Nursing Level III

NTQF Level III

Learning guide -15

Unit of Competence	**Provid Basic First aid and Emergency Care**
Module Title:	**Providing Basic First aid and Emergency Care**
LG Code:	**HLT NUR3 LO1 LG-13**
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TTLM Code:	**HLT NUR3 M LO 1TTLM, 09 2019 V1**

LO: 1 Introduce general human anatomy and physiology

Instruction Sheet	Learning Guide #

This learning guide is developed to provide you the necessary information regarding the following content coverage and topics –

- Introduction to human anatomy
- Anatomy and physiology of integumentary system
- Anatomy and physiology of musculoskeletal system
- Anatomy and physiology of respiratory system
- Anatomy and physiology of digestive system
- Anatomy and physiology of cardiovascular system
- Anatomy and physiology of genitourinary system
- Anatomy and physiology of endocrine system
- Anatomy and physiology of nervous system
- Anatomy and Physiology of head, eye, ear, nose and trout (HEENT)
- Anatomy and physiology of the reproductive system

This guide will also assist you to attain the learning outcome stated in the cover page.
Specifically, upon completion of this Learning Guide, you will be able to

Define Introduction to anatomy

Describe Anatomy and physiology of integumentary system

Explain Anatomy and physiology of musculoskeletal system

Describe Anatomy and physiology of respiratory system

Describe Anatomy and physiology of digestive system

Describe Anatomy and physiology of cardiovascular system

Describe Anatomy and physiology of genitourinary system

Describe Anatomy and physiology of endocrine system

Describe Anatomy and physiology of nervous system

Describe Anatomy and Physiology of head, eye, ear, nose and trout (HEENT)

Describe Anatomy and physiology of the reproductive system

Learning Instructions:

1. Read the specific objectives of this Learning Guide.
2. Follow the instructions described in number 3 to 11.
3. Read the information written in the information “Sheet 1, Sheet 2, Sheet 3, Sheet 4 Sheet 5, Sheet 6, Sheet 7, Sheet 8, Sheet 9, Sheet 10 and Sheet 11”.
4. Accomplish the “Self-check 1, Self-check t 2, Self-check 3 , Self-check 4, Self-check 5 , Self-check 6, Self-check 7, Self-check 8 , Self-check 9 , Self-check 10 , Self-check 11 ” in page 9, 17, 34, 54, 64, 75, 84, 93, 117, 126, and 143 respectively.
5. Ask from your trainer the key to correction (key answers) or you can request your trainer to correct your work. (You are to get the key answer only after you finished answering the Self-check 1).
6. Submit your accomplished Self-check. This will form part of your training portfolio.
7. Your trainer will give you feedback and the evaluation will be either satisfactory or unsatisfactory. If unsatisfactory, your trainer shall advice you on additional work. But if satisfactory you can proceed to Learning Guide #2.

Information Sheet-1	Introduce general human anatomy and physiology

1 .Introduction to human anatomy

1.1 Introduction - Anatomy is the science of the structure of the body. When used without qualification, the term is applied usually to human anatomy. The word is derived indirectly from the Greek anatome, a term built from ana, meaning "up," and tome, meaning "a cutting" (compare the words tome, microtome, and epitome). From an etymological point of view, the term" dissection" (dis-, meaning" asunder, " and secare, meaning "to cut") is the Latin equivalent of the Greek anatome.

1.2 Terms of position and direction

All descriptions in human anatomy are expressed in relation to the anatomical position, a convention whereby the body is erect, with the head, eyes, and toes directed forward and the upper limbs by the side and held so that the palms of the hands face forward. There is no implication that the anatomical position is one of rest. It is often necessary, however, to describe the position of the viscera also in the recumbent posture, because this is a posture in which patients are frequently examined clinically.

The median plane is an imaginary vertical plane of section that passes longitudinally through the body and divides it into right and left halves. The median plane intersects the surface of the front and back of the body at what are called the anterior and posterior me dian lines. It is a common error, however, to refer to the" midline" when the median plane is meant.

Any vertical plane through the body that is parallel with the median plane is called a sagittal plane. The sagittal planes are named after the sagittal suture of the skull, to which they are parallel. The term "parasagittal" is redundant: anything parallel with a sagittal plane is still sagittal.

Any vertical plane that intersects the median plane at a right angle and separates the body into anterior and posterior parts is termed a coronal, or frontal, plane.

The term horizontal plane refers to a plane at a right angle to both the median and coronal planes: it separates the body into superior and inferior parts. This is often termed an axial plane, particularly in radiology.

The term transverse means at a right angle to the longitudinal axis of a structure. Thus, a transverse section through an artery is not necessarily horizontal. A transverse section through the hand is horizontal, whereas a transverse section through the foot is coronal

The term medial means nearer to the median plane, and lateral means farther from it. Thus, in the anatomical position, the thumb is lateral to the little finger, whereas the big toe is medial to the little toe. Intermediate means lying between two structures, one of which is medial and the other lateral. In the upper limb radial means lateral and ulnar means medial: in the lower limb fibular or peroneal means lateral and tibial means medial. The border of a limb on which either the thumb or the big toe is situated is sometimes called preaxial, and the opposite border, postaxial. These two terms are based on the arrangement of the limbs in the embryo during the sixth postovulatory week, when the thumbs and the big toes are both on the rostral border of the limbs

Medial and lateral rotation (which should never be referred to as internal and external) means rotation (e.g., of the hip) around a vertical axis so that the anterior aspect of the part moves medially or laterally, respectively.

Anterior or ventral means nearer the front of the body. Posterior or dorsal means nearer the back. In the upper limb the term palmar (formerly volar) means anterior. In the foot, plantar means inferior, and the term dorsal is commonly used for superior in the foot.

Superior means nearer the top or upper end of the body. Inferior means nearer the lower end. Cranial or cephalic is sometimes used in stead of superior, and caudal instead of inferior. Rostral means nearer the "front end," that is, the region of the nose and mouth. this is superior in the most of the body althoug it represents the anterior aspect of the head.

The suffix "-ad" is sometimes added to a positional term to indicate the idea of motion. Thus, cephalad means proceeding toward the head. Such terms are useful occasionally in describing growth processes, but their application is best limited.

In the limbs, proximal and distal are used to indicate, respectively, nearer to and farther from the root or attached end of the limb. (Proximal and distal have a special meaning in the case of the teeth.)

Internal and external mean, respectively, nearer to and farther from the center of an organ or a cavity. Superficial and deep mean, respectively, nearer to and farther from the surface of the body.

The term middle is used for a structure lying between two others that are anterior and posterior, or superior and inferior, or internal and external.

In addition to the technical terms of position and direction, certain common expressions may be cautiously used in anatomical descriptions: front, back, in front of, behind, forward, backward, upper, lower, above, below, upward, downward, ascending, descending. These terms are free of ambiguity only if they are used in reference to the anatomical position. A number of other common terms, such as "under," however, are generally best avoided. In this work we will use technical terms of position and direction.

1.3 Definition of Human anatomy: Two branches of science—anatomy and physiology—provide the foundation for understanding the body's parts and functions. **Anatomy** (a-NAT-o¯-me¯; *ana-* _ up; *-tomy* _ process of cutting) is the science of body *structures* and the relationships among them. It was first studied by **dissection** (dis-SEK-shun; *dis-* _ apart; *-section* _ act of cutting), the careful cutting apart of body structures to study their relationships.

Anatomy deals with structures of the body, **physiology** (fiz_-e¯-OL-o¯-je¯; *physio-* _ nature; *-logy* _ study of) is the science of body *functions*—how the body parts work. Because structure and function are so closely related, you will learn about the human body by studying its anatomy and physiology together. The structure of a part of the body allows performance of certain functions. For example, the bones of the skull join tightly to form a rigid case that protects the brain. The bones of the fingers are more loosely joined to allow a variety of movements.

In human body from the smallest to the largest, there are six levels of organization will help you to understand anatomy and physiology: the chemical cellular, tissue, organ, system, and organism levels of organization.

1.4 Levels of structural

The levels of structural organization are chemical, cellular, tissue, organ, system, and organismal.

1.4.1 Chemical level. This very basic level can be compared to the letters of the alphabet and includes **atoms,** the smallest units of matter that participate in chemical reactions, and **molecules,** two or more atoms joined together. Two familiar molecules found in the body are deoxyribonucleic acid (DNA), the genetic material passed from one generation to the next, and glucose, commonly known as blood sugar.

1.4.2. Cellular level. Molecules combine to form **cells,** the basic structural and functional units of an organism. Cells are the smallest living units in the human body. Among the many kinds of cells in your body are muscle cells, nerve cells, and epithelial cells. Figure 1 shows a smooth muscle cell, one of the three types of muscle cells in the body.

1.4.3. Tissue level. Tissues are groups of cells and the materials surrounding them that work together to perform a particular function, similar to the way words are put together to form sentences. There are just four basic types of tissue in your body: *epithelial tissue*, *connective tissue*, *muscular tissue*, and *nervous tissue.*

1.4.4 Organ level. At this level different types of tissues are joined together. **organs** are structures that are composed of two or more different types of tissues; they have specific functions and usually have recognizable shapes. Examples of organs are the stomach, skin, bones, heart, liver, lungs, and brain. Figure 1

1.4.5 System level. A system consists of related organs with a common function. An example of the system level, also called the **organ-system level,** is the digestive system, which breaks down and absorbs food. Its organs include the mouth, salivary glands, pharynx (throat), esophagus, stomach, small intestine, large intestine, liver, gallbladder, and pancreas. Sometimes an organ is part of more than one system. The pancreas, for example, is part of both the digestive system and the hormone- producing endocrine system.

1.4.6. Organismal level. An **organism,** any living individual can be compared to a book in our analogy. All the parts of the human body functioning together constitute the total organism.

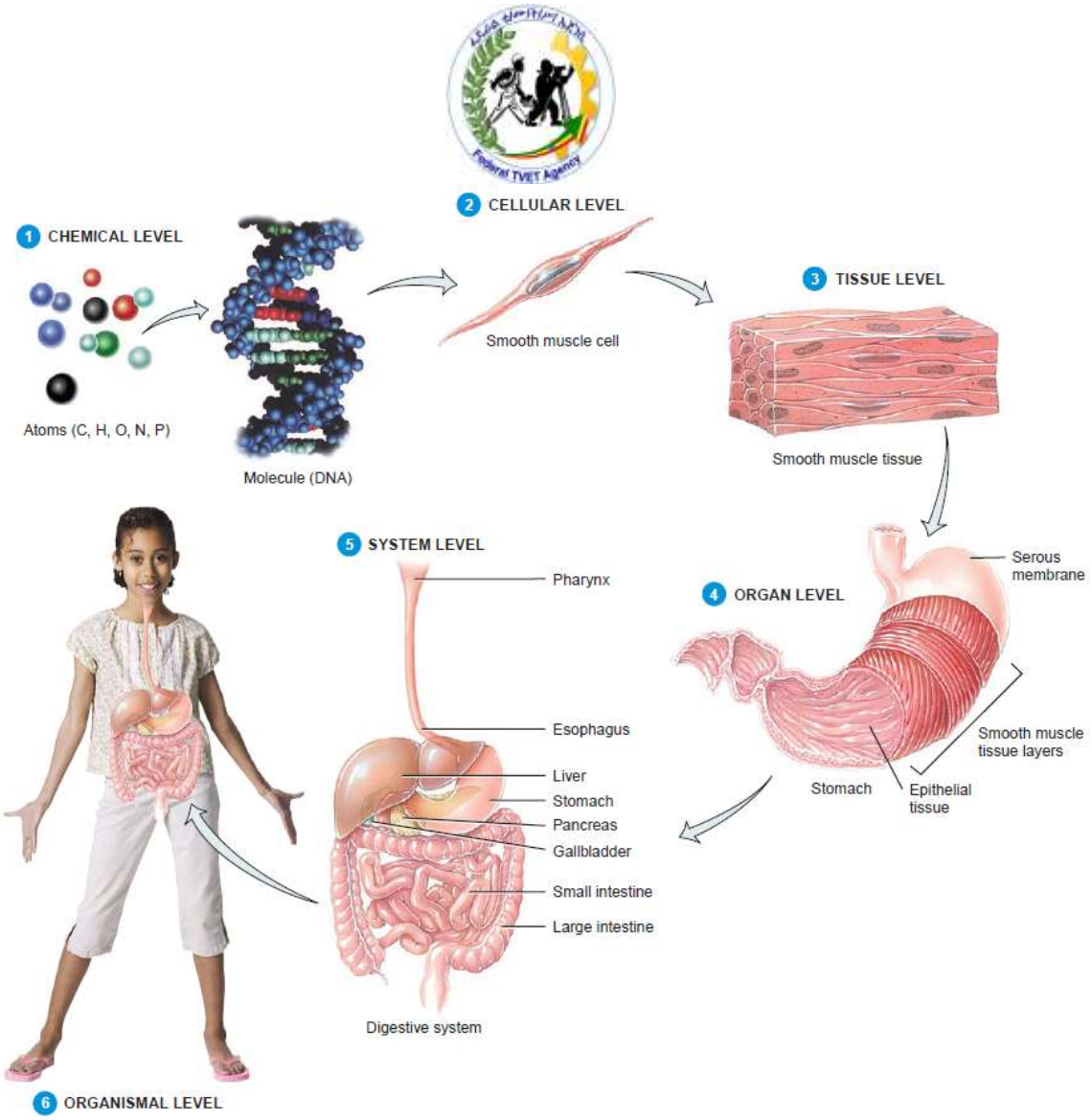

Figure 1: Levels of structural organization in the human body.

Self-Check 1	Written Test

Directions: Answer all the questions listed below. Use the Answer sheet provided in the next page:

1. Which level of structural organization is composed of two or more different types of tissues that work together to perform a specific function? (3 points)
2. Which type of plane would include the entire length of the vertebral column? (3 points)
3. Which types of planes would pass through both shoulder joints? (3 points)
4. Which type of plane is transverse to (a) the little finger, (b) the big toe, and (c) the neck? (4 points)
5. How is the thigh moved into a position of flexion, abduction, and lateral rotation? (5 points)

Note: **Satisfactory rating - 12 points Unsatisfactory - below 10 points**

You can ask you teacher for the copy of the correct answers.

Answer Sheet

Score = _____
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Short Answer Questions

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Information Sheet 2	2.1 Anatomy and physiology of integumentary system are described

2. T H E I N T E G U M E N TA R Y S Y S T E M

2.1 The integumentary (in-teg-u--MEN-tar-e-; *in* _ inward; *tegere* _ to cover) **system** is composed of the skin, hair, oil and sweat glands, nails, and sensory receptors. The integumentary system helps maintain a constant body temperature, protects the body, and provides sensory information about the surrounding environment

2.2 Components of the integumentary system.; The skin consists of a superficial, thin epidermis and a deep, thicker dermis Deep to the skin is the subcutaneous layer, which attaches the dermis to underlying fascia.

- The **skin** (also known as the **cutaneous membrane** or **integument)** covers the external surface of the body and is the largest organ of the body in both surface area and weight. The skin consists of two main parts (Figure 2). The superficial, thinner portion, which is composed of *epithelial tissue*, is the **epidermis** (ep_-i- DERM-is; *epi-* _ above). The deeper, thicker *connective tissue* portion is the **dermis.**

- Epidermis: is composed of keratinized stratified squamous epithelium. It contains four 8principal types of cells: keratinocytes, melanocytes, Langerhans cells, and Merkel cells. About 90% of epidermal cells are **keratinocytes** (ker-a-TIN-o¯-sı¯ts; *keratino-* _ hornlike; *-cytes* _ cells), which are arranged in four or five layers and produce the protein **keratin.** keratin is a tough, fibrous protein that helps protect the skin and underlying tissues from heat, microbes, and chemicals. Keratinocytes also produce lamellar granules, which release a water-repellent sealant that decreases water entry and loss and inhibits the entry of foreign materials. About 8% of the epidermal cells are **melanocytes** (MEL-ano¯-sı¯ts; *melano-* _ black), which develop from the ectoderm of a developing embryo and produce the pigment melanin. **Melanin** is a yellow-red or brown-black pigment that contributes to skin color and absorbs damaging ultraviolet (UV) light.

- Langerhans cells (LANG-er-hans) arise from red bone marrow and migrate to the epidermis (Figure 2), where they constitute a small fraction of the epidermal cells.

Merkel cells are the least numerous of the epidermal cells. They are located in the deepest layer of the epidermis, where they contact the flattened process of a sensory neuron (nerve cell), a structure called a **Merkel (tactile) disc** Merkel cells and their associated Merkel discs detect touch sensations.

Stratum Basale

The deepest layer of the epidermis is the **stratum basale** (ba-SA-le¯; *basal*- _ base), composed of a single row of cuboidal or columnar keratinocytes. Some cells in this layer are *stem cells* that undergo cell division to continually produce new keratinocytes.

Stratum Spinosum

Superficial to the stratum basale is the **stratum spinosum** (spi-NO¯ -sum; *spinos*- _ thornlike), arranged in 8 to 10 layers of many-sided keratinocytes fitting closely together. These keratinocytes have the same organelles as cells of the stratum basale.

Stratum Corneum

The **stratum corneum** (COR-ne¯-um; *corne*- _ horn or horny) consists on average of 25 to 30 layers of flattened dead keratinocytes. These cells are continuously shed and replaced by cells from the deeper strata

Dermis

The second, deeper part of the skin, the **dermis,** is composed of a strong connective tissue containing collagen and elastic fibers. Based on its tissue structure, the dermis can be divided into a superficial papillary region and a deeper reticular region. The **papillary region** makes up about one-fifth of the thickness of the total layer (see Figure 2). It consists of areolar connective tissue containing thin collagen and fine elastic fibers.

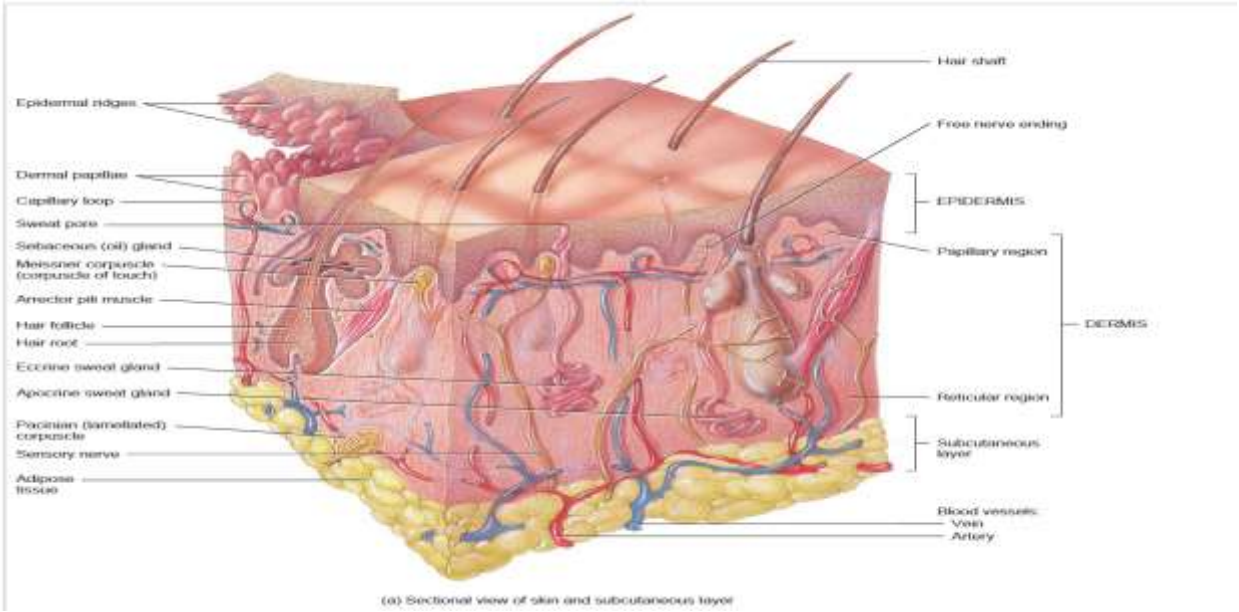

Fig 2: Structure of skin

2.3 Accessory structures of the skin—hair, skin glands, and nails—develop from the embryonic epidermis. They have a host of important functions. For example, hair and nails protect the body, and sweat glands help regulate body temperature.

2.4 Function of Skin

1. Skin functions include body temperature regulation, blood storage, protection, sensation, excretion and absorption, and synthesis of vitamin D.

2. The skin participates in thermoregulation by liberating sweat at its surface and by adjusting the flow of blood in the dermis.

3. The skin provides physical, chemical, and biological barriers that help protect the body.

4. Cutaneous sensations include tactile sensations, thermal sensations, and pain.

2.5 Hairs, or *pili* (PI-le¯), are present on most skin surfaces except the palms, palmar surfaces of the fingers, the soles, and plantar surfaces of the feet.

Each hair is composed of columns of dead, keratinized epidermal cells bonded together by extracellular protein.

Each hair follicle goes through a growth cycle, which consists of a growth stage, a regression stage, and a resting stage, Scalp hair is in the growth stage for 2 to 6 years, the regression stage

for 2 to 3 weeks, and the resting stage for about 3 months. Normal hair loss in the adult scalp is about 70–100 hairs per day. Both the rate of growth and the replacement cycle may be altered by illness, radiation therapy, chemotherapy, age, genetics, gender, and severe emotional stress. Rapid weight-loss diets that severely restrict calories or protein increase hair loss. **Alopecia** (al_-o-PE¯ -she¯ -a), the partial or complete lack of hair, may result from genetic factors, aging, endocrine disorders, chemotherapy, or skin disease.

2.6 Hair Color

The color of hair is due primarily to the amount and type of melanin in its keratinized cells. Melanin is synthesized by melanocytes scattered in the matrix of the bulb and passes into cells of the cortex and medulla of the hair (Figure 2).

Dark-colored hair contains mostly eumelanin; blond and red hair contain variants of pheomelanin. Hair becomes gray because of a progressive decline in melanin production; gray hair contains only a few melanin granules. White hair results from the lack of melanin and the accumulation of air bubbles in the shaft.

2.7 Skin Glands glands are epithelial cells that secrete a substance.

- **Sebaceous glands** (se-BA¯ -shus; *sebace-* _ greasy) or **oil glands** are simple, branched acinar glands. With few exceptions, they are connected to hair follicles. The secreting portion of a sebaceous gland lies in the dermis and usually opens into the neck of a hair follicle. Sebaceous glands secrete an oily substance called **sebum** (SE¯ -bum), a mixture of triglycerides, cholesterol, proteins, and inorganic salts.

- **Sudoriferous Glands:** There are three to four million **sweat glands,** or **sudoriferous glands** (soo_-dor-IF-er-us; *sudor-* _ sweat; *-ferous* _ bearing). The cells of these glands release sweat, or perspiration, into hair follicles or onto the skin surface through pores. Sweat glands are divided into two main types, eccrine and apocrine, based on their structure, location, and type of secretion.

- **Eccrine sweat glands** (EK-rin; *eccrine* _ secreting outwardly), also known as **merocrine sweat glands,** are simple, coiled tubular glands that are much more common than apocrine sweat glands. They are distributed throughout the skin of most regions of the body, especially in the skin of the forehead, palms, and soles.

- **Apocrine sweat glands** (AP-o--krin; *apo*- _ separated from) are also simple, coiled tubular glands. They are found mainly in the skin of the axilla (armpit), groin, areolae (pigmented areas around the nipples) of the breasts, and bearded regions of the face in adult males.

- **Nails** are plates of tightly packed, hard, dead, keratinized epidermal cells that form a clear, solid covering over the dorsal surfaces of the distal portions of the digits. Each nail consists of a nail body, a free edge, and a nail root.

- The **Nail body (plate)** is the visible portion of the nail. It is comparable to the stratum corneum of the general epidermis, with the exception that its flattened, keratinized cells fill with a harder type of keratin and do not shed

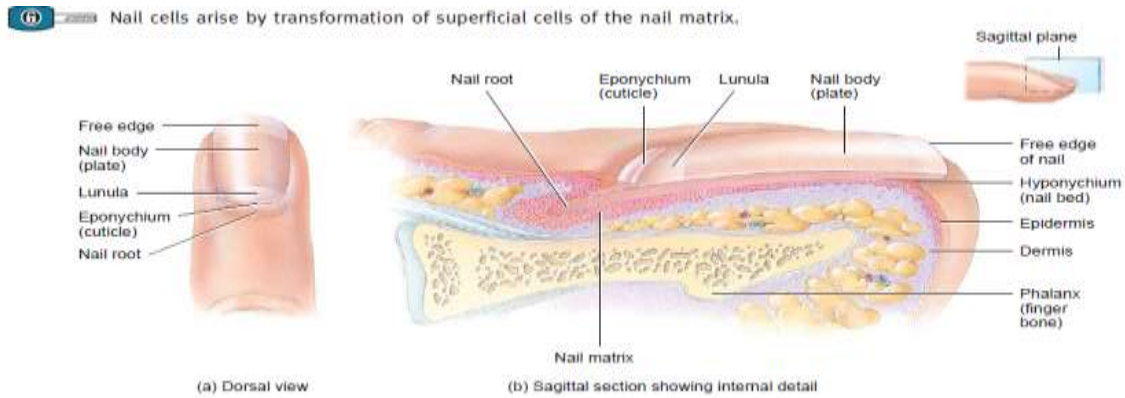

Fig 3: Nail cells arise by transformation of superficial cells of the nail matrix.

2.8 Maintaining Homeostasis: Skin Wound Healing

- In an epidermal wound, the central portion of the wound usually extends down to the dermis; the wound edges involve only superficial damage to the epidermal cells.
- Epidermal wounds are repaired by enlargement and migration of basal cells, contact inhibition, and division of migrating and stationary basal cells.
- During the inflammatory phase of deep wound healing, a blood clot unites the wound edges, epithelial cells migrate across the wound, vasodilation and increased permeability of blood vessels enhance delivery of phagocytes, and mesenchymal cells develop into fibroblasts.
- During the migratory phase, fibroblasts migrate along fibrin threads and begin synthesizing collagen fibers and glycoproteins.
- During the proliferative phase, epithelial cells grow extensively.

- During the maturation phase, the scab sloughs off, the epidermis is restored to normal thickness, collagen fibers become more organized, fibroblasts begin to disappear, and blood vessels are restored to normal.

2.9 Development of the Integumentary System

- The epidermis develops from the embryonic ectoderm, and the accessory structures of the skin (hair, nails, and skin glands) are epidermal derivatives.
- The dermis is derived from mesodermal cells.

2.10 Aging and the Integumentary System

- Most effects of aging begin to occur when people reach their late forties.
- Among the effects of aging are wrinkling, loss of subcutaneous adipose tissue, atrophy of sebaceous glands, and decrease in the number of melanocytes and Langerhans cells.

Self-Check 2	Written Test

1. What structures are included in the integumentary system? (3 Point)
2. How does the process of keratinization occur? (3 Point)
3. What are the structural and functional differences between the epidermis and dermis? (3 Point)
4. Describe the layers of the epidermis and the cells that compose them. (3 Point)
5. Compare the composition of the papillary and reticular regions of the dermis. (3 Point)
6. Explain the basis for different skin colors. (3 Point)
7. What types of tissues make up the epidermis and the dermis? (3 Point)
8. In what two ways does the skin help regulate boy temperature? (2 Point)
9. How does the skin serve as a protective barrier? (2 Point)

Note: **Satisfactory rating - 14 points Unsatisfactory - below 14 points**

You can ask you teacher for the copy of the correct answers.

Answer Sheet

Score = _____
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Information Sheet 3	1.3. Anatomy and physiology of musculoskeletal system

3.1 Introduction: A bone is made up of several different tissues: bone or osseous tissue, cartilage, dense connective tissues, epithelium, adipose tissue, and nervous tissue.

- The entire framework of bones and their cartilages constitutes the skeletal system.

