN AND PELVIS****15. Introduction and Osteology**

219

Introduction to Abdomen 219  
 Osteology 219  
 Lumbar Vertebrae 219  
 Ossification 222  
 Clinical Anatomy 222  
 The Sacrum/Vertebra Magnum 224  
 Sacral Canal 226  
 Attachments on the Sacrum 226  
 Relations of the Sacrum 226  
 Sex Differences 227  
 Ossification 227  
 Coccyx 227  
 Ossification 228  
 Bony Pelvis 228  
 Sex Differences in the Pelvis 229  
 Anatomical Position of the Pelvis 229  
 Intervertebral Joints 230  
 Intervertebral Disc 230  
 Video 2.15.1 Lumbar Vertebrae  
 Video 2.15.2 Sacrum and Coccyx  
 Video 2.15.3 Bony Pelvis  
 Video 2.15.4 Pelvic Cavity  
 Mnemonics 231  
 Facts to Remember 231  
 Clinicoanatomical Problem 231  
 Further Reading 231  
 Frequently Asked Questions 232  
 Multiple Choice Questions 232  
 Viva Voce 232

**16. Anterior Abdominal Wall**

233

Surface Landmarks 233  
 Skin and Superficial Fascia 234  
 Dissection 234  
 Umbilicus 235  
 Clinical Anatomy 236  
 Superficial Fascia 237  
 Clinical Anatomy 237  
 Cutaneous Nerves 237  
 Cutaneous Arteries 238  
 Cutaneous Veins 238  
 Clinical Anatomy 239  
 Muscles of the Anterolateral Abdominal Wall 239  
 External Oblique Muscle 239  
 Internal Oblique Muscle 240

Dissection 240  
 Transversus Abdominis Muscle 241  
 Dissection 241  
 Rectus Abdominis Muscle 241  
 Actions of the Main Muscles of the Anterior Abdominal Wall 242  
 Inguinal Ligament 242  
 Conjoint Tendon or Falx Inguinalis 243  
 Cremaster Muscle 243  
 Pyramidalis 243  
 Dissection 243  
 Clinical Anatomy 244  
 Deep Nerves 244  
 Deep Arteries 244  
 Rectus Sheath 246  
 New Concepts of Rectus Sheath 247  
 Fascia Transversalis 248  
 Dissection 248  
 Inguinal Canal 249  
 Definition 249  
 Boundaries 249  
 Structures Passing through Inguinal Canal 250  
 Constituents of the Spermatic Cord 250  
 Mechanism of Inguinal Canal 251  
 Development of Inguinal Canal 251  
 Dissection 251  
 Clinical Anatomy 251  
 Video 2.16 Anterior Abdominal Wall  
 Mnemonics 254  
 Facts to Remember 254  
 Clinicoanatomical Problem 254  
 Further Reading 255  
 Frequently Asked Questions 255  
 Multiple Choice Questions 255  
 Viva Voce 256

**17. Male External Genital Organs**

257

Introduction 257  
 Dissection 257  
 External Genital Organs 257  
 Penis 257  
 Root of Penis 257  
 Body of Penis and its Histology 258  
 Clinical Anatomy 260  
 Scrotum 260  
 Clinical Anatomy 261  
 Testis 261  
 External Features 262

Arterial Supply 263  
 Histology of Seminiferous Tubule 264  
**Clinical Anatomy** 264  
 Epididymis 265  
**Clinical Anatomy** 265  
 Histology 265  
 Development of Male Reproductive System 266  
 Descent of the Testis 266  
 Ducts 266  
 External Genitalia 267  
 Molecular Regulation 267  
**Facts to Remember** 267  
**Clinicoanatomical Problem** 267  
 Further Reading 268  
**Frequently Asked Questions** 268  
**Multiple Choice Questions** 268  
**Viva Voce** 269

## 18. Abdominal Cavity and Peritoneum 270

Introduction 270  
 Nine Regions of Abdomen 270  
 Peritoneum 271  
 Functions of Peritoneum 272  
**Clinical Anatomy** 273  
 Peritoneal Folds 273  
 Greater Omentum 274  
**Dissection** 275  
 Lesser Omentum 276  
 Mesentery 277  
 Mesoappendix 277  
**Dissection** 277  
 Transverse Mesocolon 278  
**Dissection** 278  
 Sigmoid Mesocolon 278  
**Dissection** 278  
 Reflection of Peritoneum 278  
 Peritoneal Cavity 279  
 Vertical Tracing/Sagittal Tracing 279  
 Horizontal Tracing above Transverse Colon 280  
 Horizontal Tracing below the Level of the Transverse Colon 280  
 Horizontal Tracing of Peritoneum in the Lesser Pelvis/True Pelvis (Male) 281  
 Horizontal Tracing of Peritoneum in the Lesser Pelvis/True Pelvis (Female) 281  
 Epiploic Foramen/Omental Foramen/Foramen of Winslow 281  
 Lesser Sac or Omental Bursa 282  
**Clinical Anatomy** 283  
 Special Regions of the Peritoneal Cavity 283  
 Supracolic Compartment/Subphrenic Spaces 284  
 Hepatorenal Pouch (Morrison's Pouch) 285  
 Infracolic Compartments 285  
 Paracolic Gutters 285  
 Rectouterine Pouch (Pouch of Douglas) 285  
**Clinical Anatomy** 285  
 Peritoneal Fossae (Recesses) 286  
**Clinical Anatomy** 287  
 Development of Gut and its Folds 288  
**Video 2.18 Peritoneal Cavity**  
**Facts to Remember** 288  
**Clinicoanatomical Problem** 288  
 Further Reading 289  
**Frequently Asked Questions** 289  
**Multiple Choice Questions** 289  
**Viva Voce** 290

## 19. Abdominal Part of Oesophagus and Stomach 291

Introduction 291  
**Dissection** 291  
 Abdominal Part of Oesophagus 291  
 Histology 292  
**Clinical Anatomy** 292  
 Stomach 294  
 Location 294  
 External Features 294  
 Relations of Stomach 295  
 Blood Supply 296  
 Lymphatic Drainage 296  
 Nerve Supply 297  
 Interior of Stomach 297  
 Functions of Stomach 297  
**Dissection** 298  
**Clinical Anatomy** 298  
 Histology of Stomach 299  
 Development 299  
 Molecular Regulation of Gut Tube Development 299  
**Video 2.19 Stomach**  
 Mnemonics 300  
**Facts to Remember** 300  
**Clinicoanatomical Problem** 300  
 Further Reading 300  
**Frequently Asked Questions** 301  
**Multiple Choice Questions** 301  
**Viva Voce** 301

## 20. Small and Large Intestines 302

Introduction 302  
 Small Intestine 302  
 Relevant Features 302  
 Large Surface Area 302  
 Duodenum 304  
**Dissection** 304  
 Peritoneal Relations 305  
 Suspensory Muscle of Duodenum or Ligament of Treitz 307  
 Histology 308  
**Clinical Anatomy** 308  
 Jejunum and Ileum 309  
 Histology 310  
 Meckel's Diverticulum (Diverticulum Ileii) 310  
**Dissection** 310  
**Clinical Anatomy** 310  
 Large Intestine 311  
**Dissection** 313  
**Clinical Anatomy** 313  
 Caecum 313  
**Dissection** 314  
**Clinical Anatomy** 315  
 Vermiform Appendix 315  
 Histology 317  
**Clinical Anatomy** 317  
 Ascending Colon 318  
 Right Colic Flexure (Hepatic Flexure) 318  
 Transverse Colon 318  
 Left Colic Flexure (Splenic Flexure) 318  
 Descending Colon 318  
 Sigmoid Colon (Pelvic Colon) 318  
 Histology of Colon 319  
 Development of Intestines 319



📺 **Video 2.20 Small and Large Intestines**

- Mnemonics 320
- Facts to Remember 320
- Clinicoanatomical Problem 320
- Further Reading 320
- Frequently Asked Questions 321
- Multiple Choice Questions 321
- Viva Voce 322

## 21. Large Blood Vessels of the Gut 323

- Introduction 323
- Blood Vessels 323
- Coeliac Trunk 323
- Origin and Length 323
- Branches 324
- Superior Mesenteric Artery 325
- Origin, Course and Termination 325
- Branches 326
- Superior Mesenteric Vein 327
- Dissection 328
- Clinical Anatomy 328
- Inferior Mesenteric Artery 328
- Branches 328
- Inferior Mesenteric Vein 328
- Clinical Anatomy 329
- Marginal Artery of Drummond 329
- Portal Vein 329
- Branches 331
- Tributaries 331
- Portosystemic Communications (Portocaval Anastomoses) 331
- Clinical Anatomy 332
- Development 333
- Facts to Remember 333
- Clinicoanatomical Problem 333
- Further Reading 334
- Frequently Asked Questions 334
- Multiple Choice Questions 334
- Viva Voce 335

## 22. Extrahepatic Biliary Apparatus 336

- Introduction 336
- Right and Left Hepatic Ducts 336
- Common Hepatic Duct 336
- Gallbladder 336
- Cystic Duct 338
- Bile Duct 338
- Sphincters Related to the Bile and Pancreatic Ducts 339
- Vascular and Nerve Supply 339
- Dissection 340
- Clinical Anatomy 340
- Histology of Gallbladder 341
- Development 342
- Facts to Remember 342
- Clinicoanatomical Problems 342
- Further Reading 342
- Frequently Asked Questions 343
- Multiple Choice Questions 343
- Viva Voce 343

## 23. Spleen, Pancreas and Liver 344

- Introduction 344
- Spleen 344
- Dissection 344

- External Features 345
- Relations 345
- Arterial Supply 346
- Venous Drainage 347
- Lymphatic Drainage 347
- Clinical Anatomy 347
- Histology 349
- Development 349
- Pancreas 349
- Head of the Pancreas 349
- Body of the Pancreas 350
- Tail of the Pancreas 351
- Ducts of the Pancreas 351
- Arterial Supply 352
- Venous Drainage 352
- Lymphatic Drainage 352
- Nerve Supply 352
- Functions 353
- Dissection 353
- Clinical Anatomy 353
- Histology 353
- Development 354
- Molecular Regulation 355
- Liver 355
- External Features 355
- Relations 356
- Arterial Supply 357
- Venous Drainage 358
- Lymphatic Drainage 358
- Nerve Supply 358
- Hepatic Segments 358
- Dissection 359
- Clinical Anatomy 359
- Histology 360
- Development 361
- Molecular Regulation 361

📺 **Video 2.23 Glands of Abdominal Cavity**

- Mnemonics 361
- Facts to Remember 361
- Clinicoanatomical Problem 362
- Further Reading 362
- Frequently Asked Questions 362
- Multiple Choice Questions 363
- Viva Voce 363

## 24. Kidney and Ureter 364

- Kidney 364
- External Features 365
- Hilum 365
- Relations of the Kidneys 365
- Capsules or Coverings of Kidney 365
- Structure 367
- Blood Supply of Kidney 369
- Lymphatic Drainage 369
- Nerve Supply 369
- Exposure of the Kidney from Behind 369
- Histology 370
- Dissection 371
- Clinical Anatomy 371
- Ureter 373
- Dimensions 373
- Normal Constrictions 374
- Relations 374
- Abdominal Part of Ureter 374
- Pelvic Part of Ureter 375

Intravesical Part 376  
 Blood Supply 376  
 Nerve Supply 376  
 Histology 376  
**Clinical Anatomy** 377  
 Development of Kidney and Ureter 377  
 Anomalies of the Kidney and Ureter 377  
 Molecular Regulation of Kidney Development 377  
 • **Video 2.24 Kidney and Ureter**  
 Mnemonics 377  
**Facts to Remember** 379  
**Clinicoanatomical Problem** 379  
 Further Reading 379  
**Frequently Asked Questions** 379  
**Multiple Choice Questions** 380  
**Viva Voce** 380

## 25. Suprarenal Gland and Chromaffin System 381

Suprarenal Gland 381  
 Right Suprarenal Gland 381  
 Left Suprarenal Gland 382  
 Structure and Function 382  
 Arterial Supply 383  
 Venous Drainage 383  
 Lymphatic Drainage 383  
 Nerve Supply 383  
**Clinical Anatomy** 383  
 Histology 384  
 Development 384  
 Molecular Regulation 384  
**Dissection** 384  
 Chromaffin System 384  
**Facts to Remember** 385  
**Clinicoanatomical Problem** 385  
 Further Reading 385  
**Frequently Asked Questions** 386  
**Multiple Choice Questions** 386  
**Viva Voce** 386

## 26. Thoracoabdominal Diaphragm 387

Introduction 387  
 Gross Anatomy 387  
 Openings in the Thoracoabdominal Diaphragm 389  
 Relations 389  
 Nerve Supply 389  
 Actions 390  
**Dissection** 390  
**Clinical Anatomy** 390  
 Development 391  
 Mnemonics 391  
**Facts to Remember** 392  
**Clinicoanatomical Problem** 392  
 Further Reading 392  
**Frequently Asked Questions** 393  
**Multiple Choice Questions** 393  
**Viva Voce** 393

## 27. Posterior Abdominal Wall 394

Introduction 394  
 Blood Vessels, Muscles and Nerves 394  
 Abdominal Aorta 394  
 Relations 394

Branches 394  
 Common Iliac Arteries 396  
 Inferior Vena Cava 396  
 Tributaries 396  
**Clinical Anatomy** 397  
 Abdominal Parts of Azygos and Hemiazygos Veins 397  
 Lymph Nodes of Posterior Abdominal Wall 398  
 Cisterna Chyli 398  
 Muscles of the Posterior Abdominal Wall 398  
**Dissection** 398  
**Clinical Anatomy** 400  
 Thoracolumbar Fascia (Lumbar Fascia) 400  
 Nerves of the Posterior Abdominal Wall 401  
 Abdominal Part of the Autonomic Nervous System 402  
 Lumbar Sympathetic Chain 402  
 Coeliac Ganglia and Coeliac Plexus 402  
 Superior Hypogastric Plexus (Presacral Nerve) 403  
 Inferior Hypogastric Plexuses 404  
**Clinical Anatomy** 404  
 Layers of the Abdomen 405  
 Mnemonics 406  
**Facts to Remember** 406  
**Clinicoanatomical Problem** 406  
 Further Reading 406  
**Frequently Asked Questions** 407  
**Multiple Choice Questions** 407  
**Viva Voce** 407

## 28. Perineum 408

Introduction 408  
 Superficial Boundaries 408  
 Deep Boundaries of the Perineum 408  
 Divisions of the Perineum 409  
 Anal Region 409  
 Perineal Body 409  
 External Anal Sphincter 410  
 Ischioanal Fossa 410  
 Spaces and Canals of the Fossa 411  
 Contents of Ischioanal Fossa 411  
**Dissection** 412  
**Clinical Anatomy** 412  
 Male Perineum 412  
 Male External Genital Organs 412  
 Male Urogenital Region 412  
**Dissection** 413  
**Clinical Anatomy** 413  
 Superficial Perineal Space 413  
 Deep Perineal Space 413  
 Boundaries 416  
 Deep Transversus Perinei 416  
 Distal Urethral Sphincter Mechanism 416  
 Perineal Membrane 416  
**Clinical Anatomy** 417  
 Female Perineum 418  
 Female External Genital Organs/Pudendum/Vulva 418  
 Female Urogenital Region 419  
**Clinical Anatomy** 419  
 Superficial Perineal Space 420  
 Deep Perineal Space 420  
 Boundaries 420  
 Contents 420  
 Urethral Sphincter Mechanism 420  
 Compressor Urethrae 420  
 Sphincter Urethrovaginalis 420  
 Perineal Membrane 421

Pudendal Canal 421  
 Pudendal Nerve 422  
 Clinical Anatomy 423  
 Internal Pudendal Artery 423  
 Internal Pudendal Vein 424  
 Histology of Body of Penis/Clitoris 424  
 Facts to Remember 424  
 Clinicoanatomical Problem 425  
 Further Reading 425  
 Frequently Asked Questions 425  
 Multiple Choice Questions 425  
 Viva Voce 426

## 29. Preliminary Consideration of Boundaries and Contents of Pelvis 427

Introduction 427  
 Lesser Pelvis 427  
 Muscles 427  
 Pelvic Inlet (Superior Aperture of Pelvis) 428  
 Pelvic Outlet (Inferior Aperture of Pelvis) 429  
 Clinical Anatomy 429  
 Pelvic Floor 429  
 Clinical Anatomy 429  
 Pelvic Cavity 430  
 Contents 430  
 Structures Crossing the Pelvic Inlet/Brim of the Pelvis 430  
 Facts to Remember 431  
 Clinicoanatomical Problem 431  
 Further Reading 431  
 Frequently Asked Questions 432  
 Multiple Choice Questions 432  
 Viva Voce 432

## 30. Urinary Bladder and Urethra 433

Introduction 433  
 Urinary Bladder 433  
 External Features 433  
 Relations 434  
 Ligaments of the Bladder 434  
 Inferior of the Bladder 435  
 Arterial Supply 435  
 Venous Drainage 435  
 Lymphatic Drainage 436  
 Nerve Supply 436  
 Histology of Urinary Bladder 436  
 Dissection 436  
 Clinical Anatomy 436  
 Urethra 437  
 Male Urethra 437  
 Posterior Part 438  
 Anterior Part 439  
 Clinical Anatomy 440  
 Female Urethra 440  
 Walls of Urethra 440  
 Micturition 441  
 Clinical Anatomy 441  
 Development of Urinary Bladder and Urethra 441  
 Facts to Remember 442  
 Clinicoanatomical Problem 442  
 Further Reading 442  
 Frequently Asked Questions 443  
 Multiple Choice Questions 443  
 Viva Voce 443

## 31. Female Reproductive Organs 444

Introduction 444  
 Internal Genital Organs 444  
 Ovaries 444  
 External Features 445  
 Relations 445  
 Arterial Supply 446  
 Venous Drainage 446  
 Histology 446  
 Clinical Anatomy 447  
 Dissection 447  
 Uterine Tubes 447  
 Course and Relations 447  
 Blood Supply 448  
 Lymphatic Drainage 448  
 Nerve Supply 448  
 Histology 448  
 Clinical Anatomy 449  
 Uterus 449  
 Size and Shape 450  
 Normal Position and Angulation 450  
 Parts of Uterus 451  
 Cervix of Uterus 451  
 Ligaments of Uterus 452  
 Arterial Supply 452  
 Venous Drainage 453  
 Lymphatic Drainage 453  
 Nerve Supply 453  
 Age and Reproductive Changes 453  
 Supports of the Uterus 453  
 Role of Individual Supports 454  
 Histology 455  
 Clinical Anatomy 456  
 Vagina 456  
 Extent and Situation 457  
 Fornices of Vagina 457  
 Relations 457  
 Arterial Supply 457  
 Venous Drainage 458  
 Lymphatic Drainage 458  
 Nerve Supply 458  
 Ureter in Female Pelvis 458  
 Histology 458  
 Clinical Anatomy 459  
 Development 459  
 Molecular Regulation 461  
 Video 2.31 Female Reproductive System  
 Mnemonics 461  
 Facts to Remember 461  
 Clinicoanatomical Problem 461  
 Further Reading 462  
 Frequently Asked Questions 462  
 Multiple Choice Questions 462  
 Viva Voce 463

## 32. Male Internal Genital Organs 464

Introduction 464  
 Dissection 464  
 Ductus Deferens 464  
 Course and Relations 464  
 Arterial Supply 465  
 Venous Drainage 465  
 Histology 466  
 Development 466

