

<b>K S R INSTITUTE FOR ENGINEERING AND TECHNOLOGY, TIRUCHENGODE – 637 215</b>					
<b>Autonomous Institution</b>					
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<b>END SEMESTER ANSWER KEY</b>					

## Part A

### 1) What is the energy source for all types of diffusion?

Kinetic energy is source of all types of diffusion in genral, But Active transport requires ATP for its activity.

### 2) Name the two cell types involved in connecting body parts or regions.

The two cell types involved in connecting body parts or regions are nerve cells (neurons) and connective tissue cells.

### 3) Identify the major anatomical area of a longer bone.

A long bone has two parts: the diaphysis and the epiphysis. The diaphysis is the tubular shaft that runs between the proximal and distal ends of the bone.

### 4) How do the movements promoted by skeletal muscle differ from those promoted by smooth muscle.

Smooth muscle differs from skeletal muscle in function. Unlike skeletal muscle, smooth muscle is capable of maintaining tone for extended periods and often contracts involuntarily.

### 5) List the two major brain areas involved in the nervous control of breathing.

This is normally controlled by the medulla oblongata, a region of the hindbrain. The medulla oblongata sends signals to the heart and diaphragm in reaction to carbon dioxide and oxygen levels, allowing for easier breathing. Pons regulates the breathing rate.

### 6) Recall the three factors that are important in promoting venous return.

Factors promoting venous return are:

- Skeletal muscle activity.
- Presence of valves in veins.
- Pressure changes.

### 7) What are villi and why they are important.

Villi are finger-like projections which are richly supplied with blood vessels. They are present in the inner lining of the small intestine and help in the absorption of nutrients by increasing the surface area for absorption.

### 8) Predict two functions of large intestine.

The large intestine has 3 primary functions: absorbing water and electrolytes, producing and absorbing vitamins, and forming and propelling feces toward the rectum for elimination.

**9) Outline why is brain tumour more likely to be formed from glial cells than from neuron.**

Glial cells are the most common cellular component of the brain and divide rapidly whereas neurons don't divide. Most brain tumors come from the glial cells or other non-neuronal cells in the CNS. Neuronal tumours are a rare group of brain tumors made of abnormal neurons.

**10) Infer the five basic taste sensations.**

Taste receptors in the mouth sense the five basic tastes: sweetness, sourness, saltiness, bitterness, and savouriness.

**Part B (5 x 13 = 65)**

**11. a) Discuss the general characteristics and important function of epithelial cells.**

<b>Introduction</b>	<b>Classification</b>	<b>Function</b>	<b>Diagram</b>
2	3	4	4

**Introduction:**

Epithelial tissue or epithelium forms the outer covering of the skin and also lines the body cavity. It forms the lining of respiratory, digestive, reproductive and excretory tracts. They perform various functions such as absorption, protection, sensation and secretion.

Characteristics:

Epithelial tissue is formed from a tightly fitted continuous layer of cells. One surface of the epithelial tissue is exposed to either the external environment or the body fluid. The other surface is attached to tissue by a membrane, which consists of fibres and polysaccharides secreted by epithelial cells.

There is little intercellular material present between cells. There are specialized junctions present between the cells of the epithelium that link individual cells.

- Tight junctions- prevent leakage across tissues.
- Adhering junctions- keep the neighboring tissues well cemented together.
- Gap junctions- facilitate the movement of ions and molecules across the tissue.

Epithelial cells form membranes. The epithelial membrane consists of a layer of epithelial tissue and has underlying connective tissue.

There are two types of epithelial membranes, mucous membrane and serous membrane.

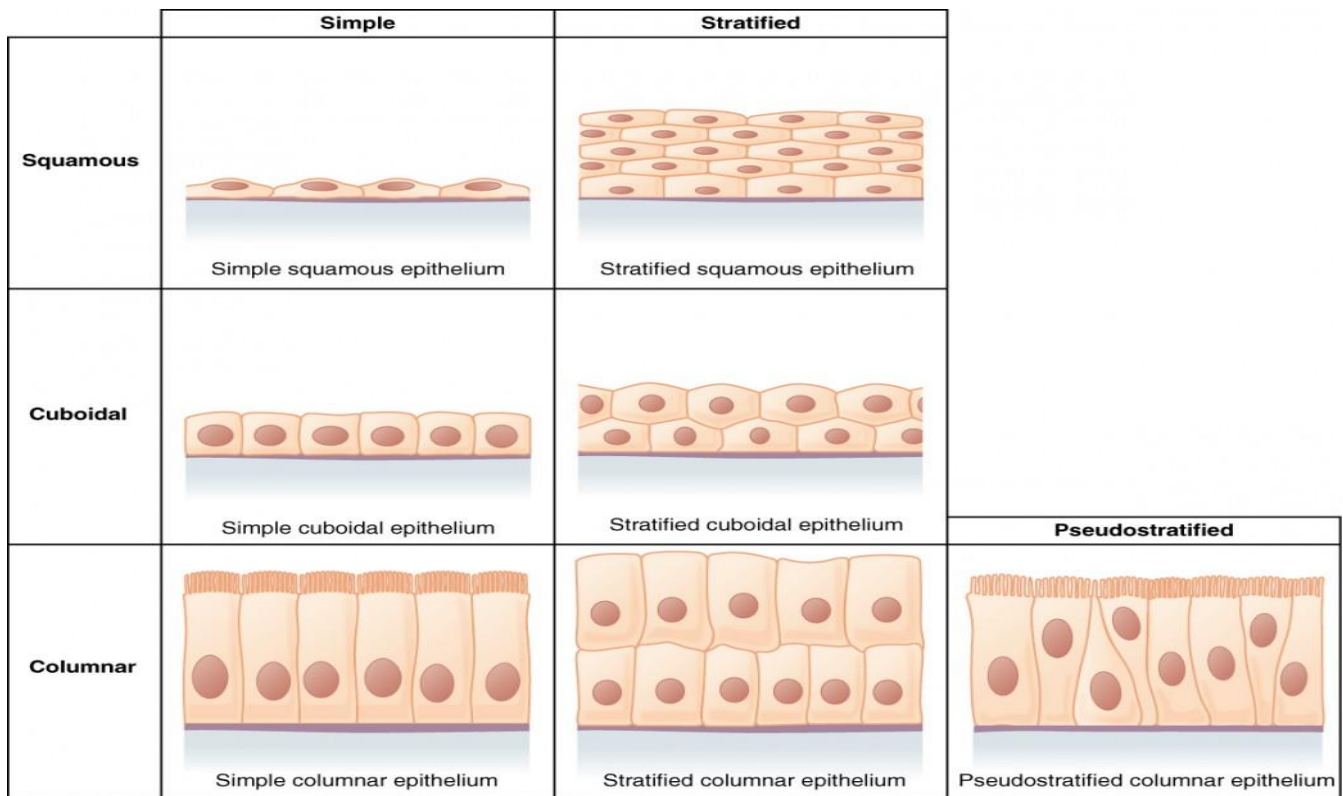
**Mucous membrane:** It is also known as mucosa. There are goblet cells present, which secrete mucus. The mucus helps in lubrication, protection and easy movement of materials. It prevents tissues from drying. It lines the body cavities such as respiratory and digestive tracts, which open outside the body.

