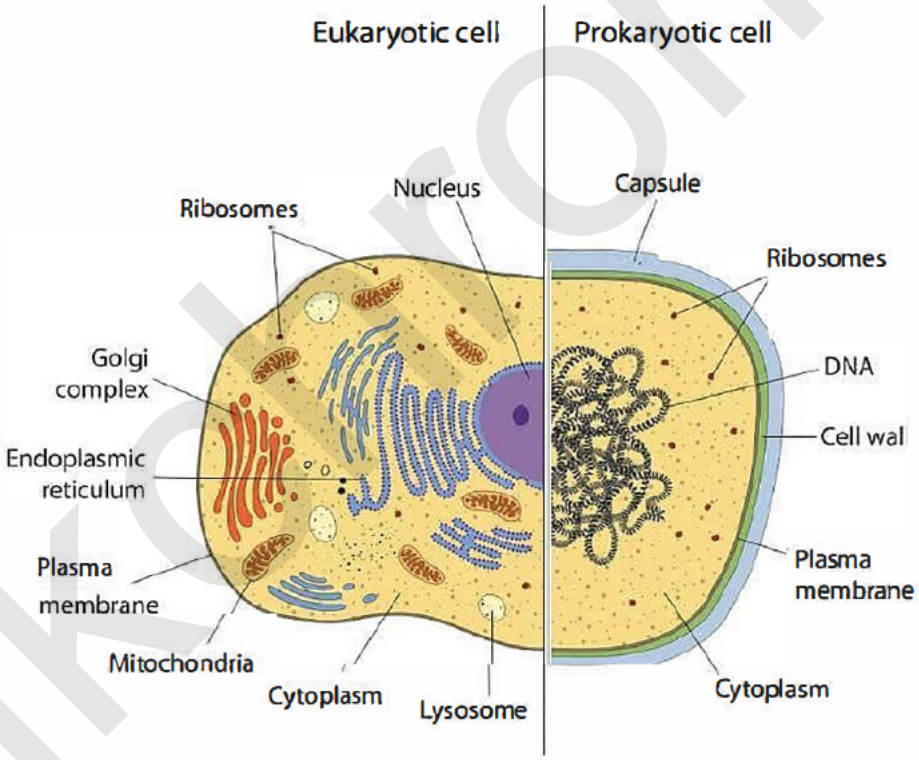
JK Chrome

NCERT Summary

Gist of Biology – 1

Components of Cell

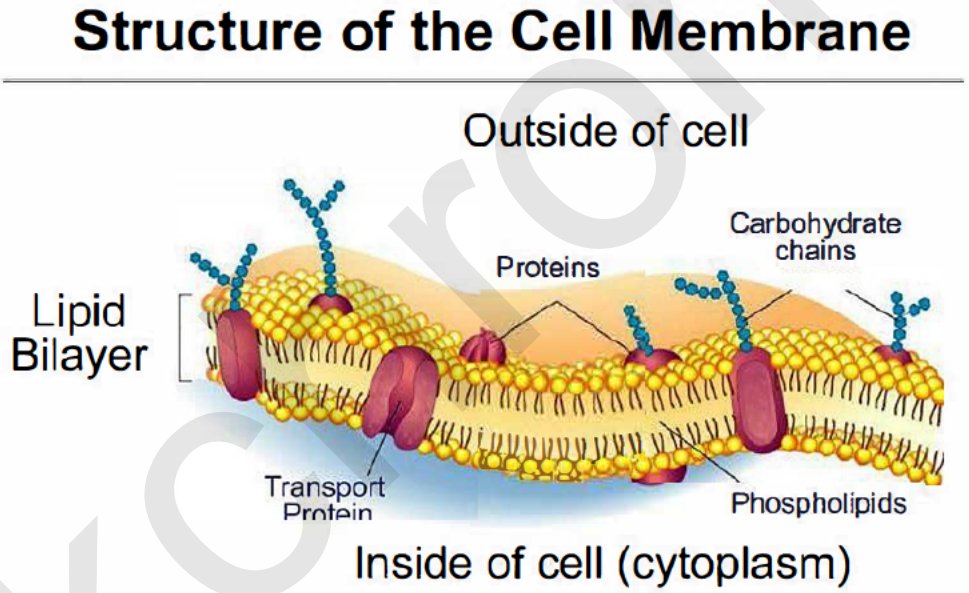
In living organisms, there are two types of cellular organizations. If we look at very simple organisms like bacteria and blue-green algae, We will discover cells that have no defined nucleus these are **prokaryotes cells**. The cells which have definite nucleus are known as a **eukaryote**.