- Clinical Anatomy 466
- Seminal Vesicles 466
- Ejaculatory Duct 466
- Prostate 466
- Situation 467
- Gross Features 467
- Zones of the Prostate 467
- Capsules and Ligaments of Prostate 468
- Structures within the Prostate 468
- Structural Zones of the Prostate 469
- Blood Supply 469
- Lymphatic Drainage 469
- Nerve Supply 469
- Age Changes in Prostate 469
- Histology 470
- Development 470
- Clinical Anatomy 470
- Vertebral System of Veins/Batson's Plexus 471
- Communications and Implications 471
- ▶ **Video 2.32 Male Reproductive System**
- Facts to Remember 471
- Clinicoanatomical Problems 471
- Further Reading 472
- Frequently Asked Questions 472
- Multiple Choice Questions 472
- Viva Voce 473

### 33. Rectum and Anal Canal 474

- Introduction 474
- Rectum 474
- Situation 474
- Dimensions 474
- Relations 475
- Mucosal Folds 475
- Arterial Supply 476
- Venous Drainage 477
- Lymphatic Drainage 477
- Nerve Supply 478
- Supports of Rectum 478
- Dissection 478
- Clinical Anatomy 479
- Anal Canal 480
- Length, Extent and Direction 480
- Relations of the Anal Canal 480
- Interior of the Anal Canal 480
- Musculature of the Anal Canal 481
- Anorectal Ring 481
- Surgical Spaces Related to the Anal Canal 482
- Arterial Supply 482
- Venous Drainage 482
- Lymphatic Drainage 482
- Nerve Supply 483
- Dissection 483
- Clinical Anatomy 483
- Histology 484
- Development 484
- Facts to Remember 484
- Clinicoanatomical Problem 485
- Further Reading 485
- Frequently Asked Questions 485
- Multiple Choice Questions 485
- Viva Voce 486

### 34. Walls of Pelvis 487

- Introduction 487
- Vessels of the Pelvis 487
- Internal Iliac Artery 487
- Course 487
- Relations 487
- Branches 487
- Branches of Anterior Division 487
- Branches of Posterior Division 489
- Internal Iliac Vein 489
- Lymph Nodes of the Pelvis 490
- Dissection 490
- Nerves of the Pelvis 490
- Lumbosacral Plexus 490
- Branches from Dorsal Divisions 490
- Branches from Ventral Division 491
- Coccygeal Plexus 491
- Clinical Anatomy 491
- Pelvic Autonomic Nerves 491
- Pelvic Sympathetic System 491
- Pelvic Splanchnic Nerves 491
- Dissection 491
- Pelvic Fascia 492
- Pelvic Muscles 492
- Levator Ani 493
- Pubococcygeus Part 493
- Iliococcygeus Part 493
- Ischiococcygeus Part 494
- Nerve Supply 494
- Actions of the Levator Ani and Coccygeus 494
- Relations of the Levator Ani 494
- Dissection 494
- Clinical Anatomy 494
- Joints of Pelvis 495
- Lumbosacral Joints 495
- Sacrococcygeal and Intercoccygeal Joints 495
- Sacroiliac Joint 495
- Ligaments 496
- Factors Providing Stability 497
- Blood Supply 497
- Nerve Supply 497
- Movements 497
- Pubic Symphysis 497
- Mechanism of Pelvis 497
- Dissection 497
- Clinical Anatomy 498
- Facts to Remember 498
- Clinicoanatomical Problem 498
- Further Reading 498
- Frequently Asked Questions 499
- Multiple Choice Questions 499
- Viva Voce 499

### 35. Surface Marking of Abdomen and Pelvis 500

- Planes and Regions of the Abdomen 500
- Surface Marking 500
- Viscera 500
- Spleen 500
- Stomach 500
- Duodenum 501
- Caecum 501
- Ileocaecal Orifice or Valve 501

Appendix 501  
 Ascending Colon 501  
 Transverse Colon 502  
 Descending Colon 502  
 Rectum and Anal Canal 502  
 Liver 502  
 Gallbladder 502  
 Bile Duct 502  
 Pancreas 502  
 Kidney 502  
 Ureter 503  
 Vessels 503  
 Abdominal Aorta 503  
 Common Iliac Artery 503  
 External Iliac Artery 503  
 Coeliac Trunk and its Branches 503  
 Superior Mesenteric Artery 503  
 Inferior Mesenteric Artery 504  
 Inferior Vena Cava 504  
 Portal Vein 504  
 Miscellaneous 504  
 Inguinal Canal 504  
 Root of Mesentery 504  
 Further Reading 504

### 36. Radiological and Imaging Procedures 505

Introduction 505  
 Plain Skiagram of Abdomen 505  
 Alimentary Canal (Barium Studies) 506  
 Barium Meal Examination 506  
 Barium Enema 507  
 Pyelography 507  
 Excretory (Intravenous or Descending) Pyelography 507

Retrograde (Instrumental or Ascending) Pyelography 508  
 Biliary Apparatus (Ultrasonography) 508  
 Hysterosalpingography 509  
 Further Reading 509

### Appendix 2: Nerves, Arteries and Clinical Terms 510

Nerves of Abdomen 510  
 Lower Intercostal Nerves 510  
 Upper Lumbar Nerves 510  
 Lumbar Plexus 510  
 Sacral Plexus 511  
 Pudendal Nerve 511  
 Abdominal Part of Sympathetic Trunk 511  
 Aortic Plexus 511  
 Pelvic Part of Sympathetic Trunk 511  
 Collateral or Prevertebral Ganglia and Plexuses 512  
 Coeliac Plexus 512  
 Superior Hypogastric Plexus 512  
 Autonomic Nerve Supply of Various Organs 512  
 Gastrointestinal Tract 512  
 Genitourinary Tract 513  
 Clinical Anatomy 514  
 Arteries of Abdomen and Pelvis 514  
 Clinical Terms 517  
 Multiple Choice Questions 520  
 Early Clinical Exposure (ECE) Cases 521  
 Spots on Abdomen and Pelvis 523  
 Answers: Spots on Abdomen and Pelvis 524

**Index 525**





# Ethical Aspects of Cadaveric Dissection

The cadaver, the dead body, that we dissect, plays an important role in the teaching of anatomy to medical students. The cadaver and the bones become an important part of our life as medical students as some academics have even referred to the cadaver as the 'first teacher' in the medical school.

We must pay due respect to the cadavers and bones kept in the dissection hall or museum. In some medical schools, it is mandatory to take an 'oath' before beginning the cadaveric dissection which aims to uphold the dignity of the mortal remains of the departed soul while other medical schools help the student to undertake dissection in a proper manner and empathise with the families of the donor. During the course of dissection, the student is constantly reminded of the sanctity of the body he/she is studying so that the noble donation of someone's body is used only as a means of gaining scientific knowledge/progress. Each and every dissected part afterwards is disposed or cremated with full dignity.

Honour of the donor and his/her family is the prime responsibility of the health professional. 'The dead teach the living', and the living pledge to use this knowledge for the upliftment of humankind.

Three-dimensional models and computer simulations cannot replace the tactile appreciation achieved by cadaveric dissection and we should always be grateful to those who have donated their bodies and strive to respect them. We have the privilege to study the human being through a body of a fellow human and have to be humble and carry forward the legacy of nobility and selflessness in our careers.

*(Contributed by Dr Puneet Kaur)*

# Index of Competencies

## Competency based Undergraduate Curriculum for the Indian Medical Graduate

<i>Code</i>	<i>Competency</i>	<i>Chapter</i>	<i>Page no</i>
AN 14.1	Identify the given bone, its side, important features and keep it in anatomical position	2	7
AN 14.2	Identify and describe joints formed by the given bone	2	7
AN 14.3	Describe the importance of ossification of lower end of femur and upper end of tibia	2	21
AN 14.4	Identify and name various bones in the articulated foot with individual muscle attachment	2	32
AN 15.1	Describe and demonstrate origin, course, relations, branches (or tributaries), termination of important nerves and vessels of anterior thigh	3, 4	57, 69
AN 15.2	Describe and demonstrate major muscles with their attachment, nerve supply and actions	3, 4	60, 67
AN 15.3	Describe and demonstrate boundaries, floor, roof and contents of femoral triangle	3	52
AN 15.4	Explain anatomical basis of psoas abscess and femoral hernia	3	55, 61
AN 15.5	Describe and demonstrate adductor canal with its content	3	63
AN 16.1	Describe and demonstrate origin, course, relations, branches (or tributaries), termination of important nerves and vessels of gluteal region	5	82
AN 16.2	Describe anatomical basis of sciatic nerve injury during gluteal intramuscular injections	5	80
AN 16.3	Explain the anatomical basis of Trendelenburg sign	5	82
AN 16.4	Describe and demonstrate the hamstrings group of muscles with their attachment, nerve supply and actions	7	95
AN 16.5	Describe and demonstrate the origin, course, relations, branches (or tributaries), termination of important nerves and vessels on the back of thigh	7	99
AN 16.6	Describe and demonstrate the boundaries, roof, floor, contents and relations of popliteal fossa	6	87
AN 17.1	Describe and demonstrate the type, articular surfaces, capsule, synovial membrane, ligaments, relations, movements and muscles involved, blood and nerve supply, bursae around the hip joint	12	161
AN 17.2	Describe anatomical basis of complications of fracture neck of femur	12	164
AN 17.3	Describe dislocation of hip joint and surgical hip replacement	12	164
AN 18.1	Describe and demonstrate major muscles of anterior compartment of leg with their attachment, nerve supply and actions	8	109
AN 18.2	Describe and demonstrate origin, course, relations, branches (or tributaries), termination of important nerves and vessels of anterior compartment of leg	8	109
AN 18.3	Explain the anatomical basis of foot drop	8	115
AN 18.4	Describe and demonstrate the type, articular surfaces, capsule, synovial membrane, ligaments, relations, movements and muscles involved, blood and nerve supply, bursae around the knee joint	12	166
AN 18.5	Explain the anatomical basis of locking and unlocking of the knee joint	12	171
AN 18.6	Describe knee joint injuries with its applied anatomy	12	173
AN 18.7	Explain anatomical basis of osteoarthritis	12	173
AN 19.1	Describe and demonstrate the major muscles of back of leg with their attachment, nerve supply and actions	9	126
AN 19.2	Describe and demonstrate the origin, course, relations, branches (or tributaries), termination of important nerves and vessels of back of leg	9	130
AN 19.3	Explain the concept of "Peripheral heart"	9	127
AN 19.5	Describe factors maintaining importance arches of the foot with its importance	13	187

<i>Code</i>	<i>Competency</i>	<i>Chapter</i>	<i>Page no</i>
AN 19.6	Explain the anatomical basis of flat foot and club foot	13	191
AN 19.7	Explain the anatomical basis of metatarsalgia and plantar fasciitis	10	137
AN 20.1	Describe and demonstrate the type, articular surfaces, capsule, synovial membrane, ligaments, relations, movements and muscles involved, blood and nerve supply of tibiofibular and ankle joint	12	174
AN 20.2	Describe the subtalar and transverse tarsal joints	12	179
AN 20.3	Describe and demonstrate fascia lata, venous drainage, lymphatic drainage, retinacula and dermatomes of lower limb	11	148
AN 20.4	Explain anatomical basis of enlarged inguinal lymph nodes	11	154
AN 20.5	Explain anatomical basis of varicose veins and deep vein thrombosis	11	151
AN 20.6	Identify the bones and joints of lower limb seen in anteroposterior and lateral view radiographs of various regions of lower limb	14	200
AN 20.7	Identify and demonstrate important bony landmarks of lower limb: Vertebral levels of highest point of iliac crest, posterior superior iliac spines, iliac tubercle, pubic tubercle, ischial tuberosity, adductor tubercle, tibial tuberosity, head of fibula, medial and lateral malleoli, condyles of femur and tibia, sustentaculum tali, tuberosity of fifth metatarsal, tuberosity of the navicular	14	194
AN 20.8	Identify and demonstrate palpation of femoral, popliteal, posterior tibial, anterior tibial and dorsalis pedis blood vessels in a simulated environment	14	195
AN 20.9	Identify and demonstrate Palpation of vessels (femoral, popliteal, dorsalis pedis, post-tibial), mid-inguinal point, Surface projection of: Femoral nerve, saphenous opening, Sciatic, tibial, common peroneal and deep peroneal nerve, Great and small saphenous veins	14	198
AN 20.10	Describe basic concept of development of lower limb	1	3
AN 44.1	Describe and demonstrate the planes (transpyloric, transtuberular, subcostal, lateral vertical, linea alba, linea semilunaris), regions and quadrants of abdomen	18	270
AN 44.2	Describe and identify the fascia, nerves and blood vessels of anterior abdominal wall	16	237
AN 44.3	Describe the formation of rectus sheath and its contents	16	246
AN 44.4	Describe and demonstrate extent, boundaries, contents of Inguinal canal including Hesselbach's triangle	16	249
AN 44.5	Explain the anatomical basis of inguinal hernia	16	251
AN 44.6	Describe and demonstrate attachments of muscles of anterior abdominal wall	16	239
AN 44.7	Enumerate common abdominal incisions	16	244
AN 45.1	Describe thoracolumbar fascia	27	400
AN 45.2	Describe and demonstrate Lumbar plexus for its root value, formation and branches	27	401
AN 45.3	Mention the major subgroups of back muscles, nerve supply and action	27	398
AN 46.1	Describe and demonstrate coverings, internal structure, side determination, blood supply, nerve supply, lymphatic drainage and descent of testis with its applied anatomy	17	261
AN 46.2	Describe parts of epididymis	17	265
AN 46.3	Describe penis under following headings: Parts, components, blood supply and lymphatic drainage	17	257
AN 46.4	Explain the anatomical basis of varicocoele	17	264
AN 46.5	Explain the anatomical basis of Phimosi and circumcision	17	260
AN 47.1	Describe and identify boundaries and recesses of lesser and greater sac	18	279, 282
AN 47.2	Name and identify various peritoneal folds and pouches with its explanation	18	283
AN 47.3	Explain anatomical basis of ascites and peritonitis	18	273, 285
AN 47.4	Explain anatomical basis of subphrenic abscess	18	285
AN 47.5	Describe and demonstrate major viscera of abdomen under following headings: anatomical position, external and internal features, important peritoneal and other relations, blood supply, nerve supply, lymphatic drainage and applied aspects)	19 20	291 302

<i>Code</i>	<i>Competency</i>	<i>Chapter</i>	<i>Page no</i>
AN 47.6	Explain the anatomical basis of splenic notch, accessory spleens, Kehr's sign, different types of vagotomy, liver biopsy (site of needle puncture), referred pain in cholecystitis, obstructive jaundice, referred pain around umbilicus, radiating pain of kidney to groin and lymphatic spread in carcinoma stomach	22, 23	340, 347, 359
AN 47.7	Mention the clinical importance of Calot's triangle	22	340
AN 47.8	Describe and identify the formation, course relations and tributaries of portal vein, inferior vena cava and renal vein	21, 27	329, 396, 397
AN 47.9	Describe and identify the origin, course, important relations and branches of abdominal aorta, coeliac trunk, superior mesenteric, inferior mesenteric and common iliac artery	21, 27	323, 394, 396
AN 47.10	Enumerate the sites of portosystemic anastomosis	21	331
AN 47.11	Explain the anatomic basis of hematemesis and caput medusae in portal hypertension	21	331
AN 47.12	Describe important nerve plexuses of posterior abdominal wall	27	402
AN 47.13	Describe and demonstrate the attachments, openings, nerve supply and action of the thoracoabdominal diaphragm	26	387
AN 47.14	Describe the abnormal openings of thoracoabdominal diaphragm and diaphragmatic hernia	26	390
AN 48.1	Describe and identify the muscles of Pelvic diaphragm	34	492
AN 48.2	Describe and demonstrate the (position, features, important peritoneal and other relations, blood supply, nerve supply, lymphatic drainage and clinical aspects of) important male and female pelvic viscera	31, 32	444, 464
AN 48.3	Describe and demonstrate the origin, course, important relations and branches of internal iliac artery	34	487
AN 48.4	Describe the branches of sacral plexus	34	490
AN 48.5	Explain the anatomical basis of suprapubic cystostomy, urinary obstruction in benign prostatic hypertrophy, retroverted uterus, prolapse uterus, internal and external haemorrhoids, anal fistula, vasectomy, tubal pregnancy and tubal ligation	31, 32	449, 456, 466
AN 48.6	Describe the neurological basis of automatic bladder	30	436
AN 48.7	Mention the lobes involved in benign prostatic hypertrophy and prostatic cancer	32	470
AN 48.8	Mention the structures palpable during vaginal and rectal examination	31, 33	456, 479
AN 49.1	Describe and demonstrate the superficial and deep perineal pouch (boundaries and contents)	28	415
AN 49.2	Describe and identify perineal body	28	409
AN 49.3	Describe and demonstrate perineal membrane in male and female	28	415
AN 49.4	Describe and demonstrate boundaries, content and applied anatomy of Ischiorectal fossa	28	410
AN 49.5	Explain the anatomical basis of perineal tear, episiotomy, perianal abscess and anal fissure	28, 33	412, 483
AN 50.2	Describe and demonstrate the type, articular ends, ligaments and movements of intervertebral joints, sacroiliac joints and pubic symphysis	34	495
AN 50.4	Explain the anatomical basis of scoliosis, lordosis, prolapsed disc, spondylolisthesis and spina bifida	15	222
AN 52.1	Describe and identify the microanatomical features of gastro-intestinal system: Oesophagus, fundus of stomach, pylorus of stomach, duodenum, jejunum, Ileum, large intestine, appendix, liver, gall bladder, pancreas and suprarenal gland, colon	19, 20 22, 23 25, 33	299, 308, 309, 317, 319, 341, 349, 353, 360, 384, 484
AN 52.2	Describe and identify the microanatomical features of: Urinary system: Kidney, ureter and urinary bladder male reproductive system: Testis, epididymis, vas deferens, prostate and penis female reproductive system: Ovary, uterus, uterine tube, cervix, placenta and umbilical cord	17, 24, 30, 31, 32	258, 264, 265, 370, 376, 436, 446, 448, 455, 458, 465, 470
AN 52.5	Describe the development and congenital anomalies of Diaphragm	26	390, 391
AN 52.6	Describe the development and congenital anomalies of: Foregut, midgut and hindgut, caecum, spleen, pancreas, liver, gallbladder	19, 20 22, 23 33	299, 313, 319 342, 349, 354 361, 484
AN 52.7	Describe the development of urinary system	24, 25	377, 384

<i>Code</i>	<i>Competency</i>	<i>Chapter</i>	<i>Page no</i>
AN 52.8	Describe the development of male and female reproductive system	17, 31, 32	265, 459, 466
AN 53.2	Demonstrate the anatomical position of bony pelvis and show boundaries of pelvic inlet, pelvic cavity, pelvic outlet	29	427
AN 53.3	Define true pelvis and false pelvis and demonstrate sex determination in male and female bony pelvis	15	229
AN 53.4	Explain and demonstrate clinical importance of bones of abdominopelvic region (sacralization of lumbar vertebra, lumbarization of 1st sacral vertebra, types of bony pelvis and coccyx)	15	222
AN 54.1	Describe and identify features of plain X-ray abdomen	36	505
AN 54.2	Describe and identify the special radiographs of abdominopelvic region (contrast X-ray barium swallow, barium meal, barium enema, cholecystography, intravenous pyelography and hysterosalpingography)	36	506



Competency-Based  
**BD Chaurasia's**  
**Human Anatomy**

Regional and Applied | Dissection and Clinical

Ninth  
 Edition

Volume  
**3**

Volume 1 UPPER LIMB and THORAX  
 Volume 2 LOWER LIMB, ABDOMEN and PELVIS  
 Volume 3 HEAD and NECK  
 Volume 4 BRAIN-NEUROANATOMY

Widely acclaimed as a standard textbook in view of its simple language, comprehensive coverage, lucid presentation and neatly-drawn line diagrams, **BD Chaurasia's Human Anatomy** remains the most preferred textbook in India and abroad. This edition has been thoroughly revised and updated to make it extremely informative and much more student-friendly.

