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Applied Anatomy & Physiology

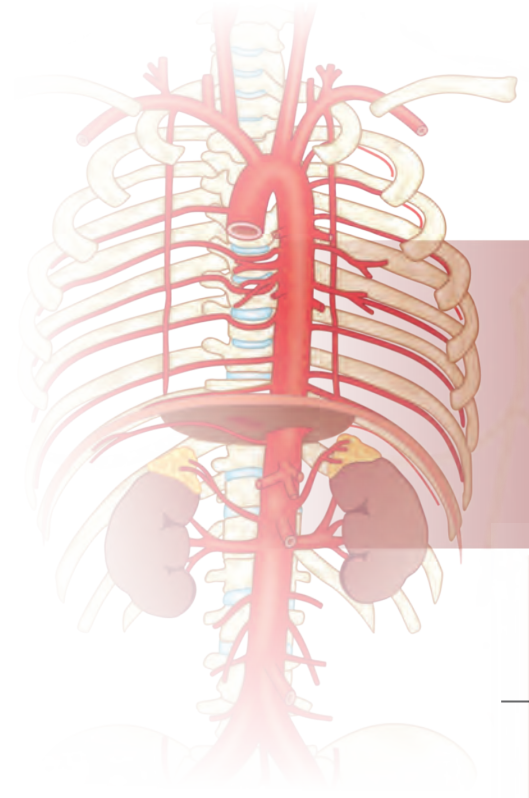
for BSc Nursing Students

As per the Revised INC Syllabus (2021-22) for BSc Nursing

2nd Edition

CBS Publishers & Distributors Pvt. Ltd.

Edited by
Krishna Garg



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An Initiative by CBS Nursing Division

Extends its Tribute to

Dr B D Chaurasia

(1937–1985)

Dr B D Chaurasia was Reader in Anatomy at GR Medical College, Gwalior.
He completed his MBBS in 1960, MS in 1965 and received his PhD degree in 1975.
He was an 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 was posthumously honoured by Dr Kailash Nath Kathju Award for
Science from MP State government.
He had a large number of research papers to his credit.

CBS Nursing Knowledge Tree

Extends its Tribute to

Florence Nightingale

For glorifying the role of women as nurses,
For holding the title of " The Lady with the Lamp,"
For working tirelessly for humanity–
Florence Nightingale will always be
remembered for her
selfless and memorable services to the
human race.

Florence Nightingale
(May 1820 – August 1910)

About the Editor

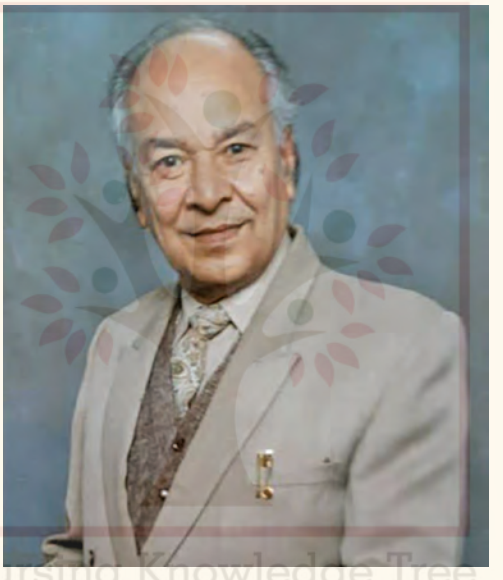
Krishna Garg MBBS, MS, PhD, FAMS, FIAMS, FIMSA, FASI, is ex-Professor and Head of Department of Anatomy, Lady Hardinge Medical College (LHMC), New Delhi. She joined LHMC in 1964 where she completed her MS and PhD and taught anatomy till 1996. At present, she is associated with Bakson's Homeopathic Medical College, Greater Noida and Kalka Dental College, Meerut as faculty of Anatomy.

She has been the editor of BD Chaurasia's Human Anatomy of 4th – 6th editions and is Chief Editor of 7th and 8th editions. She has received Fellowship of the Academy of Medical Sciences (FAMS) in 2005. She was honoured with Excellence award in Anatomy in 2004 from Delhi Medical Association and award from NAMS in 2021. She received Lifetime Achievement Award in 2015, Fellowship of Anatomical Society of India and DMA Distinguished Services Award in 2012.

She is an avid writer. She is an author of companion pocketbooks—BDC Human Anatomy (Vols 1–3) and BDC Human Anatomy for Dental Students 5/e. She is the co-author of Textbook of Histology 6/e, Textbook of Neuroanatomy 6/e, Anatomy and Physiology for GNM, Anatomy and Physiology for Allied Health Sciences, Practical Anatomy Workbook, Practical Histology Workbook, Practical Anatomy Workbook for Dental students and Theory and Practical of Anatomy & Physiology for Diploma Students of Pharmacy and for B. Pharma students (Semesters I and II). She is editor of Human Embryology 2/e and Handbook of General Anatomy 6/e. There are two books in Hindi – one for nursing and another for Allied Health Sciences. Her last book so far is Manual of Human Anatomy Practical Dissection.

Dedicated to

The memories of my husband Late Dr D P Garg



21-7-1936 — 28-10-2020

MBBS, DMRT, DMRD, MD (Radiodiagnosis)

Ex Professor & HOD of Radiology

Lady Hardinge Medical College and Associated Hospitals, New Delhi

—Krishna Garg

Preface to the Second Edition

BD Chaurasia's *Human Anatomy* has been a core title for students of anatomy for nearly 42 years. This book has been prepared for the students of medical stream. It is immensely popular among the readers. This book is widely recommended for other medical streams too.

As an author my journey started in the year 2017 when myself and Dr Medha Joshi wrote a book for GNM students under CBS banner. This book had been well accepted by the students. Besides, I have been Chief Editor of BD Chaurasia's book for UG medical students. A few years ago, I was invited to write a book for UG (BSc) Nursing students because with the passage of time, a need was felt to have a book of anatomy integrated with physiology for the students. It was decided by CBS to come up with latest version of *BD Chaurasia's* book according to latest INC Syllabus. This book, now in its second edition, is written to meet the needs of students of nursing and allied health sciences.

The human body is studied by having system-wise presentation. The approach is straight, simple and informative. Each chapter is supplemented by Nursing implications/Applications, Applied Aspects and Aging Changes.

"Each image speaks thousand words"—I kept this in mind and have used self-explanatory images in the book. The figures in the text are easy-to-digest and mainly line diagrams so that a student can easily draw and reproduce them. Each chapter starts with Chapter Outline, followed by Key Terminology, Anatomical Description with integrated physiology supported by figures and tables.

Unit I is especially dedicated to the basics of anatomy and physiology for proper understanding of the concepts that are under discussion in the book. Rest of the units from Unit II to Unit X are dedicated to separate description of the systems in a human body.

Student Assignment section in the end of each chapter is an added advantage to the readers as the knowledge gained by reading can easily be assessed by self-evaluation. Here, the student is given the long and short answer questions with a worksheet that has MCQs including—Match the Columns, One Word Answers, Label the Images, Enumeration and defining of the various terms.

This second edition is a hybrid edition with multiple digital features like, See and Perceive, Dil Mange More, Listen and Recall, Read Digitally, Student Assignment.

Nonetheless, the book has supporting features including High-Yield Points, Extra Edge, Recent Advances, Note, Nursing implications, Clinical Aspects and Aging Changes. These features will definitely update the knowledge of the readers.

I am always pleased to receive feedback from readers. It helps me to improve the further editions of the book.

What's New in this Edition?

- Thoroughly revised and updated content; at places, various new matters have been added keeping the syllabus as well as the students' requirements in mind.
- Enlarged anatomical and physiological structures; more figures, flowcharts are added to facilitate learning of the subjects.
- A new chapter, *Basics of Genetics*, has been added.
- Applications and implications in nursing including nursing assessment, diagnostic tests and diseases associated with respective system under discussion, are given in detail.
- 50+ cases are added in the respective chapters.

Special Features of the Book

- First Book as per the Revised INC Syllabus 2021-22
- A perfect amalgamation of Applied Anatomy and Physiology
- Applications and implications in nursing including nursing assessment, diagnostic tests and diseases associated with respective system under discussion, are given in detail. This is an additional feature important for nursing students.
- 100+ 3D Animated Videos and Images included in this edition are given in our online platform Nursing Next Live App, for imbibing the concepts with ease.

- Chapter-wise Applied Aspects and Aging Changes are given.
- Appendices cover Important Dissectors/Cadaveric Images of Human Body Organs, Charts and High-Yield Topics
- 1000+ Illustrations, Real-Time Photographs Flowcharts, Tables and Graphs
- 20+ Student Assignment Exercises with (LAQs, SAQs, IBQs, Fill in the blanks, Match the following, and MCQs to assess self-knowledge).
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- **See & Perceive:** Get 100+ 3D Animated Videos and Images.
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- **Assess Yourself** - Chapter-wise MCQs/Match the Following/Fill in the Blanks
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  - Regular Hybrid Updates covering Recent Advances, Mnemonics, Tips & Tricks and much more

Krishna Garg

Acknowledgments

I am highly grateful to The Almighty for His guidance and grace which enabled me to do this immensely popular book with multiple facets.

I want to mention the names of my colleagues who have always encouraged and also imparted valuable suggestions—Dr Gayatri Rath, Dr Shashi Raheja, Dr Mangala Kohli and Dr Medha Joshi. Moreover, I can't forget to appreciate the moral support rendered by my family members—Dr Suvira Gupta, Dr J P Gupta, Ms Meenakshi Saran, Mr Manoj Garg, Ms Rekha Garg, Dr Manish Garg, Dr Shilpa Garg, Dr Surbhi Gupta, Ms Kanika Saran, Mr Shikhar Garg, Ms Sarita Garg and all other dear family members.

I owe thanks to Dr Sudipta Kundu—Head and Associate Professor of Physiology, Kalka Dental College, Meerut, UP.

I would like to thank **Mr Satish Kumar Jain** (Chairman) and **Mr Varun Jain** (Managing Director), M/s CBS Publishers and Distributors Pvt Ltd for providing me the platform in bringing out the book. I have no words to describe the role, efforts, inputs and initiatives undertaken by **Mr Bhupesh Aarora** [Sr. Vice President – Publishing and Marketing (Health Sciences Division)] for helping and motivating me.

I sincerely thank the entire CBS team for bringing out the book with utmost care and attractive presentation. I would like to thank Ms Nitasha Arora (Assistant General Manager Publishing – Medical and Nursing), Ms Daljeet Kaur (Assistant Publishing Manager) and Dr Anju Dhir (Sr. Product Manager and Medical Development Editor) for their publishing support. I would also extend our thanks to Mr Shivendu Bhushan Pandey (Sr. Manager and Team Lead), Ms Surbhi Gupta (Sr. English Editor), Mr Ashutosh Pathak (Sr. Proofreader cum Team Coordinator) and all the production team members for devoting laborious hours in designing and typesetting the book.

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Publisher's Desk

Dear Reader,

Nursing Education has a rich history, often characterized by traditional teaching techniques that have evolved over time. Primarily, teaching took place within classroom settings. Lectures, textbooks, and clinical rotations were the core teaching tools; and students majorly relied on textbooks by local or foreign publishers for quality education. However, today, technology has completely transformed the field of nursing education, making it an integral part of the curriculum. It has evolved to include a range of technological tools that enhance the learning experience and better prepare students for clinical practice.

As publishers, we've been contributing to the field of Medical Science, Nursing and Allied Sciences and earned the trust of many. By supporting **Indian authors**, coupled with **nursing webinars and conferences**, we have paved an easier path for aspiring nurses, empowering them to excel in national and state level exams. With this, we're not only enhancing the quality of patient care but also enabling future nurses to adapt to new challenges and innovations in the rapidly evolving world of healthcare. Following the ideology of **Bringing learning to people instead of people going for learning**, so far, we've been doing our part by:

- Developing quality content by qualified and well-versed authors
- Building a strong community of faculty and students
- Introducing a smart approach with Digital/Hybrid Books, and
- Offering simulation Nursing Procedures, etc.

Innovative teaching methodologies, such as modern-age Phygital Books, have sparked the interest of the Next-Gen students in pursuing advanced education. The enhancement of educational standards through **Omnipresent Knowledge Sharing Platforms** has further facilitated learning, bridging the gap between doctors and nurses.

At Nursing Next Live, a sister concern of CBS Publishers & Distributors, we have long recognized the immense potential within the nursing field. Our journey in innovating nursing education has allowed us to make substantial and meaningful contributions. With the vision of strengthening learning at every stage, we have introduced several plans that cater to the specific needs of the students, including but not limited to **Plan UG** for undergraduates, **Plan MSc** for postgraduate aspirants, **Plan FDP** for upskilling faculties, **SDL** for integrated learning and **Plan NP** for bridging the gap between theoretical & practical learning. Additionally, we have successfully completed seven series of our **Target High** Book in a very short period, setting a milestone in the education industry. We have been able to achieve all this just with the sole vision of laying the foundation of diversified knowledge for all. With the rise of a new generation of educated, tech-savvy individuals, we anticipate even more remarkable advancements in the coming years.

