Model Answer for Question Paper Code: AU6901
LZC 502: Animal Physiology
B. Sc. Vth Semester
Department of Zoology, Guru Ghasidas Vishwavidyalaya

Q 1: Multiple Choice Questions (1X10=10)

1. What is pH of pancreatic juice?
   d. 7.1-8.2
2. Aminopeptidase enzyme is responsible for the digestion of protein and it is present in:
   a. Intestinal juice
3. Maltase converts:
   a. Maltose to glucose
4. The normal range of WBc present in per µl blood sample is:
   c. 5000-10000
5. Formation of thrombin activates:
   a. Factor-8
6. Respiratory Quotient of protein diet is:
   c. 0.8
7. O_2 is found in dissolved condition is about:
   a. 1.5%
8. Smallest cranial nerve is:
   c. Auditory nerve
9. Maximum reabsorption takes place in:
   a. PCT
10. M line of myofibril is formed by:
    d. None of the above

Section B: Descriptive type Question (5X4=20)

1) Describe the physiology of fat digestion in different parts of alimentary canal?

Answer:

Digestion and absorption of fats

Most of the fat in the human diet is in the form of triacylglycerol (TAG), which consists of three fatty acids linked to glycerol. In the digestive tract, TAG is hydrolyzed by the enzyme lipase, to release free fatty acids and monoglycerides.

Emulsification and digestion

The key issue in the digestion and absorption of fats is one of solubility: lipids are hydrophobic, and thus are poorly soluble in the aqueous environment of the digestive tract. The digestive enzyme, lipase, is water soluble and can only work at the surface of fat globules. Digestion is greatly aided by emulsification, the breaking up of fat globules into much smaller emulsion droplets. Bile salts and phospholipids are amphipathic molecules that are present in the bile. Motility in the small intestine breaks fat globules apart into small droplets that are coated with bile salts and phospholipids, preventing the emulsion droplets from re-associating.

The emulsion droplets are where digestion occurs. Emulsification greatly increases the surface area where water-soluble lipase can work to digest TAG. Another factor that helps is colipase, an amphipathic protein that binds and anchors lipase at the surface of the emulsion droplet.

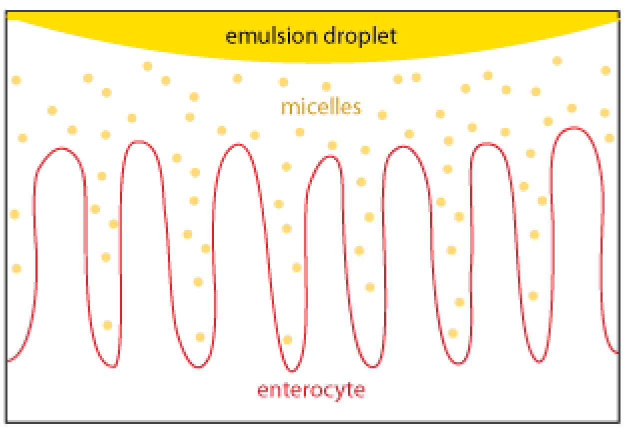
Micelles

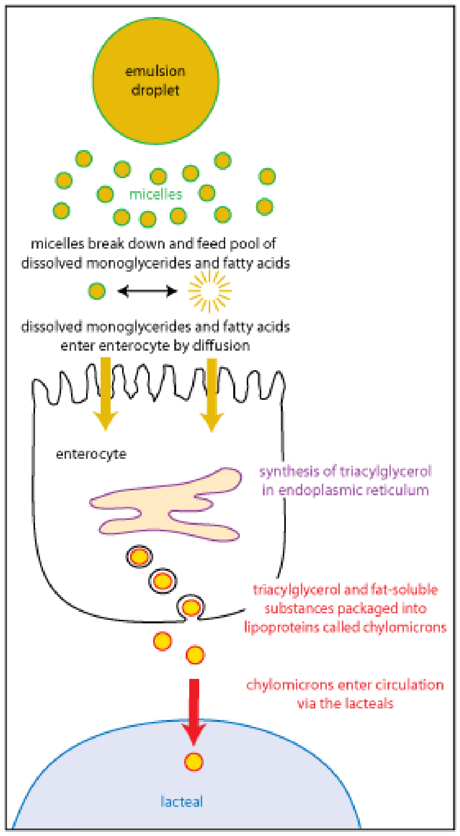
After digestion, monoglycerides and fatty acids associate with bile salts and phopholipids to form micelles. Micelles are about 200 times smaller than emulsion droplets (4-7nm versus 1µm for emulsion droplets). Micelles are necessary because they transport the poorly soluble monoglycerides and fatty acids to the surface of the enterocyte where they can be absorbed. As well, micelles contain fat soluble vitamins and cholesterol. The figure at right illustrates that micelles are small enough to fall between the the microvilli.