**Serous membrane:** The serous membrane lines the body cavities, which do not open outside the body, such as the lining of the pleural cavity, pericardial membranes. These membranes secrete the fluid inside the cavity and are made up of simple squamous epithelium.

Glands are made up of epithelial cells. There are two types of glands, exocrine and endocrine. Exocrine glands secrete their product into a duct, e.g. goblet cells, sweat glands. Endocrine glands are called ductless glands and they release their product directly into the blood or intestinal fluid, e.g. hormones.

**Functions**

- Protection: As it covers the entire body surface, it is the first line of defence against any kind of mechanical injury, chemical exposure, excessive fluid loss and infections. Ciliary projections present in the nose or upper respiratory tract, trap the dust particles and prevent it from entering the body
- Absorption: The epithelial lining of the digestive tract absorbs water and nutrients
- Exchange of substances: Epithelial tissue regulates the exchange of substances between body and external environment as well as the internal exchange between different parts of the body. Everything that enters the body or enters the bloodstream by absorption has to cross the epithelial barrier
- Sensation: Sensory receptors are present in the epithelial tissue of the nose, eyes and ears, taste bud, etc. that help in transmitting signals from the external stimuli to the brain
- Secretion: Various glands made up of epithelial cells secrete hormones, enzymes, saliva, mucus, sweat, etc.



**11. b) Discuss briefly the process of replication and mitosis.**

Introduction	Cell cycle and mitosis	Replication	Diagram
2	4	3	3

**Cell cycle:**

Cell cycle refers to the series of events that take place in a cell, resulting in the duplication of DNA and division of cytoplasm and organelles to produce two daughter cells.

A typical eukaryotic cell cycle is divided into two main phases: -

## Interphase

- G1 phase (Gap 1) – G1 phase is the phase of the cell between mitosis and initiation of replication of the genetic material of the cell. During this phase, the cell is metabolically active and continues to grow without replicating its DNA.
- S phase (Synthesis) – DNA replication takes place during this phase. If the initial quantity of DNA in the cell is denoted as  $2N$ , then after replication it becomes  $4N$ . The centriole also divides into two centriole pairs in the cells which contain centriole.
- G2- phase (Gap 2) –During this phase, the RNA, proteins, other macromolecules required for multiplication of cell organelles, spindle formation, and cell growth are produced as the cell prepares to go into the mitotic phase.

## M phase

This is the mitotic phase or the phase of the equational division as the cell undergoes a complete reorganization to give birth to a progeny that has the same number of chromosomes as the parent cell.

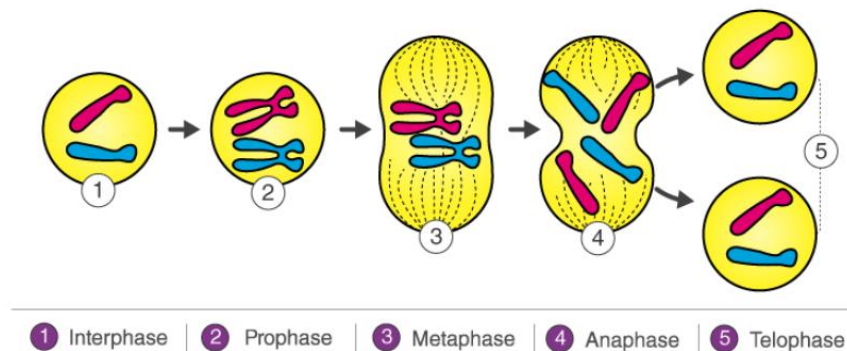
The mitotic phase is divided into four overlapping stages: -

**Prophase** - Prophase is the first phase of mitosis, the process that separates the duplicated genetic material carried in the nucleus of a parent cell into two identical daughter cells.

**Metaphase** - Metaphase is a stage during the process of cell division (mitosis or meiosis). Normally, individual chromosomes are spread out in the cell nucleus.

**Anaphase** - In anaphase, the sister chromatids separate from each other and are pulled towards opposite ends of the cell.

**Telophase** - Telophase is the fifth and final phase of mitosis, the process that separates the duplicated genetic material carried in the nucleus of a parent cell into two identical daughter cells.



Following are the important steps involved in DNA replication:

### Initiation

For the replication to begin there is a particular region called the origin of replication. This is the point where the replication originates. Replication begins with the spotting of this origin followed by the unwinding of the two DNA strands.