But the thing which both have in common is that there are compartments surrounded by some type of membrane. These are called cell membranes.

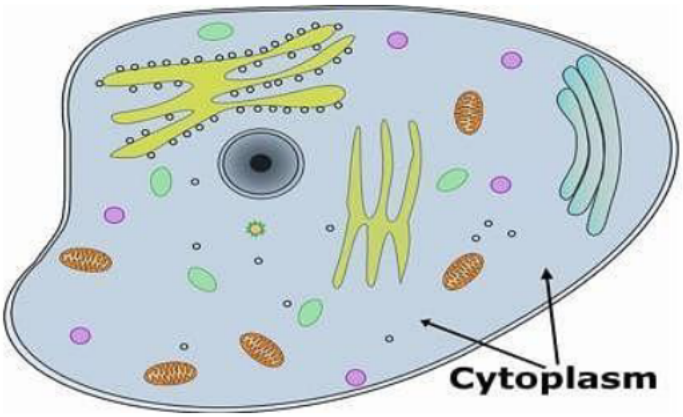
1. Cell Membranes

- It is like a plastic bag with some tiny holes that bag holds all of the cell pieces and fluids inside the cell and keeps foreign particles outside the cell. The holes are there to let some things move in and out of the cell.
- Compounds called **proteins** and **phospholipids** make up most of the cell membrane. The phospholipids make the basic bag. The proteins are found around the holes and help move molecules in and out of the cell.
- Substances like CO_2 and O_2 can move across the cell membranes by a process called **diffusion**.
- **Diffusion** is a process of movements of substance from a region of high concentration to a region where its concentration is low.
- Water also obeys the law of diffusion. The movement of water molecules is called **osmosis**.



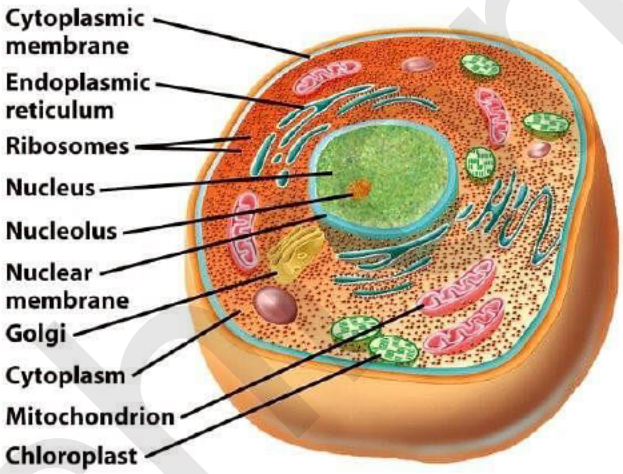
2. Cytoplasm

- It is the fluid that fills a cell. Scientists used to call the **fluid protoplasm**. Cytoplasm contains many specialized cells called organ cells. Each of these organ cells performs a specific function for the cell.



3. Cell Organelles

Organelles are living part of the cell have **definite shape, structure and functions.**



Cell Organelles

To keep their function different from each other these organelles use membranes bound with little structure within themselves.
Some of the important organelles are:

(a) Endoplasmic Reticulum

- It is a network of **tubular** membranes connected at one end to the nucleus and on the other to the plasma membranes.
- Endoplasmic reticular (ER) are two types:
  (i) Rough endoplasmic reticular (**RER**)
  (ii) Smooth endoplasmic reticulum (**SER**)

- Functions of Endoplasmic reticular (ER) are:
  (i) It forms the supporting skeleton framework of the cell.
  (ii) It provides a pathway for the distribution of nuclear material.
  (iii) It provides surface for various enzymatic reactions.

