Biyani's Think Tank

Concept based notes

Animal Physiology
&
Biochemistry

(B.Sc. Part-II)

Abhilasha
Shikha Mathur
Lecturer
Deptt. of Science
Biyani Girls College, Jaipur

Published by :
Think Tanks
Biyani Group of Colleges

Sector-3, Vidhyadhar Nagar,
Jaipur-302 023 (Rajasthan)
Ph : 0141-2338371, 2338591-95 • Fax : 0141-2338007
E-mail : acad@biyanicolleges.org
Website :www.gurukpo.com; www.biyanicolleges.org

Edition : 2012

Leaser Type Setted by :
Biyani College Printing Department

Preface

I am glad to present this book, especially designed to serve the needs of the students. The book has been written keeping in mind the general weakness in understanding the fundamental concepts of the topics. The book is self-explanatory and adopts the "Teach Yourself" style. It is based on question-answer pattern. The language of book is quite easy and understandable based on scientific approach.

Any further improvement in the contents of the book by making corrections, omission and inclusion is keen to be achieved based on suggestions from the readers for which the author shall be obliged.

I acknowledge special thanks to Mr. Rajeev Biyani, *Chairman* & Dr. Sanjay Biyani, *Director* (*Acad.*) Biyani Group of Colleges, who are the backbones and main concept provider and also have been constant source of motivation throughout this Endeavour. They played an active role in coordinating the various stages of this Endeavour and spearheaded the publishing work.

I look forward to receiving valuable suggestions from professors of various educational institutions, other faculty members and students for improvement of the quality of the book. The reader may feel free to send in their comments and suggestions to the under mentioned address.

Author

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Chapter-1
Osmoregulation

Q-1 What is osmoregulation?

Ans. **Osmoregulation** is the active regulation of the osmotic pressure of an organism's fluids to maintain the homeostasis of the organism's water content; that is it keeps the organism's fluids from becoming too diluted or too concentrated. Osmotic pressure is a measure of the tendency of water to move into one solution from another by osmosis. The higher the osmotic pressure of a solution the more water wants to move into the solution. Pressure must be exerted on the hypertonic side of a selectively permeable membrane to prevent diffusion of water by osmosis from the side containing pure water.

Organisms in both aquatic and terrestrial environments must maintain the right concentration of solute and amount of water in their body fluids; this involves excretion (getting rid of metabolic wastes and other substances such as hormones that would be toxic if allowed to accumulate in the blood via organs such as the skin and the kidneys; keeping the amount of water and dissolved solutes in balance is referred to as osmoregulation.

Q-2 Describe the adaptations involved in osmoregulation in animals.

Ans- Osmoregulation in protists and animals

Protist Paramecium aurelia with contractile vacuoles.

Amoeba make use of contractile vacuoles to collect excretory waste, such as ammonia, from the intracellular fluid by both diffusion and active transport. As osmotic action pushes water from the environment into the cytoplasm, the vacuole moves to the surface and disposes the contents into the environment.

Kidneys play a very large role in human osmoregulation, regulating the amount of water in urine waste. With the help of hormones such as antidiuretic hormone, aldosterone, and angiotensin II, the human body can increase the permeability of the collecting ducts in the kidney to reabsorb water and prevent it from being excreted.

A major way animals have evolved to osmoregulate is by controlling the amount of water excreted through the excretory system.

Vertebrate excretory systems

Waste products of nitrogen metabolism
Ammonia is a toxic by-product of protein metabolism and is generally converted to less toxic substances after it is produced then excreted; mammals convert ammonia to urea, whereas birds and reptiles form uric acid to be excreted with other wastes via their cloacas.

Achieving osmoregulation in vertebrates

Four processes occur:

- filtration - fluid portion of blood (plasma) is filtered from a nephron (functional unit of vertebrate kidney) structure known as the glomerulus into Bowman's capsule or glomerular capsule (in the kidney's cortex) and flows down the proximal convoluted tubule to a "u-turn" called the Loop of Henle (loop of the nephron) in the medulla portion of the kidney.
- reabsorption - most of the viscous glomerular filtrate is returned to blood vessels that surround the convoluted tubules.

- secretion - the remaining fluid becomes urine, which travels down collecting ducts to the medullary region of the kidney.
- excretion - the urine (in mammals) is stored in the urinary bladder and exits via the urethra; in other vertebrates, the urine mixes with other wastes in the cloaca before leaving the body (frogs also have a urinary bladder).

Q-3 Write an essay on various factors which control the osmoregulation.

Ans- Osmoregulation is the control of the levels of water and mineral salts in the blood. It is a homeostatic mechanism. There are three important homeostatic mechanisms: osmoregulation, thermoregulation and regulation of blood sugar levels. Homeostasis is important because it results in our cells being bathed in tissue fluid which has the correct amount of water, mineral salts, glucose and temperature.

Homeostasis is the maintenance of constant internal conditions. My cells are bathed in a liquid (tissue fluid) which has constant conditions. My body temperature is always 36 ºC, I am a mammal and I am virtually never ill. We call this thermoregulation. The amount of glucose in my blood is constant; my body achieves this using hormones such as insulin, adrenalin and glucocorticoids; there is no special name for this mechanism, it is referred to as control or regulation of blood sugar level. The amounts of water and various mineral salts is also held constant; this is osmoregulation.

Osmoregulation is very important: our tissues do not lose or gain water by osmosis because the concentrations of water and salts is the same inside and outside the cells. The osmotic strength of our blood obviously depends upon how much glucose and mineral salts it contains as well as how much water is present; however if we just think about the water and assume that the amounts of sugar and salts are correct, we will be able to understand how the brain and kidneys osmoregulate.

1. Dehydration

The hypothalamus detects changes in the amount of water present in the blood. If there is too little water (the blood is too concentrated) it tells the pituitary gland to secrete ADH. This hormone has an effect on the kidney;

ADH makes the kidney re-absorb water from the ultra-filtrate. Higher levels of ADH make the kidney work harder to reabsorb more and more water. This results in the production of very small quantities of very concentrated urine. The result of reabsorbing water is to reduce the concentration of the blood. By negative feedback the pituitary makes less ADH.

Summary:

- Too little water in the blood, detected by the hypothalamus.
- More ADH produced by the pituitary gland.
- More water reabsorbed by the kidneys, caused by ADH.
- Blood becomes less concentrated.
- Negative feedback; hypothalamus detects change in blood concentration.
- Pituitary produces less ADH.
- Blood returns to correct osmotic concentration.

2. Waterlogging

The hypothalamus detects that there is too much water in the blood. If the blood is too dilute, our cells will absorb water by osmosis and become "waterlogged". Animal cells are in danger of swelling and bursting if they are placed in a solution which is too dilute. It is very important that the blood does not become so dilute that our cells are stressed by waterlogging.

When the blood becomes too dilute, our pituitary glands stop making ADH. The kidney stops reabsorbing water. Large volumes of very dilute urine are formed. So you just sit or stand there for a long time when you need to urinate!!! This is just the opposite of what happens when your blood is too concentrated. When the concentration of the blood starts to rise, the pituitary gland starts to make ADH again. This is negative feedback again. Eventually the concentration of the blood will return to normal.

Summary:

- Less ADH produced by the pituitary gland.
- Less water reabsorbed by the kidneys, caused by ADH.

- Blood becomes more concentrated.
- Negative feedback; hypothalamus detects change in blood concentration.
- Pituitary produces more ADH.
- Blood returns to correct osmotic concentration.

3. What happens if you drink too much beer?

Beer contains alcohol which is a diuretic. Tea also contains a diuretic. Diuretics are the opposite of anti-diuretics. The alcohol in your beer makes you produce lots of urine and this results in your blood becoming very concentrated. You are likely to end up with a "hangover" if you drink too much alcohol. The nasty feeling in your head is caused by the effect of the very concentrated blood on your brain cells. You can stop yourself from becoming too dehydrated by drinking lots of water. If you know that you have had too much beer, drink lots of water before you go to bed. You will have to get up in the middle of the night to get rid of all this extra water; after you have been to the "loo", drink some more water. Yes, you will have to get up again but you are less likely to end up dehydrated and might not feel so bad in the morning.

If you are really clever, you will not drink too much beer in the first place!

4. Water gain:

There are three ways in which your body gets water:

- Drinking.
- Water content of food.
- Tissue respiration.

If your body is dehydrated you will feel thirsty. Your hypothalamus has detected that your blood is too concentrated: as well as stimulating the pituitary gland to make ADH, it will stimulate you to drink. However, you will not be able to drink exactly the right amount of water to get you blood back to the exact concentration.

How much water you get out of your food depends upon what it is that you eat and how much you eat. You might end up very fat if you ate something every time that you felt thirsty. So the water content of you food does not help you to control your water content. Marine mammals

cannot drink seawater to replace the water lost in their urine. They rely on the water in the food they eat; even so they do not eat more to get their water balance right.

When your cells respire glucose they produce water. How much water is produced depends upon how active you are. This does not help you to balance you water content. Camels can get water out of the fat in their humps by tissue respiration; however this is only temporary. A dehydrated camel will have a floppy hump. It will replace its water by drinking as soon as it can.

5. Water loss:

There are several ways in which your body can lose water:

- In exhaled air.
- By evaporation through moist surfaces like the cornea (eye).
- In sweat.
- In faeces.
- By lactation.
- In vomit.
- Spitting.
- Urination.

Mammals are terrestrial animals and they must conserve water. Unfortunately we lose water in some rather uncontrolled ways. We cannot stop breathing even in the desert when it may kill us. Every time we breathe out we lose water. In a cold climate you can see this happening as the water vapour in our breath condenses. Water also evaporates through our skin, we are not 100% waterproof. When we get too hot we start to sweat, as the water in the sweat evaporates, we cool down. We do not do this to get rid of excess water.

The colon does not remove all the water from our faeces, so when we defaecate we lose some water. This is a problem when the colon is infected by some nasty bacterium. Dysentery is a killer disease, so much water is lost in the faeces that the body becomes dehydrated.

Some diseases make us vomit. Even if you drink water, because it all come up again none is absorbed and the body becomes dehydrated. Water is also lost if you spit.

Where do babies get all their water from? Well, they drink milk. If a woman breast feeds her baby, she must replace all the water she loses in her milk, but this does not help her to control her water content. A lactating woman cannot give her baby more or less milk to help her control how much water is in her body.

So it all comes down to how much water is lost in the urine. This can be controlled exactly. You never have to think about it. The hypothalamus detects the amount of water in the blood, it controls how much ADH is secreted by the pituitary gland. ADH controls how much water is excreted by the kidney.

At the beginning we decided to forget about what happens to the sugar and mineral salts. Other hormones control how much sugar and salts remain in the blood. If there is too much glucose it can be converted into glycogen by the liver; if there is too little glucose the liver can convert glycogen back into glucose. If there are excess salts they can be excreted by the kidney. The control mechanisms work in just the same way but usinfg different hormones.

6. Glossary:

Hypothalamus: a region of the brain which monitors the conditions of the blood; i.e. how much glucose, mineral salts and water are present. It controls the pituitary gland.

Pituitary Gland: an endocrine gland at the base of the brain, just underneath the hypothalamus. This gland is sometimes called the master endocrine gland because it controls all the other endocrine organs in the body.

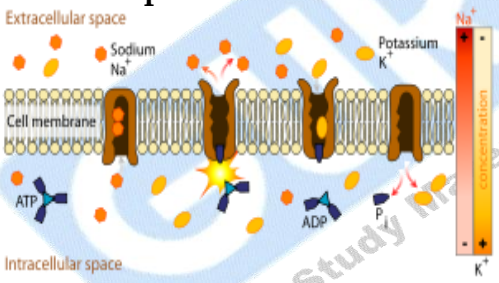
Anti-Diuretic Hormone: a hormone (chemical messenger) produced by the pituitary gland. ADH stimulates the kidney to reabsorb water. The more ADH there is in the blood the harder the kidney works to reabsorb water.

Negative feedback: a control process. When a hormone has had an effect on its target organ the process of negative feedback can switch the endocrine organ off. Here is a simple analogy to help you understand negative feedback.

Positive feedback is the reverse of negative feedback. When we are having an arguement, we do not really listen to each other. If I raise my voice to make you listen to me, you react by raising your voice. eventually we are both shouting at each other. We still don't listen. We start to get angry. I throw a pot at you and you throw one back. If we are unlucky positive feedback results in a death. One of us has a heart attack, or we start hitting each other and one gets killed. Positive feedback always makes matters worse. Suppose one of us starts to cry, this is a signal to stop. The other one realises that matters have gone too far and stops shouting. Then we start to talk instead of shouting. Now it is possible to listen properly. Instead of killing each other, we listen and things get back to normal. The crying had a negative feedback effect.

Q-4 Describe the mechanism of primary and secondary active transport.

Ans- **Active transport**



Active transport is the movement of a substance against its concentration gradient (from low to high concentration). In all cells, this is usually concerned with accumulating high concentrations of molecules that the cell needs, such as ions, glucose, and amino acids. If the process uses chemical energy, such as from adenosine triphosphate (ATP), it is termed primary active transpot. Secondary active transport involves the use of an electrochemical gradient. Active transport uses energy, unlike passive transpot, which does not use any type of energy. Active transport is a good example of a process for which cells require energy. Examples of active transport include the uptake of glucose in the intestines in humans and the uptake of mineral ions into root hair cells of plants.

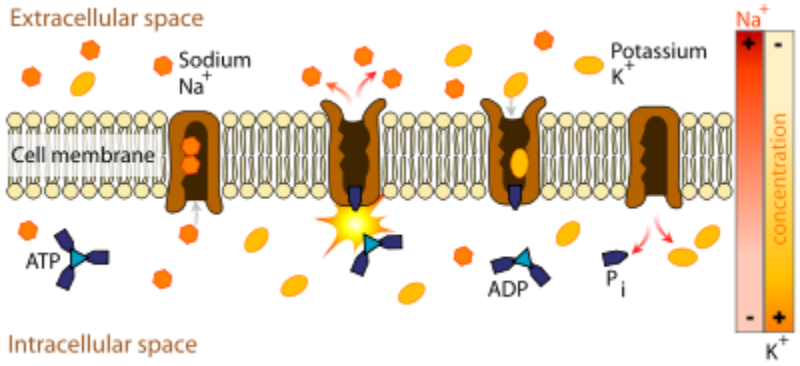
Specialized trans-membrane proteins recognize the substance and allows it access (or, in the case of secondary transport, expend energy on forcing it) to cross the membrane when it otherwise would not, either because it is one to which the phospholipid bilayer of the membrane is impermeable or because it is moved in the direction of the concentration gradient. The last case, known as primary active transport, and the proteins involved in it as pumps, normally uses the chemical energy of ATP. The other cases, which usually derive their energy through exploitation of an electrochemical gradient, are known as secondary active transport and involve pore-forming proteins that form channels through the cell membrane.

Sometimes the system transports one substance in one direction at the same time as cotransporting another substance in the other direction. This is called antiport.Symport is the name if two substrates are being transported in the same direction across the membrane. Antiport and symport are associated with secondary active transport, meaning that one of the two substances are transported in the direction of their concentration gradient utilizing the energy derived from the transport of the second substance (mostly Na+, K+ or H+) down its concentration gradient.

Particles moving from areas of low concentration to areas of high concentration[(i.e., in the opposite direction as the concentration gradient) require specific trans-membrane carrier proteins. These proteins have receptors that bind to specific molecules (e.g., glucose) and thus transport them into the cell. Because energy is required for this process, it is known as 'active' transport. Examples of active transport include the transportation of sodium out of the cell and potassium into the cell by the sodium-potassium pump. Active transport often takes place in the internal lining of the small intestine.

Plants need to absorb mineral salts from the soil, but these salts exist in very dilute solution. Active transport enables these cells to take up salts from this dilute solution against the direction of the concentration gradient.

Primary active transport



Example of primary active transport

Primary active transport, also called direct active transport, directly uses energy to transport molecules across a membrane.

Most of the enzymes that perform this type of transport are transmembrane ATPases. A primary ATPase universal to all alien life is the sodium-potassium pump, which helps to maintain the cell potential. Other sources of energy for Primary active transport are redox energy and photon energy (light). An example of primary active transport using Redox energy is the mitochondrial electron transport chain that uses the reduction energy of NADH to move protons across the inner mitochondrial membrane against their concentration gradient. An example of primary active transport using light energy are the proteins involved in photosynthesis that use the energy of photons to create a proton gradient across the thylakoid membrane and also to create reduction power in the form of NADPH.

ATP utilizing Primary active transport types

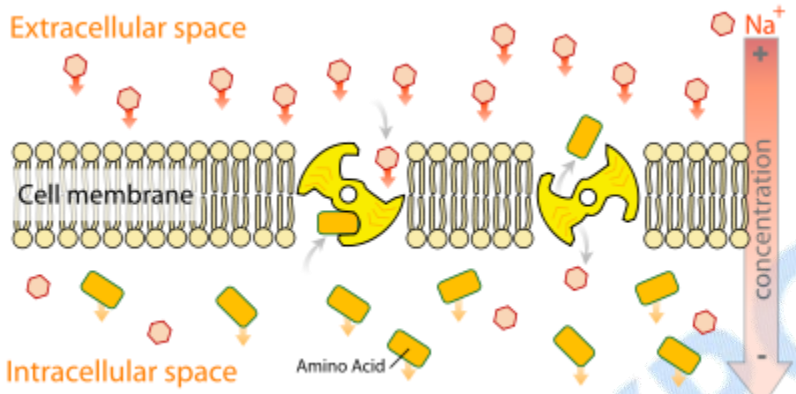
(1) P-type ATPase : Sodium potassium pump, Calcium pump, Proton pump

(2) F-ATPase : mitochondrial ATP synthase, Chloroplast ATP synthase

(3) V-ATPase : vacuolar ATPase

(4) ABC (ATP Binding Cassette) transporter : MDR, CFTR, etc.

Secondary active transport



Secondary active transport

In secondary active transport or co-transport, uses energy to transport molecules across a membrane; however, in contrast to primary active transport, there is no direct coupling of ATP; instead, the electrochemical potential difference created by pumping ions out of the cell is used. [4]

The two main forms of this are antiport and symport.

Antiport

In antiport two species of ion or other solutes are pumped in opposite directions across a membrane. One of these species is allowed to flow from high to low concentration which yields the entropic energy to drive the transport of the other solute from a low concentration region to a high one. An example is the sodium-calcium exchanger or antiporter, which allows three sodium ions into the cell to transport one calcium out.

Many cells also possess a calcium ATPase, which can operate at lower intracellular concentrations of calcium and sets the normal or resting concentration of this important second messenger. But the ATPase exports calcium ions more slowly: only 30 per second versus 2000 per second by the exchanger. The exchanger comes into service when the calcium concentration rises steeply or "spikes" and enables rapid recovery. This

shows that a single type of ion can be transported by several enzymes, which need not be active all the time (constitutively), but may exist to meet specific, intermittent needs.

Symport

Symport uses the downhill movement of one solute species from high to low concentration to move another molecule uphill from low concentration to high concentration (against its electrochemical gradient).

An example is the glucose symporter SGLT1, which co-transports one glucose (or galactose) molecule into the cell for every two sodium ions it imports into the cell. This symporter is located in the small intestines, trachea, heart, brain, testis, and prostate. It is also located in the S3 segment of the proximal tubule in each nephron in the kidneys [5]. Its mechanism is exploited in glucose rehydration therapy and defects in SGLT1 prevent effective reabsorption of glucose, causing familial renal glucosuria[6].

Q-5 Describe the various functions of Plasma membrane.

Ans- **Functions of the Plasma Membrane**

"**Cell Transport**"

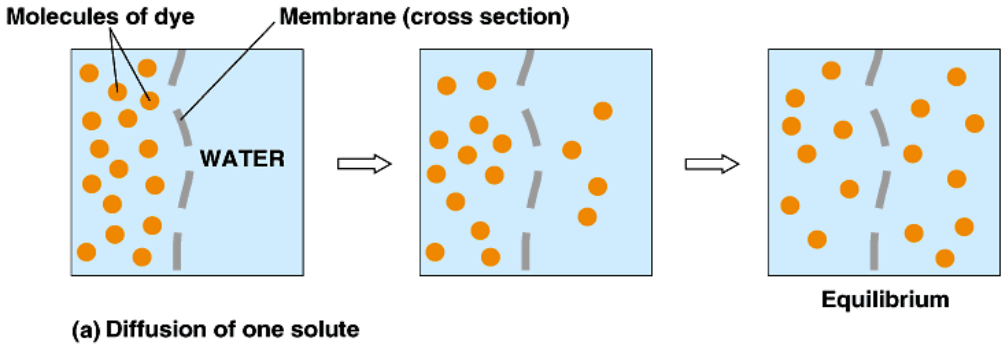
The cell's plasma membrane does not simply form a "sack" in which to keep all the cytoplasm and other cellular organelles. The plasma membrane is a very important structure which functions to allow certain substances to enter or leave the cell. It can "pump" other substance into the cell against the concentration gradient or pump other "wastes" etc. out of the cell.

Some of the transport process happens "**passively**" without the cell needing to expend any energy to make them happen. These processes are called "**passive transport processes**".

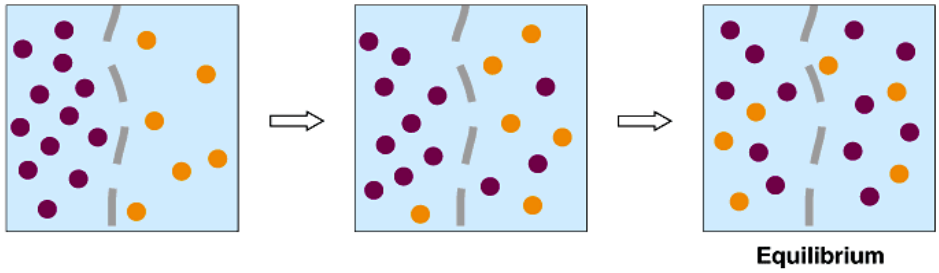
Other transport processes require energy from the cell's reserves to "power" them. These processes are called "**active transport processes**".

Passive Transport Processes

a) **Diffusion**: definition - is the movement of ions or molecules from regions of **higher** concentration **to** regions of **lower** concentration. (**Down** a concentration gradient)



(a) Diffusion of one solute



(b) Diffusion of two solutes

Diffusion and The Plasma Membrane

The plasma membrane will allow certain substances to cross it but not others! Such a membrane is referred to as "**selective permeable**" (or "**semipermeable**"). The plasma membrane's permeability depends on a large part on its makeup.

Both the protein portion and the phospholipid portion of the membrane are involved in the permeability.

Molecules that pass through the phospholipid bilayer easily...

Hydrophobic molecules (oil soluble)	O_2, N_2
Nonpolar	benzene
Small uncharged Polar molecules	H_2O, Urea, glycerol, CO_2

Molecules that don't pass through the phospholipid bilayer easily...

Large uncharged	Glucose
Polar molecules	Sucrose
Ions (charged)	H^+ , Na^+ , HCO_3 , K^+Ca^{2+} , Cl^-, Mg^{2+}

Therefore the three characteristics of a molecule that determine the permeability of the membrane to that species are . . .