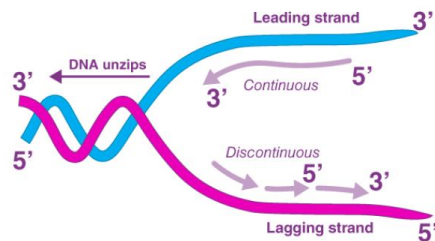
Unzipping of DNA strands in their entire length is not feasible due to high energy input. Hence, first, a replication fork is created catalysed by the helicase enzyme, which unzips the DNA strand.

## Elongation

As the strands are separated, the polymerase enzymes start synthesising the complementary sequence in each of the strands. The parental strands will act as a template for newly synthesising daughter strands.

## Termination

Termination of replication occurs in different ways in different organisms. In E.coli like organisms, chromosomes are circular. And this happens when the two replication forks between the two terminals meet each other.



12. a) Explain the role of bone salts and the organic matrix in making bone both hard and flexible.

Introduction	Bone salts and types	Bone matrix and its types
3	5	5

### Introduction:

Bone matrix refers to the matrix component of bone tissue. It provides the structural framework and mechanical support for bones, especially as it provides a site where new bone tissues are deposited during bone growth, remodeling, and repair.

The bone matrix is made up of organic and inorganic components. The organic component includes collagen fibers and ground substance.

### Organic bone matrix components:

The collagen and ground substance are the primary organic components of the bone matrix. Other organic components are other bone matrix proteins, non-collagenous proteins, proteoglycans, and growth factors.

Collagen: Collagens are the predominant type of protein in the bone matrix. They are of two types: fibrillar and nonfibrillar.

Fibrillar type: Examples of fibrillar collagen are Type I collagen, Type III collagen, and Type V collagen. The primary type of collagen though is Type I collagen. Type I collagen is an important component as it plays various roles:

- ✓ Type I collagen provides tensile strength that allows the bone to resist stretching and bending and support the body weight.
- ✓ Type I collagen gives bones a degree of flexibility, especially to withstand forces without breaking.
- ✓ Type I collagen provides a scaffold for the deposition of mineral crystals during the mineralization of the bone, especially during bone formation, bone remodeling, and bone regeneration or repair.
- ✓ Type I collagen interacts with the cells in the matrix, which is crucial in bone homeostasis.

## Bone Salts:

The inorganic components of the bone matrix are mainly the mineralized hydroxyapatite along with the small amounts of other inorganic minerals and ions. Some of the inorganic components in the bone matrix are as follows:

**Hydroxyapatite:** Hydroxyapatite [chemical formula:  $\text{Ca}_{10}(\text{PO}_4)_6(\text{OH})_2$ ] is a calcium phosphate biomineral. It is in crystalline form and occurs as the predominant component of the bone matrix (significantly greater than the other bone matrix components, including Type I collagen, which contributes to approximately 35% of the bone's dry weight).

Other minerals: some of them are as follows ...

- Calcium ( $\text{Ca}^{2+}$ ) ions are an essential component of hydroxyapatite crystals and are crucial for bone mineralization.
- Phosphate ( $\text{PO}_4^{3-}$ ) ions are also part of the hydroxyapatite bone matrix and are necessary for bone mineralization.
- Magnesium ( $\text{Mg}^{2+}$ ) ions also have a vital role in bone mineralization and in regulating calcium levels.
- Sodium ( $\text{Na}^+$ ) ions are involved in maintaining the body's electrolyte balance.
- Potassium ( $\text{K}^+$ ) ions help maintain the acid-base balance in the bone.

## 12. B) Describe various types of muscles and its structure.

Introduction	Types	Structure	Function	Diagram
2	2	3	3	3

### Introduction:

Muscle is a soft tissue found in both animals and humans. The cells of the muscles comprise protein filaments of actin and myosin that slide past one another, which produces contraction and changes both the length and the shape of the cell.

### Types:

There are three major muscle types found in the human body: skeletal, cardiac, and smooth muscle. Each muscle type has unique cellular components, physiology, specific functions, and pathology.

### Types of Muscles

- Skeletal or striated muscles
- Cardiac muscles
- Smooth muscles

Based on the muscle action, muscles are further classified into:

- Voluntary muscles
- Involuntary muscles

## **Skeletal muscles**

Structure:

- Skeletal muscle is a series of muscle fibres composed of muscle cells, which are long and multinucleated.
- Skeletal muscles are cylindrically shaped with branched cells attached to the bones by an elastic tissue or collagen fibres called tendons, which are composed of connective tissues.
- The end of each skeletal muscle has a tendon, which connects the muscle to bone and connects directly to the collagenous, the outer covering of skeletal muscle.

Functions:

- It maintains body posture.
- It regulates body temperature.
- It connects to and controls the motions of the skeleton.
- It is responsible for performing muscular involuntary movements.
- It is responsible for body movements such as breathing, extending the arm, typing, writing, etc.

## **Cardiac muscles**

Structure:

Cardiac muscle exists only within the human heart. It is a specialized form of muscle evolved to continuously and repeatedly contract, providing circulation of blood throughout the body. Cardiac muscle has a regular pattern of fibres like that of smooth muscles.

Functions:

The primary function of the cardiac muscle is to regulate the functioning of the heart by the relaxation and contraction of the heart muscles. Other functions of cardiac muscles include:

- The cardiac muscles function as the involuntary muscle.
- The cardiac muscles are also involved in the movement or the locomotion.
- The cardiac muscles work without stopping, day and night. They work automatically and make the heart contract so that the heart can squeeze the blood vessels and release them so that the heart can fill up with blood again.