(b) Ribosomes

Synthesizes protein, and ER sent this protein in various parts of the cell. Whereas SER helps in the manufacture of fats.

- Functions of these proteins and fats:
  (i) Protein and fat (lipid) help in building the cell membranes. This process is known as **membrane biogenesis**.
  (ii) Some other proteins and fat function as enzymes and hormones.
  (iii) Smooth endoplasmic reticulum (SER) plays a crucial role in detoxifying many poisons and drugs.

(c) Golgi Apparatus

- It is found in most cells. It is another packaging organelle like the endoplasmic reticulum.
- It gathers simple molecules and combines them to make molecules that are more complex. It then takes those big molecules, packages them in vesicles and either stores them for faster use or sends them out of the cell.
- **Other functions:** Its functions include the storage modifications and packaging of products in vesicles. It is also the organelle that builds lysosomes (cells digestion machines).

(d) Lysosomes

- It is a kind of waste disposal system of the cell.
- It helps to keep the cell clean by digesting any foreign material.
- Old organs cell end up in the lysosomes. When the cell gets damaged, lysosomes may burst and the enzymes digest their own cell.
- Therefore lysosomes are also known as the "**suicide bags**" of the cell.

(e) Mitochondria

- It is known as the **powerhouse** of the cell.
- The energy required for various chemical activities headed for life is released by mitochondria in the form of ATP (adenosine triphosphate) molecules.

- ATP is known as the **energy currency of the cell**. The body uses energy is stored in ATP for making new chemical compounds and for mechanical work.
- Mitochondria are strange organelles in the sense that they have their own DNA and ribosomes, therefore mitochondria are able to make their own protein.
- Mitochondria is **absent in bacteria** and the **red blood cells** of mammals and higher animals.

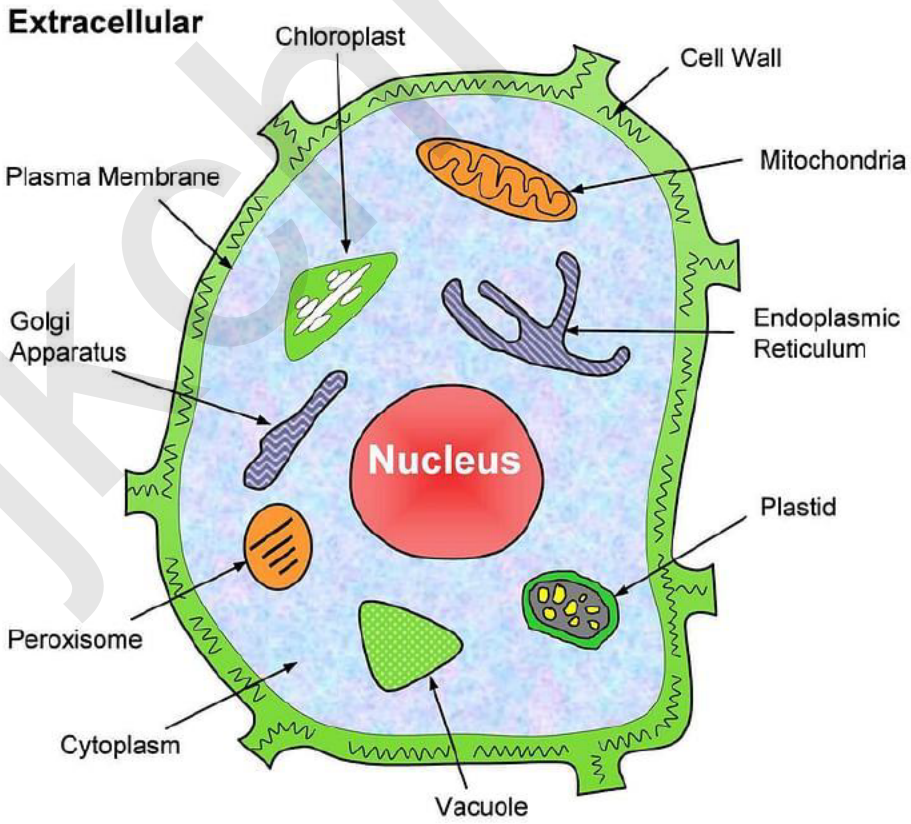
(f) Centrioles

- It is a micro-tubular structure.
- Centrioles are concerned with cell division. It initiates cell division.