We take immense pride in our achievements and eagerly look forward to the future, brimming with new opportunities for innovation, growth and collaborations with experienced minds such as yourself who can contribute to our mission as Authors, Reviewers and/or Faculties. Together, let's foster a generation of nurses who are confident, competent, and prepared to succeed in a technology-driven healthcare system.

Mr Bhupesh Aarora
(Sr Vice President – Publishing & Marketing)
bhupeshaarora@cbspd.com| +91 95553 53330

Special Features of the Book

Dear Students

All of us who have been part of the Publishing Process in CBS, congratulate you all for choosing an exciting and rewarding profession. This book is conceived and designed to equip you with basic as well as applied knowledge of Anatomy and Physiology which will certainly help you all during practice. This book is studded with the following features:

LEARNING OBJECTIVES

After going through this unit, you will be able to:

- Define the terms related to the anatomical position.
- Describe the anatomical planes.
- Define and describe the terms used to describe movements.
- Describe the organization of human body and structure of cell, tissues, membranes and glands.

Learning Objectives enlist what the students will learn after studying the entire unit.

Chapter Outline provides a glimpse of the entire chapter in one go.

CHAPTER OUTLINE

Anatomy and Physiology—A Brief Introduction
Main Branches of Anatomy
Main Branches of Physiology
Language of Anatomy
Anatomical Positions
Anatomical Planes
Body Cavities

Important **Key Terms** have been added in the beginning of every chapter to get a quick and easy understanding of important terms in one go.

KEY TERMS

Anatomical position: The positioning of the body when it is standing upright and facing forward with each arm hanging on either side of the body and the palms facing forward.
Coronal plane: A horizontal plane running from side to side; divides the body or any of its parts into anterior and posterior portions.
Eversion: A type of movement at the foot that involves turning outward the sole of the foot away from the body's midline.
Inversion: The movement of the sole toward the median plane.
Lithotomy position: Lying on back with legs flexed at 90° at the hips.
Midsagittal plane: The median vertical longitudinal plane that divides a bilaterally symmetrical body into right and left halves.
Pronation: A rotational movement of the forearm that results in the palm facing posteriorly.
Prone position: A body position in which the person lies flat with the chest down and the backup.
Protraction: The act of moving an anatomical part forward.
Retraction: Movement that results in the protracted portion of the body being moved on a parallel plane, back to its original position.

High Yield Point

It is quite amazing to note that complex human body develops from a single cell—zygote, which is an outcome of fusion of ovum and sperm. A cell divides and redivides to form a fetus. These cells have same genetic make-up and they resemble the genetic make-up of zygote. As the fetus grows, cells differentiate with different functional specializations and perform separate functions.

Important facts, concepts and ideas have been covered in-between the text in **High Yield Point** boxes.

Important topics and concepts from exam point of view have been given as a separate entity in **Must Know** boxes.

Must Know

Effects of smoking

The major adverse effects of smoking on the respiratory system include lung cancer, chronic bronchitis and emphysema. Carbon monoxide present in the smoke binds to hemoglobin and reduces its oxygen-carrying capacity. Nicotine constricts the bronchioles that lead to decrease in the flow of air into and out of lungs. Irritants in the smoke destroy cilia that are present on the lining of the respiratory system. Without cilia, the epithelium cannot clear the passageway for mucus and debris, which helps in the growth of microorganisms, leading to respiratory infections.

Numerous tables have been used in the Units to facilitate learning in a quick way.

TABLE 1.1: Body cavities

Cranial cavity	Formed by the cranial bones and holds the brain
Vertebral canal	Formed by the vertebrae and contains the spinal cord
Thoracic cavity	Formed by the thoracic cage, muscles of the chest, sternum and the thoracic vertebrae; contains the pleural, pericardial cavities with heart, lungs and blood vessels
Pleural cavity	Fluid-filled space that surrounds both lungs
Pericardial cavity	Fluid-filled space that surrounds the heart; the serous membrane of the pericardial cavity is the pericardium
Mediastinum	Central portion of the thoracic cavity; contains the heart, thymus, trachea, several major blood vessels, and esophagus
Abdominal cavity	Contains liver, stomach, spleen, small intestine, and most of the large intestine; the serous membrane of the abdominal cavity is the peritoneum
Pelvic cavity	Contains bladder, some part of the large intestine, and reproductive organs (internal)

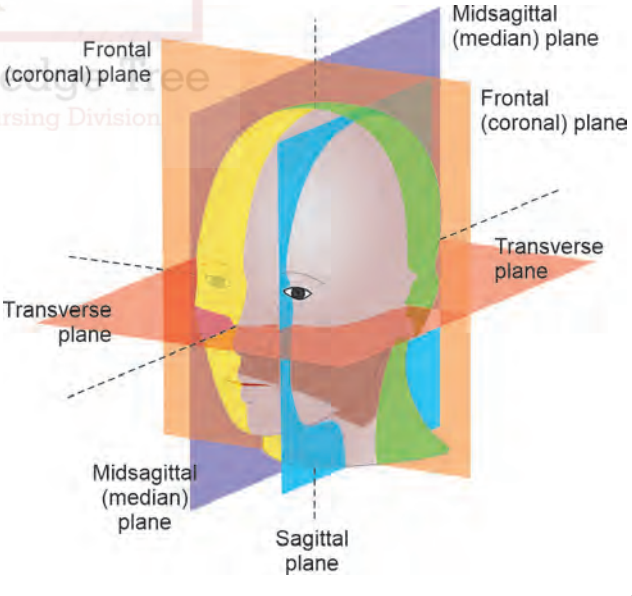
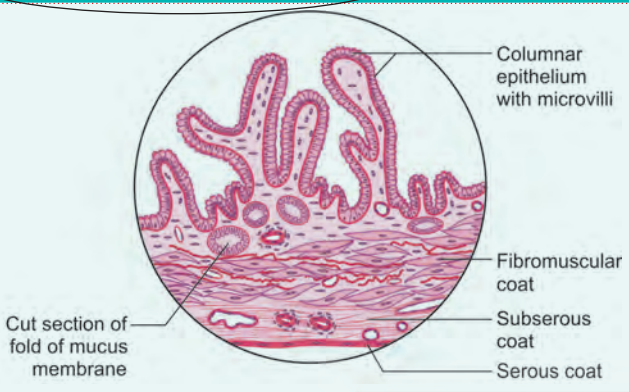


Fig. 1.7: Anatomical planes

Enlarged Illustrations and real-time anatomical structures images are used to make learning easy for students.

HISTOLOGICAL FACTS TO REMEMBER



- Epithelium is of tall columnar cells with microvilli.
- Muscularis mucosae and glands are absent.
- Outer fibromuscular coat with a few smooth muscle fibers and collagen fibers.

Fig. 7.49. Histology of gallbladder

50+ Histological slides with **Histological Facts to Remember** have been provided for their identification from practical point of view.

Applied aspects covered are related to the anatomical knowledge for effective clinical implementation and improving patient outcomes.

APPLIED ASPECTS

Diseases of pancreas

Pancreatitis:

This may be acute or chronic. Acute one is due to viral infection (mumps) hypocalcemia, excessive alcohol, etc. Chronic pancreatitis is due to repeated attacks of acute variety. These cases show formation of cysts by protein material from acinar cells.

Tumors of pancreas:

Tumors of pancreas are common. These cause obstructive jaundice. In acute stage nothing is given orally. Then liquid/soft bland diet, which is low in fat is advised. Later on 5–6 small soft bland meals are recommended.

APPLICATIONS AND IMPLICATIONS IN NURSING

Purpose: To equip nurses with relevant knowledge about anatomy and physiology of digestive system in patient care.

NURSING ASSESSMENT

Collect subjective and objective data to perform a focused digestive system assessment to understand the functions of the digestive system.

Subjective Assessment

The order of examination performed is inspection, auscultation, percussion, and light and deep palpation. Prior to examination, ask the patient if pain is present and to indicate where; use a facility-approved pain scale to assess level of pain. This location should be the last examined. Warm your hands for patient comfort and position yourself on the patient's right side, then proceed systematically.

Many important must know facts from Nursing point of view have been covered under **Nursing Implication and Applications** at the end of every chapter for better understanding of Nursing Clinical Correlation of the relevant system disease condition.

AGING CHANGES TO BE REMEMBERED

Body water content, ages 40–60
- Males 55%
- Females 47%

After age 60
- Males 50%
- Females 45%

Effect of Aging in various systems have been emphasized for better understanding of anatomical and physiological changes in elderly population.

At many places **Tips to Keep the System Healthy** and importance of diet, Yoga and mediation have been incorporated to keep yourself aware about the health crisis and maintain ideal health.

TIPS TO KEEP THE SYSTEM HEALTHY

- One must do 'pranayama' deep breathing with holding breaths at end of inspiration and at end of expiration. Try holding the breath as long as possible to expand the lungs—do this every 3–5 hours.
- Maintain a balanced diet.
- Do not smoke.

APPENDIX 4

Dissection Images

Anatomy is learnt with the help of various human bones and by dissecting (cutting open) the dead human body (cadaver). The cadaver is embalmed by formalin and few other chemicals to prevent breakdown of proteins. This preserves the body

Important appendices including **High-Yield Topics** and **Dissector/Cadaveric Images** have been added covering important actual dissection photographs of human body organs and parts to keep yourself fully prepared for your practical examination.

Detailed **Student Assignment** in the form of exercises in each and every chapter will facilitate structured learning and revision of the material provided in the respective chapters.

STUDENT ASSIGNMENT

LONG ANSWER QUESTIONS

1. Discuss the regulation of respiration.
2. Describe various lung volumes and capacities.

SHORT ANSWER QUESTIONS

1. What are the components of respiratory system?
2. Name the bronchopulmonary segments of right lung.

MULTIPLE CHOICE QUESTIONS

1. **Which of these body systems is involved in the removal of carbon dioxide?**
   a. Respiratory system
   b. Digestive system
   c. Urinary system
   d. Reproductive system

Syllabus

APPLIED ANATOMY

Placement: I Semester **Time:** Theory 3 credits (60 hours)

Description: The course is designed to assists student to recall and further acquire the knowledge of the normal structure of human body, identify alteration in anatomical structure with emphasis on clinical application to practice nursing.

Unit	Time (Hrs)	Learning Outcomes	Content	Teaching/Learning Activities	Assessment Methods
I	8 (T)	Define the terms related to the anatomical position	**Introduction to Anatomical Terms and Organization of the Human Body** Introduction to anatomical terms relative to position—anterior, ventral, posterior dorsal, superior, inferior, median, lateral, proximal, distal, superficial, deep, prone, supine, palmar and plantar	• Lecture cum discussion	• Quiz • MCQ • Short answer
		Describe the anatomical planes	Anatomical planes (axial/transverse/horizontal, sagittal/vertical plane and coronal/frontal/oblique plane)	• Use of models	
		Define and describe the terms used to describe movements	Movements (flexion, extension, abduction, adduction, medial rotation, lateral rotation, inversion, eversion, supination, pronation, plantar flexion, dorsal flexion and circumduction	• Video demonstration	
			Cell structure, Cell division	• Use of microscopic slides	
		Organization of human body and structure of cell, tissues membranes and glands	• Tissue—definition, types, characteristics, classification, location • Membrane, glands—classification and structure • Identify major surface and bony landmarks in each body region, Organization of human body	• Lecture cum discussion	
			• Hyaline, fibro cartilage, elastic cartilage	• Video/Slides • Anatomical Torso	
		Describe the types of cartilage	• Features of skeletal, smooth and cardiacmuscle		
		Compare and contrast the features of skeletal, smooth and cardiac muscle	• Application and implication in nursing		
II	6 (T)	Describe the structure of respiratory system	**Respiratory System** • Structure of the organs of respiration	• Lecture cum discussion • Models • Video/Slides	• Short answer • Objective type
		Identify the muscles of respiration and examine their contribution to the mechanism of breathing	• Muscles of respiration • Application and implication in nursing		

Contd...

Unit	Time (Hrs)	Learning Outcomes	Content	Teaching/Learning Activities	Assessment Methods
III	6 (T)	Describe the structure of digestive system	**Digestive System** • Structure of alimentary canal and accessory organs of digestion • Application and implications in nursing	• Lecture cum discussion • Video/Slides • Anatomical Torso	• Short answer • Objective type
IV	6 (T)	Describe the structure of circulatory and lymphatic system	**Circulatory and Lymphatic System** • Structure of blood components, blood vessels ▪ Arterial and Venous system • Position of heart relative to the associated structures • Chambers of heart, layers of heart • Heart valves, coronary arteries • Nerve and blood supply to heart • Lymphatic tissue • Veins used for IV injections • Application and implication in nursing	• Lecture • Models • Video/Slides	• Short answer • MCQ
V	4 (T)	Identify the major endocrine glands and describe the structure of endocrine glands	**Endocrine System** Structure of hypothalamus, pineal gland,pituitary gland, thyroid, parathyroid, thymus, pancreas and adrenal glands	• Lecture • Models/charts	• Short answer • Objective type
VI	4 (T)	Describe the structure of various sensory organs	**Sensory Organs** • Structure of skin, eye, ear, nose and tongue • Application and implications in nursing	• Lecture • Explain with Video/models/ charts	• Short answer • MCQ
VII	10 (T)	• Describe anatomical position and structure of bones and joints • Identify major bones that make up the axial and appendicular skeleton • Classify the joints • Identify the application and implications in nursing • Describe the structure of muscle	**Musculoskeletal System** **Skeletal System** • Anatomical positions • Bones—types, structure, growth and ossification • Axial and appendicular skeleton • Joints—classification, major joints and structure • Application and implications in nursing	• Review – discussion • Lecture • Discussions • Explain using charts, skeleton and loose bones and torso • Identifying muscles involved in nursing procedures in lab	• Short answer • Objective type
		Apply the knowledge in performing nursing procedures/skills	**Muscular System** • Types and structure of muscles • Muscle groups—muscles of the head, neck, thorax, abdomen, pelvis, upper limb and lower limbs • Principal muscles—deltoid, biceps, triceps, respiratory, abdominal, pelvic floor, pelvic floor muscles, gluteal muscles and vastus lateralis • Major muscles involved in nursing procedures		
VIII	5 (T)	Describe the structure of renal system	**Renal System** • Structure of kidney, ureters, bladder, urethra • Application and implication in nursing	• Lecture • Models/charts	• MCQ • Short answer

Contd...