## **Smooth muscles**

Structure:

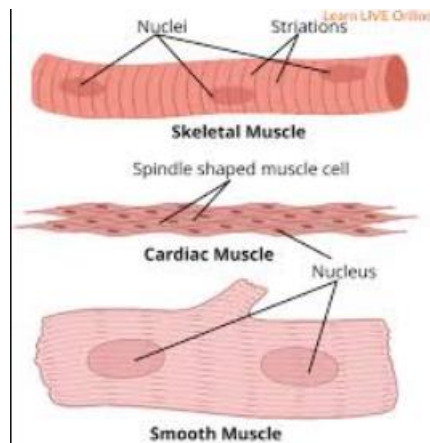
The smooth muscles of the human muscular system are spindle-shaped muscle fibres with a single nucleus. The thickness of the smooth muscles ranges between 3-10  $\mu\text{m}$  and their length ranges between 20 to 200  $\mu\text{m}$ , which are shorter compared to the skeletal muscle.

Functions

Like all other types of muscles, smooth muscles are also involved in contraction and relaxation. Other functions of smooth muscles include:

- It is involved in the sealing of orifices.
- It produces connective tissue proteins such as collagen and elastin.

- Transports chyme (a pulpy acidic fluid) for the contractions of the intestinal tube.
- Smooth muscle plays a vital role in the circulatory system by maintaining and controlling the blood pressure and flow of oxygen throughout the body.



**13. A) Describe the pathways of impulse through the intrinsic conduction system of heart.**

Introduction	Steps	Diagram
<b>3</b>	<b>5</b>	<b>5</b>

The intrinsic conduction system sets the basic rhythm of the beating heart by generating impulses which stimulate the heart to contract.

The intrinsic conduction pathway begins in the sinoatrial node. This node acts as the pacemaker of the heart because it spontaneously depolarizes. The action potential travels to the left atrium through the interatrial bundle (Bachmann's Bundle).

The SA node starts the sequence by causing the atrial muscles to contract. That's why doctors sometimes call it the anatomical pacemaker. Next, the signal travels to the AV node, through the bundle of HIS, down the bundle branches, and through the Purkinje fibers, causing the ventricles to contract.

**Steps:**

- Step 1: Stimulation of the sinoatrial node

The SA node has the fastest rate of depolarization, and thus sets the rhythm of the heart. This is known as the “pacemaker” of the heart with its sinus rhythm.

Typically, the rate of impulses is 75 per minute; the SA node has the fastest rate of depolarization in the heart.

- Step 2: Stimulation of the atrioventricular node

The depolarization wave spreads through the atria in the internodal pathway. Propagation occurs through gap junctions. Impulses are delayed for 0.1 s to allow the atria to contract prior to the ventricles. The 0.1 s pause is also attributable to the smaller diameter of the fibers in the AV node.

- Step 3: Propagation to the AV bundle

Atria and ventricles are not connected by gap junctions, and this bundle is the only electrical connection between the atria and the ventricles.

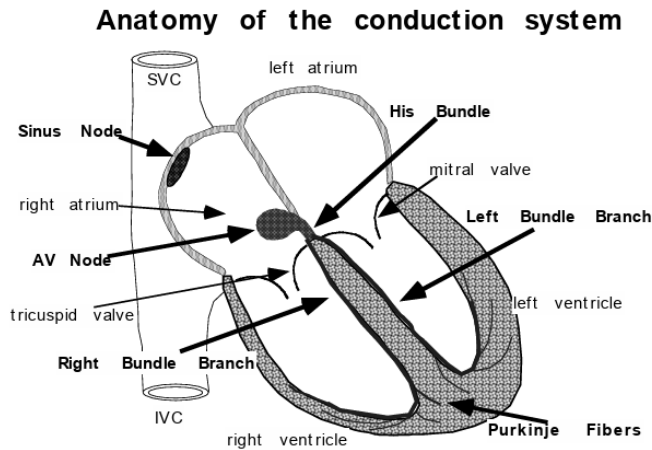
- Step 4: Splitting into the bundle branches.



These branches propagate along the interventricular septum towards the apex of the heart.

- Step 5: Propagation up the Purkinje fibers (subendocardial conducting network)

The Purkinje fibers propagate superiorly to the walls of the ventricles from the apex of the heart. These impulses travel through the means of gap junctions.



**13. b) Explain the difference between internal and external respiration.**

Introduction	Explanation	Difference	Diagram
2	3	4	4

Internal respiration occurs in the body tissues, where cells release carbon dioxide and take in oxygen from the blood. External respiration occurs in the lungs or gills and occurs when the body takes in oxygen from the atmosphere and releases carbon dioxide.

**Internal Respiration**

Internal respiration is also known as cellular respiration as it occurs inside the living cells. The exchange of carbon dioxide and oxygen gases during cellular respiration occurs between the blood and other cells of the body.

Internal respiration refers to two distinct processes. The first is the exchange of gasses between the bloodstream and the tissues. The second is the process of cellular respiration, from which cells utilize oxygen to perform basic metabolic functions.

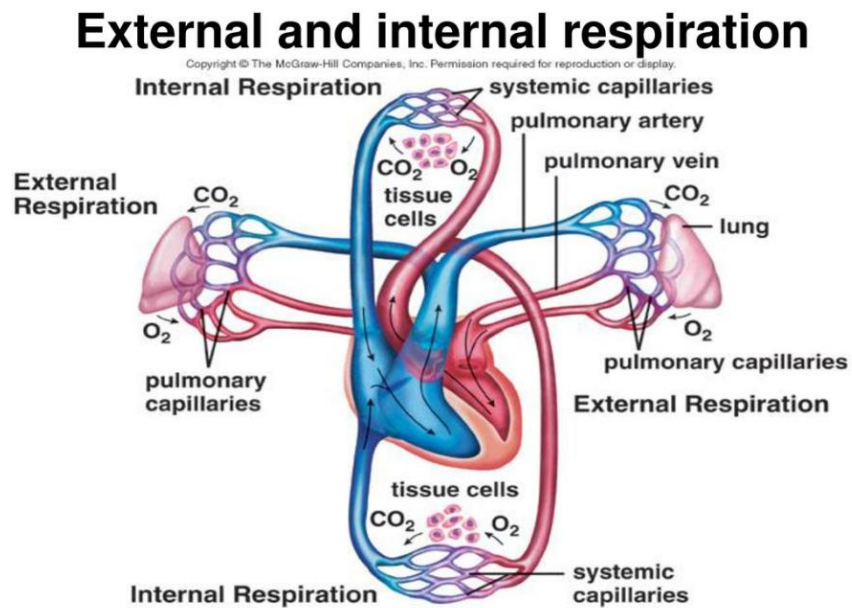
**External respiration:**

External respiration, also known as breathing, involves both bringing air into the lungs (inhalation) and releasing air to the atmosphere.