3.2 Functions of Bone and the Skeletal System

- The skeletal system functions in support, protection, movement, mineral homeostasis, blood cell production, and triglyceride storage.

3.3 Structure of Bone

- Parts of a typical long bone are the diaphysis (shaft), proximal and distal epiphyses (ends), metaphyses, articular cartilage, periosteum, medullary (marrow) cavity, and endosteum.

3.4 Histology of Bone Tissue

- Bone tissue consists of widely separated cells surrounded by large amounts of extracellular matrix.
- The four principal types of cells in bone tissue are osteogenic cells, osteoblasts, osteocytes, and osteoclasts.
- The extracellular matrix of bone contains abundant mineral salts (mostly hydroxyapatite) and collagen fibers.
- Compact bone tissue consists of osteons (haversian systems) with little space between them.
- Compact bone tissue lies over spongy bone tissue in the epiphyses and makes up most of the bone tissue of the diaphysis. Functionally, compact bone tissue is the strongest form of bone and protects, supports, and resists stress.
- Spongy bone tissue does not contain osteons. It consists of trabeculae surrounding many red bone marrow–filled spaces.
- Spongy bone tissue forms most of the structure of short, flat, and irregular bones, and the interior of the epiphyses in long bones.
- Functionally, spongy bone tissue trabeculae offer resistance along lines of stress, support and protect red bone marrow, and make bones lighter for easier movement.

3.5 Blood and Nerve Supply of Bone

- Long bones are supplied by periosteal, nutrient, metaphyseal, and epiphyseal arteries; veins accompany the arteries.
- Nerves accompany blood vessels in bone; the periosteum is rich in sensory neurons.

3.6 Bone Formation

- Bone forms by a process called ossification (osteogenesis), which begins when mesenchymal cells become transformed into osteogenic cells. These undergo cell division and give rise to cells that differentiate into osteoblasts, osteoclasts, and osteocytes.
- Ossification begins during the sixth week of embryonic life. The two types of ossification, intramembranous and endochondral, involve the replacement of a preexisting connective tissue with bone.
- Intramembranous ossification refers to bone formation directly within mesenchyme arranged in sheetlike layers that resemble membranes.
- Endochondral ossification refers to bone formation within hyaline cartilage that develops from mesenchyme. The primary ossification center of a long bone is in the diaphysis. Cartilage degenerates, leaving cavities that merge to form the medullary cavity. Osteoblasts lay down bone. Next, ossification occurs in the epiphyses, where bone replaces cartilage, except for the epiphyseal plate.
- The epiphyseal (growth) plate consists of four zones: zone of resting cartilage, zone of proliferating cartilage, zone of hypertrophic cartilage, and zone of calcified cartilage.
- Because of the cell division in the epiphyseal (growth) plate, the diaphysis of a bone increases in length.
- Bone grows in thickness or diameter due to the addition of new bone tissue by periosteal osteoblasts around the outer surface of the bone (appositional growth).
- Bone remodeling is an ongoing process in which osteoclasts carve out small tunnels in old bone tissue and then osteoblasts rebuild it.
- In bone resorption, osteoclasts release enzymes and acids that degrade collagen fibers and dissolve mineral salts.

- Dietary minerals (especially calcium and phosphorus) and vitamins (A, C, D, K, and B12) are needed for bone growth and maintenance. Insulinlike growth factors (IGFs), human growth hormone, thyroid hormones, and insulin stimulate bone growth.
- Sex hormones slow resorption of old bone and promote new bone deposition.
- A fracture is any break in a bone.
- Fracture repair involves formation of a fracture hematoma, a fibrocartilaginous callus, and a bony callus, and bone remodeling.
- Types of fractures include closed (simple), open (compound), comminuted, greenstick, impacted, stress, Pott's, and Colles'.

3.7 Bone's Role in Calcium Homeostasis

- Bone is the major reservoir for calcium in the body.
- Parathyroid hormone (PTH) secreted by the parathyroid gland increases blood Ca2_ level. Calcitonin (CT) from the thyroid gland has the potential to decrease blood Ca2_ level. Vitamin D enhances absorption of calcium and phosphate and thus raises the blood levels of these substances.

3.8 Exercise and Bone Tissue

- Mechanical stress increases bone strength by increasing deposition of mineral salts and production of collagen fibers.
- Removal of mechanical stress weakens bone through demineralization and collagen fiber reduction.

3.9 Aging and Bone Tissue

- The principal effect of aging is demineralization, a loss of calcium from bones, which is due to reduced osteoblast activity.
- Another effect is decreased production of extracellular matrix proteins (mostly collagen fibers), which makes bones more brittle and thus more susceptible to fracture.

3.10 THE AXIAL SKELETON

3.10.1 Introduction

- Bones protect soft body parts and make movement possible; they also serve as landmarks for locating parts of other body systems.

- The musculoskeletal system is composed of the bones, joints, and muscles working together.

3.10.2 Divisions of the Skeletal System

- The axial skeleton consists of bones arranged along the longitudinal axis. The parts of the axial skeleton are the skull, auditory ossicles (ear bones), hyoid bone, vertebral column, sternum, and ribs.
- The appendicular skeleton consists of the bones of the girdles and the upper and lower limbs (extremities). The parts of the appendicular skeleton are the pectoral (shoulder) girdles, bones of the upper limbs, pelvic (hip) girdles, and bones of the lower limbs.

3.11Types of Bones

- On the basis of shape, bones are classified as long, short, flat, irregular, or sesamoid. Sesamoid bones develop in tendons or ligaments.
- Sutural bones are found within the sutures of some cranial bones.

3.12 Bone Surface Markings

- Surface markings are structural features visible on the surfaces of bones.
- Each marking—whether a depression, an opening, or a process—is structured for a specific function, such as joint formation, muscle attachment, or passage of nerves and blood vessels (see

3.13 Skull

- The 22 bones of the skull include cranial bones and facial bones.
- The eight cranial bones are the frontal, parietal (2), temporal (2), occipital, sphenoid, and ethmoid.
- The 14 facial bones are the nasal (2), maxillae (2), zygomatic (2), lacrimal (2), palatine (2), inferior nasal conchae (2), vomer, and mandible.
- The nasal septum consists of the vomer, perpendicular plate of the ethmoid, and septal cartilage. The nasal septum divides the nasal cavity into left and right sides.
- Seven skull bones form each of the orbits (eye sockets).
- The foramina of the skull bones provide passages for nerves and blood vessels

- Sutures are immovable joints that connect most bones of the skull. Examples are the coronal, sagittal, lambdoid, and squamous sutures.
- Paranasal sinuses are cavities in bones of the skull that are connected to the nasal cavity. The frontal, sphenoid, and ethmoid bones and the maxillae contain paranasal sinuses.
- Fontanels are mesenchyme-filled spaces between the cranial bones of fetuses and infants. The major fontanels are the anterior, posterior, anterolaterals (2), and posterolaterals (2). After birth, the fontanels fill in with bone and become sutures.

3.14 Hyoid Bone

- The hyoid bone is a U-shaped bone that does not articulate with any other bone.
- It supports the tongue and provides attachment for some tongue muscles and for some muscles of the pharynx and neck.

3.15 Vertebral Column

- The vertebral column, sternum, and ribs constitute the skeleton of the body's trunk.
- The 26 bones of the adult vertebral column are the cervical vertebrae (7), the thoracic vertebrae (12), the lumbar vertebrae (5), the sacrum (5 fused vertebrae), and the coccyx (usually 4 fused vertebrae).
- The adult vertebral column contains four normal curves (cervical, thoracic, lumbar, and sacral) that provide strength, support, and balance.
- Each vertebra usually consists of a body, vertebral arch, and seven processes. Vertebrae in the different regions of the column vary in size, shape, and detail.

3.16 Thorax

- The thoracic skeleton consists of the sternum, ribs, costal cartilages, and thoracic vertebrae.
- The thoracic cage protects vital organs in the chest area and upper abdomen.

3.17 THE APPENDICULAR SKELETON

The bones of the appendicular skeleton contribute to homeostasis by providing attachment points and leverage for muscles, which aids body movements; by providing support and protection of internal organs, such as the reproductive organs; and by storing and releasing calcium

3.17.1Pectoral (Shoulder) Girdle

- Each of the body's two pectoral (shoulder) girdles consists of a clavicle and scapula.
- Each pectoral girdle attaches an upper limb to the axial skeleton.

3.17.2 Upper Limb (Extremity)

- Each of the two upper limbs (extremities) contains 30 bones.
- The bones of each upper limb include the humerus, the ulna, the radius, the carpals, the metacarpals, and the phalanges.

3.17.3 Pelvic (Hip) Girdle

- The pelvic (hip) girdle consists of two hip bones.
- Each hip bone consists of three parts: the ilium, pubis, and ischium.
- The hip bones, sacrum, and pubic symphysis form the bony pelvis.
- It supports the vertebral column and pelvic viscera and attaches the free lower limbs to the axial skeleton.
- The true pelvis is separated from the false pelvis by the pelvic brim

3.18 Comparison of Female and Male Pelves

- Bones of the male skeleton are generally larger and heavier than bones of the female skeleton. They also have more prominent markings for muscle attachments.
- The female pelvis is adapted for pregnancy and childbirth. Sex related differences in pelvic structure are listed and illustrated in

3.19 Lower Limb (Extremity)

- Each of the two lower limbs (extremities) contains 30 bones.
- The bones of each lower limb include the femur, the patella, the tibia, the fibula, the tarsals, the metatarsals, and the phalanges.
- The bones of the foot are arranged in two arches, the longitudinal arch and the transverse arch, to provide support and leverage.

3.20 Development of the Skeletal System

- Most bones form from mesoderm by intramembranous or endochondral ossification; much of the skeleton of the skull arises from ectoderm.

- Bones of the limbs develop from limb buds, which consist of mesoderm and ectoderm.

3.21 Musculature system

3.21.1 Introduction

- Motion results from alternating contraction and relaxation of muscles, which constitute 40–50% of total body weight.
- The prime function of muscle is changing chemical energy into mechanical energy to perform work.

3.21.2 Overview of Muscular Tissue

- The three types of muscular tissue are skeletal, cardiac, and smooth. Skeletal muscle tissue is primarily attached to bones; it isstriated and voluntary. Cardiac muscle tissue forms the wall of the heart; it is striated and involuntary. Smooth muscle tissue is located primarily in internal organs; it is nonstriated (smooth) and involuntary.
- Through contraction and relaxation, muscular tissue performs four important functions: producing body movements; stabilizing body positions; moving substances within the body and regulating organ volume; and producing heat.
- Four special properties of muscular tissues are (1) electrical excitability, the property of responding to stimuli by producing action potentials; (2) contractility, the ability to generate tension to do work; (3) extensibility, the ability to be extended (stretched); and (4) elasticity, the ability to return to original shape after contraction or extension.

3.22 Skeletal Muscle Tissue

- The subcutaneous layer separates skin from muscles, provides a pathway in blood vessels and nerves to enter and exit muscles, and protects muscles from physical trauma. Fascia lines the body wall and limbs that surround and support muscles, allows free movement of muscles, carries nerves and blood vessels, and fills space between muscles.
- Tendons and aponeuroses are extensions of connective tissue beyond muscle fibers that attach the muscle to bone or to other muscle. A tendon is generally ropelike in shape; an aponeurosis is wide and flat.
- Skeletal muscles are well supplied with nerves and blood vessels. Generally, an artery and one or two veins accompany each nerve that penetrates a skeletal muscle.

- Somatic motor neurons provide the nerve impulses that stimulate skeletal muscle to contract.
- Blood capillaries bring in oxygen and nutrients and remove heat and waste products of muscle metabolism.
- The major cells of skeletal muscle tissue are termed skeletal muscle fibers. Each muscle fiber has 100 or more nuclei because it arises from the fusion of many myoblasts. Satellite cells are myoblasts that persist after birth. The sarcolemma is a muscle fiber's plasma membrane; it surrounds the sarcoplasm. Transverse tubules are invaginations of the sarcolemma.
- Each muscle fiber (cell) contains hundreds of myofibrils, the contractile elements of skeletal muscle. Sarcoplasmic reticulum surrounds each myofibril. Within a myofibril are thin and thick filaments, arranged in compartments called sarcomeres.
- The overlapping of thick and thin filaments produces striations. Darker A bands alternate with lighter I bands.
- Myofibrils are composed of three types of proteins: contractile, regulatory, and structural. The contractile proteins are myosin (thick filament) and actin (thin filament). Regulatory proteins are
- tropomyosin and troponin, both of which are part of the thin filament.
- Structural proteins include titin (links Z disc to M line and stabilizes thick filament), myomesin (forms M line), nebulin (anchors thin filaments to Z discs and regulates length of thin filaments during development), and dystrophin (links thin filaments to sarcolemma). types of skeletal muscle fiber proteins.
- Projecting myosin heads contain actin-binding and ATP-binding sites and are the motor proteins that power muscle contraction.

3.23 Contraction and Relaxation of Skeletal Muscle Fibers

- Muscle contraction occurs because crossbridges attach to and "walk" along the thin filaments at both ends of a sarcomere, progressively pulling the thin filaments toward the center of a sarcomere.

- As the thin filaments slide inward, the Z discs come closer together, and the sarcomere shortens.
- The contraction cycle is the repeating sequence of events that causes sliding of the filaments: (1) Myosin ATPase hydrolyzes
- ATP and becomes energized; (2) the myosin head attaches to actin, forming a crossbridge; (3) the crossbridge generates force as it rotates toward the center of the sarcomere (power stroke); and
- (4) binding of ATP to the myosin head detaches it from actin. The myosin head again hydrolyzes the ATP, returns to its original position, and binds to a new site on actin as the cycle continues.
- An increase in Ca2_ concentration in the cytosol starts filament sliding; a decrease turns off the sliding process.
- The muscle action potential propagating into the T tubule system causes opening of Ca2_ release channels in the SR membrane.
- Calcium ions diffuse from the SR into the cytosol and combine with troponin. This binding causes tropomyosin to move away from the myosin-binding sites on actin.
- Ca2_ active transport pumps continually remove Ca2_ from the sarcoplasm into the SR. When the concentration of calcium ions in the cytosol decreases, tropomyosin slides back over and blocks the myosin-binding sites, and the muscle fiber relaxes.
- A muscle fiber develops its greatest tension when there is an optimal zone of overlap between thick and thin filaments. This dependency is the length–tension relationship.
- The neuromuscular junction (NMJ) is the synapse between a somatic motor neuron and a skeletal muscle fiber. The NMJ includes the axon terminals and synaptic end bulbs of a motor neuron, plus the adjacent motor end plate of the muscle fiber sarcolemma.
- When a nerve impulse reaches the synaptic end bulbs of a somatic motor neuron, it triggers exocytosis of the synaptic vesicles, which releases acetylcholine (ACh). ACh diffuses across the synaptic cleft and binds to ACh receptors, initiating a muscle action potential.

Acetylcholinesterase then quickly breaks down ACh into its component parts.

3.23 Muscle Metabolism

- Muscle fibers have three sources for ATP production: creatine, anaerobic cellular respiration, and aerobic cellular respiration.
- Creatine kinase catalyzes the transfer of a high-energy phosphate group from creatine phosphate to ADP to form new ATP molecules. Together, creatine phosphate and ATP provide enough energy for muscles to contract maximally for about 15 seconds.
- Glucose is converted to pyruvic acid in the reactions of glycolysis, which yield two ATPs without using oxygen. Such anaerobic cellular respiration can provide enough energy for 30–40 seconds of maximal muscle activity.
- Muscular activity that lasts longer than half a minute depends on aerobic cellular respiration, mitochondrial reactions that require oxygen to produce ATP.
- The inability of a muscle to contract forcefully after prolonged activity is muscle fatigue.
- Elevated oxygen use after exercise is called recovery oxygen uptake.

3.24 Control of Muscle Tension

- A motor neuron and the muscle fibers it stimulates form a motor unit. A single motor unit may contain as few as two or as many as 3000 muscle fibers.
- Recruitment is the process of increasing the number of active motor units.
- A twitch contraction is a brief contraction of all the muscle fibers in a motor unit in response to a single action potential.
- A record of a contraction is called a myogram. It consists of a latent period, a contraction period, and a relaxation period.
- Wave summation is the increased strength of a contraction thatboccurs when a second stimulus arrives before the muscle fiber has completely relaxed after a previous stimulus.
- Repeated stimuli can produce unfused (incomplete) tetanus, a sustained muscle contraction with partial relaxation between stimuli.
- More rapidly repeating stimuli produce fused (complete) tetanus, a sustained contraction without partial relaxation between stimuli.
- Continuous involuntary activation of a small number of motor units produces muscle tone, which is essential for maintaining posture.

- In a concentric isotonic contraction, the muscle shortens to produce movement and to reduce the angle at a joint. During an eccentric isotonic contraction, the muscle lengthens.
- Isometric contractions, in which tension is generated without muscle changing its length, are important because they stabilize some joints as others are moved.

3.25 Types of Skeletal Muscle Fibers

- On the basis of their structure and function, skeletal muscle fibers are classified as slow oxidative (SO), fast oxidative–glycolytic (FOG), and fast glycolytic (FG) fibers.
- Most skeletal muscles contain a mixture of all three fiber types.
- Their proportions vary with the typical action of the muscle.
- The motor units of a muscle are recruited in the following order: first SO fibers, then FOG fibers, and finally FG fibers.

3.26 Exercise and Skeletal Muscle Tissue

- Various types of exercises can induce changes in the fibers in a skeletal muscle. Endurance-type (aerobic) exercises cause a gradual transformation of some fast glycolytic (FG) fibers into fast oxidative–glycolytic (FOG) fibers.
- Exercises that require great strength for short periods produce an increase in the size and strength of fast–glycolytic (FG) fibers. The increase in size is due to increased synthesis of thick and thin filaments.

3.27 Cardiac Muscle Tissue

- Cardiac muscle is found only in the heart. Cardiac muscle fibers have the same arrangement of actin and myosin and the same bands, zones, and Z discs as skeletal muscle fibers. The fibers connect to one another through intercalated discs, which contain both desmosomes and gap junctions.
- Cardiac muscle tissue remains contracted 10 to 15 times longer than skeletal muscle tissue due to prolonged delivery of Ca2_ into the sarcoplasm.
- Cardiac muscle tissue contracts when stimulated by its own autorhythmic fibers. Due to its continuous, rhythmic activity, cardiac muscle depends greatly on aerobic cellular respiration to generate ATP.

3.28 Smooth Muscle Tissue

- Smooth muscle is nonstriated and involuntary.
- Smooth muscle fibers contain intermediate filaments and dense bodies; the function of dense bodies is similar to that of the Z discs in striated muscle.
- Visceral (single-unit) smooth muscle is found in the walls of hollow viscera and of small blood vessels. Many fibers form a network that contracts in unison.
- Multiunit smooth muscle is found in large blood vessels, large airways to the lungs, arrector pili muscles, and the eye, where it adjusts pupil diameter and lens focus. The fibers operate independently rather than in unison.
- The duration of contraction and relaxation of smooth muscle is longer than in skeletal muscle since it takes longer for Ca2_ to reach the filaments.
- Smooth muscle fibers contract in response to nerve impulses, hormones, and local factors.
- Smooth muscle fibers can stretch considerably and still maintain their contractile function.

3.29 Regeneration of Muscular Tissue

- Skeletal muscle fibers cannot divide and have limited powers of regeneration; cardiac muscle fibers can regenerate under limited circumstances; and smooth muscle fibers have the best capacity for division and regeneration.

3.30 Development of Muscle

- With few exceptions, muscles develop from mesoderm.
- Skeletal muscles of the head and limbs develop from general mesoderm. Other skeletal muscles develop from the mesoderm of somites.

3.31 Aging and Muscular Tissue

- With aging, there is a slow, progressive loss of skeletal muscle mass, which is replaced by fibrous connective tissue and fat.
- Aging also results in a decrease in muscle strength, slower muscle reflexes, and loss of flexibility.

3.32 T H E M U S C U L A R S Y S T E M

- The muscular system and muscular tissue of your body contribute to homeostasis by stabilizing body position, producing movements, regulating organ volume, moving substances within the body, and producing heat

3.33 How Skeletal Muscles Produce Movements

- Skeletal muscles that produce movement do so by pulling on bones.
- The attachment to the more stationary bone is the origin; the attachment to the more movable bone is the insertion.
- Bones serve as levers, and joints serve as fulcrums. Two different forces act on the lever: load (resistance) and effort.
- Levers are categorized into three types—first-class, second-class, and third-class (most common)—according to the positions of the fulcrum, the effort, and the load on the lever.
- Fascicular arrangements include parallel, fusiform, circular, triangular, and pennate. Fascicular arrangement affects a muscle's power and range of motion.
- A prime mover produces the desired action; an antagonist produces an opposite action. Synergists assist a prime mover by reducing unnecessary movement. Fixators stabilize the origin of a prime mover so that it can act more efficiently.

3.34 How Skeletal Muscles Are Named

- Distinctive features of different skeletal muscles include direction of muscle fascicles; size, shape, action, number of origins (or heads), and location of the muscle; and sites of origin and insertion of the muscle.
- Most skeletal muscles are named based on combinations of these features.

3.35 Principal Skeletal Muscles

- Muscles of facial expression move the skin rather than a joint when they contract, and they permit you to express a wide variety of emotions.
- The extrinsic muscles that move the eyeballs are among the fastest contracting and most precisely controlled skeletal muscles in the body. They permit you to elevate, depress, abduct, adduct, and medially and laterally rotate the eyeballs.

- Muscles that move the mandible (lower jaw) are also known as the muscles of mastication because they are involved in chewing.
- The extrinsic muscles that move the tongue are important in chewing, swallowing, and speech.
- Muscles of the floor of the anterior neck, called suprahyoid muscles, are located above the hyoid bone. They elevate the hyoid bone, oral cavity, and tongue during swallowing.
- Muscles that move the head alter its position and help balance the head on the vertebral column.
- Muscles that act on the abdominal wall help contain and protect the abdominal viscera, move the vertebral column, compress the abdomen, and produce the force required for defecation, urination, vomiting, and childbirth.
- Muscles used in breathing alter the size of the thoracic cavity so that ventilation can occur and assist in venous return of blood to the heart.
- Muscles of the pelvic floor support the pelvic viscera, resist the thrust that accompanies increases in intra-abdominal pressure, and function as sphincters at the anorectal junction, urethra, and vagina.
- Muscles of the perineum assist in urination, erection of the penis and clitoris, ejaculation, and defecation.
- Muscles that move the pectoral (shoulder) girdle stabilize the scapula so it can function as a stable point of origin for most of the muscles that move the humerus.
- Muscles that move the humerus (arm bone) originate for the most part on the scapula (scapular muscles); the remaining muscles originate on the axial skeleton (axial muscles).
- Muscles that move the radius and ulna (forearm bones) are involved in flexion and extension at the elbow joint and are organized into flexor and extensor compartments.
- Muscles that move the wrist, hand, thumb, and fingers are many and varied; those muscles that act on the digits are called extrinsic muscles.
- The intrinsic muscles of the hand are important in skilled activities and provide humans with the ability to grasp and manipulate objects precisely.

- Muscles that move the vertebral column are quite complex because they have multiple origins and insertions and because there is considerable overlap among them.
- Muscles that move the femur (thigh bone) originate for the most part on the pelvic girdle and insert on the femur; these muscles are larger and more powerful than comparable muscles in the upper limb.
- Muscles that move the femur (thigh bone) and tibia and fibula (leg bones) are separated into medial (adductor), anterior (extensor), and posterior (flexor) compartments.
- Muscles that move the foot and toes are divided into anterior, lateral, and posterior compartments.
- Intrinsic muscles of the foot, unlike those of the hand, are limited to the functions of support and locomotion.

Self-Check 3	Written Test

Fill in the blanks in the following statements.

1. Bone growth in length is called _____growth, and bone growth in diameter (thickness) is called_____ growth. (2 Point)

2. The crystallized inorganic mineral salts in bone contribute to bone's , _____while the collagen fibers and other organic molecules provide bone with . . (2 Point)

3. Membrane-filled spaces between cranial bones that enable the fetal skull to modify its size and shape for passage through the birth canal are called_____ . (2 Point)

4. The hypophyseal fossa of the sella turcica of the sphenoid bone contains the_____. (2 Point) .

5. The regions of the vertebral column that consist of fused vertebrae are the _____ and the _____ . . (2 Point)

6. A single somatic motor neuron and all of the muscle fibers it stimulates is known as _____. (2 Point)

7. The wasting away of muscle due to lack of use is known as _____.while the replacement of skeletal muscle fibers with scar tissue is known as_____. (2 Point)

8. The synaptic end bulbs of somatic motor neurons contain synaptic vesicles filled with the neurotransmitter _____ (2 Point)

Note: **Satisfactory rating - 12 points Unsatisfactory - below 10 points**

You can ask you teacher for the copy of the correct answers.

Answer Sheet

Score = _____
Rating: _____
Name: _____ Date: _____

Short Answer Questions

1. _____

_____

2_____

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Information Sheet 4	1.4. Anatomy and physiology of respiratory system

4.1 Introduction

The respiratory system contributes to homeostasis by providing for the exchange of gases—oxygen and carbon dioxide—between the atmospheric air, blood, and tissue cells. It also helps adjust the pH of body fluids.

Most of the energy required by the cells of the body is derived from chemical reactions which can only take place in the presence of oxygen (O_2). The main waste product of this reaction is carbon dioxide (CO_2). The respiratory system provides entry for O_2 and excretion for CO_2.

The **respiratory system** consists of the nose, pharynx (throat), larynx (voice box), trachea (windpipe), bronchi, and lungs. Its parts can be classified according to either structure or function. *Structurally*, the respiratory system consists of two parts: (1) The **upper respiratory system** includes the nose, pharynx, and associated structures. (2) The **lower respiratory system** includes the larynx, trachea, bronchi, and lungs. *Functionally*, the respiratory system also consists of two parts: (1) The **conducting zone** consists of a series of interconnecting cavities and tubes both outside and within the lungs.

These include the nose, pharynx, larynx, trachea, bronchi, bronchioles, and terminal bronchioles; their function is to filter, warm, and moisten air and conduct it into the lungs. (2) The **respiratory zone** consists of tissues within the lungs where gas exchange occurs. These include the respiratory bronchioles, alveolar ducts, alveolar sacs, and alveoli; they are the main sites of gas exchange between air and blood.