The ninth edition now features diagrams adapted from the first edition, originally prepared by Dr BD Chaurasia, which have been suitably redrawn, modified and colored appropriately. Many text chapters have citations to videos of osteology and soft parts which are accessible through CBSiCentral App. Clinically oriented FAQs and MCQs, and ECE cases have been included to make the volumes absolutely clinical in nature.

**Salient features of the four volumes**

- Text follows the **CBME Guidelines** and all topics are described as per the **Competency Based Undergraduate Curriculum for the Indian Medical Graduate** prescribed by the National Medical Commission.
- **Colour codes** used consistently in the drawings of various cells, tissues and organs are given at the beginning of each section.
- Impressive **line diagrams**, originally hand-drawn by Dr BD Chaurasia, adapted from the first edition of *BDC Human Anatomy*, have been incorporated in this edition to make drawing of illustrations easier for the students.
- **Videos of osteology and soft parts**, accessible from CBSiCentral App through scratch code, have been numbered and cited in the respective chapters in all the four volumes. The App also includes answers to FAQs.
- **Latest updates** on various topics have been provided from standard international publications.
- **Clinical orientation** has been enthused by structuring many FAQs and MCQs in 'clinical mode'. **Early Clinical Exposure (ECE)** has been provided in the form of signs, symptoms, investigations and treatment of a particular case.
- Important features like **viva voce questions, molecular regulation, clinicoanatomical problems, ossification, dissection (steps)** are continued from the previous editions.
- **This volume features**  
 Tables 33, Flowcharts 12, Illustrations 462, Ossification boxes 14, Dissection boxes 12, X-rays 4, Clinical Anatomy boxes 77, Facts to Remember 114, FAQs 104, MCQs 135, Viva Voce questions 227, Videos 32, Clinicoanatomical Problems 20.

**Chief Editor**

**Krishna Garg** MBBS, MS, PhD, FIMSA, FIAMS, FAMS, FASI is ex-Professor and Head, Department of Anatomy, Lady Hardinge Medical College (LHMC), New Delhi. She joined LHMC where she completed her MS and PhD and taught anatomy till her retirement. She has received fellowships of the Indian Medical Association, Academy of Medical Specialists, and the International Medical Science Academy. She was elected fellow of the Academy of Medical Sciences (FAMS) in 2005. She was honoured with Excellence Award in Anatomy in 2004 by Delhi Medical Association. She has received Life Time Achievement Award, Fellowship of Anatomical Society of India, and DMA Distinguished Services Award, in 2015. She is visiting faculty of DNB, MDS and a PhD examiner.

She is author of *Manual of Human Anatomy Dissection, Companion Pocketbook—BDC Human Anatomy (Vols 1–3)* and *BDC Human Anatomy for Dental Students 3/e*; coauthor of *Textbook of Histology 5/e, Textbook of Neuroanatomy 6/e, Anatomy and Physiology for Nurses, Anatomy and Physiology for Allied Health Sciences, Practical Anatomy Workbook, Practical Histology Workbook* and *Practical Anatomy Workbook for Dental Students*; and editor of *Human Embryology 2/e, Handbook of General Anatomy 6/e* and *BD Chaurasia's Applied Anatomy and Physiology for BSc Nursing Students*.

**Editors**

**PS Mittal** MBBS, MS is Professor, Department of Anatomy, Government Institute of Medical Sciences, Greater Noida, UP.

**Mrudula Chandrupatla** MBBS, MD is Additional Professor and Head, Department of Anatomy, and Associate Dean (Research), All India Institute of Medical Sciences, Bibinagar, Hyderabad, Telangana.



**CBS Publishers & Distributors Pvt Ltd**

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



Scan for the price of this book and catalogue

Set ISBN for Volumes 3 and 4

ISBN: 978-93-5466-477-9



Ninth  
 Edition



Competency-Based  
**Chaurasia's**  
**Human Anatomy**

Volume  
**3**

Competency-Based  
**BD Chaurasia's**

**Human Anatomy**

Regional and Applied | Dissection and Clinical

As per the CBME Guidelines | Competency Based Undergraduate Curriculum for the Indian Medical Graduate

**Head and Neck**

Scratch Code on Inside Front Cover for Accessing CBSiCentral App



Available Free on CBSiCentral App

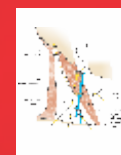
- Original Images from First Edition of BDC Human Anatomy (Vols 1–3) hand-drawn by Dr BD Chaurasia
- Videos on Osteology and Soft Parts
- Frequently Asked Questions & Answers

Volumes  
 3 & 4  
 sold together  
 as one set

Wall Chart on Nerves of Human Body



Many easily reproducible diagrams, originally hand-drawn by Dr BD Chaurasia, now modified and coloured suitably, are given at the relevant locations in the text



Dedicated to Education

**CBS Publishers & Distributors Pvt Ltd**



Ninth  
 Edition

Volume  
**3**

**Ninth Edition**

Volume



**3**

*Competency-Based*

**BD Chaurasia's**

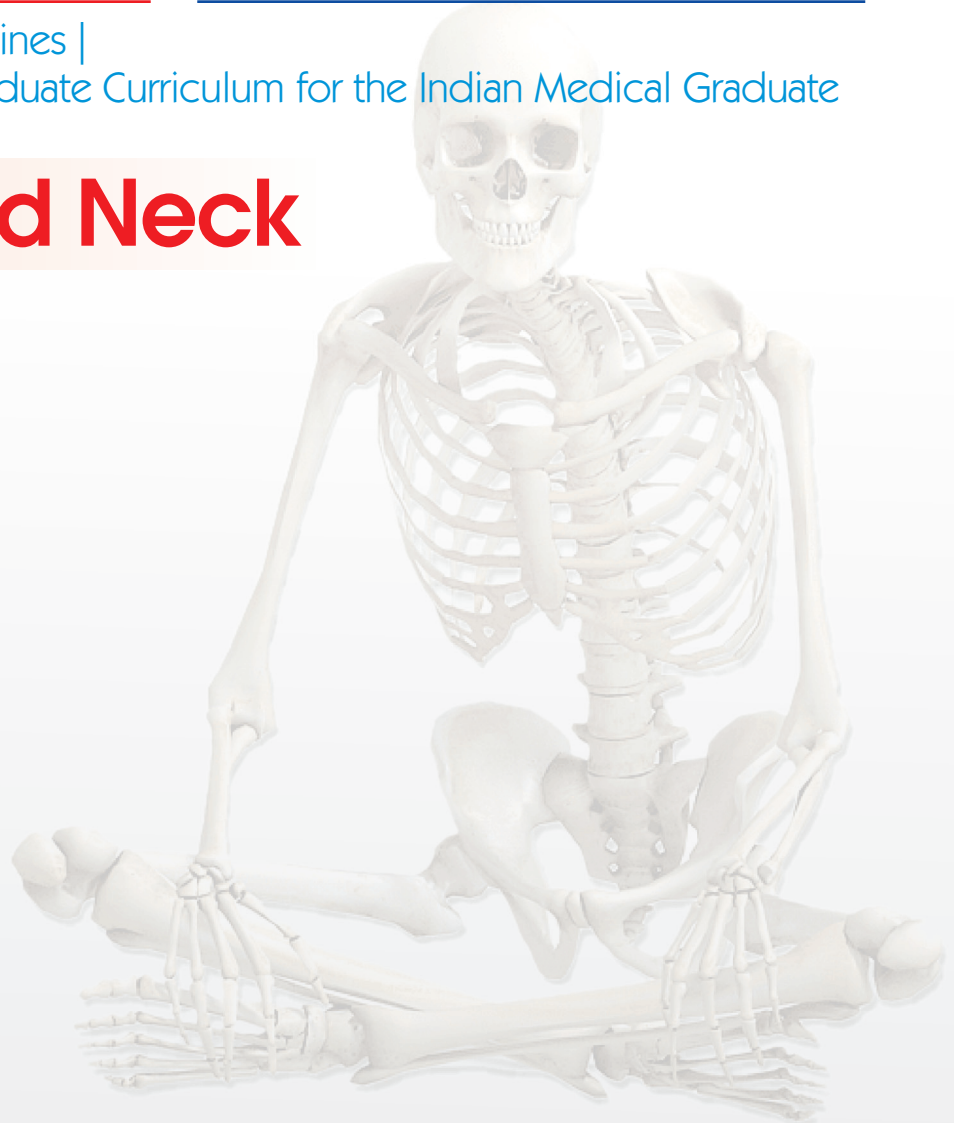
# **Human Anatomy**

**Regional and Applied   Dissection and Clinical**

As per the latest CBME Guidelines |  
Competency based Undergraduate Curriculum for the Indian Medical Graduate



**Head and Neck**







**Dr BD Chaurasia** (1937–1985)

was Reader in Anatomy at GR Medical College, Gwalior.

He received his MBBS in 1960, MS in 1965 and PhD in 1975.

He was elected fellow of National Academy of Medical Sciences (India) in 1982.

He was a member of the Advisory Board of the *Acta Anatomica* since 1981,

member of the editorial board of *Bionature*, and in addition

member of a number of scientific societies.

He had a large number of research papers to his credit.

**Ninth Edition**

**Volume**



*Competency-Based*

**3**

**BD Chaurasia's**

**Human**

**Anatomy**

**Regional and Applied Dissection and Clinical**

As per the latest CBME Guidelines |

Competency based Undergraduate Curriculum for the Indian Medical Graduate



**Head and Neck**

*Chief Editor*

**Krishna Garg**

MBBS MS PhD FIMSA FIAMS FAMS FASI

Legend of Anatomy; Nation's Who's Who

Fellow, Anatomical Society of India

Lifetime Achievement Awardee

DMA Distinguished Service Awardee

Ex-Professor and Head, Department of Anatomy

Lady Hardinge Medical College, New Delhi

*Editors*

**Mrudula Chandrupatla** MBBS MD

Additional Professor and Head, Department of Anatomy

All India Institute of Medical Sciences

Bibinagar, Hyderabad, Telangana

**Pragati Sheel Mittal** MBBS MS

Professor, Department of Anatomy

Government Institute of Medical Sciences

Greater Noida, UP

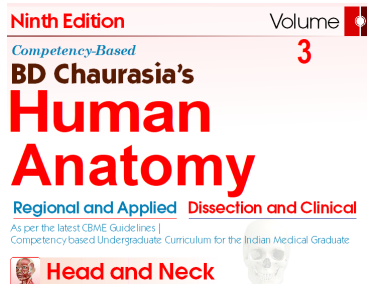


**CBSPD**

**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 editors 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 editors will not be held responsible for any inadvertent errors, omissions or inaccuracies.

**ISBN:** 978-93-5466-477-9

Copyright © Publisher and author

**Ninth Edition:** 2023

First Edition: 1979

Reprint: 1980, 1981, 1982, 1983, 1984, 1985, 1986, 1987, 1988

Second Edition: 1989

Reprint: 1990, 1991, 1992, 1993, 1994

Third Edition: 1995

Reprint: 1996, 1997, 1998, 1999, 2000, 2001, 2002, 2003, 2004

Fourth Edition: 2004

Reprint: 2005, 2006, 2007, 2008, 2009

Fifth Edition: 2010

Reprint: 2011, 2012

Sixth Edition: 2013

Reprint: 2014, 2015

Seventh Edition: 2016

Reprint: 2017, 2018, 2019

Eighth Edition: 2020

Reprint: 2021, 2022

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 author, editors 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

Fax: 011-23243014

Website: www.cbspd.com

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: +033-256330055/56 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 Thomson Press (India) Ltd., Delhi, India



to

*my teacher*

*Shri Uma Shankar Nagayach*

— BD Chaurasia



Volume  
**1**

**UPPER LIMB and THORAX**

**LOWER LIMB, ABDOMEN and PELVIS**

Volume  
**2**

Volume  
**3**

**HEAD and NECK**

**BRAIN-NEUROANATOMY**

Volume  
**4**



*This human anatomy is not systemic but regional  
Oh yes, it is theoretical as well as practical  
Besides the gross features, it is chiefly clinical  
Clinical too is very much diagrammatical.*

*Lots of tables for the muscles are provided  
Even methods for testing are incorporated  
Improved colour illustrations are added  
So that right half of brain gets stimulated*

*Tables for muscles acting on joints are given  
Tables for branches of nerves and arteries are given  
Hope these volumes turn highly useful  
Editors' hardwork under Almighty's guidance prove fruitful*

# Preface to the Ninth Edition

This edition features a number of significant modifications which we have made in the light of the wide-ranging suggestions that we received in the recent months from students, teachers and also the well-wishers of this epic textbook. As the information explodes and knowledge multiplies, appropriate improvements, additions and changes are also required to be made in the contemporary literature. Latest research information sourced from the standard international publications has been selectively incorporated in these volumes.

Numerous unique line diagrams, originally hand-drawn by late Dr BD Chaurasia and used in the first edition of the book, after thoughtful moderation, have now been incorporated in the ninth edition. Our criteria for the selection and manipulation of these drawings were clearly based on the simplicity and lucidity of the anatomic description. These simply structured illustrations can be easily reproduced by the students in multitudes of tests and examinations, including university examinations.

Diagrams form the foundation of anatomy: The drawings create imprints on the brain. Figures, artwork and the dissection are recorded in the right half of the cerebrum while the text is learnt by using left half of cerebrum. Thus, learning by drawing diagrams and steps of dissection help in using both the halves of cerebrum, which is an ideal condition. This textbook lays stress on understanding anatomic structures and details through clear, neat and crisp diagrams.

Earlier, videos of the dissection of all regions had been given free access to the readers on [CBSiCentral App](#). These videos are now uploaded on the App after reorganization of the sequences, numeration and providing appropriate citations in the text. Readers can register on the App and access the enumerated videos through the scratch code given on the inside front cover of each volume. These videos adequately compensate the scarcity of the cadavers in medical institutions for conducting dissection.

The videos of the dissection give three-dimensional image descriptions of tissues and organs which get effectively registered in brain for a longer time.

Processes and steps of dissection given in blue boxes with dissection photographs have been retained as many students and teachers appreciate the same. However, no addition in dissection photographs has been made as a separate CBSPD publication *Manual of Human Anatomy Dissection* (ISBN: 978-93-89688-00-9) with numerous dissection photographs is available to the readers who aspire to learn and enjoy the dissection in a meticulous manner.

We have incorporated all the competencies prescribed by National Medical Commission under the [Competency Based Curriculum for the Indian Medical Graduate](#) for spirited implementation of [Competency Based Medical Education Guidelines](#).

Since National Medical Commission has laid stress on teaching and learning clinical aspects from the very beginning of the MBBS study period, the questions asked are mostly clinical. [Clinical aspects](#) have been explicitly given in the text such that the students are able to learn, recapitulate and answer the clinically-oriented questions in their examinations.

As NMC curriculum also lays emphasis on [Early Clinical Exposure](#), crisply written and well-presented [ECE Cases](#) have been given at the end of every section, which make the book clinical-savvy. These case studies will help the budding doctors in imbibing the salient clinical features, getting appropriate investigations done, and treating the patients satisfactorily once they are in clinical practice.

All the illustrations in the four volumes of this book have been prepared on a common colour scheme applicable to cells, tissues and organs. Colour codes employed in the preparation of the human anatomy illustrations are given in the beginning of each section. This characteristic feature will help the students in identifying the anatomic components clearly and draw appropriately coloured diagram in a schematic manner.

Extensive research by numerous scientists has decoded the molecular control of development of organ tissues of the body. Basics of this molecular control are given briefly in these volumes.

We have continued with the practice of giving one separate **wall chart** in each volume for easy comprehension of the topics.

Sincere attempt has been made to present all facets of theory and practical anatomy to make these volumes truly holistic. In addition to the descriptive text, the following rich features lend a high pedestal to the book in the context of the international literature.

	<i>Volume 1</i>	<i>Volume 2</i>	<i>Volume 3</i>	<i>Volume 4</i>	<i>Total</i>
Figures	414	653	462	210	1739
Flowcharts	7	4	12	9	32
Dissection Boxes	37	36	12	5	90
X-rays/MRI and CT Scans	5	5	4	16	30
Ossification Boxes	13	12	14	–	39
Tables	43	52	33	23	151
Clinical Anatomy Boxes	52	101	77	41	271
Mnemonics Boxes	22	15	8	4	49
Facts to Remember	93	229	114	67	503
FAQs	99	132	104	52	387
MCQs	149	232	135	72	588
Viva Voce Questions	259	508	227	125	1119
Clinicoanatomical Problems	19	35	20	14	88
Videos	47	50	32	9	138

Chief Editor

**Krishna Garg**

email: [dr.krishnagarg@gmail.com](mailto:dr.krishnagarg@gmail.com)

Editors

**Pragati Sheel Mittal**  
**Mrudula Chandrupatla**

# Preface to the First Edition (excerpts)



The necessity of having a simple, systematized and complete book on anatomy has long been felt. The urgency for such a book has become all the more acute due to the shorter time now available for teaching anatomy, and also to the falling standards of English language in the majority of our students in India. The national symposium on 'Anatomy in Medical Education' held at Delhi in 1978 was a call to change the existing system of teaching the unnecessary minute details to the undergraduate students.

This attempt has been made with an object to meet the requirements of a common medical student. The text has been arranged in small classified parts to make it easier for the students to remember and recall it at will. It is adequately illustrated with simple line diagrams which can be reproduced without any difficulty, and which also help in understanding and memorizing the anatomical facts that appear to defy memory of a common student. The monotony of describing the individual muscles separately, one after the other, has been minimised by writing them out in tabular form, which makes the subject interesting for a lasting memory. The relevant radiological and surface anatomy have been treated in separate chapters. A sincere attempt has been made to deal, wherever required, the clinical applications of the subject. The entire approach is such as to attract and inspire the students for a deeper dive in the subject of anatomy.

The book has been intentionally split in three parts for convenience of handling. This also makes a provision for those who cannot afford to have the whole book at a time.

It is quite possible that there are errors of omission and commission in this mostly single-handed attempt. I would be grateful to the readers for their suggestions to improve the book from all angles.

I am very grateful to my teachers and the authors of numerous publications, whose knowledge has been freely utilised in the preparation of this book. I am equally grateful to my professor and colleagues for their encouragement and valuable help. My special thanks are due to my students who made me feel their difficulties, which was a great incentive for writing this book. I have derived maximum inspiration from Prof. Inderbir Singh (Rohtak), and learned the decency of work from Shri SC Gupta (Jiwaji University, Gwalior).

I am deeply indebted to Shri KM Singhal (National Book House, Gwalior) and Mr SK Jain (CBS Publishers & Distributors, Delhi), who have taken unusual pains to get the book printed in its present form. For giving it the desired get-up, Mr VK Jain and Raj Kamal Electric Press are gratefully acknowledged. The cover page was designed by Mr Vasant Paranjpe, the artist and photographer of our college; my sincere thanks are due to him. I acknowledge with affection the domestic assistance of Munne Miyan and the untiring company of my Rani, particularly during the odd hours of this work.

**BD Chaurasia**





# Acknowledgements

The editors are thankful to Dr SN Kazi (Pune) for providing maximum updates from Gray's Anatomy, 42nd Edition.