External respiration is the exchange of gases with the external environment and occurs in the alveoli of the lungs. Internal respiration is the exchange of gases with the internal environment and occurs in the tissues.

## Differences:

Internal Respiration	External respiration:
It refers to the exchange of gases between the air, the alveoli and the blood.	It refers to oxidation of the glucose and the generation of the energy.
It occurs at the individual cellular level.	It occurs via nostrils, nasal cavity, bronchus, bronchioles and alveoli.
It is a biochemical process, involving the oxidation of glucose to generate ATPs.	It is just a physical process in which air moves inside and outside of the body.
In this process, glucose undergoes oxidation to generate ATP, Carbon dioxide and water.	In this process, Oxygen moves inside the lungs and carbon dioxide is exhaled out.
Partial pressure of carbon di oxide in the blood is increased from 40mmHg to 45 mm Hg	Partial pressure of carbon di oxide in the blood is decreased from 45mmHg to 40 mm Hg



**14. a) Summarize the overall function of digestive system as digestion and absorption.**

<b>Introduction</b>	<b>Digestion process</b>	<b>Absorption process</b>	<b>Diagram</b>
<b>2</b>	<b>4</b>	<b>4</b>	<b>3</b>

**Introduction:**

The digestive system is made up of the gastrointestinal tract—also called the GI tract or digestive tract—and the liver, pancreas, and gallbladder. The GI tract is a series of hollow organs joined in a long, twisting tube from the mouth to the anus.

The processes of digestion include seven activities: ingestion, propulsion, mechanical or physical digestion, chemical digestion, secretion, absorption, and defecation. The first of these processes, ingestion, refers to the entry of food into the alimentary canal through the mouth.

Digestion Process

The process of digestion begins from the mouth and ends in the small intestine – the large intestines’ main function is to absorb the remaining water from the undigested food and enable bacterial fermentation of materials that can no longer be digested.

The alimentary canal or the gastrointestinal tract is a series of hollow organs and tubes that begins from the mouth cavity and continues into the pharynx, through the stomach, small intestines, large intestines, and finally ending at the anus. Food particles gradually get digested as they travel through various compartments of the gastrointestinal tract.

The digestion process takes place in the following steps.

Ingestion

The very first step involves mastication (chewing). The salivary glands, along with the tongue, helps to moisten and lubricate food, before being pushed down into the food pipe.

Mixing and Movement

It involves the process of lubricating and manipulating food and pushing it down the food through the food pipe (using peristalsis), and into the stomach.

Secretion

The stomach, small intestine, liver, and pancreas secrete enzymes and acids to aid the process of digestion. It functions by breaking down food particles into simple components and easily absorbable components.

Digestion

The process of converting complex food particles into simpler substances in the presence of enzymes and acids secreted by different digestive organs.

Absorption and emptying

- This process begins in the small intestine where most of the nutrients and minerals are absorbed. The excess water in the indigestible matter is absorbed by the large intestines.

- Although the stomach absorbs few of the products of digestion, it can absorb many other substances, including glucose and other simple sugars, amino acids, and some fat-soluble substances.
- The pH of the gastric contents determines whether some substances are absorbed. At a low pH, for example, the environment is acidic and aspirin is absorbed from the stomach almost as rapidly as water, but, as the pH of the stomach rises and the environment becomes more basic, aspirin is absorbed more slowly.
- Water moves freely from the gastric contents across the gastric mucosa into the blood. The net absorption of water from the stomach is small, however, because water moves just as easily from the blood across the gastric mucosa to the lumen of the stomach.
- The absorption of water and alcohol can be slowed if the stomach contains foodstuffs and especially fats, probably because gastric emptying is delayed by fats, and most water in any situation is absorbed from the small intestine.

Excretion

The process of removing indigestible substances and waste by-products from the body through the process of defecation.



**14. b) Describe how body temperature is regulated with necessary illustration.**

Introduction	Types	Mechanism	Importance
2	2	4	4

Thermoregulation is the ability of an organism to keep its body temperature within certain boundaries, even when the surrounding temperature is very different.

The internal thermoregulation process is one aspect of homeostasis: a state of dynamic stability in an organism's internal conditions, maintained far from thermal equilibrium with its environment.

If the body is unable to maintain a normal temperature and it increases significantly above normal, a condition known as hyperthermia occurs.

## Mechanism of Thermoregulation

The hypothalamus is a small section or a portion of a human brain, which is mainly involved in secretion or release of all hormones from their respective glands and controlling several body functions. The mechanisms of thermoregulation are also controlled by this Hypothalamus.

When there is a small variation in the internal body temperature, the sensors in the central nervous system sends the message to the hypothalamus and in response, the hypothalamus sends signals to various cells, muscles, and other systems in our body.

If our body needs to warm up, the mechanisms of thermoregulation include:

- **Vasoconstriction:** As the blood vessels under the skin receive signals they become narrower to decrease the blood flow and retain heat to warm the inner body.
- **Thermogenesis:** This process is mainly seen in all warm-blooded animals. The body's organs produce heat in a variety of ways to keep the body warm.
- **Hormonal thermogenesis:** In this mechanism, the thyroid gland regulates to release hormones in order to increase the body's metabolism, which produces a more amount of heat to maintain a stable internal body temperature.