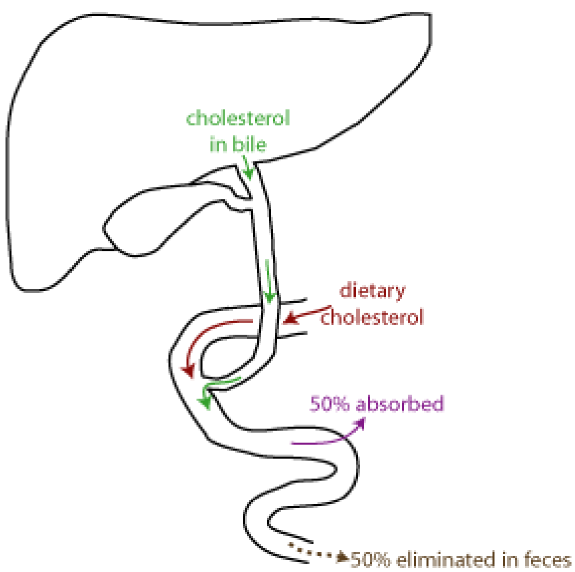
Micelles are constantly breaking down and re-forming, feeding a small pool of monoglycerides and fatty acids that are in solution. Only freely dissolved monoglycerides and fatty acids can be absorbed, NOT the micelles. Because of their nonpolar nature, monoglycerides and fatty acids can just diffuse across the plasma membrane of the enterocyte. Some absorption may be facilitated by specific transport proteins (see below, for cholesterol).

Chylomicrons

Once inside the enterocyte, monoglycerides and fatty acids are re-synthesized into TAG. The TAG is packaged, along with cholesterol and fat soluble vitamins, into chylomicrons. Chylomicrons are lipoproteins, special particles that are designed for the transport of lipids in the circulation. Chylomicrons are released by exocytosis at the basolateral surface of the enterocytes. Because they are particles, they are too large to enter typical capillaries. Instead they enter lacteals, lymphatic capillaries that poke up into the center of each villus. Chylomicrons then flow into the circulation via lymphatic vessels, which drain into the general circulation at the large veins.




emulsion droplet
micelles
micelles break down and feed pool of dissolved monoglycerides and fatty acids
dissolved monoglycerides and fatty acids enter enterocyte by diffusion
enterocyte
synthesis of triacylglycerol in endoplasmic reticulum
triacylglycerol and fat-soluble substances packaged into lipoproteins called chylomicrons
chylomicrons enter circulation via the lacteals
lacteal


cholesterol in bile
dietary cholesterol
50% absorbed
50% eliminated in feces

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2) Describe function, physical characters and principal component of blood?

Answer:

Blood is a connective tissue composed of a liquid extracellular matrix called blood plasma that dissolves and suspends various cells and cell fragments.

Function of blood:

Transportation: Blood transports oxygen from the lungs to the cells of the body and carbon dioxide from the body cells to the lungs for exhalation. It carries nutrients from the gastrointestinal tract to body cells and hormones from endocrine glands to other body cells. Blood also transports heat and waste products to various organs for elimination from the body.

Regulation: Blood helps to regulate pH through the use of buffers. It also adjusts body temperature through the heat absorbing and coolant properties of the water in the blood plasma.

Protection: After injury, blood clotting protects in excessive loss from the cardiovascular system. WBCs protects against disease by phagocytosis. Several blood protein i.e. antibodies and interferon's protect against diseases.