Dr Vikas Verma (Lucknow) revised the chapters on Joints and Nerves of Limbs and gave very useful inputs. Dr Tripta Bhagat (Ghaziabad) edited clinical anatomy portions of the volumes.

We have the blessings and good wishes of Prof NA Faruqi (Aligarh); Dr DC Naik (Rewa); Dr SD Joshi and Dr SS Joshi (Indore); Dr (Brig) Rakesh Gupta (Greater Noida); Dr DR Singh (Lucknow); Dr M Kaul; Dr C Anand and Dr I Bahl (Delhi); Dr Mohsin Azmi (Kanpur); Dr Medha Joshi (Ghaziabad); Dr Surbhi Gupta (Delhi); and Dr Nitin Nagarkar (Raipur).

We are thankful to Dr Surjit Ghatak (Jodhpur); Dr Vinay Sharma (Muzzafarnagar); Dr Deepu Singh Kataria and Dr Anup Singh Gurjar (Pali); Dr Jagmohan Sharma; Dr Deepak Sharma; Dr Rajesh Arora and Dr Pooja Garg (Jaipur); Dr Sumit Gupta (Kota); Dr Gopal Sharma and Dr Manoj Sharma (Jhalawar); Dr Rekha Parashar (Chittorgarh); Dr Santosh Kumar (Dholpur); Dr BK Aghera (Sirohi), Dr Isha Srivastav; Dr Aprajita Raizada; Dr Sajjan Skaria; Dr Anjali Jain and Dr Kalpana Sharma (Udaipur); for giving feedback for various sections of the volumes.

We are grateful to Dr Hitant Vohra and Dr Anu Sharma (Ludhiana); Dr Anupma Mahajan (Amritsar); Dr Vanita Gupta (Jammu), for editing chapters to enhance the value of the volumes.

We are grateful to Dr Ravikant (Amritsar); Dr Sangeeta and Dr Nusrat Jabeen (Jammu); Dr Kalyan Singh and Dr Rajan Singla (Patiala); Dr Anjali Jain and Dr Aprajita Sikka (Ludhiana); Dr Bashir (Srinagar); Dr Seema and Dr Ritu (Rajouri); Dr Mubeen (Kathua); Dr RK Srivastava (Kanpur); Dr Punita Manik (Lucknow); Dr Binod Kumar; Dr Sunita Nayak and Dr Shambhu Prasad (Patna); Dr AK Dubey (Ranchi); Dr Satyam Khare; Dr Shilpi Jain and Dr Alok Tripathi (Meerut), for promoting the volumes.

We have been getting constant encouragement and support from Dr Ranjana Verma, Dr Muthukrishnan P, Dr Yogesh Yadav, Dr Pullimi Vineel and Dr Anupma Gupta (Greater Noida); Dr Nisha Kaul (Ghaziabad); Dr Vinay Singhal (Saharanpur); Dr RK Ashoka (Mathura); Dr Vineet Guha (Khandwa); Dr Manisha Sinha (Raipur); Dr Jahan Shirin (Kanpur); Dr Damyanti (Manipur); Dr Daisy Sahni (Chandigarh); and Dr MK Anand (Bhuj).

Our regards and affection to Dr Rewa Choudhry, Dr Shilpa Paul, Dr Smita Kakar, Dr Anita Tuli, Dr Gayatri Rath, Dr Shashi Raheja, Dr Shyama Rajdan, Dr Mangala Kohli, Dr A Sheriff, Dr SB Ray, Dr Vandana Mehta, Dr Sabita Mishra, Dr Renu Chauhan, Dr Jyoti Arora, Dr Sneha Aggarwal and Dr TS Roy (Delhi), for going through the volumes.

We would like to thank Dr Pritha Bhuiyan (Mumbai); Dr Brijendra Singh (Rishikesh); Col. Dr Sushil Kumar (Pune); Dr AK Srivastava (Lucknow); Dr MK Pant (Dehradun); Dr Shakuntala Pai (Manipal); Dr Simmi Mehra (Rajkot); Dr Fatima M De Souza (Goa); Dr Mukesh Mittal (Shivpuri); Dr Priti Sinha (Saharanpur); Dr Rakesh K Verma (Lucknow); Dr Rashmi Malhotra (Rishikesh); Dr Sandiya Kurup (Kalanchery); Dr Simmi Soni (Aziznagar); Dr Sunita Gupta (Ahmedabad) and many-many other teachers all over the globe, for giving us good wishes.

Videos of bones and soft parts of human body, prepared at Kathmandu University School of Medical Sciences, have now been added with the respective chapters and are available at our mobile App [CBSiCentral](#). I (chief editor) am grateful to Dr R Koju, CEO of KUSMS and Dhulikhel Hospital, for his generosity.

The moral support of my (chief editor) family members, Late Dr DP Garg, Dr Suvira Gupta, Dr JP Gupta, Mr Manoj, Ms Rekha, Mr Sanjay, Ms Meenakshi, Dr Manish, Dr Shilpa Garg, Dr Naveen Garg, Dr Manoj, Dr Nalini Shukla, Dr Vikas Verma and Dr Swati Gupta, is appreciated.

The magnanimity shown by Mr SK Jain (Chairman) and Mr Varun Jain (Director), CBS Publishers & Distributors, has been always forthcoming. The unquestionable support of Mr YN Arjuna (Senior Vice President—Publishing, Editorial and Publicity) and his entire team comprising Ms Ritu Chawla (GM—Production), Mr Sanjay Chauhan, Mr Neeraj Prasad and Mr Rohan Prasad (Graphic Artists); Mr Surendra Jha and Mr Prasenjit Paul (Copy Editors); Ms Jyoti Kaur and Mr Tarun Rajput (DTP Operators) has made an excellent contribution to bring out this edition. We are really obliged to them and pray for their prosperity.

*Chief Editor*

**Krishna Garg**

email: [dr.krishnagarg@gmail.com](mailto:dr.krishnagarg@gmail.com)

*Editors*

**Pragati Sheel Mittal**  
**Mrudula Chandrupatla**

## *Thus spoke the cadaver*

*Handle me with little love and care  
As I had missed it in my life affair  
Was too poor for cremation or burial  
That is why am lying in dissection hall*

*You dissect me, cut me, section me  
But your learning anatomy should be precise  
Worry not, you would not be taken to court  
As I am happy to be with the bright lot*

*Couldn't dream of a fridge for cold water  
Now my body parts are kept in refrigerator  
Young students sit around me with friends  
A few dissect, rest talk, about food, family and movies  
How I enjoy the dissection periods  
Don't you? Unless you are interrogated by a teacher*

*When my parts are buried post-dissection  
Bones are taken out for the skeleton  
Skeleton is the crown glory of the museum  
Now I am being looked up by great enthusiasm*

*If not as skeletons as loose bones  
I am in their bags and in their hostel rooms  
At times, I am on their beds as well  
Oh, what a promotion to heaven from hell*

*I won't leave you, even if you pass anatomy  
Would follow you in forensic medicine and pathology  
Would be with you even in clinical teaching  
Medicine line is one where dead teach the living*

*One humble request I'd make  
Be sympathetic to persons with disease  
Don't panic, you'll have enough money  
And I bet, you'd be singularly happy*

*—Krishna Garg*



# Contents



<i>Preface to the Ninth Edition</i>	vii
<i>Preface to the First Edition (Excerpts)</i>	ix
<i>Index of Competencies</i>	xxi

## 1. Introduction and Osteology

3

Introduction	3
Functions of Head and Neck	3
Skull	4
Bones of the Skull	4
Anatomical Position of Skull	5
Peculiarities of Skull Bones	5
Exterior of the Skull	6
Norma Verticalis	6
Clinical Anatomy	7
Norma Occipitalis	7
Norma Frontalis	8
Clinical Anatomy	10
Norma Lateralis	10
Clinical Anatomy	13
Norma Basalis	13
Attachments of Exterior of Skull	18
Interior of the Skull	21
Internal Surface of Cranial Vault	22
Internal Surface of the Base of Skull	22
Anterior Cranial Fossa	22
Clinical Anatomy	23
Middle Cranial Fossa	23
Clinical Anatomy	25
Posterior Cranial Fossa	25
Clinical Anatomy	26
Attachments and Relations: Interior of the Skull	26
Principles Governing Fractures of the Skull	27
The Orbit	27
Foetal Skull/Neonatal Skull	29
Dimensions	29
Structure of Bones	29
Ossification	30
Postnatal Growth of Skull	30
Clinical Anatomy	30
Sex Differences in the Skull	31
Craniometry	31
Mandible	32
Body	32
Ramus	32
Attachments and Relations of the Mandible	33
Foramina and Relations to Nerves and Vessels	34
Ossification	34
Age Changes in the Mandible	34
Structures Related to Mandible	35
Clinical Anatomy	35
Maxilla	35
Side Determination	35

Features	35
Articulations of Maxilla	38
Ossification	38
Age Changes	38
Parietal Bone	39
Side Determination	39
Features	39
Occipital Bone	39
Anatomical Position	39
Features	39
Frontal Bone	40
Anatomical Position	40
Temporal Bone	41
Side Determination	41
Features	41
Sphenoid Bone	44
Body of Sphenoid	44
Greater Wings	44
Lesser Wings	45
Pterygoid Processes	46
Ethmoid Bone	46
Cribriform Plate	46
Perpendicular Plate	46
Labyrinths	47
Vomer	47
Inferior Nasal Conchae	47
Zygomatic Bones	47
Nasal Bones	48
Lacrimal Bones	48
Palatine Bones	49
Hyoid Bone	49
Attachments on the Hyoid Bone	50
Development	50
Clinical Anatomy	50
Cervical Vertebrae	51
Identification	51
Typical Cervical Vertebrae	51
Ossification	52
First Cervical Vertebra	52
Ossification	53
Second Cervical Vertebra	53
Seventh Cervical Vertebra	54
Ossification	54
Clinical Anatomy	54
Ossification of Cranial Bones	56
Foramina of Skull Bones and their Contents	57
Development of Neurocranium	58
► Video 3.1 Bones of Skull	
Mnemonics	59

Facts to Remember 59  
 Clinicoanatomical Problem 59  
 Further Reading 59  
 Frequently Asked Questions 60  
 Multiple Choice Questions 60  
 Viva Voce 61

## 2. Scalp, Temple and Face 62

Introduction 62  
 Surface Landmarks 62  
 Scalp and Superficial Temporal Region 63  
 Scalp 63  
 Dissection 63  
 Superficial Temporal Region 65  
 Clinical Anatomy 67  
 Face 67  
 Skin 67  
 Superficial Fascia 67  
 Dissection 68  
 Facial Muscles 68  
 Nerve Supply of Face 71  
 Clinical Anatomy 73  
 Sensory Nerve Supply 74  
 Clinical Anatomy 74  
 Arteries of the Face 75  
 Dissection 75  
 Facial Artery 75  
 Veins of the Face 76  
 Clinical Anatomy 76  
 Lymphatic Drainage of the Face 77  
 Eyelids or Palpebrae 77  
 Dissection 78  
 Clinical Anatomy 78  
 Lacrimal Apparatus 79  
 Components 79  
 Dissection 79  
 Clinical Anatomy 80  
 Development of Face 80  
 Molecular Regulation 80  
 Video 3.2 Scalp and Face  
 Mnemonics 81  
 Facts to Remember 81  
 Clinicoanatomical Problems 81  
 Further Reading 81  
 Frequently Asked Questions 82  
 Multiple Choice Questions 82  
 Viva Voce 83

## 3. Side of the Neck 84

Introduction 84  
 Landmarks 84  
 Boundaries 84  
 Skin 84  
 Superficial Fascia 85  
 Dissection 85  
 Clinical Anatomy 86  
 Deep Cervical Fascia (Fascia Colli) 86  
 Investing Layer 86  
 Clinical Anatomy 88  
 Pretracheal Fascia 88  
 Clinical Anatomy 88  
 Prevertebral Fascia 88  
 Clinical Anatomy 89  
 Carotid Sheath 89

Buccopharyngeal Fascia 90  
 Pharyngobasilar Fascia 90  
 Pharyngeal Spaces 90  
 Retropharyngeal Space 90  
 Lateral Pharyngeal Space 90  
 Sternocleidomastoid (Sternomastoid) Muscle 90  
 Clinical Anatomy 91  
 Posterior Triangle 92  
 Dissection 92  
 Clinical Anatomy 93  
 Contents of the Posterior Triangle 94  
 Clinical Anatomy 96  
 Video 3.3 Side of the Neck  
 Facts to Remember 97  
 Clinicoanatomical Problem 97  
 Further Reading 97  
 Frequently Asked Questions 98  
 Multiple Choice Questions 98  
 Viva Voce 98

## 4. Anterior Triangle of the Neck 99

Introduction 99  
 Surface Landmarks 99  
 Structures in the Anterior Median Region  
 of the Neck 100  
 Dissection 101  
 Clinical Anatomy 101  
 Anterior Triangle 103  
 Boundaries 103  
 Subdivisions 103  
 Submental Triangle 104  
 Digastric Triangle 104  
 Dissection 104  
 Carotid Triangle 105  
 Dissection 105  
 Muscular Triangle 107  
 Dissection 107  
 Ansa Cervicalis or Ansa Hypoglossi 108  
 Common Carotid Artery 108  
 Clinical Anatomy 108  
 External Carotid Artery 108  
 Branches 109  
 Potential Tissue Spaces in Head and Neck 111  
 Video 3.4 Anterior Triangle of the Neck  
 Mnemonics 111  
 Facts to Remember 111  
 Clinicoanatomical Problem 111  
 Further Reading 112  
 Frequently Asked Questions 112  
 Multiple Choice Questions 112  
 Viva Voce 113

## 5. Parotid Region 114

Introduction 114  
 Salivary Glands 114  
 Parotid Gland 114  
 Dissection 114  
 Clinical Anatomy 115  
 Relations 115  
 Parotid Duct/Stenson's Duct 119  
 Clinical Anatomy 119  
 Histology 120  
 Development 120



▶ **Video 3.5 Parotid Gland**

- Facts to Remember 120  
 Clinicoanatomical Problem 120  
 Further Reading 120  
 Frequently Asked Questions 121  
 Multiple Choice Questions 121  
 Viva Voce 121

## 6. Temporal and Infratemporal Regions 122

- Introduction 122  
 Temporal Fossa 122  
 Infratemporal Fossa 122  
 Landmarks on the Lateral Side of the Head 123  
 Muscles of Mastication 123  
 Features 123  
 Temporal Fascia 123  
 Dissection 123  
 Relations of Lateral Pterygoid 125  
 Relations of Medial Pterygoid 126  
 Clinical Anatomy 126  
 Maxillary Artery 126  
 Dissection 126  
 Branches of Maxillary Artery 127  
 Clinical Anatomy 128  
 Pterygoid Venous Plexus 129  
 Temporomandibular Joint 129  
 Dissection 129  
 Clinical Anatomy 132  
 Mandibular Nerve 133  
 Dissection 134  
 Otic Ganglion 136  
 Clinical Anatomy 137  
 ▶ **Video 3.6 Infratemporal Fossa**  
 Mnemonics 137  
 Facts to Remember 138  
 Clinicoanatomical Problem 138  
 Further Reading 148  
 Frequently Asked Questions 138  
 Multiple Choice Questions 139  
 Viva Voce 139

## 7. Submandibular Region 140

- Introduction 140  
 Suprahyoid Muscles 140  
 Dissection 142  
 Submandibular Salivary Gland 143  
 Dissection 144  
 Submandibular Duct/Wharton's Duct 146  
 Sublingual Salivary Gland 146  
 Submandibular Ganglion 146  
 Histology 146  
 Clinical Anatomy 146  
 Comparison of the Three Salivary Glands 147  
 ▶ **Video 3.7 Submandibular Salivary Gland**  
 Facts to Remember 148  
 Clinicoanatomical Problem 149  
 Further Reading 149  
 Frequently Asked Questions 150  
 Multiple Choice Questions 150  
 Viva Voce 150

## 8. Structures in the Neck 151

- Introduction 151  
 Glands 151  
 Thyroid Gland 151  
 Dissection 151  
 Clinical Anatomy 155  
 Histology 156  
 Development 156  
 Parathyroid Glands 157  
 Clinical Anatomy 157  
 Histology 158  
 Thymus 158  
 Clinical Anatomy 159  
 Histology of Thymus 159  
 Development of Thymus and Parathyroid Glands 159  
 Blood Vessels of the Neck 160  
 Subclavian Artery 160  
 Dissection 160  
 Clinical Anatomy 163  
 Common Carotid Artery 163  
 Dissection 163  
 Clinical Anatomy 164  
 Internal Carotid Artery 164  
 Subclavian Vein 165  
 Internal Jugular Vein 166  
 Clinical Anatomy 167  
 Brachiocephalic Vein 167  
 Nerves of the Neck 167  
 Glossopharyngeal Nerve—IX Nerve 167  
 Vagus Nerve—X Nerve 167  
 Accessory Nerve—XI Nerve 167  
 Cervical Part of Sympathetic Trunk 169  
 Formation 169  
 Dissection 169  
 Ganglia 169  
 Clinical Anatomy 170  
 Lymphatic Drainage of Head and Neck 171  
 Superficial Group 171  
 Dissection 171  
 Deep Group 172  
 Deepest Group 172  
 Main Lymph Trunks at the Root of the Neck 173  
 Clinical Anatomy 173  
 Styloid Apparatus 174  
 Development of the Arteries 174  
 ▶ **Video 3.8 Thyroid Gland**  
 Mnemonics 175  
 Facts to Remember 175  
 Clinicoanatomical Problem 175  
 Further Reading 175  
 Frequently Asked Questions 176  
 Multiple Choice Questions 176  
 Viva Voce 177

## 9. Prevertebral and Paravertebral Regions 178

- Introduction 178  
 Prevertebral Muscles 178  
 Vertebral Artery 178  
 Dissection 178  
 Scalenovertbral Triangle 180  
 Development of Vertebral Artery 181  
 Trachea 181  
 Clinical Anatomy 181

Oesophagus 182  
 Clinical Anatomy 182  
 Joints of the Neck 182  
 Clinical Anatomy 185  
 Paravertebral Region 186  
 Scalene Muscles 186  
 Dissection 186  
 Cervical Pleura 188  
 Cervical Plexus 188  
 Phrenic Nerve 190  
 Facts to Remember 191  
 Clinicoanatomical Problems 191  
 Further Reading 191  
 Frequently Asked Questions 192  
 Multiple Choice Questions 192  
 Viva Voce 192

## 10. Back of the Neck 193

Introduction 193  
 Dissection 193  
 Nerve Supply of Skin 194  
 Ligamentum Nuchae 194  
 Muscles of the Back 195  
 Suboccipital Region 198  
 Dissection 198  
 Suboccipital Muscles 198  
 Exposure of Suboccipital Triangle 199  
 Clinical Anatomy 200  
 Video 3.10 Muscles of the Back  
 Mnemonics 201  
 Facts to Remember 201  
 Clinicoanatomical Problem 201  
 Further Reading 201  
 Frequently Asked Questions 202  
 Multiple Choice Questions 202  
 Viva Voce 202

## 11. Contents of Vertebral Canal 203

Introduction 203  
 Contents 203  
 Dissection 203  
 Clinical Anatomy 205  
 Spinal Nerves 205  
 Clinical Anatomy 206  
 Vertebral System of Veins 207  
 Facts to Remember 207  
 Clinicoanatomical Problem 207  
 Frequently Asked Question 208  
 Multiple Choice Questions 208  
 Viva Voce 208