If our body needs to cool down, the mechanisms of thermoregulation include:

**Sweating:** Here the sweat glands receive signals to release sweat and it cools our skin as it evaporates. This helps by lowering the internal temperature.

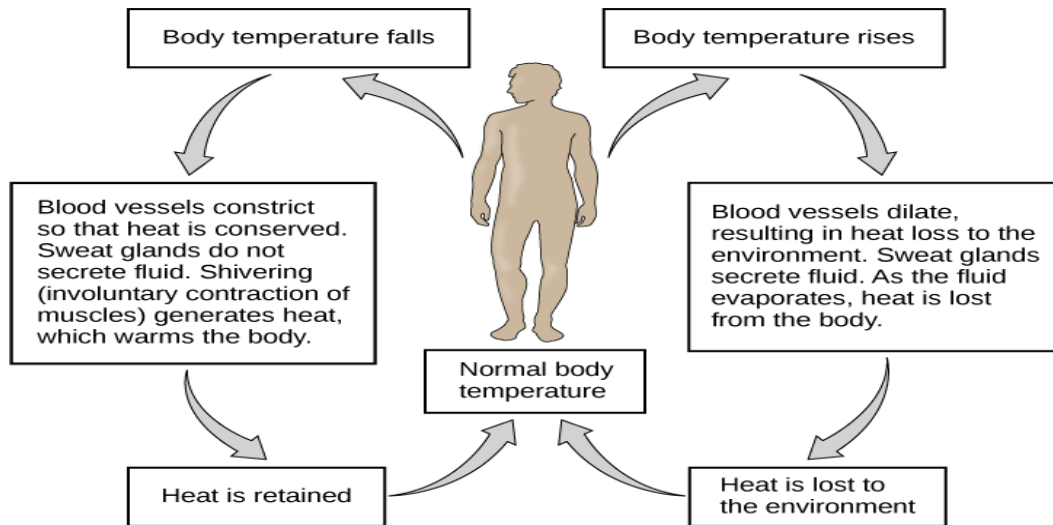
**Vasodilatation:** In this process, the blood vessels present beneath the skin expand and increases the blood flow, which cools by releasing the body's heat through heat radiation.

## Importance of Thermoregulation

The mechanisms thermoregulation are all designed to return the body to homeostasis or a state of equilibrium. This process helps in controlling the loss or gain of heat and maintaining of an optimum temperature range by an organism.

As mentioned earlier, average healthy body temperature falls within a  $37^{\circ}\text{C}$  to  $37.8^{\circ}\text{C}$ . However, if the body temperature falls from  $37^{\circ}\text{C}$  to  $35^{\circ}\text{C}$  or lower, then a person may suffer from a medical emergency of hypothermia. This condition leads to cardiac arrest, brain damage, and even death. The factors affecting the hypothermia or lower in the internal body temperature include metabolic conditions, such as an under-functioning thyroid gland, usage of alcohols and other drugs.

In the case of hyperthermia, a medical condition in which the body temperature rises from  $37^{\circ}\text{C}$  to  $42^{\circ}\text{C}$ , then a person may suffer from the brain damage or even death in rare cases. The factors affecting the hyperthermia or raise internal body temperature include exercise, fever, digestion, some hormonal changes, and other infections.



**15. A) Explain the structural and functional classification of nervous system.**

<b>Introduction</b>	<b>CNS, Parts &amp; Function</b>	<b>PNS, Parts &amp; Function</b>	<b>Diagram</b>
<b>2</b>	<b>4</b>	<b>4</b>	<b>3</b>

The nervous system is a network of neurons whose main feature is to generate, modulate and transmit information between all the different parts of the human body. This property enables many important functions of the nervous system, such as regulation of vital body functions (heartbeat, breathing, digestion), sensation and body movements. Ultimately, the nervous system structures preside over everything that makes us human, our consciousness, cognition, behavior and memories.

The nervous system consists of two divisions.

- Central nervous system (CNS) is the integration and command center of the body.
- Peripheral nervous system (PNS) represents the conduit between the CNS and the body. It is further subdivided into the somatic nervous system (SNS) and the autonomic nervous system (ANS).

The nervous system (NS) is structurally broken down into two divisions.

- Central nervous system (CNS) - consists of the brain and spinal cord.
- Peripheral nervous system (PNS) - gathers all neural tissue outside the CNS

Functionally, the PNS is further subdivided into two functional divisions.

- Somatic nervous system (SNS) - informally described as the voluntary system.
- Autonomic nervous system (ANS) - described as the involuntary system.

**Central Nervous System**

Central Nervous System (CNS) is often called the central processing unit of the body. It consists of the brain and the spinal cord.

## Brain

The brain is one of the important, largest and central organ of the human nervous system. It is the control unit of the nervous system, which helps us in discovering new things, remembering and understanding, making decisions, and a lot more. It is enclosed within the skull, which provides frontal, lateral and dorsal protection. The human brain is composed of three major parts:

- Forebrain: The anterior part of the brain, consists of Cerebrum, Hypothalamus and Thalamus.
- Midbrain: The smaller and central part of the brainstem, consists of Tectum and Tegmentum.
- Hindbrain: The central region of the brain, composed of Cerebellum, Medulla and Pons.

## Spinal Cord

The spinal cord is a cylindrical bundle of nerve fibers and associated tissues enclosed within the spine and connect all parts of the body to the brain. It begins in continuation with the medulla and extends downwards. It is enclosed in a bony cage called vertebral column and surrounded by membranes called meninges. The spinal cord is concerned with spinal reflex actions and the conduction of nerve impulses to and from the brain.