Physical characteristic of blood:

Temperature: $38^{o}C$ ($100^{o}F$)
Slightly alkaline: (pH 7.35 to 7.45)
Colour: Bright red (High oxygen content)
: Dark red (Low oxygen content)
Volume: 5-6 liters (M)
: 4-5 liters (F)

Component of blood: About 8% blood is present in our body.

- **Blood plasma (55%)**
  - **Water (91.5%)**
  - **Protein (7%)**
    - Albumin 54%,
    - Globulin 38%,
    - Fibrinogen 7%,
    - All other 1%
  - **Other substances (1.5%)**
    - **Electrolytes, Nutrients, Gases,**
    - **Regulatory substance and Waste products**
- **Formed elements (45%)**
  - **RBC (99%) 4.8-5.4 million**
  - **Platelets (150000-400000)**
  - **WBC (5000-10,000)**
    - **Neutrophils 60-70%**
    - **Lymphocyte 20-25%**
    - **Monocytes 3-8%**
    - **Eosinophils 2-4%**
    - **Basophils 0.5-1.0%**

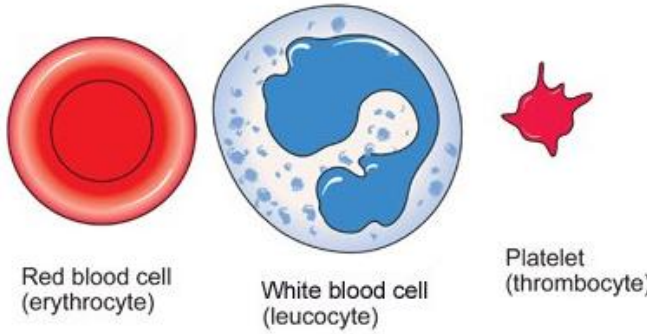


Figure showing formed cell elements

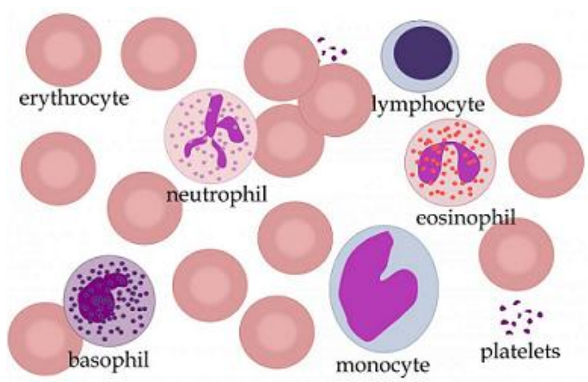


Figure showing formed cell elements

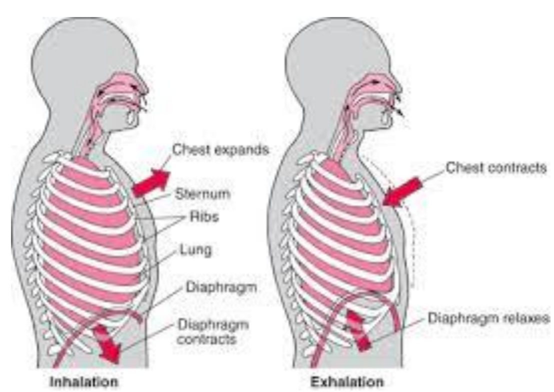
Figure showing different type of WBCs

3) **What is breathing? Explain the event that causes inhalation and exhalation?**
Answer:

Breathing is the process that moves air in and out of the lungs, or oxygen through other breathing organs such as gills. For organisms with lungs, breathing is also called ventilation, which includes both inhalation and exhalation. Breathing is one part of physiological respiration required to sustain life. Aerobic organisms of birds, mammals, and reptiles—require oxygen to release energy via cellular respiration, in the form of the metabolism of energy-rich molecules such as glucose. Breathing is only one of the processes that deliver oxygen to where it is needed in the body and remove carbon dioxide. Another important process involves the movement of blood by the circulatory system. Gas exchange occurs in the pulmonary alveoli by passive diffusion of gases between the alveolar gas and the blood in lung capillaries. Once these dissolved gases are in the blood, the heart powers their flow around the body (via the circulatory system). The medical term for normal relaxed breathing is eupnea.