## 12. Cranial Cavity 209

Introduction 209  
 Contents of Cranial Cavity 209  
 Dissection 209  
 Cerebral Dura Mater 210  
 Clinical Anatomy 213  
 Venous Sinuses of Dura Mater 213  
 Cavernous Sinus 213  
 Dissection 213  
 Clinical Anatomy 216  
 Superior Sagittal Sinus 216  
 Clinical Anatomy 217

Straight Sinus 217  
 Transverse Sinuses 217  
 Sigmoid Sinuses 217  
 Clinical Anatomy 217  
 Hypophysis Cerebri (Pituitary Gland) 218  
 Dissection 218  
 Subdivisions/Parts and Development 219  
 Molecular Regulation 219  
 Histology 219  
 Clinical Anatomy 220  
 Trigeminal Ganglion 221  
 Dissection 221  
 Clinical Anatomy 222  
 Middle Meningeal Artery 222  
 Dissection 223  
 Clinical Anatomy 223  
 Other Structures Seen in Cranial Fossae after  
 Removal of Brain 223  
 Dissection 223  
 Internal Carotid Artery 223  
 Cranial Nerves 224  
 Petrosal Nerves 224  
 Video 3.12 Cranial Cavity  
 Facts to Remember 225  
 Clinicoanatomical Problem 226  
 Further Reading 226  
 Frequently Asked Questions 226  
 Multiple Choice Questions 227  
 Viva Voce 227

## 13. Contents of the Orbit 228

Introduction 228  
 Orbits 228  
 Dissection 228  
 Orbital fascia or Periorbita 228  
 Facial Sheath of Eyeball or Bulbar Fascia 229  
 Extraocular Muscles 229  
 Involuntary Muscles 229  
 Dissection 229  
 Clinical Anatomy 233  
 Vessels of the Orbit 234  
 Ophthalmic Artery 234  
 Dissection 234  
 Clinical Anatomy 236  
 Ophthalmic Veins 236  
 Nerves of the Orbit 236  
 Optic Nerve 236  
 Clinical Anatomy 237  
 Ciliary Ganglion 237  
 Oculomotor Nerve 237  
 Trochlear Nerve 238  
 Abducent Nerve 238  
 Branches of Ophthalmic Division of Trigeminal Nerve 238  
 Some Branches of Maxillary Division of Trigeminal Nerve 240  
 Sympathetic Nerves of the Orbit 241  
 Video 3.13 Orbit  
 Mnemonics 241  
 Facts to Remember 241  
 Clinicoanatomical Problem 241  
 Further Reading 241  
 Frequently Asked Questions 242  
 Multiple Choice Questions 242  
 Viva Voce 242

**14. Mouth and Pharynx**

243

- Oral Cavity 243
- Vestibule 243
- Clinical Anatomy 243
- Oral Cavity Proper 244
- Nerve Supply of Gums 245
- Clinical Anatomy 245
- Teeth 245
- Clinical Anatomy 246
- Stages of Development of Deciduous Teeth 247
- Molecular Regulation of Teeth Development 247
- Hard Palate 249
- Dissection 249
- Soft Palate 249
- Muscles of the Soft Palate 251
- Clinical Anatomy 253
- Development of Palate 253
- Pharynx 254
- Dissection 254
- Parts of the Pharynx 255
- Waldeyer's Lymphatic Ring 255
- Clinical Anatomy 255
- Palatine Tonsil (The Tonsil) 256
- Clinical Anatomy 257
- Histology 257
- Development 258
- Laryngeal Part of Pharynx (Laryngopharynx) 258
- Structure of Pharynx 258
- Muscles of the Pharynx 259
- Structures in between Pharyngeal Muscles 260
- Dissection 261
- Killians' Dehiscence 261
- Clinical Anatomy 262
- Nerve Supply of Pharynx 262
- Blood Supply of Pharynx 262
- Lymphatic Drainage of Pharynx 262
- Deglutition (Swallowing) 262
- Development 263
- Pharyngotympanic Tube 263
- Clinical Anatomy 264
- ▶ Video 3.14 Pharynx
- Mnemonics 264
- Facts to Remember 264
- Clinicoanatomical Problem 264
- Further Reading 265
- Frequently Asked Questions 265
- Multiple Choice Questions 265
- Viva Voce 266

**15. Nose, Paranasal Sinuses and Pterygopalatine Fossa**

267

- Introduction 267
- Nose 267
- External Nose 267
- Nasal Cavity 267
- Clinical Anatomy 268
- Nasal Septum 268
- Dissection 269
- Clinical Anatomy 270
- Lateral Wall of Nose 270
- Dissection 270
- Conchae and Meatuses 271
- Dissection 272

- Clinical Anatomy 273
- Olfactory Nerve—1st Nerve 273
- Clinical Anatomy 273
- Paranasal Sinuses 273
- Dissection 274
- Clinical Anatomy 275
- Pterygopalatine Fossa 276
- Maxillary Nerve 276
- Pterygopalatine Ganglion/Sphenopalatine Ganglion/Ganglion of Hay Fever/Meckel's Ganglion 278
- Dissection 279
- Clinical Anatomy 279
- Summary of Pterygopalatine Fossa 279
- ▶ Video 3.15 Nose
- Facts to Remember 280
- Clinicoanatomical Problem 280
- Further Reading 280
- Frequently Asked Questions 281
- Multiple Choice Questions 281
- Viva Voce 281

**16. Larynx**

282

- Introduction 282
- Constitution of Larynx 282
- Dissection 282
- Cartilages of Larynx 283
- Laryngeal Joints 285
- Laryngeal Ligaments and Membranes 285
- Cavity of Larynx 286
- Mucous Membrane of Larynx 286
- Clinical Anatomy 287
- Intrinsic Muscles of Larynx 287
- Clinical Anatomy 290
- Movements of Vocal Folds 291
- Infant's Larynx 291
- Mechanism of Speech 292
- ▶ Video 3.16 Larynx
- Facts to Remember 292
- Clinicoanatomical Problem 292
- Further Reading 293
- Frequently Asked Questions 293
- Multiple Choice Questions 293
- Viva Voce 294

**17. Tongue**

295

- Introduction 295
- Dissection 295
- Parts of Tongue 295
- Clinical Anatomy 296
- Papillae of the Tongue 296
- Muscles of the Tongue 297
- Hypoglossal Nerve—XII Nerve 299
- Clinical Anatomy 299
- Histology 300
- Development of Tongue 301
- Taste Pathway 302
- Clinical Anatomy 302
- ▶ Video 3.17 Tongue
- Facts to Remember 302
- Clinicoanatomical Problem 303
- Further Reading 303
- Frequently Asked Questions 303

Multiple Choice Questions 303  
Viva Voce 304

## 18. Ear 305

Introduction 305  
External Ear 305  
Auricle/Pinna 306  
External Acoustic Meatus 306  
Dissection 307  
Tympanic Membrane 307  
Clinical Anatomy 309  
Middle Ear 310  
Dissection 310  
Functions of Middle Ear 314  
Tympanic or Mastoid Antrum 314  
Dissection 315  
Clinical Anatomy 315  
Internal Ear 316  
Bony Labyrinth 316  
Membranous Labyrinth 317  
Vestibulocochlear Nerve 319  
Clinical Anatomy 319  
Development 320  
Molecular Regulation 320  
Reasons of Earache 320  
Video 3.18 Ear  
Mnemonics 320  
Facts to Remember 320  
Clinicoanatomical Problem 321  
Further Reading 321  
Noise Pollution 321  
Frequently Asked Questions 322  
Multiple Choice Questions 322  
Viva Voce 322

## 19. Eyeball 323

Introduction 323  
Outer Coat 324  
Sclera 324  
Dissection 325  
Cornea 325  
Dissection 325  
Clinical Anatomy 325  
Middle Coat 326  
Choroid 326  
Ciliary Body 326  
Iris 327  
Clinical Anatomy 327  
Inner Coat/Retina 328  
Clinical Anatomy 328  
Aqueous Humour 329  
Clinical Anatomy 329  
Lens 329  
Dissection 330  
Clinical Anatomy 330  
Vitreous Body 331  
Development 331  
Molecular Regulation 331

Video 3.19 Eyeball  
Facts to Remember 331  
Clinicoanatomical Problem 331  
Further Reading 331  
Frequently Asked Questions 332  
Multiple Choice Questions 332  
Viva Voce 332

## 20. Surface Marking and Radiological Anatomy 333

Introduction 333  
Surface Landmarks 333  
Landmarks on the Face 333  
Landmarks of the Lateral Side of the Head 334  
Landmarks on the Side of the Neck 335  
Landmarks on the Anterior Aspect of the Neck 336  
Other Important Landmarks 337  
Surface Marking of Various Structures 337  
Arteries 337  
Veins/Sinuses 338  
Nerves 339  
Glands 341  
Paranasal Sinuses 342  
Radiological Anatomy 342  
Lateral View of Skull (Plain Skiagram) 342  
Special PA View of Skull for Paranasal Sinuses 344  
Carotid Angiogram 344  
Further Reading 344

## Appendix: Parasympathetic Ganglia, Arteries, Pharyngeal Arches and Clinical Terms 345

Introduction 345  
Cervical Plexus 345  
Phrenic Nerve 345  
Sympathetic Trunk 345  
Parasympathetic Ganglia 345  
Submandibular Ganglion 345  
Pterygopalatine Ganglion 346  
Otic Ganglion 347  
Ciliary Ganglion 348  
Arteries of Head and Neck 349  
Pharyngeal Apparatus 351  
Structures Derived from Components of Pharyngeal Arches 351  
Derivatives of Endodermal Pouches 351  
Derivatives of Ectodermal Clefts 351  
Molecular Regulation of Pharyngeal Arches 352  
Clinical Terms 352

Early Clinical Exposure (ECE) Cases 354

Spots on Head and Neck 355

Answers: Spots on Head and Neck 356

Index 357

# Ethical Aspects of Cadaveric Dissection

The cadaver, the dead body, that we dissect, plays an important role in the teaching of anatomy to medical students. The cadaver and the bones become an important part of our life as medical students as some academics have even referred to the cadaver as the 'first teacher' in the medical school.

We must pay due respect to the cadavers and bones kept in the dissection hall or museum. In some medical schools it is mandatory to take an 'oath' before beginning the cadaveric dissection which aims to uphold the dignity of the mortal remains of the departed soul while other medical schools help the student to undertake dissection in a proper manner and empathise with the families of the donor. During the course of dissection the student is constantly reminded of the sanctity of the body he/she is studying so that the noble donation of someone's body is used only as a means of gaining scientific knowledge/progress. Each and every dissected part afterwards is disposed or cremated with full dignity.

Honour of the donor and his/her family is the prime responsibility of the health professional. 'The dead teach the living', and the living pledge to use this knowledge for the upliftment of humankind.

Three-dimensional models and computer simulations cannot replace the tactile appreciation achieved by cadaveric dissection and we should always be grateful to those who have donated their bodies and strive to respect them. We have the privilege to study the human being through a body of a fellow human and have to be humble and carry forward the legacy of nobility and selflessness in our careers.

*(Contributed by Dr Puneet Kaur)*





# Index of Competencies



## Competency based Undergraduate Curriculum for the Indian Medical Graduate

<i>Code</i>	<i>Competency</i>	<i>Chapter</i>	<i>Page no</i>
AN 26.1	Demonstrate anatomical position of skull, Identify and locate individual skull bones in skull	1	4, 50
AN 26.2	Describe the features of norma frontalis, verticalis, occipitalis, lateralis and basalis	1	6
AN 26.3	Describe cranial cavity, its subdivisions, foramina and structures passing through them	1	22
AN 26.4	Describe morphological features of mandible	1	32
AN 26.5	Describe features of typical and atypical cervical vertebrae (atlas and axis)	1	50
AN 26.6	Explain the concept of bones that ossify in membrane	1	56
AN 26.7	Describe the features of the 7th cervical vertebra	1	54
AN 27.1	Describe the layers of scalp, its blood supply, its nerve supply and surgical Importance	2	63
AN 27.2	Describe emissary veins with its role in spread of infection from extracranial route to intracranial venous sinuses	1	5
AN 28.1	Describe and demonstrate muscles of facial expression and their nerve supply	2	68
AN 28.2	Describe sensory innervation of face	2	74
AN 28.3	Describe and demonstrate origin /formation, course, branches /tributaries of facial vessels	2	75
AN 28.4	Describe and demonstrate branches of facial nerve with distribution	2	71
AN 28.5	Describe cervical lymph nodes and lymphatic drainage of head, face and neck	2, 8	66, 171
AN 28.6	Identify superficial muscles of face, their nerve supply and actions	2	68
AN 28.7	Explain the anatomical basis of facial nerve palsy	2	71
AN 28.8	Explain surgical importance of deep facial vein	2	76
AN 28.9	Describe and demonstrate the parts, borders, surfaces, contents, relations and nerve supply of parotid gland with course of its duct and surgical importance	5	114
AN 28.10	Explain the anatomical basis of Frey's syndrome	5	119
AN 29.1	Describe and demonstrate attachments, nerve supply, relations and actions of sternocleidomastoid	3	90
AN 29.2	Explain anatomical basis of Erb's and Klumpke's palsy	4 (vol 1)	64, 65
AN 29.3	Explain anatomical basis of wry neck	3	91
AN 29.4	Describe and demonstrate attachments of: 1) inferior belly of omohyoid 2)scalenus anterior 3) scalenus medius 4) levator scapulae	3 9, 10	94 186, 197
AN 30.1	Describe the cranial fossae and identify related structures	1, 12	22, 223
AN 30.2	Describe and identify major foramina with structures passing through them	1	27
AN 30.3	Describe and identify dural folds and dural venous sinuses	12	210, 213
AN 30.4	Describe clinical importance of dural venous sinuses	12	213
AN 30.5	Explain effect of pituitary tumours on visual pathway	12	220
AN 31.1	Describe and identify extra ocular muscles of eyeball	13	230
AN 31.2	Describe and demonstrate nerves and vessels in the orbit	13	234, 236
AN 31.3	Describe anatomical basis of Horner's syndrome	8	170
AN 31.4	Enumerate components of lacrimal apparatus	2	79
AN 31.5	Explain the anatomical basis of oculomotor, trochlear and abducent nerve palsies along with strabismus	4 (vol 4)	73

<i>Code</i>	<i>Competency</i>	<i>Chapter</i>	<i>Page no</i>
AN 32.1	Describe boundaries and subdivisions of anterior triangle	4	103
AN 32.2	Describe and demonstrate boundaries and contents of muscular, carotid, digastric and submental triangles	4	104, 105
AN 33.1	Describe and demonstrate extent, boundaries and contents of temporal and infratemporal fossae	6	122
AN 33.2	Describe and demonstrate attachments, direction of fibres, nerve supply and actions of muscles of mastication	6	123
AN 33.3	Describe and demonstrate articulating surface, type and movements of temporomandibular joint	6	129
AN 33.4	Explain the clinical significance of pterygoid venous plexus	6	129
AN 33.5	Describe the features of dislocation of temporomandibular joint	6	132
AN 34.1	Describe and demonstrate the morphology, relations and nerve supply of submandibular salivary gland and submandibular ganglion	7	143
AN 34.2	Describe the basis of formation of submandibular stones	7	146
AN 35.1	Describe the parts, extent, attachments, modifications of deep cervical fascia	3	86
AN 35.2	Describe and demonstrate location, parts, borders, surfaces, relations and blood supply of thyroid gland	8	151
AN 35.3	Demonstrate and describe the origin, parts, course and branches subclavian artery	8	160
AN 35.4	Describe and demonstrate origin, course, relations, tributaries and termination of internal jugular and brachiocephalic veins	8	166
AN 35.5	Describe and demonstrate extent, drainage and applied anatomy of cervical lymph nodes	8	171
AN 35.6	Describe and demonstrate the extent, formation, relation and branches of cervical sympathetic chain	8	169
AN 35.7	Describe the course and branches of IX, X, XI and XII nerve in the neck	8	167
AN 35.8	Describe the anatomically relevant clinical features of thyroid swellings	8	155
AN 35.9	Describe the clinical features of compression of subclavian artery and lower trunk of brachial plexus by cervical rib	8	165
AN 35.10	Describe the fascial spaces of neck	3	90
AN 36.1	Describe the 1) morphology, relations, blood supply and applied anatomy of palatine tonsil 2) composition of soft palate	14	249, 256
AN 36.2	Describe the components and functions of Waldeyer's lymphatic ring	14	255
AN 36.3	Describe the boundaries and clinical significance of pyriform fossa	16	287
AN 36.4	Describe the anatomical basis of tonsillitis, tonsillectomy, adenoids and peri-tonsillar abscess	14	257
AN 36.5	Describe the clinical significance of Killian's dehiscence	14	261
AN 37.1	Describe and demonstrate features of nasal septum, lateral wall of nose, their blood supply and nerve supply	15	268
AN 37.2	Describe location and functional anatomy of paranasal sinuses	15	273
AN 37.3	Describe anatomical basis of sinusitis and maxillary sinus tumours	15	275
AN 38.1	Describe the morphology, identify structure of the wall, nerve supply, blood supply and actions of intrinsic and extrinsic muscles of the larynx	16	282
AN 38.2	Describe the anatomical aspects of laryngitis	16	287
AN 38.3	Describe anatomical basis of recurrent laryngeal nerve injury	16	290
AN 39.1	Describe and demonstrate the morphology, nerve supply, embryological basis of nerve supply, blood supply, lymphatic drainage and actions of extrinsic and intrinsic muscles of tongue	17	297
AN 39.2	Explain the anatomical basis of hypoglossal nerve palsy	17	299
AN 40.1	Describe and identify the parts, blood supply and nerve supply of external ear	18	305
AN 40.2	Describe and demonstrate the boundaries, contents, relations and functional anatomy of middle ear and auditory tube	14, 18	263, 311

<i>Code</i>	<i>Competency</i>	<i>Chapter</i>	<i>Page no</i>
AN 40.3	Describe the features of internal ear	18	316
AN 40.4	Explain anatomical basis of otitis externa and otitis media	18	315
AN 40.5	Explain anatomical basis of myringotomy	18	309
AN 41.1	Describe and demonstrate parts and layers of eyeball	19	323
AN 41.2	Describe the anatomical aspects of cataract, glaucoma and central retinal artery occlusion	19	329, 330
AN 41.3	Describe the position, nerve supply and actions of intraocular muscles	19	326
AN 42.1	Describe the contents of the vertebral canal	11	203
AN 42.2	Describe and demonstrate the boundaries and contents of suboccipital triangle	10	198
AN 42.3	Describe the position, direction of fibres, relations, nerve supply, actions of semispinalis capitis and splenius capitis	10	195
AN 43.1	Describe and demonstrate the movements with muscles producing the movements of atlantooccipital joint and atlantoaxial joint	9	183
AN 43.2	Identify, describe and draw the microanatomy of pituitary gland, thyroid, parathyroid gland, tongue, salivary glands, tonsil, epiglottis, cornea, retina	8, 12, 14, 17, 19	156, 219, 257, 296, 325, 328
AN 43.3	Identify, describe and draw microanatomy of sclero-corneal junction, cochlea- organ of corti	18, 19	318, 326
AN 43.4	Describe the development and developmental basis of congenital anomalies of face, palate, tongue, branchial apparatus, pituitary gland, thyroid gland and eye	2, 8, 12, 14, 17, 19	80, 156, 219, 253, 301, 331
AN 43.5	Demonstrate: 1) Testing of muscles of facial expression, extraocular muscles, muscles of mastication 2) Palpation of carotid arteries, facial artery, superficial temporal artery 3) Location of internal and external jugular veins 4) Location of hyoid bone, thyroid cartilage and cricoid cartilage with their vertebral levels	2, 20	73, 333
AN 43.6	Demonstrate surface projection of: Thyroid gland, parotid gland and duct, pterion, common carotid artery, internal jugular vein, subclavian vein, External jugular vein, facial artery in the face and accessory nerve	20	337
AN 43.7	Identify the anatomical structures in: 1) Plain X-ray skull 2) AP view and lateral view 3) Plain X-ray cervical spine-AP and lateral view 4) Plain xray of paranasal sinuses	20	342
AN 43.8	Describe the anatomical route used for carotid angiogram	20	344
AN 43.9	Identify anatomical structures in carotid angiogram and vertebral angiogram	20	344



Competency-Based  
**BD Chaurasia's**  
**Human Anatomy**

Regional and Applied | Dissection and Clinical

Ninth  
Edition

Volume  
**4**

- Volume 1 UPPER LIMB and THORAX
- Volume 2 LOWER LIMB, ABDOMEN and PELVIS
- Volume 3 HEAD and NECK
- Volume 4 BRAIN-NEUROANATOMY

Widely acclaimed as a standard textbook in view of its simple language, comprehensive coverage, lucid presentation and neatly-drawn line diagrams, **BD Chaurasia's Human Anatomy** remains the most preferred textbook in India and abroad. This edition has been thoroughly revised and updated to make it extremely informative and much more student-friendly.