(g) Plastids

- These are present only in plant cells.

<u>There are two types of plastids:</u>
(i) Chromoplasts (color plastids)
(ii) Leucoplast (white or colorless plastids)



Plastid in Plant Cell

- **Chromoplast** imparts color to flowers and fruits.
- **Leucoplasts** are in which starch, oils and protein are stored.
- **Plastids** are self-replicating. i.e. they have the power to divide, as they contain DNA, RNA and ribosomes.
- Plastids contain the pigment **chlorophyll** that is known as **chloroplast**. It is the site for photosynthesis.

The abovementioned cell organelles are the living part of the cell but there are some non – living parts within the cell-like vacuoles and granules:

(h) Vacuoles

- It is a fluid-filled space enclosed by membranes.
- It is a storage sacs for solid or liquid contents. It stores excess water, minerals, food substance, pigments and waste products.
- Its size in animal is small and in plant it is big.
- Many substances of importance in the life of the plant cell are stored in vacuoles. These are amino acids sugars. It also Contains Various organic acids and some proteins.

(i) Granules

- It is **not bounded** by any membranes.
- It store fats, proteins and carbohydrates.

4. Cell Nucleus

- The cell nucleus acts like the brain of the cell.
- It helps control eating, movement and reproduction.
- Not all cells have a nucleus.

The Nucleus contain the following components:

(a) Nuclear Envelope

- It surrounds the nucleus and all of its contents nuclear envelope is a membrane similar to the cell membranes around the whole cell.

(b) Chromatin

- When the cell is in resting state there is something called chromatin in the nucleus.

- Chromatin is made up of DNA, RNA and nucleus protein. DNA and RNA are the nucleus acids inside the cell.
- When the cell is going to divide, the chromatin becomes very compact. It condenses when the chromatin comes together we can see the chromosomes.

(c) Chromosomes

- Chromosomes make organisms what they are. They carry all the information used to help a cell grow, thrive, and reproduce.
- Chromosomes are made up of DNA.
- Segments of DNA in specific patterns are called **genes**.
- In prokaryotes, DNA floats in the cytoplasm in an area called the **nucleoid**.
- Chromosomes are not always visible. They usually sit around uncoiled and as loose shards called chromatin.
- When it is time for all cells to reproduce, they condense and wrap up very tightly. The tightly round DNA in the chromosome.
- Chromosomes are usually **found in pairs**.
- Human Beings probably have **46** chromosomes (**23** pairs).
- Peas only have 12, a dog has 78 chromosomes.
- The number of chromosomes is not related to the intelligence or complexity of the creature.

(d) Nucleolus

- It is a dense spherical granule contained within the nucleus, its size is related to the synthetic activity of the cell.
- Neurons cell have a comparatively larger nucleate than those cell have no synthetic activity.
- The nucleolus stores proteins.

Cell Division

Organisms grow and reduce through cell division. Plants continue to grow by cell division all their lives. But in most animals cells divide more slowly once the body takes shape.
<u>There are two methods of replication mitosis and meiosis:</u>