## **Peripheral Nervous System**

Peripheral Nervous System (PNS) is the lateral part of the nervous system that develops from the central nervous system which connects different parts of the body with the CNS. We carry out both voluntary and involuntary actions with the help of peripheral nerves.

PNS includes two types of nerve fibers:

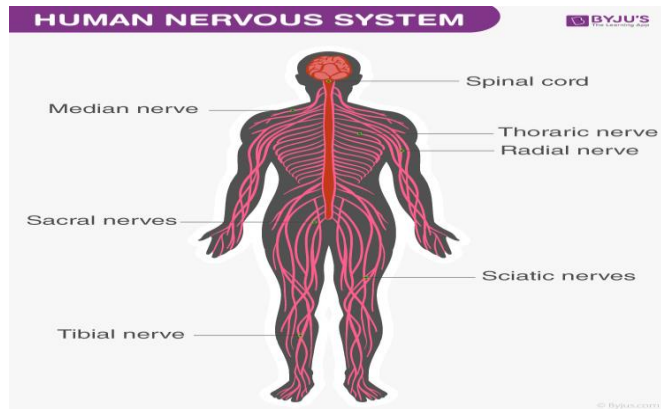
- Afferent nerve fibers – These are responsible for transmitting messages from tissues and organs to the CNS.
- Efferent nerve-fibers – These are responsible for conveying messages from CNS to the corresponding peripheral organ.

Classification of the peripheral nervous system:

- Somatic neural system (SNS): It is the neural system that controls the voluntary actions in the body by transmitting impulses from CNS to skeletal muscle cells. It consists of the somatic nerves.
- Autonomic neural system (ANS): The autonomic neural system is involved in involuntary actions like regulation of physiological functions (digestion, respiration, salivation, etc.). It is a self-regulating system which conveys the impulses from the CNS to the smooth muscles and involuntary organs (heart, bladder and pupil). The autonomic neural system can be further divided into:

Sympathetic nervous system – Intro & function

Parasympathetic nervous system - Intro & function



15. b) Explain the image formation on the retina with appropriate diagram.

Introduction	Steps in image formation	Diagram
3	6	4

An image is formed on the retina with light rays converging most at the cornea and upon entering and exiting the lens. Rays from the top and bottom of the object are traced and produce an inverted real image on the retina. The distance to the object is drawn smaller than scale.

Steps:

- Light Rays enter the eye through the cornea. It acts as the front covering of an eye or the shield of an eye to protect it from the entrance of foreign particles and the process of refraction begins in the cornea.
- The cornea and lens of an eye together form the real image on the retina when light passes into the eye, it passes first from the cornea since it has a curved surface and acts as the convex, it begins to focus on the light rays.
- The light then passes over the pupil and hits the lens of the eye.
- The lens which is also convex further focuses the light so that it will hit the retina at the back of the eyeball that forms the image. The image that is formed on the retina is real and inverted. The retina comprises specialized cells that are sensitive to light also known as rod and cone cells.
- Both the cells get stimulated and send signals to the brain which turns them into erect images that allow us to see.
- Then the light Rays pass through the pupil, it controls the intensity of light entering the eye, and then the light Rays pass through the convex lens.
- Then the refracted Rays pass through a dense substance This substance is like a gel and is present in the eyeball. And finally, the image on the retina of an eye is formed.
- The retina acts as a screen used to capture images and then this image is converted into electrical signals that are sent to the brain. The images reflected from the convex lens are real.
- Thus real images are formed under the retina of the human eye.



**Ray Diagram:**  
(Using a simple outline of the eye)

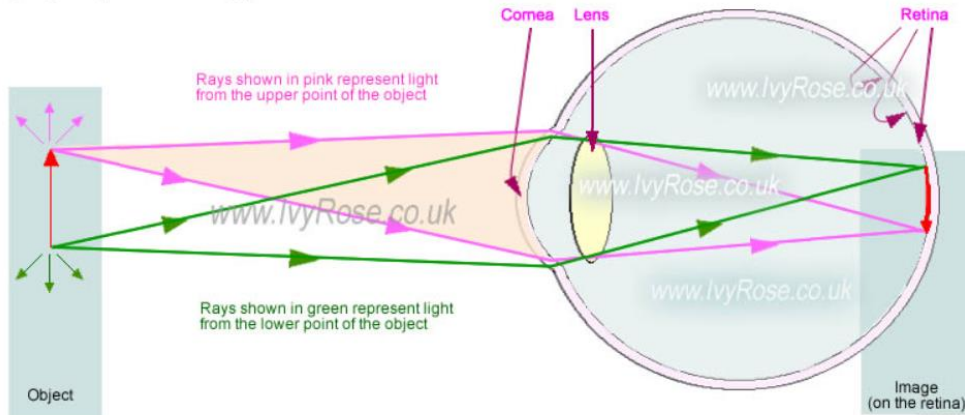


Diagram: Copyright IvyRose Ltd., 2009.

Above: Basic Ray Diagram of image formation within the Human Eye.

### Part C (1 x 15=15)

16) a Access the information obtained from electrocardiogram and present the significance of each with ECG wave form.

Introduction	Types of waves	Significance	Diagram
2	6	3	4

#### **Introduction:**

An electrogram of the heart which is a graph of voltage versus time of the electrical activity of the heart using electrodes placed on the skin. These electrodes detect the small electrical changes that are a consequence of cardiac muscle depolarization followed by repolarization during each cardiac cycle (heartbeat). Changes in the normal ECG pattern occur in numerous cardiac abnormalities, including:

- Cardiac rhythm disturbances (such as atrial fibrillation and ventricular tachycardia),
- Inadequate coronary artery blood flow (such as myocardial ischemia and myocardial infarction),
- and electrolyte disturbances (such as hypokalemia and hyperkalemia).