The ninth edition now features diagrams adapted from the first edition, originally prepared by Dr BD Chaurasia, which have been suitably redrawn, modified and colored appropriately. Many text chapters have citations to videos of osteology and soft parts which are accessible through CBSiCentral App. Clinically oriented FAQs and MCQs, and ECE cases have been included to make the volumes absolutely clinical in nature.

**Salient features of the four volumes**

- Text follows the **CBME Guidelines** and all topics are described as per the **Competency Based Undergraduate Curriculum for the Indian Medical Graduate** prescribed by the National Medical Commission.
- **Colour codes** used consistently in the drawings of various cells, tissues and organs are given at the beginning of each section.
- Impressive **line diagrams**, originally hand-drawn by Dr BD Chaurasia, adapted from the first edition of *BDC Human Anatomy*, have been incorporated in this edition to make drawing of illustrations easier for the students.
- **Videos of osteology and soft parts**, accessible from CBSiCentral App through scratch code, have been numbered and cited in the respective chapters in all the four volumes. The App also includes answers to FAQs.
- **Latest updates** on various topics have been provided from standard international publications.
- **Clinical orientation** has been enthused by structuring many FAQs and MCQs in 'clinical mode'. **Early Clinical Exposure (ECE)** has been provided in the form of signs, symptoms, investigations and treatment of a particular case.
- Important features like **viva voce questions, molecular regulation, clinicoanatomical problems, ossification, dissection (steps)** are continued from the previous editions.
- **This volume features**  
 Tables 23, Flowcharts 9, Illustrations 210, Dissection boxes 5, X-rays 16, Clinical Anatomy boxes 41, Facts to Remember 67, FAQs 52, MCQs 72, Viva Voce questions 125, Videos 9, Clinicoanatomical Problems 14.

*Chief Editor*

**Krishna Garg** MBBS, MS, PhD, FIMSA, FIAMS, FAMS, FASI is ex-Professor and Head, Department of Anatomy, Lady Hardinge Medical College (LHMC), New Delhi. She joined LHMC where she completed her MS and PhD and taught anatomy till her retirement. She has received fellowships of the Indian Medical Association, Academy of Medical Specialists, and the International Medical Science Academy. She was elected fellow of the Academy of Medical Sciences (FAMS) in 2005. She was honoured with Excellence Award in Anatomy in 2004 by Delhi Medical Association. She has received Life Time Achievement Award, Fellowship of Anatomical Society of India, and DMA Distinguished Services Award, in 2015. She is visiting faculty of DNB, MDS and a PhD examiner.

She is author of *Manual of Human Anatomy Dissection, Companion Pocketbook—BDC Human Anatomy (Vols 1–3)* and *BDC Human Anatomy for Dental Students 3/e*; coauthor of *Textbook of Histology 5/e, Textbook of Neuroanatomy 6/e, Anatomy and Physiology for Nurses, Anatomy and Physiology for Allied Health Sciences, Practical Anatomy Workbook, Practical Histology Workbook and Practical Anatomy Workbook for Dental Students*; and editor of *Human Embryology 2/e, Handbook of General Anatomy 6/e* and *BD Chaurasia's Applied Anatomy and Physiology for BSc Nursing Students*.

*Editors*

**PS Mittal** MBBS, MS is Professor, Department of Anatomy, Government Institute of Medical Sciences, Greater Noida, UP.

**Mrudula Chandrupatla** MBBS, MD is Additional Professor and Head, Department of Anatomy, and Associate Dean (Research), All India Institute of Medical Sciences, Bibinagar, Hyderabad, Telangana.



**CBS Publishers & Distributors Pvt Ltd**  
 4819/XI, Prahlad Street, 24 Ansari Road, Daryaganj, New Delhi 110 002, India  
 E-mail: delhi@cbspd.com, customercare@cbspd.com; Website: www.cbspd.com  
 New Delhi | Bengaluru | Chennai | Kochi | Kolkata | Lucknow | Mumbai  
 Hyderabad | Jharkhand | Nagpur | Patna | Pune | Uttarakhnad



Scan for the price of this book and catalogue

Set ISBN for Volumes 3 and 4

ISBN: 978-93-5466-477-9



Volume  
**4**

Competency-Based  
**Chaurasia's**  
**Human Anatomy**

Ninth  
Edition



Competency-Based  
**BD Chaurasia's**

**Human Anatomy**

Regional and Applied | Dissection and Clinical

As per the CBME Guidelines | Competency Based Undergraduate Curriculum for the Indian Medical Graduate

**Brain-Neuroanatomy**

Ninth  
Edition

Volume  
**4**

Scratch Code on Inside Front Cover for Accessing CBSiCentral App



Volumes  
3 & 4  
sold together  
as one set

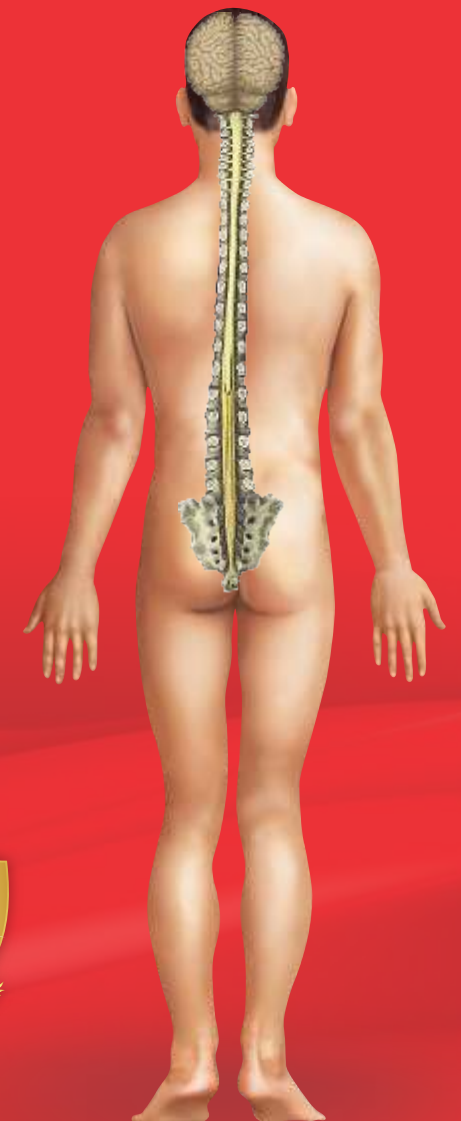
Available Free on CBSiCentral App

- Original Images from First Edition of BDC Human Anatomy (Vols 1–3) hand-drawn by Dr BD Chaurasia
- Videos on Osteology and Soft Parts
- Frequently Asked Questions & Answers

Wall Chart on  
Brain-Neuroanatomy



Many easily reproducible diagrams, originally hand-drawn by Dr BD Chaurasia, now modified and coloured suitably, are given at the relevant locations in the text



Dedicated to Education

**CBS Publishers & Distributors Pvt Ltd**



**Ninth Edition**

Volume



**4**

*Competency-Based*

**BD Chaurasia's**

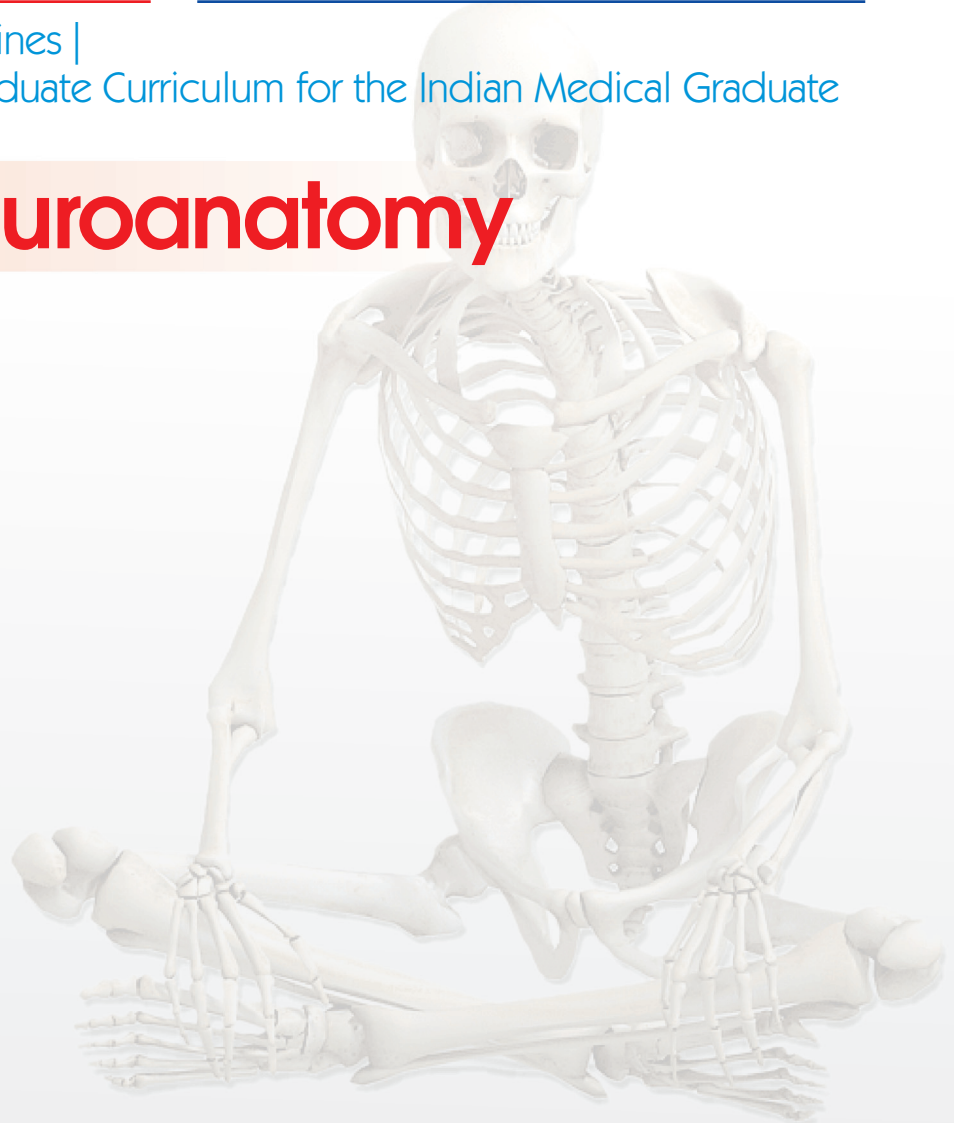
# **Human Anatomy**

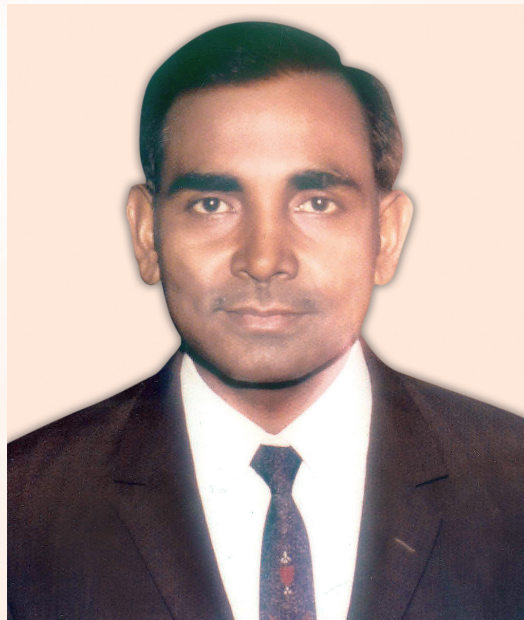
**Regional and Applied   Dissection and Clinical**

As per the latest CBME Guidelines |  
Competency based Undergraduate Curriculum for the Indian Medical Graduate



**Brain-Neuroanatomy**





**Dr BD Chaurasia** (1937–1985)

was Reader in Anatomy at GR Medical College, Gwalior.

He received his MBBS in 1960, MS in 1965 and PhD in 1975.

He was elected fellow of National Academy of Medical Sciences (India) in 1982.

He was a member of the Advisory Board of the *Acta Anatomica* since 1981,

member of the editorial board of *Bionature*, and in addition

member of a number of scientific societies.

He had a large number of research papers to his credit.

**Ninth Edition**

**Volume**



**4**

*Competency-Based*

**BD Chaurasia's**

# **Human Anatomy**

**Regional and Applied Dissection and Clinical**

As per the latest CBME Guidelines |  
Competency based Undergraduate Curriculum for the Indian Medical Graduate



## **Brain-Neuroanatomy**

*Chief Editor*

**Krishna Garg**

MBBS MS PhD FIMSA FIAMS FAMS FASI

Legend of Anatomy; Nation's Who's Who  
Fellow, Anatomical Society of India  
Lifetime Achievement Awardee  
DMA Distinguished Service Awardee

Ex-Professor and Head, Department of Anatomy  
Lady Hardinge Medical College, New Delhi

*Editors*

**Mrudula Chandrupatla** MBBS MD

Additional Professor and Head, Department of Anatomy  
All India Institute of Medical Sciences  
Bibinagar, Hyderabad, Telangana

**Pragati Sheel Mittal** MBBS MS

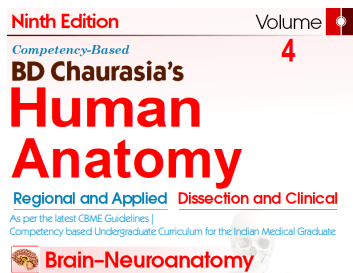
Professor, Department of Anatomy  
Government Institute of Medical Sciences  
Greater Noida, UP



**CBSPD**

**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 editors 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 editors will not be held responsible for any inadvertent errors, omissions or inaccuracies.

**ISBN:** 978-93-5466-477-9

Copyright © Publisher and author

**Ninth Edition:** 2023

First Edition: 1979

Reprint: 1980, 1981, 1982, 1983, 1984, 1985, 1986, 1987, 1988

Second Edition: 1989

Reprint: 1990, 1991, 1992, 1993, 1994

Third Edition: 1995

Reprint: 1996, 1997, 1998, 1999, 2000, 2001, 2002, 2003, 2004

Fourth Edition: 2004

Reprint: 2005, 2006, 2007, 2008, 2009

Fifth Edition: 2010

Reprint: 2011, 2012

Sixth Edition: 2013

Reprint: 2014, 2015

Seventh Edition: 2016

Reprint: 2017, 2018, 2019

Eighth Edition: 2020

Reprint: 2021, 2022

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 author, editors 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

Fax: 011-23243014

Website: www.cbspd.com

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: +033-256330055/56 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 Thomson Press (India) Ltd., Delhi, India



to

*my teacher*

*Shri Uma Shankar Nagayach*

— BD Chaurasia





Volume

1

UPPER LIMB and THORAX

Volume

2

LOWER LIMB, ABDOMEN and PELVIS

Volume

3

HEAD and NECK

Volume

4

BRAIN-NEUROANATOMY



*This human anatomy is not systemic but regional  
Oh yes, it is theoretical as well as practical  
Besides the gross features, it is chiefly clinical  
Clinical too is very much diagrammatical.*

*Lots of tables for the muscles are provided  
Even methods for testing are incorporated  
Improved colour illustrations are added  
So that right half of brain gets stimulated*

*Tables for muscles acting on joints are given  
Tables for branches of nerves and arteries are given  
Hope these volumes turn highly useful  
Editors' hardwork under Almighty's guidance prove fruitful*

# Preface to the Ninth Edition

This edition features a number of significant modifications which we have made in the light of the wide-ranging suggestions that we received in the recent months from students, teachers and also the well-wishers of this epic textbook. As the information explodes and knowledge multiplies, appropriate improvements, additions and changes are also required to be made in the contemporary literature. Latest research information sourced from the standard international publications has been selectively incorporated in these volumes.

Numerous unique line diagrams, originally hand-drawn by late Dr BD Chaurasia and used in the first edition of the book, after thoughtful moderation, have now been incorporated in the ninth edition. Our criteria for the selection and manipulation of these drawings were clearly based on the simplicity and lucidity of the anatomic description. These simply structured illustrations can be easily reproduced by the students in multitudes of tests and examinations, including university examinations.

Diagrams form the foundation of anatomy: The drawings create imprints on the brain. Figures, artwork and the dissection are recorded in the right half of the cerebrum while the text is learnt by using left half of cerebrum. Thus, learning by drawing diagrams and steps of dissection help in using both the halves of cerebrum, which is an ideal condition. This textbook lays stress on understanding anatomic structures and details through clear, neat and crisp diagrams.

Earlier, videos of the dissection of all regions had been given free access to the readers on [CBSiCentral App](#). These videos are now uploaded on the App after reorganization of the sequences, numeration and providing appropriate citations in the text. Readers can register on the App and access the enumerated videos through the scratch code given on the inside front cover of each volume. These videos adequately compensate the scarcity of the cadavers in medical institutions for conducting dissection.

The videos of the dissection give three-dimensional image descriptions of tissues and organs which get effectively registered in brain for a longer time.

Processes and steps of dissection given in blue boxes with dissection photographs have been retained as many students and teachers appreciate the same. However, no addition in dissection photographs has been made as a separate CBSPD publication *Manual of Human Anatomy Dissection* (ISBN: 978-93-89688-00-9) with numerous dissection photographs is available to the readers who aspire to learn and enjoy the dissection in a meticulous manner.

We have incorporated all the competencies prescribed by National Medical Commission under the [Competency Based Curriculum for the Indian Medical Graduate](#) for spirited implementation of [Competency Based Medical Education Guidelines](#).

Since National Medical Commission has laid stress on teaching and learning clinical aspects from the very beginning of the MBBS study period, the questions asked are mostly clinical. [Clinical aspects](#) have been explicitly given in the text such that the students are able to learn, recapitulate and answer the clinically-oriented questions in their examinations.

As NMC curriculum also lays emphasis on [Early Clinical Exposure](#), crisply written and well-presented [ECE Cases](#) have been given at the end of every section, which make the book clinical-savvy. These case studies will help the budding doctors in imbibing the salient clinical features, getting appropriate investigations done, and treating the patients satisfactorily once they are in clinical practice.

All the illustrations in the four volumes of this book have been prepared on a common colour scheme applicable to cells, tissues and organs. Colour codes employed in the preparation of the human anatomy illustrations are given in the beginning of each section. This characteristic feature will help the students in identifying the anatomic components clearly and draw appropriately coloured diagram in a schematic manner.