4.2 Classification of respiratory system

The organs of respiratory system can be divided structurally and functionally

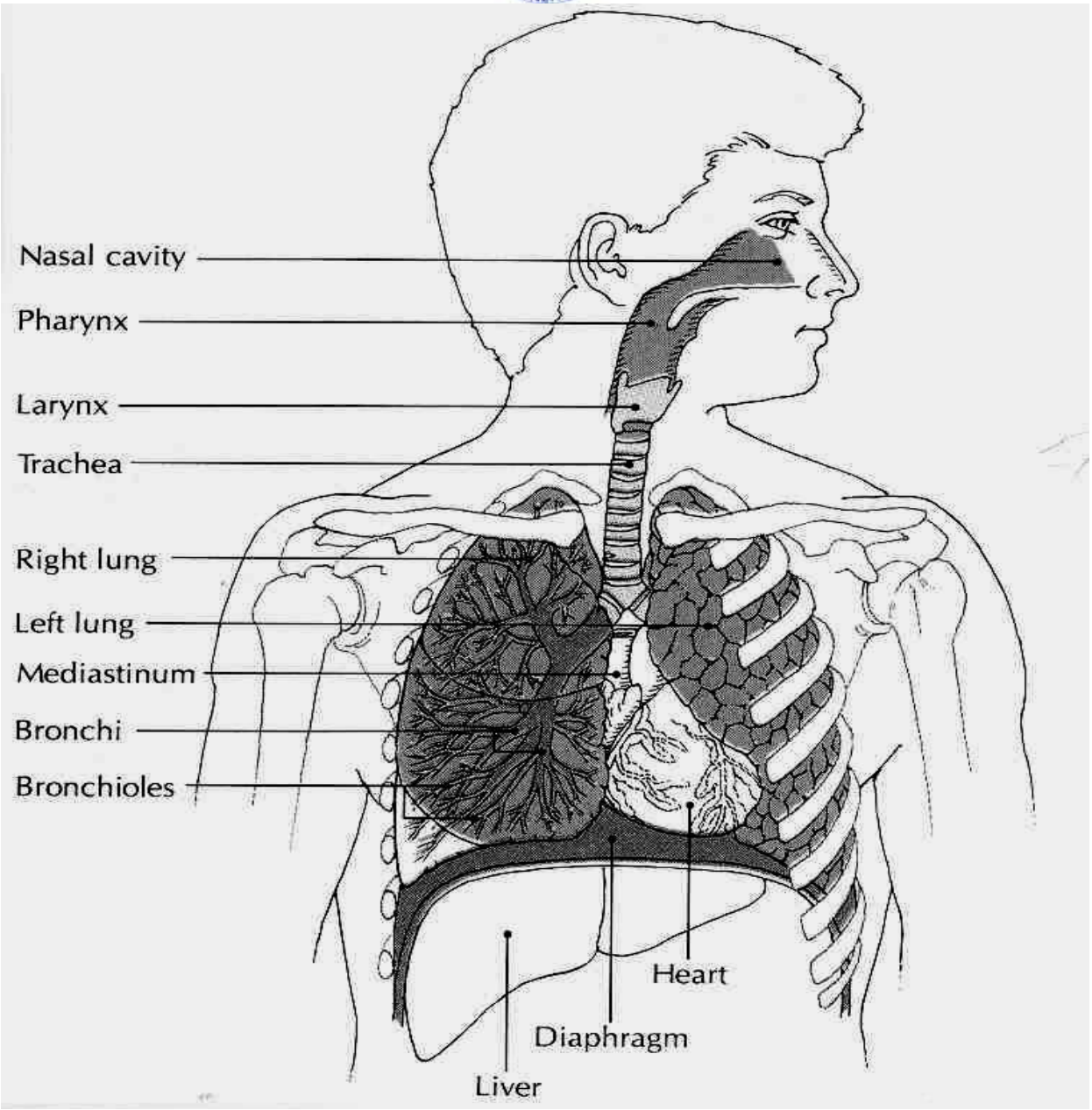
I. **Structurally**, respiratory system consists two parts
   A. ***The upper respiratory system***: nose & pharynx
   B. ***The lower respiratory system***: larynx, trachea, bronchi, and lungs

II. **Functionally**, respiratory system consists two parts
   A. ***The conductive zone:*** consists of the nose, pharynx, larynx, trachea, & bronchi
      ♪ The general functions of the conductive zone are

- ✓ Filter, warmth & moister air
- ✓ Conduct it into the lungs

B. ***The respiratory zone***: consists of tissue within the lung where gas exchange occur

- ♪ It includes the respiratory bronchioles, alveoli ducts, alveoli sacs & alveoli
- ♪ It is the main site of gas exchange between air & blood



4.3 The nose

- It is the first of the respiratory organs that consists of external and internal portion

4.3.1 External nose

- It consists of supporting frame work of bone & hyaline cartilage covered with muscle and skin & lined by mucous membrane

- Bony framework external nose is made up of ***frontal, nasal bone, & maxillae***
- The cartilaginous framework of external nose is consists of
  A. ***Septal cartilage:*** forms anterior portion of the nasal septum
  B. ***Lateral nasal cartilage***: inferior to nasal bone
  C. ***The alar cartilage***: forms a portion of the walls of the nostrils
- The external nose is flexible because it consists of pliable hyaline cartilage
- On the undersurface of the external nose are two openings called the external nares or nostrils.
- The interior structures of the external nose have ***3 functions***
  A. warming moistening and filtering incoming air
  B. detecting olfactory stimuli &
  C. modifying speech vibrations as they pass the large hollow resonating chamber

4.3.2 Internal nose

- It is a large cavity in the anterior aspect of the skull & lined with mucus membrane
- It lies inferior to the nasal bone & superior to the mouth
- ***Anteriorlly***, the internal nose merges with external nose & ***posteriorly*** it communicates with the pharynx through two openings called ***internal nares***
- The four pairs of paranasal sinuses (sphenoid, frontal, ethmoid & maxillae) & nasolacrimal ducts open into the interior nose
- The space within the internal nose is called the nasal cavity
- The vertical partition, the nasal septum, divides the nasal cavity in to right and left sides
- The nasal septum is formed by
  - Anterior portion hyaline cartilages
  - The remaining vomer perpenidicular plate of the ethmoid maxillae and palatine bone

4.4 The pharynx (throat)

Pharynx is a funnel shaped tube about 12-14 cm long that extending from the interior nares to the esophagus. It is just posterior to the nasal and oral cavities superior to larynx & anterior to cervical vertebrae. Its wall is composed of skeletal muscle and lined by mucus membrane

4.5 Wall of the pharynx

The pharynx is composed of three layers of tissue

1. **Mucous membrane** lining the pharynx. It is composed of
    a. Columnar at Nasopharynx and
    b. Stratified squamous at Oropharynx and Laryngopharynx.
2. **Fibrous tissue** forming the intermediate layer
3. **Muscle tissue** known as constrictor muscle, which is involuntary and used for swallowing and speech.

4.6 Divisions of Pharynx

Pharynx can divided into three anatomical regions

1. **Nasopharynx** – is the superior portion of pharynx
    - It lies posterior to the nasal cavity and extends to the soft palate.
    - It has 5 openings: 2 internal nares, 2 leads to Eustachian tube & one leads to oropharynx
    - It receives air from the nasal cavity and also exchanges small amount of air with the auditory tube to equalize pressure between the pharynx and the middle ear.
    - On its posterior wall there is the pharyngeal tonsil (adenoid). It is prominent in children, but gradually atrophies.
2. **Oropharynx** - is the intermediate portion of pharynx
    - It lies posterior to oral cavity
    - It extends from the level of the soft palate to the level of the hyoid bone or the body of the third cervical vertebrae.
    - Palatine tonsil is found here
    - It has both respiratory and digestive function mean that it serves as a common passage for air and food & drink
3. **Laryngopharynx**- is the inferior portion of pharynx
    - It begins as the level of hyoid bone and opens into the esophagus posteriorly and larynx anteriorly.
    - It has both respiratory and digestive function

4.7 Functions of Pharynx

1. Passage way for air and food
2. Providing a resonating chamber for speech and sound

3. Houses the tonsil, which participate in the immunological reaction against foreign invades

4.8 The larynx (voice box)

- ♣ It is a short passageway that connect the Laryngopharynx with the trachea
- ♣ It lies in the middle of the neck anterior to the esophagus and the 4^{th} though 6^{th} cervical vertebrae
- ♣ The mucus membrane lining the larynx forms two pairs of folds
  1. Upper pair is called vestibular or false vocal folds
  2. Lower pair serves as the true vocal cord

4.9 The Walls of Larynx

Its wall composed of ***9 pieces of cartilages***

A. Three occur singly

1. Thyroid cartilage
2. Cricoid cartilage
3. Epiglottis

B. Three occur in pairs

1. Arytenoid cartilages
2. Cunieiform
3. Corniculate cartilage

4.10 Thyroid cartilage "Adam's apple"

- ♪ It is the most prominent and largest cartilage of the larynx
- ♪ It consists of two flat pieces of cartilage known as the laminae, which are fused together anteriorly to form the laryngeal prominence ***(Adam's apple).***
- ♪ It gives a triangular shape to the anterior larynx
- ♪ It present in both male and female but due to two reasons males have prominent thyroid cartilage than females
  1. Males have larger thyroid cartilage than females
  2. Males have less fat pad lying over the neck

4.11 The epiglottis

- ♪ The epiglottis is a large leaf shaped pieces of elastic cartilage that covered with epithelium

- Its inferior portion is attached to the anterior part of the thyroid cartilage and hyoid bone
- The superior ("leaf") portion is unattached and is free to move up & down like a trap door
- During swallowing, the pharynx and larynx rise; elevation of larynx causes the epiglottis to move down and form a lid over the glottis, closing off
- The closing of the larynx during swallowing routes liquids and food into esophagus

A **cricoid cartilage** lies below the thyroid cartilage. It completely encircles the larynx. It articulates with arytenoids and thyroid cartilage.

The **arytenoids cartilages** are two tough pyramid shaped cartilages situated on top of cricoids cartilage. They give attachment to vocal cords.

4.12 Functions of larynx

- Larynx constitutes part of the vital airway to the lungs
- Its mucus membrane helps in the removal of dust particles (filtering) and in warming, moistening, & humidifying the inspired air
- Larynx also serves as organ of sound (voice) production
- It also prevents passing food in to trachea food

4.13 The trachea (windpipe)

The trachea or windpipe is a 10 to 11 cm long tubular passage for air that continue from larynx

It is located anterior to the esophagus and extends from larynx (C_4 C_6) to the superior border of the 5^{th} thoracic vertebra where it divides (Bifurcates) in to the left and right primary bronchi.

4.14 Structures in association with trachea

- Superiorly - Larynx
- Inferiorly – bronchi
- Posteriorly – esophagus
- Anteriorly - Thyroid gland, arch of aorta & sternum
- Laterally - thyroid gland & the lungs

4.15 Structure: The tracheal wall is made up of 4 layers

1. **Mucosa**: the inner layer consists of ciliated columnar epithelium containing goblet cells which secrete mucus
2. **Sub-mucosa**: the middle layer consists of areolar connective tissue.
3. **Hyaline cartilage**: trachea composed of from 16 to 20 incomplete horizontal rings of cartilages situated one above the other resembles letter ”C” - shaped.

   The open part of each C shaped cartilage ring faces the esophagus. This arrangement helps the esophagus to slightly expand into the trachea during swallowing.
4. **Adventitia**: the outer layer of trachea consists of areolar connective tissue & elastic tissue that joins the trachea to surrounding tissues

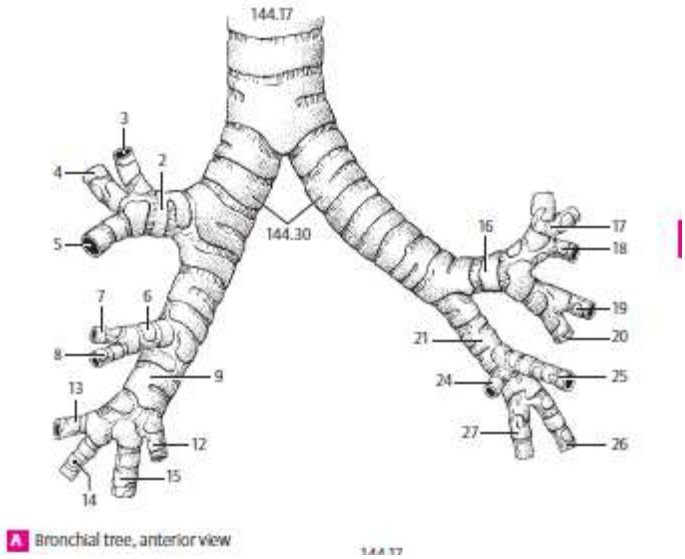
The arterial blood supply is mainly by inferior thyroid and bronchial arteries and venous return is through the inferior thyroid veins. The nerve supply is by parasympathetic & sympathetic fibers

4.16 Function of the trachea

- The trachea performs simple but vital function; it furnishes part of the open passage way through which air can reach the lungs from the outsides

4.17 The bronchi

- At the superior border of5th thoracic vertebrae, trachea bifurcates into a right primary bronchus, which goes to the right lung, and left primary bronchus which goes into left lung.
- The ***right bronchus is more vertical, wider and shorter*** (2.5 cm) than the left (which has 5 cm long). As a result an aspiration object is more likely to enter & lodge in the right primary bronchus than the left.
- Like a trachea, primary bronchi contain incomplete rings of cartilages. As they become smaller, the cartilages become less well defined and more irregular. The bronchi are lined with ciliated columnar epithelium.
- On entering the lungs, the primary bronchi divide to form smaller bronchi: the ***secondary (lobar) bronchi***, one for each lobe of the lung



- ♣ After entering the right lung at the hilum, it divides in ***to three secondary bronchi***, one for each lobe.
- ♣ After entering the lung it divides in to ***two secondary bronchi***, one for each lobe.
- ♣ The secondary bronchi continue to branch, forming still smaller bronchi, called ***tertiary (segmental) bronchi*** that divide into bronchioles
- ♣ Bronchioles, in turn, branch repeatedly and form smallest one branch into even smaller tubes called ***terminal bronchioles.***
- ↳ The trachea and the two primary bronchi and their many branches resemble an inverted tree trunk with its branches and therefore, called as **the bronchial tree**.

- ***Blood and nerve supply***

- ❋ Arterial - bronchial artery
- ❋ Venous - mainly by bronchial vein
- ❋ Nerve - vagus stimulates constriction and sympathetic dilation

4.18 Functions of the bronchi

1. Bronchi ***distributes air*** to the lungs
2. Involuntary muscles determine the diameter of the respiratory passages, thus ***controlling the Volume of air entering***

3. The mucus that covers a large portion of the respiratory tree membrane serves as the most important ***air purification mechanism***. Air entering the nose is generally contaminated with one or more common irritants like insects, dust, pollen and microorganism.

- ♪ A remarkable effective air purification mechanism removes almost every form of contaminant before inspired reaches the alveoli.
- ♪ More than 125ml of respiratory mucus is produced daily. It forms ***mucus blanket***, a continuous sheet that covers the lining of air distribution tubes in the respiratory system.
- ♪ The microscopic hair like cilia, that cover the epithelial cells in the respiratory mucosa, move in only one direction.
- ♪ Mucus blanket moves upward to the pharynx from the lower portion of the bronchial tree on hair like cilia that cover the epithelial cells in the respiratory system mucosa.
- ♪ The result is movement of mucus towards the pharynx. Cigarette smoking paralyzes these cilia and result in accumulation of mucus and typical smoker's cough, an effort to clear the secretion.

4.19 The Lungs

Lungs are paired cone shaped organs in the thoracic cavity.

A serous membrane that enclosed & protects each lung is called ***pleura***. Pleura have two layers.

1. **Visceral pleura** – is the deepest portion that covers and adherent to lung
2. **Parietal pleura** – is a superficial layer that lines the entire thoracic cavity.
   It adherents to the internal surface of the chest wall and the superior surface of diaphragm

- ↳ A small space between the parietal and visceral pleura is called ***pleural cavity***. Pleural cavity contains small amount of lubricating fluid called ***pleural fluid*** which secreted by the membrane

4.20 Functions of Pleural fluid

- ✓ Reduces friction between the parietal & visceral pleura
- ✓ Allows the layers to slide easily over one another during breathing

- The lungs extend from the diaphragm to just slightly superior to the clavicles and lie against the ribs anteriorly and posteriorly.
- The rounded like narrow superior portion of the lung is ***apex***.
- The broad inferior portion of the lungs, ***the base***, is concave & fits over the convex area of the diaphragm.
- ***The costal surface*** is convex shaped surface of the lungs that lying against with ribs and intercostals muscles.
- ***The medial surface*** are concave and are separated from each other by a space called the ***Mediastinum*** which is occupied by the heart, the great vessels, the trachea, bronchus, esophagus, lymph nodes, lymph vessels and nerves.
- The medial surface of each lung has a roughly triangular shaped area known as the ***hilus***, in which structures enter and leave the lung
- Structures entering and leaving each lung at the hilus are bronchus, pulmonary artery, pulmonary veins, bronchial artery, bronchial vein, lymph vessels and parasympathetic & sympathetic nerves.

4.21 The lobes, fissures and lobules

- Each lung is divided into lobes by ***fissures***
- The right lung is divided in to ***three distinct lobes: superior, middle and inferior lobe***.
- The left lung is divided in to ***two lobes: superior and inferior lobe.***
- The right lung has ***two fissures***: ***horizonta***l, separate the superior and middle lobes, and ***oblique fissure*** extends inferiorly and anteriorly
- The left lung has only ***oblique fissure*** that separate the superior and inferior lobes
- Each lobe receives its own ***secondary (lobar) bronchus***. Thus, the right lung primary bronchus gives rise to three lobar bronchi called superior, middle & inferior lobar bronchi. The left lung primary bronchus gives rise to superior and inferior secondary (lobar) bronchi.
- The secondary bronchi give rise to the ***tertiary (segmental) bronchi***. There are ***10 tertiary*** bronchi in each lung.

- ♣ The lobes of the lungs can be further subdivided into functional units called ***lobules (bronchopulmonary segment).***
- ♣ Each bronchopulmonary segment is served by tertiary bronchus
- ♣ Terminal bronchioles subdivided into microscopic bronchioles called ***respiratory bronchioles***
- ♣ Respiratory bronchioles, in turn, subdivided into ***alveolar ducts***
- ♣ Around the circumference of the alveolar ducts are numerous ***alveoli and alveolar sacs***
- ♣ ***An alveolus*** is a cup shaped out pouching supported by thin elastic basement membrane
- ♣ ***An alveolar sac*** consists of two or more alveoli that share common opening
- ♣ The exchange of O_2 & CO_2 between the air spaces in the lungs & the blood takes place by diffusion across the alveolar and capillary wall, which together form the ***respiratory membrane***

4.22 Function of the lungs

- ↳ The lungs perform two functions: ***air distribution and gas exchange***

4.23 Respiration

A human body can survive without food for as long as several weeks and without water for several days, but if breathing stops for 3 to 6 minutes, death is a likely outcome. Body tissues, especially the heart and the bran, require a constant supply of oxygen. The respiratory system delivers air containing oxygen to the blood and removes CO_2, the gaseous waste product of metabolism.

The exchange of gases between the atmosphere, blood and cells is called ***respiration***. Respiration has ***three basic processes*** or steps

1. **Pulmonary ventilation (breathing)** is the inhalation (inflow) and exhalation (outflow) of air between the atmosphere and the alveoli of the lungs

   Breathing has two phases:

   A. **Inspiration**: is the act of drawing air into the lungs (breathing in)
   B. **Expirations**: is expelling air from the lungs into the atmosphere (breathing out)

2. **Pulmonary (external) respiration** is the exchange of gases between the alveoli of the lungs and the blood in the pulmonary capillary

   Pulmonary capillary blood gains O_2 via diffusion and losses CO_2.

3. **Tissue (internal) respiration** is the exchange of gases between the systemic capillaries & cells of the body**.** The blood gain CO_2 and losses O_2.

4.24 Inspiration

- Inspiration is the active phase of breathing. It is the drawing of air into the lungs
- The major muscles involved in quiet inspiration are the ***diaphragm and the external intercostals*** muscles.
- The **dome- shaped diaphragm**, the skeletal muscle that separates the thoracic cavity from the abdominal cavity, is a major muscle of inspiration.
- As the diaphragm contracts, it moves downward, and this make the volume of the thoracic cavity increases. The external gradient thus established causes air to enter in to the lungs.
- The **external intercostals** also assist inspiration. These skeletal muscles extend from rib to rib, and when they contract
  1. They pull the ribs upward and outward, ***enlarging the transverse diameter*** of the thoracic cavity and
  2. They move the lower end of the sternum forward, ***enlarging the anterior- posterior diameter*** of the cavity.
- During inspiration, the abdominal muscles are relaxed to allow for movement of the abdominal organs when the diaphragm contracts.
- In addition, contraction of the sternocleoidomastoid muscle, pectoralis minor, and serratus anterior muscles can aid in elevation of the sternum and rib cage during forceful inspiration.
- As the size of the thorax increases the intrapleural and intraalveolar pressure decrease and inspiration occur.

- The moment intraalveolar pressure becomes less than atmospheric pressure, a pressure gradient exists between the atmosphere and the interior of the lungs; air then necessarily moves into the lung

4.25 Expiration

- Expiration is the expulsion of air from the lungs
- It is passive phase of breathing
- The inspiratory muscles relax, causing a decrease in the size of the thorax and an increase in intrapleural pressure and intraalveolar pressure, which in turn cause outward flow of air from the lungs into the atmosphere
- The intra- alveolar pressure thus increases above the atmospheric pressure and air moves out of the lungs.
- In contrast, forced expiration is an active process that occurs during strenuous physical activity.
- In forceful expiration, the abdominal and internal intercostals muscles contract forcibly, pressing the viscera against the passive diaphragm and depressing the rib cage, cause increase intraalveolar pressure.

4.25 Mechanics of Breathing

Inspiration requires continual work by the muscles that increase the volume of the thoracic cavity and expand the lunge. During inspiration, air is brought in to the lungs to equalize a reduction of air pressure caused by the enlarged thoracic cavity. During normal expiration, these muscles relax (1) to decrease the volume of the thoracic, and (2) to move air out of the lungs.

4.26 Pressures Involved in Breathing

The three important pressures in breathing are:

1. ***The atmospheric pressure*** is the pressure of air (gases) exerted by the air around us.
   At sea level this pressure is equal to ***760 mmHg***.

2. ***The intra- alveolar pressure*** is the pressure within the alveoli that increases or decreases with each breath, but is always equal to atmospheric pressure at the end of inspiration or expiration.
3. ***The intrapleural pressure***, the pressure within the pleural cavity, fluctuates with each breath. However, it is always negative (about -4 mmHg) with respect to the atmospheric pressure. This negative pressure is due primarily to factors that cause the visceral and parietal pleural to adhere to each other.

4.27 Lung Volumes and Capacities

The events of pulmonary ventilation can be described by subdividing the amount of air in the lungs into ***four volumes and four capacities***.

The apparatus used to measure theses amounts is called ***a respirometer***.

I. Lung Volumes

These are the ***four non-overlapping components*** of the total lung capacity.

1. **Tidal volume (TV):-** is the amount of air inhaled or exhaled with each breath during normal quiet breathing and is about 500 ml.
2. **Inspiratory reserve volume (IRV):-** signifies the amount of air that can be forcefully inhaled over and above the tidal volume. It averages 3100 ml in adults.
3. **Expiratory reserve volume (ERV):-** is the amount of air that can be forcibly exhaled over and above the TV, and is about 1200 ml.
4. **Residual volume (RV**):- is the amount of air remaining in the lungs after a forced expiration, and is about 1200 ml.

II. Lung Capacities

These are calculated by combining various lung volumes.

1. **Inspiratory capacity (IC):-** is the maximum amount of air that can be inspired at the end of a normal tidal volume expiration (i.e., IC= TV+IRV). The amount is about 3600 ml.
2. **Functional residual capacity (FRC):-** is the volume of air remaining in the lungs and a normal tidal volume tidal volume expiration (FRC= ERV +RV) .It is about 2400 ml in adults.

3. **Vital capacity (VC):-** is the maximum amount of air that can be expired following maximum inspiration (VC= TV+IRV+EV). The value averages 4800ml in a normal subject.
4. **Total lung capacity (TLC) :-** is the maximum amount of air in the lungs following maximum inspiration, and is about 600ml (TLC= TV+IRV+ERV+RV).

↳ About 150 ml of air is present in the nasal passages, trachea, bronchi, and bronchioles. This is known as the anatomical dead space (ADS) because no gas exchange occurs there. Therefore, only 350 ml of the inspired tidal volume (TV) reaches the alveoli

4.28 Partial Pressures

Each gas in a mixture of gases has its pressure, called the **partial pressure (p)**, which is, related, to its concentration (or percentage). The total pressure of the mixture is thus calculated by adding all the partial pressures. Atmospheric air is a mixture of several gases- oxygen (21%) CO_2 (0.04%), Nitrogen (78%), water vapor, and a number of other gases. We can determine the partial pressure of each gas in the mixture by multiplying the percentage of the gas in the mixture by the total pressure in the mixture.

Eg. – PO_2= 21% X 760 mmHg = 160 mmHg

PCO_2 = 0.04%X760 mmHg = 0.3 mmHg

Table 1 : The partial pressures (mmHg) of Respiratory Gases in Atmospheric Air, Alveolar Air, Blood, and Tissue Cells

	Atmospheric Air	Alveolar Air	Deoxygenated Blood	Oxygenated Blood	Tissue Cells
pO_2	160	105	40	105	40
pCO_2	0.4	40	45	40	45

4.29 Air way obstruction

Causes of Respiratory failure

A. anatomical Obstruction

1. Obstruction by tongue the most common cause of respiratory emergency is interference with breathing caused by the tongue's dropping back and obstructing the throat
2. Other causes of obstruction that constrict the air passages :
    - Acute asthma
    - Croup
    - Swelling after burns of face, throat
    - Swallowing of corrosive poisons
    - Direct injury caused by a blow

B. Mechanical Obstruction

1. Partial or complete blockage of the air passage by a solid foreign object lodged in the pharynx or in any part of the air way
2. Accumulation of fluids (mucus, blood, or saliva) in the back of the throat
3. Inhalation of vomitus

C. Air depleted of oxygen or containing toxic gases

1. Causes of asphyxia

Asphyxia may occur from breathing air that does not contain sufficient oxygen or air containing carbon monoxide or other toxic gas.

2. Explosion hazard

- In addition to the dangers of asphyxia from carbon monoxide or by other gases, there is often an explosion hazard.
- Combustible gases that accumulate in confined spaces such as mines cisterns and sewers or in room where natural or manufactured gas is free in the air are explosive in certain concentrations.

3. Additional causes of respiratory failure:-

a. Electrocution

b. Drowning
c. Circulatory collapse
d. Heat disease
e. External strangulation, as in hanging
f. Compression of the chest
g. Disease or injury to the lungs (in adequate ventilation may be caused by injuries that collapse or compress lung tissue, injuries that permit air to enter through sucking wound.
h. Poison by respiratory depressing, such as morphine, opium, codeine, alcohol.

4.30 The Breathing Process

A. Inhalation phase

1. The muscle of the chest lifts the ribs, expanding the chest.
2. The diaphragm which is dome shaped, contract and descend toward the abdomen.
   - Chest cavity increase in size and atmospheric air flow in.

B. Exhalation Phase

1. The muscle relaxes allowing the ribs and diaphragm to resume their former position.
2. The Chest cavity becomes smaller and air flow out side.

C. Rate of Breathing

In adults RR is about 12-18/min.

For artificial respiration to be effective the volume of air that enters must exceed the amount that is already in the air passage and that is needed for normal respiration.

D. Need for Oxygen

- The body does not store oxygen but needs continuous supply to carry on the life process.
- Oxygen must be available to all body cells and is transported through out the body by the blood.
- Air entering body is :- 21% oxygen
  04% carbon dioxide

- The reminder of air is largely nitrogen
- Air leaving the body is:- 16% oxygen

  4% CO_2

Self-Check 4	**Written Test**

1. Describe the events that cause inhalation and exhalation (3 Point)

2. Describe the anatomy of the nose, pharynx, larynx, trachea, bronchi, and lungs.(3 Point)

3. Identify the functions of each respiratory system structure (3 Point)

4. How does the larynx function in respiration and voice production? (3 point)

5. Oxygen in blood is carried primarily in the form of _____; carbon dioxide is carried as _____, _____, and _____. (3 Point)

Note: **Satisfactory rating - 16 points Unsatisfactory - below 15 points**

You can ask you teacher for the copy of the correct answers.

Answer Sheet

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Short Answer Questions

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Information Sheet 5	**1.5. Anatomy and physiology of digestive system**

5.1 T H E D I G E S T I V E S Y S T E M A N D H O M EO S T A S I S

The digestive system contributes to homeostasis by breaking down food into forms that can be absorbed and used by body cells. It also absorbs water, vitamins, and minerals, and eliminates wastes from the body. The food we eat contains a variety of nutrients, which are used for

building new body tissues and repairing damaged tissues. Food is also vital to life because it is our only source of chemical energy. The organs involved in the breakdown of food—collectively called the **digestive system.**

Two groups of organs compose the digestive system: the gastrointestinal (GI) tract and the accessory digestive organs.