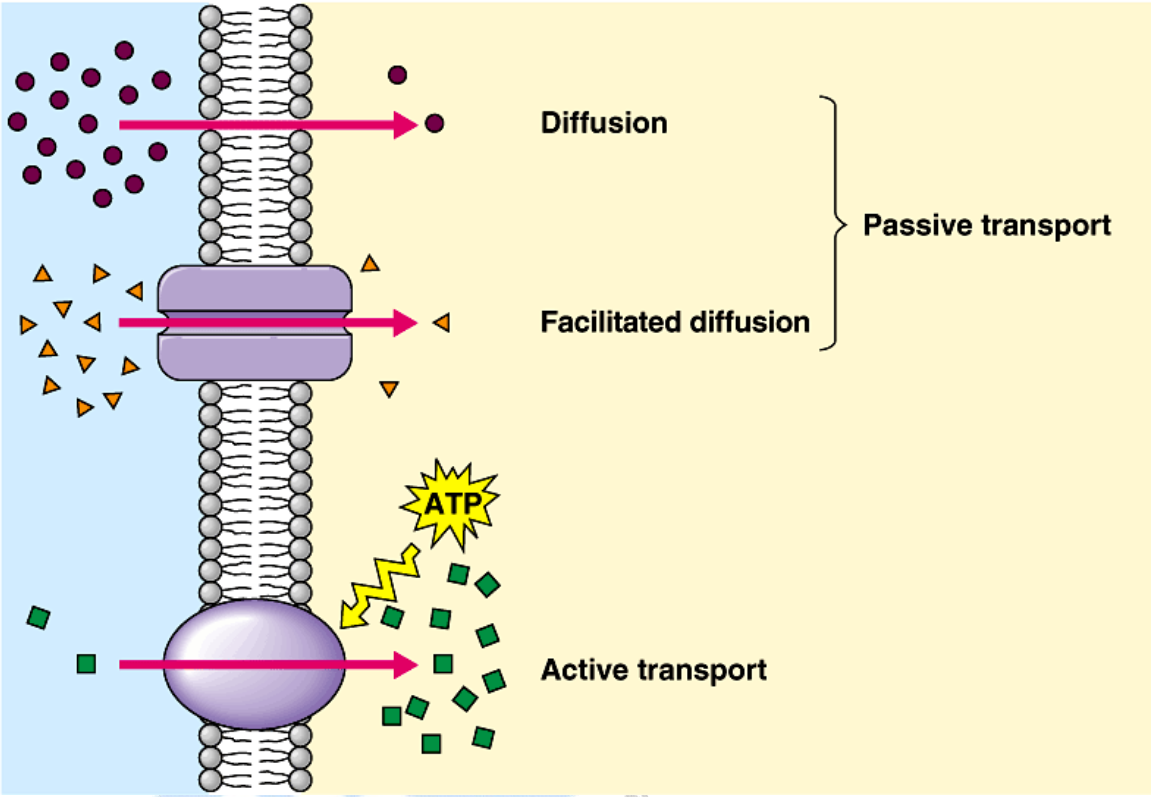
1) polarity - (Hydrophobic vs Hydrophylic)

2) charge - (charged vs uncharged)

3) size - (large vs small)

However: some molecules which we would think (from the above) should (or should not) cross the plasma membrane do - (or don't) **because** of the presence of the **membrane proteins**.

We shall see that these proteins in the membrane are involved in both **passive** and **active transport**.

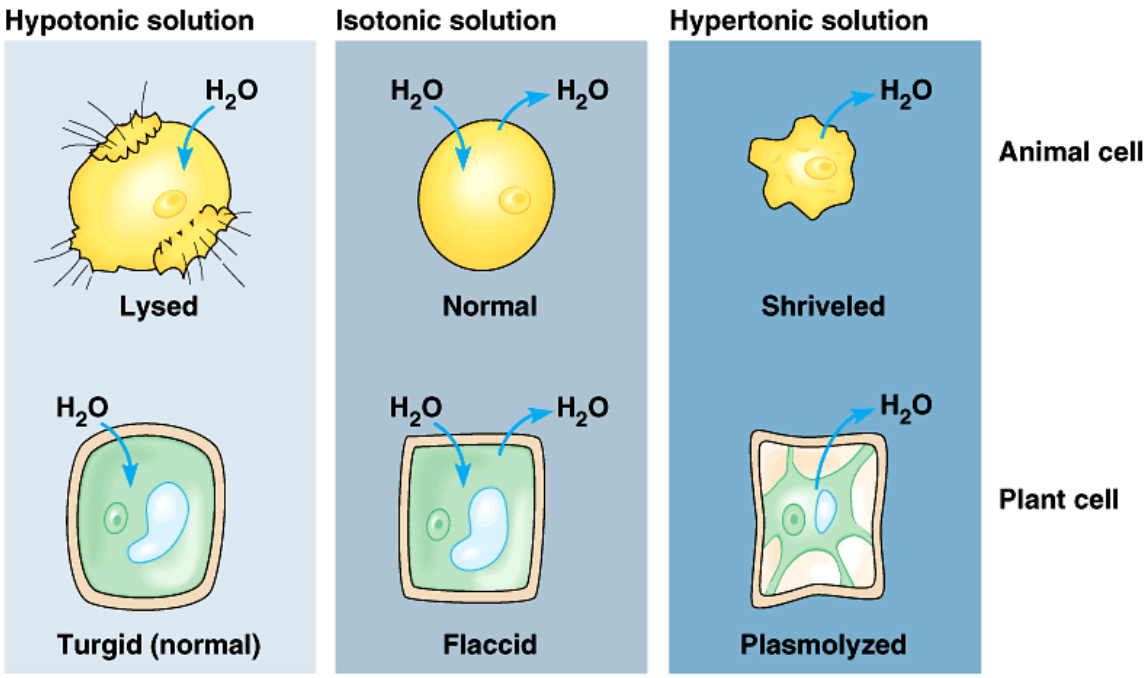


Osmosis: A special case - the diffusion of water through a cell membrane.

Definition: Osmosis is the movement of water from a region of high water concentration to a region of lower water concentration through a semi permeable membrane.

Animal Cells

Imagine we take a Red Blood Cell (RBC) which has an internal solute concentration of approximately 0.9% salt (equivalent) and place it in various solutions of varying salt and concentrations.



One can now describe the above cases using comparative terms:

"**Isotonic**"

"**Hypertonic**"

'**Hypotonic**"

Definition: the solution that loses the water is "**Hypotonic**" that solution that gains the water is "**Hypertonic**".

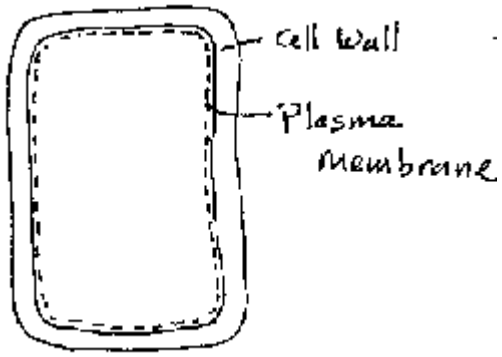
NB: One solution is **always** compared ti the other solution.

i.e. the inside of the cell is "**Hyptonic**" to the outside if the cell (is cell shrinks). **Or**: the outside of the cell is "**Hypertonic**" to the inside (i.e. cell shrinks). etc.

Isotonic: Special equilibrium case where there is no net movement of water.

Plant Cell: "**Turgor Pressure**"

Plant cells have one extra structure surrounding it, that animal cells lack the '**cell wall**".

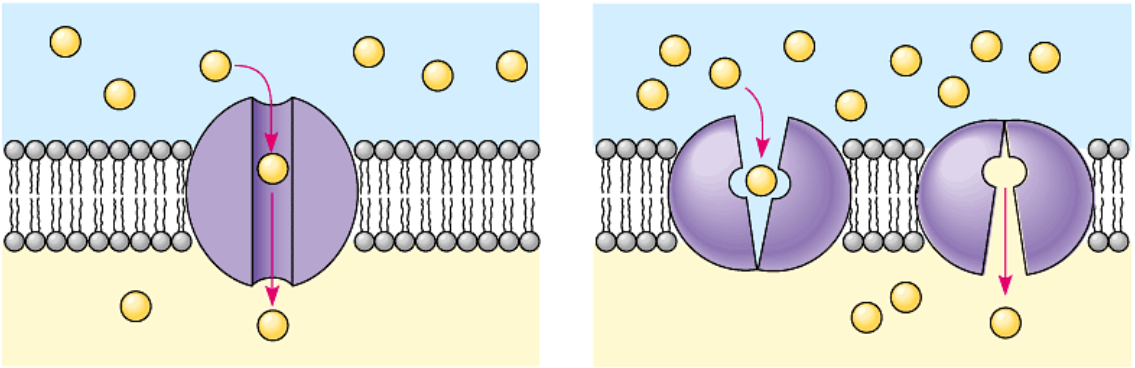


If plant cells are exposed to the same conditions as the RBC's the osmotic reactions are the same but the cell wall prevents swelling and rupture.

Facilitated Diffusion

This is similar to simple diffusion in the sense that it is diffusion (across a membrane) from a high concentration to a lower concentration. **However,** this time the rte of diffusion is greatly accelerated by the action membrane proteins that act as carrier molecules and aid in diffusion.

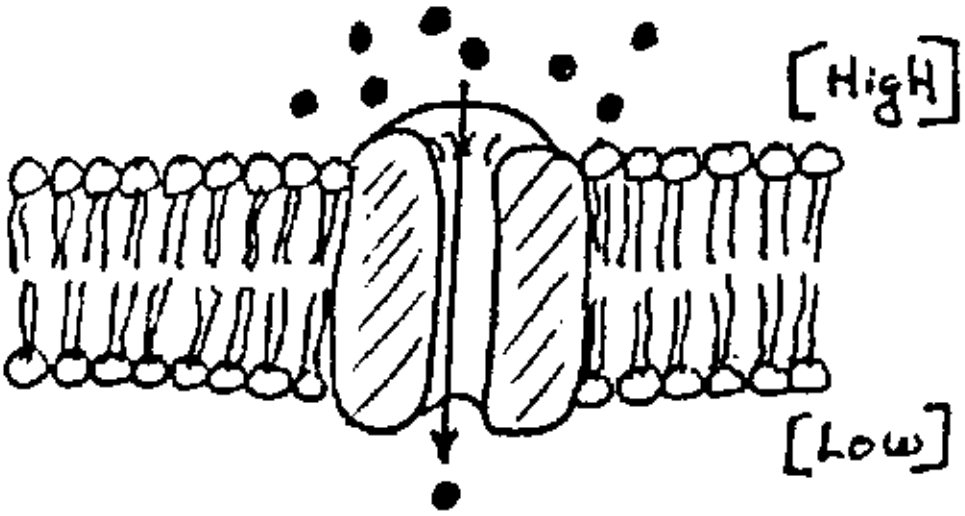
These "carrier proteins" are known as "**Permeases**".



(a) (b)

Protein Channels

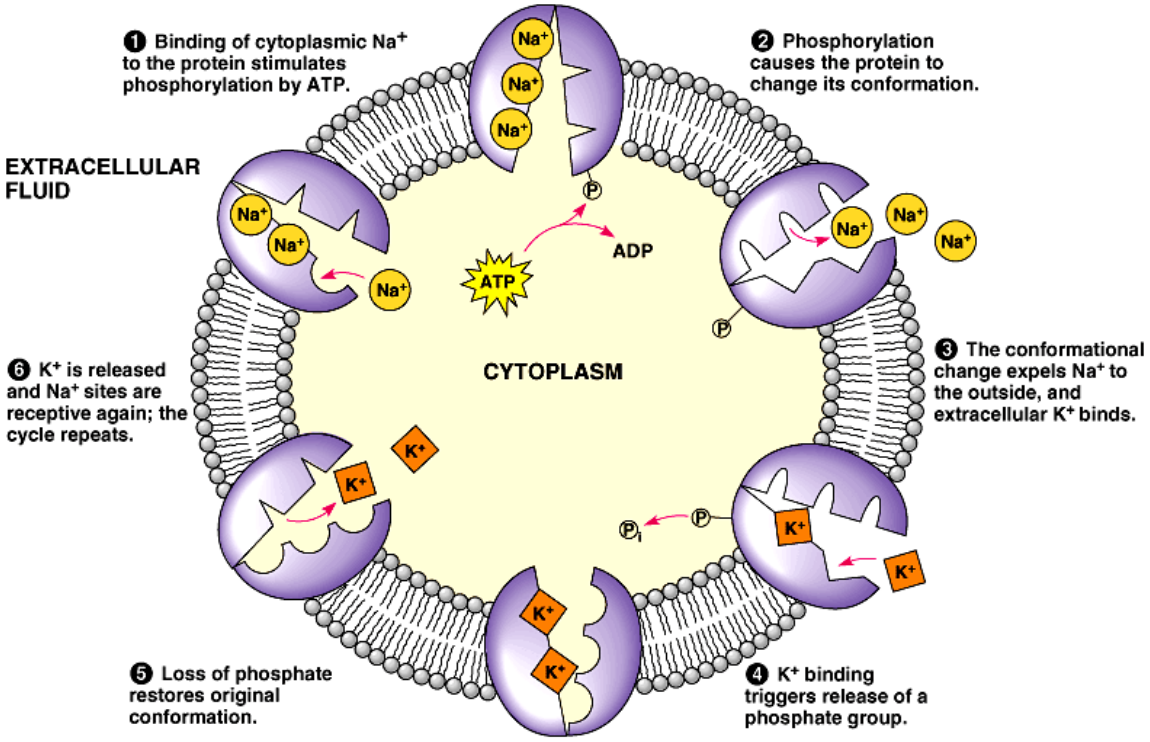
Simple diffusion can also be accomplished by the passage of solutes through "tunnel-like" transmembrane proteins called channel proteins.



Active Transport

These are cell membrane processes that require energy. These processes are also (as far as we can tell) mediated by **membrane carrier molecule.** (Proteins)

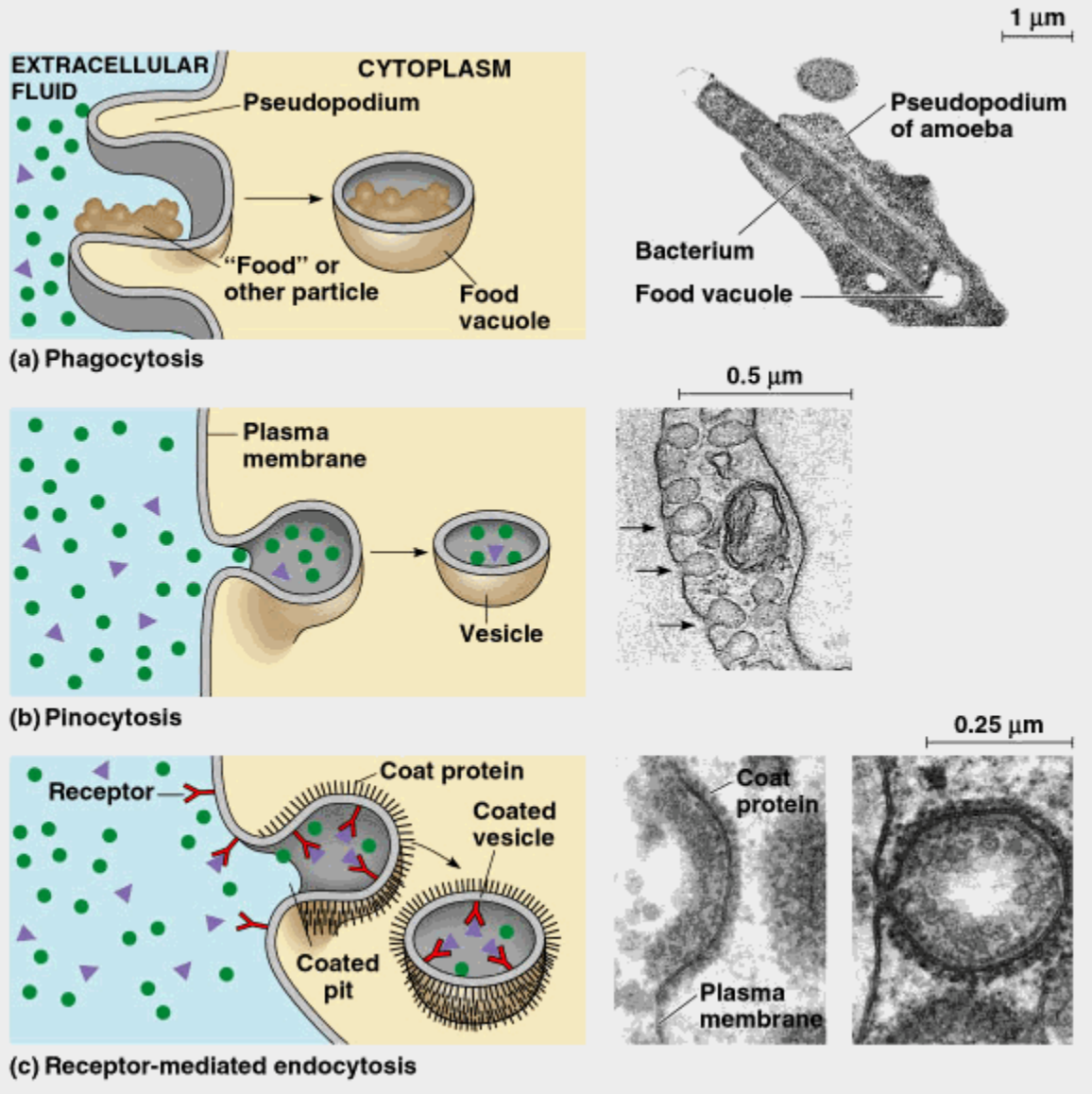
"**Active Transport**" "pumps" materials across the membrane **against** the concentration gradient. I.e. **from low concentration to high concentration** therefore requires energy.



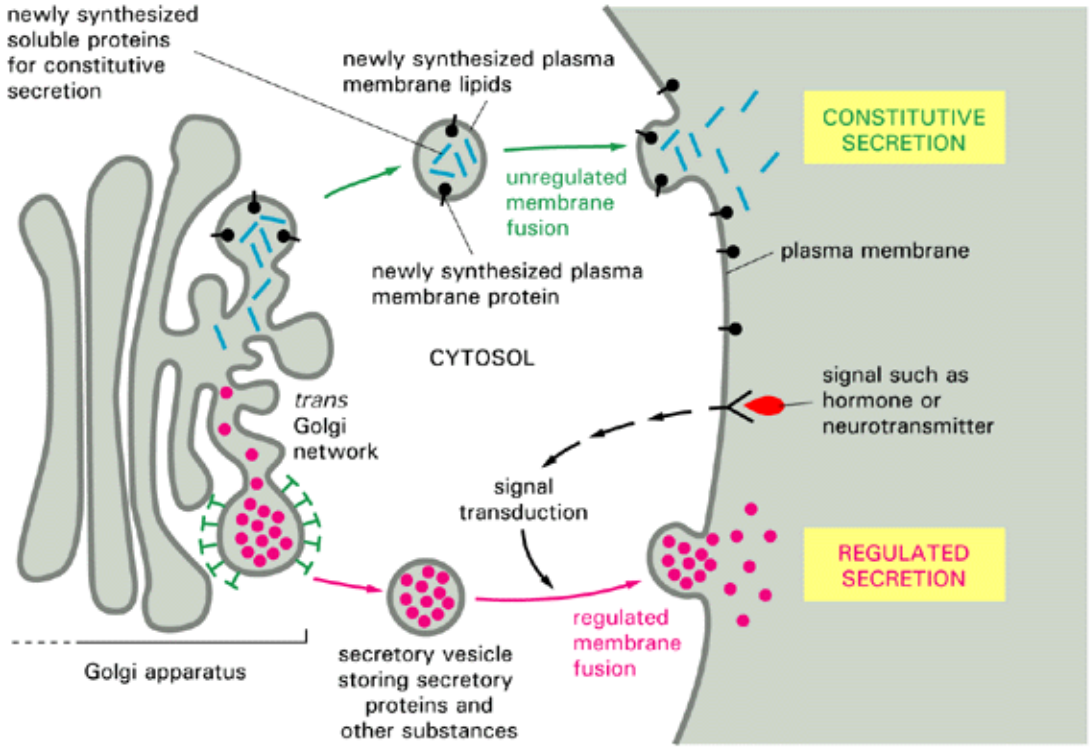
Other Energy Requiring Process

A. **Endocytosis**: Large materials transported into the cell.

Endocytosis includes three slightly different processes.



B. **Exocytosis**: Material (wastes etc.) are expelled from the cell (recall golgi vesicles).



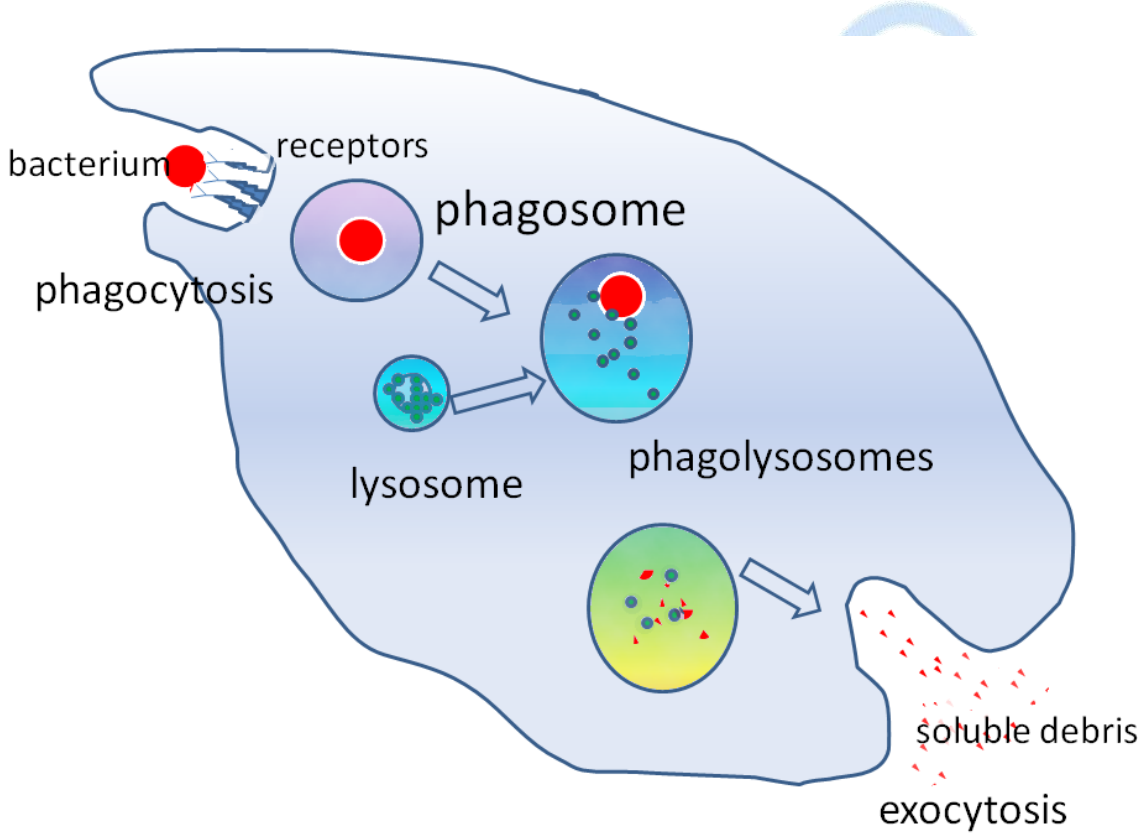
Q-6 What is phagocytosis?