Inhalation (also known as inspiration) is the flow of air into an organism. It is a vital process for all human life. In humans it is the movement of air from the external environment, through the airways, and into the alveoli. Inhalation begins with the contraction of the muscles attached to the rib cage; this causes an expansion in the chest cavity. Then takes place the onset of contraction of the diaphragm, which results in expansion of the intrapleural space and an increase in negative pressure according to Boyle's Law. This negative pressure generates airflow because of the pressure difference between the atmosphere and alveolus. Air enters, inflating the lung through either the nose or the mouth into the pharynx (throat) and trachea before entering the alveoli.

Exhalation (or expiration) is the flow of the respiratory current out of the organism. In humans it is the movement of air out of the bronchial tubes, through the airways, to the external environment during breathing. This happens due to elastic properties of the lungs, as well as the internal intercostal muscles which lower the rib cage and decrease thoracic volume. As the thoracic diaphragm relaxes during exhalation it causes the tissue it has depressed to rise superiorly and put pressure on the lungs to expel the air. During forced exhalation, as when blowing out a candle, expiratory muscles including the abdominal muscles and internal intercostal muscles generate abdominal and thoracic pressure, which forces air out of the lungs.

1. 

4) Briefly describe the muscle protein found in our body.

Answer

Myofibrils are built from three kinds of protein.

Contractile protein- which generate force during contraction

Regulatory protein- which help switch the contraction process on and off.

Structural protein- which keeps the thick and thin filament in the proper alignment, give the myofibril elasticity.

Contractile protein:

The two contractile proteins in muscles are myosin and actin, which are the main component of thick and thin filament. Myosin functions as motor protein in all three types of tissue. Motor protein pull or push the various cellular structures to achieve movement by converting the chemical energy in ATP to mechanical energy of motion or the production of force. In skeletal muscle about 3oo molecules of myosin from a single thick filament. Each myosin molecule is shaped like two golf clubs twisted together. The myosin tail points towards the M-line in the center of the sarcomere. Tails of neighbouring myosin molecule lie parallel to one another forming the shaft of the thick filament. The two projections of each myosin molecule (heads) are called myosin heads. Thin filament are anchored to Z-discs. Their main component of the protein is actin. Individual molecule joins to form an actin filament that is twisted into a helix. On each actin molecule a myosin binding site is present, where a myosin head can attach.

Regulatory protein:

The regulatory protein present in smaller amount. The regulatory proteins are tropomyosin and troponin. these proteins are the part of thin filament.In relaxed condition, the tropomyosin cover the myosin binding sites on actin. The myosin heads of thick filaments are held in place where troponin molecules are present on the tropomyosin strand. During contraction the the myosin heads binds to actin and form cross bridge. The myosin actin cross bridges rotate toward center of the sarcomere.

Structural protein:

The structural protein are the very important protein found in very less amount but contribute amajor in the alingnment, stability, elasticity and extensibility of myofibrils. Few important structural proteins are – titin, a actinin, myomesin nebulinand dystrophin.titin is the third most plentyful protein in skeletal muscle after actin and myosin. Titin is 50 times larger than an average sized protein. Each titin molecule spasm half a sarcomere, from a Z-line to M-line. In relaxed muscle the distance covered by a titin molecule connect a Z-line to the M-line of the sarcomere, thereby helping stabilize the position thick filament. Titin molecule that extends from Z-line to the beginning of thick filament is very elastic. It stretch atleast four times its resting length and then spring back.

Titin helps the sarcomere return to its resting length after a muscle has contracted or strectchand prevent the central location of the A-band.

α –actinin: alpha(α) actinin is the dense material that is found on the Z-line binds to actin molecules of the thin filaments and to titin.

Myomesin: molecule of myomesin form the M-line protein bind to titin and connect adjacent thick filament to one another.

5) Give an account on initiation and conductance of nerve impulse.