Unit	Time (Hrs)	Learning Outcomes	Content	Teaching/Learning Activities	Assessment Methods
IX	5 (T)	Describe the structure of reproductive system	**Reproductive System** • Structure of male reproductive organs • Structure of female reproductive organs • Structure of breast	• Lecture • Models/charts	• MCQ • Short answer
X	6 (T)	• Describe the structure of nervous system including the distribution of the nerves, nerve plexuses • Describe the ventricular system	**Nervous System** • Review structure of neurons • CNS, ANS and PNS (Central, autonomic and peripheral) • Structure of brain, spinal cord, cranial nerves, spinal nerves, peripheral nerves, functional areas of cerebral cortex • Ventricular system—formation, circulation, and drainage • Application and implication in nursing	• Lecture • Explain with models • Video slides	• MCQ • Short answer

Note: Few lab hours can be planned for visits, observation and handling (less than 1 credit lab hours are not specified separately)

APPLIED PHYSIOLOGY

Placement: I Semester **Time:** Theory 3 credits (60 hours)

Description: The course is designed to assists student to acquire comprehensive knowledge of the normal functions of the organ systems of the human body to facilitate understanding of physiological basis of health, identify alteration in functions and provide the student with the necessary physiological knowledge to practice nursing.

Unit	Time (Hrs)	Learning Outcomes	Content	Teaching/Learning Activities	Assessment Methods
I	4 (T)	Describe the physiology of cell, tissues, membranes and glands	**General Physiology—Basic Concepts** • Cell physiology including transportation across cell membrane • Body fluid compartments, distribution of total body fluid, intracellular and extracellular compartments, major electrolytes and maintenance of homeostasis • Cell cycle • Tissue—formation, repair • Membranes and glands—functions • Application and implication in nursing	• Review – discussion • Lecture cum discussion • Video demonstrations	• Quiz • MCQ • Short answer
II	6 (T)	• Describe the physiology and mechanism of respiration • Identify the muscles of respiration and examine their contribution to the mechanism of breathing	**Respiratory System** • Functions of respiratory organs • Physiology of respiration • Pulmonary circulation—functional features • Pulmonary ventilation, exchange of gases • Carriage of oxygen and carbon dioxide, exchange of gases in tissue • Regulation of respiration • Hypoxia, cyanosis, dyspnea, periodic breathing • Respiratory changes during exercise • Application and implication in nursing	• Lecture • Video slides	• Essay • Short answer • MCQ

Contd...

Unit	Time (Hrs)	Learning Outcomes	Content	Teaching/Learning Activities	Assessment Methods
III	8 (T)	Describe the functions of digestive system	**Digestive System** • Functions of the organs of digestive tract • Saliva—composition, regulation of secretion and functions of saliva • Composition and function of gastric juice, mechanism and regulation of gastric secretion • Composition of pancreatic juice, function, regulation of pancreatic secretion • Functions of liver, gallbladder and pancreas • Composition of bile and function • Secretion and function of small and large intestine • Movements of alimentary tract • Digestion in mouth, stomach, small intestine, large intestine, absorption of food • Application and implications in nursing	• Lecture cum discussion • Video/slides	• Essay • Short answer • MCQ
IV	6 (T)	Explain the functions of the heart, and physiology of circulation	**Circulatory and Lymphatic System** • Functions of heart, conduction system, cardiac cycle, stroke volume and cardiac output • Blood pressure and pulse • Circulation—principles, factors influencing blood pressure, pulse • Coronary circulation, pulmonary and systemic circulation • Heart rate—regulation of heart rate • Normal value and variations • Cardiovascular homeostasis in exercise and posture • Application and implication in nursing	• Lecture • Discussion • Video/slides	• Short answer • MCQ
V	5 (T)	Describe the composition and functions of blood	**Blood** • Blood—functions, physical characteristics • Formation of blood cells • Erythropoiesis—functions of RBC, RBC lifecycle • WBC—types, functions • Platelets—function and production of platelets • Clotting mechanism of blood, clotting time, bleeding time, PTT • Hemostasis—role of vasoconstriction, platelet plug formation in hemostasis, coagulation factors, intrinsic and extrinsic pathways of coagulation • Blood groups and types • Functions of reticuloendothelial system, immunity • Application in nursing	• Lecture • Discussion • Videos	• Essay • Short answer • MCQ
VI	5 (T)	Identify the major endocrine glands and describe their functions	**Endocrine System** • Functions and hormones of pineal gland, pituitary gland, thyroid, parathyroid, thymus, pancreas and adrenal glands • Other hormones • Alterations in disease • Application and implication in nursing	• Lecture • Explain using charts	• Short answer • MCQ

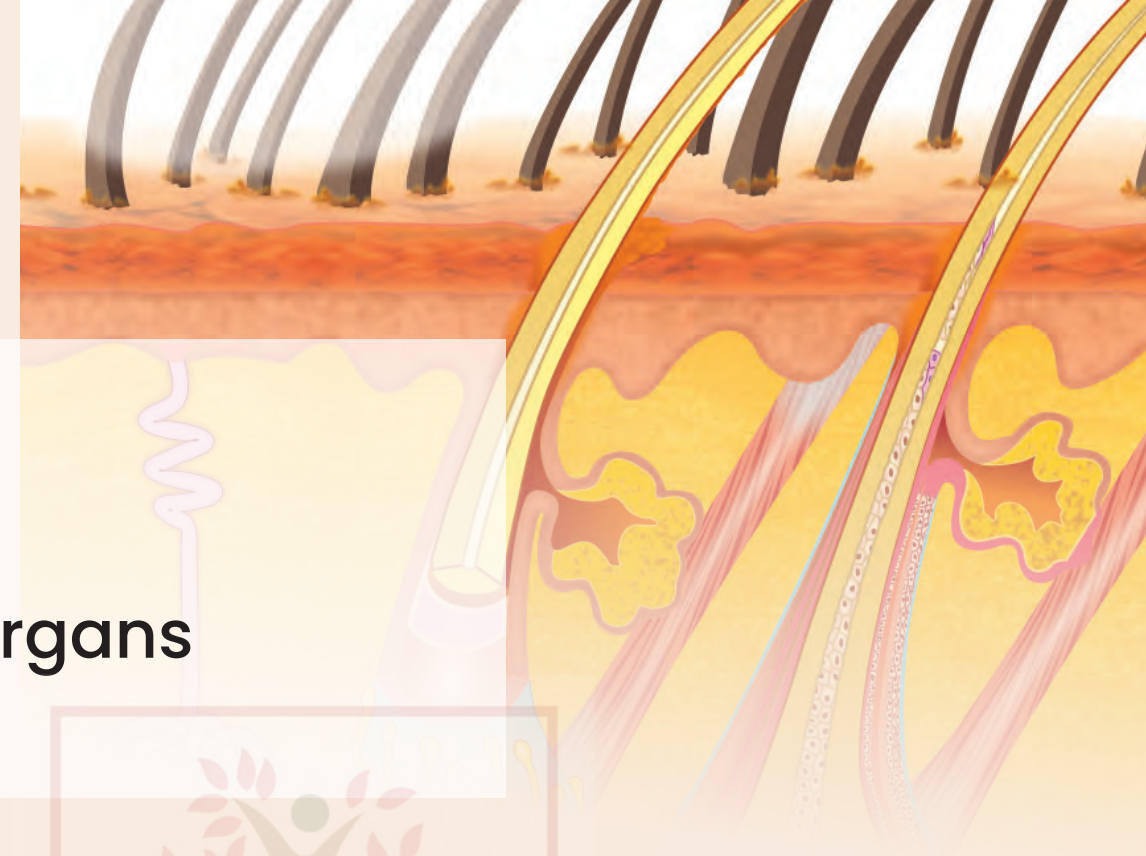
Contd...

Unit	Time (Hrs)	Learning Outcomes	Content	Teaching/Learning Activities	Assessment Methods
VII	4 (T)	Describe the structure of various sensory organs	**Sensory Organs** • Functions of skin • Vision, hearing, taste and smell • Errors of refraction, aging changes • Application and implications in nursing	• Lecture • Video	• Short answer • MCQ
VIII	6 (T)	Describe the functions of bones, joints, various types of muscles, its special properties and nerves supplying them	**Musculoskeletal System** • Bones—functions, movements of bones of axial and appendicular skeleton, bone healing • Joints and joint movements • Alteration of joint disease • Properties and functions of skeletal muscles—mechanism of muscle contraction • Structure and properties of cardiac muscles and smooth muscles • Application and implication in nursing	• Lecture • Discussion • Video presentation	• Structured essay • Short answer • MCQ
IX	4 (T)	Describe the physiology of renal system	**Renal System** • Functions of kidney in maintaining homeostasis • GFR • Functions of ureters, bladder and urethra • Micturition • Regulation of renal function • Application and implication in nursing	• Lecture • Charts and models	• Short answer • MCQ
X	4 (T)	Describe the structure of reproductive system	**Reproductive System** • Female reproductive system—menstrual cycle, function and hormones of ovary, oogenesis, fertilization, implantation, functions of breast • Male reproductive system—spermatogenesis, hormones and its functions, semen • Application and implication in providing nursing care	• Lecture • Explain using charts, models, specimens	• Short answer • MCQ
XI	8 (T)	Describe the functions of brain, physiology of nerve stimulus, reflexes, cranial and spinal nerves	**Nervous System** • Overview of nervous system • Review of types, structure and functions of neurons • Nerve impulse • Review functions of brain-medulla, pons, cerebrum, cerebellum • Sensory and motor nervous system • Peripheral nervous system • Autonomic nervous system • Limbic system and higher mental functions—hippocampus, thalamus, hypothalamus • Vestibular apparatus • Functions of cranial nerves • Autonomic functions • Physiology of pain—somatic, visceral and referred • Reflexes • CSF formation, composition, circulation of CSF, blood brain barrier and blood CSF barrier • Application and implication in nursing	• Lecture cum discussion • Video slides	• Brief structured essays • Short answer • MCQ • Critical reflection

Note: Few lab hours can be planned for visits, observation and handling (less than 1 credit lab hours are not specified separately)

Contents

For more Dissection Images refer **BD Chaurasia's A&P Digital**



Unit V

Sensory Organs

UNIT OUTLINE

LEARNING OBJECTIVES

After going through this unit, you will be able to:

- Enumerate the layers of epithelium of thick skin.
- Name the nerve supply and action of arrector pilorum muscle.
- Structure of the various parts of the hair.
- Enumerate differences between superficial and deep fasciae.
- Trace the taste pathway and mechanism of taste pathway.
- Discuss mechanism of smell and trace the pathway of smell in central nervous system.
- Trace the visual pathway.
- Describe the structure and function of cochlea.