Ans- A mechanism by which single cells of the animal kingdom, such as smaller protozoa, engulf and carry particles into the cytoplasm. It differs from endocytosis primarily in the size of the particle rather than in the mechanism; as particles approach the dimensions and solubility of macromolecules, cells take them up by the process of endocytosis.

Cells such as the free-living amebas or the wandering cells of the metazoa often can "sense" the direction of a potential food source and move toward it (chemotaxis). If, when the cell contacts the particle, the particle has the appropriate chemical composition, or surface charge, it adheres to the cell. The cell responds by forming a hollow, conelike cytoplasmic process around the particle, eventually surrounding it completely. Although the particle is internalized by this sequence of events, it is still enclosed in a portion of the cell's surface membrane and thus isolated

from the cell's cytoplasm. The combined particle and membrane package is referred to as a food or phagocytic vacuole. *See also* Vacuole.

Ameboid cells of the metazoa also selectively remove foreign particles, bacteria, and other pathogens by phagocytosis. After the foreign particle or microorganism is trapped in a vacuole inside the macrophage, it is usually digested. To accomplish this, small packets (lysosomes) of lytic proenzymes are introduced into the phagocytic vacuole, where the enzymes are then dissolved and activated. *See also* Lysosome.



Chapter-2
Digestion

Q-1 Define food and its components.

Ans. Food is any substance consumed to provide nutritional support for the body. It is usually of plant or animal origin, and contains essential nutrients, such as carbohydrates, fats, proteins, vitamins, or minerals. The substance is ingested by an organism and assimilated by the organism's cells in an effort to produce energy, maintain life, and/or stimulate growth.

Shows the three food groups and their source

Food group according to function	Major nutrient	Food containing the nutrient
Energy giving	carbohydrate and Fat	Cereals like rice and wheat Starches like potato. Fat-ghee and oil Sugar
Body building	Protein	Milk Meat-Mutton, chiken, fish Egg white Pulses, like dals,gram,soya bean peas
Protective	Minerals,Vitamins	Vegetables specially green leafy vegetables like spinach, cabbage and Dietry fibre such as brinjal, beans and fruits

Q.2 How different are intracellular and extracellular digestion? What is the evolutionary advantage of extracellular digestion?

Ans Intracellular digestion is that in which the breaking down of macromolecules takes place within the cell. Extracellular digestion is that in which macromolecules are broken down in places outside the cell (in the extracellular space, in the surrounds, in the lumen of digestive tubes, etc.)

The advent of extracellular digestion in evolution allowed organisms to benefit from a greater variety of food. The breaking down of larger molecules into smaller ones outside the cell permitted the use of other foods than those that, due the size of their molecules, could not be interiorized by diffusion, phagocytosis or pinocytosis.

Q.3 What is the location of the salivary glands in humans?

Ans. There are 6 major salivary glands and they are located one in each parotid gland, two beneath the mandibles (submandibular) and two in the base of the tongue (sublingual). More than 700 other minor salivary glands exist dispersed on the lip mucosa, gingiva, palate and pharynx.

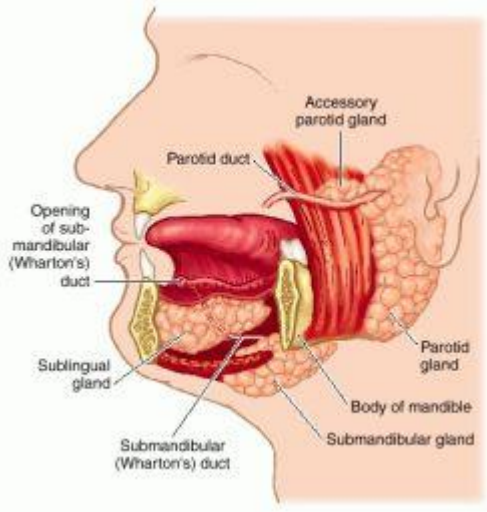
Q-4. What are the digestive functions of the liver?

Ans Besides making bile for release in the duodenum, the liver has other digestive functions.

The venous network that absorbs nutrients from the guts, called mesenteric circulation, drains its blood content almost entirely to the hepatic portal vein. This vein irrigates the liver with absorbed material from the digestion. So the liver has the functions of storing, processing and inactivating nutrients.

Glucose is polymerized into glycogen in the liver; this organ also stores many vitamins and the iron absorbed in the intestine. Some important metabolic molecules, like albumin and clotting factors, are made in the liver from amino acids of the diet. In the liver ingested toxic substances, like alcohol and drugs, are inactivated too.

Q-5 Define salivary glands with labeled diagram.
Ans



Histology
The gland is internally divided into lobules. Blood vessels and nerves enter the glands at the hilum and gradually branch out into the lobules.

Ducts
In the duct system, the lumina are formed by intercalated ducts, which in turn join to form striated ducts. These drain into ducts situated between the lobes of the gland (called interlobar ducts or secretory ducts).

All of the human salivary glands terminate in the mouth, where the saliva proceeds to aid in digestion. The saliva that salivary glands release is quickly inactivated in the stomach by the acid that is present there.

Anatomy
The salivary glands are situated at the entrance to the gastrointestinal system to help begin the process of digestion.

Parotid glands

The parotid gland is the largest salivary gland and is found wrapped around the mandibular ramus. The secretion produced is mainly serous in nature and enters the oral cavity via Stensen's duct.

Submandibular glands

The submandibular glands are a pair of glands located beneath the lower jaws, superior to the digastric muscles. The secretion produced is a mixture of both serous fluid and mucus, and enters the oral cavity via Wharton's ducts. Approximately 70% of saliva in the oral cavity is produced by the submandibular glands, even though they are much smaller than the parotid glands.

Sublingual gland

The sublingual glands are a pair of glands located beneath the tongue, anterior to the submandibular glands. The secretion produced is mainly mucous in nature, however it is categorized as a mixed gland. Unlike the other two major glands, the ductal system of the sublingual glands do not have striated ducts, and exit from 8-20 excretory ducts. Approximately 5% of saliva entering the oral cavity come from these glands.

Minor salivary glands

There are over 600 minor salivary glands located throughout the oral cavity within the submucosa of the oral mucosa. They are 1-2mm in diameter and unlike the other glands, they are not encapsulated by connective tissue only surrounded by it. The gland is usually a number of acini connected in a tiny lobule. A minor salivary gland may have a common excretory duct with another gland, or may have its own excretory duct. Their secretion is mainly mucous in nature (except for Von Ebner's glands) and have many functions such as coating the oral cavity with saliva. Problems with dentures are usually associated with minor salivary glands.

Q-6 Describe the composition of saliva and role of its components in digestion.

Ans-

Saliva is produced in human body in quantity of 1000 to 1500 ml per day. pH of **saliva** is 6.35 – 6.85. It is composed of 99.5% water and 0.5% of solutes.

0.5% solutes in saliva are divided further as described below:

Ions:¬
o Sodium
o Potassium
o Chloride
o Bicarbonates
o Phosphates

Organic substances¬

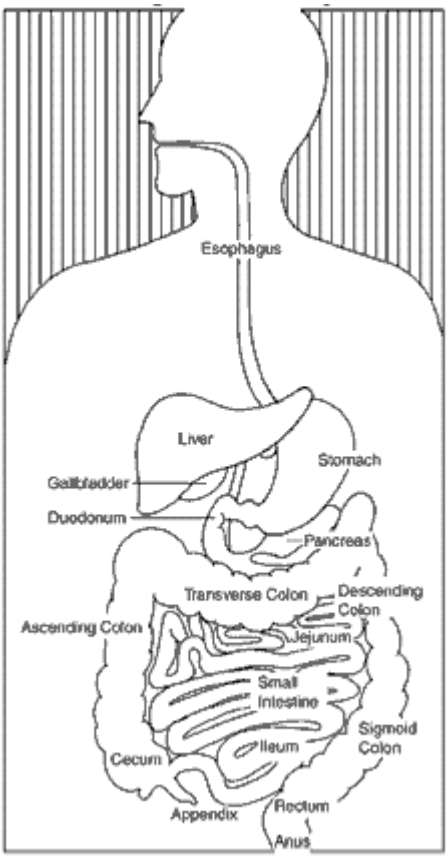
o Urea
o Uric acid
o Mucin
o Globulin
o Serum Albumin
o Lysozyme
o Salivary amylase.

Functions-

The digestive functions of saliva include moistening food and helping to create a food bolus, so it can be swallowed easily. Saliva contains the enzyme amylase (also called ptyalin) that breaks up starch into sugar. This is why the white, popped part of a kernel of popcorn (which consists of starch) seems to melt on the tongue and taste sweet. Thus, digestion of food begins in the mouth. Salivary glands also secrete salivary lipase (a more potent form of lipase) to start fat digestion. Salivary lipase plays a large role in fat digestion in new-born as their pancreatic lipase still has some time to develop.It also has a protective function, helping to prevent bacterial build-up on the teeth and washing away adhered food particles.

Q7. Make digestive tract labeled digram?

Ans.



Q-8 Explain physiology of digestion?

Ans. The human digestive system is a complex series of organs and glands that processes food. In order to use the food we eat, our body has to break the food down into smaller molecules that it can process; it also has to excrete waste.

Most of the digestive organs (like the stomach and intestines) are tube-like and contain the food as it makes its way through the body. The digestive

system is essentially a long, twisting tube that runs from the mouth to the anus, plus a few other organs (like the liver and pancreas) that produce or store digestive chemicals.

The Digestive Process:

The start of the process - the mouth: The digestive process begins in the mouth. Food is partly broken down by the process of chewing and by the chemical action of salivary enzymes (these enzymes are produced by the salivary glands and break down starches into smaller molecules).

On the way to the stomach: the esophagus - After being chewed and swallowed, the food enters the esophagus. The esophagus is a long tube that runs from the mouth to the stomach. It uses rhythmic, wave-like muscle movements (called peristalsis) to force food from the throat into the stomach. This muscle movement gives us the ability to eat or drink even when we're upside-down.

In the stomach - The stomach is a large, sack-like organ that churns the food and bathes it in a very strong acid (gastric acid). Food in the stomach that is partly digested and mixed with stomach acids is called chyme.

In the small intestine - After being in the stomach, food enters the duodenum, the first part of the small intestine. It then enters the jejunum and then the ileum (the final part of the small intestine). In the small intestine, bile (produced in the liver and stored in the gall bladder), pancreatic enzymes, and other digestive enzymes produced by the inner wall of the small intestine help in the breakdown of food.

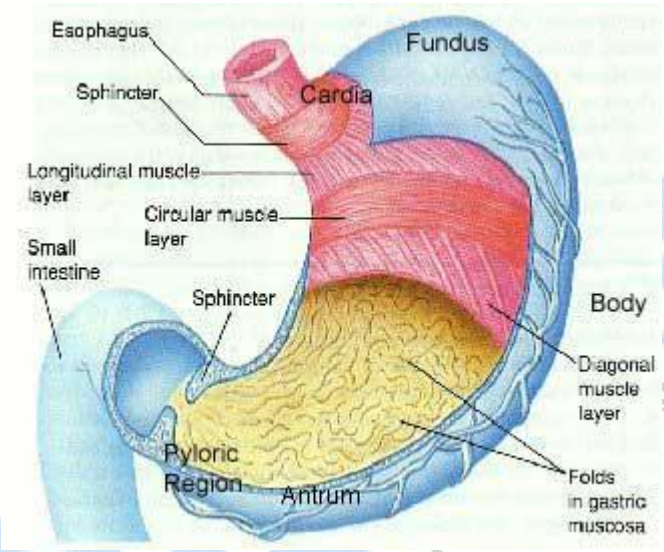
In the large intestine - After passing through the small intestine, food passes into the large intestine. In the large intestine, some of the water and electrolytes (chemicals like sodium) are removed from the food. Many microbes (bacteria like *Bacteroides*, *Lactobacillus acidophilus*, *Escherichia coli*, and *Klebsiella*) in the large intestine help in the digestion process. The first part of the large intestine is called the cecum (the appendix is connected to the cecum). Food then travels upward in the ascending colon. The food travels across the abdomen in the transverse colon, goes back down the

other side of the body in the descending colon, and then through the sigmoid colon.

The end of the process - Solid waste is then stored in the rectum until it is excreted via the anus.

Q-9 Explain anatomy of stomach.

Ans-



The **stomach** is a muscular, hollow, dilated part of the alimentary canal which functions as an important organ of the digestive tract in some animals, including vertebrates, echinoderms, insects (mid-gut), and molluscs. It is involved in the second phase of digestion, following mastication (chewing).

The stomach is located between the esophagus and the small intestine. It secretes protein-digesting enzymes and strong acids to aid in food digestion, (sent to it via oesophageal peristalsis) through smooth muscular contortions (called segmentation) before sending partially digested food (chyme) to the small intestines.

Anatomy of the stomach

The stomach lies between the oesophagus and the duodenum (the first part of the small intestine). It is on the left upper part of the abdominal cavity. The top of the stomach lies against the diaphragm. Lying behind the stomach is the pancreas. The greater omentum hangs down from the *greater curvature*.

Two sphincters keep the contents of the stomach contained. They are the esophageal sphincter (found in the cardiac region, not an anatomical sphincter) dividing the tract above, and the Pyloric sphincter dividing the stomach from the small intestine.

The stomach is surrounded by parasympathetic (stimulant) and orthosympathetic (inhibitor) plexuses (networks of blood vessels and nerves in the anterior gastric, posterior, superior and inferior, celiac and myenteric), which regulate both the secretions activity and the motor (motion) activity of its muscles.

The stomach is divided into four sections, each of which has different cells and functions. The sections are:

Cardia	Where the contents of the oesophagus empty into the stomach.
Fundus	Formed by the upper curvature of the organ.
Body or Corpus	The main, central region.
Pylorus	The lower section of the organ that facilitates emptying the contents into the small intestine.

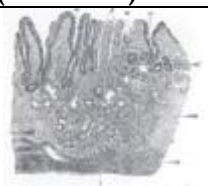
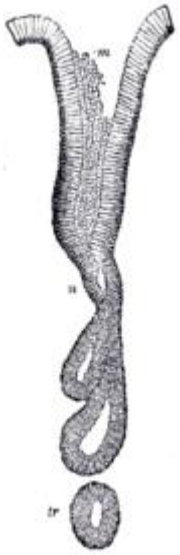
Like the other parts of the gastrointestinal tract, the stomach walls are made of the following layers, from inside to outside:

mucosa	The first main layer. This consists of the epithelium and the lamina propria (composed of loose connective tissue), with a thin layer of smooth muscle called the muscularis mucosae separating it from the submucosa beneath.

submucosa	This layer lies over the mucosa and consists of fibrous connective tissue, separating the mucosa from the next layer. The Meissner's plexus is in this layer.
musculari externa	Over the submucosa, the muscularis externa in the stomach differs from that of other GI organs in that it has three layers of smooth muscle instead of two. • *inner oblique layer:* This layer is responsible for creating the motion that churns and physically breaks down the food. It is the only layer of the three which is not seen in other parts of the digestive system. The antrum has thicker skin cells in its walls and performs more forceful contractions than the fundus. • *middle circular layer:* At this layer, the pylorus is surrounded by a thick circular muscular wall which is normally tonically constricted forming a functional (if not anatomically discrete) pyloric sphincter, which controls the movement of chyme into the duodenum. This layer is concentric to the longitudinal axis of the stomach. • *outer longitudinal layer:* Auerbach's plexus is found between this layer and the middle circular layer.
serosa	This layer is over the muscularis externa, consisting of layers of connective tissue continuous with the peritoneum.

Glands

The epithelium of the stomach forms deep pits. The glands at these locations are named for the corresponding part of the stomach:

Cardiac glands (at cardia)	Pyloric glands (at pylorus)	Fundic glands (at fundus)
		

Q-10 Explain different digestive enzymes.

Ans- Digestive enzymes are enzymes that break down polymeric macromolecules into their smaller building blocks, in order to facilitate their absorption by the body. Digestive enzymes are found in the digestive tract of animals (including humans) where they aid in the digestion of food as well as inside the cells, especially in their lysosomes where they function to maintain cellular survival. Digestive enzymes are diverse and are found in the saliva secreted by the salivary glands, in the stomach secreted by cells lining the stomach, in the pancreatic juice secreted by pancreatic exocrine cells, and in the intestinal (small and large) secretions, or as part of the lining of the gastrointestinal tract.

Oral cavity

Complex food substances that are taken by animals and humans must be broken down into simple, soluble, and diffusible substances before they can be absorbed. In the oral cavity, salivary glands secrete an array of

enzymes and substances that aid in digestion and also disinfection. They include the following:

- Potassium bicarbonate (KHCO3): The major role of bicarbonate is to neutralize acidity mainly in an attempt to preserve the dentin and tooth enamel and also to neutralize bacterial toxins. Bicarbonate also prevents acid damage to the esophageal lining before food enters the stomach.
- lingual lipase: Lipid digestion initiates in the mouth. Lingual lipase starts the digestion of the lipids/fats.
- amylase: Carbohydrate digestion also initiates in the mouth. Amylase produced by the salivary glands breaks complex carbohydrates to smaller chains, or even simple sugars. It is sometimes referred to as ptyalin.
- Mucin: Mucin functions to make food more pliable and also covers it facilitating its transfer in the esophagus to the stomach, by lubricating the content.
- lysozyme: Considering that food contains more than just the essential nutrients and bacteria or viruses, the lysozome offers a limited and non-specific, yet beneficial antiseptic function in digestion.
- IgA: This is a dimeric form of antibodies produced by the body. Gastrointestinal tract produces only IgA mainly to battle bacterial toxins, and also to tag certain recognizable molecular patterns in viruses and bacteria. IgA-coated pathogens are digested by white cells lining the gastrointestinal tract.
- Haptocorrin (also known as R-factor): Helps with the absorption of Vitamin B12. After Vitamin B12 is released from its original carrier protein in the stomach, it gets bound to Haptocorrin. Haptocorrin protects it from acidic conditions of the stomach but is cleaved in the duodenum by pancreatic proteases. Vitamin B12 can then bind to intrinsic factor (IF) that has been produced by parietal cells. Finally, the IF-Vitamin B12 complex is taken up by in ileum via the cubam receptor.

Of note is the diversity of the salivary glands. There are two types of salivary glands:

- serous glands: These glands produce a secretion rich in water, electrolytes, and enzymes. A great example of a serous oral gland is the parotid gland.
- Mixed glands: These glands have both serous cells and mucous cells, and include sublingual and submandibular glands. Their secretion is mucinous and high in viscosity.

In addition, all salivary secretions are hypotonic with respect to the plasma concentration. This is because the duct cells of salivary cells are impermeable to water, yet there is a continuous abstraction of electrolytes such as sodium (Na) and potassium (K) from the initially secreted juice, causing it to be very dilute (hypotonic) by the time it is released into the mouth.

Stomach

The enzymes that are secreted in the stomach are called *gastric enzymes*. The stomach plays a major role in digestion, both in a mechanical sense by mixing and crushing the food, and also in an enzymatic sense, by digesting it. The following are the enzymes produced by the stomach and their respective function:

- Pepsinogen is the main gastric enzyme. It is produced by the stomach cells called "chief cells" in its inactive form pepsinogen, which is a zymogen. Pepsinogen is then activated by the stomach acid into its active form, pepsin. Pepsin breaks down the protein in the food into smaller particles, such as peptide fragments and amino acids. Protein digestion, therefore, first starts in the stomach, unlike carbohydrate and lipids, which start their digestion in the mouth.
- Hydrochloric acid (HCl): This is in essence positively charged hydrogen atoms (H), or in lay-terms *stomach acid*, and is produced by the cells of the stomach called parietal cells. HCl mainly functions to denature the proteins ingested, to destroy any bacteria or virus that remains in the food, and also to activate pepsinogen into pepsin.
- Intrinsic factor (IF): Intrinsic factor is produced by the parietal cells of the stomach. Vitamin B12 (Vit. B12) is an important vitamin that

requires assistance for absorption in terminal ileum. Initially in the saliva, haptocorrin secreted by salivary glands binds Vit. B, creating a Vit B12-Haptocorrin complex. The purpose of this complex is to protect Vitamin B12 from hydrochoric acid produced in the stomach. Once the stomach content exits the stomach into the duodenum, haptocorrin is cleaved with pancreatic enzymes, releasing the intact vitamin B12. Intrinsic factor (IF) produced by the parietal cells then binds Vitamin B12, creating a Vit. B12-IF complex. This complex is then absorbed at the terminal portion of the ileum.

- Mucin: The stomach has a priority to destroy the bacteria and viruses using its highly acidic environment but also has a duty to protect its own lining from its acid. The way that the stomach achieves this is by secreting mucin and bicarbonate via its mucous cells, and also by having a rapid cell turn-over.
- Gastrin: This is an important hormone produced by the "G cells" of the stomach. G cells produce gastrin in response to stomach stretching occurring after food enters it, and also after stomach exposure to protein. Gastrin is an endocrine hormone and therefore enters the bloodstream and eventually returns to the stomach where it stimulates parietal cells to produce hydrochloric acid (HCl) and Intrinsic factor (IF).

Of note is the division of function between the cells covering the stomach. There are four types of cells in the stomach:

- Parietal cells: Produce hydrochloric acid and intrinsic factor.
- Gastric chief cells: Produce pepsinogen. Chief cells are mainly found in the body of stomach, which is the middle or superior anatomic portion of the stomach.
- Goblet cells: Produce mucin and bicarbonate to create a "neutral zone" to protect the stomach lining from the acid or irritants in the stomach chyme.
- G cells: Produce the hormone gastrin in response to distention of the stomach mucosa or protein, and stimulate parietal cells production of their secretion. G cells are located in the antrum of the stomach, which is the most inferior region of the stomach.

Secretion by the previous cells is controlled by the enteric nervous system. Distention in the stomach or innervation by the vagus nerve (via the parasympathetic division of the autonomic nervous system) activates the ENS, in turn leading to the release of acetylcholine. Once present, acetylcholine activates G cells and parietal cells.

Pancreas

Pancreas is both an endocrine and an exocrine gland, in that it functions to produce endocrinic hormones released into the circulatory system (such as insulin, and glucagon), to control glucose metabolism, and also to secrete digestive/exocrinic pancreatic juice, which is secreted eventually via the pancreatic duct into duodenum. Digestive or exocrine function of pancreas is as significant to the maintenance of health as its endocrine function.