The **gastrointestinal (GI) tract,** or **alimentary canal** (*alimentary* _ nourishment), is a continuous tube that extends from the mouth to the anus through the thoracic and abdominopelvic cavities. Organs of the gastrointestinal tract include the mouth, most of the pharynx, esophagus, stomach, small intestine, and large intestine.

The **accessory digestive organs** include the teeth, tongue, salivary glands, liver, gallbladder, and pancreas. Teeth aid in the physical breakdown of food, and the tongue assists in chewing and swallowing. The other accessory digestive organs, however, never come into direct contact with food. They produce or store secretions that flow into the GI tract through ducts; the secretions aid in the chemical breakdown of food.

The GI tract contains food from the time it is eaten until it is digested and absorbed or eliminated. Muscular contractions in the wall of the GI tract physically break down the food by churning it and propel the food along the tract, from the esophagus to the anus. The contractions also help to dissolve foods by mixing them with fluids secreted into the tract. Enzymes secreted by accessory digestive organs and cells that line the tract break down the food chemically.

Overall, the digestive system performs six basic processes:

1. *Ingestion.* This process involves taking foods and liquids into the mouth (eating).

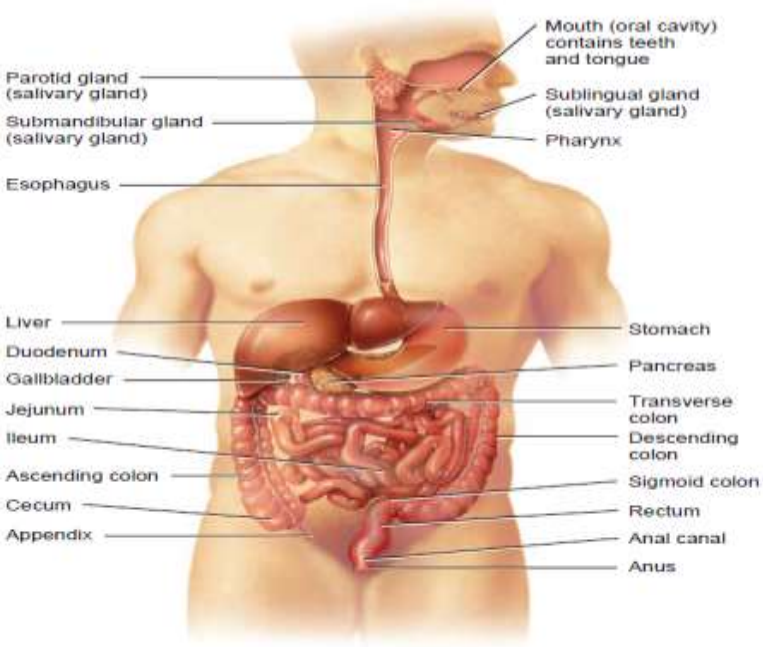
2. *Secretion.* Each day, cells within the walls of the GI tract and accessory digestive organs secrete a total of about 7 liters of water, acid, buffers, and enzymes into the lumen (interior space) of the tract.

3. *Mixing and propulsion.* Alternating contractions and relaxations of smooth muscle in the walls of the GI tract mix food and secretions and propel them toward the anus. This capability of the GI tract to mix and move material along its length is called **motility.**

4. *Digestion.* Mechanical and chemical processes break down ingested food into small molecules. In **mechanical digestion** the teeth cut and grind food before it is swallowed, and then smooth muscles of the stomach and small intestine churn the food. As a result, food molecules become dissolved and thoroughly mixed with digestive enzymes. In **chemical digestion** the large carbohydrate, lipid, protein, and nucleic acid molecules in food are split into smaller molecules by hydrolysis Digestive enzymes produced by the salivary glands, tongue, stomach, pancreas, and small intestine catalyze these catabolic reactions. A few substances in food can be absorbed without chemical digestion. These include vitamins, ions, cholesterol, and water.

5. *Absorption.* The entrance of ingested and secreted fluids, ions, and the products of digestion into the epithelial cells lining the lumen of the GI tract is called **absorption.** The absorbed substances pass into blood or lymph and circulate to cells throughout the body.

6. *Defecation.* Wastes, indigestible substances, bacteria, cells sloughed from the lining of the GI tract, and digested materials that were not absorbed in their journey through the digestive tract leave the body through the anus in a process called **defecation.** The eliminated material is termed **feces.**



(a) Right lateral view of head and neck and anterior view of trunk

5.2 Layers of the GI Tract

1. The basic arrangement of layers in most of the gastrointestinal tract, from deep to superficial, is the mucosa, submucosa, muscularis, and serosa.

2. Associated with the lamina propria of the mucosa are extensive patches of lymphatic tissue called mucosa-associated lymphoid tissue (MALT).

5.3 Neural Innervation of the GI Tract

1. The gastrointestinal tract is regulated by an intrinsic set of nerves known as the enteric nervous system (ENS) and by an extrinsic set of nerves that are part of the autonomic nervous system (ANS).

2. The ENS consists of neurons arranged into two plexuses: the myenteric plexus and the submucosal plexus.

3. The myenteric plexus, which is located between the longitudinal and circular smooth muscle layers of the muscularis, regulates GI tract motility.

4. The submucosal plexus, which is located in the submucosa, regulates GI secretion.

5. Although the neurons of the ENS can function independently, they are subject to regulation by the neurons of the ANS.

6. Parasympathetic fibers of the vagus (X) nerves and pelvic splanchnic nerves increase GI tract secretion and motility by increasing the activity of ENS neurons.

7. Sympathetic fibers from the thoracic and upper lumbar regions of the spinal cord decrease GI tract secretion and motility by inhibiting ENS neurons.

5.4 Peritoneum

1. The peritoneum is the largest serous membrane of the body; it lines the wall of the abdominal cavity and covers some abdominal organs.

2. Folds of the peritoneum include the mesentery, mesocolon, falciform ligament, lesser omentum, and greater omentum.

5.5 Mouth

1. The mouth is formed by the cheeks, hard and soft palates, lips, and tongue.

2. The vestibule is the space bounded externally by the cheeks and lips and internally by the teeth and gums.

3. The oral cavity proper extends from the vestibule to the fauces.

4. The tongue, together with its associated muscles, forms the floor of the oral cavity. It is composed of skeletal muscle covered with mucous membrane.

5. The upper surface and sides of the tongue are covered with papillae, some of which contain taste buds.

6. The major portion of saliva is secreted by the major salivary glands, which lie outside the mouth and pour their contents into ducts that empty into the oral cavity.

7. There are three pairs of major salivary glands: parotid, submandibular, and sublingual glands.

8. Saliva lubricates food and starts the chemical digestion of carbohydrates.

9. Salivation is controlled by the nervous system.

10. The teeth (dentes) project into the mouth and are adapted for mechanical digestion.

11. A typical tooth consists of three principal regions: crown, root, and neck.

12. Teeth are composed primarily of dentin and are covered by enamel, the hardest substance in the body.

13. There are two dentitions: deciduous and permanent.

14. Through mastication, food is mixed with saliva and shaped into a soft, flexible mass called a bolus.

15. Salivary amylase begins the digestion of starches, and lingual lipase acts on triglycerides.

5.6 Pharynx

1. The pharynx is a funnel-shaped tube that extends from the internal nares to the esophagus posteriorly and to the larynx anteriorly.

2. The pharynx has both respiratory and digestive functions.

5.7 Esophagus

1. The esophagus is a collapsible, muscular tube that connects the pharynx to the stomach.

2. It contains an upper and a lower esophageal sphincter.

5.8 Deglutition

1. Deglutition, or swallowing, moves a bolus from the mouth to the stomach.

2. Swallowing consists of a voluntary stage, a pharyngeal stage (involuntary), and an esophageal stage (involuntary).

5.9 Stomach

1. The stomach connects the esophagus to the duodenum.

2. The principal anatomic regions of the stomach are the cardia, fundus, body, and pylorus.

3. Adaptations of the stomach for digestion include rugae; glands that produce mucus, hydrochloric acid, pepsin, gastric lipase, and intrinsic factor; and a three-layered muscularis.

4. Mechanical digestion consists of mixing waves.

5. Chemical digestion consists mostly of the conversion of proteins into peptides by pepsin.

6. The stomach wall is impermeable to most substances.

7. Among the substances the stomach can absorb are water, certain ions, drugs, and alcohol.

5.10 Pancreas

1. The pancreas consists of a head, a body, and a tail and is connected to the duodenum via the pancreatic duct and accessory duct.

2. Endocrine pancreatic islets (islets of Langerhans) secrete hormones, and exocrine acini secrete pancreatic juice.

3. Pancreatic juice contains enzymes that digest starch (pancreatic amylase), proteins (trypsin, chymotrypsin, carboxypeptidase, and elastase), triglycerides (pancreatic lipase), and nucleic acids (ribonuclease and deoxyribonuclease).

5.11 Liver and Gallbladder

1. The liver has left and right lobes; the right lobe includes a quadrate lobe and a caudate lobe. The gallbladder is a sac located in a depression on the posterior surface of the liver that stores and concentrates bile.

2. The lobes of the liver are made up of lobules that contain hepatocytes (liver cells), sinusoids, stellate reticuloendothelial (Kupffer) cells, and a central vein.

3. Hepatocytes produce bile that is carried by a duct system to the gallbladder for concentration and temporary storage.

4. Bile's contribution to digestion is the emulsification of dietary lipids.

5. The liver also functions in carbohydrate, lipid, and protein metabolism; processing of drugs and hormones; excretion of bilirubin; synthesis of bile salts; storage of vitamins and minerals; phagocytosis; and activation of vitamin D.

5.12 Small Intestine

1. The small intestine extends from the pyloric sphincter to the ileocecal sphincter.

2. It is divided into duodenum, jejunum, and ileum.

3. Its glands secrete fluid and mucus, and the circular folds, villi, and microvilli of its wall provide a large surface area for digestion and absorption.

4. Brush-border enzymes digest _-dextrins, maltose, sucrose, lactose, peptides, and nucleotides at the surface of mucosal epithelial cells.

5. Pancreatic and intestinal brush-border enzymes break down starches into maltose, maltotriose, and _-dextrins (pancreatic amylase), _-dextrins into glucose (_-dextrinase), maltose to glucose (maltase), sucrose to glucose and fructose (sucrase), lactose to glucose and galactose (lactase), and proteins into peptides (trypsin, chymotrypsin, and elastase). Also, enzymes break off amino acids at the carboxyl ends of peptides (carboxypeptidases) and break off amino acids at the amino ends of peptides (aminopeptidases). Finally, enzymes split dipeptides into amino acids (dipeptidases), triglycerides to fatty acids and monoglycerides (lipases), and nucleotides to pentoses and nitrogenous bases (nucleosidases and phosphatases).

6. Mechanical digestion in the small intestine involves segmentation and migrating motility complexes.

7. Absorption occurs via diffusion, facilitated diffusion, osmosis, and active transport; most absorption occurs in the small intestine.

8. Monosaccharides, amino acids, and short-chain fatty acids pass into the blood capillaries.

9. Long-chain fatty acids and monoglycerides are absorbed from micelles, resynthesized to triglycerides, and formed into chylomicrons.

10. Chylomicrons move into lymph in the lacteal of a villus.

11. The small intestine also absorbs electrolytes, vitamins, and water.

5.13 Large Intestine

1. The large intestine extends from the ileocecal sphincter to the anus.

2. Its regions include the cecum, colon, rectum, and anal canal.

3. The mucosa contains many goblet cells, and the muscularis consists of teniae coli and haustra.

4. Mechanical movements of the large intestine include haustral churning, peristalsis, and mass peristalsis.

5. The last stages of chemical digestion occur in the large intestine through bacterial action. Substances are further broken down, and some vitamins are synthesized.

6. The large intestine absorbs water, ions, and vitamins.

7. Feces consist of water, inorganic salts, epithelial cells, bacteria, and undigested foods.

8. The elimination of feces from the rectum is called defecation.

9. Defecation is a reflex action aided by voluntary contractions of the diaphragm and abdominal muscles and relaxation of the external anal sphincter.

5.14 Phases of Digestion

1. Digestive activities occur in three overlapping phases: cephalic phase, gastric phase, and intestinal phase.

2. During the cephalic phase of digestion, salivary glands secrete saliva and gastric glands secrete gastric juice in order to prepare the mouth and stomach for food that is about to be eaten.

3. The presence of food in the stomach causes the gastric phase of digestion, which promotes gastric juice secretion and gastric motility.

4. During the intestinal phase of digestion, food is digested in the small intestine. In addition, gastric motility and gastric secretion decrease in order to slow the exit of chyme from the stomach, which prevents the small intestine from being overloaded with more chyme than it can handle.

5. The activities that occur during the various phases of digestion are coordinated by neural pathways and by hormones.

5.15 Development of the Digestive System

1. The endoderm of the primitive gut forms the epithelium and glands of most of the gastrointestinal tract.

2. The mesoderm of the primitive gut forms the smooth muscle and connective tissue of the gastrointestinal tract.

5.16 Aging and the Digestive System

1. General changes include decreased secretary mechanisms, decreased motility, and loss of tone.

2. Specific changes may include loss of taste, pyorrhea, hernias, peptic ulcer disease, constipation, hemorrhoids, and diverticular diseases.

Self-Check 5	Written Test

1. Identify the organs of the digestive system. (3 points)
2. Which components of the digestive system are GI tract organs, and which are accessory digestive organs? (4 Points)

3. Which organs of the digestive system come in contact with food, and what are some of their digestive functions? (3 Points)
4. Describe the basic processes performed by the digestive system. (4 Points)
5. Mention the six basic digestive system performs (6 Points)

Note: **Satisfactory rating - 12 points Unsatisfactory - below 10 points**

You can ask you teacher for the copy of the correct answers.

Answer Sheet

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Information Sheet 6	**1.6. Anatomy and physiology of cardiovascular system**

6.1 THE CARDIOVASCULAR SYSTEM: THE BLOOD: Blood contributes to homeostasis by transporting oxygen, carbon dioxide, nutrients, and hormones to and from your body's cells. It helps regulate body pH and temperature, and provides protection against disease through phagocytosis and the production of antibodies.

The cardiovascular system (cardio- heart; vascular blood vessels) consists of three interrelated components: blood, the heart, and blood vessels. Blood transports various substances, helps regulate several life processes, and affords protection against disease.

Blood, which is a liquid connective tissue, has three general functions.

6.2 Functions and Properties of Blood

- Blood transports oxygen, carbon dioxide, nutrients, wastes, and hormones.
- It helps regulate pH, body temperature, and water content of cells.
- It provides protection through clotting and by combating toxins and microbes through certain phagocytic white blood cells or specialized blood plasma proteins.
- Physical characteristics of blood include a viscosity greater than that of water; a temperature of 38_C (100.4_F); and a pH of 7.35–7.45.
- Blood constitutes about 8% of body weight, and its volume is 4–6 liters in adults.
- Blood is about 55% blood plasma and 45% formed elements.
- The hematocrit is the percentage of total blood volume occupied by red blood cells.
- Blood plasma consists of 91.5% water and 8.5% solutes. Principal solutes include proteins (albumins, globulins, fibrinogen), nutrients, vitamins, hormones, respiratory gases, electrolytes, and waste products.
- The formed elements in blood include red blood cells (erythrocytes), white blood cells (leukocytes), and platelets.

6.3 Formation of Blood Cells

- Hemopoiesis is the formation of blood cells from hemopoietic stem cells in red bone marrow.
- Myeloid stem cells form RBCs, platelets, granulocytes, and monocytes. Lymphoid stem cells give rise to lymphocytes.

- Several hemopoietic growth factors stimulate differentiation and proliferation of the various blood cells.

6.4 Red Blood Cells

- Mature RBCs are biconcave discs that lack nuclei and contain hemoglobin.
- The function of the hemoglobin in red blood cells is to transport oxygen and some carbon dioxide.
- RBCs live about 120 days. A healthy male has about 5.4 million RBCs/_L of blood; a healthy female has about 4.8 million/_L.
- After phagocytosis of aged RBCs by macrophages, hemoglobin is **5.** RBC formation, called erythropoiesis, occurs in adult red bone marrow of certain bones. It is stimulated by hypoxia, which stimulates the release of erythropoietin by the kidneys.
- A reticulocyte count is a diagnostic test that indicates the rate of erythropoiesis.

6. 5 White Blood Cells

- WBCs are nucleated cells. The two principal types are granulocytes (neutrophils, eosinophils, and basophils) and agranulocytes (lymphocytes and monocytes).
- The general function of WBCs is to combat inflammation and infection. Neutrophils and macrophages (which develop from monocytes) do so through phagocytosis.
- Eosinophils combat the effects of histamine in allergic reactions, phagocytize antigen–antibody complexes, and combat parasitic worms. Basophils liberate heparin, histamine, and serotonin in allergic reactions that intensify the inflammatory response.
- B lymphocytes, in response to the presence of foreign substances called antigens, differentiate into plasma cells that produce antibodies. Antibodies attach to the antigens and render them harmless. This antigen–antibody response combats infection and provides immunity. T lymphocytes destroy foreign invaders directly. Natural killer cells attack infectious microbes and tumor cells.

- Except for lymphocytes, which may live for years, WBCs usually live for only a few hours or a few days. Normal blood contains 5000–10,000 WBCs/_L.

6.6 Platelets

- Platelets (thrombocytes) are disc-shaped cell fragments that splinter from megakaryocytes. Normal blood contains 150,000– 400,000 platelets/_L.
- Platelets help stop blood loss from damaged blood vessels by forming a platelet plug.

6.7 Stem Cell Transplants from Bone Marrow and Cord-Blood

- Bone marrow transplants involve removal of red bone marrow as a source of stem cells from the iliac crest.
- In a cord-blood transplant, stem cells from the placenta are removed from the umbilical cord.
- Cord-blood transplants have several advantages over bone marrow transplants.

6.8 Hemostasis

- Hemostasis refers to the stoppage of bleeding.
- It involves vascular spasm, platelet plug formation, and blood clotting (coagulation).
- In vascular spasm, the smooth muscle of a blood vessel wall contracts, which slows blood loss.
- Platelet plug formation involves the aggregation of platelets to stop bleeding.
- A clot is a network of insoluble protein fibers (fibrin) in which formed elements of blood are trapped.
- The chemicals involved in clotting are known as clotting (coagulation) factors.
- Blood clotting involves a cascade of reactions that may be divided into three stages: formation of prothrombinase, conversion of prothrombin into thrombin, and conversion of soluble fibrinogen into insoluble fibrin.

- Clotting is initiated by the interplay of the extrinsic and intrinsic pathways of blood clotting.
- Normal coagulation requires vitamin K and is followed by clot retraction (tightening of the clot) and ultimately fibrinolysis (dissolution of the clot).
  - Clotting in an unbroken blood vessel is called thrombosis. A thrombus that moves from its site of origin is called an embolus

6.9 Blood Groups and Blood Types

- ABO and Rh blood groups are genetically determined and based on antigen–antibody responses.
- In the ABO blood group, the presence or absence of A and B antigens on the surface of RBCs determines blood type.
- In the Rh system, individuals whose RBCs have Rh antigens are classified as Rh_; those who lack the antigen are Rh_.
- Hemolytic disease of the newborn (HDN) can occur when an Rh_ mother is pregnant with an Rh_ fetus.
- Before blood is transfused, a recipient's blood is typed and then either cross-matched to potential donor blood or screened for the presence of antibodies.

6.10 The Cardiovascular System: The Heart

H E H E A R T A N D H O M EO S T A S I S : The heart pumps blood through blood vessels to all body tissues.

The **cardiovascular system** (*cardio-* _ heart; *vascular* _ blood vessels) consists of three interrelated components: blood, the heart, and blood vessels. Blood must be constantly pumped through the body's blood vessels so that it can reach body cells and exchange materials with them. To accomplish this, the heart beats about 100,000 times every day, which adds up to 35 million beats in a year and about 2.5 billion times in an average lifetime. Even while you are sleeping, your heart pumps 30 times its own weight (5 L or 5.3 qt) each minute, which amounts to more than 14,000 liters (3600 gal) of blood in a day and 10 million liters (2.6 million gal) in a year.

6.11 Anatomy of the Heart

- The heart is located in the mediastinum; about two-thirds of its mass is to the left of the midline.
- The heart is shaped like a cone lying on its side. Its apex is the pointed, inferior part. Its base is the broad, superior part.
- The pericardium is the membrane that surrounds and protects the heart; it consists of an outer fibrous layer and an inner serous pericardium, which is composed of a parietal and a visceral layer.
- Between the parietal and visceral layers of the serous pericardium is the pericardial cavity, a potential space filled with a few milliliters of lubricating pericardial fluid that reduces friction between the two membranes.
- Three layers make up the wall of the heart: epicardium (visceral layer of the serous pericardium), myocardium, and endocardium.
- The epicardium consists of mesothelium and connective tissue, the myocardium is composed of cardiac muscle tissue, and the endocardium consists of endothelium and connective tissue.
- The heart chambers include two superior chambers, the right and left atria, and two inferior chambers, the right and left ventricles.
- External features of the heart include the auricles (flaps of each atrium that slightly increase their volume), the coronary sulcus between the atria and ventricles, and the anterior and posterior sulci between the ventricles on the anterior and posterior surfaces of the heart, respectively.
- The right atrium receives blood from the superior vena cava, inferior vena cava, and coronary sinus. It is separated internally from the left atrium by the interatrial septum, which contains the fossa ovalis. Blood exits the right atrium through the tricuspid valve.

- The right ventricle receives blood from the right atrium. It is separated internally from the left ventricle by the interventricular septum and pumps blood through the pulmonary valve into the pulmonary trunk.
- Oxygenated blood enters the left atrium from the pulmonary veins and exits through the bicuspid (mitral) valve.
- The left ventricle pumps oxygenated blood through the aortic valve into the aorta.
- The thickness of the myocardium of the four chambers varies according to the chamber's function. The left ventricle, with the highest workload, has the thickest wall.
- The fibrous skeleton of the heart is dense connective tissue that surrounds and supports the valves of the heart.

6.12 Heart Valves and Circulation of Blood

- Heart valves prevent backflow of blood within the heart. The atrioventricular (AV) valves, which lie between atria and ventricles, are the tricuspid valve on the right side of the heart and the bicuspid (mitral) valve on the left. The semilunar (SL) valves are the aortic valve, at the entrance to the aorta, and the pulmonary valve, at the entrance to the pulmonary trunk.
- The left side of the heart is the pump for systemic circulation, the circulation of blood throughout the body except for the air sacs of the lungs. The left ventricle ejects blood into the aorta, and blood then flows into systemic arteries, arterioles, capillaries, venules, and veins, which carry it back to the right atrium.
- The right side of the heart is the pump for pulmonary circulation, the circulation of blood through the lungs. The right ventricle ejects blood into the pulmonary trunk, and blood then flows into pulmonary arteries, pulmonary capillaries, and pulmonary veins, which carry it back to the left atrium.

- The coronary circulation provides blood flow to the myocardium. The main arteries of the coronary circulation are left and right coronary arteries; the main veins are the cardiac veins and the coronary sinus.

6.13 Cardiac Muscle Tissue and the Cardiac: Conduction System

- Cardiac muscle fibers usually contain a single centrally located nucleus. Compared to skeletal muscle fibers, cardiac muscle fibers have more and larger mitochondria, slightly smaller sarcoplasmic reticulum, and wider transverse tubules, which are located at Z discs.
- Cardiac muscle fibers are connected end-to-end via intercalated discs. Desmosomes in the discs provide strength, and gap junctions allow muscle action potentials to conduct from one muscle fiber to its neighbors.
- Autorhythmic fibers form the conduction system, cardiac muscle fibers that spontaneously depolarize and generate action potentials.
- Components of the conduction system are the sinoatrial (SA) node (pacemaker), atrioventricular (AV) node, atrioventricular (AV) bundle (bundle of His), bundle branches, and Purkinje fibers.
- Phases of an action potential in a ventricular contractile fiber include rapid depolarization, a long plateau, and repolarization.
- Cardiac muscle tissue has a long refractory period, which prevents tetanus.
- The record of electrical changes during each cardiac cycle is called an electrocardiogram (ECG). A normal ECG consists of a P wave (atrial depolarization), a QRS complex (onset of ventricular depolarization), and a T wave (ventricular repolarization).
- The P-Q interval represents the conduction time from the beginning of atrial excitation to the beginning of ventricular excitation.
- The S-T segment represents the time when ventricular contractile fibers are fully depolarized.

6.14 The Cardiac Cycle

- A cardiac cycle consists of the systole (contraction) and diastole (relaxation) of both atria, plus the systole and diastole of both ventricles. With an average heartbeat of 75 beats/min, a complete cardiac cycle requires 0.8 seconds.
- The phases of the cardiac cycle are (a) atrial systole, (b) ventricular systole, and (c) relaxation period.
- S1, the first heart sound (lubb), is caused by blood turbulence associated with the closing of the atrioventricular valves. S2, the second sound (dupp), is caused by blood turbulence associated with the closing of semilunar valves.

6.15 Cardiac Output

- Cardiac output (CO) is the amount of blood ejected per minute by the left ventricle into the aorta (or by the right ventricle into the pulmonary trunk). It is calculated as follows: CO (mL/min) _ stroke volume (SV) in mL/beat _ heart rate (HR) in beats per minute.
- Stroke volume (SV) is the amount of blood ejected by a ventricle during each systole.
- Cardiac reserve is the difference between a person's maximum cardiac output and his or her cardiac output at rest.
- Stroke volume is related to preload (stretch on the heart before it contracts), contractility (forcefulness of contraction), and afterload (pressure that must be exceeded before ventricular ejection can begin).
- According to the Frank-Starling law of the heart, a greater preload (end-diastolic volume) stretching cardiac muscle fibers just before they contract increases their force of contraction until the stretching becomes excessive.
- Nervous control of the cardiovascular system originates in the cardiovascular center in the medulla oblongata.

- Sympathetic impulses increase heart rate and force of contraction; parasympathetic impulses decrease heart rate.
- Heart rate is affected by hormones (epinephrine, norepinephrine, thyroid hormones), ions (Na_, K_, Ca2_), age, gender, physical fitness, and body temperature.

6.16 Exercise and the Heart

- Sustained exercise increases oxygen demand on muscles.
- Among the benefits of aerobic exercise are increased cardiac output, decreased blood pressure, weight control, and increased fibrinolytic activity.

6.17 Help for Failing Hearts

- A cardiac (heart) transplant is the replacement of a severely damaged heart with a normal one.
- Cardiac arrest devices and procedures include the intra-aortic balloon pump, ventricular arrest device, cardiomyoplasty, and a skeletal muscle arrest device.

6.18 Development of the Heart

- The heart develops from mesoderm.
- The endocardial tubes develop into the four-chambered heart and great vessels of the heart.

Self-Check 6	Written Test

1. Describe the location of the heart. (2 point)
2. Describe the structure of the pericardium and the heart wall.(3 Point)
3. Discuss the external and internal anatomy of the chambers of the heart. (4 point)
4. Describe the functions of blood.(3 points)
5. Describe the physical characteristics and principal components of blood.(3 point)

Note: **Satisfactory rating - 12 points Unsatisfactory - below 10 points**

You can ask you teacher for the copy of the correct answers.

Answer Sheet

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Information Sheet 7	**1.7. Anatomy and physiology of genitourinary system**

The **urinary system** consists of two kidneys, two ureters, one urinary bladder, and one urethra (Figure 7.1). After the kidneys filter blood plasma, they return most of the water and solutes to the bloodstream. The remaining water and solutes constitute **urine,** which passes through the ureters and is stored in the urinary bladder until it is excreted from the body through the urethra.