Answer:

The human nervous system contains roughly 100 billion neurons, connected in elaborate networks that transmit information from one location in the body to another. Consisting of the brain and spinal cord, the central nervous system interprets sensory input, initiates muscle contraction, and carries out all other cognitive tasks. The nerves that communicate messages between the central nervous system and the rest of the body compose the peripheral nervous system.

The transmission of a nerve impulse along a neuron from one end to the other occurs as a result of electrical changes across the membrane of the neuron. The membrane of an unstimulated neuron is polarized—that is, there is a difference in electrical charge between the outside and inside of the membrane. The inside is negative with respect to the outside.

Polarization is established by maintaining an excess of sodium ions (Na^+) on the outside and an excess of potassium ions (K^+) on the inside. A certain amount of Na^+ and K^+ is always leaking across the membrane through leakage channels, but Na^+/K^+ pumps in the membrane actively restore the ions to the appropriate side.

The main contribution to the resting membrane potential (a polarized nerve) is the difference in permeability of the resting membrane to potassium ions versus sodium ions. The resting membrane is much more permeable to potassium ions than to sodium ions resulting in slightly more net potassium ion diffusion (from the inside of the neuron to the outside) than sodium ion diffusion (from the outside of the neuron to the inside) causing the slight difference in polarity right along the membrane of the axon.

The following events characterize the transmission of a nerve impulse:

•**Resting potential:** The resting potential describes the unstimulated, polarized state of a neuron (at about –70 millivolts).

•**Graded potential.** A graded potential is a change in the resting potential of the plasma membrane in the response to a stimulus. A graded potential occurs when the stimulus causes Na^+ or K^+ gated channels to open. If Na^+ channels open, positive sodium ions enter, and the membrane depolarizes (becomes more positive). If the stimulus opens K^+ channels, then positive potassium ions exit across the membrane and the membrane hyperpolarizes (becomes more negative). A graded potential is a local event that does not travel far from its origin. Graded potentials occur in cell bodies and dendrites. Light, heat, mechanical pressure, and chemicals, such as neurotransmitters, are examples of stimuli that may generate a graded potential (depending upon the neuron).

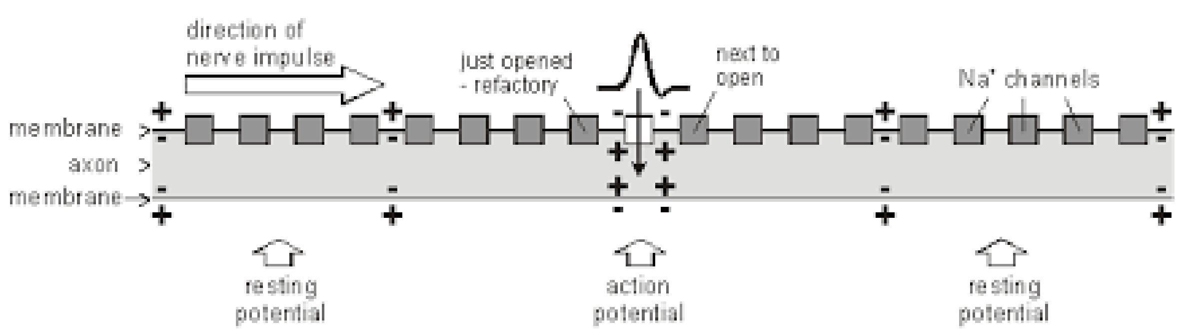
The following four steps describe the initiation of an impulse to the “resetting” of a neuron to prepare for a second stimulation:

1. Action potential: Unlike a graded potential, an action potential is capable of traveling long distances. If a depolarizing graded potential is sufficiently large, Na^+ channels in the trigger zone open. In response, Na^+ on the outside of the membrane becomes depolarized (as in a graded potential). If the stimulus is strong enough—that is, if it is above a certain threshold level—additional Na + gates open, increasing the flow of Na + even more, causing an action potential, or complete depolarization (from –70 to about +30 millivolts). This in turn stimulates neighboring Na + gates, farther down the axon, to open. In this manner, the action potential travels down the length of the axon as opened Na + gates stimulate neighboring Na + gates to open. The action potential is an all-or-nothing event: When the stimulus fails to produce depolarization that exceeds the threshold value, no action potential results, but when threshold potential is exceeded, complete depolarization occurs.