ANIMATED VIDEOS/IMAGES

3D Animated Videos

12.1 A TO D: Anatomy of ear and mechanism of hearing

3D Animated Images

Figs 12.4A and B: A. Taste pathway; B. Mechanism of taste pathway

Figs 12.5A and B: A. Olfactory rootlets for sense of smell; B. Magnified olfactory rootlets

Figs 12.7A and B: A. Physiological mechanism of smell; B. Pathway of smell in central nervous system

Fig. 12.9: Cross-section of human eye

Fig. 12.13: Extraocular muscles-lateral view

Fig. 12.17: Visual pathway

Figs 12.21A and B: A. Anatomy of ear; B. Diagrammatic representation of parts of an ear

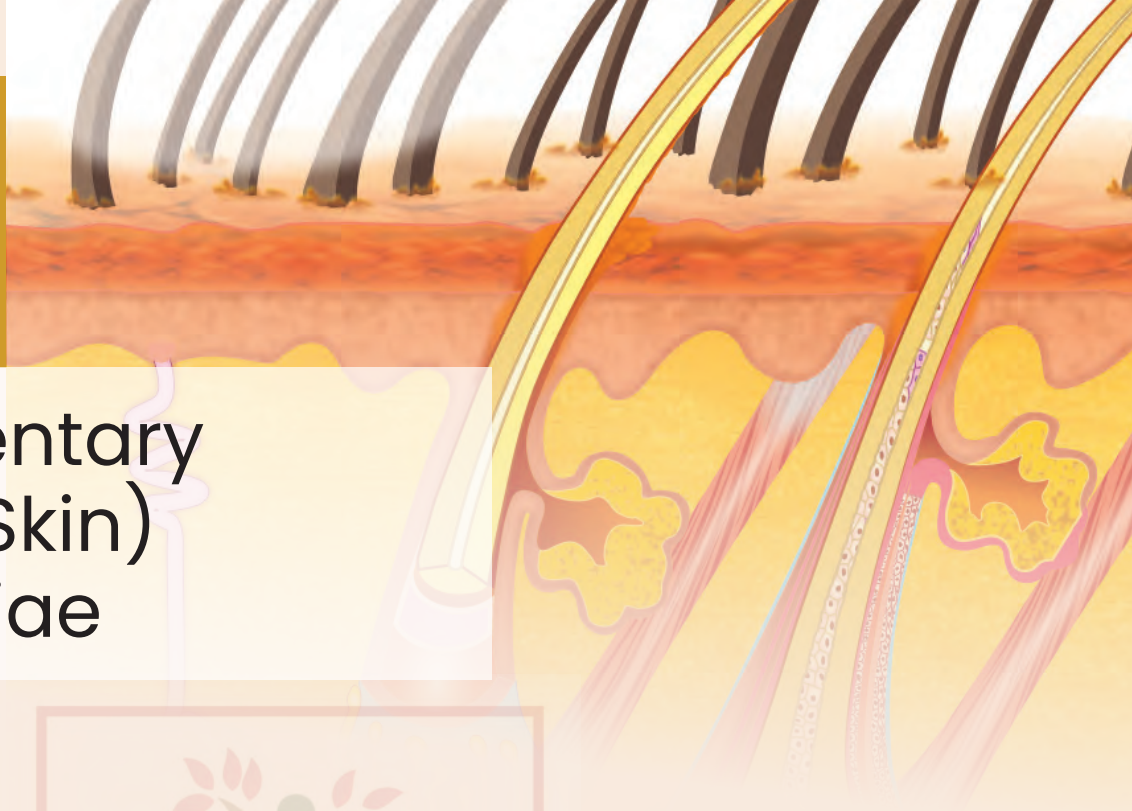
Fig. 12.24: Auditory ossicles of middle ear

Fig. 12.28: Structure of cochlea

Figs 12.33B: Mechanism of hearing

11

Integumentary System (Skin) and Fasciae



CHAPTER OUTLINE

- Introduction
- Integumentary System (Skin)
  - Histology of Skin
  - Pigmentation of Skin
  - Blood Supply
  - Nerve Supply
  - Surface Irregularities of the Skin
  - Appendages of Skin
  - Functions of Skin
  - Thermoregulation
- Fasciae
  - Distribution of Fat in the Fascia
  - Superficial Fascia
  - Deep Fascia

KEY TERMS

Appendages of skin: They are sweat glands, sebaceous gland, hair follicle, arrector pilorum muscle and nails.

Arrector pilorum muscle: These are smooth muscle fibers, supplied by sympathetic fibers; on contraction, the hair becomes erect.

Color of nails: Pink color shows enough hemoglobin; blue color shows cyanosis; yellow color reveals the jaundice in the person.

Hair follicle: It consists of shaft of hair comprised of medulla, cortex and cuticle with inner root sheath, outer root sheath and connective tissue sheath.

Layers of dermis: These are outer reticular layer and inner papillary layer.

Layers of epidermis: These are stratum basale, stratum spinosum, stratum granulosum, stratum lucidum and stratum corneum.

Nails: They consist of root, body (nail plate) free edge, nail fold and lunula.

Sebaceous glands: They are holocrine glands present in the angle between hair follicle and the arrector pilorum muscle.

Sweat glands: A simple tubular gland of the skin that secretes perspiration, is widely distributed in nearly all parts of the human skin. They are of two types: Apocrine glands are present mainly in the axilla; eccrine glands are present all over the body. Sweat maintains temperature and water balance of the body.

INTRODUCTION

Sense organs are the specialized organs composed of sensory neurons, which help us to perceive and respond to our surroundings. There are five sense organs—**skin** with its appendages, **eyes**, **ears**, **nose** and **tongue**. Skin and fasciae are dealt in this chapter. Rest are described in the Chapter on Sensory Organs.

INTEGUMENTARY SYSTEM (SKIN)

Skin is the general covering of the entire external surface of the body. It is continuous with the mucous membrane at the orifices of the body (Fig. 11.1). It has sensory nerve endings that help in perceiving pain, touch, hot or cold, etc. Because of the presence of sweat glands, it helps the body in temperature regulation.

Histology of Skin

The histology of skin is shown in Figure 11.1.

Surface Area

In an adult, the surface area of the skin is 1.5–2 (average 1.7) sq. meters.

Must Know

Du Bois formula: The surface area of an individual can be calculated by Du Bois formula. Therefore,

$$A = W \times H \times 71.84$$

Where, A = Surface area in sq.cm, W = weight in kg, and H = height in cm.

Pigmentation of Skin

The color of the skin is determined by at least five pigments present in it.

1. *Melanin* (brown), present in the germinative zone of the epidermis.
2. *Melanoid*, (resembles melanin present diffusely throughout the epidermis.
3. *Carotene* (yellow to orange), present in stratum corneum and the fat cells of dermis and superficial fascia.
4. *Hemoglobin* (purple).
5. *Oxyhemoglobin* (red), present in the cutaneous vessels.

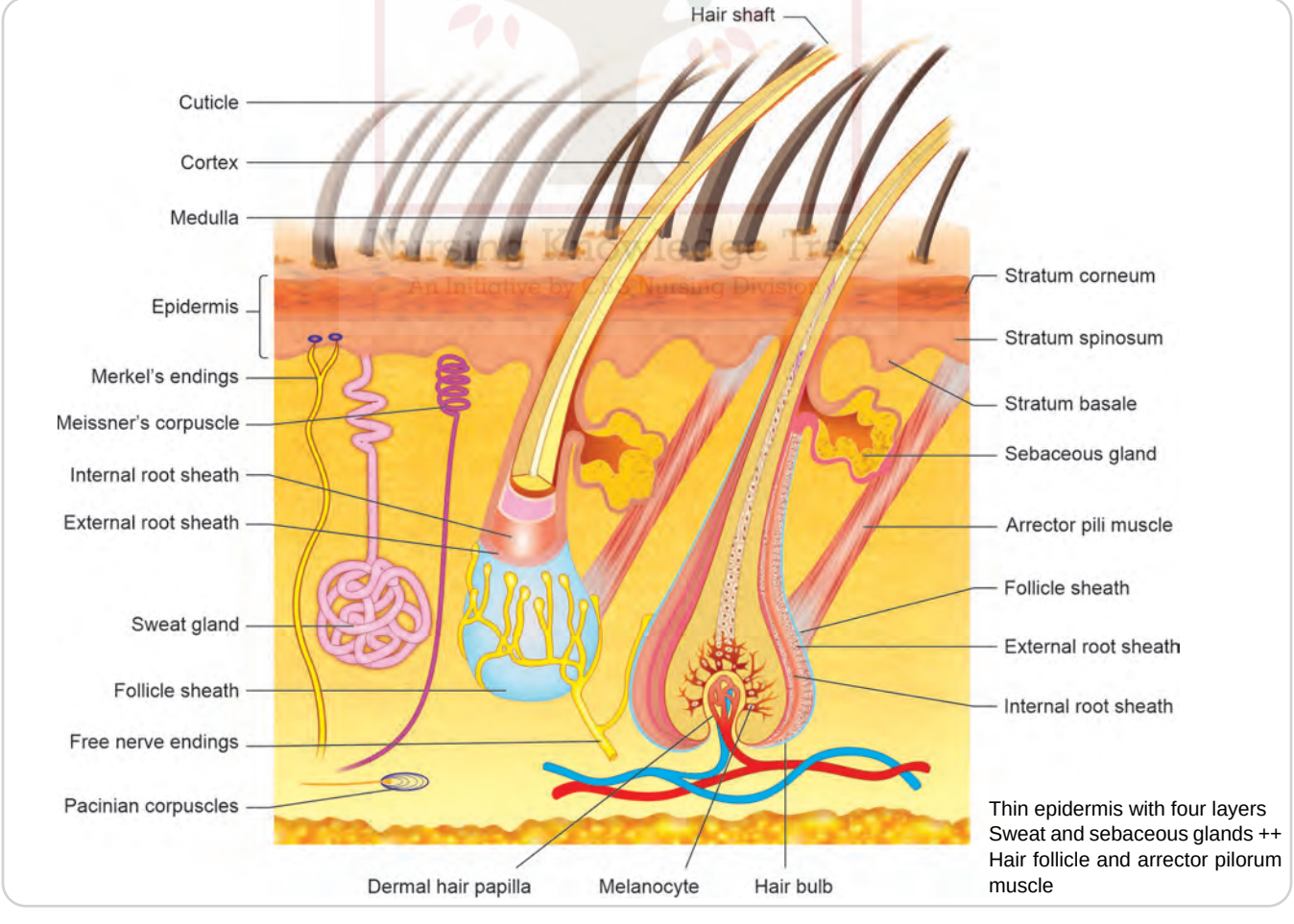
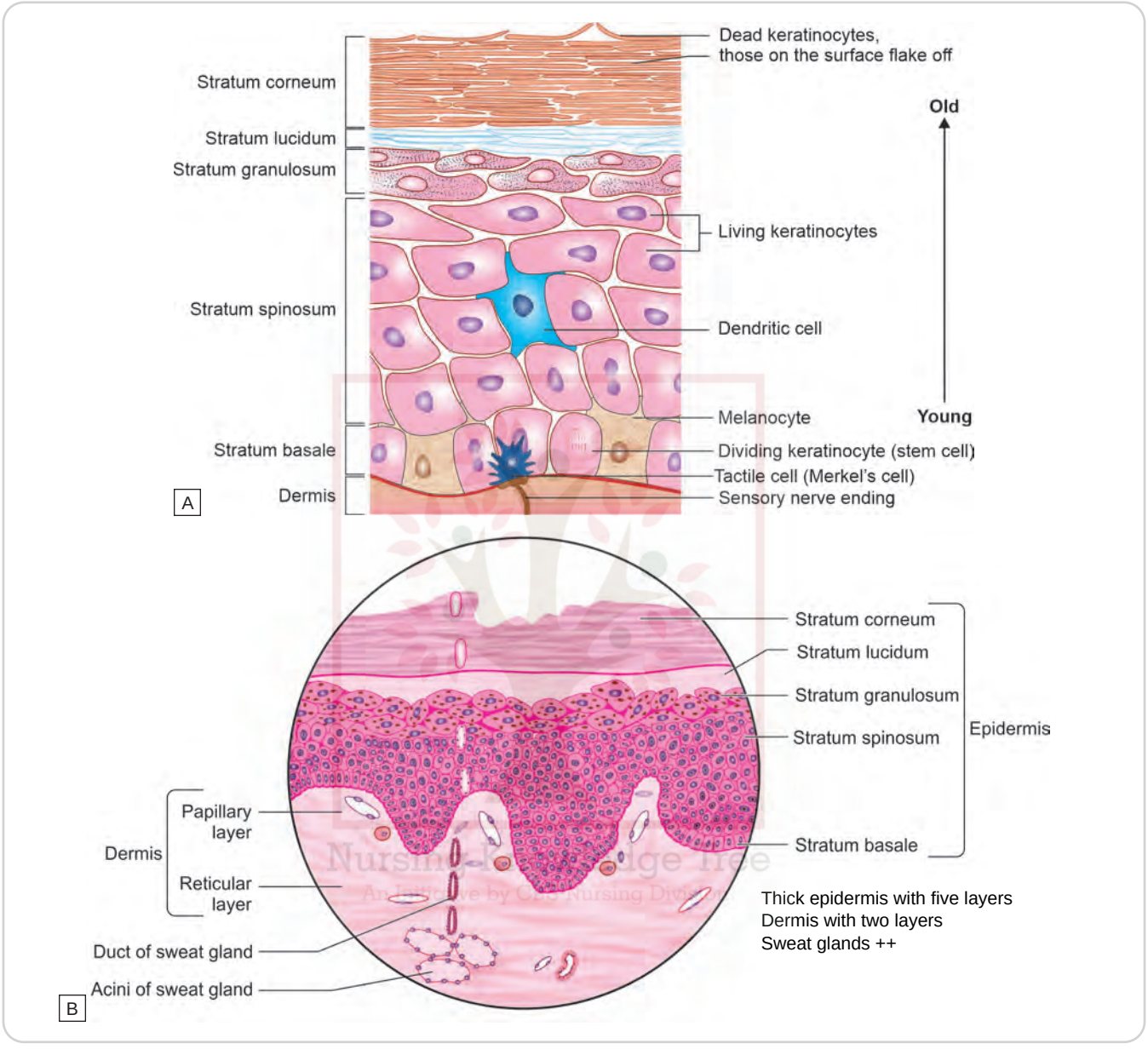


Fig. 11.1: Histology of thin skin with nerve endings



Figs 11.2A and B: **A.** Cells of the dermis; **B.** Histology of thick skin

Thickness

The thickness of the skin varies from about 0.5–3 mm.