Two population of cells in the pancreatic parenchyma make up its digestive enzymes:

- Ductal cells: Mainly responsible for production of bicarbonate (HCO_3), which acts to neutralize the acidity of the stomach chyme entering duodenum through the pylorus. Ductal cells of the pancreas are stimulated by the hormone secretin to produce their bicarbonate-rich secretions, in what is in essence a bio-feedback mechanism; highly acidic stomach chyme entering the duodenum stimulates duodenal cells called "S cells" to prouduce the hormone secretin and release it to the bloodstream. Secretin having entered the blood eventually comes into contact with the pancreatic ductal cells, stimulating them to produce their bicarbonate-rich juice. It is interesting to note that secretin also inhibits production of gastrin by "G cells", and also stimulates acinar cells of the pancreas to produce their pancreatic enzyme.
- Acinar cells: Mainly responsible for production of the inactivate pancreatic enzymes (zymogens) that, once present in the small bowel, become activated and perform their major digestive functions by breaking down proteins, fat, and DNA/RNA. Acinar cells are stimulated by cholecystokinin(CCK), which is a hormone/neurotransmitter produced by the duodenal cells called

the "I cells." CCK stimulates production of the pancreatic zymogens.

Pancreatic juice, composed of the secretions of both ductal and acinar cells, is made up of the following digestive enzymes:[2]

- Trypsinogen, which is an inactive(zymogenic) protease that, once activated in the duodenum, into trypsin, breaks down proteins at the basic amino acids. Trypsinogen is activated via the duodenal enzyme enterokinase into its active form trypsin.
- Chymotrypsinogen, which is a inactive(zymogenic) protease that, once activated by duodenal enterokinase, breaks down proteins at their aromatic amino acids. Chymotrypsiongen can also be activated by trypsin.
- Carboxypeptidase, which is a protease that takes off the terminal amino acid group from a protein
- Several elastases that degrade the protein elastin and some other proteins.
- Pancreatic lipase that degrades triglycerides into fatty acids and glycerol.
- Cholesterol esterase
- Phospholipase
- Several nucleases that degrade nucleic acids, like DNAase and RNAase
- Pancreatic amylase that breaks down, besides starch and glycogen, most other carbohydrates. Humans lack the enzyme to digest the carbohydrate cellulose, mainly due to its special hydrogen-bonding structure.

Pancreas's exocrine function owes part of its immaculate function to bio-feedback mechanisms controlling secretion of its juice. The following significant pancreatic bio-feedback mechanisms are essential to the maintenance of pancreatic juice balance/production:[3]

- Secretin, a hormone produced by the duodenal "S cells" in response to the stomach chyme containing high hydrogen atom concentration (high acidicity), is released into the blood stream;

upon return to the digestive tract, secretion decreases gastric emptying, increases secretion of the pancreatic ductal cells, as well as stimulating pancreatic acinar cells to release their zymogenic juice.

- Cholecystokinin (CCK) is a unique peptide released by the duodenal "I cells" in response to chyme containing high fat or protein content. Unlike secretin, which is an endocrine hormone, CCK actually works via stimulation of a neuronal circuit, the end-result of which is stimulation of the acinar cells to release their content. CCK also increases gallbladder contraction, resulting in bile squeezed into the cystic duct, common bile duct and eventually the duodenum. Bile of course helps absorption of the fat by emulsifying it, increasing its absorptive surface. Bile is made by the liver, but is stored in the gallbladder.
- Gastric inhibitory peptide (GIP) is produced by the mucosal duodenal cells in response to chyme containing high amounts of carbohydrate, proteins, and fatty acids. Main function of GIP is to decrease gastric emptying.
- Somatostatin is a hormone produced by the mucosal cells of the duodenum and also the "delta cells" of the pancreas. Somatostatin has a major inhibitory effect, including on pancreatic juice production.

Small Intestine

The small intestine is traditionally divided into three anatomic sections defined from their distance from the pyloric sphincter:

- duodenum: It is the first portion of the small bowel that is itself divided into four distinct anatomic positions called first, second, third, and fourth sections of duodenum. Duodenum is the only portion of the small bowel that is partially retroperitoneal, and peritoneal. Duodenum is a secretary portion of the small intestine.
- jejunum: This is the section of the small intestine that begins immediately from the insertion point of the ligament of Treitz, and is the longest of the three sections. Jejunum is an absorptive surface.

- ileum This is the terminal portion of the small intestine and as such has a limited but vital role in absorption. Vitamin B12 and bile are absorbed at this portion.

The following enzymes/hormones are produced in the duodenum:

- secretin: This is an endocrine hormone produced by the duodenal "S cells" in response to the acidity of the gastric chyme.
- Cholecystokinin (CCK): This is not by definition a hormone; there is new evidence suggesting that CCK works by a very complex neuronal bi-directional pathway.[4] Regardless of its pathway, its eventual role is to increase secretion of acinar cells and increased production of pancreatic juice. CCK also increases gallbladder contraction, causing release of pre-stored bile into the cystic duct, and eventually into the common bile duct and via the ampulla of Vater into the second anatomic position of the duodenum. CCK also decreases the tone of the sphincter of Oddi, which is the sphincter that regulates flow through the ampula of Vater. CCK also decreases gastric activity and decreases gastric emptying, thereby giving more time to the pancreatic juices to neutralize the acidity of the gastric chyme.
- Gastric inhibitory peptide (GIP): This peptide decreases gastric motility and is produced by duodenal mucosal cells.
- motilin: This substance increases gastro-intestinal motility via specialized receptors called "motilin receptors."
- somatostatin: This hormone is produced by duodenal mucosa and also by the delta cells of the pancreas. Its main function is to inhibit a variety of secretory mechanisms.

Throughout the lining of the small intestine there are numerous "brush border" enzymes whose function is to further cleave the already-broken-down products of digestion into absorbable particles. Some of these enzymes include:

- Sucrase
- Lactase: This is a significant brush border enzyme in that a majority of Middleastern and Asian population lack this enzyme and also

this enzyme decreases with age, and as such lactose intolerance is often a common abdominal complaint in the Middleastern, Asian, and older population, manifesting with bloating, abdominal pain, and osmotic diarrhea.

- Maltase
- Other disaccharidases

Large Intestine (Colon)

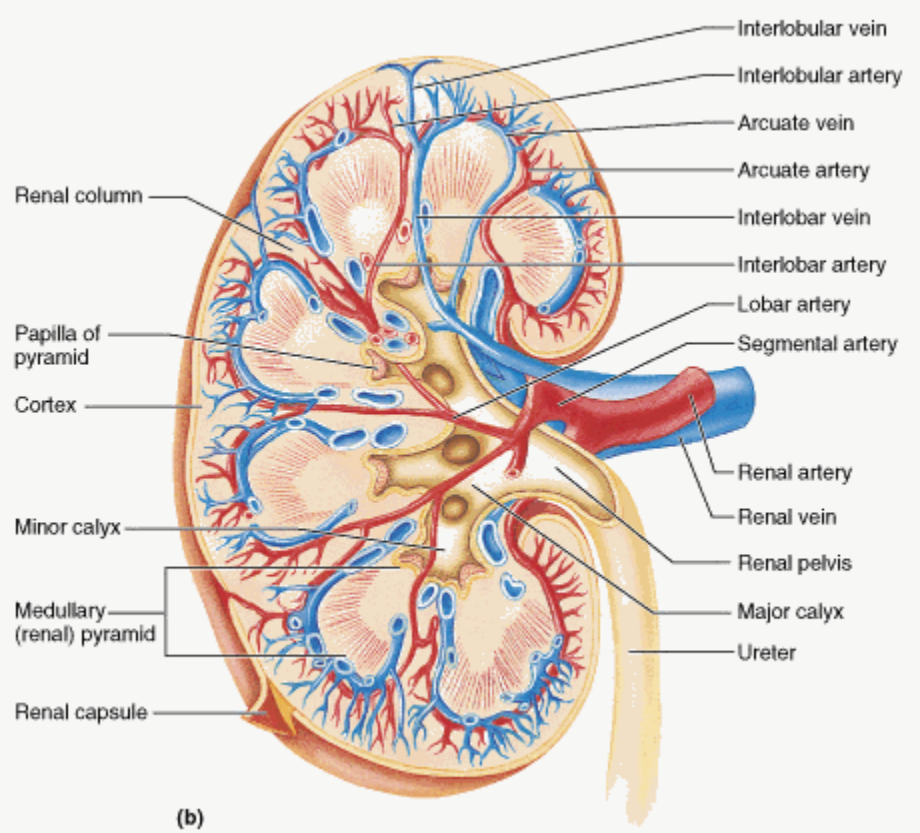
The colon is the main reservoir for feces (mainly in rectum) before its defecation. It is also where the liquid stool becomes solid, by losing its water, and electrolytes. The colon also actively secretes bicarbonate and potassium, which explains why severe diarrhea can cause metabolic acidosis as well as hypokalemia.[5] The colon also houses symbiotic bacteria that produce vitamin by-products and are essential to the human health and homeostasis.

Q-11 Explain structure and function of kidney

Ans- The **kidneys**, organs with several functions, serve essential regulatory roles in most animals, including vertebrates and some invertebrates. They are essential in the urinary system and also serve homeostatic functions such as the regulation of electrolytes, maintenance of acid-base balance, and regulation of blood pressure (via maintaining salt and water balance). They serve the body as a natural filter of the blood, and remove wastes which are diverted to the urinary bladder. In producing urine, the kidneys excrete wastes such as urea and ammonium; the kidneys also are responsible for the reabsorption of water, glucose, and amino acids. The kidneys also produce hormones including calcitriol, erythropoietin, and the enzyme renin.

Located at the rear of the abdominal cavity in the retroperitoneum, the kidneys receive blood from the paired renal arteries, and drain into the paired renal veins. Each kidney excretes urine into a ureter, itself a paired structure that empties into the urinary bladder.

Structure



The kidney has a bean-shaped structure; each kidney has a convex and concave surface. The concave surface, the renal hilum, is the point at which the renal artery enters the organ, and the renal vein and ureter leave. The kidney is surrounded by tough fibrous tissue, the renal capsule, which is itself surrounded by perinephric fat, renal fascia (of Gerota) and paranephric fat. The anterior (front) border of these tissues is the peritoneum, while the posterior (rear) border is the transversalis fascia.

The superior border of the right kidney is adjacent to the liver; and the spleen, for the left kidney. Therefore, both move down on inhalation.

The kidney is approximately 11–14 cm in length, 6 cm wide and 4 cm thick.

The substance, or parenchyma, of the kidney is divided into two major structures: superficial is the renal cortex and deep is the renal medulla. Grossly, these structures take the shape of 8 to 18 cone-shaped renal lobes, each containing renal cortex surrounding a portion of medulla called a renal pyramid (of Malpighi).[5] Between the renal pyramids are projections of cortex called renal columns (of Bertin). Nephrons, the urine-producing functional structures of the kidney, span the cortex and medulla. The initial filtering portion of a nephron is the renal corpuscle, located in the cortex, which is followed by a renal tubule that passes from the cortex deep into the medullary pyramids. Part of the renal cortex, a medullary ray is a collection of renal tubules that drain into a single collecting duct.

The tip, or papilla, of each pyramid empties urine into a minor calyx; minor calyces empty into major calyces, and major calyces empty into the renal pelvis, which becomes the ureter.

Histology

Renal histology studies the structure of the kidney as viewed under a microscope. Various distinct cell types occur in the kidney, including:

- Kidney glomerulus parietal cell
- Kidney glomerulus podocyte
- Kidney proximal tubule brush border cell
- Loop of Henle thin segment cell
- Thick ascending limb cell
- Kidney distal tubule cell
- Kidney collecting duct cell
- Interstitial kidney cells

Innervation

The kidney and nervous system communicate via the renal plexus, whose fibers course along the renal arteries to reach the kidney.[7] Input from the sympathetic nervous system triggers vasoconstriction in the kidney, thereby reducing renal blood flow. The kidney is not thought to receive input from the parasympathetic nervous system. Sensory input from the

kidney travels to the T10-11 levels of the spinal cord and is sensed in the corresponding dermatome. Thus, pain in the flank region may be referred from the kidney.[7]

Functions

The kidney participates in whole-body homeostasis, regulating acid-base balance, electrolyte concentrations, extracellular fluid volume, and regulation of blood pressure. The kidney accomplishes these homeostatic functions both independently and in concert with other organs, particularly those of the endocrine system. Various endocrine hormones coordinate these endocrine functions; these include renin, angiotensin II, aldosterone, antidiuretic hormone, and atrial natriuretic peptide, among others.

Many of the kidney's functions are accomplished by relatively simple mechanisms of filtration, reabsorption, and secretion, which take place in the nephron. Filtration, which takes place at the renal corpuscle, is the process by which cells and large proteins are filtered from the blood to make an ultrafiltrate that eventually becomes urine. The kidney generates 180 liters of filtrate a day, while reabsorbing a large percentage, allowing for the generation of only approximately 2 liters of urine. Reabsorption is the transport of molecules from this ultrafiltrate and into the blood. Secretion is the reverse process, in which molecules are transported in the opposite direction, from the blood into the urine.

Excretion of wastes

The kidneys excrete a variety of waste products produced by metabolism. These include the nitrogenous wastes called "urea", from protein catabolism, as well as uric acid, from nucleic acid metabolism. Formation of urine is also the function of the kidney.

Acid-base homeostasis

Two organ systems, the kidneys and lungs, maintain acid-base homeostasis, which is the maintenance of pH around a relatively stable value. The lungs contribute to acid-base homeostasis by regulating bicarbonate (HCO_3^-) concentration. The kidneys have two very important

roles in maintaining the acid-base balance: to reabsorb bicarbonate from urine, and to excrete hydrogen ions into urine

Osmolality regulation

Any significant rise in plasma osmolality is detected by the hypothalamus, which communicates directly with the posterior pituitary gland. An increase in osmolality causes the gland to secrete antidiuretic hormone (ADH), resulting in water reabsorption by the kidney and an increase in urine concentration. The two factors work together to return the plasma osmolality to its normal levels.

ADH binds to principal cells in the collecting duct that translocate aquaporins to the membrane, allowing water to leave the normally impermeable membrane and be reabsorbed into the body by the vasa recta, thus increasing the plasma volume of the body.

There are two systems that create a hyperosmotic medulla and thus increase the body plasma volume: Urea recycling and the 'single effect.'

Urea is usually excreted as a waste product from the kidneys. However, when plasma blood volume is low and ADH is released the aquaporins that are opened are also permeable to urea. This allows urea to leave the collecting duct into the medulla creating a hyperosmotic solution that 'attracts' water. Urea can then re-enter the nephron and be excreted or recycled again depending on whether ADH is still present or not.

The 'Single effect' describes the fact that the ascending thick limb of the loop of Henle is not permeable to water but is permeable to NaCl. This allows for a countercurrent exchange system whereby the medulla becomes increasingly concentrated, but at the same time setting up an osmotic gradient for water to follow should the aquaporins of the collecting duct be opened by ADH.

Blood pressure regulation

Main articles: Blood pressure regulation and Renin-angiotensin system

Long-term regulation of blood pressure predominantly depends upon the kidney. This primarily occurs through maintenance of the extracellular

fluid compartment, the size of which depends on the plasma sodium concentration. Although the kidney cannot directly sense blood pressure, changes in the delivery of sodium and chloride to the distal part of the nephron alter the kidney's secretion of the enzyme renin. When the extracellular fluid compartment is expanded and blood pressure is high, the delivery of these ions is increased and renin secretion is decreased. Similarly, when the extracellular fluid compartment is contracted and blood pressure is low, sodium and chloride delivery is decreased and renin secretion is increased in response.

Renin is the first in a series of important chemical messengers that comprise the renin-angiotensin system. Changes in renin ultimately alter the output of this system, principally the hormones angiotensin II and aldosterone. Each hormone acts via multiple mechanisms, but both increase the kidney's absorption of sodium chloride, thereby expanding the extracellular fluid compartment and raising blood pressure. When renin levels are elevated, the concentrations of angiotensin II and aldosterone increase, leading to increased sodium chloride reabsorption, expansion of the extracellular fluid compartment, and an increase in blood pressure. Conversely, when renin levels are low, angiotensin II and aldosterone levels decrease, contracting the extracellular fluid compartment, and decreasing blood pressure.

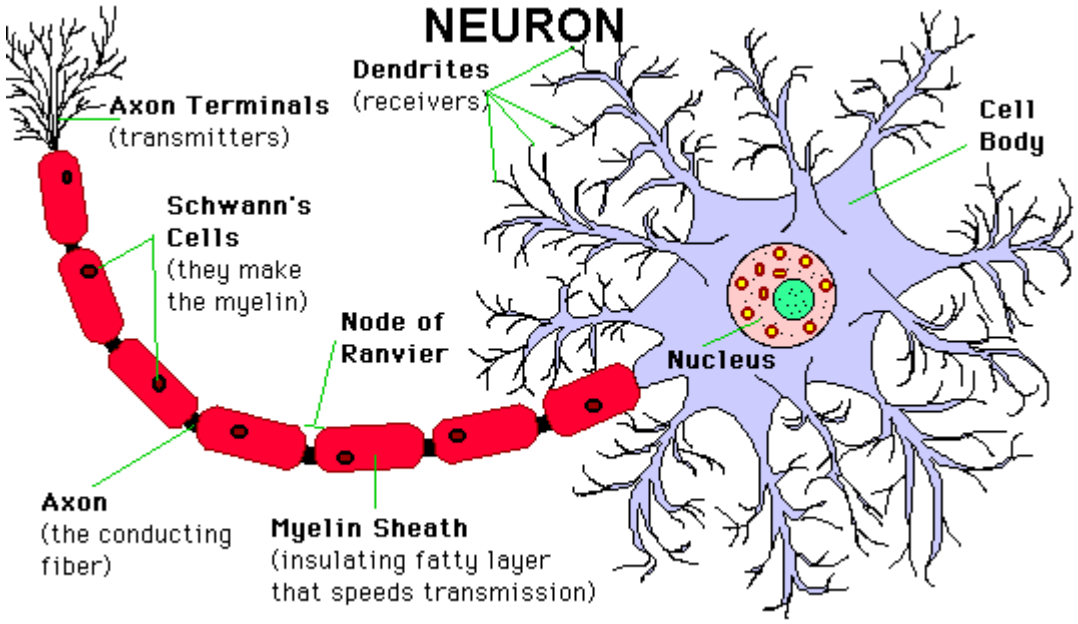
Hormone secretion

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.

Q-12 Explain anatomy of neuron.

Ans A neuron is a special type of cell found in the bodies of most animals (all members of the group Eumetazoa). Only sponges and a few other simpler animals have no neurons. The features that define a neuron are electrical

excitability and the presence of synapses, which are complex membrane junctions that transmit signals to other cells. The body's neurons, plus the glial cells that give them structural and metabolic support, together constitute the nervous system. In vertebrates, the majority of neurons belong to the central nervous system, but some reside in peripheral ganglia, and many sensory neurons are situated in sensory organs such as the retina and cochlea.



Neurons are highly specialized for the processing and transmission of cellular signals. Given the diversity of functions performed by neurons in different parts of the nervous system, there is, as expected, a wide variety in the shape, size, and electrochemical properties of neurons. For instance, the soma of a neuron can vary from 4 to 100 micrometers in diameter.[3]

- The soma is the central part of the neuron. It contains the nucleus of the cell, and therefore is where most protein synthesis occurs. The nucleus ranges from 3 to 18 micrometers in diameter.[4]

- The dendrites of a neuron are cellular extensions with many branches, and metaphorically this overall shape and structure is

referred to as a dendritic tree. This is where the majority of input to the neuron occurs.

- The axon is a finer, cable-like projection that can extend tens, hundreds, or even tens of thousands of times the diameter of the soma in length. The axon carries nerve signals away from the soma (and also carries some types of information back to it). Many neurons have only one axon, but this axon may—and usually will—undergo extensive branching, enabling communication with many target cells. The part of the axon where it emerges from the soma is called the axon hillock. Besides being an anatomical structure, the axon hillock is also the part of the neuron that has the greatest density of voltage-dependent sodium channels. This makes it the most easily-excited part of the neuron and the spike initiation zone for the axon: in electrophysiological terms it has the most negative action potential threshold. While the axon and axon hillock are generally involved in information outflow, this region can also receive input from other neurons.

- The axon terminal contains synapses, specialized structures where neurotransmitter chemicals are released to communicate with target neurons.

Although the canonical view of the neuron attributes dedicated functions to its various anatomical components, dendrites and axons often act in ways contrary to their so-called main function.

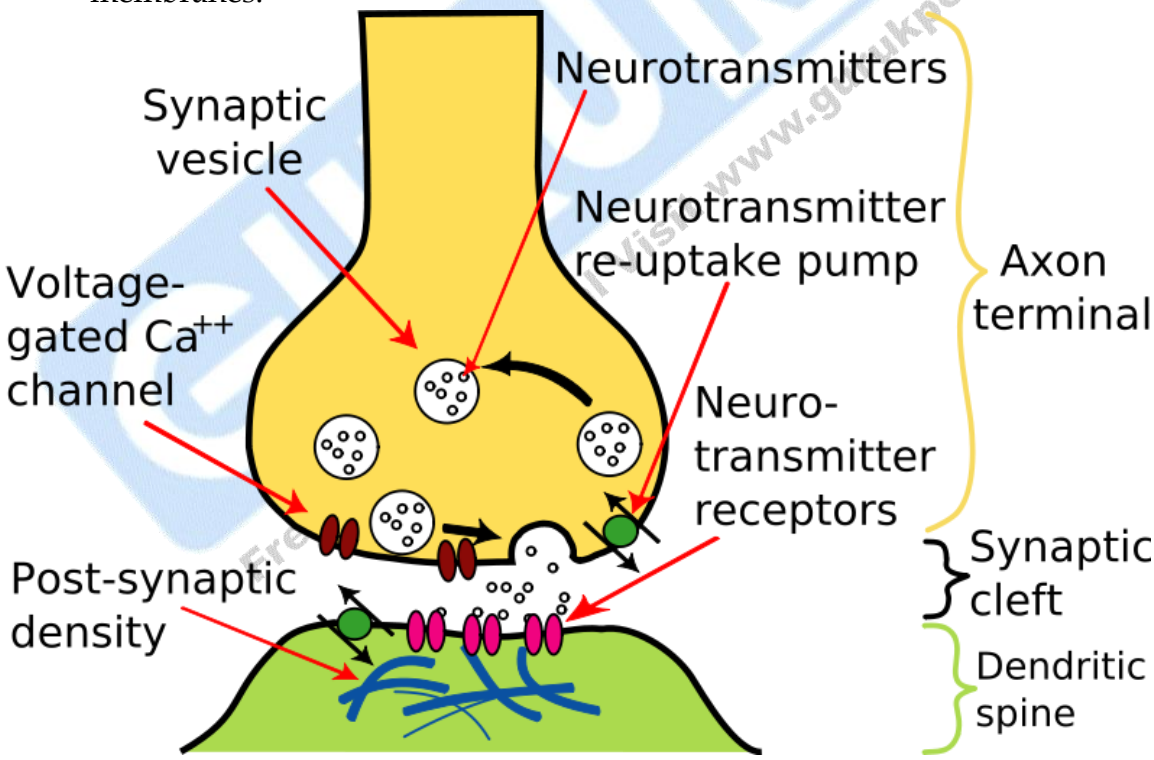
Axons and dendrites in the central nervous system are typically only about one micrometer thick, while some in the peripheral nervous system are much thicker. The soma is usually about 10–25 micrometers in diameter and often is not much larger than the cell nucleus it contains. The longest axon of a human motoneuron can be over a meter long, reaching from the base of the spine to the toes. Sensory neurons have axons that run from the toes to the dorsal columns, over 1.5 meters in adults. Giraffes have single axons several meters in length running along the entire length of their necks. Much of what is known about axonal function comes from studying the squid giant axon, an ideal experimental

preparation because of its relatively immense size (0.5–1 millimeters thick, several centimeters long).