#### **Types:**

There are three main components to an ECG:

- The P wave, which represents depolarization of the atria.
- The QRS complex, which represents depolarization of the ventricles.
- The T wave, which represents repolarization of the ventricles.

#### **The P wave:**

The first wave on an ECG is the P wave, indicating atrial depolarization in which the atria contract (atrial systole). The P wave is the first wave on the ECG because the action potential for the heart is generated in the sinoatrial (SA) node, located on the atria, which sends action potentials directly through Bachmann's bundle to depolarize the atrial muscle cells.

Increased or decreased P waves can indicate problems with the potassium ion concentration in the body that will alter nerve activity. A missing P wave indicates atrial fibrillation, a cardiac arrhythmia in which the heart beats irregularly, preventing efficient ventricular diastole. This is generally not fatal on its own.

**QRS Complex:**

The QRS complex refers to the combination of the Q, R, and S waves, and indicates ventricular depolarization and contraction (ventricular systole). The Q and S waves are downward waves while the R wave, an upward wave, is the most prominent feature of an ECG. The QRS complex represents action potentials moving from the AV node, through the bundle of His and left and right branches and Purkinje fibers into the ventricular muscle tissue. Abnormalities in the QRS complex may indicate cardiac hypertrophy or myocardial infarctions.

**The T Wave and ST Segment:**

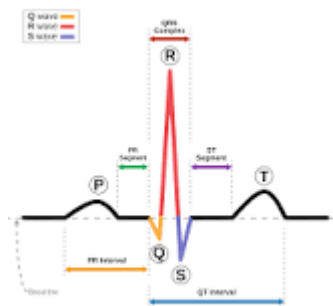
The T Wave indicates ventricular repolarization, in which the ventricles relax following depolarization and contraction. The ST segment refers to the gap (flat or slightly upcurved line) between the S wave and the T wave and represents the time between ventricular depolarization and repolarization. An elevated ST segment is the classic indicator for myocardial infarctions, though missing or downward sloping ST segments may indicate myocardial ischemia.

Following the T wave is the U wave, which represents repolarization of the Purkinje fibers. It is not always visible on an ECG because it is a very small wave in comparison to the others.

**Ventricular fibrillation**

When ECG output shows no identifiable P waves, QRS complexes, or T waves, it indicates ventricular fibrillation, a severe arrhythmia. During ventricular fibrillation, the heart beats extremely fast and irregularly and can no longer pump blood, acting as a mass of quivering, disorganized muscle movements.

Ventricular fibrillation will cause sudden cardiac death within minutes unless electrical resuscitation (with an AED) is performed immediately.



**16 b) Analyze the various mechanism of urine formation with relevant sketch.**

Introduction	Steps	Functions	Diagram
2	6	3	4

Urine is a waste byproduct formed from excess water and metabolic waste molecules during the process of renal system filtration. The primary function of the renal system is to regulate blood volume and plasma osmolarity, and waste removal via urine is essentially a convenient way that the body performs many functions using one process.

## Steps

1. Glomerular filtration
2. Tubular reabsorption
3. Tubular secretion

## Glomerular Filtration

- The glomerulus is where blood is filtered. The Bowman's capsule epithelium, the endothelium of glomerular blood vessels, and the membrane between these two layers - all participate in this form of filtration.
- Glomerular filtration begins when the fluid fraction of blood is filtered by the glomerulus and enters the glomerular capsule as glomerular filtrate. The filtrate is a liquid that enters the nephron after leaving the bloodstream. Except for the formed elements and plasma proteins, it encompasses all chemicals in the blood.
- Water, glucose, ions, amino acids, and nitrogenous wastes are all found in this filtrate, which is collected by the renal corpuscle.
- Water and other solutes are forced out of the circulation into Bowman's capsule by high blood pressure in the glomerulus. This high blood pressure is due to the afferent arteriole being more prominent than the efferent arteriole.
- It is a non-energy using method (ATP).
- Other capillary membranes are 1,000 times more permeable to water and solutes than the filtering membrane.

## Reabsorption

- The reabsorption process takes place mostly in the renal tubules (the proximal convoluted tubule (PCT), a loop of Henle, and the distal convoluted tubule (DCT)). This is where 99% of the filtrate is produced.
- The Proximal Convoluted Tubule (PCT): The proximal convoluted tubules are where the majority of reabsorption takes place. The glucose in the filtrate is reabsorbed into the blood, most of which occurs in the PCT. The Na<sup>+</sup>-K<sup>+</sup> pump, which employs ATP, actively transports most of the sodium cations (65%) from the proximal convoluted tubules back into circulation. Amino acids and vitamins are reabsorbed into the bloodstream from the PCT.
- Loop of Henle: The remaining water is reabsorbed by the descending limb. From the ascending limb, sodium ions and chloride ions are reabsorbed.
- The Distal Convoluted Tubule (DCT): DCT is capable of selective reabsorption of chemicals that have remained in the filtrate. It is dependent on the body's present needs. Hormones such as aldosterone regulate it. Also, aldosterone regulates sodium ions' reabsorption in DCT.

## Secretion

- It includes tubular secretion. It entails adding substances to the filtrate obtained from the blood in peritubular capillaries (by active transport).
- Any remaining nitrogenous wastes, some medications, and H<sup>+</sup> ions are the main materials secreted to maintain the pH of the blood.
- Tubular cells secrete hydrogen ions, potassium ions, and other ions into the filtrate.

- As  $\text{Na}^+$  is reabsorbed, the potassium ( $\text{K}^+$ ) cation is released into DCT. The hormone aldosterone regulates  $\text{K}^+$  secretion.
- The pH of the blood rises as  $\text{H}^+$  ions are released into the filtrate (it becomes less acidic).
- The secretion also removes urea, uric acid, ammonium ions, and certain medicines from the blood.
- Urine is the result of the fluid entering the collecting duct.