2. Repolarization. In response to the inflow of Na +, K + channels open, this time allowing K + on the inside to rush out of the cell. The movement of K + out of the cell causes repolarization by restoring the original membrane polarization. Unlike the resting potential, however, in repolarization the K + are on the outside and the Na + are on the inside. Soon after the K + gates open, the Na + gates close.

3. Hyperpolarization. By the time the K + channels close, more K + have moved out of the cell than is actually necessary to establish the original polarized potential. Thus, the membrane becomes hyperpolarized (about –80 millivolts).

4. Refractory period. With the passage of the action potential, the cell membrane is in an unusual state of affairs. The membrane is polarized, but the Na + and K + are on the wrong sides of the membrane. During this refractory period, the axon will not respond to a new stimulus. To reestablish the original distribution of these ions, the Na + and K + are returned to their resting potential location by Na +/K + pumps in the cell membrane. Once these ions are completely returned to their resting potential location, the neuron is ready for another stimulus.



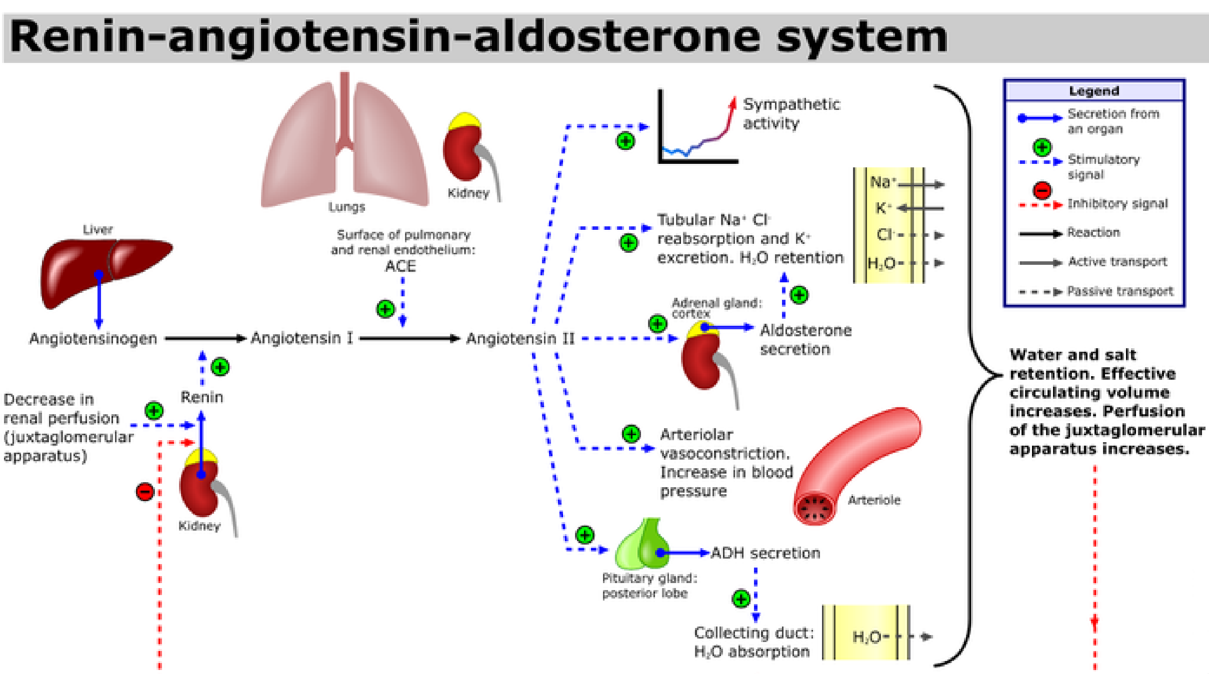
6) Give an account on the regulation of excretion.