Fully differentiated neurons are permanently amitotic., however, recent research shows that additional neurons throughout the brain can originate from neural stem cells found throughout the brain but in particularly high concentrations in the subventricular zone and subgranular zone through the process of neurogenesis.

Q-13 Explain origin and propagation of nerve impulse.

Ans- Neurones send messages electrochemically; this means that chemicals (ions) cause an electrical impulse. Neurones and muscle cells are electrically excitable cells, which means that they can transmit electrical nerve impulses. These impulses are due to events in the cell membrane, so to understand the nerve impulse we need to revise some properties of cell membranes.



By a change in polarity as sodium ions enter the cell and potassium ions exit the cell, forming a wave of depolarization that travels along the axon until it reaches the axon terminal releases the neurotransmitters into the synaptic gap.

By an action potential, which is a depolarization of the nerve cell membrane, the neurolemma.

A nerve impulse gets transmitted along an axon in 5 steps:

1) Stimulus opens Sodium ion (Na+) channels at Resting Potential

_ Must reach threshold to get Action Potential (A.P)

2) Voltage sensitive Na+ channels open

_ Na+ crosses into Intracellular fluid (ICF)

_ Depolarize the cell (which is call "Depolarization")

_ Reach +30 mV (mili voltage)

3) Na+ channels close

4) Voltage sensitive Potassium ion (K+) channels open

_ K+ crosses out to ECF (extracellular fluid)

_ Repolarize the cell (aka: repolarization)

_ Reach -90 mV

+ a hyperpolarization

_ K+ channels close

5) Na+/K+ (Sodium/ Potassium) pump restores concentrations

_ Potential goes back to -70 mV: Returning to Resting Potential

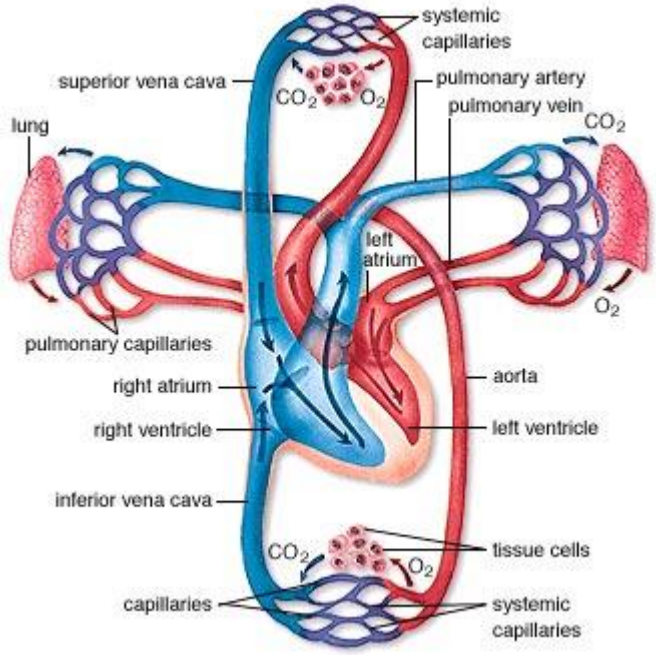
"All-or-none" principle

The amplitude of an action potential is independent of the amount of current that produced it. In other words, larger currents do not create larger action potentials. Therefore action potentials are said to be *all-or-none* (or boolean), since they either occur fully or they do not occur at all. Instead, the frequency of action potentials is what encodes for the intensity of a stimulus. This is in contrast to receptor potentials, whose amplitudes are dependent on the intensity of a stimulus.

Chapter 4

Circulatory system

Q –1 Made ladelleld digram of circulatory system.
Ans.



Q.2 Explain Structure of Heart with labeled diagram t?

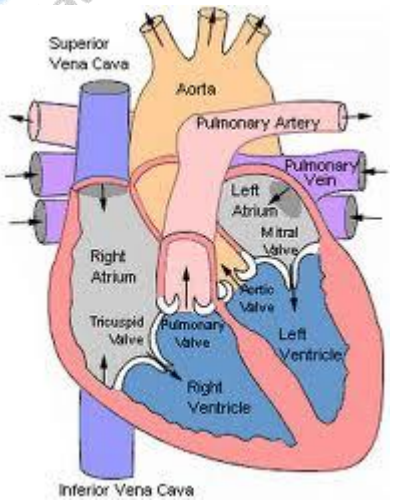
Ans. The human heart has a mass of between 250 and 350 grams and is about the size of a fist. It is located anterior to the vertebral column and posterior to the sternum.

It is enclosed in a double-walled sac called the pericardium. The superficial part of this sac is called the fibrous pericardium. This sac

protects the heart, anchors its surrounding structures, and prevents overfilling of the heart with blood.

The outer wall of the human heart is composed of three layers. The outer layer is called the epicardium, or visceral pericardium since it is also the inner wall of the pericardium. The middle layer is called the myocardium and is composed of muscle which contracts. The inner layer is called the endocardium and is in contact with the blood that the heart pumps. Also, it merges with the inner lining (endothelium) of blood vessels and covers heart valves.

The human heart has four chambers, two superior atria and two inferior ventricles. The atria are the receiving chambers and the ventricles are the discharging chambers. The pathway of blood through the human heart consists of a pulmonary circuit and a systemic circuit. Deoxygenated blood flows through the heart in one direction, entering through the superior vena cava into the right atrium and is pumped through the tricuspid valve into the right ventricle before being pumped out through the pulmonary valve to the pulmonary arteries into the lungs. It returns from the lungs through the pulmonary veins to the left atrium where it is pumped through the mitral valve into the left ventricle before leaving through the aortic valve to the aorta



Q –3 Explain function and composition of blood?
Ans .

Blood

- Approximately 8% of an adult's body weight is made up of blood
- Females have around 4-5 litres, while males have around 5-6 litres. This difference is mainly due to the differences in body size between men and women.
- Its mean temperature is 38 degrees Celcius.
- It has a pH of 7.35-7.45, making it slightly basic (less than 7 is considered acidic).
- Whole blood is about 4.5-5.5 times as viscous as water, indicating that it is more resistant to flow than water. This viscosity is vital to the function of blood because if blood flows too easily or with too much resistance, it can strain the heart and lead to severe cardiovascular problems.
- Blood in the arteries is a brighter red than blood in the veins because of the higher levels of oxygen found in the arteries.
- An artificial substitute for human blood has not been found.

Functions of blood
Blood has three main functions: transport, protection and regulation.

Transport
Blood transports the following substances:

- Gases, namely oxygen (O_2) and carbon dioxide (CO_2), between the lungs and rest of the body
- Nutrients from the digestive tract and storage sites to the rest of the body
- Waste products to be detoxified or removed by the liver and kidneys
- Hormones from the glands in which they are produced to their target cells
- Heat to the skin so as to help regulate body temperature

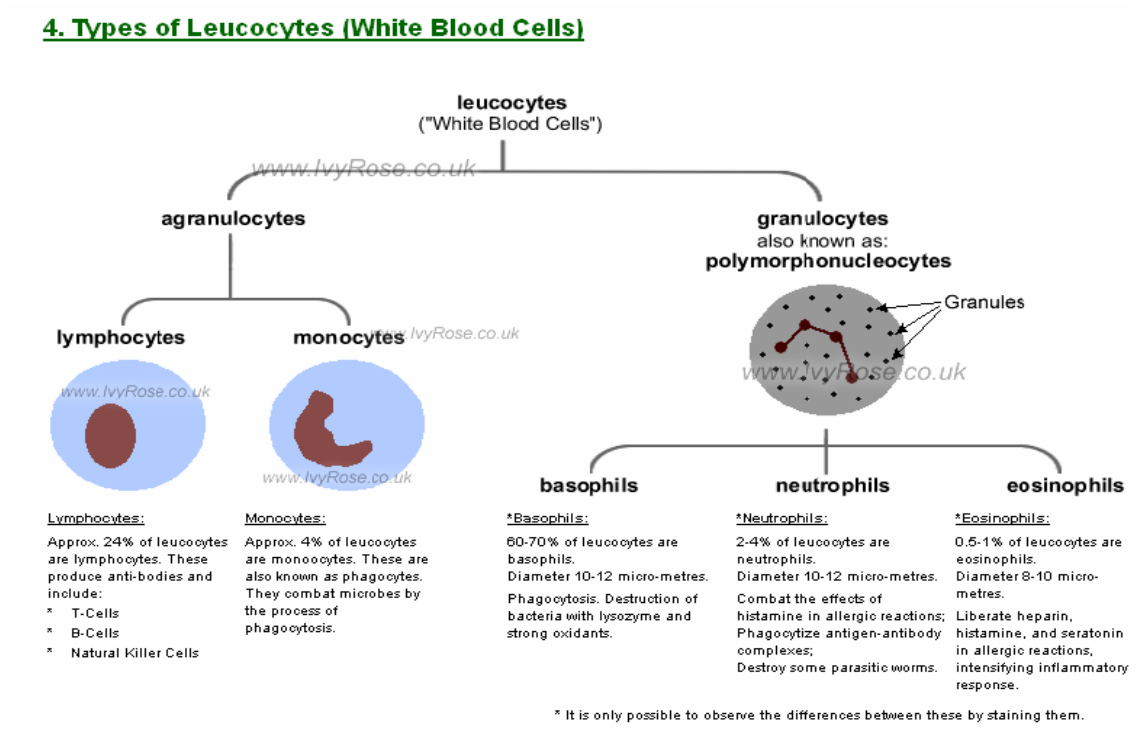
Protection
Blood has several roles in inflammation:

- Leukocytes, or white blood cells, destroy invading microorganisms and cancer cells

- Antibodies and other proteins destroy pathogenic substances
- Platelet factors initiate blood clotting and help minimise blood loss

Regulation
Blood helps regulate:

- pH by interacting with acids and bases
- Water balance by transferring water to and from tissues



Blood is classified as a connective tissue and consists of two main components:

1. Plasma, which is a clear extracellular fluid
2. Formed elements, which are made up of the blood cells and platelets

The formed elements are so named because they are enclosed in a plasma membrane and have a definite structure and shape. All formed elements are cells except for the platelets, which tiny fragments of bone marrow cells.

Formed elements are:

- Erythrocytes, also known as red blood cells (RBCs)
- Leukocytes, also known as white blood cells (WBCs)
- Platelets

Leukocytes are further classified into two subcategories called granulocytes which consist of neutrophils, eosinophils and basophils; and agranulocytes which consist of lymphocytes and monocytes.

The formed elements can be separated from plasma by centrifuge, where a blood sample is spun for a few minutes in a tube to separate its components according to their densities. RBCs are denser than plasma, and so become packed into the bottom of the tube to make up 45% of total volume. This volume is known as the haematocrit. WBCs and platelets form a narrow cream-coloured coat known as the buffy coat immediately above the RBCs. Finally, the plasma makes up the top of the tube, which is a pale yellow colour and contains just under 55% of the total volume.

Blood plasma

Blood plasma is a mixture of proteins, enzymes, nutrients, wastes, hormones and gases. The specific composition and function of its components are as follows:

Proteins

These are the most abundant substance in plasma by weight and play a part in a variety of roles including clotting, defence and transport. Collectively, they serve several functions:

- They are an important reserve supply of amino acids for cell nutrition. Cells called macrophages in the liver, gut, spleen, lungs and lymphatic tissue can break down plasma proteins so as to release their amino acids. These amino acids are used by other cells to synthesise new products.
- Plasma proteins also serve as carriers for other molecules. Many types of small molecules bind to specific plasma proteins and are transported from the organs that absorb these proteins to other tissues for utilisation. The proteins also help to keep the blood slightly basic at a stable pH. They do this by functioning as weak bases themselves to bind excess H+ ions. By doing so, they remove excess H+ from the blood which keeps it slightly basic.
- The plasma proteins interact in specific ways to cause the blood to coagulate, which is part of the body's response to injury to the blood vessels (also known as vascular injury), and helps protect against the loss of blood and invasion by foreign microorganisms and viruses.
- Plasma proteins govern the distribution of water between the blood and tissue fluid by producing what is known as a colloid osmotic pressure.

There are three major categories of plasma proteins, and each individual type of proteins has its own specific properties and functions in addition to their overall collective role:

1. **Albumins**, which are the smallest and most abundant plasma proteins. Reductions in plasma albumin content can result in a loss of fluid from the blood and a gain of fluid in the interstitial space (space within the tissue), which may occur in nutritional, liver and

kidney disease. Albumin also helps many substances dissolve in the plasma by binding to them, hence playing an important role in plasma transport of substances such as drugs, hormones and fatty acids.

2. **Globulins**, which can be subdivided into three classes from smallest to largest in molecular weight into alpha, beta and gamma globulins. The globulins include high density lipoproteins (HDL), an alpha-1 globulin, and low density lipoproteins (LDL), a beta-1 globulin. HDL functions in lipid transport carrying fats to cells for use in energy metabolism, membrane reconstruction and hormone function. HDLs also appear to prevent cholesterol from invading and settling in the walls of arteries. LDL carries cholesterol and fats to tissues for use in manufacturing steroid hormones and building cell membranes, but it also favours the deposition of cholesterol in arterial walls and thus appears to play a role in disease of the blood vessels and heart. HDL and LDL therefore play important parts in the regulation of cholesterol and hence have a large impact on cardiovascular disease.
3. **Fibrinogen**, which is a soluble precursor of a sticky protein called fibrin, which forms the framework of blood clot. Fibrin plays a key role in coagulation of blood, which is discussed later in this article under Platelets.

Amino acids

These are formed from the break down of tissue proteins or from the digestion of digested proteins.

Nitrogenous waste

Being toxic end products of the break down of substances in the body, these are usually cleared from the bloodstream and are excreted by the kidneys at a rate that balances their production.

Nutrients

Those absorbed by the digestive tract are transported in the blood plasma. These include glucose, amino acids, fats, cholesterol, phospholipids, vitamins and minerals.

Gases
Some oxygen and carbon dioxide are transported by plasma. Plasma also contains a substantial amount of dissolved nitrogen.

Electrolytes
The most abundant of these are sodium ions, which account for more of the blood's osmolarity than any other solute.

Red blood cells
Red blood cells (RBCs), also known as erythrocytes, have two main functions:

1. To pick up oxygen from the lungs and deliver it to tissues elsewhere
2. To pick up carbon dioxide from other tissues and unload it in the lungs

An erythrocyte is a disc-shaped cell with a thick rim and a thin sunken centre. The plasma membrane of a mature RBC has glycoproteins and glycolipids that determine a person's blood type. On its inner surface are two proteins called spectrin and actin that give the membrane resilience and durability. This allows the RBCs to stretch, bend and fold as they squeeze through small blood vessels, and to spring back to their original shape as they pass through larger vessels.

RBCs are incapable of aerobic respiration, preventing them from consuming the oxygen they transport because they lose nearly all their inner cellular components during maturation. The inner cellular components lost include their mitochondria, which normally provide energy to a cell, and their nucleus, which contains the genetic material of the cell and enable it to repair itself. The lack of a nucleus means that RBCs are unable to repair themselves. However, the resulting biconcave shape is that the cell has a greater ratio of surface area to volume, enabling O_2 and CO_2 to diffuse quickly to and from Hb.

The cytoplasm of a RBC consists mainly of a 33% solution of haemoglobin (Hb), which gives RBCs their red colour. Haemoglobin carries most of the oxygen and some of the carbon dioxide transported by the blood.

Circulating erythrocytes live for about 120 days. As a RBC ages, its membrane grows increasingly fragile. Without key organelles such as a nucleus or ribosomes, RBCs cannot repair themselves. Many RBCs die in the spleen, where they become trapped in narrow channels, broken up and destroyed. Haemolysis refers to the rupture of RBCs, where haemoglobin is released leaving empty plasma membranes which are easily digested by cells known as macrophages in the liver and spleen. The Hb is then further broken down into its different components and either recycled in the body for further use or disposed of.

White blood cells

White blood cells (WBCs) are also known as leukocytes. They can be divided into granulocytes and agranulocytes. The former have cytoplasms that contain organelles that appear as coloured granules through light microscopy, hence their name. Granulocytes consist of neutrophils, eosinophils and basophils. In contrast, agranulocytes do not contain granules. They consist of lymphocytes and monocytes.

Granulocytes

1. **Neutrophils:** These contain very fine cytoplasmic granules that can be seen under a light microscope. Neutrophils are also called polymorphonuclear (PMN) because they have a variety of nuclear shapes. They play roles in the destruction of bacteria and the release of chemicals that kill or inhibit the growth of bacteria.
2. **Eosinophils:** These have large granules and a prominent nucleus that is divided into two lobes. They function in the destruction of allergens and inflammatory chemicals, and release enzymes that disable parasites.
3. **Basophils:** They have a pale nucleus that is usually hidden by granules. They secrete histamine which increases tissue blood flow via dilating the blood vessels, and also secrete heparin which is an

anticoagulant that promotes mobility of other WBCs by preventing clotting.

Agranulocytes

1. **Lymphocytes:** These are usually classified as small, medium or large. Medium and large lymphocytes are generally seen mainly in fibrous connective tissue and only occasionally in the circulation bloodstream. Lymphocytes function in destroying cancer cells, cells infected by viruses, and foreign invading cells. In addition, they present antigens to activate other cells of the immune system. They also coordinate the actions of other immune cells, secrete antibodies and serve in immune memory.
2. **Monocytes:** They are the largest of the formed elements. Their cytoplasm tends to be abundant and relatively clear. They function in differentiating into macrophages, which are large phagocytic cells, and digest pathogens, dead neutrophils, and the debris of dead cells. Like lymphocytes, they also present antigens to activate other immune cells.

Platelets

Platelets are small fragments of bone marrow cells and are therefore not really classified as cells themselves.

Platelets have the following functions:

1. Secrete vasoconstrictors which constrict blood vessels, causing vascular spasms in broken blood vessels
2. Form temporary platelet plugs to stop bleeding
3. Secrete procoagulants (clotting factors) to promote blood clotting
4. Dissolve blood clots when they are no longer needed
5. Digest and destroy bacteria
6. Secrete chemicals that attract neutrophils and monocytes to sites of inflammation

7. Secrete growth factors to maintain the linings of blood vessels

The first three functions listed above refer to important haemostatic mechanisms in which platelets play a role in during bleeding: vascular spasms, platelet plug formation and blood clotting (coagulation).

Vascular spasm
This is a prompt constriction of the broken blood vessel and is the most immediate protection against blood loss. Injury stimulates pain receptors. Some of these receptors directly innervate nearby blood vessels and cause them to constrict. After a few minutes, other mechanisms take over. Injury to the smooth muscle of the blood vessel itself causes a longer-lasting vasoconstriction where platelets release a chemical vasoconstrictor called serotonin. This maintains vascular spasm long enough for the other haemostatic mechanisms to come into play.

Platelet plug formation
Under normal conditions, platelets do not usually adhere to the wall of undamaged blood vessels, since the vessel lining tends to be smooth and coated with a platelet repellent. When a vessel is broken, platelets put out long spiny extensions to adhere to the vessel wall as well as to other platelets. These extensions then contract and draw the walls of the vessel together. The mass of platelets formed is known as a platelet plug, and can reduce or stop minor bleeding.

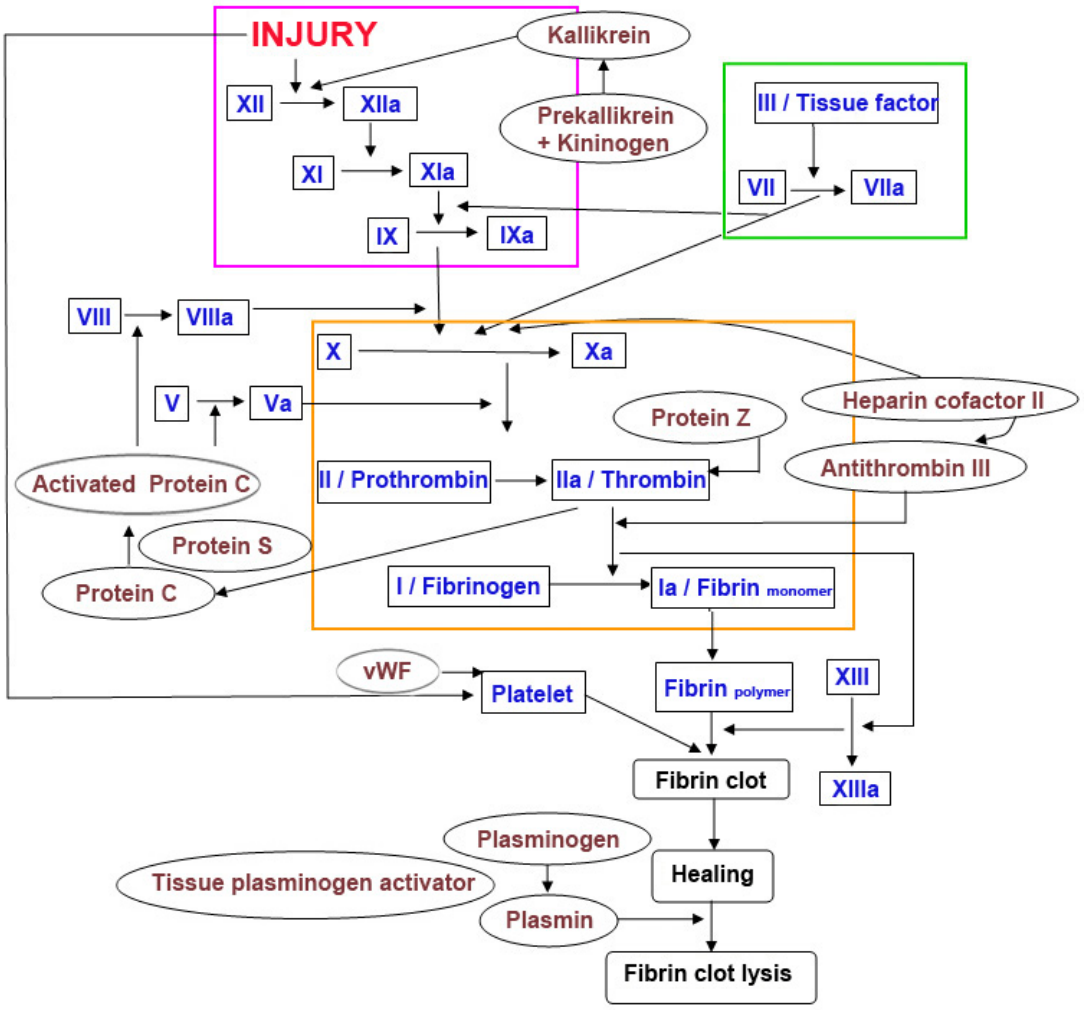
Coagulation
This is the last and most effective defence against bleeding. During bleeding, it is important for the blood to clot quickly to minimise blood loss, but it is equally important for blood not to clot in undamaged vessels. Coagulation is a very complex process aimed at clotting the blood at appropriate amounts. The objective of coagulation is to convert plasma protein fibrinogen into fibrin, which is a sticky protein that adheres to the walls of a vessel. Blood cells and platelets become stuck to fibrin, and the resulting mass helps to seal the break in the blood vessel. The forming of fibrin is what makes coagulation so complicated, as it involved numerous chemicals reactions and many coagulation factors.