The skin is composed of two distinct layers, epidermis and dermis.

1. **Epidermis:** It is the superficial, avascular layer of stratified squamous epithelium. It is ectodermal in origin and gives rise to the appendages of the skin, namely hair, nails, sweat glands and sebaceous glands.

   Structurally, the epidermis is made up of a deep **germinative zone**, comprising Stratum basale, Stratum spinosum, and Stratum granulosum. (Figs 11.2A and B).

   Superficial cornified zone: Stratum lucidum, and Stratum corneum

   The germinative zone contains:

   - DOPA, positive *melanocytes* of neural crest origin, which synthesize melanin.
   - Langerhans cells, which are phagocytic in nature.
   - Merkel's cells which are sensory receptor cells in stratum basale (Figs 11.2A and B).

2. **Dermis or corium:** Dermis or corium is the deep, vascular layer of the skin, derived from mesoderm.

   It is made up of connective tissues (with variable elastic fibers). The connective tissue is arranged into a superficial *papillary layer* and a deep *reticular layer*.

The papillary layer forms conical, blunt projections which fit into reciprocal depressions on the undersurface of the epidermis. The reticular layer is composed chiefly of the white fibrous tissue arranged mostly in parallel bundles.

The direction of the bundles, constituting flexure or *cleavage lines* (Langer's lines), is longitudinal in the limbs and horizontal in the trunk and neck.

Dermis is the real skin, because when dried, it makes hide, and when gets tanned it looks like leather.

Blood Supply

The dermis is vascular while epidermis is avascular.

Nerve Supply

There are motor and sensory nerves. The motor nerve fibers are autonomic nerve fibers which are sudomotor, pilomotor and vasomotor. The sensory nerve endings in the skin are of the following types:

- Free nerve endings, Merkel's disc, Meissner's corpuscles.
- Pacinian corpuscles, Ruffini's endings, Krause's bulbs.

Surface Irregularities of the Skin

Skin is marked by three types of surface irregularities:

1. **Tension lines:** These lines to some extent correspond to variations in the pattern of fibers in the dermis.
2. **Flexure lines (skin creases or skin joints):** These are certain permanent lines along which the skin folds during habitual movements of the joints.
3. **Papillary ridges (friction ridges):** They are confined to palms, soles and their digits. They form narrow ridges separated by fine parallel grooves, arranged in curved arrays. They correspond to patterns of dermal papillae. Their study constitutes a branch of science, called dermatoglyphics (finger-prints).

High Yield Points

- Three major patterns in the human fingerprints include loops, whorls and arches (Fig. 11.3).
- These patterns and many other minor features are determined genetically by multifactorial inheritance.
- These do not change throughout life, except to enlarge. This serves as a basis for identification through fingerprints or footprints.

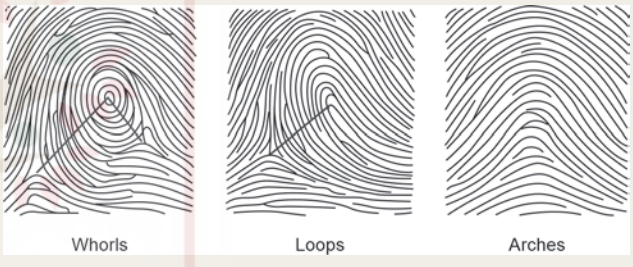


Fig. 11.3: Types of papillary ridges

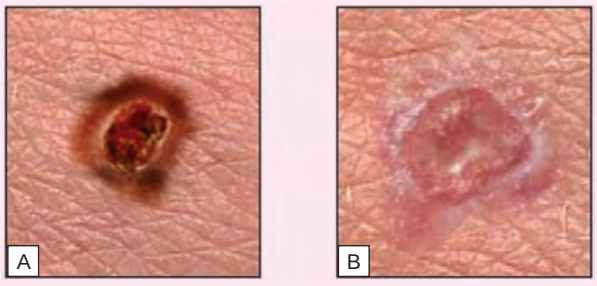
Skin of palm and sole is thick, rest of the body has thin skin. Table 11.1 compares the two types of skin.

TABLE 11.1: Differences between thick and thin skin

Thick skin	Thin skin
The skin from the palms and soles, so named because of its relatively thick epidermis	The skin from areas of the body other than the palms and soles, so named because of its relatively thin epidermis
Occurs on the soles of feet, palms of hands, and the surface lining of the fingers and toes	Covers the rest of the body
Thick epidermis of five layers 1. Stratum basale 2. Stratum spinosum 3. Stratum granulosum 4. Stratum lucidum 5. Stratum corneum	Thin epidermis of four layers: 1. Stratum basale 2. Stratum spinosum 3. Thin stratum granulosum 4. Thin stratum corneum
Lacks hair follicles	Contains hair follicles
Lacks arrector pili muscles	Contains arrector pili muscles attached to hair follicles
Thin dermis	Thick dermis
Lacks sebaceous glands	Contains sebaceous glands
Has numerous, spirally coiled sweat glands	Has fewer sweat glands
Denser sensory receptors	Sparser sensory receptors
Contains both ridges and furrows on the surface	Lacks ridges and furrows on the surface
Contains regular dermal papillae	Contains irregular dermal papillae
More restricted to mechanical abrasion	Performs the other functions of the skin

APPLIED ASPECTS

Skin Cancer (Figs 11.4A and B)



Figs 11.4A and B: **A.** Squamous cell carcinoma; **B.** Basal cell carcinoma

Benign and Malignant Cancer of Skin

- **Squamous cell carcinoma (SCC)** SCC of the skin is the second most common form of skin cancer. SCC of the skin is also known as cutaneous squamous cell carcinoma (cSCC).
- **Cutaneous squamous cell carcinoma (cSCC):** It is characterized by abnormal and accelerated growth of squamous cells. When it is diagnosed early, most SCCs are curable. SCC of the skin is also known as cutaneous squamous cell carcinoma (cSCC). The early signs that could be alarming are - wart-like growth on skin, stubborn red bump on skin, scaly area of skin that bleeds or has crust and skin sore or thick growth of skin on lower lip.
- **Basal cell carcinoma (BCC):** Basal cell carcinoma is a type of skin cancer that generally develops on areas of skin exposed to the sun, like face. On brown or black skin, it looks like a bump of brown or glossy black color. It has a rolled border.

Appendages of Skin

Nails

Nails are hardened keratin plates (cornified zone) on the dorsal surface of the tips of fingers and toes. Each nail has the following parts.

- *Root* is the proximal hidden part which is buried into the nail groove and is overlapped by the nail fold of the skin (Figs 11.5A and B).
- *Body* is the exposed part of the nail which is adherent to the underlying skin; root and body together form *nail's plate*.
- *Free border* is the distal part free from the skin. It is attached to the under surface by hyponychium.

The proximal part of the body presents a white opaque crescent called *lunule*. Each lateral border of the nail body is overlapped by a fold of a skin, termed the *nail* fold and the groove between nail body and nail fold is called *nail groove*.

The skin (germinative zone + dermis) beneath the root and body of the nail is called *nail bed*. The germinative zone of the nail bed beneath the root and lunule is thick and proliferative (germinal matrix), and is responsible for the growth of the nail. The rest of the nail bed is thin (sterile matrix) over which the growing nail glides. Under the translucent body (except lunule) of the nail, the corium is very vascular. This accounts for their pink color.

Nail of middle finger grows the fastest.

Hair

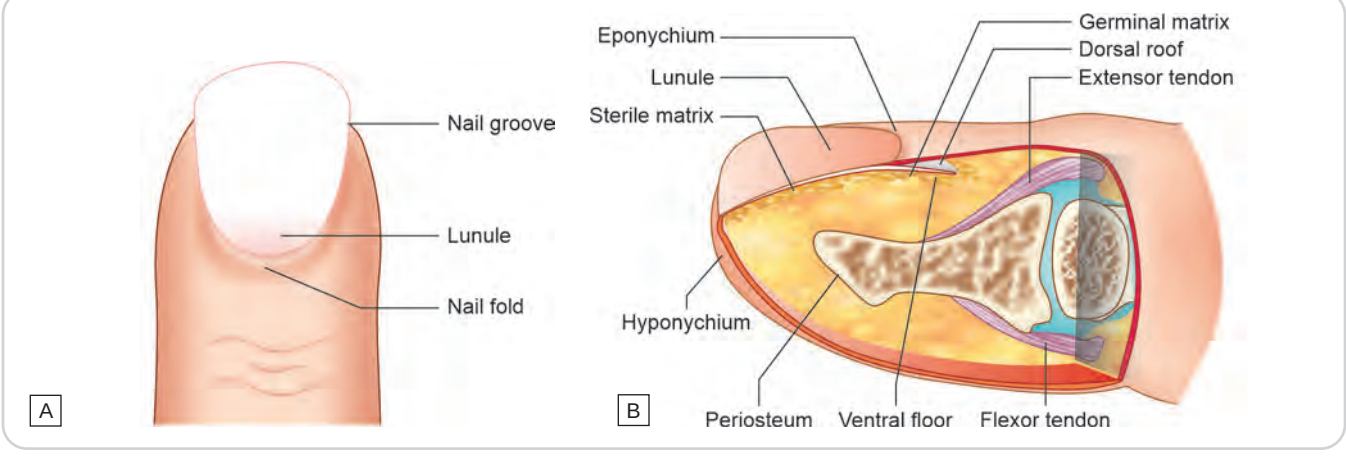
Hairs are keratinous filaments derived from invaginations of the germinative layer of epidermis into the dermis.

These are peculiar to mammals and help in conservation of their body heat.

Hair are distributed all over the body, except for the palms, soles, dorsal aspect of distal phalanges, umbilicus, glans penis, inner surface of prepuce, the labia minora, and inner surface of labia majora.

Structure of hair: Each hair has an implanted part called the **root**, a **bulb** and a projecting part, called the **shaft**.

Layers of shaft: Innermost is the medulla, cortex is the middle one and cuticle is a single outer layer:



Figs 11.5A and B: **A.** Parts of a nail; **B.** Anatomy of nail

The root is surrounded by a **hair follicle** (a sheath of epidermis and dermis), and is expanded at its proximal end to form the **hair bulb**. Each hair bulb is invaginated at its end by hair papilla (vascular connective tissue) which forms the neurovascular hilum of the hair and its sheath.

Hair follicle surrounds the hair. Wall of the follicle comprises:

- Inner root sheath
- Outer root sheath
- Connective tissue sheath (Fig. 11.6).

The arrectores pilorum muscles (smooth muscles supplied by sympathetic nerve) connect the undersurface of the follicles to the superficial part of the dermis. Arrector pili muscles are absent in a few regions like hair of face, axilla, eyelashes, eyebrows, hair of anterior nares and of external auditory meatus.

Growth of hair: The hairs grow at the rate of about 1.5–2.2 mm/week.

Color of hair: Color of hair depends upon the amount and type of melanin pigment.

Sweat Glands

Sudoriferous or sweat glands are distributed all over the skin, except for the lips, glans penis and nail bed. These glands are of two types; *eccrine* and *apocrine* (Table 11.2).