Extensive research by numerous scientists has decoded the molecular control of development of organ tissues of the body. Basics of this molecular control are given briefly in these volumes.

We have continued with the practice of giving one separate **wall chart** in each volume for easy comprehension of the topics.

Sincere attempt has been made to present all facets of theory and practical anatomy to make these volumes truly holistic. In addition to the descriptive text, the following rich features lend a high pedestal to the book in the context of the international literature.

	<i>Volume 1</i>	<i>Volume 2</i>	<i>Volume 3</i>	<i>Volume 4</i>	<i>Total</i>
Figures	414	653	462	210	1739
Flowcharts	7	4	12	9	32
Dissection Boxes	37	36	12	5	90
X-rays/MRI and CT Scans	5	5	4	16	30
Ossification Boxes	13	12	14	–	39
Tables	43	52	33	23	151
Clinical Anatomy Boxes	52	101	77	41	271
Mnemonics Boxes	22	15	8	4	49
Facts to Remember	93	229	114	67	503
FAQs	99	132	104	52	387
MCQs	149	232	135	72	588
Viva Voce Questions	259	508	227	125	1119
Clinicoanatomical Problems	19	35	20	14	88
Videos	47	50	32	9	138

Chief Editor

**Krishna Garg**

email: [dr.krishnagarg@gmail.com](mailto:dr.krishnagarg@gmail.com)

Editors

**Pragati Sheel Mittal**  
**Mrudula Chandrupatla**

# Preface to the First Edition (excerpts)



The necessity of having a simple, systematized and complete book on anatomy has long been felt. The urgency for such a book has become all the more acute due to the shorter time now available for teaching anatomy, and also to the falling standards of English language in the majority of our students in India. The national symposium on 'Anatomy in Medical Education' held at Delhi in 1978 was a call to change the existing system of teaching the unnecessary minute details to the undergraduate students.

This attempt has been made with an object to meet the requirements of a common medical student. The text has been arranged in small classified parts to make it easier for the students to remember and recall it at will. It is adequately illustrated with simple line diagrams which can be reproduced without any difficulty, and which also help in understanding and memorizing the anatomical facts that appear to defy memory of a common student. The monotony of describing the individual muscles separately, one after the other, has been minimised by writing them out in tabular form, which makes the subject interesting for a lasting memory. The relevant radiological and surface anatomy have been treated in separate chapters. A sincere attempt has been made to deal, wherever required, the clinical applications of the subject. The entire approach is such as to attract and inspire the students for a deeper dive in the subject of anatomy.

The book has been intentionally split in three parts for convenience of handling. This also makes a provision for those who cannot afford to have the whole book at a time.

It is quite possible that there are errors of omission and commission in this mostly single-handed attempt. I would be grateful to the readers for their suggestions to improve the book from all angles.

I am very grateful to my teachers and the authors of numerous publications, whose knowledge has been freely utilised in the preparation of this book. I am equally grateful to my professor and colleagues for their encouragement and valuable help. My special thanks are due to my students who made me feel their difficulties, which was a great incentive for writing this book. I have derived maximum inspiration from Prof. Inderbir Singh (Rohtak), and learned the decency of work from Shri SC Gupta (Jiwaji University, Gwalior).

I am deeply indebted to Shri KM Singhal (National Book House, Gwalior) and Mr SK Jain (CBS Publishers & Distributors, Delhi), who have taken unusual pains to get the book printed in its present form. For giving it the desired get-up, Mr VK Jain and Raj Kamal Electric Press are gratefully acknowledged. The cover page was designed by Mr Vasant Paranjpe, the artist and photographer of our college; my sincere thanks are due to him. I acknowledge with affection the domestic assistance of Munne Miyan and the untiring company of my Rani, particularly during the odd hours of this work.

**BD Chaurasia**



# Acknowledgements

The editors are thankful to Dr SN Kazi (Pune) for providing maximum updates from Gray's Anatomy, 42nd Edition.

Dr Vikas Verma (Lucknow) revised the chapters on Joints and Nerves of Limbs and gave very useful inputs. Dr Tripta Bhagat (Ghaziabad) edited clinical anatomy portions of the volumes.

We have the blessings and good wishes of Prof NA Faruqi (Aligarh); Dr DC Naik (Rewa); Dr SD Joshi and Dr SS Joshi (Indore); Dr (Brig) Rakesh Gupta (Greater Noida); Dr DR Singh (Lucknow); Dr M Kaul; Dr C Anand and Dr I Bahl (Delhi); Dr Mohsin Azmi (Kanpur); Dr Medha Joshi (Ghaziabad); Dr Surbhi Gupta (Delhi); and Dr Nitin Nagarkar (Raipur).

We are thankful to Dr Surjit Ghatak (Jodhpur); Dr Vinay Sharma (Muzzafarnagar); Dr Deepu Singh Kataria and Dr Anup Singh Gurjar (Pali); Dr Jagmohan Sharma; Dr Deepak Sharma; Dr Rajesh Arora and Dr Pooja Garg (Jaipur); Dr Sumit Gupta (Kota); Dr Gopal Sharma and Dr Manoj Sharma (Jhalawar); Dr Rekha Parashar (Chittorgarh); Dr Santosh Kumar (Dholpur); Dr BK Aghera (Sirohi), Dr Isha Srivastav; Dr Aprajita Raizada; Dr Sajan Skaria; Dr Anjali Jain and Dr Kalpana Sharma (Udaipur); for giving feedback for various sections of the volumes.

We are grateful to Dr Hitant Vohra and Dr Anu Sharma (Ludhiana); Dr Anupma Mahajan (Amritsar); Dr Vanita Gupta (Jammu), for editing chapters to enhance the value of the volumes.

We are grateful to Dr Ravikant (Amritsar); Dr Sangeeta and Dr Nusrat Jabeen (Jammu); Dr Kalyan Singh and Dr Rajan Singla (Patiala); Dr Anjali Jain and Dr Aprajita Sikka (Ludhiana); Dr Bashir (Srinagar); Dr Seema and Dr Ritu (Rajouri); Dr Mubeen (Kathua); Dr RK Srivastava (Kanpur); Dr Punita Manik (Lucknow); Dr Binod Kumar; Dr Sunita Nayak and Dr Shambhu Prasad (Patna); Dr AK Dubey (Ranchi); Dr Satyam Khare; Dr Shilpi Jain and Dr Alok Tripathi (Meerut), for promoting the volumes.

We have been getting constant encouragement and support from Dr Ranjana Verma, Dr Muthukrishnan P, Dr Yogesh Yadav, Dr Pullimi Vineel and Dr Anupma Gupta (Greater Noida); Dr Nisha Kaul (Ghaziabad); Dr Vinay Singhal (Saharanpur); Dr RK Ashoka (Mathura); Dr Vineet Guha (Khandwa); Dr Manisha Sinha (Raipur); Dr Jahan Shirin (Kanpur); Dr Damyanti (Manipur); Dr Daisy Sahni (Chandigarh); and Dr MK Anand (Bhuj).

Our regards and affection to Dr Rewa Choudhry, Dr Shilpa Paul, Dr Smita Kakar, Dr Anita Tuli, Dr Gayatri Rath, Dr Shashi Raheja, Dr Shyama Rajdan, Dr Mangala Kohli, Dr A Sheriff, Dr SB Ray, Dr Vandana Mehta, Dr Sabita Mishra, Dr Renu Chauhan, Dr Jyoti Arora, Dr Sneh Aggarwal and Dr TS Roy (Delhi), for going through the volumes.

We would like to thank Dr Pritha Bhuiyan (Mumbai); Dr Brijendra Singh (Rishikesh); Col. Dr Sushil Kumar (Pune); Dr AK Srivastava (Lucknow); Dr MK Pant (Dehradun); Dr Shakuntala Pai (Manipal); Dr Simmi Mehra (Rajkot); Dr Fatima M De Souza (Goa); Dr Mukesh Mittal (Shivpuri); Dr Priti Sinha (Saharanpur); Dr Rakesh K Verma (Lucknow); Dr Rashmi Malhotra (Rishikesh); Dr Sandiya Kurup (Kalanchery); Dr Simmi Soni (Aziznagar); Dr Sunita Gupta (Ahmedabad) and many-many other teachers all over the globe, for giving us good wishes.

Videos of bones and soft parts of human body, prepared at Kathmandu University School of Medical Sciences, have now been added with the respective chapters and are available at our mobile App [CBSiCentral](#). I (chief editor) am grateful to Dr R Koju, CEO of KUSMS and Dhulikhel Hospital, for his generosity.

The moral support of my (chief editor) family members, Late Dr DP Garg, Dr Suvira Gupta, Dr JP Gupta, Mr Manoj, Ms Rekha, Mr Sanjay, Ms Meenakshi, Dr Manish, Dr Shilpa Garg, Dr Naveen Garg, Dr Manoj, Dr Nalini Shukla, Dr Vikas Verma and Dr Swati Gupta, is appreciated.



The magnanimity shown by Mr SK Jain (Chairman) and Mr Varun Jain (Director), CBS Publishers & Distributors, has been always forthcoming. The unquestionable support of Mr YN Arjuna (Senior Vice President—Publishing, Editorial and Publicity) and his entire team comprising Ms Ritu Chawla (GM—Production), Mr Sanjay Chauhan, Mr Neeraj Prasad and Mr Rohan Prasad (Graphic Artists); Mr Surendra Jha and Mr Prasenjit Paul (Copy Editors); Ms Jyoti Kaur and Mr Tarun Rajput (DTP Operators) has made an excellent contribution to bring out this edition. We are really obliged to them and pray for their prosperity.

*Chief Editor*

**Krishna Garg**

email: [dr.krishnagarg@gmail.com](mailto:dr.krishnagarg@gmail.com)

*Editors*

**Pragati Sheel Mittal**  
**Mrudula Chandrupatla**

## *Thus spoke the cadaver*

*Handle me with little love and care  
As I had missed it in my life affair  
Was too poor for cremation or burial  
That is why am lying in dissection hall*

*You dissect me, cut me, section me  
But your learning anatomy should be precise  
Worry not, you would not be taken to court  
As I am happy to be with the bright lot*

*Couldn't dream of a fridge for cold water  
Now my body parts are kept in refrigerator  
Young students sit around me with friends  
A few dissect, rest talk, about food, family and movies  
How I enjoy the dissection periods  
Don't you? Unless you are interrogated by a teacher*

*When my parts are buried post-dissection  
Bones are taken out for the skeleton  
Skeleton is the crown glory of the museum  
Now I am being looked up by great enthusiasm*

*If not as skeletons as loose bones  
I am in their bags and in their hostel rooms  
At times, I am on their beds as well  
Oh, what a promotion to heaven from hell*

*I won't leave you, even if you pass anatomy  
Would follow you in forensic medicine and pathology  
Would be with you even in clinical teaching  
Medicine line is one where dead teach the living*

*One humble request I'd make  
Be sympathetic to persons with disease  
Don't panic, you'll have enough money  
And I bet, you'd be singularly happy*

*—Krishna Garg*



# Contents



<i>Preface to the Ninth Edition</i>	vii
<i>Preface to the First Edition (excerpts)</i>	ix
<i>Index of Competencies</i>	xviii
<i>Glossary</i>	xix

## 1. Introduction 3

Divisions of Nervous System 3
Anatomical 3
Functional 3
Cellular Architecture 4
Neuron 4
Synapse 6
Neuroglial Cells 6
Grey Matter and White Matter 7
Reflex Arc 7
Parts of the Nervous System 8
Central Nervous System 8
Components of Central Nervous System 8
Peripheral Nervous System 9
Clinical Anatomy 10
Receptors 10
Sensory Afferent Receptors 10
Motor Efferent Endings 12
Functional Classification 13
Clinical Anatomy 13
Development of Brain 13
Neural Tube 13
Parts of Brain 18
Molecular Regulation of Development of Spinal Cord and Brain 19
Spinal Cord 19
Clinical Anatomy 19
Gross Study of Brain 20
Facts to Remember 23
Clinicoanatomical Problem 23
Further Reading 23
Frequently Asked Questions 23
Multiple Choice Questions 23
Viva Voce 24

## 2. Meninges of the Brain and Cerebrospinal Fluid 25

Introduction 25
The Meninges 25
Dura Mater 25
Dissection 25
Arachnoid Mater 26
Pia Mater 28
Extradural (Epidural) and Subdural Spaces 28
Subarachnoid Space 28
Cisterns 28
Clinical Anatomy 30
Cerebrospinal Fluid (CSF) 30
Clinical Anatomy 31

Mnemonics 32
Facts to Remember 32
Clinicoanatomical Problem 32
Further Reading 32
Frequently Asked Questions 33
Multiple Choice Questions 33
Viva Voce 33

## 3. Spinal Cord 34

Introduction 34
Dissection 34
Meningeal Coverings 35
Cauda Equina 36
External Features of Spinal Cord 36
Internal Structure 36
Clinical Anatomy 36
Spinal Nerves 38
Spinal Segment 38
Nuclei of Spinal Cord 38
Nuclei in Anterior Grey Column or Horn 39
Nuclei in Lateral Grey Column or Horn 40
Nuclei in Posterior Grey Column or Horn 40
Laminar Organisation in Spinal Cord 40
Sensory Receptors 41
Tracts of the Spinal Cord 41
Descending Tracts 41
Pyramidal or Corticospinal Tracts 41
Extrapyramidal Tracts 42
Ascending Tracts 45
Intersegmental Tracts 49
Clinical Anatomy 49
Facts to Remember 52
Clinicoanatomical Problems 53
Further Reading 53
Frequently Asked Questions 54
Multiple Choice Questions 54
Viva Voce 55

## 4. Cranial Nerves 56

Introduction 56
Features 56
Embryology 56
Functional Components of Cranial Nerves 56
Nuclei 57
General Somatic Efferent (GSE) Nuclei 57
Special Visceral Efferent/Branchial Efferent Nuclei 57
General Visceral Efferent Nuclei 58
General Visceral Afferent Nucleus and Special Visceral Afferent Nucleus 59
General Somatic Afferent Nuclei 61

Special Somatic Afferent Nuclei 61  
 First Cranial Nerve 63  
 Olfactory (Smell) Pathway 63  
**Clinical Anatomy** 63  
 Second Cranial Nerve 64  
 Human Vision 64  
 Optic Pathways 64  
 Reflexes 65  
**Clinical Anatomy** 68  
 Third Cranial Nerve 69  
 Oculomotor Nerve 69  
 Functional Components 69  
 Nucleus 69  
 Course and Distribution 69  
**Clinical Anatomy** 71  
 Fourth Cranial Nerve 71  
 Trochlear Nerve 71  
 Functional Components 71  
 Nucleus 71  
 Course and Distribution 72  
**Clinical Anatomy** 73  
 Sixth Cranial Nerve 73  
 Abducent Nerve 73  
 Functional Components 73  
 Nucleus 73  
 Course and Distribution 73  
**Clinical Anatomy** 73  
 Fifth Cranial Nerve 74  
 Trigeminal Nerve 74  
 Nuclear Columns 74  
 Sensory Components of V Nerve 74  
 Motor Components for Muscles 75  
 Branches of Trigeminal Nerve 75  
 Ophthalmic Nerve Division (Sensory) 76  
 Maxillary Nerve Division (Sensory) 76  
 Mandibular Nerve Division (Sensory and Motor) 77  
**Clinical Anatomy** 77  
 Seventh Cranial Nerve 78  
 Facial Nerve 78  
 Functional Components 78  
 Nuclei 78  
 Course and Relations 78  
 Branches and Distribution 79  
 Ganglia 81  
**Clinical Anatomy** 81  
 Eighth Cranial Nerve 82  
 Vestibulocochlear Nerve 82  
 Pathway of Hearing 82  
 Vestibular Pathway 85  
**Clinical Anatomy** 85  
 Ninth Cranial Nerve 85  
 Glossopharyngeal Nerve 85  
 Functional Components 86  
 Nuclei 87  
 Course and Relations 87  
 Branches and Distribution 88  
**Clinical Anatomy** 89  
 Tenth Cranial Nerve 89  
 Vagus Nerve 89  
 Functional Components 89  
 Nuclei 89  
 Course and Relations in Head and Neck 89  
 Branches in Head and Neck 90  
**Clinical Anatomy** 91  
 Eleventh Cranial Nerve 92  
 Accessory Nerve 92  
 Functional Components 92  
 Nuclei 92

Course and Distribution of the Cranial Root 92  
 Course and Distribution of the Spinal Root 92  
**Clinical Anatomy** 93  
 Twelfth Cranial Nerve 94  
 Hypoglossal Nerve 94  
 Functional Components/Nuclear Columns 94  
 Nucleus 94  
 Course and Relations 94  
 Extracranial Course 94  
 Branches and Distribution 95  
**Clinical Anatomy** 95  
 Foramina for Cranial Nerves and their Branches 96  
 Mnemonics 96  
 Facts to Remember 96  
 Clinicoanatomical Problem 97  
 Further Reading 97  
 Frequently Asked Questions 98  
 Multiple Choice Questions 98  
 Viva Voce 99

## 5. Brainstem

100

Introduction 100  
 Medulla Oblongata 100  
 External Features 100  
 Internal Structure 102  
 Transverse Section through the Lower Part of the Medulla Passing through the Pyramidal Decussation 102  
 Transverse Section through the Middle of Medulla Passing through the Sensory Decussation 103  
 Transverse Section through the Upper Part of Medulla Passing through the Floor of Fourth Ventricle/Open Part 103  
 Blood Supply 106  
**Clinical Anatomy** 106  
 Development 107  
 Pons 107  
 External Features 107  
 Internal Structure 107  
 Tegmentum in the Lower Part of Pons 108  
 Tegmentum in the Upper Part of Pons 108  
 Blood Supply 109  
**Clinical Anatomy** 109  
 Development 110  
 Midbrain 110  
 Subdivisions 110  
 External Features 111  
 Internal Structure 111  
 Transverse Section of Midbrain at the Level of Inferior Colliculi 111  
 Transverse Section of Midbrain at the Level of Superior Colliculi 112  
 Blood Supply 113  
 Medial Longitudinal Bundle 113  
**Clinical Anatomy** 113  
 Development 114  
**Video 4.5 Brainstem**  
 Mnemonics 114  
 Facts to Remember 114  
 Clinicoanatomical Problem 115  
 Further Reading 115  
 Frequently Asked Questions 115  
 Multiple Choice Questions 115  
 Viva Voce 116

**6. Cerebellum**

117

- Introduction 117
- Location 117
- External Features 117
- Parts of Cerebellum 118
- Morphological Divisions of Cerebellum 118
- Functional Divisions of Cerebellum 120
- Connections of Cerebellum 120
- Grey Matter of Cerebellum 121
- Blood Supply 121
- Functions of Cerebellum 121
- Clinical Anatomy 124
- Histological Structure 124
- Development 125
- ▶ **Video 4.6 Cerebellum**
- Facts to Remember 125
- Clinicoanatomical Problem 125
- Further Reading 125
- Frequently Asked Questions 126
- Multiple Choice Questions 126
- Viva Voce 126

**7. Fourth Ventricle**

127

- Introduction 127
- Lateral Boundaries 127
- Floor 127
- Roof 128
- Angles 129
- Cavity and Recesses of Fourth Ventricle 130
- Clinical Anatomy 130
- Facts to Remember 131
- Clinicoanatomical Problem 131
- Further Reading 131
- Frequently Asked Questions 132
- Multiple Choice Questions 132
- Viva Voce 132