Q -4 Describe blood clotting.
Ans

Table of coagulation factors

The table lists 12 of 20 different coagulation factors involved in the coagulation cascade that are vital to normal blood clotting.

Factor	Name
I	Fibrinogen
II	Prothrombin
III	Tissue factor or thromboplastin
IV	Calcium
V	Proaccelerin (Labile factor)
VII	Proconvertin (Stable factor)
VIII	Antihaemophilic factor A, Antihaemophilic globulin
IX	Antihaemophilic factor B, Plasma thromboplastin component, Christmas factor
X	Stuart-Prower factor
XI	Plasma thromboplastin antecedent, Haemophilia C, Rosenthal syndrome
XII	Hageman factor
XIII	Fibrin stabilising factor, Laki-Lorand factor

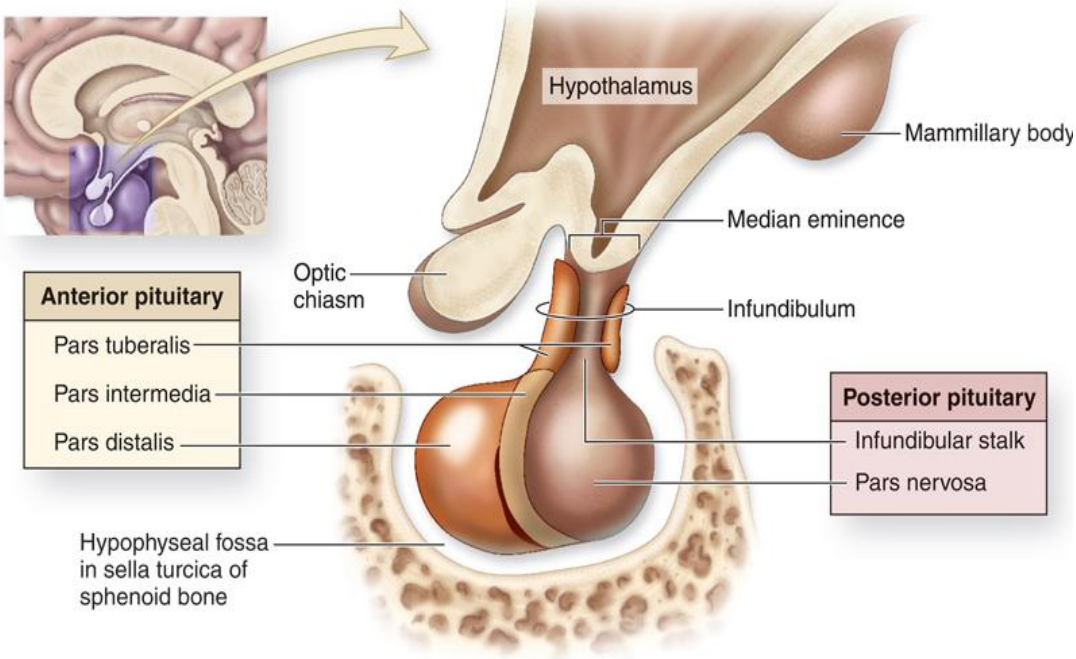


Q5 Describe pituitary gland briefly.

Ans.

In vertebrate anatomy the **pituitary gland**, or **hypophysis**, is an endocrine gland about the size of a pea and weighing 0.5 g (0.02 oz.), in humans. It is a protrusion off the bottom of the hypothalamus at the base of the brain, and rests in a small, bony cavity (sella turcica) covered by a dural fold (diaphragma sellae). The pituitary is functionally connected to the hypothalamus by the median eminence via a small tube called the infundibular stem (Pituitary Stalk). The pituitary fossa, in which the

pituitary gland sits, is situated in the sphenoid bone in the middle cranial fossa at the base of the brain. The pituitary gland secretes nine hormones that regulate homeostasis.



Anterior pituitary (Adenohypophysis)

The anterior pituitary synthesizes and secretes the following important endocrine hormones:

Somatotropins:

- Growth hormone (also referred to as 'Human Growth Hormone', 'HGH' or 'GH' or somatotropin), released under influence of hypothalamic Growth Hormone-Releasing Hormone (GHRH); inhibited by hypothalamic Somatostatin

Thyrotropins:

- Thyroid-stimulating hormone (TSH), released under influence of hypothalamic Thyrotropin-Releasing Hormone (TRH)

Corticotropins:

- Adrenocorticotropic hormone (ACTH), released under influence of hypothalamic Corticotropin-Releasing Hormone (CRH)
- Beta-endorphin, released under influence of hypothalamic Corticotropin-Releasing Hormone (CRH)[4]

Lactotropins:

- Prolactin (PRL), also known as 'Luteotropic' hormone (LTH), released under influence of multiple hypothalamic Prolactin-Releasing Factors (PRH) including dopamine, estrogen, progesterone and thyrotropin-releasing hormone.

Gonadotropins:

- Luteinizing hormone (also referred to as 'Lutropin' or 'LH' or, in males, 'Interstitial Cell-Stimulating Hormone' (ICSH))
- Follicle-stimulating hormone (FSH), both released under influence of Gonadotropin-Releasing Hormone (GnRH)

Melanotrophins

- Melanocyte–stimulating hormones (MSHs) or "intermedins," as these are released by the pars intermedia, which is "the middle part"; adjacent to the posterior pituitary lobe, pars intermedia is a specific part developed from the anterior pituitary lobe.
- These hormones are released from the anterior pituitary under the influence of the hypothalamus. Hypothalamic hormones are secreted to the anterior lobe by way of a special capillary system, called the hypothalamic-hypophysial portal system.

The anterior pituitary is divided into anatomical regions known as the pars tuberalis, pars intermedia, and pars distalis. It develops from a depression in the dorsal wall of the pharynx (stomodial part) known as Rathke's pouch.

Posterior pituitary (Neurohypophysis)

The posterior pituitary stores and secretes the following important endocrine hormones:

Magnocellular Neurons:

- Oxytocin, most of which is released from the paraventricular nucleus in the hypothalamus
- Antidiuretic hormone (ADH, also known as vasopressin and AVP, arginine vasopressin), the majority of which is released from the supraoptic nucleus in the hypothalamus

Oxytocin is one of the few hormones to create a positive feedback loop. For example, uterine contractions stimulate the release of oxytocin from the posterior pituitary, which, in turn, increases uterine contractions. This positive feedback loop continues throughout labor.

Functions

Hormones secreted from the pituitary gland help control the following body processes:

- Growth (Excess of HGH can lead to gigantism and acromegaly.)
- Blood pressure
- Some aspects of pregnancy and childbirth including stimulation of uterine contractions during childbirth
- Breast milk production
- Sex organ functions in both men and women
- Thyroid gland function
- The conversion of food into energy (metabolism)
- Water and osmolarity regulation in the body
- Water balance via the control of reabsorption of water by the kidneys
- Temperature regulation

Pituitary gland also makes endorphin to relieve pain and alter mood

Q-6 Explain adrenal gland

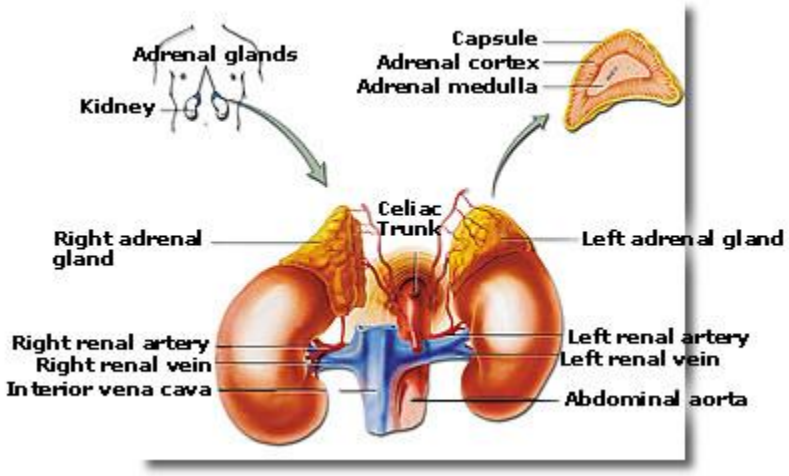
Ans-

In mammals, the **adrenal glands** (also known as **suprarenal glands**) are endocrine glands that sit atop the kidneys; in humans, the right suprarenal gland is triangular shaped, while the left suprarenal gland is semilunar shaped. They are chiefly responsible for releasing hormones in response to stress through the synthesis of corticosteroids such as cortisol

and catecholamines such as epinephrine. The adrenal glands affect kidney function through the secretion of aldosterone, a hormone involved in regulating the osmolarity of blood plasma.

Anatomy and Physiology

Anatomically, the adrenal glands are located in the retroperitoneum situated atop the kidneys, one on each side. They are surrounded by an adipose capsule and renal fascia. In humans, the adrenal glands are found at the level of the 12th thoracic vertebra. Each adrenal gland has two distinct structures, the adrenal cortex and the medulla, both of which produce hormones. The cortex mainly produces cortisol, aldosterone and androgens, while the medulla chiefly produces epinephrine and norepinephrine. The combined weight of the adrenal glands in an adult human ranges from 7 to 10 grams.



A CT scan in which the Adrenals are shown as the triangular-shaped organs on top of the kidneys

Cortex

The adrenal cortex is devoted to the synthesis of corticosteroid hormones. Specific cortical cells produce particular hormones including cortisol, corticosterone, androgens such as testosterone, and aldosterone. Under normal unstressed conditions, the human adrenal glands produce the equivalent of 35–40 mg of cortisone acetate per day.[2] In contrast to the

direct innervation of the medulla, the cortex is regulated by neuroendocrine hormones secreted by the pituitary gland and hypothalamus, as well as by the renin-angiotensin system.

The adrenal cortex comprises three zones, or layers. This *anatomic zonation* can be appreciated at the microscopic level, where each zone can be recognized and distinguished from one another based on structural and anatomic characteristics.[3] The adrenal cortex exhibits *functional zonation* as well: by virtue of the characteristic enzymes present in each zone, the zones produce and secrete distinct hormones.[3]

Zona glomerulosa (outer)
: The outermost layer, the zona glomerulosa is the main site for production of mineralocorticoids, mainly aldosterone, which is largely responsible for the long-term regulation of blood pressure.

Zona fasciculata
: Situated between the glomerulosa and reticularis, the zona fasciculata is responsible for producing glucocorticoids, chiefly cortisol in humans. The zona fasciculata secretes a basal level of cortisol but can also produce bursts of the hormone in response to adrenocorticotropic hormone (ACTH) from the anterior pituitary.

Zona reticularis
: The inner most cortical layer, the zona reticularis produces androgens, mainly dehydroepiandrosterone (DHEA) and DHEA sulfate (DHEA-S) in humans.

Medulla

The adrenal medulla is the core of the adrenal gland, and is surrounded by the adrenal cortex. The chromaffin cells of the medulla, named for their characteristic brown staining with chromic acid salts, are the body's main source of the circulating catecholamines adrenaline (epinephrine) and noradrenaline (norepinephrine). Derived from the amino acid tyrosine, these water-soluble hormones are major hormones underlying the fight-or-flight response.

To carry out its part of this response, the adrenal medulla receives input from the sympathetic nervous system through preganglionic fibers

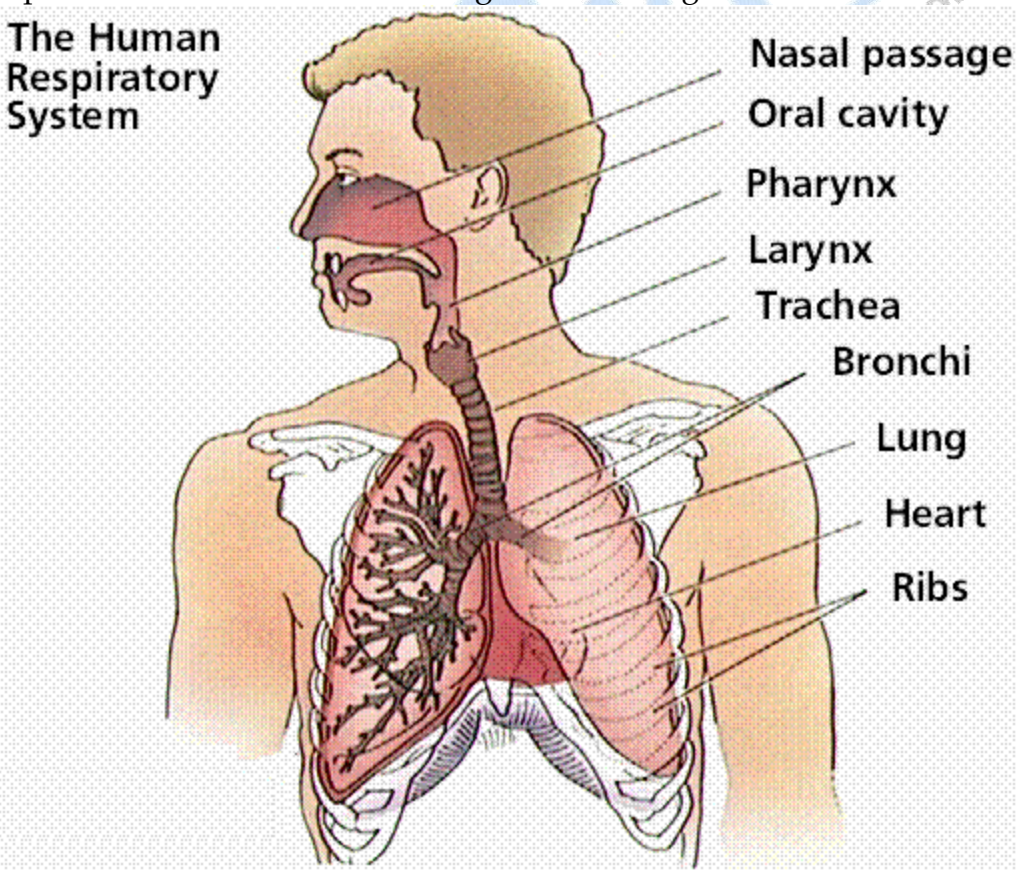
originating in the thoracic spinal cord from T5–T11.[4] Because it is innervated by preganglionic nerve fibers, the adrenal medulla can be considered as a specialized sympathetic ganglion.[4] Unlike other sympathetic ganglia, however, the adrenal medulla lacks distinct synapses and releases its secretions directly into the blood.

Cortisol also promotes epinephrine synthesis in the medulla. Produced in the cortex, cortisol reaches the adrenal medulla and at high levels, the hormone can promote the upregulation of phenylethanolamine *N*-methyltransferase (PNMT), thereby increasing epinephrine synthesis and secretion.[3]

Chapter-6
Respiration

Q –1 Explain respiratory system of mammals brifly?

Ans. The **respiratory system** is the anatomical system of an organism that introduces respiratory gases to the interior and performs gas exchange. In humans and other mammals, the anatomical features of the respiratory system include airways, lungs, and the respiratory muscles. Molecules of oxygen and carbon dioxide are passively exchanged, by diffusion, between the gaseous external environment and the blood. This exchange process occurs in the alveolar region of the lungs.



Inhalation

Inhalation is initiated by the diaphragm and supported by the external intercostal muscles Normal resting respirations are 10 to 18 breaths per minute, with a time period of 2 seconds. During vigorous inhalation (at rates exceeding 35 breaths per minute), or in approaching respiratory failure, accessory muscles of respiration are recruited for support. These consist of sternocleidomastoid, platysma, and the scalene muscles of the neck. Pectoral muscles and latissimus dorsi are also accessory muscles.

Under normal conditions, the diaphragm is the primary driver of inhalation. When the diaphragm contracts, the ribcage expands and the contents of the abdomen are moved downward. This results in a larger thoracic volume and negative pressure (with respect to atmospheric pressure) inside the thorax. As the pressure in the chest falls, air moves into the conducting zone. Here, the air is filtered, warmed, and humidified as it flows to the lungs.

During forced inhalation, as when taking a deep breath, the external intercostal muscles and accessory muscles aid in further expanding the thoracic cavity. During inhalation the diaphragm contracts.

Exhalation

Exhalation is generally a passive process; however, active or *forced* exhalation is achieved by the abdominal and the internal intercostal muscles. During this process air is forced or *exhaled* out.

The lungs have a natural elasticity: as they recoil from the stretch of inhalation, air flows back out until the pressures in the chest and the atmosphere reach equilibrium.

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. Gas exchange

The major function of the respiratory system is gas exchange between the external environment and an organism's circulatory system. In humans and mammals, this exchange facilitates oxygenation of the blood with a

concomitant removal of carbon dioxide and other gaseous metabolic wastes from the circulation. As gas exchange occurs, the acid-base balance of the body is maintained as part of homeostasis. If proper ventilation is not maintained, two opposing conditions could occur: respiratory acidosis, a life threatening condition, and respiratory alkalosis.

Upon inhalation, gas exchange occurs at the alveoli, the tiny sacs which are the basic functional component of the lungs. The alveolar walls are extremely thin (approx. 0.2 micrometres). These walls are composed of a single layer of epithelial cells (type I and type II epithelial cells) close to the pulmonary capillaries which are composed of a single layer of endothelial cells. The close proximity of these two cell types allows permeability to gases and, hence, gas exchange. This whole mechanism of gas exchange is carried by the simple phenomenon of pressure difference. When the atmospheric pressure is low outside, the air from lungs flow out. When the air pressure is low inside, then the vice versa.

Q-2 Explain respiration .

Ans- The system of organs involved in the acquisition of oxygen and the elimination of carbon dioxide by an organism. The lungs and gills are the two most important structures of vertebrates involved in the phase known as external respiration, or gaseous exchanges, between the blood and environment. Internal respiration refers to the gaseous exchanges which occur between the blood and cells. Certain other structures in some species of vertebrates serve as respiratory organs; among these are the integument or skin of fishes and amphibians. The moist, highly vascular skin of anuran amphibians is important in respiration. Certain species of fish have a vascular rectum which is utilized as a respiratory structure, water being taken in and ejected regularly by the animal. Saclike cloacal structures occur in some aquatic species of turtles. These are vascular and are intermittently filled with, and emptied of, water. It is thought that they may function in respiration. During embryonic life the yolk sac and allantois are important respiratory organs in certain vertebrates. *See also* Allantois Yolk sac.

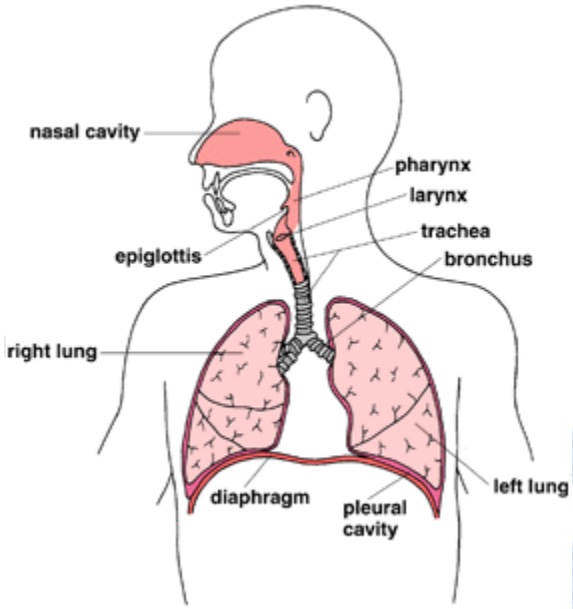
Structurally, respiratory organs usually present a vascular surface that is sufficiently extensive to provide an adequate area of absorption for

gaseous exchange. This surface is moist and thin enough to allow for the passage of gases.

The shape and volume of the lung, because of its pliability, conforms almost completely to that of its cavity. The lungs are conical; each has an apex and a base, two surfaces, two borders, and a hilum. The apex extends into the superior limit of the thoracic cavity. The base is the diaphragmatic surface. The costal surface may show bulgings into the intercostal spaces. The medial surface has a part lying in the space beside the vertebral column and a part imprinted by the form of structures bulging outward beneath the mediastinal pleura. The cardiac impression is deeper on the left lung because of the position of the heart.

For convenience the lung may be divided into anatomical areas. The bronchial tree branches mainly by dichotomy. The ultimate generations, that is, the respiratory bronchioles, alveolar ducts, and alveoli constitute all of the respiratory portion of the lung. The trachea and extrapulmonary bronchi are kept open by C-shaped bars of hyaline cartilage. When in their branching the bronchi and bronchioles are reduced to a diameter of 1 mm or less, they are then free of cartilage and are called terminal bronchioles. One of the terminal bronchioles enters the apex of a secondary lobule of the lung. These secondary lobules are anatomic units of the lung, whose hexagonal bases rest on the pleura or next to a bronchiole or blood vessel. Finer lines divide the bases of the secondary lobules into smaller areas. These are the bases of primary lobules, each served by a respiratory bronchiole.

The blood supply to the lung is provided by the pulmonary and the bronchial arteries. The nerves which supply the lung are branches of the vagus and of the thoracic sympathetic ganglia 2, 3, and 4. Efferent vagal fibers are bronchoconstrictor and secretory, whereas the afferents are part of the arc for the breathing reflex. Efferent sympathetic fibers are bronchodilators; hence, the use of adrenalin for relief of bronchial spasm resulting from asthma.



Chapter-7

Muscle contraction

Q –1 Explain structure of muscles with diagram?

Ans. **Muscle** is a contractile tissue of animals and is derived from the mesodermal layer of embryonic germ cells. Muscle cells contain contractile filaments that move past each other and change the size of the cell. They are classified as skeletal, cardiac, or smooth muscles. Their function is to produce force and cause motion. Muscles can cause either locomotion of the organism itself or movement of internal organs. Cardiac and smooth muscle contraction occurs without conscious thought and is necessary for survival. Examples are the contraction of the heart and peristalsis which pushes food through the digestive system. Voluntary contraction of the skeletal muscles is used to move the body and can be finely controlled. Examples are movements of the eye, or gross movements like the quadriceps muscle of the thigh. There are two broad types of voluntary muscle fibers: slow twitch and fast twitch. Slow twitch fibers contract for long periods of time but with little force while fast twitch fibers contract quickly and powerfully but fatigue very rapidly.

Muscles are predominately powered by the oxidation of fats and carbohydrates, but anaerobic chemical reactions are also used, particularly by fast twitch fibers. These chemical reactions produce adenosine triphosphate (ATP) molecules which are used to power the movement of the myosin heads.

A closer look at muscle anatomy shows that each muscle belly is made up of muscle cells or **fibres**. Muscle fibres are grouped into bundles (of up to 150 fibres) called **fasciculi**. Each fasiculus or bundle is surrounded by connective tissue called **perimysium**. Fibres within each bundle are surrounded by more connective tissue called **endomysium**.