Answer:

Regulation of excretion by hormone secretion:

Direct control of water excretion in the kidneys is exercised by the anti-diuretic hormone (ADH), released by the posterior lobe of the pituitary gland. ADH causes the insertion of water channels into the membranes of cells lining the collecting ducts, allowing water reabsorption to occur. Without ADH, little water is reabsorbed in the collecting ducts and dilute urine is excreted. There are several factors that influence the secretion of ADH. The first of these happen when the blood plasma gets too concentrated. When this occurs, special receptors in the hypothalamus release ADH. When blood pressure falls, stretch receptors in the aorta and carotid arteries stimulate ADH secretion to increase volume of the blood.

The Kidneys also regulate the salt balance in the blood by controlling the excretion and the reabsorption of various ions. As noted above, ADH plays a role in increasing water reabsorption in the kidneys, thus helping to dilute bodily fluids. The kidneys also have a regulated mechanism for reabsorbing sodium in the distal nephron. This mechanism is controlled by aldosterone, a steroid hormone produced by the adrenal cortex. Aldosterone promotes the excretion of potassium ions and the reabsorption of sodium ions. The release of Aldosterone is initiated by the kidneys. The juxtaglomerular apparatus is a renal structure consisting of the macula densa, mesangial cells, and juxtaglomerular cells. Juxtaglomerular cells (JG cells, also known as granular cells) are the site of renin secretion. Renin is an enzyme that converts angiotensinogen (a large plasma protein produced by the liver) into Angiotensin I and eventually into Angiotensin II which stimulates the adrenal cortex to produce aldosterone. The reabsorption of sodium ions is followed by the reapsorption of water. This causes blood pressure as well as blood volume to increase.



The kidneys secrete a variety of hormones, including erythropoietin, and the enzyme renin. Erythropoietin is released in response to hypoxia (low levels of oxygen at tissue level) in the renal circulation. It stimulates erythropoiesis (production of red blood cells) in the bone marrow. Calcitriol, the activated form of vitamin D, promotes intestinal absorption of calcium and the renal reabsorption of phosphate. Part of the renin-angiotensin-aldosterone system, renin is an enzyme involved in the regulation of aldosterone levels.

Atrial natriuretic hormone (ANH) is released by the atria of the heart when cardiac cells are stretched due to increased blood volume. ANH inhibits the secretion of renin by the juxtaglomerular apparatus and the secretion of the aldosterone by the adrenal cortex. This promotes the excretion of sodium. When sodium is excreted so is water. This causes blood pressure and volume to decrease.

7) Write short notes on any two:

- **a. External structure of heart**
- **b. Balanced diet**
- **c. Nephrons**

Balanced diet

A balanced diet is one which contains different types of blood in such quantities and proportions so that the need for calories, protein, mineral vitamin and other nutrients are adequately met. Diet requirement bases on the basis of age and gender. The daily requirement of individual diet depends upon the growth status, physical activity and physical stress or illness. A balanced diet has a major role in achieving long healthy life.

1. It helps in controlling body weight, heart rate and blood pressure.
2. Increase in exercise capacity and muscle performance.
3. Improves blood system, lowers harmful cholesterol and triglyceride and increases the beneficial HDL cholesterol.
4. Produces mental and physical relaxation.

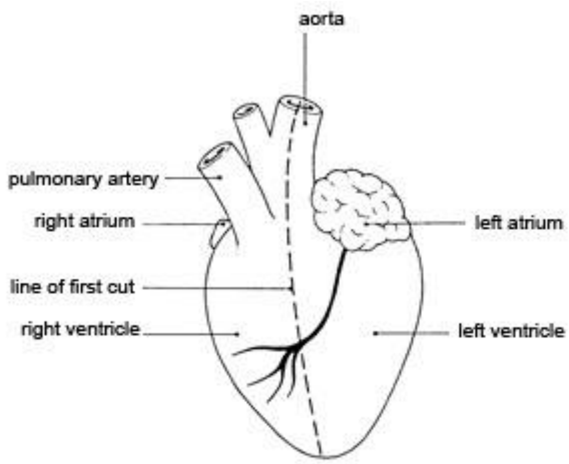
Energy expenditure for work:

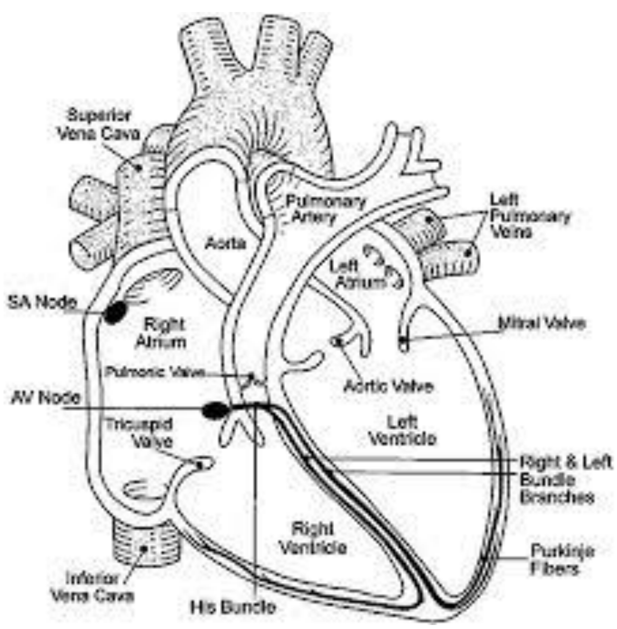
Additional energy is required for the performance of daily work
Light work: 1.7 cal/K/hour
Moderate work: 2.7 cal/K/hour
Heavy work: 5.2 cal/K/hour

Calories requirement:

	Work	Man	Woman
1	Sedentary work	2400	1900
2	Moderate work	2800	2200
3	Heavy work	3900	3000
4	Pregnancy	-	3000
5	Lactation period	-	3700

External structure of heart





Nephron

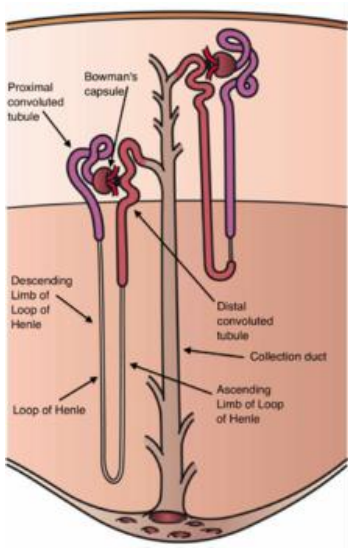
Nephron is the basic structural and functional unit of the kidney. Its chief function is to regulate the concentration of water and soluble substances like sodium salts by filtering the blood, reabsorbing what is needed and excreting the rest as urine. A nephron eliminates wastes from the body, regulates blood volume and blood pressure, controls levels of electrolytes and metabolites, and regulates blood pH. Its functions are vital to life and are regulated by the endocrine system by hormones such as antidiuretic hormone, aldosterone, and parathyroid hormone. In humans, a normal kidney contains 800,000 to 1.5 million nephrons.

Two general classes of nephrons are cortical nephrons and juxtamedullary nephrons. Nephrons are classified according to the length of their associated Loop of Henle and location of their renal corpuscle. All nephrons have their renal corpuscles in the cortex.

Cortical nephrons have their Loop of Henle in the renal medulla near its junction with the renal cortex.

Loop of Henle of juxtamedullary nephrons is located deep in the renal medulla; they are called *juxtamedullary* because their renal corpuscle is located near the medulla.

The majority of nephrons are cortical. Cortical nephrons have a shorter loop of Henle compared to juxtamedullary nephrons. The longer loop of Henle in juxtamedullary nephrons create a hyperosmolar gradient that allows for the creation of concentrated urine.[4]



Kidney nephron drawing with labels of the following: the Bowman's capsule, proximal convoluted tubule, loop of Henle, descending limb of loop of Henle, ascending limb of loop of Henle, distal convoluted tubule, and collecting duct. Each nephron is composed of an initial filtering component (the "renal corpuscle") and a tubule specialized for reabsorption and secretion (the "renal tubule"). The renal corpuscle filters out solutes from the blood, delivering water and small solutes to the renal tubule for modification.