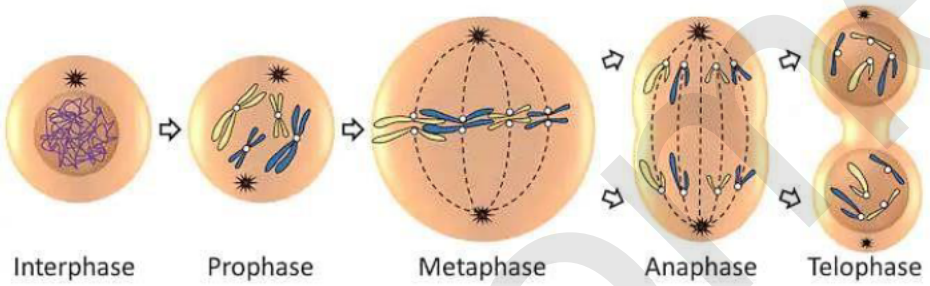
1. Mitosis

The main theme of this replication is that mitosis is the simple duplication of a cell and all of its parts. It duplicates its DNA and the two new cells (daughter cells) have

the same pieces and generic code. Beyond the idea that two identical cells are created, there are five steps in this process. You should remember the term **PMATI**. <u>It breaks down to:</u>

- Prophase
- Metaphase
- Anaphase
- Telophase

Interphase



Stages of Mitosis

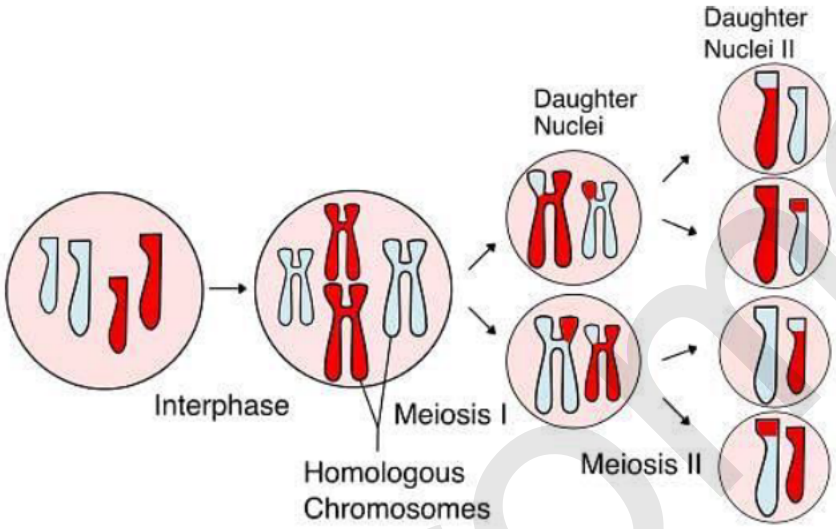
➢ **The Phases**

- **Prophase**: A cell gets the idea that it is time to divide. First it has to get everything ready. Cell needs to duplicate DNA, get certain pieces in the right position (centrioles) and generally prepare the cell for the process of mitotic division.
- **Metaphase:** The DNA lines up along a central axis and then DNA condensed into chromosomes.
- **Anaphase:** Here the separation begins. Half of the chromosomes are pulled to one side of the cell half to go the other way.
- **Telophase:** Now the division is finishing up. We have now two separate cells each with half of the original DNA.
- **Interphase:** This is the normal state of the cell.

2. Meiosis

- It's for sexual reproduction.
- The main theme of meiosis is that there are **two** cell division.
- Mitosis has one division and meiosis has two divisions in this process four cells are created where there was originally one.
- Meiosis happens when it's time to reproduce an organism.

- The steps of meiosis are very simple. When we break it down its just two PMATI's in a row. The interphase that happens between the two processes is very short and the DNA is not duplicated.
- Meiosis is the great process that shuffles the cell's gene-sis around. Instead of creating two new cells with equal number of chromosomes (like mitosis).