1. **Eccrine glands:** The eccrine glands are much more abundant and distributed in almost every part of the skin. The coiled part, called the *body* of the gland, lies in the deeper part of corium or in the subcutaneous tissue. The straight part, called the *duct*, traverses the dermis and epidermis and opens on the surface of the skin.
   - **Location:** The glands are large in the axilla and groin, most numerous in the palms and soles. The eccrine glands are *merocrine* in nature, i.e., produce

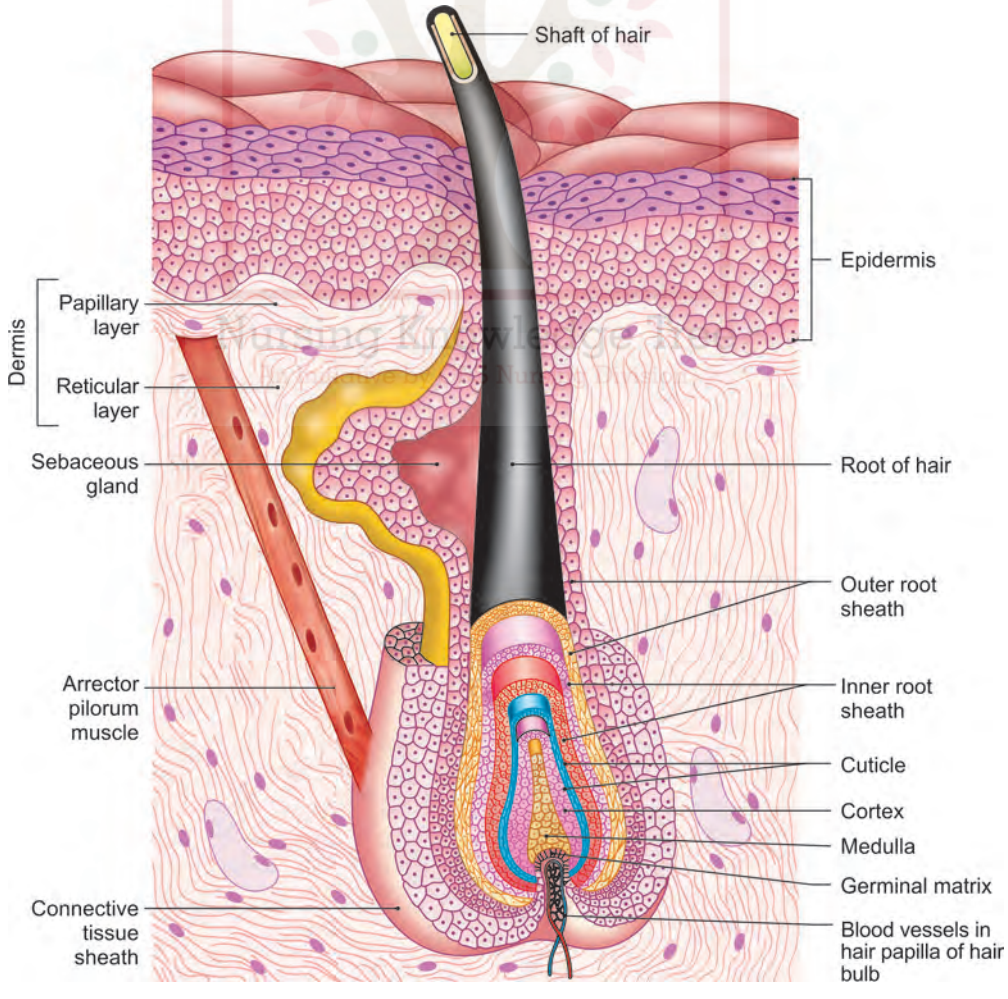


Fig. 11.6: Hair follicle with arrector pilorum muscle

TABLE 11.2: Differences between eccrine and apocrine sweat glands

Characteristics	Eccrine sweat gland	Apocrine sweat gland
Activity	Throughout life	Active at puberty
Opening on surface	Through the sweat pore	Around hair shaft
Function	Maintain temperature	Provides peculiar odor
Nervous control	Postganglionic sympathetic neurons, which are cholinergic	Postganglionic sympathetic neurons which are adrenergic
Secretion	Watery with salts	Viscid with lipids and proteins

thin watery secretion without any disintegration of the epithelial cells.
- **Control:** They are supplied and controlled by *cholinergic sympathetic nerves*.
- **Functions:** The glands help in regulation of the body temperature by evaporation of sweat and also help in excreting the body salts.

2. **Apocrine glands:** Apocrine glands are confined to axilla, eyelids (Moll's glands), nipple and areola of the breast, perianal region and the external genitalia.
   - **Structure:** They are larger than eccrine glands and produce a thicker secretion having a characteristic odor. They develop in close association with hair. *Ceruminous glands* of the external auditory meatus are modified apocrine sweat glands.
   - **Nervous control:** The apocrine glands also are merocrine in nature, but are regulated by a dual autonomic control.
   - **Functions:** In animals, they produce chemical signals or pheromones, which are important in courtship and social behavior.

Sebaceous Glands

- **Location:** Sebaceous glands, producing an oily secretion, are widely distributed all over the dermis of the skin.
- **Structure:** Sebaceous glands are small and sacculated in appearance, made up of a cluster of about 2–5 piriform alveoli.
  - Most of their ducts open into the hair follicles.
  - Sebaceous glands are *holocrine* in nature.
- **Nervous control:** The secretion is under *hormonal control*, especially the androgens.
- **Functions:** It lubricates skin and protects it from moisture. Sebum also lubricates hair and prevents them from becoming brittle.

Functions of Skin

- **Protection:** Skin protects the body from mechanical injuries.
  - **Physical barrier:** Due to stratum corneum, skin acts as a barrier against bacterial infections, heat and cold, wet and drought, acid and alkali.
  - **Immune properties:** Langerhans cells phagocytose antigen and take it to T lymphocytes.
  - **Reflex action:** Sensory nerve endings start reflex action against painful stimuli and prevent it from damage.
- **Regulation of body temperature:** The internal body temperature is maintained in a normal range by homeostatic mechanisms despite wide fluctuations in environmental temperature (Fig. 11.6). Human and mammals are homeothermic, i.e., they maintain constant body temperature. Body temperature is least at 5 am and is highest in afternoon. If the rate of body heat production equals the rate of heat loss, the body maintains a constant core temperature near 98.6°F (37°C).
  - *Core temperature* is temperature in body structures that lie deep to the skin and subcutaneous layer.
  - *Shell temperature* is the temperature near body surface in the skin and the subcutaneous layer. Normally, shell temperature is lower than core temperature by 1°–6°C depending on environmental temperature.
- **Heat production:** The production of body heat is proportional to metabolic rate. Factors affecting the metabolic rate are:
  - **Body temperature:** Higher the body temperature, higher is the metabolic rate. For each 1°C rise in core temperature, metabolic rate increases by 10%.
  - **Exercise:** During strenuous exercise metabolic rate may increase up to 20 times the basal metabolic rate (BMR) due to contraction of skeletal muscles.
  - **Nervous system:** Stimulation of sympathetic division of autonomic nervous system releases norepinephrine and epinephrine, both of which increase the metabolic rate.
  - **Hormones:** Thyroid hormones are the main regulators of BMR. BMR increases as blood levels of thyroid hormones rise. Growth hormone, testosterone and insulin also increase the BMR.
  - **Ingestion of food:** This activity raises the metabolic rate by 10–20% during the process of digestion, absorption and storage of nutrients. This food induced increase in heat production is maximally seen after eating a high protein diet.

- **Metabolic rate** is also affected by gender (lower in females except during pregnancy and lactation), sleep (lower), and age (higher in children).

- **Heat loss:** Normal body temperature is maintained only when heat is lost to the environment at the same rate as it is produced by metabolic reactions. Heat from the body can be lost by:
  - **Conduction:** It is the exchange of heat that occurs between molecules of two materials that are in direct contact with each other. At rest, about 3% of body heat is lost *via* conduction to solid materials in contact with body such as chair and clothing. If a body is submerged in cold or hot water, heat loss or gain *via* conduction is much greater because water conducts heat 20 times more effectively than air.
  - **Convection:** It is the transfer of heat by movement of a gas/liquid between areas of different temperature. Contact of air/water with human body results in heat transfer by both conduction and convection. When cool air comes in contact with body, it warms and becomes less dense; and is carried away by convection currents created as less dense air rises. At rest, about 15% of body heat is lost to air *via* conduction and convection.
  - **Radiation:** It is the transfer of heat in the form of infrared rays between a warmer object and a cooler one without physical contact. About 60% heat loss occurs *via* radiation in a resting room at 21°C.
  - **Evaporation:** It is the conversion of liquid to a vapor. Every milliliter of water evaporates taking with it about 0.58 calories of heat. At rest, about 22% of heat is lost through evaporation of about 700 mL water per day (300 mL in exhaled air and 400 mL from skin surface).

    Heat is also lost through respiratory tract, urine and *via* feces.

The body temperature regulation is shown diagrammatically in (Fig. 11.7).

- **Hypothalamic thermostat:** The **control center** that regulates the temperature is the **preoptic area** in the **anterior hypothalamus**. Nerve signals from preoptic area are transmitted to the **heat losing center and heat promoting center** of the hypothalamus.

Thermoregulation

If core temperature declines, mechanisms that conserve heat and increase heat production to raise body temperature to normal become active *via* several negative feedback mechanisms. Temperature receptors in skin and hypothalamus send nerve impulses to control centers in hypothalamus, which in turn sends impulses to heat promoting center.

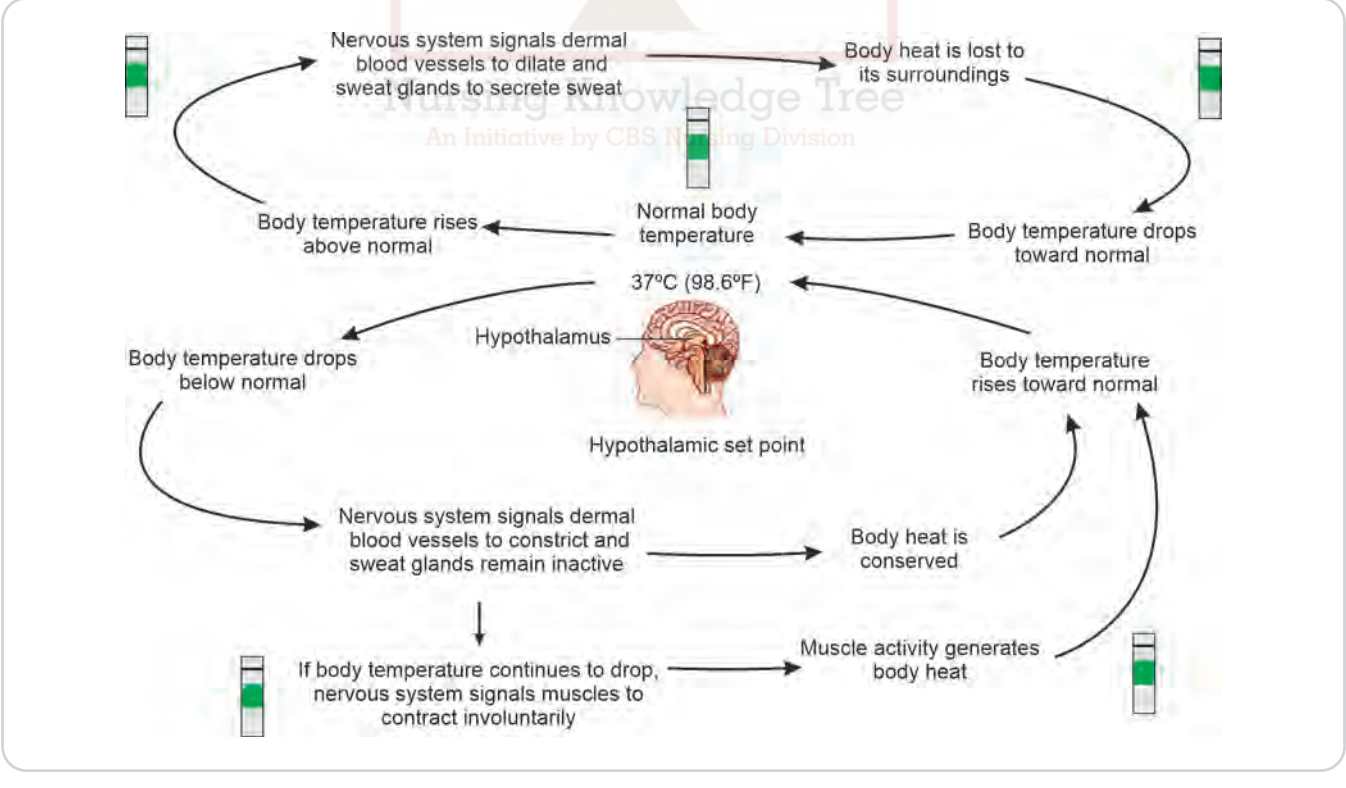


Fig. 11.7: Regulation of body temperature

These impulses also cause release of thyroid-stimulating hormone (TSH). These impulses help to raise the core temperature by:

- **Constriction of blood vessels of the skin:** There is decrease in heat loss through skin due to decrease in flow of blood to skin. Piloerection, i.e., contraction of arrector pili muscles, which causes skin hair to stand up, forms an insulating layer to conserve heat.
- **Increased release of hormones by adrenal medulla:** These hormones bring about an increase in cellular metabolism, which increases heat production.
- **Increased TSH releases:** Increased secretion of thyroid hormones from thyroid gland, which in turn increases metabolic rate.
- Impulses from the brain cause **shivering** (skeletal muscles contract in a repetitive cycle), increasing the metabolic rate.

High Yield Point

In infants, increased metabolism of brown fat enhances heat production. This is known as nonshivering thermogenesis. Shivering does not occur in infants.

All the mechanisms mentioned above result in increase in body temperature.

Must Know

Hyperthermia

Hyperthermia occurs if the body temperature rises above normal, the hypothalamic control center sends nerve impulses which stimulate heat losing center and inhibit heat promoting center. Stimulation of heat losing center causes dilatation of blood vessels in skin and excess heat is lost to the environment *via* radiation and conduction as an increased volume of blood flows from warmer core of body into cooler skin. In addition, metabolic rate decreases and shivering does not occur. Increased perspiration also leads to increased loss of heat. Anorexia (loss of appetite) causes decreased metabolism and decreased heat production. Decreased muscular activity also results in decreased heat production. All these responses help to return body temperature to normal.

Hypothermia

Hypothermia occurs when core temperature is below 35°C (95°F). At core temperature below 32°C (89.6°F) compensatory mechanisms to restore body temperature fail and there is muscle rigidity, cramps and lowered blood pressure, pulse and respiratory rate, followed by mental confusion and disorientation. Death usually occurs when body temperature falls below 25°C (77°F).