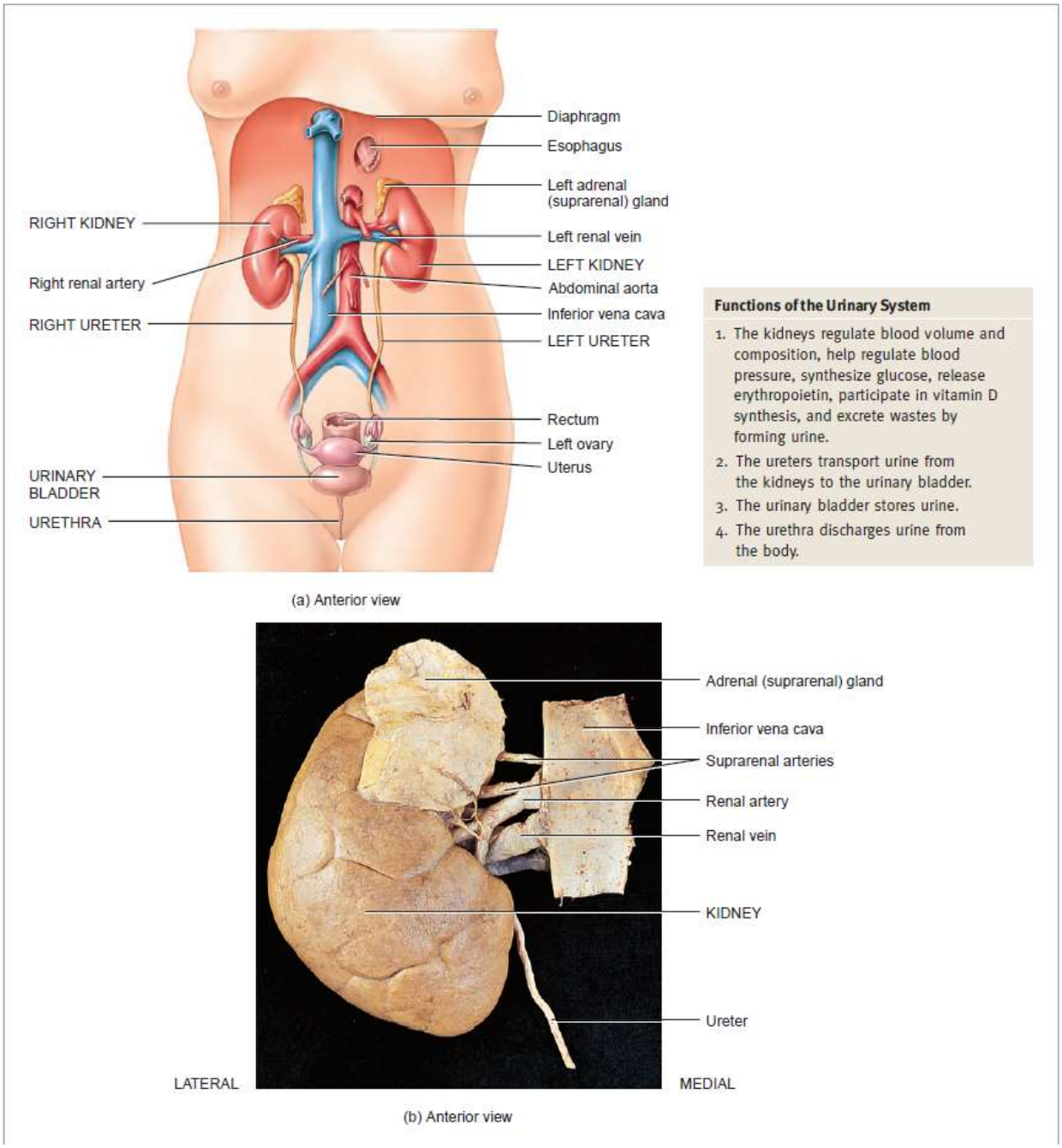

Fig 7.1 – the urinary system

7.1 Introduction

- The organs of the urinary system are the kidneys, ureters, urinary bladder, and urethra.

- After the kidneys filter blood and return most water and many solutes to the bloodstream, the remaining water and solutes constitute urine.

7.2 Overview of Kidney Functions

- The kidneys regulate blood ionic composition, blood osmolarity, blood volume, blood pressure, and blood pH.
- The kidneys also perform gluconeogenesis, release calcitriol and erythropoietin, and excrete wastes and foreign substances.

7.3 Anatomy and Histology of the Kidneys

- The kidneys are retroperitoneal organs attached to the posterior abdominal wall.
- Three layers of tissue surround the kidneys: renal capsule, adipose capsule, and renal fascia.
- Internally, the kidneys consist of a renal cortex, a renal medulla, renal pyramids, renal papillae, renal columns, major and minor calyces, and a renal pelvis.
- Blood flows into the kidney through the renal artery and successively into segmental, interlobar, arcuate, and interlobular arteries; afferent arterioles; glomerular capillaries; efferent arterioles; peritubular capillaries and vasa recta; and interlobular, arcuate, and interlobar veins before flowing out of the kidney through the renal vein.
- Vasomotor nerves from the sympathetic division of the autonomic nervous system supply kidney blood vessels; they help regulate the flow of blood through the kidney.
- The nephron is the functional unit of the kidneys. A nephron consists of a renal corpuscle (glomerulus and glomerular or Bowman's capsule) and a renal tubule.
- A renal tubule consists of a proximal convoluted tubule, a loop of Henle, and a distal convoluted tubule, which drains into a collecting duct (shared by several nephrons). The loop of Henle consists of a descending limb and an ascending limb.
- A cortical nephron has a short loop that dips only into the superficial region of the renal medulla; a juxtamedullary nephron has a long loop of Henle that stretches through the renal medulla almost to the renal papilla.

- The wall of the entire glomerular capsule, renal tubule, and ducts consists of a single layer of epithelial cells. The epithelium has distinctive histological features in different parts of the tubule.
- The juxtaglomerular apparatus (JGA) consists of the juxtaglomerular cells of an afferent arteriole and the macula densa of the final portion of the ascending limb of the loop of Henle.

7.4 Overview of Renal Physiology

- Nephrons perform three basic tasks: glomerular filtration, tubular secretion, and tubular reabsorption.

7.5 Glomerular Filtration

- Fluid that enters the capsular space is glomerular filtrate.
- The filtration membrane consists of the glomerular endothelium, basal lamina, and filtration slits between pedicels of podocytes.
- Most substances in blood plasma easily pass through the glomerular filter. However, blood cells and most proteins normally are not filtered.
- Glomerular filtrate amounts to up to 180 liters of fluid per day. This large amount of fluid is filtered because the filter is porous and thin, the glomerular capillaries are long, and the capillary blood pressure is high.
- Glomerular blood hydrostatic pressure (GBHP) promotes filtration; capsular hydrostatic pressure (CHP) and blood colloid osmotic pressure (BCOP) oppose filtration. Net filtration pressure (NFP) _ GBHP _ CHP _ BCOP. NFP is about 10 mmHg.
- Glomerular filtration rate (GFR) is the amount of filtrate formed in both kidneys per minute; it is normally 105–125 mL/min.
- Glomerular filtration rate depends on renal autoregulation, neural regulation, and hormonal regulation. summarizes regulation of GFR.

7.6 Tubular Re absorption and Tubular Secretion

- Tubular reabsorption is a selective process that reclaims materials from tubular fluid and returns them to the bloodstream. Reabsorbed substances include water, glucose, amino acids, urea, and ions, such as sodium, chloride, potassium, bicarbonate, and phosphate
- Some substances not needed by the body are removed from the blood and discharged into the urine via tubular secretion. Included are ions (K_, H_, and NH4 _), urea, creatinine, and certain drugs.
- Reabsorption routes include both paracellular (between tubule cells) and transcellular (across tubule cells) routes.
- The maximum amount of a substance that can be reabsorbed per unit time is called the transport maximum (Tm).
- About 90% of water reabsorption is obligatory; it occurs via osmosis, together with reabsorption of solutes, and is not hormonally regulated. The remaining 10% is facultative water reabsorption, which varies according to body needs and is regulated by ADH.
- Na_ ions are reabsorbed throughout the basolateral membrane via primary active transport.
- In the proximal convoluted tubule, sodium ions are reabsorbed through the apical membranes via Na_–glucose symporters and Na_/H_ antiporters; water is reabsorbed via osmosis; Cl_, K_, Ca2_, Mg2_, and urea are reabsorbed via passive diffusion; and NH3 and NH4 _ are secreted.
- The loop of Henle reabsorbs 20–30% of the filtered Na_, K_, Ca2_, and HCO3_; 35% of the filtered Cl_; and 15% of the filtered water.
- The distal convoluted tubule reabsorbs sodium and chloride ions via Na_–Cl_ symporters.
- In the collecting duct, principal cells reabsorb Na_ and secrete K_; intercalated cells reabsorb K_ and HCO3_ and secrete H_.

- Angiotensin II, aldosterone, antidiuretic hormone, atrial natriuretic peptide, and parathyroid hormone regulate solute and water reabsorption, as summarized in

7.7 Production of Dilute and Concentrated Urine

- In the absence of ADH, the kidneys produce dilute urine; renal tubules absorb more solutes than water.
- In the presence of ADH, the kidneys produce concentrated urine; large amounts of water are reabsorbed from the tubular fluid into interstitial fluid, increasing solute concentration of the urine.
- The countercurrent multiplier establishes an osmotic gradient in the interstitial fluid of the renal medulla that enables production of concentrated urine when ADH is present.

7.8 Evaluation of Kidney Function

- A urinalysis is an analysis of the volume and physical, chemical, and microscopic properties of a urine sample.
- Chemically, normal urine contains about 95% water and 5% solutes. The solutes normally include urea, creatinine, uric acid, urobilinogen, and various ions.
- Renal clearance refers to the ability of the kidneys to clear (remove) a specific substance from blood.

7.9 Urine Transportation, Storage, and Elimination

- The ureters are retroperitoneal and consist of a mucosa, muscularis, and adventitia. They transport urine from the renal pelvis to the urinary bladder, primarily via peristalsis.
- The urinary bladder is located in the pelvic cavity posterior to the pubic symphysis; its function is to store urine before micturition.
- The urinary bladder consists of a mucosa with rugae, a muscularis (detrusor muscle), and an adventitia (serosa over the superior surface).
- The micturition reflex discharges urine from the urinary bladder via parasympathetic impulses that cause contraction of the detrusor muscle and relaxation of the internal urethral sphincter muscle and via inhibition of impulses in somatic motor neurons to the external urethral sphincter.

- The urethra is a tube leading from the floor of the urinary bladder to the exterior. Its anatomy and histology differ in females and males. In both sexes, the urethra functions to discharge urine from the body; in males, it discharges semen as well.

7.10 Waste Management in Other Body Systems

- Besides the kidneys, several other tissues, organs, and processes temporarily confine wastes, transport waste materials for disposal, recycle materials, and excrete excess or toxic substances.
- Buffers bind excess H_, the blood transports wastes, the liver converts toxic substances into less toxic ones, the lungs exhale CO2, sweat glands help eliminate excess heat, and the gastrointestinal tract eliminates solid wastes.

7.11 Development of the Urinary System

- The kidneys develop from intermediate mesoderm.
- The kidneys develop in the following sequence: pronephros, mesonephros, and metanephros. Only the metanephros remains and develops into a functional kidney.

7.12 Aging and the Urinary System

- With aging, the kidneys shrink in size, have a decreased blood flow, and filter less blood.
- Common problems related to aging include urinary tract infections, increased frequency of urination, urinary retention or incontinence, and renal calculi.

Self-Check 7	Written Test

1. List the function of kidney (3 Point)
2. Describe methods used for evaluation of kidney function (3 Point)
3. The renal corpuscle consists of the _____ and _____. (3 Point)
4. Discharge of urine from the urinary bladder is called _____.(3 Point)
5. Which of the following are mechanisms that control GFR? (1) Renal autoregulation, (2) neural regulation, (3) hormonal regulation, (4) chemical regulation of ions, (5) presence or absence of a transporter. (3 Point)

   (a) 1, 2, and 3 (b) 2, 3, and 4 (c) 3, 4, and 5

   (d) 1, 3, and 5 (e) 1, 3, and 4

Note: **Satisfactory rating - 10 points Unsatisfactory - below 10 points**

You can ask you teacher for the copy of the correct answers.

Answer Sheet

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Information Sheet 8	1.8. Anatomy and physiology of endocrine system

8.1 Introduction

1. Hormones regulate the activity of smooth muscle, cardiac muscle, and some glands; alter metabolism; spur growth and development; influence reproductive processes; and participate in circadian (daily) rhythms.

8.2 Comparison of Control by the Nervous and Endocrine Systems

1. The nervous system controls homeostasis through nerve impulses and neurotransmitters, which act locally and quickly. The endocrine system uses hormones, which act more slowly in distant parts of the body.

2. The nervous system controls neurons, muscle cells, and glandular cells; the endocrine system regulates virtually all body cells.

8.3 Endocrine Glands

1. Exocrine glands (sudoriferous, sebaceous, mucous, and digestive) secrete their products through ducts into body cavities or onto body surfaces. Endocrine glands secrete hormones into interstitial fluid. Then, the hormones diffuse into the blood.

2. The endocrine system consists of endocrine glands (pituitary, thyroid, parathyroid, adrenal, and pineal glands) and other hormonesecreting tissues (hypothalamus, thymus, pancreas, ovaries, testes, kidneys, stomach, liver, small intestine, skin, heart, adipose tissue, and placenta).

8.4 Hormone Activity

1. Hormones affect only specific target cells that have receptors to recognize (bind) a given hormone. The number of hormone receptors may decrease (down-regulation) or increase (up-regulation).

2. Circulating hormones enter the bloodstream; local hormones (paracrines and autocrines) act locally on neighboring cells.

3. Chemically, hormones are either lipid-soluble (steroids, thyroid hormones, and nitric oxide) or water-soluble (amines; peptides, proteins, and glycoproteins; and eicosanoids).

4. Water-soluble hormone molecules circulate in the watery blood plasma in a "free" form (not attached to plasma proteins); most lipid-soluble hormones are bound to transport proteins synthesized by the liver

8.5 Mechanisms of Hormone Action

1. Lipid-soluble steroid hormones and thyroid hormones affect cell function by altering gene expression.

2. Water-soluble hormones alter cell function by activating plasma membrane receptors, which elicit production of a second messenger that activates various enzymes inside the cell.

3. Hormonal interactions can have three types of effects: permissive, synergistic, or antagonistic.

8.6 Control of Hormone Secretion

1. Hormone secretion is controlled by signals from the nervous system, chemical changes in blood, and other hormones.

2. Negative feedback systems regulate the secretion of many hormones.

8.7 Hypothalamus and Pituitary Gland

1. The hypothalamus is the major integrating link between the nervous and endocrine systems.

2. The hypothalamus and pituitary gland regulate virtually all aspects of growth, development, metabolism, and homeostasis.

3. The pituitary gland is located in the hypophyseal fossa and is divided into the anterior pituitary (glandular portion), the posterior pituitary (nervous portion), and the pars intermedia (avascular zone in between).

4. Secretion of anterior pituitary hormones is stimulated by releasing hormones and suppressed by inhibiting hormones from the hypothalamus.

5. The blood supply to the anterior pituitary is from the superior hypophyseal arteries. Hypothalamic releasing and inhibiting hormones enter the primary plexus and flow to the secondary plexus in the anterior pituitary by the hypophyseal portal veins.

6. The anterior pituitary consists of somatotrophs that produce human growth hormone (hGH); lactotrophs that produce prolactin (PRL); corticotrophs that secrete adrenocorticotropic hormone (ACTH) and melanocyte-stimulating hormone (MSH); thyrotrophs that secrete thyroid-stimulating hormone (TSH); and gonadotrophs that synthesize follicle-stimulating hormone (FSH) and luteinizing hormone (LH).

7. Human growth hormone (hGH) stimulates body growth through Insulin like growth factors (IGFs). Secretion of hGH is inhibited by GHIH (growth hormone–inhibiting hormone, or somatostatin) and promoted by GHRH (growth hormone–releasing hormone).

8. TSH regulates thyroid gland activities. Its secretion is stimulated by TRH (thyrotropin-releasing hormone) and suppressed by GHIH.

9. FSH and LH regulate the activities of the gonads—ovaries and testes. Their secretion is controlled by GnRH (gonadotropinreleasing hormone).

10. Prolactin (PRL) helps initiate milk secretion. Prolactin-inhibiting hormone (PIH) suppresses secretion of PRL; prolactin-releasing hormone (PRH) and TRH stimulate PRL secretion.

11. ACTH regulates the activities of the adrenal cortex and is controlled by CRH (corticotropin-releasing hormone).

12. Dopamine inhibits secretion of MSH.

13. The posterior pituitary contains axon terminals of neurosecretory cells whose cell bodies are in the hypothalamus.

14. Hormones made by the hypothalamus and stored in the posterior pituitary are oxytocin (OT), which stimulates contraction of the uterus and ejection of milk from the breasts, and antidiuretic hormone (ADH), which stimulates water reabsorption by the kidneys and constriction of arterioles.

15. Oxytocin secretion is stimulated by uterine stretching and suckling during nursing; ADH secretion is controlled by osmotic pressure of the blood and blood volume.

8.8 Thyroid Gland

1. The thyroid gland is located inferior to the larynx.

2. It consists of thyroid follicles composed of follicular cells, which secrete the thyroid hormones thyroxine (T4) and triiodothyronine (T3), and parafollicular cells, which secrete calcitonin (CT).

3. Thyroid hormones are synthesized from iodine and tyrosine within thyroglobulin (TGB). They are transported in the blood bound to plasma proteins, mostly thyroxine-binding globulin (TBG).

4. Secretion is controlled by TRH from the hypothalamus and thyroid-stimulating hormone (TSH) from the anterior pituitary.

5. Thyroid hormones regulate oxygen use and metabolic rate, cellular metabolism, and growth and development.

6. Calcitonin (CT) can lower the blood level of calcium ions (Ca2_) and promote deposition of Ca2_into bone matrix. Secretion of CT is controlled by the Ca2_level in the blood.

8.9 Parathyroid Glands

1. The parathyroid glands are embedded in the posterior surfaces of the lateral lobes of the thyroid gland. They consist of chief cells and oxyphil cells.

2. Parathyroid hormone (PTH) regulates the homeostasis of calcium, magnesium, and phosphate ions by increasing blood calcium and magnesium levels and decreasing blood phosphate levels. PTH secretion is controlled by the level of calcium in the blood.

8.10 Adrenal Glands

1. The adrenal glands are located superior to the kidneys. They consist of an outer adrenal cortex and inner adrenal medulla.

2. The adrenal cortex is divided into a zona glomerulosa, a zona fasciculata, and a zona reticularis; the adrenal medulla consists of chromaffin cells and large blood vessels.

3. Cortical secretions include mineralocorticoids, glucocorticoids, and androgens.

4. Mineralocorticoids (mainly aldosterone) increase sodium and water reabsorption and decrease potassium reabsorption. Secretion is controlled by the renin–angiotensin–aldosterone (RAA) pathway and by K_ level in the blood.

5. Glucocorticoids (mainly cortisol) promote protein breakdown, gluconeogenesis, and lipolysis; help resist stress; and serve as anti-inflammatory substances. Their secretion is controlled by ACTH.

6. Androgens secreted by the adrenal cortex stimulate growth of axillary and pubic hair, aid the prepubertal growth spurt, and contribute to libido.

7. The adrenal medulla secretes epinephrine and norepinephrine (NE), which are released during stress and produce effects similar to sympathetic responses. (See Table 18.8 on page 669.)

8.11 Pancreatic Islets

1. The pancreas lies in the curve of the duodenum. It has both endocrine and exocrine functions.

2. The endocrine portion consists of pancreatic islets or islets of Langerhans, made up of four types of cells: alpha, beta, delta, and F cells.

3. Alpha cells secrete glucagon, beta cells secrete insulin, delta cells secrete somatostatin, and F cells secrete pancreatic polypeptide.

4. Glucagon increases blood glucose level; insulin decreases blood glucose level. Secretion of both hormones is controlled by the level of glucose in the blood.

8.12 Ovaries and Testes

1. The ovaries are located in the pelvic cavity and produce estrogens, progesterone, and inhibin. These sex hormones govern the development and maintenance of female secondary sex

characteristics, reproductive cycles, pregnancy, lactation, and normal female reproductive functions.

2. The testes lie inside the scrotum and produce testosterone and inhibin. These sex hormones govern the development and maintenance of male secondary sex characteristics and normal male reproductive functions.

- Pineal Gland

1. The pineal gland is attached to the roof of the third ventricle of the brain. It consists of secretory cells called pinealocytes, neuroglia, and endings of sympathetic postganglionic axons.

2. The pineal gland secretes melatonin, which contributes to setting the body's biological clock (controlled in the suprachiasmatic nucleus). During sleep, plasma levels of melatonin increase.

- Thymus

1. The thymus secretes several hormones related to immunity.

2. Thymosin, thymic humoral factor (THF), thymic factor (TF), and thymopoietin promote the maturation of T cells.

8.13 Other Endocrine Tissues and Organs,

- Eicosanoids, and Growth Factors

1. Body tissues other than those normally classified as endocrine glands contain endocrine tissue and secrete hormones, including the gastrointestinal tract, placenta, kidneys, skin, and heart.

2. Prostaglandins and leukotrienes are eicosanoids that act as local hormones in most body tissues.

3. Growth factors are local hormones that stimulate cell growth and division.

8.14 The Stress Response

1. Productive stress is termed eustress, and harmful stress is termed distress.

2. If stress is extreme, it triggers the stress response (general adaptation syndrome), which occurs in three stages: the fight-or-flight response, resistance reaction, and exhaustion.

3. The stimuli that produce the stress response are called stressors. Stressors include surgery, poisons, infections, fever, and strong emotional responses.

4. The fight-or-flight response is initiated by nerve impulses from the hypothalamus to the sympathetic division of the autonomic nervous system and the adrenal medulla. This response rapidly increases circulation, promotes ATP production, and decreases nonessential activities.

5. The resistance reaction is initiated by releasing hormones secreted by the hypothalamus, most importantly CRH, TRH, and GHRH. Resistance reactions are longer lasting and accelerate breakdown reactions to provide ATP for counteracting stress.

6. Exhaustion results from depletion of body resources during the resistance stage.

7. Stress may trigger certain diseases by inhibiting the immune system.

An important link between stress and immunity is interleukin-l, produced by macrophages; it stimulates secretion of ACTH.

8.15 Development of the Endocrine System

1. The development of the endocrine system is not as localized as in other systems because endocrine organs develop in widely separated parts of the embryo.

2. The pituitary gland, adrenal medulla, and pineal gland develop from ectoderm; the adrenal cortex develops from mesoderm; and the thyroid gland, parathyroid glands, pancreas, and thymus develop from endoderm.

8.16 Aging and the Endocrine System

1. Although some endocrine glands shrink as we get older, their performance may or may not be compromised.

2. Production of human growth hormone, thyroid hormones, cortisol, aldosterone, and estrogens decreases with advancing age.

3. With aging, the blood levels of TSH, LH, FSH, and PTH rise.

4. The pancreas releases insulin more slowly with age, and receptor sensitivity to glucose declines.

5. After puberty, thymus size begins to decrease, and thymic tissue is replaced by adipose and areolar connective tissue.

Self-Check 8	Written Test

1. Define endocrine system (3point)

2. Describe Mechanisms of Hormone Action (3point)
3. List hormones and its function produce by Thyroid Gland (3point)
4. Mention the function of ovaries and Testes (3point)
5. List the function of Parathyroid Glands (3point)

Note: **Satisfactory rating - 10 points Unsatisfactory - below 10 points**

You can ask you teacher for the copy of the correct answers.

Answer Sheet

Score = _____

Rating: _____

Name: _____ Date: _____

Short Answer Questions

1. _____

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Information Sheet 9	1.9. Anatomy and physiology of nervous system

9 Nervous systems

9.1 INTRODUCTION

The nervous system and the endocrine system together perform a vital function for the body: *communication*. **Homeostasis**: (relatively constancy of the normal body's internal environment) & survival depend on this function. Because communication provides the means for controlling and integrating the many different functions performed by organs, tissues and cells

Integrating means unifying; unifying body functions means controlling them in the way that make them work together to accomplish homeostasis and thus survival

- ❖ Communication makes possible control
- ❖ Control makes possible integration
- ❖ Integration makes possible homeostasis
- ❖ Homeostasis makes possible survival

In general, the nervous system controls rapid activities of the body such as muscular contraction; rapidly changing visceral events and the rate of the endocrine glands secrete their secretion.

In contrast the endocrine system regulates principally the metabolic function of the body

9.2 Organization of the Nervous System

The nervous system is composed of brain, spinal cord and nerves. Based on the relative position of the structures in the nervous system, nervous system divides in to two:

1. Central nervous system (CNS) &
2. Peripheral nervous system (PNS)

9.2.1 Central nervous system (CNS)

- ➢ The structural & functional center of the entire nervous system
- ➢ It consists of brain and spinal cord
- ➢ It is the source of thought, emotions and memories

9.2.2 Peripheral nervous system (PNS)

- ➢ Composed of all nerves and their branches
- ➢ Nerves originate from the brain are called cranial nerves

- Nerves originate from the spinal cord are called spinal nerves

Peripheral nervous system also divided in to two

A. Somatic nervous system (SNS)

Chiefly concerned with our interaction with the external environment

It involves the special sensory organs like eye, ear

The major effectors tissue is the muscle

B. Autonomic nervous system(ANS)

Chiefly concerned with the regulation and maintenance of the internal environment

Play a key role in the maintenance of the homeostasis

It innervates cells of visceral system includes the cardiovascular system, digestive system, respiratory system, endocrine system

PNS also divides in to two

1. Sympathetic nervous system &
2. Parasympathetic nervous system

9.3 Function of Nervous System

The nervous system caries out a complex array of tasks. These diverse activities can be grouped into three basic functions

1. Sensory function

Sensory receptors detect internal stimuli (like increase in blood pressure) and external stimuli (like rain drop on the forehead)

Sensory receptors are specialized cells that monitor changes in the internal and external environment.