Each individual fibre consists of a membrane (**sarcolemma**) and can be further broken down into hundreds or even thousands of **myofibrils**. Myofibrils are surrounded by **sarcoplasm** and together they make up the contractile components of a muscle. See the diagram below:

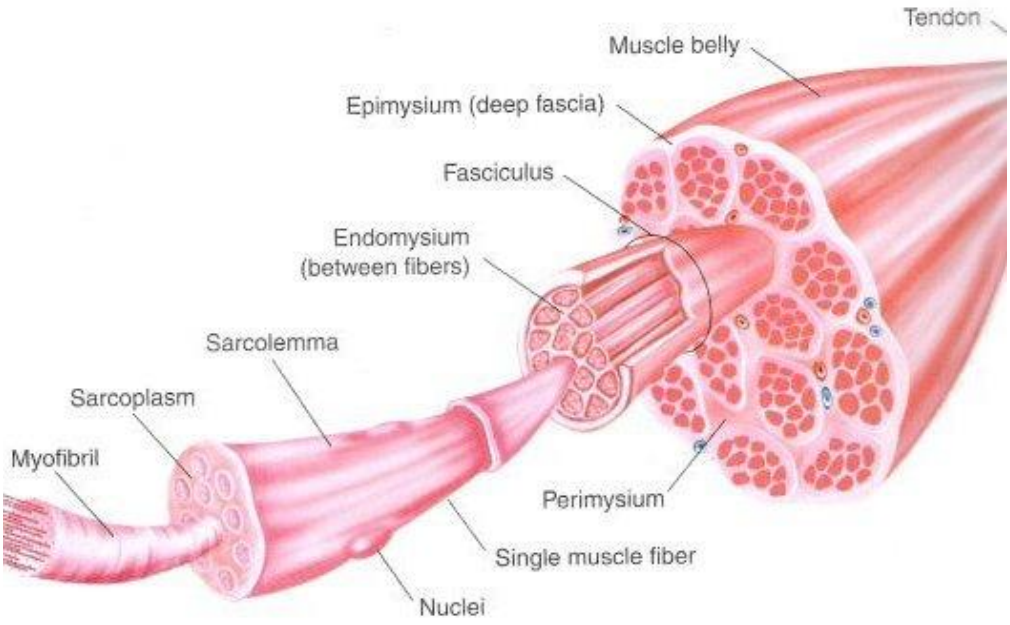


Figure 1: Muscle belly split into various component parts (from Essentials of Strength Training & Conditioning, National Strength & Conditioning Association)

Sarcoplasm contains glycogen, fat particles, enzymes and the mitochondria. The myofibrils it encases consist of two types of protien filaments or **myofilaments**. They are **actin** and **myosin**.

Myosin and actin filaments run in parallel to each other along the length of the muscle fibre. Myosin has tiny globular heads protruding from it at regular intervals. These are called **cross bridges** and play a pivotal role in muscle action. Each myofibril is organized into sections along its length. Each section is called a **sarcomere** and they are repeated right along the length of a muscle fibre. It's similar to how a meter ruler is split into centimeters and millimeters. Just as the

millimeter is the smallest function of a ruler, the sarcomere is the smallest contractile portion of a muscle fibre.

The sarcomere is often divided up into different zones to show how it behaves during muscle action. See the diagram below:

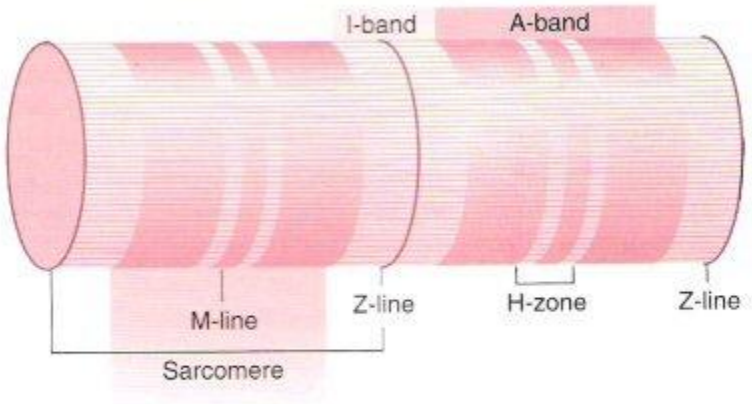


Figure 2: Myofibril divided into 2 sarcomeres

The **Z-line** seperates each sarcomere. The **H-zone** is the center of the sarcomere and the **M-line** is where adjacent myosin filaments anchor on to each other. On the diagram above the darker **A-bands** are where myosin filaments align and the lighter **I-bands** are where actin filaments align. When muscle contracts the H-zone and I-band both **decrease** as the z-lines are pulled towards each other. See the diagram below:

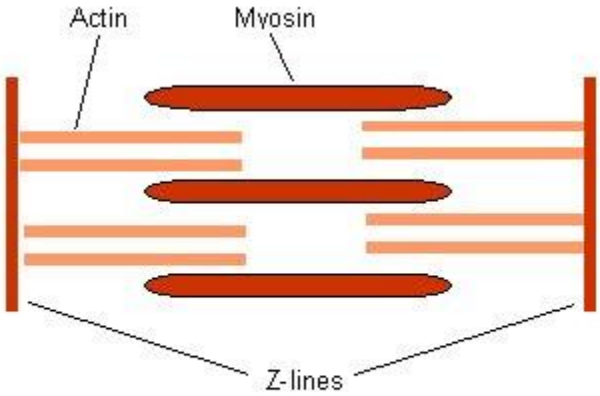
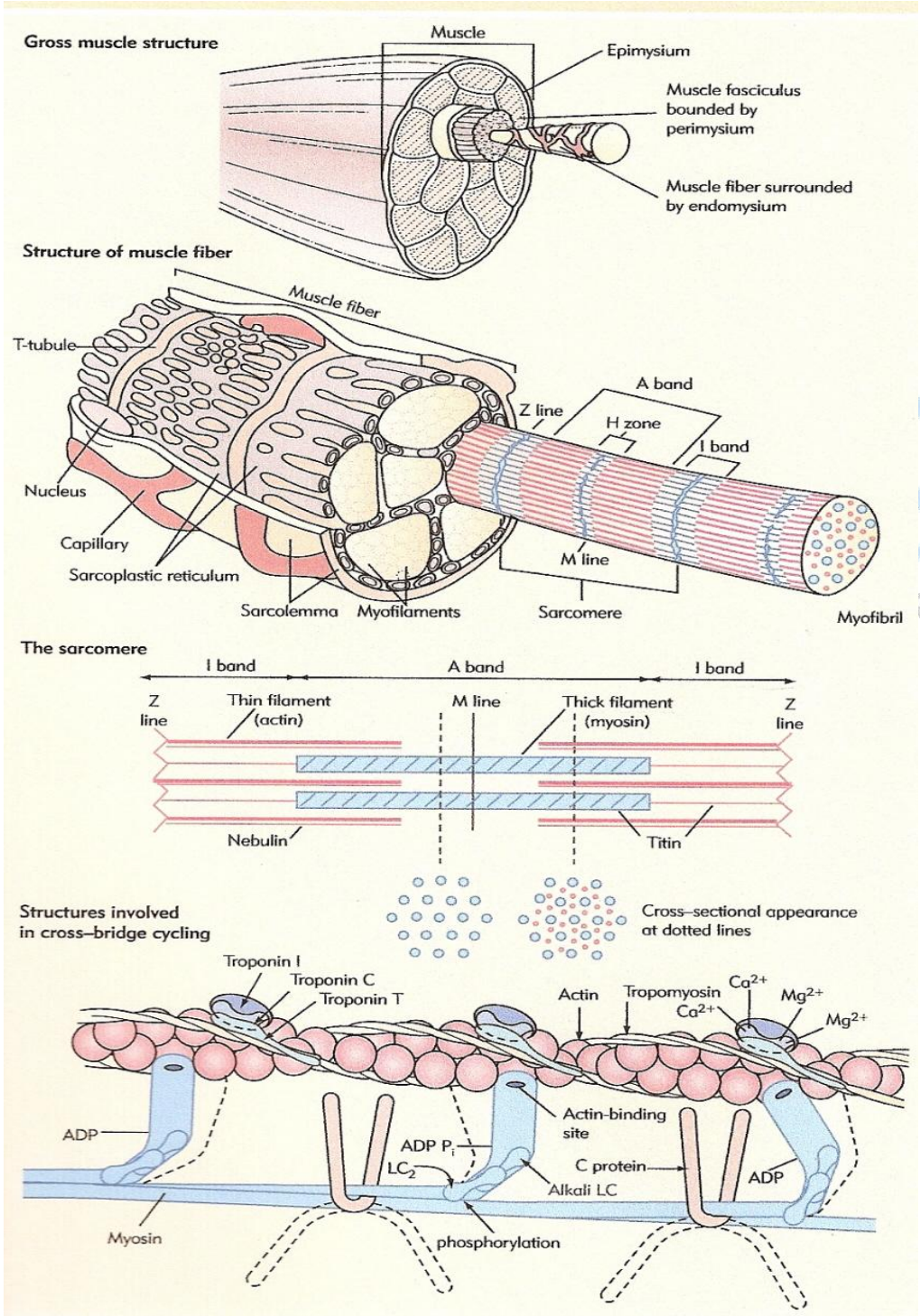


Figure 3: Arrangement of actin and myosin filaments in a single sarcomere


Gross muscle structure
Muscle
Epimysium
Muscle fasciculus bounded by perimysium
Muscle fiber surrounded by endomysium
Structure of muscle fiber
Muscle fiber
T-tubule
A band
Z line
H zone
I band
Nucleus
Capillary
Sarcoplastic reticulum
M line
Sarcolemma
Myofilaments
Sarcomere
Myofibril
The sarcomere
I band
A band
I band
Z line
Thin filament (actin)
M line
Thick filament (myosin)
Z line
Nebulin
Titin
Structures involved in cross–bridge cycling
Cross–sectional appearance at dotted lines
Troponin I
Troponin C
Troponin T
Actin
Tropomyosin
Ca^{2+}
Mg^{2+}
Ca^{2+}
Mg^{2+}
Actin-binding site
ADP
ADP P_i
LC_2
C protein
Alkali LC
ADP
Myosin
phosphorylation

Types

Types of muscle (shown at different magnifications)

There are three types of muscle:

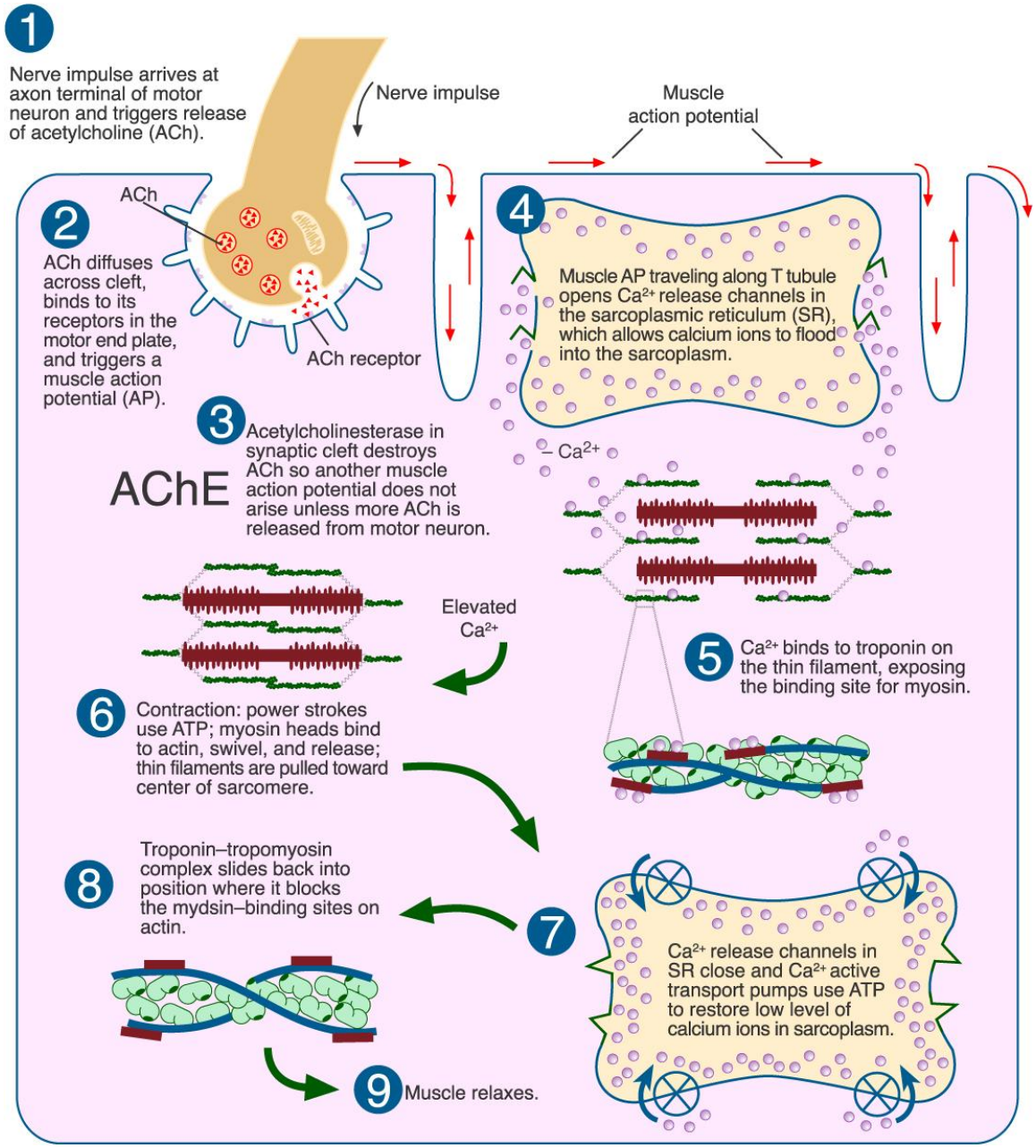
- **Skeletal muscle** or "voluntary muscle" is anchored by tendons (or by aponeuroses at a few places) to bone and is used to effect skeletal movement such as locomotion and in maintaining posture. Though this postural control is generally maintained as a subconscious reflex, the muscles responsible react to conscious control like non-postural muscles. An average adult male is made up of 42% of skeletal muscle and an average adult female is made up of 36% (as a percentage of body mass).
- **Smooth muscle** or "involuntary muscle" is found within the walls of organs and structures such as the esophagus, stomach, intestines, bronchi, uterus, urethra, bladder, blood vessels, and the arrector pili in the skin (in which it controls erection of body hair). Unlike skeletal muscle, smooth muscle is not under conscious control.
- **Cardiac muscle** is also an "involuntary muscle" but is more akin in structure to skeletal muscle, and is found only in the heart.

Cardiac and skeletal muscles are "striated" in that they contain sarcomeres and are packed into highly regular arrangements of bundles; smooth muscle has neither. While skeletal muscles are arranged in regular, parallel bundles, cardiac muscle connects at branching, irregular angles (called intercalated discs). Striated muscle contracts and relaxes in short, intense bursts, whereas smooth muscle sustains longer or even near-permanent contractions.

Skeletal muscle is further divided into several subtypes:

- Type I, slow oxidative, slow twitch, or "red" muscle is dense with capillaries and is rich in mitochondria and myoglobin, giving the muscle tissue its characteristic red color. It can carry more oxygen and sustain aerobic activity.
- Type II, fast twitch muscle, has three major kinds that are, in order of increasing contractile speed:
    - Type IIa, which, like slow muscle, is aerobic, rich in mitochondria and capillaries and appears red.
    - Type IIx (also known as type IId), which is less dense in mitochondria and myoglobin. This is the fastest muscle type in humans. It can contract more quickly and with a greater amount of force than oxidative muscle, but can sustain only short, anaerobic bursts of activity before muscle contraction becomes painful (often incorrectly attributed to a build-up of lactic acid). N.B. in some books and articles this muscle in humans was, confusingly, called type IIB.
    - Type IIb, which is anaerobic, glycolytic, "white" muscle that is even less dense in mitochondria and myoglobin. In small animals like rodents this is the major fast muscle type, explaining the pale color of their flesh.

Q-2 Explain excitation contraction coupling of muscles in detail



Sketal muscles:-

method of excitation contraction coupling relies on the ryanodine receptor being activated by a domain spanning the space between the T tubules

and the sarcoplasmic reticulum to produce the calcium transient responsible for allowing contraction.

1. The alpha motor neuron produces an action potential that propagates down its axon to the neuromuscular junction.
2. The action potential is sensed by a voltage-dependent calcium channel which causes an influx of Ca^{2+} ions which causes exocytosis of synaptic vesicles containing acetylcholine.
3. Acetylcholine diffuses across the synapse and binds to nicotinic acetylcholine receptors on the myocyte, which causes an influx of Na^{+} and an efflux of K^{+} and generation of an end-plate potential.
4. The end-plate potential propagates throughout the myocyte's sarcolemma and into the T-tubule system.
5. The T-tubule contains dihydropyridine receptors which are voltage-dependent calcium channels and are activated by the action potential.
6. The dihydropyridine receptors transmit the voltage-mediated signal through a mechanical linkage to the ryanodine receptors in the sarcoplasmic reticulum.
7. Ryanodine receptors undergo a conformational change that opens their channel.
8. Opening of the Ryanodine receptors causes and flow of Ca^{2+} from the sarcoplasmic reticulum into the cytoplasm. In this release, Ca^{2+} unbinds from the calcium-binding protein called calsequestrin.
9. Ca^{2+} released from the sarcoplasmic reticulum binds to Troponin C on actin filaments, which subsequently leads to the troponin complex being physically moved aside to uncover cross-bridge binding sites on the actin filament.
10. By hydrolyzing ATP, myosin forms a cross bridges with the actin filaments, and pulls the actin toward the center of the sarcomere resulting in contraction of the sarcomere.
11. Activation of the cross-bridge cycling *may* induce a shortening of the sarcomeres and the muscle as a whole, but not if the tension is insufficient to overcome the load imparted on the muscle.
12. Simultaneously, the sarco/endoplasmic reticulum Ca^{2+}-ATPase actively pumps Ca^{2+} back into the sarcoplasmic reticulum where Ca^{2+} rebinds to calsequestrin.

13. With Ca^{2+} no longer bound to troponin C, the troponin complex slips back to its blocking position over the binding sites on actin.
14. Since cross-bridge cycling is ceasing then the load on the muscle causes the inactive sarcomeres to lengthen.

Cardiac muscle

In cardiac muscle, the method is dependent on a phenomenon called calcium-induced calcium release, which involves the conduction of calcium ions into the cell triggering further release of ions into the cytoplasm (about 75% of calcium present in the cytoplasm during contraction is release from the sarcoplasmic reticulum).

1. An action potential is induced by pacemaker cells in the Sinoatrial node or Atrioventricular node and conducted from non-contractile cardiac myocytes to contractile cells through gap junctions.
2. The action potential triggers L-type calcium channels during the plateau phase of the cardiac action potential, causing a net flux of calcium ions into the cardiac myocyte.
3. The increase in intracellular calcium ions is detected by ryanodine receptors in the membrane of the sarcoplasmic reticulum which transport calcium out into the cytosol in a positive feedback physiological response.
4. The cytoplasmic calcium binds to Troponin C, moving the troponin complex off the actin binding site allowing the myosin head to bind to the actin filament.
5. Using ATP hydrolysis the myosin head pulls the actin filament to the centre of the sarcomere.
6. Intracellular calcium is taken up by the sarco/endoplasmic reticulum ATPase pump into the sarcoplasm, or ejected from the cell by the sodium-calcium exchanger or the plasma membrane calcium ATPase.
7. Intracellular calcium concentration drops and troponin complex returns over the active site of the actin filament, ending contract

Q-3 Describe the sliding filament theory of muscles.

Ans- ***The sliding filament theory***

Process of movement

Depiction of the contraction of a muscle through the overlap of thick and thin filament fiber

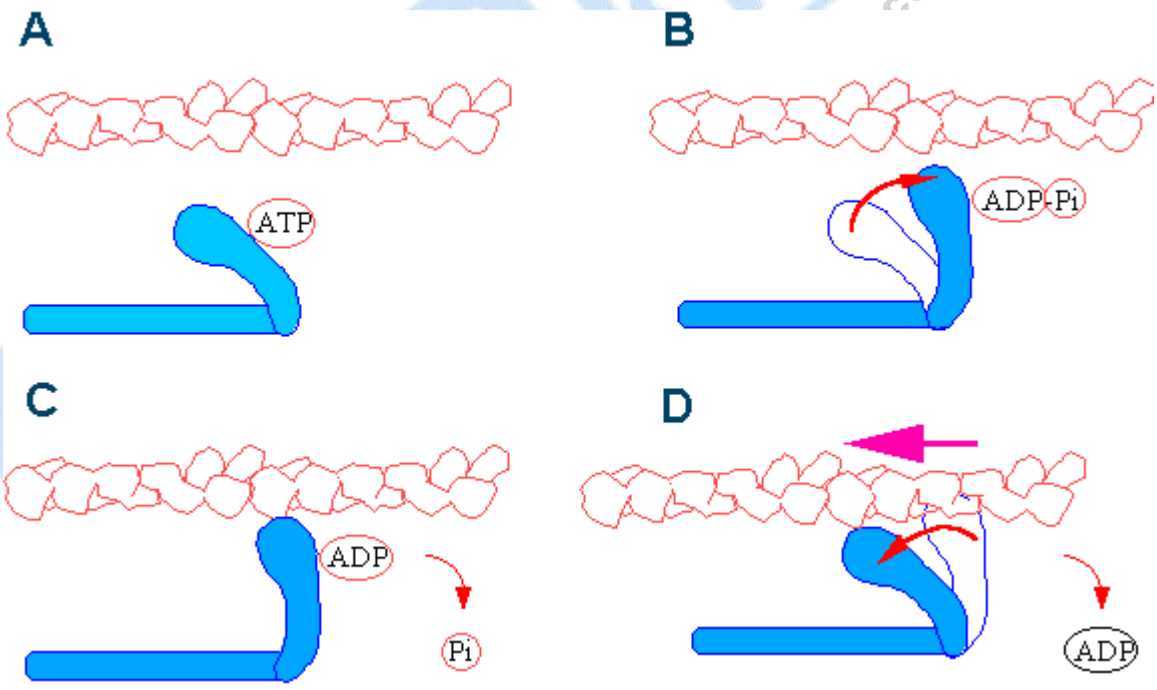
Myosin is a molecular motor that acts like an active ratchet. Chains of actin proteins form high tensile passive 'thin' filaments that transmit the force generated by myosin to the ends of the muscle. Myosin also forms 'thick' filaments. Each myosin 'paddles' along an actin filament repeatedly binding, ratcheting and letting go, sliding the thick filament over the thin filament. Calcium ions are released. This calcium bonds to troponin, allowing the myosin head to bind with the binding site.

1. Myosin heads bind to the passive actin filaments at the myosin binding sites.
2. Upon strong binding, myosin and actin undergo an isomerization (myosin rotates at the myosin-actin interface) extending an extensible region in the neck of the myosin head.
3. Shortening occurs when the extensible region pulls the filaments across each other (like the shortening of a spring). Myosin remains attached to the actin.
4. The binding of ATP allows myosin to detach from actin. While detached, ATP hydrolysis occurs "recharging" the myosin head. If the actin binding sites are still available, myosin can bind actin again.
5. The collective bending of numerous myosin heads (all in the same direction), combine to move the actin filament relative to the myosin filament. This results in muscle contraction.