Meiosis

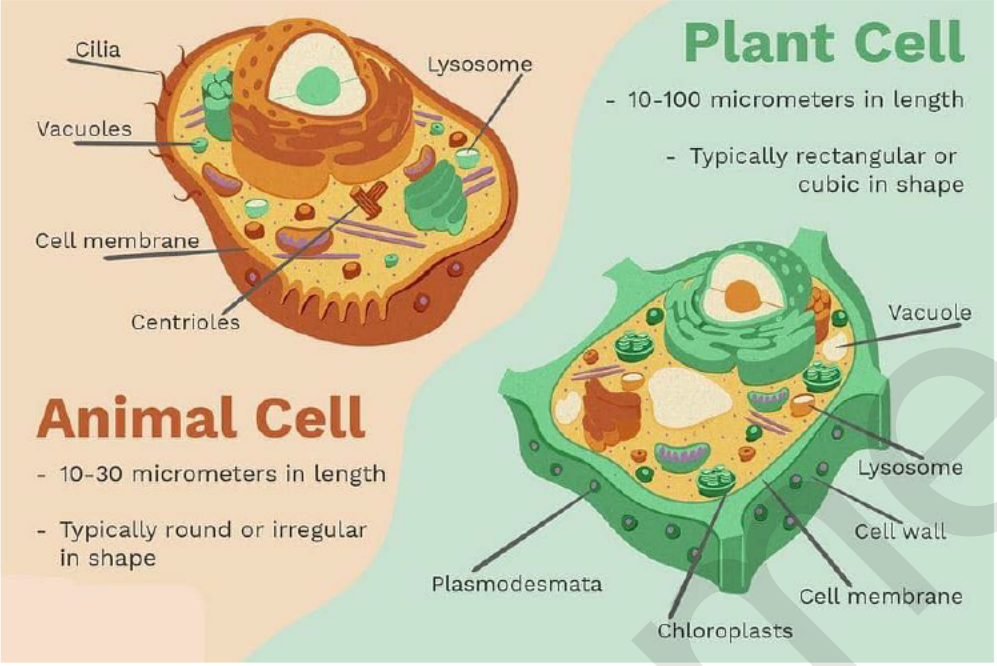
- The cell does a second division soon after the first. This second division divides the number of chromosomes in half.
- Scientists call, this process as meiosis I and II, but its just two PMATI's.
- **Meiosis I**
  - This is basically live PMATI of regular mitosis.
  - Pairs of chromosomes are lined up at the center of the cell and then pulled to each side.
  - Meiosis is a bit different because there are something called **crossing-over** happens with the DNA.
  - This crossing over is an exchange of genes. The genes are mixed up not resulting in a perfect duplicate like mitosis.
  - The cell divides, having two new cells with a pair of chromosomes each. Since this is meiosis. There is very short interphase and division begins again.
- **Meiosis II**
  - In this division the DNA that remains in the cell begins to condense and form short chromosomes and the center of the cell and the centrioles are in position for the duplication.
  - Each one **splits into two pieces**. They don't divide up the DNA between the cells. They split the DNA that exists.

- Each daughter cell will get one half of the DNA needed to make a functioning cell.
- When it's all over we left with **four haploid cells** (means half the regular number) that are called **gametes**.
- The eventual purpose of the gametes will be to find other gametes with which they can combine.

➢ Some Important Facts Regarding Cells

- Nerve cells in animals are the longest cells.
- Smallest human cell is red blood cell.
- Largest human cell is female ovum.
- The single largest cell in the world is of an ostrich.
- The smallest cells are those of the **mycoplasma**.
- Every minute about 3 millions cells in our body die.
- Sieve tube in plants and the mature mammalian red blood cells do not have a nucleus.
- The red blood cell carries respiratory gases.
- Sieve cells in plants transport nutrients in plants.
- The lysosomal enzymes of the sperm cells digest the limiting membranes of the ovum (egg). Thus the sperm is able to enter the ovum.
- During the transformation of a tadpole into a frog. The embryonic tissues like gills and tail are digested by the lysosome.
- Mitochondria contain DNA, hence capable of replication.
- Matrix is a transparent, homogenous semi-fluid substance. In its active state. It remains saturated with water.