Neurons called **sensory or afferent neurons** carry this sensory information in to the brain and spinal cord through cranial and spinal nerves

2. Integrative function

The nervous system integrates (process) sensory information by analyzing and storing some of the information and make decisions for appropriate response

Interneurons are neurons that carry this integration process

The vast majority of neurons in the body are inter neurons

3. Motor function

Once sensory information is integrated, the nervous system may elicit an appropriate motor response such as a muscle contraction or gland secretion

Motor (efferent) neurons are neurons carry information from the brain towards the spinal cord or out of the brain and spinal cord to effectors (muscle o& glands) through cranial and spinal nerves

Stimulus of the effectors by motor neurons cause muscle to contract and glands to secrete

9.4 Cells of the Nervous System

There are two main types of cells that compose the nervous system. These are

1. Neurons
2. Neuroglia

9.5 Neurons

Neurons are electrically excitable cells (the ability to responds to stimuli by producing action potential) that conduct the impulse

Parts of Neurons

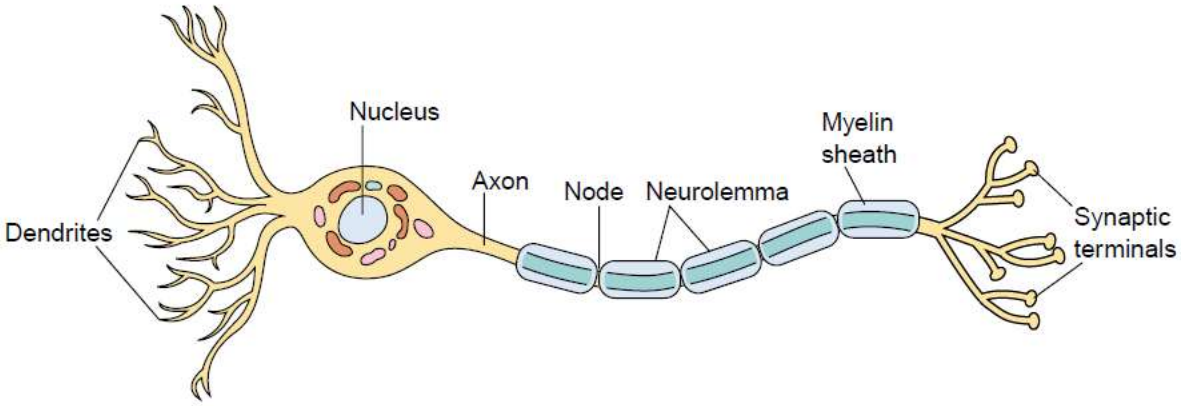
Most neurons have three parts:

A. Cells body
B. Dendrites &
C. Axon } are processes

- ***CELL BODY (SOMA)***

Contain nucleus surrounding by cytoplasm that includes organelles such as Lysosomes, mitochondria and golgi complex

Cells membrane encloses the entire neurons



Dendrites (Little Trees)

- Dendrites are processes that branch extensively from the cell body like tiny tree
- Dendrites are the ***receiving portion*** of a neuron that receiving stimuli and conduct electrical signals towards the cell body or axon
- They are short and highly branched and form a tree shaped array of processes extending from the cell body
- ***AXON***
- Axon is a single process extending from axon hillock (cone shaped elevation in the cell body)
- Axon is a long thin cylindrical projection from the cell body
- Axons conduct ***impulse away*** from the cell body
- The axon ends by dividing into many fine processes called ***axon terminals (telodendria)***
- The tips of some axon terminals swell into bulb shaped structure called ***synaptic end bulb*** which contain many tiny membrane enclosed sacs called ***synaptic vesicles*** that stores a chemical neurotransmitters

- When neurotransmitter molecules are released from synaptic vesicles, they excite or inhibit other neuron, muscles or glands
- NB. Nerves fiber is a general term for any neuronal process or extension emerges from the cell body of a neuron

NEUROGLIA

- These are smaller than the neuron but 5 – 50 times more numerous
- They do not generate or propagate action potential (impulse)
- The general functions of Neuroglia are support, nourish and protect the neurons and maintain homeostasis in the interstitial fluid that bathes them

Types: there are six types of Neuroglia

These six Neuroglias can be categorized as Neuroglia of CNS and Neuroglia of PNS

Neuroglia of CNS	***Neuroglia of PNS***
1. Astrocytes	1. Schwann cells
2. Oligodendrocytes	2. Satellite cells
3. Microglia	
4. Ependymal cells	

ASTROCYTES

- Astrocytes are star shaped cells have many processes
- They are largest and most numerous of the Neuroglia

Functions:

1. Support neurons because they contain microfilaments
2. Help in forming the blood brain barrier(BBB)
   BBB restrict movement of substance between blood and interstitial fluid of CNS
3. They help to maintain the appropriate chemical environment for the generation of nerve impulses

OLIGODENDROCYTES (cells with few branches)

- These are smaller than Astrocytes and have fewer processes

Function

1. Help to hold nerve fibers together
2. Forming and maintaining the myelin sheath around CNS axon

Myelin sheath is multilayered lipid and protein that covering some axon

It insulates the axon and increases speed of nerve impulse

MICROGLIA

- Microglias are small, usually stationary cells found in the CNS

Function

- Carry out phagocytosis (engulfing and destroying microorganism and cellular debris)

EPENDYMAL CELLS

- Ependymal cells are cells that resemble epithelial cells

Function

1. Forming thin sheet that line fluid filled cavity in the brain and spinal cord
2. Produce, monitor and assist in the circulation of cerebrospinal fluid

SCHWANN CELL

- Schwann cells are cells encircle PNS axon

Function

1. Form myelin sheath around axon of PNS
2. Participate in axon regeneration

NB. Axon of neuron surrounded by a myelin sheath produced by Schwann cells in the PNS and oligodenrocytes in the CNS are said to be ***myelinated***

SATELLITE CELLS

- Satellite cells are flat cells surrounded the cell body of neurons of PNS ganglia (ganglia are collection of neuronal cell bodies outside the CNS

Function

1. Provide structural support
2. Regulate the exchange of material between neuronal cell body and interstitial fluid

9.5 Central Nervous System

- CNS is the structural and functional center of the entire nervous system
- Its two structures, the brain and the spinal cord, are found along the mid sagital plain of the body

9.6 Protective Coverage of CNS

- The brain is protected in the cranial cavity of the skull and the spinal cord is surrounded in the spinal column
- In addition, tough connective tissue called meninges and a cushion of cerebrospinal fluid (CSF) surround and protect the delicate nervous tissues of brain and spinal cord

9.7 Meninges and Cerebrospinal Fluid

- The meninges are three connective tissue membrane coverings that encircle the brain and spinal cord. The spinal meninges surround the spinal cord and are continuous with the cranial meninges which encircle the brain
- The three district layers of meninges are Dura mater, aracnoid membrane and pia mater

A. **Dura mater**: is the most superficial layer that composed of a dense, irregular tough and strong with fibrous tissue

B. **Arachnoid mater**: is the middle meninx that is made up of delicate collagen fiber and some elastic fibers

C. **Pia mater**: is the inner most meninx that is thin transparent connective tissue layer

It adheres to the surface of the spinal cord and brain. Within the pia mater are many blood vessels that are supply oxygen and nutrients to the brain and spinal cord

- There are several spaces between and around the meninges. **Three** of these spaces are

1. **Epidural space**: is immediately outside the dura mater but inside the vertebral and cranial cavities. It contains a supporting cushion of fat and other connective tissues

2. **Subdural space**: is between the dura mater and arachnoid membrane
   Subdural space contains small amount of lubricant interstitial fluid
3. **Subarachnoid space**: the space between the arachnoid mater & the pia mater
   This space contains a significant amount of cerebrovascular fluid

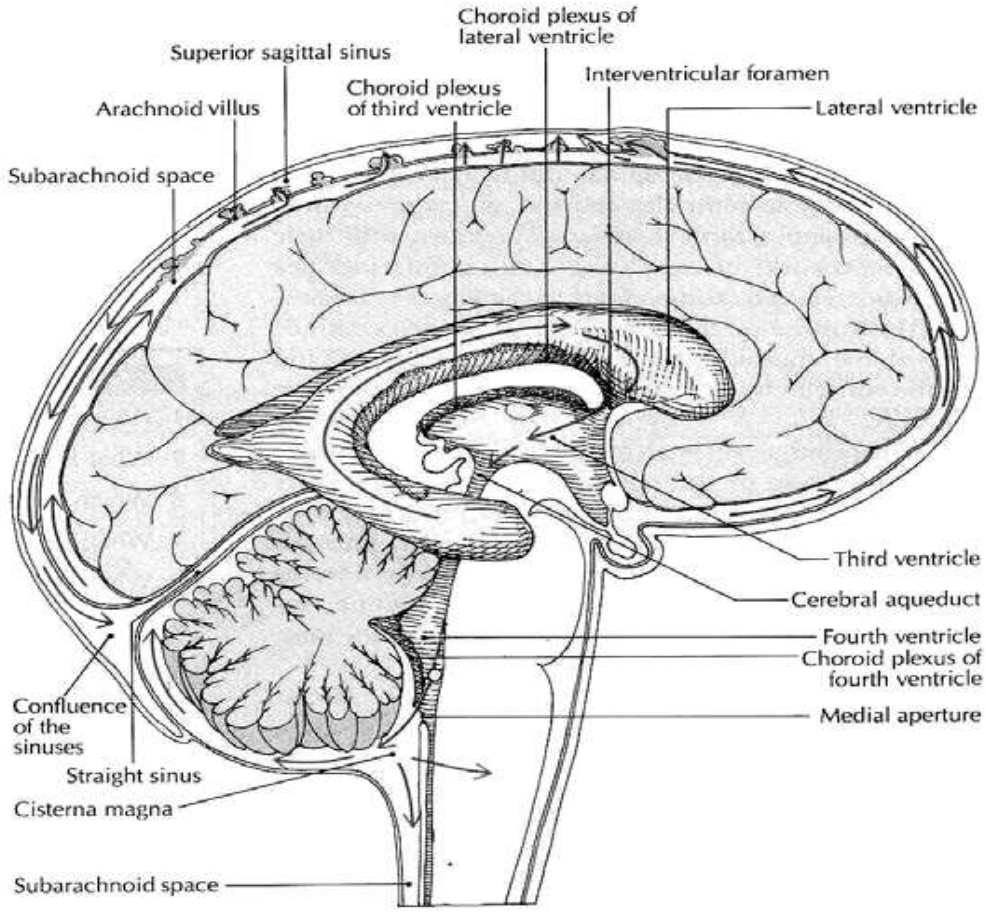
9.8 Cerebrovascular Fluid

- **CSF** is a clear, colorless liquid that protects the brain and spinal cord from chemical and physical injuries. CSF continuously circulates through cavities in the brain & spinal cord and around brain and spinal cord in the subarachnoid space. It also carries oxygen, glucose and other needed chemicals from the blood to neurons and Neuroglias.
- The large fluid filled spaces within the brain are called **ventricles.** There are **four ventricles** in the brain. The **two lateral** (first & second) ventricles are located one in each hemispheres of the cerebrum. The **third ventricle** is a narrow cavity along the midline superior to the hypothalamus and between the right and left halves of the thalamus. The **fourth ventricle** is a tiny diamond shaped space that lies between the brain stem and the cerebellum. The total volume of CSF is 80 - 150 mL in the adult & it contains glucose, protein, lactic acid, urea, cations (Na^+, K^+, Ca^{++}, Mg^{++}) and anions (Cl^-, HCO_3^-)

9.9 Formation and circulation of CSF

- The sites of CSF production are the **choroid plexuses**, a network of capillaries that project from the pia mater in to the lateral ventricles and in to the roofs of the 3rd& 4th ventricles. The capillaries are covered by Ependymal cells that form CSF from blood plasma.
- The CSF formed in choroid plexuses of each lateral ventricle flows into the 3rd ventricles through two narrow, oval openings called the **interventricular foramina**.
- More CSF is added by the choroid plexuses in the roof of the 3rd ventricles.
- The fluid then flows through the **aqueduct of the midbrain (cerebral aqueduct)** which passes through the midbrain in to the 4th ventricle.
- The choroid plexus of the 4th ventricle contributes more fluid.

- CSF enters the subarachnoid space through **three opening** in the roof of the 4th ventricle: **a median aperture** and the **paired lateral apertures** one on each side.
- CSF then circulates in the central canal of the spinal cord and in the subarachnoid space around the surface of the brain and spinal cord.
- CSF is gradually reabsorbed in to the blood through **arachnoid villi**; finger like extensions of the arachnoid that project into the dura venous sinuses.
- Because the rate of formation and re-absorption are the same, the pressure of CSF normally is constant.



BRAIN

- The brain is one of the largest organs of the adult's body. In adults, it weighs about 1.4Kg and consists of 100billion neurons and 900 billions glias.

9.10 Major parts of the brain

- Brain consists of **four** major parts. These are:

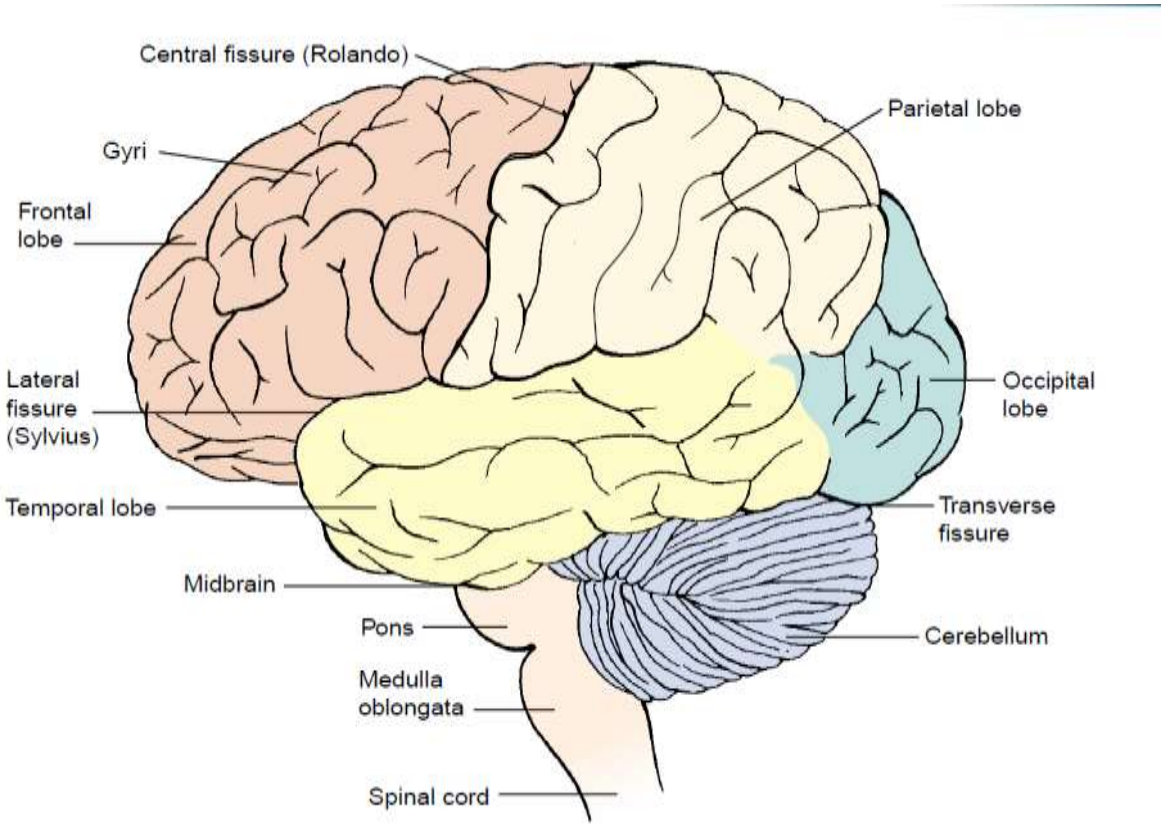
1. **Brain stem**- is the continuation of the spinal cord

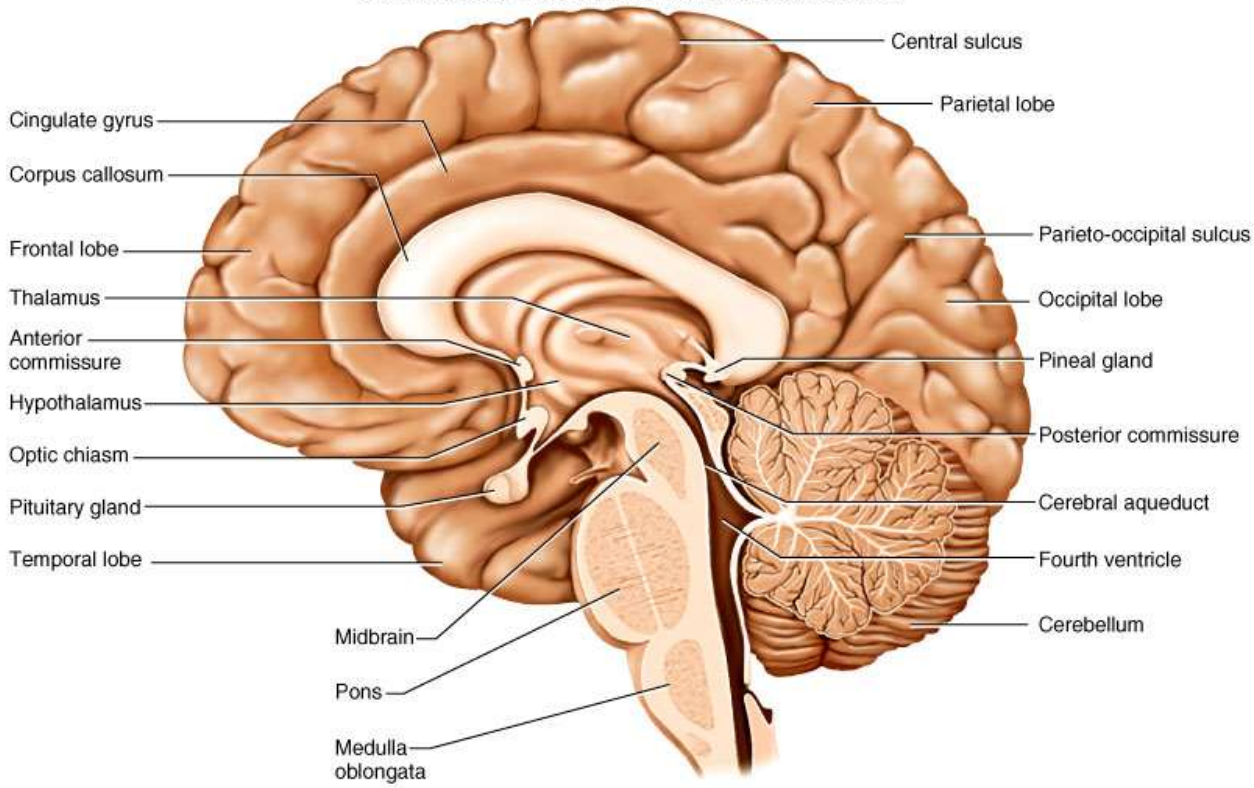
   It has 3 parts: medulla oblongata, Pons and midbrain

2. **Diencephalon**- superior to brain stem

   It consists of thalamus and hypothalamus

3. **Cerebellum**- posterior to brain stem
4. **Cerebrum** – the largest part of the brain





(a)

9.11 Brain Stem

- It is the part of the brain located between diencephalon and spinal cord.
- It consists of medulla oblongata, Pons and midbrain

9.12 Medulla Oblongata

- It is the lower portion of the brain that continuous with the superior part of the spinal cord. Medulla begins at the foramen magnum and extends to the inferior border of the Pons.

Functions:

1. Medulla contains '***vital centers'*** so it is the most vital part of the entire brain.

   These vital centers are:

   A. *Cardiac center*: regulates the rate & force of heart beat

B. *Vasomotor center*: regulates the diameter of the blood vessels

C. *Respiratory center*: regulates the respiration

2. It also contains other centers like swallowing, vomiting, coughing, sneezing and hiccupping
3. Medulla contains origins of cranial nerve from 8 – 12

9.13 Pons

- Pons lies directly superior to the medulla, inferior to the midbrain and anterior to the cerebellum. It is a bridge that connects parts of the brain with one another.

Function:

1. It contains pneumotaxic area (which mainly controls rate and depth of breathing) and apneustic area. Together with medulla, the pneumotaxic area and apneustic areas help to control breathing
2. The Pons also contains nuclei of origin for cranial nerve 5 – 8

9.14 Mid Brain

- It extends from the pons to diencephalon. The cerebral aqueduct passes through midbrain to connect the third & fourth ventricles.

Function:

1. Relays motor output from the cerebral cortex to the pons and sensory input from the spinal cord to the thalamus.
2. It coordinates movements of the eyeballs
3. It also coordinates movements of the head and trunk in response to auditory stimuli.
4. It contains nuclei of origin for cranial nerves 3 & 4

9.15 Cerebellum

- The cerebellum, second largest brain part, occupies the inferior and posterior aspects of the cranial cavity.
- It is posterior to the medulla & pons and inferior to the posterior portion of the cerebrum. A deep groove, called the *transverse fissure*, separates the cerebellum from the cerebrum. shape of the cerebellum resembles a "*butterfly*".

Functions: The cerebellum performs three general functions, all of which have to do with the control of skeletal muscles.

1. Coordinates complex *skilled movements*, together with cerebral cortex, by coordinating the activities of group of muscles
2. Regulates or controls *posture.* It makes movements of smooth, efficient and coordinated
3. Controls skeletal muscles to *maintain balance*
   - Sensory impulses from equilibrium receptors in the ear reach the cerebellum
   - Cerebellum may have role in cognition and language processing

9.16 Diencephalon

- Diencephalon is the part of the brain located between the cerebrum and the midbrain. It surrounds the 3rd ventricles and contains the thalamus and hypothalamus.

9.17 Thalamus

- Thalamus makes up 80% of the diencephalon. It is the ***main relay station for most sensory impulses*** that reach the primary sensory areas of the cerebral cortex from the spinal cord and brain stem. It is located superior to the hypothalamus.

Function: the primary functions of thalamus are

1. Produce sensation

   Impulses from appropriate receptors on reaching the thalamus produce conscious recognition of the crude, less critical sensation of pain, temperature, touch and pressure. Relay all kinds of sensory impulses, except olfactory to the cerebrum
2. Plays a part in the mechanism responsible for emotions by associating sensory impulses with feelings of pleasantness ad unpleasantness
3. Involves in the movements planning and controls
4. Plays a part in the arousal or alerting mechanisms

9.18 Hypothalamus

- Hypothalamus lies beneath the thalamus. It forms the floor of the 3rd ventricle. Hypothalamus is a small but functionally important area of the brain.

Function:

Hypothalamus performs many functions of the greatest importance both for survival and for the enjoyment of life.

1. *Control of the ANS*

   It controls and integrates activities of the ANS, which regulates contractions of smooth and cardiac muscle and secretion of many glands and pituitary gland. Through the ANS, hypothalamus is a major regulator of visceral activities, including regulation of heart rate, movement of food through the GIT, and contraction of urinary bladder

2. *Production of hormones*

- Hypothalamus produces ***oxytocin & antidiuretic*** hormone
- It also produces ***five releasing hormones*** which stimulate secretion of anterior pituitary gland
  A. Growth hormone releasing hormone – GhRH
  B. Thyrotropin releasing hormone – TRH
  C. Gonadotropin releasing hormone- GnRH
  D. Prolactin releasing hormone – PRH
  E. Corticotrophin releasing hormone – CRH
- In addition, hypothalamus produces **two inhibiting hormone** which suppress secretion of anterior pituitary gland
  A. Growth hormone inhibiting hormone – GHIH
  B. Prolactin inhibiting hormone –PIH

3. *Regulate emotional & behavioral patterns*

   Hypothalamus participates in expression of rage, pain, aggression and behavioral pattern related to sexual arousal

4. *Regulates eating and drinking behavior*

- Hypothalamus consists of:
  A. "appetite center" – regulates appetite & therefore the amount of food intake
  B. "thirst center" – regulates water intake

5. *Control body temperature*

   If the temperature of blood flowing through the hypothalamus is above normal, the hypothalamus directs the ANS to stimulate activities that promote heat loss (vasodilatation, sweating)

   When blood temperature is below normal, the hypothalamus generates impulse that promote heat production and retention

6. *Regulates circadian rhythmus and state of consciousness*

   The hypothalamus establishes patterns of awakening & sleep that occur on a circadian schedule (cycle of about 24 hours)

9.19 Cerebrum

- *Cerebrum i*s the largest & uppermost part of the brain. It composed of two halves: the right & left cerebral hemispheres, which are separated by the **falx cerebri**.

It has many folds and grooves

- ♣ The folds are called ***gyri or convulutions***
- ♣ The deepest grooves between folds are known as ***fissures***
- ♣ The shallow grooves between folds are known as ***sulci***

9.20 Lobes of Cerebrum

Each cerebral hemisphere divided in to 4 lobes

a. Parietal lobe
b. Frontal lobe
c. Temporal lobe
d. Occipital lobe

FISSURES

a. **Longitudinal fissure** is the most prominent and deepest fissure that divides the cerebrum in to two hemispheres (right & left cerebral hemispheres)
b. **Fissure of Ronaldo** (central sulcus) is groove between the frontal & parietal lobes
c. **Lateral fissure** is a deep groove between the temporal lobe below and the parietal & frontal lobe above

d. **Parieto- occipital fissure** is a groove that separates the occipital lobe from the parietal lobe

9.21 Functions of the cerebrum

The cerebrum is the 'seat of intelligence'; it provides us with the ability

- to read, write & speak;
- to make calculations, compose music;
- to remember the past, and plan for the future and
- to create

The main functions of cerebrum can be grouped by areas in the cerebrum. These are:

1. **sensory areas**: involves in the perception of sensory information

Perception of information like touch, pain, itching, tickle, temperature by **somatosensory** area of cerebrum

The primary visual area and primary auditory area receive information for vision and sound respectively
The primary gustatory area and primary olfactory area receive impulses fro taste and smell respectively

2. **Motor area**: control muscular movements

The primary motor area controls voluntary contraction of specific muscles or group of muscles

The speech area is involved in the articulation of speech

3. **Associated (integrated) area**: performs more complex integrative functions like:

A. **Consciousness**: is a state of awareness of one's self, one's environment and others being
B. **Language:** the language ability consists the ability to speak and write words and the ability to understand spoken and written words
C. **Emotion**: it comprises both subjective experience and objective expressions
   It includes anger, fear, sexual feeling, pleasure and sorrow
D. **Memory** cortex is capable of storing and retrieving both short and long term memories

9.22 Spinal cord

- ***Spinal cord*** is roughly cylindrical delicate structure that lies within the spinal cavity.

- In adults, it extends from the *medulla to the superior border of the 2nd lumbar* vertebra. It has a distance of 45 cm (8 inches).
- Spinal cord protected by bony vertebrae, spinal meninges, CSF and a cushion adipose tissue.

Two bundles of axons, called roots, connect nerves to a segment of the cord

1. The posterior (dorsal) root: carry sensory information into spinal cord
2. The anterior (ventral) root: carry motor information out of spinal cord

There fore on each side of spinal cord dorsal & ventral nerve roots join together to form a single mixed nerve called a ***spinal nerve***.

There are ***31 pairs*** of spinal nerves

- ♠ 8 Cervical nerves
- ♠ 12 Thoracic nerves
- ♠ 5 Lumber nerves
- ♠ 5 Sacral nerves &
- ♠ 1 Coccygeal nerve

9.23 Functional of Spinal Cord

- Spinal cord has two general functions

1. It provide conduction path way to & from the brain

a. Ascending (sensory) tracts

- Conduct sensory impulses up the core to the brain

b. Descending (motor) tracts

- Conduct motor impulses down the cord from the brain

2. Spinal cord serves as the reflex center

Reflex center is the place in the arc where incoming sensory impulses became out going motor impulses. They are structures that switch from afferent to efferent neurons.

9.24 Peripheral Nervous System (PNS)

- The nerves connecting the brain & the spinal cord to other parts of the body constitute the peripheral nervous system. The PNS comprises from Cranial nerves Spinal nerves

9.25 Cranial Nerves

- The 12 pairs of cranial nerves are nerves originated or attached to the brain. Each cranial nerve has both a ***number***, designated by a roman number, & a ***name***.
- The number designates a nerve's distribution or function. Cranial nerve can be classified as:

A. Sensory nerves: I, II, & VIII
B. Motor nerves: III, IV, VI, XI & XII
C. Mixed nerves: V, VII, IX & X

I. ***Olfactory nerve*** Sensory nerve emerges from the nose & it contains axons that conduct nerve impulse olfaction, the sense of smell.
II. ***Optic nerve*** Sensory nerve emerges from eyes (retina) & it contains axons that conduct nerve impulse for vision.
III. ***Oculomotor nerve*** Motor nerve emerges from mid brain & innervates the extrinsic eye ball muscles: superior rectus, inferior rectus, medial rectus & inferior oblique. So it controls the movement of eye ball & eye lid.
IV. ***Trochlear nerve*** Motor nerve it is the smallest cranial nerve originated from mid brain. It innervates the superior oblique muscle of eye ball. So it controls the movement of eye ball.
V. ***Trigeminal nerve*** mixed nerve the largest cranial nerve & emerges from pons. Sensory axons of the trigeminal nerve carry impulse for touch, pain & thermal sensation from facial areas. It is motor axons supply muscles of mastication so control chewing movement.
VI. ***Abducens nerve*** Motor nerve originates from pons and innervates the lateral rectus muscle. It causes abduction of the eye ball (lateral rotation).
VII. ***Facial nerve*** Mixed nerve it is sensory axon extend from the taste buds of the anterior two third of the tongue and end in the pons. Its motor neurons arise from the pons and innervate

facial, scalp & neck muscles. Its main functions are facial expression, secretion of saliva & tears plus sense of taste.