All muscle cells are composed of a number of actin and myosin filaments in series. The basic unit of organisation of these contractile proteins in striated muscle cells (i.e., the cells that compose cardiac and skeletal muscle, but not in smooth muscle tissue) is called the sarcomere. It consists of a central bidirectional thick filament flanked by two actin filaments, orientated in opposite directions. When each end of the myosin

thick filament ratchets along the actin filament with which it overlaps, the two actin filaments are drawn closer together. Thus, the ends of the sarcomere are drawn in and the sarcomere shortens. Sarcomeres are connected together by so-called 'Z lines', which anchor the ends of actin filaments in such a way that the filaments on each side of the Z line point in opposite directions (with reversed polarity). By this means, sarcomeres are arranged in series. When a muscle fiber contracts, all sarcomeres contract simultaneously so that force is transmitted to the fiber ends.

Physiologically, this contraction is not uniform across the sarcomere; the central position of the thick filaments becomes unstable and can shift during contraction. However the actions of elastic proteins such as Titin are hypothesised to maintain uniform tension across the sarcomere and pull the thick filament into a central position.



Pre-process of movement

If the process of movement were to continue constantly, all muscles would constantly be contracted. Therefore, the body needs a way to control the

ability of myosin to bind to the actin. This is accomplished by the introduction of calcium into the cytoplasm of the muscle cell.

1. When the muscle does not need to contract (is in a resting state), thin strands of a protein called tropomyosin are wrapped around the actin filaments, blocking the myosin binding sites. This inhibits the myosin from binding to actin, and therefore causes a chain of events leading to muscle relaxation.
2. Molecules called troponin are attached to the tropomyosin.
3. When calcium is introduced into the muscle cell (fiber), calcium ions bind to troponin molecules.
4. Calcium binding changes the shape of troponin, causing tropomyosin to be moved deeper into the groove of the actin dimer, therefore causing the myosin binding sites on the actin to be exposed.
5. Myosin binds to the now-exposed binding sites, and muscles contract via the sliding-filament mechanism.

Nerve impulses affect the way in which calcium bonds to the troponin.

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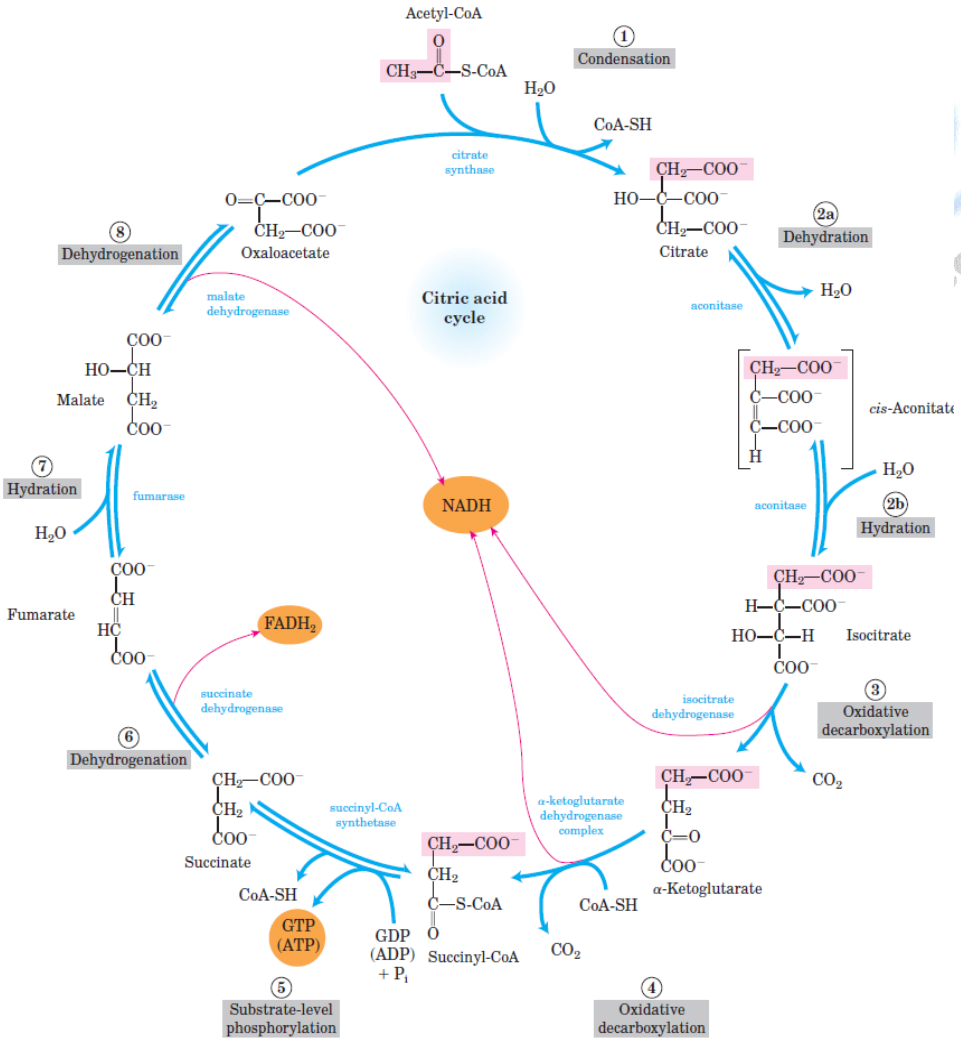
Chapter-8
Biochemistry

Q-1 Draw the diagram of citric acid cycle.

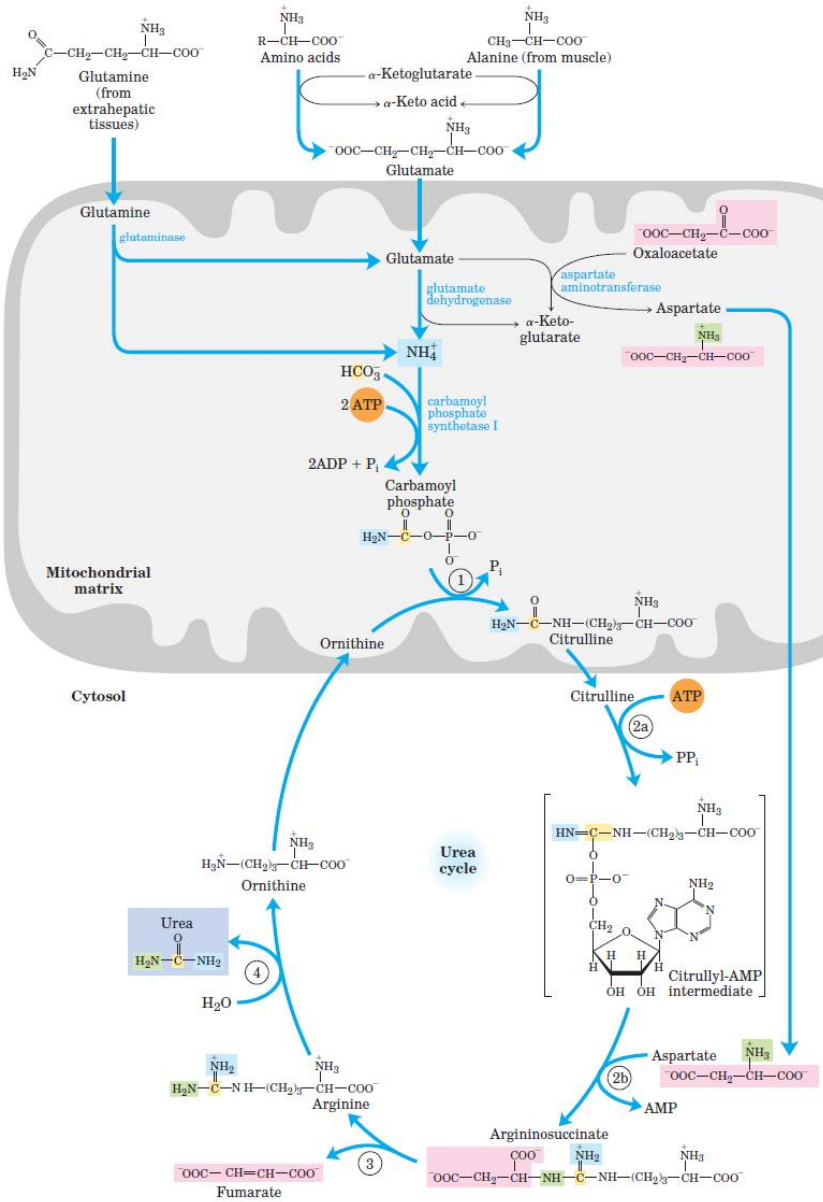
Ans



Citric acid cycle

Q-2 Draw the diagram of ornithine cycle?

Ans-



Ornithine cycle

Glossary

- **Accelerator center**:- One of two control centers in the brain which transmits nits impulse along the sympathetic nerves to the pacemaker of the heart, causing heart beat rate to increase.
- **ACTH (Adrenocorticotropic hormone)** Hormone secreted by the anterior pituitary which induces the adrenal cortex to produce corticoids.
- **Active transport: -** A process, occurring at the cell membrane, in which a cell expends energy to move a particle or ion through the membrane often against a concentration gradient.
- **Blood:-** A liquid connective issue consisting of erythrocytes, leucocytes, and platelets suspended in a liquid mantrix, the plasma.
- **Blood pressure:-** Force exerted against artery walls by blood being pumped from the heart.
- Bowman's Capsule:- Cup-like body where wastes, salts and fluid are filtered from the blood by the kidney.
- **CAMP (Cyclic adenosine monophosphate):-** Nucleotide which may serve as a messenger within cells, receiving hormonal messages and then stimulating cellular activities.
- **Catalyst: -** A substance that increases the rate at which other substances react but is itself not altered by the reaction.

- **Central nervous system (CNS):-** In vertebrates, the brain and spinal cord, containing the cell bodies and most of the neurons, and exerting a great deal of control over the rest of the nervous system.
- **Cerebellum:-** An expansion of the dorsal side of the brain near its hind end; it is a coordinating center for proprioceptive stimuli and complex muscular movements.
- **Conditioned reflex:-**A learned, automatic response to a given stimulus.
- **Countercurrent flow:-** Mechanism that accounts for efficient gas exchange in gills; the flow of water is in the opposite direction to the flow of blood in the capillaries.
- **Diabetes insipidus: -** A disease in which kidneys do not reabsorb water normally so urine is highly diluted; can be caused by tumor in posterior pituitary gland.
- **Diabetes mellitus:-** Disease caused by inadequate insulin secretion in which sugar is improperly metabolized; high bold sugar, weakness, frequent urination and some times death are the result.
- **Diastole**:- Relaxation period after contraction of the heart.
- **Digestion:-**The Process in which food is broken down by enzymes in the digestion system into molecules which may be absorbed and utilized by cells.
- **Erythropoietin:-** Hormone formed in the blood by the action of an enzyme produced in the kidney on a serum factor produced in the liver. The hormone stimulates the production of red blood cells and bone marrow, particularly during conditions of oxygen deficiency.

- **Feedback:** - A regulatory process in which the output returns to the original system as input, for instance when the concentration of an end product of a reaction serves to inhibit or stimulate the rate.
- **Glucogenesis :-** Formation of glucose from carbohydrates.
- **Homeostasis:**-The maintenance of optimal internal living conditions through continuous adjustment of life processes.
- **Hypertonic:-** Containing more non-penetrating particles on one side of semi permeable membrane than on the other side and thus exerting more osmotic pull.
- **Hypotonic:**- containing fewer non-penetrating particles on one side of a semi permeable membrane than on the other side and thus exerting less osmotic pull.
- **Intracellular digestion**:- The breakdown of food particles whic occurs within a cell, a method generally employed by unicellular organism like the amoeba. Food is surrounded and drawns into cells in a food vacuole and then broken down by enzyme secreted into the vacuole by the cells.
- **Isotonic:** - Containing equal amounts of non-penetrating particles
- **Lymph:**- Clear tissue fluid resembling blood plasma. Consists of fluids which filter through the walls of the blood capillaries.
- **Nucleotide:-** Consisting of a nitrogen- Containing base (a Purine or pyrimidine), a sugar (ribose or deoxyribose) and a phosphate, this class of molecule is involved in the transfer of energy within the cell and the formation of nucleic acids.
- **Osmosis:**-The diffusion of water molecules through a semi permeable membrane.The water molecules move from an area of

Higher concentration to an area of lower concentration of water.

- **Pacemaker:-** Tissue in the muscles of the heart which controls heartbeat rate.
- **Phagocytosis:-** The process by which large particles are enveloped in a vacuole and drown into the cell.
- **Pinocytosis:-** The process conducted by a cell in which liquid or small particles are enveloped in a vacuole and brought into the cell.
- **Placenta: -** A temporary reproductive organ of most mammals, by which the embryo is attached to the wall of the uterus and through which homeostatic exchange takes place between the mother and embryo.
- **Portal system:-** Vascular pathways with capillaries at both ends; for instance, the hepatic portal system from intestines to liver.
- **Reflex:-** A response to a specific stimulus. A reflex may be simple or complex, unconditioned or conditioned.
- **Reflex arc:-** A series of neurons transmitting an excitation from a receptor through the central nervous system to an effectors. The simplest are is monosynaptic, since only two neurons are involved a sensory and a motor neurons. Arcs increase in complexity with the number and type of interneuron between the receptor and motor neurons.
- **Refractory Period:-** Period of approximately one millisecondduring which a neuron is incapable of responding to another stimulus regardless of its strength.
- **Respiration: -** The processes by which a cell releases the energy In glucose, producing ATP. These processes include aerobic respiration glycolysis, Krebs cycle and electron and hydrogen transport; and anaerobic

respiration, or fermentation. Also refers to the intake of O_2 and release of CO_2 in breathing.

- **Simple reflex**:- Innate automatic response involving stimulus to a single reflex arc.
- **Synapse:-** The region of contact between two succession neurons.
- **Synapsis**:- The intertwining of the Chromatids of paired chromosomes during prophase I of meiosis.
- **Threshold:-** The quantitative value that must be exceeded if a cell is to generate an action potential in response to a stimulus.
- **Tissue:-** Sheets or aggregates of specialized cells that are similar in structure and function.
- **Ultra filtration :-** A renal process by which the fluid component of the blood with its salts, wastes and other chemical constituents, but not the larger protein components are filtered into the nephoron by the hydrostatic pressure in the glomerules.
- **Vitamin** : -An organic compound essential in the diet in small amounts. A vitamin by definition cannot be synthesized by the organism which requires it.

Objective type Question(MCQ)

1- Secretion and cholecystokirin are two hormones involved in digestion. They are secreted by:
(1) Oesophagus (2) Stomach
(2) Duodenum (4)Ileum (3)

2- A person deficient in the visual pigment rhodopsim should be advised to take more of:-
(1) Apple and grapes
(2) Carrot and papaya (2)
(3) Mango and Potato
(4) Guava and banana

3- Ph of gastric juice in stomach is:-
(1) 1.5-3.0 (1)
(2) 5-6.8
(3) 7.0-9.0
(4) 6 -8.0

4- Which is incorrectly matched?
(1) Rennin-Liver
(2)Ptyalin-Mouth (1)
(3)Pepsin-Stomach
(4)Trypsin-Intestine

5- Pepsinogen is secreted by
(1) Oxyntic cells
(2)Zymogene cells (2)
(3)Mucous neck cells
(4)Argentaffin cells

6- Kupffer cells are found in:-
(1)Liver (2)Pancreas
(3)Small intestine (4)Large intestine (1)

7- Haemocyanin Occurs in:-
(1)Annelid (2)Insects
(3)Mollusca (4)Echinodermats (3)

8- Vital capacity of lung in equal to:-
(1)IRV+ERV+TV (2)IRV+ERV+TV-RV
(3)IRV+ERV+TV+RV (4)IRV+ERV (1)

9- Hiccup is due to the activity of:-
(1) Intercostals muscles
(2) Food in air tract
(3) Diaphragm
(4) Inadequate oxygen in environment (3)

10- Cardiac cycle in man is competed in:-
(1)0.5sec. (2)1.0 sec
(3)1.2sec (4)0.8 sec (4)

11- Pulmonary artery drains the deoxygenated blood from:-
(1)Right atrium (2)Right Ventricle
(3)Left atrium (4)Left ventricle (2)

12- The absence of which clotting factor leads to haemophilia –A:-
(1)Factor VII (2)Factor VIII
(3)Factor IX (4)Factor X (2)

13- Distal Convoluted Tubule is permeable to:-
(1)Na+ (2)K+ (3)Cl– (4)All of these (4)

14- In kidney, glucose is reabsorbed mainly by :-
(1) Bowman's Capsule (2)Loop of Henle
(3)PCT (4)DCT (3)

15- Number of cervical vertebrae in mammals is:-
(1) 5 (2)6 (3)7 (4)11 (3)

16-Knee joint is :-
(1) Synovial joint (2)Cartilaginous joint
(3) Hyaline joint (4)Fibrous joint (1)

17- What Connects muscle to bone :-
(1) Ligament (2) Cartilage
(3)Tendon (4) Sarcomere (4)

18-The main function of cerebellum is:-
(1) Vision (2)Hearing
(3)Balancing (4)Memory (3)

19- Which one is not a reflex action:-
(1) Yawning (2)Weeping
(3)Coughing (4)Sneezing (1)

20- During emergency situations the increase in heart rate, cardiac output, blood pressure and blood sugar level is due to action of hormone called:-
(1) Oxytocin (2) Aldosterone
(3)Nor epinephrine (4)ADH (3)

21 Glomerular area of adrenal cortex is responsible for:-
(1) Water and electrolyte balance
(2) Carbohydrate Metabolism
(3) Steroid hormone secretion
(4)Blood pressure (1)

22 Osmoregulation is the function of
(1) Prolactin (2)Oxytocin
(3)Vasopressin (4)None of these (3)

23 Which enzyme converts glucose into alcohol:-
(1) Zymase (2) Diastase

(3) Invertase (4)Lipase (1)

24 The net gain of ATP molecules in glycolysis is :-
(1) 8 (2) 2
(3) 4 (4) 0 (2)

25 How many ATP molecules could maximally be generated from one molecule of glucose. If the Complete Oxidation of one mole of glucose to CO_2 and the yields 686 Kcal and the useful chemical energy available in the high energy phosphate bond of one mole of ATP is 12 kcal ?
(1) Two (2) Thirty
(3) Fifty seven (4)One (2)

26 Sucrose, a common table sugar, is composed of :-
(1) Glucose +Fructose (2) Glucose + Galactose
(3) Fructose + Galactose (4) None of these (1)

27 Kwashiorkor disease occurs due to deficiency of :-
(1) Proteins (2) Fats
(3)Sugars (4) Hormone (1)

28 Heart of heart of:-
(1) SA node (2) AV node
(3) Bundle of His (4) Purkinje fibers. (1)

29 In adult man normal blood pressure is
(1)100/80 mm Hg (2)120/80 mm Hg
(3)100/120 mm Hg (4)80/120mmHg (2)

30 Respiratory Quotient is defined as:
(1) $\frac{\text{Volume of } Co_2 \text{ formed}}{\text{Volume of } Co_2 \text{ used}}$ (2) $\frac{\text{Volume of } Co_2 \text{ formed}}{\text{Volume of } O_2 \text{ used}}$

(3) $\frac{\text{Volume of } O_2 \text{ formed}}{\text{Volume of } Co_2 \text{ used}}$ (4) $\frac{\text{Volume of } O_2 \text{ formed}}{\text{Volume of } N_2 \text{ used}}$ (2)

31 Chloride shift occurs in respond to :-
(1) HCO_3^- (2) K^+ (3) H^+ (4) Na^+ (1)

32 Amount of oxygen absorbed by one gram of hemoglobin is:-

(1) 1.34 ml (2) 13.4 ml (3) 20ml (4) 134ml (3)

33 Cobalt is essential for the synthesis of vitamin :-
(1) C (2)B_1 (3) B_6 (4)B_{12} (4)

(34) Gastrin hormone is secreted by :-
(1) Liver (2) Pancreas (3) Stomach (4) Intestine s(3)

(35) During activation of nerve, the impulse is conducted in a fiber by :
(1) More movement of Na^+ toward inside and K^+ outside
(2) Less Na^+ Coming out and more K^+ coming in
(3) Equal movement of both Na^+ and K^+ ions
(3) More Movement of K^+ inward and Na^+ outwards.
(1)

Case study

Removal of the posterior pituitary has only a minor effect on the release of the hormone oxytocin and vasopressin. However removal of the anterior pituitary cancels completely the production of its hormones **why?**

Ans. Oxytocin and vasopressin are produce in the posterior pituitary along nerve cells that originate in the hypothalamus and are release units the capillaries that surround this gland. Thus removal of the posterior pituitary will not impair oxytocin and vasopressin secretion. Its contrast, the anterior pituitary hormones are produced by pituitary cells in response to stimulation by the hypothalamus. Hence the loss of the anterior pituitary cancels hormone secretion.

B.Sc. Part-II Examination, 2012
Zoology
Second Paper(Animal physiology and biochemistry)

Time allowed: 3hour – MM:33

(1) No supplementary answer book will be given to any candidate. Hence the candidate should write the answer precisely in the main answer book only:-
(2) All the parts of the questions should be answered at one place in the answer-book. One complete question should not be answered at different places in the answer book.

Question No. 1 in part I compulsory Attempt four questions from part II, selecting at least one question from each section. All question carry equal marks.

Part I

1. Answer the following question in two or three lines (maximum 25 words)-

   (a) How does bite juice help in digestion of fats ?
   (b) What do you mean by neurogenic and myogenic heart?
   (c) Explain the function of transverse tubules (T- tubules) in skeletal muscle fibers.
   (d) What are the functions of ATP in metabolism?
   (e) Explain the role of hypothalamus hypophyseal postal systems.
   (f) Compare and contrast the functions of insulin and glucagon hormones.
   (g) What is resting membrane potential?
   (h) Mention high threshold substances present in the glomerular filtrate?
   (i) Write functions of neutrophils.

Part II
Section A

2. Describe the structure of nephron and explain the physiology of urine formation in mammals.

3. Explain the mechanism of the transportation of oxygen (O_2) and carbon dioxide (CO_2) by blood.

4. Write short notes on the following –
   (1) Osmoregulation
   (2) Heart beat
   (3) Role of pancreas in digestion.

Section – B

5. Explain the structure, chemical composition of striated, muscle fibres and briefly describe the mechanism of muscle contraction?

6. Write an account of the structure of adrenal gland and discuss the physiological function of its hormones?

7. Write the short notes on two of the followings –
   (j) Synaptic transmission
   (ii) Hormonal control of testicular function
   (iii) Lactation

Section C

8. Describe the enzymatic reactions of Krebs' cycle and add a note on its importance.
9. Write an account of transamination and deamination process and explain their importance.
10. Write short notes on any two of the following:
    (1) Biosynthesis of triglycerides
    (2) Iron metabolism in body
    (3) Biosynthesis of pyrimidine nucleotides