Fever usually results from infection and is due to release of chemicals **(pyrogens)** from affected tissue. The pyrogens through prostaglandins act on the hypothalamic thermostat and reset it to higher temperature. The body responds by activating heat producing mechanisms, e.g., shivering and vasoconstriction, until the new higher temperature is reached. When hypothalamic thermostat is reset to normal level due to disappearance of pyrogens, heat loss mechanisms are activated, e.g., sweating and vasodilatation, until body temperature falls to the normal. Death occurs if core temperature rises above 44°–46°C (112°–114°F). Heat stroke occurs with prolonged work in hot and humid atmosphere. This leads to cramps, headache and circulatory collapse due to temperature rise—till 41°C.

Rest of the functions associated with skin are:

- **Sensory:** Skin is sensory to touch, pain and temperature.
- **Regulation of body temperature:** Heat is lost through evaporation of sweat. It is conserved by the fat and hair.
- **Absorption:** Oily substances are freely absorbed by the skin.
- **Secretion:** Skin secretes sweat and sebum.
- **Excretion:** The excess of water, salts and waste products are excreted through the sweat.
- **Regulation of pH:** A good amount of acid is excreted through the sweat.
- **Synthesis:** In the skin, vitamin D is synthesized.
- **Storage:** Skin stores chlorides.
- **Reparative:** The cuts and wounds of the skin are quickly healed.
- **Water balance:** Skin does not permit water to pass in and out of the body. Thus it maintains the water balance of the body.

FASCIAE

Fascia is a band or sheet of connective tissues, primarily collagen, beneath the skin that attaches, encloses, stabilizes, and separates muscles and other internal organs.

Distribution of Fat in the Fascia

Fat is *abundant* in the gluteal region (buttocks), lumbar region (flanks) front of the thighs anterior abdominal wall below the umbilicus, mammary gland.

Fat is *absent* from the eyelids, external ear, penis and scrotum.

In females, fat is in the superficial fascia of the lower abdomen, upper thigh, whereas in males it is inside the abdominal cavity.

Types of Fats

There are two types of fat, i.e., yellow and brown fat.

Most of the body fat is yellow, only in hibernating animals it is brown. The cells of brown fat are smaller with several small droplets and multiple mitochondria.

1. Superficial Fascia

The **superficial fascia** is a loose connective tissue layer immediate **deep** to the skin. It contains fat, lymphatics, glands, blood vessels and nerves.

Important Features of Superficial Fascia

Superficial fascia is *most distinct* in the lower part of the anterior abdominal wall, perineum and the limbs.

- It is *very thin* on the dorsal aspect of the hands and feet.
- It is *very dense* in the scalp, palms and soles.
- Superficial fascia shows *stratification* (into two layers) in the lower part of anterior abdominal wall, perineum and uppermost part of the thighs.

It contains:

- Subcutaneous muscles in the face (muscles of facial expression), neck (platysma) and scrotum (dartos).
- Mammary gland.
- Deeply situated sweat glands.
- Localized groups of lymph nodes.
- Cutaneous nerves and vessels.

Functions of Superficial Fascia

- Superficial fascia facilitates movements of the skin.
- It serves as a soft medium for the passage of the vessels and nerves to the skin.
- It conserves body heat.

2. Deep Fascia

Deep fascia is a tough inelastic fibrous sheet, which invests the body beneath the superficial fascia. It is devoid of fat (Fig. 11.8).

Distribution

- Deep fascia is *best defined* in the limbs where it forms tough and tight sleeves.
- It is absent on the trunk and face.

Characteristic Features

Extensions (prolongations) of the deep fascia form:

- The intermuscular septa.
- The fibroareolar sheaths for the muscles, vessels and nerves.

Thickenings of the deep fascia form:

- Retinacula (retention bands) around certain joints.
- The palmar and plantar aponeuroses.

Interruptions in the deep fascia on the subcutaneous bones.

Modifications of Deep Fascia

- Forms the intermuscular septa.
- Covers each muscle as *epimysium* which sends in the septa to enclose each muscle fasciculus known as *perimysium*. From the *perimysium, septa* pass to enclose each muscle fiber. These fine septa are the *endomysium*.
- Deep fascia covers each nerve as *epineurium*, each nerve fascicle as *perineurium* and individual nerve fiber as *endoneurium*.
- Forms sheaths around large arteries, e.g., femoral sheath.

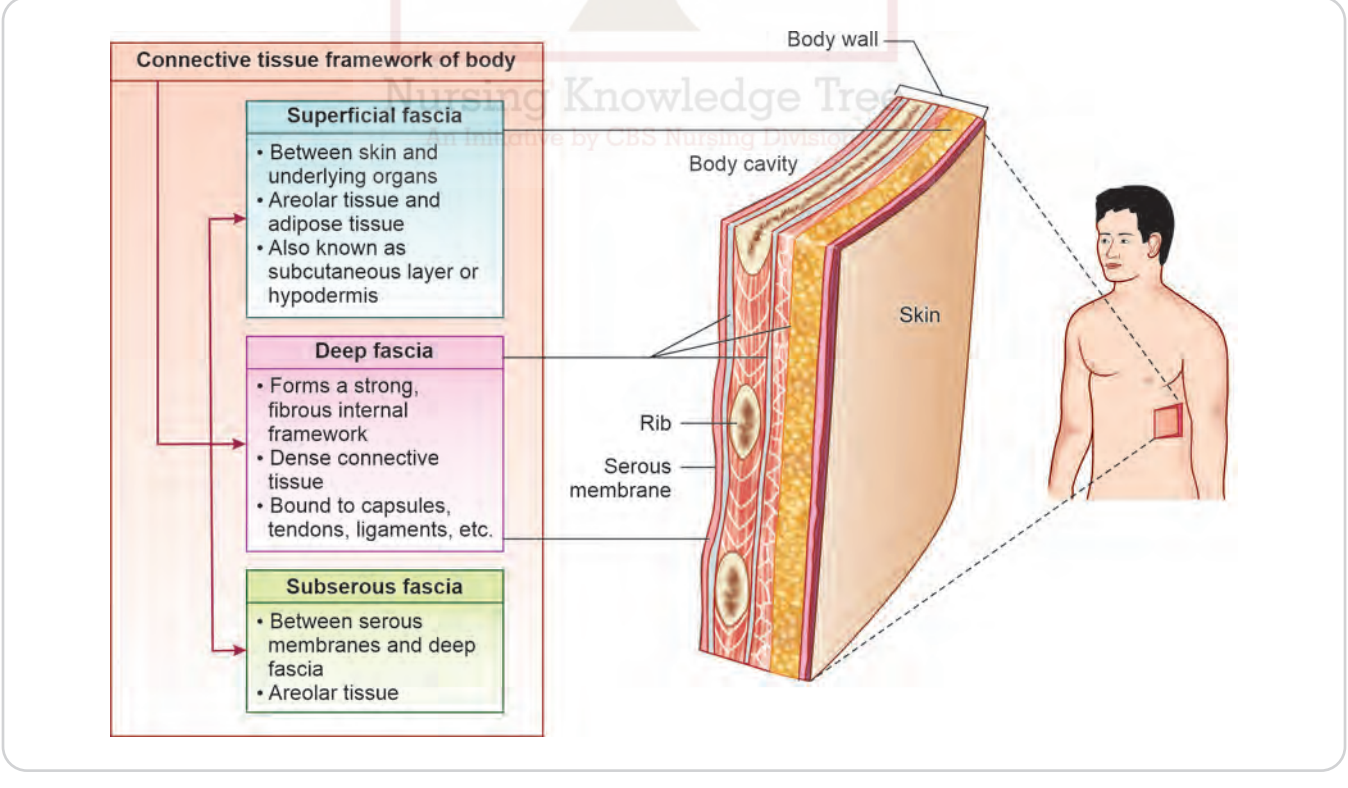


Fig. 11.8: Connective tissue framework of body/fasciae

TABLE 11.3: Differences between superficial and deep fascia

Characteristics	Superficial fascia	Deep fascia
Definition	Superficial fascia is a layer of loose thin connective tissue that lies directly beneath the skin	Deep fascia is a dense connective tissue that surrounds muscles and separates muscles into functional groups
Location	Found between skin and muscle	Found between adjacent muscles
Connective tissue	Loose connective tissue	Dense connective tissue
Function	Serves as insulation, store water and fat, provides pathways to nerves and blood vessels, etc.	Separates the muscles into functional groups and wraps the muscles; also cover all organs of the body
Fat	Contains fat	Devoid of fat
Part of the skin	Part of the skin	Not a part of the skin
Extensibility	More extensible	Less extensible

- Modified to form the capsule, synovial membrane and bursae in relation to the joints.
- Forms tendon sheaths.
- In the region of palm and sole, it is modified to form aponeurosis, e.g., palmar and plantar aponeurosis.

In the forearm and leg, the deep fascia is modified to form the *interosseous membrane*, which keeps:

- The two bones at optimum distance.
- Increases surface area for attachment of muscles.
- Transmits weight from one bone to other.

APPLIED ASPECTS

- Deep fascia of the leg helps in **venous return** from the legs. The muscular contractions press on the deep veins and form an effective mechanism of venous return. This contraction becomes more effective within the tight sleeve of deep fascia.
- **Deep fascia planes:** The deep fascia forms planes and the fluid or pus tracks along these fascial planes. The tubercular abscess of the cervical vertebrae passes along the prevertebral fascia into the posterior triangle of neck or into the axilla.

Differences between superficial and deep fasciae are shown in Table 11.3.

Functions

- Deep fascia keeps the underlying structures in position and preserves the characteristic surface contours of the limbs and neck.
- It provides extra surface for muscular attachments.
- It helps in venous and lymphatic return.
- The retinacula act as pulleys and serve to prevent the loss of power.

Must Know

Whenever skin incisions are to be made, these should be parallel to the lines of cleavage as they will result in small scars.

APPLICATIONS AND IMPLICATIONS IN NURSING

NURSING ASSESSMENT

Purpose: To equip nurses with relevant knowledge about anatomy and physiology of skin to apply in nursing care. Collect subjective and objective data to perform a focused respiratory assessment to understand the functions of the respiratory system.

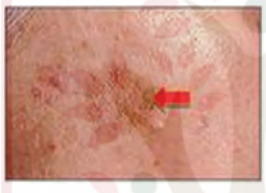
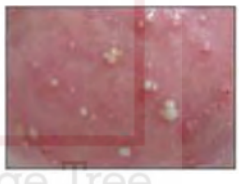
History:

- Current and past history of skin issues such as pigmentation or itching, rashes, mole or any treatment taken for these.
- Patient's age, gender, family history, race, culture, environmental factors and current health practices.
- Check for environmental or occupational exposure
- Note the family history.
- Any changes in nail thickness, discoloration, splitting, breaking and separation from the nail bed—it may be an indication of a systemic condition.

Inspection:

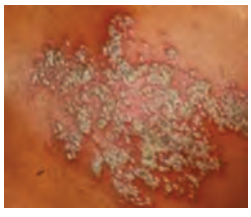
- Includes assessment of skin color, moisture, temperature, texture, mobility and turgor and skin lesions.
- Use the correct term to describe any lesions. The Table 11.4 is given here for help:

TABLE 11.4: Skin diseases and manifestations

 **Bulla** Circumscribed collection of free fluid >1 cm.	 **Macule** Circular flat discoloration <1 cm brown, blue, red or hypopigmented.	 **Nodule** Circular, elevated, solid lesion >1 cm.	 **Patch** Circumscribed flat discoloration >1 cm.
 **Papule** Superficial solid elevated, ≤0.5 cm, color varies.	 **Plaque** Superficial elevated solid flat topped lesion >1 cm.	 **Pustule** Vesicles containing pus (inflammatory cells).	 **Vesicle** Circular collection of free fluid ≤1 cm.
 **Wheal** Edematous, transitory, plaque, may last few hours.	 **Scale** Epidermal thickening, consists of flakes of plates of compacted desquamated layers of stratum corneum.	 **Crust** Dried serum or exudate on skin.	 **Fissure** Crack or split.
 **Excoriation** Linear erosion.	 **Erosion** Loss of epidermis, superficial, part or all of the epidermis has been lost.	 **Lichenification** Thickening of the epidermis seen with exaggeration of normal skin lines.	 **Scale** Thickening, permanent fibrotic changes that occur on the skin following damage of the epidermis.

Common Diseases/Disorders of Skin

Keloid
Overgrowth of connective tissue at site of injury or burn.



Herpes zoster virus (HZV) infection
HZ causes vesicular lesion around the nasal and oral orifices and along a dermatome. It is also responsible for causing chickenpox.

Boil (furuncle)
Boil is an infection and suppuration of the hair follicle and the sebaceous gland.

Sebaceous cyst
Common in the scalp. It is due to obstruction of the duct of a sebaceous gland. If the condition gets severe, the condition is acne vulgaris.

Scabies
A mite infection. It is commonly seen in genital region and in interdigital cleft.

Fungal infection of nail
It is common and may occur in between the toes also.

Psoriasis
A skin disease which causes red, itchy scaly patches; can be seen most commonly on the scalp, trunk, elbows and knees.

Vitiligo
An autoimmune disease leading to white patches on skin.