VIII. ***Vestibulocochlear nerve*** Sensory nerve it has two branches: vestibular branch and the cochlear branch. The vestibular branch carries impulses for equilibrium and the cochlear branch carries impulses for hearing.

IX. ***Glossopharyngeal nerve*** Mixed nerve contains sensory fibers from posterior one third of tongue and pharynx and it provide sensory of taste. It supplies for large salivary gland and control secretion of saliva. Motor nerve control swallowing of muscle of pharynx.

X. ***Vagus nerve*** Mixed nerve longest cranial nerve distributed from the head and neck into thorax & abdomen and supply most of the organs in the thoracic & abdominal cavity. It also supplies glands of GI tracts, and smooth muscle of respiratory, and GI tracts. Also contains motor nerve to the larynx (voice box).

XI. ***Accessory nerve*** Motor nerve originates from brain stem & spinal cord supplies to the voluntary muscles of pharynx, larynx and soft palate that are used in swallowing. The other branch controls muscles of necks and controls shoulder movement, turning movement of head. Since one branch supplies muscle of larynx, it voice production

XII. ***Hypoglossal nerve*** Motor nerve originates in the medulla and supply muscles of tongue thus produces movement of tongue during speech and swallowing.

9.26 Mnemonic For Cranial Nerves

A. Types of neurons

- *"Some Says Marry Money But My Brother Says Bad Business Marry Money"*
- S stand for sensory neuron, M for motor neuron and B for both

B. Names of the nerves

- *"On Old Olympic, To Touch And Feel Victory Greatly Verify Ability & Hard work".*
- The first letter of each word is the first letter of cranial nerve.

9.27 Spinal Nerves

The 31 pair's spinal nerves arise from the spinal cord. These are

1. The 8 Cervical nerve pairs = C_1 through C_8
2. The 12 Thoracic nerve pairs = T_1 through T_{12}
3. The 5 Lumbar nerve pairs = L_1 through L_5
4. The 5 Sacral nerve pairs = S_1 through S_5
5. The 1 Coccygeal pair of spinal nerve

The nerve pair C_1 passes between skull and the 1st cervical vertebra.

The spinal nerves emerge from spinal canal through inter-vertebral foramina.

There are two bundles of axons called **ROOTS** connect the spinal nerve to a segments of the spinal cord

a. Dorsal (posterior) root : carry sensory fibers
b. Ventral (anterior) root: carry motor fibers

♣ Therefore all spinal nerves are ***mixed nerves***

Branches of spinal nerves

After emerging from spinal canal through inter-vertebral foramina, spinal nerves divided into 4 branches. These branches are:

1. **Posterior ramus**: serves the deep muscle and skin of the *posterior surface of the trunk*.
2. **Anterior ramus**: serves the muscles and structures of upper and lower *extremities* and the skin of the *lateral and anterior surface of the trunk*
3. **Meningeal branch**: reenters the vertebral cavity through inter-vertebral foramina and supplies the vertebrae, meninges, vertebral ligaments and blood vessels of spinal cord
4. **Rami communicants**: is components of the autonomic nervous system (ANS)

NB. Ramus means branch

9.28 Spinal plexuses

- Axons from the anterior rami of spinal nerves, except for $T_2 – T_{12}$ do not go directly to the body structures they supply.
- Instead, they form networks on both the left & right sides of the body by joining with various numbers of axons from the anterior rami of adjacent nerves.

- These networks of axons are called ***plexuses.***

The principal plexuses are:

1. **Cervical plexus:** is formed by the anterior rami of the C_1 - C_5 and supplies the skin and muscles of the head, neck & and superior part of the shoulders and chest
2. **Brachial plexus:** is formed by roots of C_5 – C_8 & T_1 and provides the entire nerve supply to the shoulders & upper limbs (arm, forearm, wrists, & hands)
3. **Lumbar plexus**: is the formed by roots of L_1 – L_4 and supplies the anterio lateral abdominal wall, external genitals and parts of the lower limbs
4. **Sacral plexus**: is formed by roots of L_4 – L_5 & S_1 – S_4 and supplies the buttocks, perineum, and lower limbs

9.29 The Autonomic Nervous System

ANS is a part of PNS which control the involuntary actions of the body include the smooth muscle, cardiac muscle, blood vessels and viscera. The PNS divided into:

A. Somatic nervous system: operates under conscious control &
B. ANS: usually operates without conscious control and it is really a functionally rather than anatomical system

ANS is composed of two principal divisions:

A. **Sympathetic division**: arises from the thoraco-lumbar outflow that is from the 12 thoracic and the first two lumbar segments. Therefore the sympathetic division is also called the ***thoracolumbar*** division
B. **Parasympathetic division**: arises from the cranial and sacral outflow

a. Cranial outflow: originates from 3^{rd}, 7^{th}, 9^{th} & 10^{th} cranial nerves
b. Sacral outflow originate from 2^{nd}, 3^{rd} & 4^{th} sacral segments

♣ Hence the parasympathetic division is also know as **craniosacral** division

Most organs of the body receive both sympathetic and parasympathetic stimulations & their effect on given organ is usually opposites.

9.30 Sympathetic division

- **Sympathetic division** acts mainly during activity, physical and emotional stress. Sympathetic division (flight or flight response) effects can be visualizing by body change that occurs during "*E situations*" such as Exercise, Emergency, Excitement & Embarrassment. Sympathetic division can be divided in to

    1. **Cervical division**: arise from the upper 2 thoracic segments Supplies eye, salivary gland, skin and blood vessels
    2. **Cardiopulmonary division**: arises from the upper 5 thoracic segments Supply to the heart and lungs
    3. **Splanchic division**: arises from the lower 6 thoracic & upper 2 lumbar segments

       Supplies to the stomach, small intestine, Proximal part of large intestine, gallbladder, kidneys, spleen, suprarenal medulla, blood vessels and sexual organs
    4. **Somatic division**: arises from the 4^{th} to 8^{th} thoracic segments supplies to skeletal muscles & skin

9.31 Parasympathetic Division

- In contrast to the "fight-or-flight" activities of the sympathetic division, the parasympathetic division enhances "rest & digest" activities. The five Parasympathetic responses can remember by acronym SLUDD. It stands for:

❖ S = Salivation
❖ U = Urination
❖ L = Lacrimation
❖ D = digestion
❖ D = Defecation

- Beside stimulation of SLUDD responses, the parasympathetic division carries the "three decrease". These are decrease heart rate, diameter of airway & diameter of pupils.

EFFECT OF SYMPATHETIC AND PARASYMPATHETIC SYSTEMS ON SELECTED ORGANS

EFFECTS	SYMPATHETIC SYSTEMS	PARASYMPATHETIC SYSTEMS
Pupils of eyes	Dilation	Constriction
Sweat glands	Stimulation	None
Digestive systems		
A. Glands of digestion	Inhibition	Stimulation
B. Digestive muscles	Decrease contraction (peristalsis)	Increase contraction (peristalsis)
Heart	Increase rate & strength of heart beat	Decrease rate & strength of heart beat
Respiratory system	Bronchiodilation	Bronchioconstriction
Urinary bladder	Relaxation	Contraction
Blood vessels		
A. Skeletal muscle	Dilation	Constriction
B. Cardiac muscles	Dilation	Constriction
C. Skin & other organs	Constriction	None
Liver	Increase glucose release	None
Adrenal medulla	Secretion of epinephrine & norepinephrine	None
Penis	Ejaculation	Erection

Self-Check 9	Written Test

Match the following:

_____ (a) the part of the neuron that contains the nucleus and organelles
_____ (b) rough endoplasmic reticulum in neurons; site of protein synthesis
_____ (c) store neurotransmitter
_____ (d) the process that propagates nerve impulses toward another neuron, muscle fiber, or gland cell
_____ (e) the highly branched receiving or input portions of a neuron
_____ (f) a multilayered lipid and protein covering for axons produced by neuroglia
_____ (g) the outer nucleated cytoplasmic layer of the Schwann cell
_____ (h) first portion of the axon, closest to the axon hillock
_____ (i) site of communication between two neurons or between a neuron and an effector cell
_____ (j) form the cytoskeleton of a neuron
_____ (k) gaps in the myelin sheath of an axon
_____ (l) general term for any neuronal process
_____ (m) area where the axon joins the cell body
_____ (n) area where nerve impulses arise
_____ (o) the numerous fine processes at the ends of an axon and its collaterals
_____ (p) interstitial fluid-filled space separating two neurons

(1) myelin sheath
(2) neurolemma
(3) nodes of Ranvier
(4) cell body
(5) Nissl bodies
(6) neurofibrils
(7) dendrites
(8) axon
(9) axon hillock
(10) initial segment
(11) trigger zone
(12) synaptic cleft
(13) nerve fiber
(14) axon terminals
(15) synapse
(16) synaptic vesicles

Note: **Satisfactory rating - 12 points Unsatisfactory - below 10 points**

You can ask you teacher for the copy of the correct answers

Answer Sheet

Score = _____
Rating: _____
Name: _____ Date: _____

Matching

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Information Sheet 10	**1.10. Anatomy and Physiology of head, eye, ear, nose and trout**

	(HEENT)

10.1 Anatomic and Physiologic Overview of the Eye

- Unlike most organs of the body, the eye is available for external examination, and its anatomy is more easily assessed than many other body parts (Fig.10.1).
- The eyeball, or globe, sits in a protective bony structure known as the orbit. Lined with muscle and connective and adipose tissues, the orbit is about 4 cm high, wide, and deep, and it is shaped roughly like a four-sided pyramid, surrounded on three sides by the sinuses: ethmoid (medially), frontal (superiorly), and maxillary (inferiorly).
- The optic nerve and the ophthalmic artery enter the orbit at its apex through the optic foramen.
- The eyeball is moved though all fields of gaze by the extra ocular muscles. The four rectus muscles and two oblique muscles are innervated by cranial nerves (CN) III, IV, and VI. Normally, the movements of the two eyes are coordinated, and the brain perceives a single image.
- The eyelids composed of thin elastic skin that covers striated and smooth muscles, protect the anterior portion of the eye.

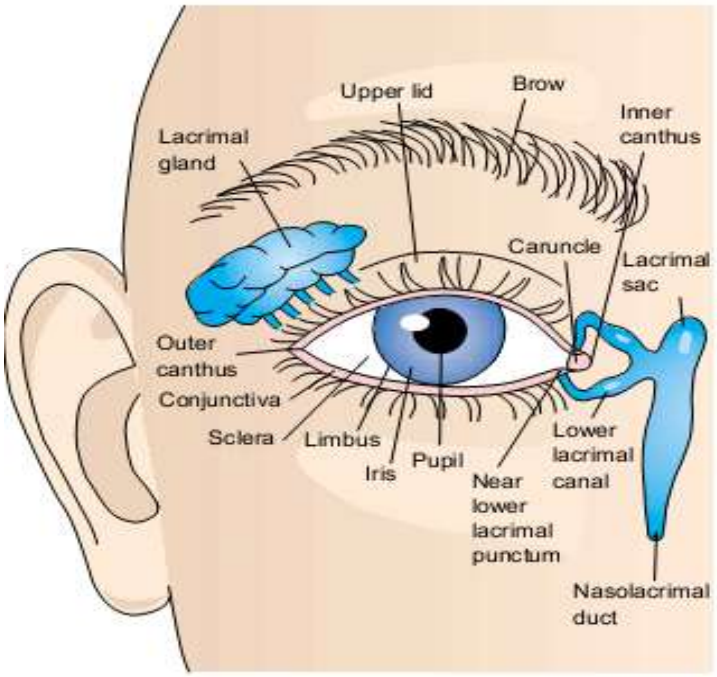

Fig10.1 External structures of the eye and position of the lacrimal structures

- The eyelids contain multiple glands, including sebaceous, sweat, and accessory lacrimal glands, and they are lined with conjunctiva material.
- The upper lid normally covers the uppermost portion of the iris and is innervated by the oculomotor nerve (CN III).
- The lid margins contain meibomian glands, the inferior and superior puncta, and the eyelashes. The triangular spaces formed by the junction of the eyelids are known as the inner or medial can-thus and the outer or lateral canthus.
- With every blink of the eyes, the lids wash the cornea and conjunctiva with tears.
- Tears are vitally important to eye health. They are formed by the lacrimal gland and the accessory lacrimal glands.
- A healthy tear is composed of three layers: lipoid, aqueous, and mucoid.
- If there is a defect in the composition of any of these layers, the integrity of the cornea may be compromised. Tears are secreted in response to reflex or emotional stimuli.
- The conjunctiva, a mucous membrane, provides a barrier to the external environment and nourishes the eye. The goblet cells of the conjunctiva secrete lubricating mucus.

- The bulbar conjunctiva covers the sclera, whereas the palpebral conjunctiva lines the inner surface of the upper and lower eyelids.
- The junction of the two portions is known as the fornix.
- The sclera, commonly known as the white of the eye, is a dense, fibrous structure that comprises the posterior five sixths of the eye.
- The sclera helps to maintain the shape of the eyeball and protects the intraocular contents from trauma.
- The sclera may have a slightly bluish tinge in young children, a dull white color in adults, and a slightly yellowish color in the elderly.
- Externally, it is overlaid with conjunctiva, which is a thin, transparent, mucous membrane that contains fine blood vessels.
- The conjunctiva meets the cornea at the limbus on the outermost edge of the iris.

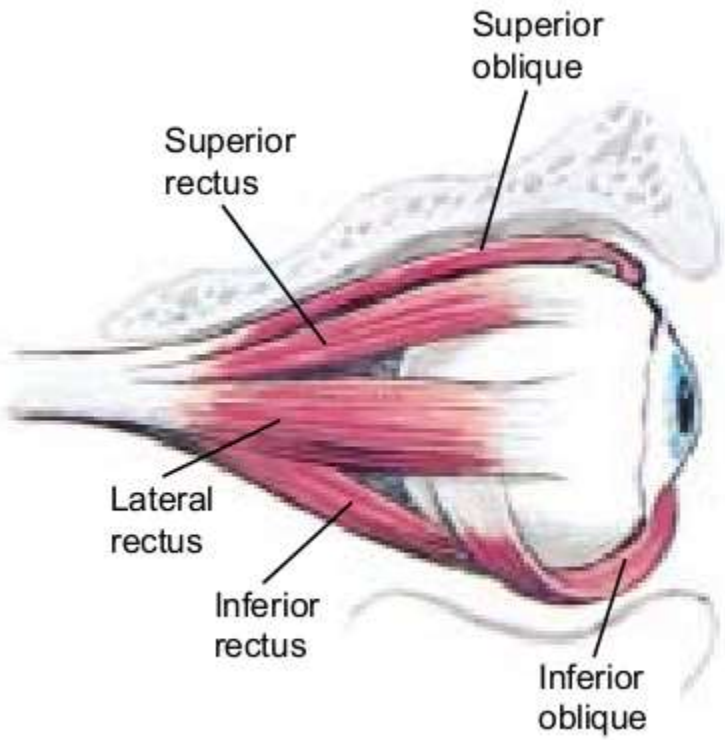

Fig 10.2 The extra ocular muscles responsible for eye movement.

The medial rectus muscle (not shown) is responsible for opposing the movement of the lateral rectus muscle.

- The cornea a transparent, avascular, domelike structure, forms the most anterior portion of the eyeball and is the main refracting surface of the eye. It is composed of five lay-ers: epithelium, Bowman's membrane, stroma, Descemet's mem-brane, and endothelium.
- The epithelial cells are capable of rapid replication and are completely replaced every 7 days.
- Behind the cornea lies the anterior chamber, filled with a continually replenished supply of clear aqueous humor, which nourishes the cornea.
- The aqueous humor is produced by the ciliary body, and its production is related to the intraocular pressure (IOP). Normal pressure is 10 to 21 mm Hg.
- The uvea consists of the iris, the ciliary body, and the choroid.
- The iris, or colored part of the eye, is a highly vascularized, pigmented collection of fibers surrounding the pupil.
- The pupil is a space that dilates and constricts in response to light. Normal pupils are round and constrict symmetrically when a bright light shines on them.
- About 20% of the population has pupils that are slightly unequal in size but that respond equally to light.
- Dilation and constriction are controlled by the sphincter and dilator pupil-lae muscles.
- The dilator muscles are controlled by the sympathetic nervous system, whereas the sphincter muscles are controlled by the parasympathetic nervous system.
- Directly behind the pupil and iris lies the lens, a colorless and almost completely transparent, biconvex structure held in position by zonular fibers.
- It is avascular and has no nerve or pain fibers.
- The lens enables focusing for near vision and refocusing for distance vision. The ability to focus and refocus is called accommodation.
- The lens is suspended behind the iris by the zonules and is connected to the ciliary body.
- The ciliary body controls accommodation through the zonular fibers and the ciliary muscles. The aqueous humor is anterior to the lens; posterior to the lens is the vitreous humor.

- All cells formed throughout life are retained by the lens, which makes the cell structure of the lens susceptible to the degenerative effects of aging.
- The lens con-tinues to grow throughout life, laying down fibers in concentric rings.
- This gradual thickening becomes evident in the fifth decade of life and eventually results in an increasingly dense core or nucleus, which can limit accommodative powers.
- The posterior chamber is a small space between the vitreous and the iris.
- Aqueous fluid is manufactured in the posterior chamber by the ciliary body.
- This aqueous fluid flows from the posterior chamber into the anterior chamber, from which it drains through the trabecular meshwork into the canal of Schlemm.
- The choroid lies between the retina and the sclera. It is a vascular tissue, supplying blood to the portion of the sensory retina closest to it.
- The ocular fundus is the largest chamber of the eye and contains the vitreous humor, a clear, gelatinous substance, com-posed mostly of water and encapsulated by a hyaloids membrane.
- The vitreous humor occupies about two thirds of the eye's volume and helps maintain the shape of the eye.
- As the body ages, the gel-like characteristics are gradually lost, and various cells and fibers cast shadows that the patient perceives as "floaters." The vitreous is in continuous contact with the retina and is attached to the retina by scattered collagenous filaments.
- The vitreous shrinks and shifts with age.
- The innermost surface of the fundus is the retina. The retina is composed of 10 microscopic layers and has the consistency of wet tissue paper.
- It is neural tissue, an extension of the optic nerve. Viewed through the pupil, the landmarks of the retina are the optic disc, the retinal vessels, and the macula.
- The point of entrance of the optic nerve into the retina is the optic disc.
- The optic disc is oval or circular, is pink, and has sharp margins. In the disc, a physiologic depression or cup is present centrally, with the retinal blood vessels emanating from it.

- The retinal tissues arise from the optic disc and line the inner surface of the vitreous chamber. The retinal vessels also enter the eye through the optic nerve, branching out through the retina and forming superior and inferior arcades.
- The area of the retina responsible for central vision is the macula.
- The rest of the retina is responsible for peripheral vision.
- In the center of the macula is the most sensitive area, the fovea, which is avascular and surrounded by the superior and inferior vascular arcades.
- Two important layers of the retina are the retinal pigment epithelium (RPE) and the sensory retina.
- A single layer of cells constitutes the RPE, and these cells have numerous functions, including the absorption of light. The sensory retina contains the photoreceptor cells: rods and cones.
- Rods and cones are long, narrow cells shaped like rods or cones. The rods are mainly responsible for night vision or vision in low light, whereas the cones provide the best vision for bright light, color vision, and fine detail.
- Cones are distributed throughout the retina with their greatest concentration in the fovea. Rods are absent in the fovea.
- Good visual acuity depends on a healthy, functioning eyeball and an intact visual pathway. This pathway is made up of the retina, optic nerve, optic chiasm, optic tracks, lateral geniculate bodies, optic radiations, and the visual cortex area of the brain.
- The pathway is an extension of the central nervous system.
- The optic nerve is also known as the second cranial nerve (CN II). Its purpose is to transmit impulses from the retina to the occipital lobe of the brain.
- The optic nerve head, or optic disc, is the physiologic blind spot in each eye. The optic nerve leaves the eye and then meets the optic nerve from the other eye at the optic chiasm.
- The chiasm is the anatomic point at which the nasal fibers from the nasal retina of each eye cross to the opposite side of the brain.
- The nerve fibers from the temporal retina of each eye remain uncrossed.

- Fibers from the right half of each eye, which would be the left visual field, therefore carry impulses to the right occipital lobe.
- Fibers from the left half of each eye, or the right visual field, carry impulses to the left occipital lobe.
- Beyond the chiasm, these fibers are known as the optic tract. The optic tract continues on to the lateral geniculate body.
- The lateral geniculate body leads to the optic radiations and then to the cortex of the occipital lobe of the brain.

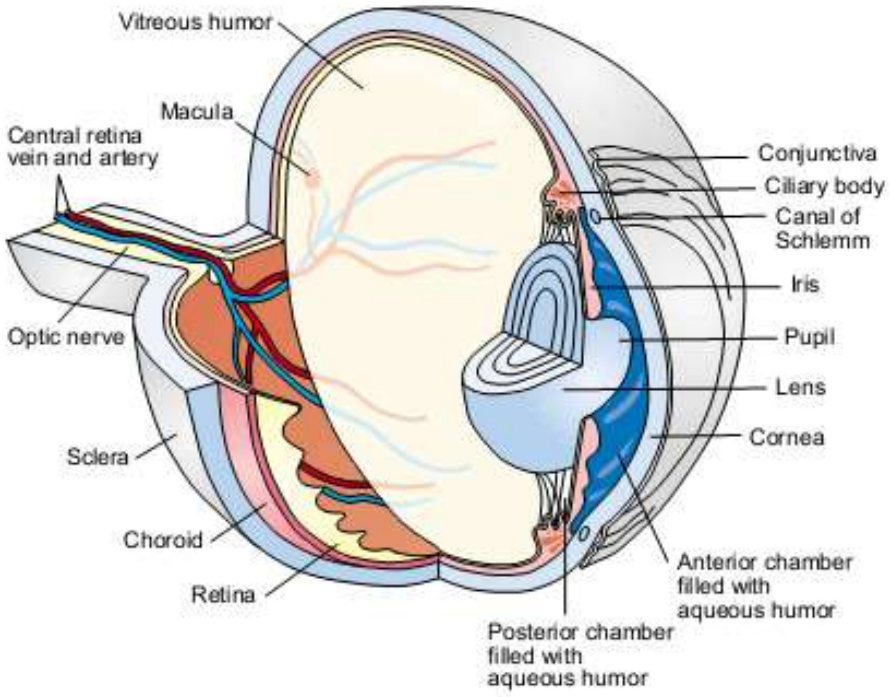

Fig 10.3 Three-dimensional cross-section of the eye

Self-Check 10	Written Test

Match the following:

____(a) upper and lower eyelids; shade the eyes during sleep, spread lubricating secretions over the eyeballs	(1) palpebrae
____(b) produces and drains tears	(2) tarsal or Meibomian glands
____(c) arch transversely above the eyeballs and help protect the eyeballs from foreign objects, perspiration, and the direct rays of the sun	(3) conjunctiva
____(d) move the eyeball medially, laterally, superiorly, or inferiorly	(4) eyelashes
____(e) a thick fold of connective tissue that gives form and support to the eyelids	(5) lacrimal apparatus
____(f) modified sebaceous glands; secretion helps keep eyelids from adhering to one another	(6) extrinsic eye muscles
____(g) project from the border of each eyelid; help protect the eyeballs from foreign objects, perspiration, and direct rays of the sun	(7) eyebrows
____(h) a thin, protective mucous membrane that lines the inner aspect of the eyelids and passes from the eyelids onto the surface of the eyeball, where it covers the sclera	(8) tarsal plate

Note: **Satisfactory rating - 10 points Unsatisfactory - below 10 points**

You can ask you teacher for the copy of the correct answers

Answer Sheet

Score = _____
Rating: _____
Name: _____ Date: _____

Matching

1. _____
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Information Sheet 11	1.11. Anatomy and physiology of the reproductive system

T H E R E P R O D U C T I V E S Y S T E M S

11.1 Introduction: The male and female reproductive organs work together to produce offspring. In addition, the female reproductive organs contribute to sustaining the growth of embryos and fetuses.

The male and female reproductive organs can be grouped by function. The **gonads**—testes in males and ovaries in females—produce gametes and secrete sex hormones. Various **ducts** then store and transport the gametes, and **accessory sex glands** produce substances that protect the gametes and facilitate their movement. Finally, **supporting structures,** such as the penis in males and the uterus in females, assist the delivery of gametes, and the uterus is also the site for the growth of the embryo and fetus during pregnancy.

The organs of the **male reproductive system** include the testes, a system of ducts (including the epididymis, ductus deferens, ejaculatory ducts, and urethra), accessory sex glands (seminal vesicles, prostate, and bulbourethral glands), and several supporting structures, including the scrotum and the penis

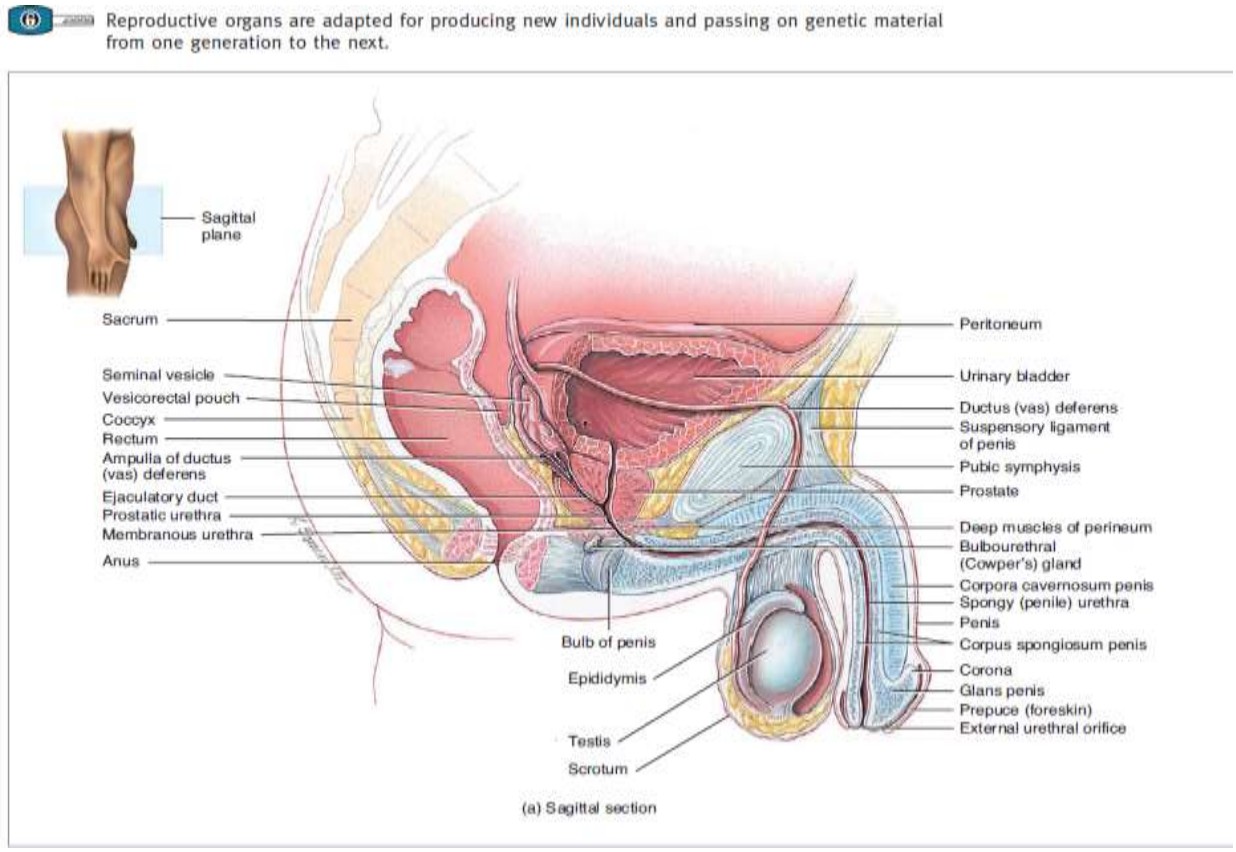

Fig 11.1 – Male organ of reproductive and surrounding environment

11.2 Scrotum

- The testes are located in a skin-covered, highly pigmented, muscular sack called the **scrotum.**
- Extends from the body behind the penis.
- The scrotum is a fibromuscular pouch divided by a median septum (raphe) forming 2 compartments, each of which contains a testis, epididymis and part of the spermatic cord.
- Layers of the scrotum consist of skin, dartos muscle, external spermatic fascia, cremasteric fascia and internal spermatic fascia, which is in close contact with the parietal layer of the tunica vaginalis
- The skin and dartos layers of the scrotum are supplied by the perineal branch of the internal pudendal artery in addition to the external pudendal branches of the femoral artery.
- The layers deep to the dartos muscle are supplied by the cremasteric branch of the inferior epigastric artery.
- The veins of the scrotum accompany the arteries, eventually draining into the external pudendal vein and subsequently the greater saphenous vein.
- Lymphatic drainage of the skin of the scrotum is by the external pudendal vessels to the medial superficial inguinal lymph nodes.
- The scrotum has a rich sensory nerve supply that includes the genital branch of the genitofemoral nerve (anterior and lateral scrotal surfaces), the ilioinguinal nerve (anterior scrotal surface),
- posterior scrotal branches of the perineal nerve (posterior scrotal surface), and the perineal branch of the posterior femoral cutaneous nerve (inferior scrotal surface).