**8. Cerebrum, Diencephalon, Basal Nuclei and White Matter**

133

- Cerebrum 133
- Dissection 133
- Features 133
- Cerebral Hemisphere 134
- Lobes of Cerebral Hemisphere 136
- Insula 136
- Sulci and Gyri on Superolateral Surface 137
- Functional or Cortical Areas of Cerebral Cortex 139
- Motor Areas 140
- Clinical Anatomy 142
- Sensory Areas 143
- Clinical Anatomy 143
- Areas of Special Sensations 143
- Clinical Anatomy 144
- Functions of Cerebral Cortex 144
- Human Speech 145
- Clinical Anatomy 145
- Histology of Cerebrum 146
- Diencephalon 147

- Dorsal Part of Diencephalon 147
- Thalamus 147
- Metathalamus (Part of Thalamus) 149
- Clinical Anatomy 151
- Epithalamus 152
- Pineal Body/Pineal Gland 152
- Ventral Part of Diencephalon 152
- Hypothalamus 153
- Functions of Hypothalamus 153
- Clinical Anatomy 154
- Subthalamus 154
- Clinical Anatomy 155
- Basal Nuclei 155
- Corpus Striatum 155
- Dissection 156
- Connections of Corpus Striatum 156
- Amygdaloid Body 157
- Clastrum 157
- Clinical Anatomy 157
- White Matter of Cerebrum 158
- Subdivisions 158
- Association (Arcuate) Fibres 158
- Commissural Fibres 158
- Dissection 159
- Corpus Callosum 159
- Projection Fibres 160
- Corona Radiata 160
- Internal Capsule 161
- Gross Anatomy 161
- Fibres of Internal Capsule 161
- Blood Supply 163
- Clinical Anatomy 163
- Development 163
- ▶ **Video 4.8 Cerebrum**
- Facts to Remember 164
- Clinicoanatomical Problems 164
- Further Reading 165
- Frequently Asked Questions 165
- Multiple Choice Questions 166
- Viva Voce 166

**9. Third Ventricle, Lateral Ventricle and Limbic System**

167

- Introduction 167
- Third Ventricle 167
- Dissection 167
- Clinical Anatomy 168
- Lateral Ventricle 168
- Dissection 168
- Central Part 169
- Anterior Horn 170
- Posterior Horn 171
- Inferior Horn 171
- Limbic System 172
- Clinical Anatomy 175
- ▶ **Video 4.9 Ventricles of Brain**
- Facts to Remember 175
- Clinicoanatomical Problem 175
- Further Reading 175
- Frequently Asked Questions 176
- Multiple Choice Questions 176
- Viva Voce 176



## 10. Some Neural Pathways and Reticular Formation 177

- Introduction 177
- Pyramidal Tract (Corticospinal and Corticonuclear Tracts) 177
- Clinical Anatomy** 178
- Pathway of Pain and Temperature 178
- Pathway of Touch 179
- Pathway of Proprioceptive (Kinaesthetic) Impulses—Position, Movement, Vibration 179
- Taste Pathway 180
- Reticular Formation 180
- Action of Drugs 181
- Facts to Remember** 181
- Frequently Asked Questions** 182
- Multiple Choice Questions** 182
- Viva Voce** 182

## 11. Blood Supply of Spinal Cord and Brain 183

- Introduction 183
- Blood Supply of Spinal Cord 183
- Clinical Anatomy** 184
- Blood Supply of Brain 184
- Arteries of Brain 184
- Vertebral Arteries 184
- Basilar Artery 185
- Clinical Anatomy** 186
- Internal Carotid Artery 187
- Circulus Arteriosus or Circle of Willis 188
- Arterial Supply of Different Areas 190
- Blood–Brain Barrier 191
- Perivascular Spaces 192
- Clinical Anatomy** 192
- Veins of the Brain 192
- Blood Supply of the Brainstem 194
- Clinical Anatomy** 195
- Video 4.11 Blood Supply of Brain**
- Mnemonics 195
- Facts to Remember** 195
- Clinicoanatomical Problems** 195
- Further Reading 196
- Frequently Asked Questions** 196
- Multiple Choice Questions** 196
- Viva Voce** 197

## 12. Investigations of a Neurological Case, Surface and Radiological Anatomy and Evolution of Head 198

- Introduction 198
- Investigations Required in a Neurological Case 198

- Surface Anatomy 199
- Radiological Anatomy of the Brain 200
- Evolution of the Head 200
- Further Reading 202
- Frequently Asked Questions** 202

## 13. Autonomic Nervous System 203

- Introduction 203
- Sympathetic Nervous System:
  - Thoracolumbar Outflow 203
- Parasympathetic Nervous System 206
- Nerve Supply of the Viscera 207
- Afferent Autonomic Fibres 209
- Clinical Anatomy 209
- Comparison of Parasympathetic and Sympathetic Nervous Systems 210
- Development 211
- Viva Voce** 212

## Appendix: Ventricles, Cranial Nerves, Arteries and Clinical Terms 213

- Summary of the Ventricles of the Brain 213
- Lateral Ventricle 213
- Third Ventricle 213
- Fourth Ventricle 213
- Nuclear Components of Cranial Nerves 214
- CN I: Olfactory 214
- CN II: Optic 214
- CN III: Oculomotor 214
- CN IV: Trochlear 214
- CN V: Trigeminal 214
- CN VI: Abducent 214
- CN VII: Facial 214
- CN VIII: Vestibulocochlear 214
- CN IX: Glossopharyngeal 214
- CN X + CN XI: Vagus and Cranial Part of CN XI 214
- CN XI: Spinal Part of Accessory Nerve 214
- CN XII: Hypoglossal 214
- Arteries of Brain 215
- Clinical Terms** 215
- Multiple Choice Questions** 218
- Viva Voce** 218
- Early Clinical Exposure (ECE) Cases** 219
- Spots on Brain** 221
- Answers: Spots on Brain** 222

## Index 223

# Ethical Aspects of Cadaveric Dissection

The cadaver, the dead body, that we dissect, plays an important role in the teaching of anatomy to medical students. The cadaver and the bones become an important part of our life as medical students as some academics have even referred to the cadaver as the 'first teacher' in the medical school.

We must pay due respect to the cadavers and bones kept in the dissection hall or museum. In some medical schools it is mandatory to take an 'oath' before beginning the cadaveric dissection which aims to uphold the dignity of the mortal remains of the departed soul while other medical schools help the student to undertake dissection in a proper manner and empathise with the families of the donor. During the course of dissection the student is constantly reminded of the sanctity of the body he/she is studying so that the noble donation of someone's body is used only as a means of gaining scientific knowledge/progress. Each and every dissected part afterwards is disposed or cremated with full dignity.

Honour of the donor and his/her family is the prime responsibility of the health professional. 'The dead teach the living', and the living pledge to use this knowledge for the upliftment of humankind.

Three-dimensional models and computer simulations cannot replace the tactile appreciation achieved by cadaveric dissection and we should always be grateful to those who have donated their bodies and strive to respect them. We have the privilege to study the human being through a body of a fellow human and have to be humble and carry forward the legacy of nobility and selflessness in our careers.

*(Contributed by Dr Puneet Kaur)*

# Index of Competencies



## Competency based Undergraduate Curriculum for the Indian Medical Graduate

<i>Code</i>	<i>Competency</i>	<i>Chapter</i>	<i>Page no</i>
AN 56.1	Describe and identify various layers of meninges with its extent and modifications	2	25
AN 56.2	Describe circulation of CSF with its applied anatomy	2	30
AN 57.1	Identify external features of spinal cord	3	36
AN 57.2	Describe extent of spinal cord in child and adult with its clinical implication	3	34
AN 57.3	Draw and label transverse section of spinal cord at midcervical and midthoracic level	3	41
AN 57.4	Enumerate ascending and descending tracts at mid thoracic level of spinal cord	3	41
AN 57.5	Describe anatomical basis of syringomyelia	3	49
AN 58.1	Identify external features of medulla oblongata	5	100
AN 58.2	Describe transverse section of medulla oblongata at the level of: 1) pyramidal decussation 2) sensory decussation 3) ION	5	102
AN 58.3	Enumerate cranial nerve nuclei in medulla oblongata with their functional group	5	102
AN 58.4	Describe anatomical basis and effects of medial and lateral medullary syndrome	5	106
AN 59.1	Identify external features of pons	5	107
AN 59.2	Draw and label transverse section of pons at the upper and lower level	5	107
AN 59.3	Enumerate cranial nerve nuclei in pons with their functional group	5	107
AN 60.1	Describe and demonstrate external and internal features of cerebellum	6	117
AN 60.2	Describe connections of cerebellar cortex and intracerebellar nuclei	6	120
AN 60.3	Describe anatomical basis of cerebellar dysfunction	6	124
AN 61.1	Identify external and internal features of midbrain	5	111
AN 61.2	Describe internal features of midbrain at the level of superior and inferior colliculus	5	111
AN 61.3	Describe anatomical basis and effects of Benedikt's and Weber's syndrome	5	113
AN 62.1	Enumerate cranial nerve nuclei with its functional component	4	56
AN 62.2	Describe and demonstrate surfaces, sulci, gyri, poles, and functional areas of cerebral hemisphere	8	133
AN 62.3	Describe the white matter of cerebrum	8	158
AN 62.4	Enumerate parts and major connections of basal ganglia and limbic lobe	8, 9	155, 172
AN 62.5	Describe boundaries, parts, gross relations, major nuclei and connections of dorsal thalamus, hypothalamus, epithalamus, metathalamus and subthalamus	8	147
AN 62.6	Describe and identify formation, branches and major areas of distribution of circle of Willis	11	188
AN 63.1	Describe and demonstrate parts, boundaries and features of IIIrd, IVth and lateral ventricle	7, 9	127, 167, 168
AN 63.2	Describe anatomical basis of congenital hydrocephalus	2	31
AN 64.1	Describe and identify the microanatomical features of cerebellum and cerebrum	6, 8	121, 146
AN 64.2	Describe the development of neural tube, spinal cord, medulla oblongata, pons, midbrain, cerebral hemisphere and cerebellum	1	13
AN 64.3	Describe various types of open neural tube defects with its embryological basis	3	52

# Glossary



## L: Latin word, Gr: Greek word

Allocortex	L. ancient bark	Old cortex, i.e. paleocortex and archicortex
Alveus	L. trough	White matter on the ventricular surface of hippocampus
Amygdala	L. almond	Nucleus in roof of inferior horn of lateral ventricle
Arachnoid	Gr. like spider's web	Middle meningeal layer
Archicerebellum	Gr. old cerebellum	Phylogenetic cerebellum area in caudal region
Astereognosis	Gr. loss of knowledge	Inability to recognise solid objects
Astrocyte	Gr. star cells	A type of neuroglial cell
Ataxia	Gr. negative order	Loss of muscular coordination
Athetosis	Gr. without place	Bizzare movements
Autonomic	Gr. self law	Autonomic NS
Axolemma	Gr. axis back	Covering of axon
Basis pedunculi	—	Ventral part of midbrain
Brachium	L. arm	Fibres connecting 2 parts
Brainstem	—	Midbrain + pons + medulla oblongata
Bulb	—	Medulla oblongata
Calamus scriptorum	L. reed pen	Area in caudal part of IV ventricle
Calcar	L. spur	For example, calcarine sulcus, calcar avis
Cauda equina	L. horse's tail	Lower lumbar and sacral nerve roots
Caudate nucleus	L. comma-shaped	Part of corpus striatum
Cerebellum	L. little brain	Part of brain
Cerebrum	L. brain	Cerebral cortex + diencephalon
Chorea	L. dance	Involuntary movement of limbs
Cinerium	L. ash coloured	For example, tubercinerium
Cingulum	L. girdle	Name of association fibres
Cistern	L. reservoir	
Claustrum	L. barrier	Grey matter between insula and lentiform nucleus
Colliculus	L. small swelling	For example, dorsal part of midbrain and facial colliculus
Commissure	L. joined together	Type of white fibres joining identical parts of 2 cerebral hemispheres
Corona	L. crown like	For example, corona radiata
Corpus callosum	L. body hard	Main commissural fibre bundle
Corpus striatum	L. body striped	Grey matter at base of cerebral hemisphere
Cortex	L. bark	Outer layer (i.e. grey matter) in cerebellum and cerebrum
Crus	L. leg.	For example, crus cerebri or basis pedunculi
Cuneus	L. wedge	For example, nucleus and fasciculus cuneatus and cuneus gyri in cerebral cortex
Decussation	L. like X	Crossing over
Dentate	L. toothed	For example, dentate gyrus of temporal lobe, dentate nucleus of cerebellum

Diencephalon	Gr. through brain	Thalamus + hypothalamus + epithalamus + subthalamus + metathalamus
Dura mater	L. hard mother	Outer covering of brain
Emboliformis	Gr. plug like	One of the nuclei of cerebellum
Endoneurium	Gr. within nerve	Connective tissue sheath around each nerve fibre
Entorhinal	Gr. within nose	Anterior part of parahippocampal gyrus adjacent to uncus
Ependyma	Gr. upon garment	The lining epithelium of ventricles of brain and the central canal of spinal cord
Epithalamus	Gr. upon inner chamber	Upon inner chamber
Exteroceptor	L. external + receiver	Receiver for external environment
Falx	L. sickle	For example, falx cerebri, falx cerebelli
Fasciculus	L. bundle	Bundle of white fibres
Fimbria	L. fringe	For example, bundle of fibres along medial edge of hippocampus
Forceps	L. pair of tongs	For example, forceps minor, forceps major
Fornix	L. arch	Part of limbic system
Ganglion	Gr. swelling	For example, dorsal root ganglia, basal ganglia
Genu	L. knee (bend)	For example, facial nerve, corpus callosum
Glia	Gr. glue	Neuroglia
Globus pallidus	L. ball +plate	For example, medial part of lentiform nucleus
Glomerulus	L. ball of thread	For example, glomeruli of olfactory bulb
Gracilis	L. slender	Nucleus and fasciculus gracilis
Habenula	L. rein	Swelling in epithalamus
Hemiballismus	Gr. half jumping	Violent movement of one side of body due to disease of subthalamic nucleus
Hemiplegia	Gr. half stroke	Paralysis of one side of the body
Hydrocephalus	Gr. water in head	Excessive CSF
Indusium	L. garment	Grey matter on dorsal surface of corpus callosum
Infundibulum	L. funnel	Stem of neurohypophysis
Insula	L. island	Part of cortex lying at the depth of lateral sulcus
Isocortex	Gr. same bark	Regions of cerebral cortex with 6 layers
Lemniscus	Gr. ribbon	Medial lemniscus
Lentiform	L. lens-like	Lentiform nucleus
Limbus	L. border, C-shaped	Limbic lobe, limbic system
Limen	L. threshold	Ventral part of insula
Locus ceruleus	L. place dark blue	For example, in floor of IV ventricle
Macula	L. spot	For example, macula lutea
Mammillary body	L. nipple-shaped	mammillary bodies
Medulla	L. middle	medulla oblongata
Mesencephalon	Gr. middle brain	midbrain
Metathalamus	Gr. after + inner chamber	Medial and lateral geniculate bodies
Metencephalon	Gr. after + brain	For example, pons + cerebellum
Microglia	Gr. small + glue	Type of neuroglial cells
Molecular	L. mass	Tissue with large number of nerve fibres
Myelencephalon	Gr. marrow +brain	Medulla oblongata
Neostriatum	New + striped region	Caudate nucleus and putamen
Neurite	Gr. of nerve	Axons and dendrites of the neurons
Neurobiotaxis	Gr. nerve + living attraction	Nerve cells moving towards sources of stimuli



Neuroglia	Gr. nerve + glue	Cellular, non-nervous cells glueing the neurons
Neurolemma or neurilemma	Gr. nerve-husk	Sheath around the peripheral nerve fibre
Neuropil	Gr. nerve + felt	Nerve cell process between the bodies of neurons
Nociceptive	L. to injure + to take	Response to painful stimuli
Obex	L. barrier	In fourth ventricle
Oligodendrocyte	Gr. few + processes	Type of neuroglia
Olive	L. oval	Olivary nuclei
Operculum	L. lid	Various opercula around the lateral sulcus to hide the insula
Paleocerebellum	Gr. ancient + small cerebellum	Old part of cerebellum
Paleostriatum	Gr. ancient + striped area	Old part of corpus striatum, i.e. globus pallidus
Paraplegia	Gr. beside + stroke	Paralysis of lower part of trunk and both lower limbs
Perikaryon	Gr. around + nut	Neuron
Pes	L. foot	Pes hippocampi
Pineal	L. pine	Pineal gland
Plexus	L. palit	Interwoven fibres
Pneumoencephalogram	Air + brain + to write	Visualisation of ventricles and subarachnoid space by replacing of CSF by air
Pons	L. bridge	Part between midbrain and medulla oblongata
Proprioceptive	L. one's own + receptor	Afferents from joints, tendons, etc.
Prosencephalon	Gr. before + brain	Forebrain part
Ptosis	Gr. falling	Drooping of upper eyelid
Pulvinar	L. cushioned seat	Posterior projection of thalamus
Putamen	L. shell	Lateral part of corpus striatum
Pyriform	L. pear + form	Olfactory cortex is pear-shaped in lower animals
Quadriplegia	L. four + stroke	Paralysis of all four limbs
Raphe	Gr. seam	Midline structure
Reticular	L. net	Net formation
Rhinal	Gr. nose	Related to nose
Rhinencephalon	Gr. nose + brain	Components of olfactory system
Rhombencephalon	Gr. lozenge-shaped + brain	Refers to hindbrain vesicle
Rostrum	L. beak	Beak-shaped portion of corpus callosum
Rubro	L. red	Red nucleus
Satellite	L. attendant	Cells around neurons of dorsal root ganglion and autonomic ganglia
Septum pellucidum	L. partition transparent	Septum pellucidum of lateral ventricles
Somatic	Gr. bodily	Skeletal muscles (in neurology)
Somesthetic	Gr. body + perception	Sensation of pain, touch and temperature
Splenium	Gr. bandage	Posterior thick end of corpus callosum
Striatum	L. furrowed	Caudate nucleus and putamen
Subiculum	L. decreased layer	Transitional cortex between hippocampus and para-hippocampal gyrus
Substantia gelatinosa	Substance + soft	Collection of small neurons at the apex of posterior horn of spinal cord
Substantia nigra	Substance + dark	Present in midbrain
Subthalamus	L. under + inner chamber	Region beneath thalamus
Synapse	Gr. to join	Site of contact between neurons
Syringomyelia	Gr. pipe + marrow	Cavities in grey matter around central canal
Tapetum	L. carpet	Fibres of body of corpus callosum

Tectum	L. roof	Roof of midbrain comprised of 4 colliculi
Tegmentum	L. to cover	Dorsal portion of pons and midbrain
Telachoroidea	L. web + membrane	Vascular connective tissue core of choroid plexus
Telencephalon	Gr. end + brain	Cerebral hemisphere
Telodendria	Gr. end + tree	Terminal branches of the axon
Thalamus	Gr. inner chamber	Part of diencephalon
Tomography	Gr. cutting + write	Sectional radiography
Transducer	L. to change	Mechanism which changes one form of energy into another
Trapezoid body	Trapezium like	Transverse fibres at the junction of dorsal and ventral parts of pons for auditory pathway
Uncinate	L. hood-shaped	Uncinate fasciculus
Uncus	L. hood	Hook-shaped anterior end of parahippocampal gyrus
Uvula	L. little grape	Part of inferior vermis of cerebellum
Vallecula	L. valley	Depressed area on the inferior medullary velum
Ventricle	L. diminutive of belly	Ventricles of brain
Vermis	L. worm	Middle region of cerebellum
Zona incerta	—	Grey matter in subthalamus