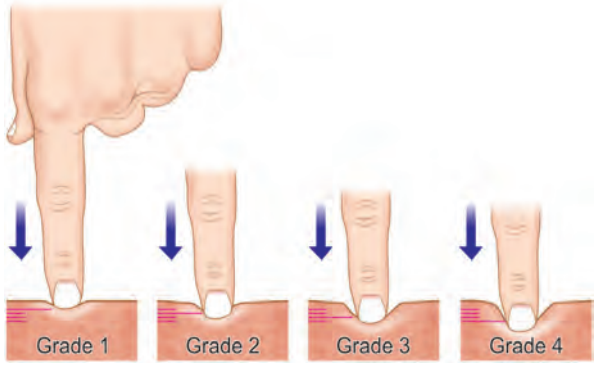
Actinic keratosis
An actinic keratosis (ak-TIN-ik ker-uh- TOE-sis) is a rough, scaly patch on the skin that develops from years of sun exposure. It is often observed on the face, lips, ears, forearms, scalp, neck or back of the hands.

Benign pigmented nevus or mole
Melanin pigment cells are found in small numbers in the basal layer of skin. These neuroectodermal cells may proliferate at the dermoepidermal junction, to form naevi of different sizes and forms.

Palpation:

- Assess the quality of scale or keratosis, texture changes and sweating differences.
- For localized lesions, palpation identifies tenderness, consistency, induration, depth and fixation.
- Palpate the temperature of skin and also note the texture and moisture.
- Check for thickness and sensitivity of skin.
- Apply pressure with a gloved finger to further assess for blanching, if erythema is present.
- Palpate edema. The scale is given as follows:

Grade 1	0–2 mm indentation; rebounds immediately.
Grade 2	3–4 mm indentation; rebounds in <15 seconds.
Grade 3	5–6 mm indentation; up to 30 seconds to rebound.
Grade 4	8 mm indentation; >20 seconds to rebound.



NURSING DIAGNOSES

- **Impaired skin integrity:**
  - Common cause of impaired skin integrity in patients is friction that is due to rubbing heels or elbows toward bed linen and moving them up in bed without using a lift sheet.
  - Another common cause of shear is elevating the head of the patient's bed. It is because the body's weight gets shifted downward onto the patient's sacrum.
  - The main reason is compression of skin resulting in reduced blood flow. It leads to bed sores.

  Braden scale (Table 11.5) helps to assess the risk of developing damage to skin integrity.
- **Poor skin turgor:** Suggests dehydration which may be a sign of underlying disease.
- **Acute pain:** Suggests impairment of tissue and surrounding regions.
- **Immobility:** Suggests development of pressure ulcers.
- **Rise in temperature:** May indicate infection in body.

TABLE 11.5: Braden scale for predicting pressure sore risk

Patient's name_____ **Evaluator's name**_____ **Date of assessment**

Sensory perception Ability to respond meaning fully to pressure-related discomfort.	**1. Completely limited** Unresponsive (does not moan, flinch or grasp) to painful stimuli, due to diminished level of consciousness or sedation. OR limited ability to feel pain over most of body.	**2. Very limited** Responds only to painful stimuli. Cannot communicate discomfort except by moaning or restlessness. OR The patient has a sensory impairment which limits the ability to feel pain or discomfort over 1/2 of body.	**3. Slightly limited** Responds to verbal commands, but cannot always communicate discomfort or the need to be turned OR The patient has some sensory impairment which limits ability to feel pain or discomfort in 1 or 2 extremities.	**4. No impairment** Responds to verbal commands. Has no sensory deficit which would limit ability to feel or voice pain or discomfort.
Moisture Degree to which skin is exposed to moisture.	**1. Constantly moist** Skin is kept moist almost constantly by perspiration, urine, etc., Dampness is detected every time patient is moved or turned.	**2. Very moist** Skin is often, but not always moist. Linen must be changed at least once a shift.	**3. Occasionally moist** Skin is occasionally moist, requiring an extra linen change approximately once a day.	**4. Rarely moist** Skin is usually dry, linen only requires changing at routine intervals.
Activity Degree of physical activity.	**1. Bedfast** Confined to bed.	**2. Chairfast** Ability to walk severely limited or nonexistent. Cannot bear own weight and/or must be assisted into chair or wheelchair.	**3. Walks occasionally** During day, but for very short distances, with or without assistance. Spends majority of each shift in bed or chair.	**4. Walks frequently** Outside room at least twice a day and inside room at least once every 2 hours during waking hours.
Mobility Ability to change and control body position.	**1. Completely immobile** Does not make even slight changes in body or extremity position without assistance.	**2. Very limited** Makes occasional slight changes in body (or extremity) position but unable to make frequent or significant changes independently.	**3. Slightly limited** Makes frequent though slight changes in body or extremity position independently.	**4. No limitation** Makes major and frequent changes in position without assistance.

Patient's name_____	Evaluator's name _____			Date of assessment
Nutrition Usual food intake pattern	**1. Very poor** Never eats a complete meal. Rarely eats >1/2 of any food offered. Eats two servings or less of protein (meat or dairy products) per day. Takes fluids poorly. Does not take a liquid dietary supplement. OR The patient is on NPO and/or maintained on clear liquids or IVs for >5 days.	**2. Probably inadequate** Rarely eats a complete meal and generally eats only about 1/2 of any food offered. Protein intake incudes only three servings of meat or dairy products per day. Occasionally takes a dietary supplement. OR The patient receives less than optimum amount of liquid diet or tube feeding.	**3. Adequate** Eats over half of most meals. Eats a total of four servings of protein (meat, dairy products) per day. Occasionally refuses a meal, but usually takes a supplement when offered. OR The patient is on a tube feeding or TPN regimen which probably meets most of nutritional needs.	**4. Excellent** Eats most of every meal. Never refuses a meal. Usually eats a total of four or more servings of meat and dairy products. Occasionally eats between meals. Does not require supplementation.
Friction and shear	**1. Problem** Requires moderate to maximum assistance in moving. Complete lifting without sliding against sheets is impossible. Frequently slides down in bed or chair, requiring frequent repositioning with maximum assistance. Spasticity contractures or agitation leads to almost constant friction.	**2. Potential problem** Moves feebly or requires minimum assistance. During a move, skin probably slides to some extent against sheets, chair, restraints or other devices. Maintains relatively good position in chair or bed most of the time but occasionally slides down.	**3. No apparent problem** Moves in bed and in chair independently and has sufficient muscle strength to lift up completely during move. Maintains good position in bed or chair.	

Total score	Total score of 12 or less represents high-risk				
Assess	Date	Evaluator's signature/Title	Assess	Date	Evaluator's signature/Title
1	/ /		3	/ /	
2	/ /		4	/ /	

Name-Last	First	Middle	Attending physician	Record no.	Room/Bed

NURSING IMPLICATIONS

- Implement wound care protocols
- Position the patient comfortably
- Ensure adequate skin perfusion
- Determine the patient's continence and skin moisture
- Alleviate the pressure
- Promote proper nutrition and fluids
- Protect the skin from further injury
- Coordinate with a wound/ostomy specialist
- Avoid irritation
- Manage the ostomy pouch
- Encourage the patient to increase fluid intake
- Bed sores can be prevented by:
  - **Shift weight frequently:** Repositioning about once an hour.
  - **Lift the weight, if possible:** Raising body off the seat by pushing on the arms of the chair, it will let the air circulate.
  - **Look into a specialty wheelchair:** It will allow you to relieve pressure.
  - Select cushion or a mattress that relieves pressure.
  - **Adjust the elevation of your bed:** Raise it not >30° this helps prevent shearing.

Tips to keep skin healthy: To keep skin healthy, consider the following suggestions for skin care:

- **Keep skin clean and dry to** limit the skin's exposure to moisture, urine and stool.
- **Protect the skin** and use moisture barrier creams to protect the skin from urine and stool. Change bedding and clothing frequently as and when needed. Watch for

buttons on the clothing and wrinkles in the bedding that irritate the skin.
- **Inspect the skin daily** for warning signs of a pressure sore. Treatments help to manage symptoms. Incorporating changes in lifestyle helps in keeping the diseases away.

AGING CHANGES TO BE REMEMBERED

Changes in Skin During Pregnancy
- Stretch marks on the belly region and limbs are seen.
- Dark spots on the breasts, nipples or inner thighs.
- Melasma—brown patches on the face around the cheeks, nose and forehead.

Changes in Skin of Elders
- With aging, the epidermis thins although the number of cell layers remain unchanged.
- The number of melanocytes decreases but size increases. Aged skin looks thinner, paler and clear (translucent).
- Changes in the connective tissue reduce the strength and elasticity of skin—elastosis.
- Sebaceous glands produce less oil when one grows older. The subcutaneous fat layer thins therefore, it reduces insulation and padding.
- The sweat glands produce less sweat.
- Rough patches, warts and blemishes are more common in older people.

CASE STUDY

Case 1 A young child got burnt with boiling water. He got burn injuries in front of trunk. Discuss the areas of burnt skin differences between an adult and a child? How much area is affected by burn?

Discussion:

In order to assess the area involved in burns, one can follow the **Rule of Nine:**
- Head and neck 9%
- Each upper limb 9%
- The front of the trunk 18%
- The back of the trunk (including buttocks) 18%
- Each lower limb 18%; and perineum 1%

Skin area burnt	Child	Adult
Front of trunk	18%	18%
Back of trunk	18%	18%
Right upper limb	9%	9%
Left upper limb	9%	9%
Head and neck	18%	18%
Perineum	1%	1%
Right lower limb	13.5%	18%
Left lower limb	13.5%	18%
Total	100%	100%

The child's 18% area is affected by burn.

STUDENT ASSIGNMENT

LONG ANSWER QUESTIONS

1. What is thermoregulation? How does it help to regulate the body temperature?
2. What do you understand by the term 'skin'? Differentiate between thick and thin skin.
3. Discuss in detail the various functions of skin.
4. Name the features and contents of superficial fascia.
5. Enumerate the modifications of deep fascia. Tabulate the differences between superficial and deep fascia.

SHORT ANSWER QUESTIONS

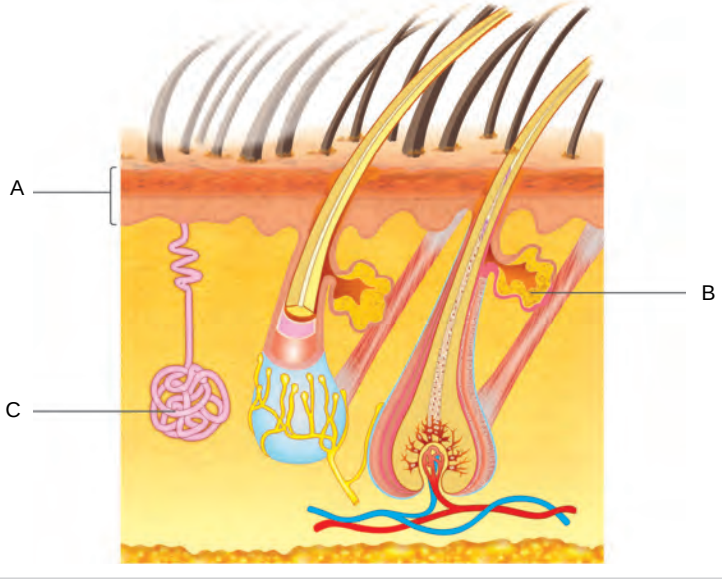
1. Enumerate the layers of epidermis of thick skin.
2. Describe the hair follicle.
3. Name the appendages of skin and their main functions.

   Write a short note on:

   a. Mole
   b. Boil
   c. Scabies
   d. Keloid
   e. Vitiligo

IMAGE-BASED QUESTION

1. Label A, B, C in the image given here.



TRUE OR FALSE

1. Thick skin has no hair.
2. Thick skin has no sweat glands.
3. Thin skin has sebaceous glands.
4. Pacinian's corpuscles are for touch.
5. Meissner's corpuscles are for vibration.
6. Merkel cell endings are for pressure.
7. Free nerve endings are for pain.

GIVE ONE WORD ANSWER

1. How many epithelial layers are there in thick and thin skin? _____
2. Mention the nerve supply of muscle attached between hair follicles and dermis of skin? _____
3. Nerve endings in the epidermis and dermis. _____
4. Secretion of sebaceous gland. _____
5. What type of gland is sebaceous gland? _____

MULTIPLE CHOICE QUESTIONS

1. The outermost layer of the skin is known as:
   a. Cutaneous b. Subcutaneous
   c. Dermis d. Epidermis

2. The layers of epidermis from outer side to inner side is:
   a. Corneum – granulosum – germinative – lucidum
   b. Corneum – lucidum – germinative – granulosum
   c. Corneum – lucidum – granulosum – germinative
   d. Lucidum – Corneum – granulosum – germinative

3. Melanocytes secrete:
   a. Sebum b. Melanin
   c. Sweat d. All of these

4. Main mechanism in thermoregulation heat loss is:
   a. Radiation
   b. Evaporation
   c. Conduction
   d. Convection

5. Which of these layers has shedding of cells occurring continuously due to wear and tear?
   a. Stratum corneum
   b. Stratum lucidum
   c. Stratum granulosum
   d. Stratum spinosum

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