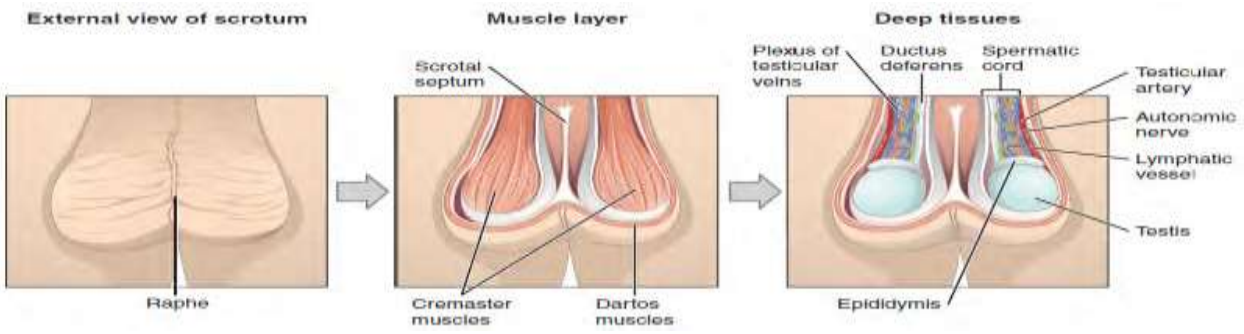

Fig -11.2: The structure of scrotum and tests – Anterior View

11.3 Tests

- The testes (singular = testis) are the male gonads—that is, the male reproductive organs.
- The testes are the primary male reproductive organ and are responsible for testosterone and sperm production.
- Each testis is 4-5-cm long, 2-3-cm wide, weighs 10-14 g and is suspended in the scrotum by the dartos muscle and spermatic cord
- They produce both sperm and androgens, such as testosterone, and are active throughout the reproductive lifespan of the male.
- Each testis is covered by the tunica vaginalis testis, tunica albuginea, and tunica vasculosa.
- The tunica vaginalis testis is the lower portion of the processus vaginalis and is reflected from the testes on the inner surface of the scrotum, thus forming the visceral and parietal layers.
- Beneath the visceral layer of the tunica vaginalis is the tunica albuginea, which forms a dense covering for the testes.
- The testes receive blood from the branch of the inferior epigastric artery and the artery to the ductus deferens.
- The pampiniform plexus drains both the testis and epididymis before coalescing to form the testicular vein, usually above the spermatic cord formation at the deep inguinal ring.
- The tenth and eleventh thoracic spinal nerves supply the testes via the renal and aortic autonomic plexuses

11.4 Epididymis

- The epididymis is a C-shaped structure lying intimately along the posterior border of each testis and includes an enlarged head, a body and a tail.
- The tunica vaginalis covers the epididymis except at the posterior border.
- Vasculature and innervation of the epididymis is the same as for the testes

11.5 Ductus (vas) deferens

- The ductus (vas) deferens is the continuation of the epididymis;
- it is 30-45-cm long and conveys sperm to the ejaculatory ducts.
- The convoluted portion of the ductus deferens becomes straighter (diameter, 2-3-mm) as it travels posterior to the testis and medial to the epididymis
- Each runs upward from an epididymis as part of a spermatic cord and then enters the pelvic cavity via an inguinal canal and passes over the bladder.
- Distally, each widens (this portion is the ampulla) and joins the duct of the seminal vesicle to form an ejaculatory duct .
- The 2 ejaculatory ducts pass thru the prostate gland and empty into the prostatic urethra .
- During ejaculation, smooth muscle peristalsis propels sperm and testicular fluid thru the ductus deferentia and the ejaculatory ducts.
- Each ductus deferens has an artery usually derived from the superior vesical artery (artery to the ductus),
- Lymphatic drainage of the ductus deferens is to the external and internal iliac nodes and innervation is mainly sympathetic from the pelvic plexus.

11.6 Spermatic cord

- The spermatic cord extends from the deep inguinal ring, through the inguinal canal to the testis.
- The layers of the spermatic cord include (from outward to inward):
- External spermatic fascia (derived from the deep fascia of the external abdominal oblique muscle),
- cremasteric fascia (derived from the internal oblique muscle), and
- internal spermatic fascia (derived from the transversalis fascia).

11.7 Prostate gland

- The prostate gland is an ovoid structure encompassing the proximal portion of the urethra and is approximately 2.5-3.0-cm by 4.0-4.5-cm, normally weighing 20-25 g.
- The base of the prostate is in contact with the bladder.
- The anterior border is in contact with the vesicoprostatic plexus,

- The posterior border is separated from the anterior surface of the rectum by the rectovesical (Denonvilliers) fascia and
- The lateral border is in contact with the levator ani and the prostatic venous plexus
- Fibers of the external urethral sphincter surround the prostate.
- The arterial supply to the prostate gland is derived from the inferior vesical artery and branches of the middle rectal artery.
- Venous drainage of the prostate forms the prostatic plexus, which eventually drains into the internal iliac vein and lymphatic drainage flows to the internal iliac nodes.
- Innervation is derived from the inferior portion of the hypogastric plexus, primarily to the connective tissue surrounding the gland.

11.8 Urethra

- The urethra stretches from the bladder to the tip of the glans penis, serving as a passage for urine and semen

Divided into 3 regions.

- The prostatic urethra is extends vertically from the bladder neck, through the prostate
- The prostatic urethra contains the orifice of the ejaculatory ducts
- The membranous urethra is w/i the urogenital diaphragm
- the membranous urethra enters the deep perineal space
- The **penile/spongy urethra** is w/i the corpus spongiosum.
- When the urethra reaches the glans penis the diameter diminishes to that of the external ostium
- Ostium is the least dilatable portion of the urethral canal

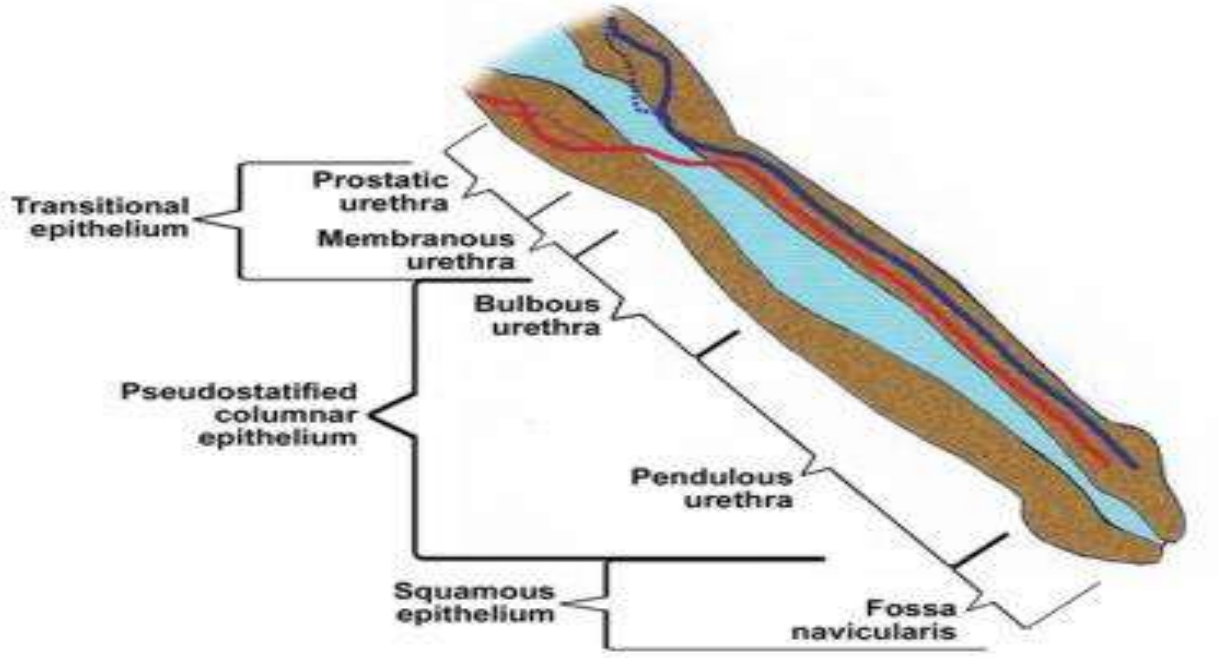

Fig 11.3: Division of urethra

11.9 Penis

- The penis is made up of an attached root and a pendulous body
- Penis and the scrotum comprise the external genitalia
- The penis functions to deliver sperm into the female reproductive tract.
- It consists of an attached root and a free shaft, which ends in an enlarged tip (glans penis)
- The loose cuff of skin around the glans is the prepuce / foreskin , and can be removed via circumcision
- Internally, the penis contains a portion of the urethra (penile or spongy urethra) as well as 3 cylindrical erectile bodies .
- An erectile body is a network of connective tissue riddled with vascular sinuses and smooth muscle.
- A mid-ventral erectile body surrounds the penile urethra and is the **corpus spongiosum** .
- Distally, it expands forming the glans penis.
- Proximally the corpus spongiosum forms part of the root of the penis known as the **bulb of the penis** .

- The 2 dorsal erectile bodies are the corpora cavernosa .
- Proximally the corpora cavernosa diverge and anchor the penis to the rami of the pubic arch.
- These portions of the corpora cavernosa are known as the crura of the penis .
- Near the border of the pubic sypmphysis the bilateral crura continue as the corpora cavernosa
- The body of the penis contains the bilateral corpora cavernosa and the median corpus spongiosum
- During penile erection, all 3 erectile bodies become engorged with blood.
- The corpus spongiosum is penetrated by the urethra as it traverses the body of the penis

11.10 Female Reproductive System

External Genitalia

- The vulva, also known as the pudendum, is a term used to describe those external organs that may be visible in the perineal area.
- The vulva consists of the following organs: mons pubis, labia minora and majora, hymen, clitoris, vestibule, urethra, Skene glands, greater vestibular (Bartholin) glands, and vestibular bulbs.
- The boundaries include the mons pubis anteriorly, the rectum posteriorly, and the genitocrural folds (thigh folds) laterally

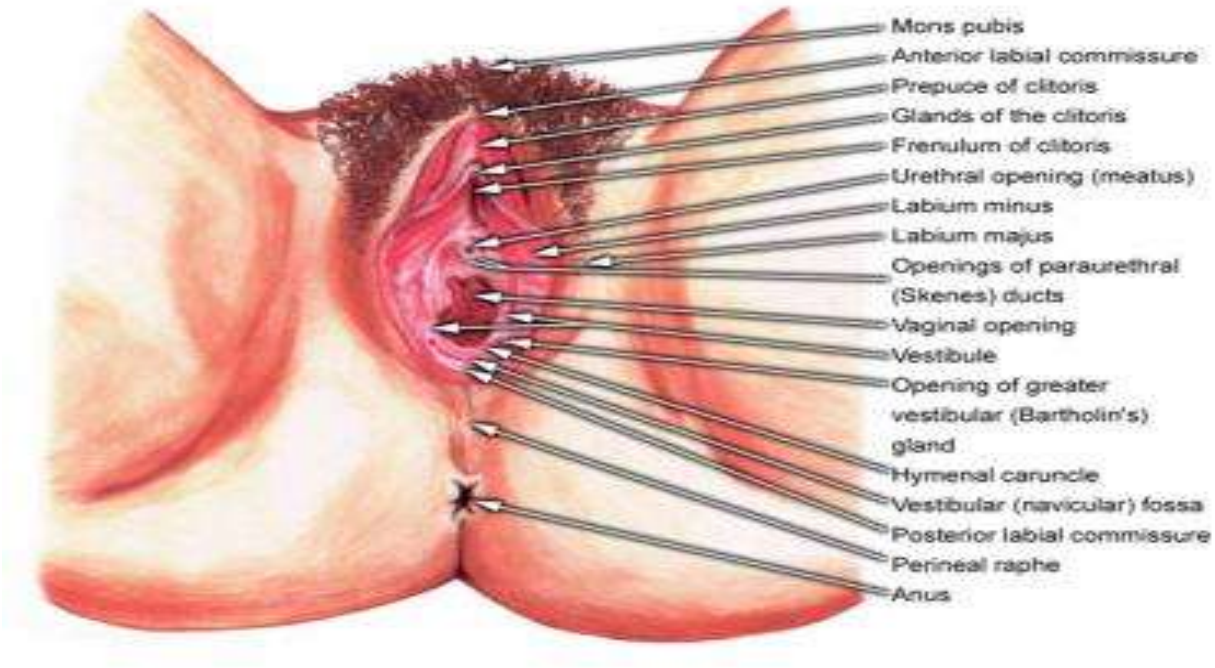

Fig 11.4 External Female genitalia

11.12 Mons pubis

- The mons pubis is the rounded portion of the vulva where sexual hair development occurs at the time of puberty.
- This area may be described as directly anterosuperior to the pubic symphysis.

11.13 Labia

- The labia majora are 2 large, longitudinal folds of adipose and fibrous tissue.
- They vary in size and distribution from female to female, and the size is dependent upon adipose content.
- They extend from the mons anteriorly to the perineal body posteriorly.
- The labia majora have hair follicles**.**
- The labia minora, also known as nymphae, are 2 small cutaneous folds that are found between the labia majora and the introitus or vaginal vestibule.
- Anteriorly, the labia minora join to form the frenulum of the clitoris.

11.14 Hymen

- The hymen is a thin membrane found at the entrance to the vaginal orifice.

- Often, this membrane is perforated before the onset of menstruation, allowing flow of menses.
- The hymen varies greatly in shape.
- The hymen consists of fibrous tissue with a few small blood vessels and is covered by stratified squamous epithelium.
- The body of the clitoris is composed of 2 channels of vessels and nerve endings that function as erectile tissue, the corpora cavernosa

Fig 11:5: Imperforated Hymen

11.15 Clitoris

- The clitoris is an erectile structure found beneath the anterior joining of the labia minora.
- Its width in an adult female is approximately 1 cm, with an average length of 1.5–2.0 cm.
- The clitoris is made up of 2 crura, which attach to the periosteum of the ischiopubic rami.
- It is a very sensitive structure, analogous to the male penis.

- It is innervated by the dorsal nerve of the clitoris, a terminal branch of the pudendal nerve.

11.16 Vestibule and urethra

- Between the clitoris and the vaginal introitus (opening) is a triangular area known as the vestibule, which extends to the posterior fourchette.
- The vestibule is where the urethral (urinary) meatus is found, approximately 1 cm anterior to the vaginal orifice, and it also gives rise to the opening of the Skene glands bilaterally.
- The urethra is composed of membranous connective tissue and links the urinary bladder to the vestibule externally.
- A female urethra ranges in length from 3.5 to 5.0 cm.
- The Skene glands secrete lubrication at the opening of the urethra.
- The greater vestibular (Bartholin) glands are also responsible for secreting lubrication to the vagina, with openings just outside the hymen, bilaterally, at the posterior aspect of the vagina.
- Each gland is small, similar in shape to a kidney bean.

11.17 Vestibular bulbs

- Finally, the vestibular bulbs are 2 masses of erectile tissue that lie deep to the bulbocavernosus muscles bilaterally.

11.18 Internal Genitalia

- Vagina is a muscular canal (approximately 10 cm long) that
- Serves as the entrance to the reproductive tract The vagina extends from the vulva externally to the uterine cervix internally.
- It is located within the pelvis, anterior to the rectum and posterior to the urinary bladder.
- The vagina lies at a 90º angle in relation to the uterus.
- The vagina is held in place by endopelvic fascia and ligaments
- The vaginal wall contains a mucosa, smooth muscle muscularis, and an adventitia.
- The mucosa is lined by stratified squamous epithelium and contains rugae, but no glands.
- The vagina is lined by rugae, which are situated in folds throughout.

- These allow easy distention, especially during child bearing.
- Cervical mucous glands provide lubrication for sexual intercourse
- The nerve supply to the vagina is primarily from the autonomic nervous system.
- Sensory fibers to the lower vagina arise from the pudendal nerve, and pain fibers are from sacral nerve roots.
- Lymphatic drainage of the vagina is generally to the external iliac nodes (upper third of the vagina), the common and internal iliac nodes (middle third), and the superficial inguinal nodes (lower third).

11.19 Uterus

- The uterus is the inverted pear-shaped female reproductive organ that lies in the midline of the body, within the pelvis between the bladder and the rectum.
- It is thick-walled and muscular, with a lining that, during reproductive years, changes in response to hormone stimulation throughout a woman's monthly cycle.
- Its average size is approximately 5 cm wide by 7 cm long (approximately 2 in by 3 in) when a female is not pregnant.
- Flexes anteriorly where it joins the vagina and is thus **anteverted**
- In older women, it may flex posteriorly instead and be **retroverted** .
- 3 major regions. The **body** is the large midportion.
- The **fundus** is the rounded portion just superior to the entrances of the uterine tubes.
- The **cervix** is the neck that projects into the vagina inferiorly.
- The cavity of the cervix is the **cervical canal** .
- It communicates with the **uterine cavity** (w/i the body of the uterus) via the **internal os** .
- It communicates with the vaginal cavity via the **external os**
- The uterus is supported laterally by the broad ligament, anteriorly by the **round ligament**, the **cervical ligaments** laterally and the **uterosacral ligaments** posteriorly.
- Another important source of uterine support is the muscles of the pelvic floor – i.e., the muscles of the **urogenital** and **pelvic diaphragms**
- The wall of the uterus made up of three layers. The **perimetrium** is the outermost layer and is serosa/adventitia (depending on the location).

- The **myometrium** is a thick layer of smooth muscle responsible for uterine contractions.
- The **endometrium** innermost layer of the uterus and is lined by a simple columnar epithelium underlain by a thick lamina propria.
- Structurally, the endometrium consists of two layers: the **stratum basalis** and the **stratum functionalis** (the basal and functional layers).
- The **stratum basalis layer** is part of the lamina propria and is adjacent to the myometrium; this layer does not shed during menses
- The **stratum functionalis** is superficial and undergoes cyclic changes in response to ovarian hormones and is shed during menstruation
- The body of the uterus is globe-shaped and is typically situated in an anteverted position, at a 90º angle to the vagina.
- The upper aspect of the body is dome-shaped and is called the fundus; it is typically the most muscular part of the uterus.

  The body of the uterus is responsible for holding a pregnancy, and strong uterine wall contractions help to expel the fetus during labor and delivery.
- The average weight of a non-pregnant, nulliparous uterus is approximately 40-50 g.
- A multiparous uterus may weigh slightly more than this, with an upper limit of approximately 110 g.
- A menopausal uterus is small and atrophied and typically weighs much less.
- The cavity of the uterus is flattened and triangular.

11.20 The Uterine Tubes

- The uterine tubes enter the uterine cavity bilaterally in the superolateral portion of the cavity.
- The vasculature of the uterus is derived from the uterine arteries and veins.
- The uterine vessels arise from the anterior division of the internal iliac, and branches of the uterine artery anastomose with the ovarian artery along the uterine tube.
- The **uterine tubes** (also called fallopian tubes or oviducts) serve as the conduit of the oocyte from the ovary to the uterus.
- located bilaterally at the superior portion of the cavity.

- Their primary function is to transport sperm toward the egg, which is released by the ovary, and then to allow passage of the fertilized egg back to the uterus for implantation.
- .Each tube is approximately 10 cm in length and 1 cm in diameter and is situated within a portion of the broad ligament called the mesosalpinx.
- The distal portion of the uterine tube ends in an orientation encircling the ovary
- The uterine tube has 4 regions.
- **Fimbriae** , ciliated fingerlike extensions that drape over the ovary.
- segment, closest to the uterus, is called the isthmus - is the constricted region where the tube joins the uterus.
- The second segment is the ampulla, which becomes more dilated in diameter and is the typical place of fertilization.
- The final segment, furthest from the uterus, is the infundibulum- an open funnel-shaped structure w/ extending fimbriae
- The infundibulum gives rise to the fimbriae, fingerlike projections that are responsible for catching the egg that is released by the ovary..

11.21 Ovaries

- The ovaries are paired organs located on either side of the uterus.
- The ovaries are responsible for housing and releasing the ova, or eggs, necessary for reproduction.
- At birth, a female has approximately 1-2 million eggs, but only 300 of these eggs ever mature and are released for the purpose of fertilization.
- The ovaries are small and oval-shaped, exhibit a grayish color
- The ovaries are approximately 3-5 cm in length during childbearing years and become much smaller and atrophic once menopause occurs.
- The ovarian ligament connects the uterus and ovary.
- The posterior portion of the broad ligament supports the ovary.
- The suspensory ligament of the ovary (infundibular pelvic ligament), a peritoneal fold overlying the ovarian vessels, attaches the ovary to the pelvic side wall.

- Blood supply to the ovary is via the ovarian artery; both right and left ovarian arteries originate directly from the descending aorta at the level of the L2 vertebra.
- The ovarian artery and vein enter and exit the ovary at the hilum.
- The left ovarian vein drains into the left renal vein, and the right ovarian vein empties directly into the inferior vena cava.
- Nerve supply to the ovaries run with the vasculature within the suspensory ligament of the ovary, entering the ovary at the hilum.
- Supply is through the ovarian, hypogastric, and aortic plexuses.
- Lymphatic drainage of the ovary is primarily to the lateral aortic nodes; however, the iliac nodes may also be involved.

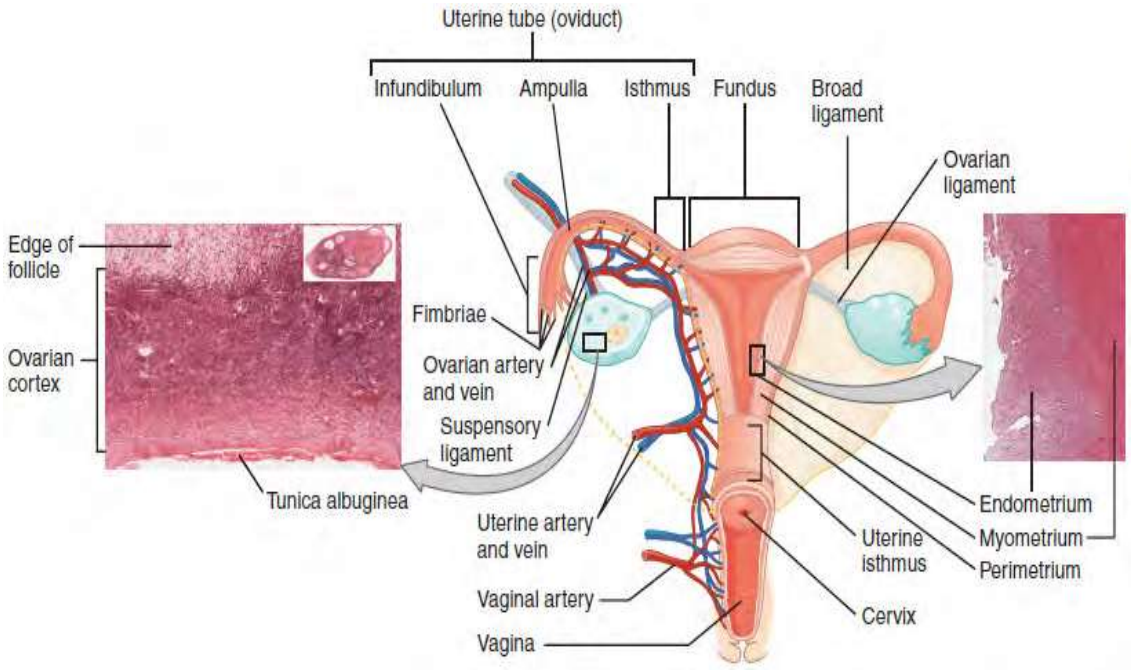

Fig 11.6 Anterior view shows the relationship of the ovaries, uterine tubes (oviducts), and uterus.

- The perineum is the diamond-shaped space between the pubic symphysis (anteriorly), the coccyx (posteriorly), and the ischial tuberosities (laterally), lying just inferior to the pelvic diaphragm (levator ani and coccygeus).
- Divided transversely into triangles, the anterior is the urogenital triangle, which includes the external genitals

- The posterior is the anal triangle, which contains the anus
- The perineum is also divided into superficial and deep layers with some of the muscles common to men and women.
- In men, there is the **deep transverse perineal** muscle that plays a role in ejaculation.

Self-Check 11	**Written Test**

____1.An organ that extend from the Mons anteriorly to the perineal body posteriorly with have hair follicles is known as _____ (2 point)

A.Mons pubis B. labia majora C. Hymen D. All are the possible answer

____2. Consists of fibrous tissue with a few small blood vessels and is covered by stratified squamous epithelium. (2 point)

A.Skene gland B. Bartholin glands C. Hymen D. vestibule

____3. A ciliated fingerlike extensions that drape over the ovary is known as ___ (2 point)

A. uterus B. cervix C.Fimbriae D. All are the possible answer

____4. An organ located within the pelvis, anterior to the rectum and posterior to the urinary bladderheld in place by endopelvic fascia and ligaments is known as ____(2 point)

A.uterus B. Hymen C.Vagina D. All are the possible answer

.____5. _____is cylindrical in shape, with an endocervical canal located in the midline, allowing passage of semen into the uterus (2 point)

A. uterus B. cervix C.Vagina D. All are the possible answer

_____6_____ are the primary male reproductive organ and are responsible for testosterone and sperm production (2 point)

A. Epididymis B.Spermatic cord C. Testes D. None

_____7. A viscous alkaline fluid containing: fructose which provides energy for sperm is:__ (2 point)

A. Ductus deferens B. Seminal fluid C.Seminal vesicles D. None

_____8. A mid-ventral erectile body surrounds the penile urethra is known as : ___ (2 point)

A) Corpora cavernosa B) corpus spongiosum C) Vas deferens D) tunica albuginea

_____9. A viscous alkaline fluid containing: fructose which provides energy for sperm is:- __(2 point)

A. Ductus deferens B. Seminal fluid C.Seminal vesicles D. None

____ 10. _____ are 2-cm in length and derived from the union of the seminal vesicle and the ampulla of the vas deferens. (2 point)

A. Ductus deferens B. Ejaculatory ducts C.Epididymis D. None

Note: **Satisfactory rating – 15 points Unsatisfactory - below 15 points**

You can ask you teacher for the copy of the correct answers.

Answer Sheet

Score = _____
Rating: _____
Date: _____

1_____

2_____

3_____

4_____

5_____

6_____

7_____

8_____

9_____

10_____

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