Comparisons between Plant Cell and Animal Cell



➢ **Similarities**

Part of cell	**Plant**	**Animal**
Cell membranes	present	present
Endoplasmic reticulum	present	Present but absent in RBC and embryonic cell.
Ribosome	present	Present
Mitochondria	present	Present but absent in RBC and bacteria
Golgi complex	present	Present but absent in mature RBC
Nucleus	present	present
Granules.	present	present

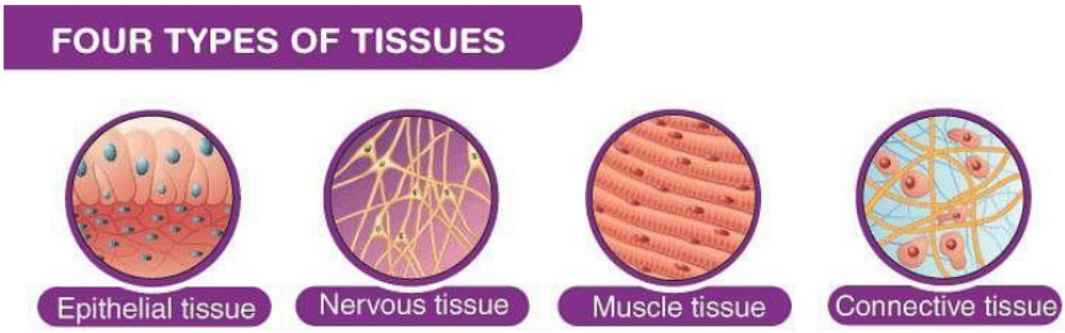
The nucleus is **absent** in mature mammalian red blood cells and sieve tubes in the phloem tissue of the vascular tube.

	Plant Cell		Animal Cell
1.	Nucleus elliptical in shape.	1.	Nucleus rounded in shape
2.	Mitochondria fewer.	2.	Mitochondria numereous.
3.	Plant cells do not burst if placed in hypotonic solution.	3.	Animal cells usually burst if placed in hopotonic solution.
4.	Centrioles absent except in lower plants.	4.	Centrioles present.
5.	Spindle formed during cell division is anastral type.	5.	Spindle formed during cell division is of amphiastral type
6.	Golgi body has distyosomes	6.	Golgi apparatus consists of a single complex.
7.	Lysosomes rare.	7.	Lysosomes present in animal cells.
8.	Glyoxysomes present.	8.	Glyxosomes absent.
9.	Crystals of inorganic substances occur inside.	9.	Crystals do not occur.
10.	Adjacent cells connected through plasmodemata by middle lamella.	10.	Adjacent cells connected by a number of junctions
11.	Cytokinesis by cell plate.	11.	Cytokinesis by cleavage.

➢ **Dissimilarities**

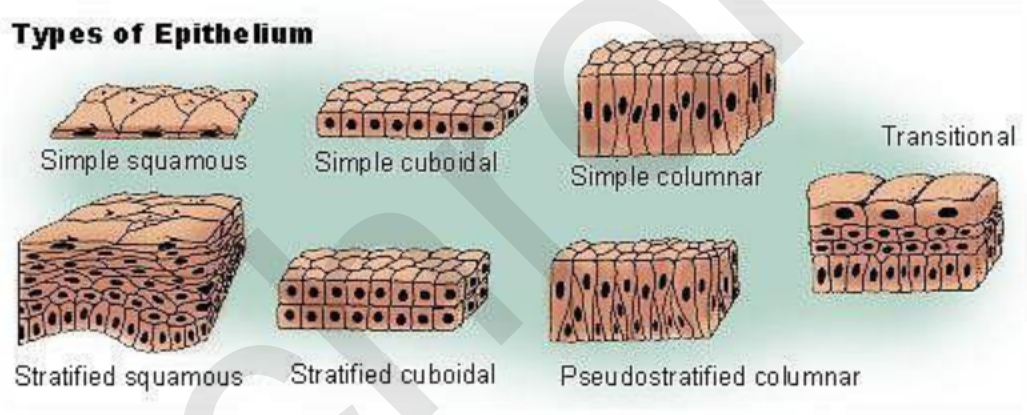
Cell part	Plant	Animals
Cell wall	present	absent
Lysosomes	absent	present
Centrioles	absent	present
Plastids	present	absent
vacuoles	present	absent

Tissue



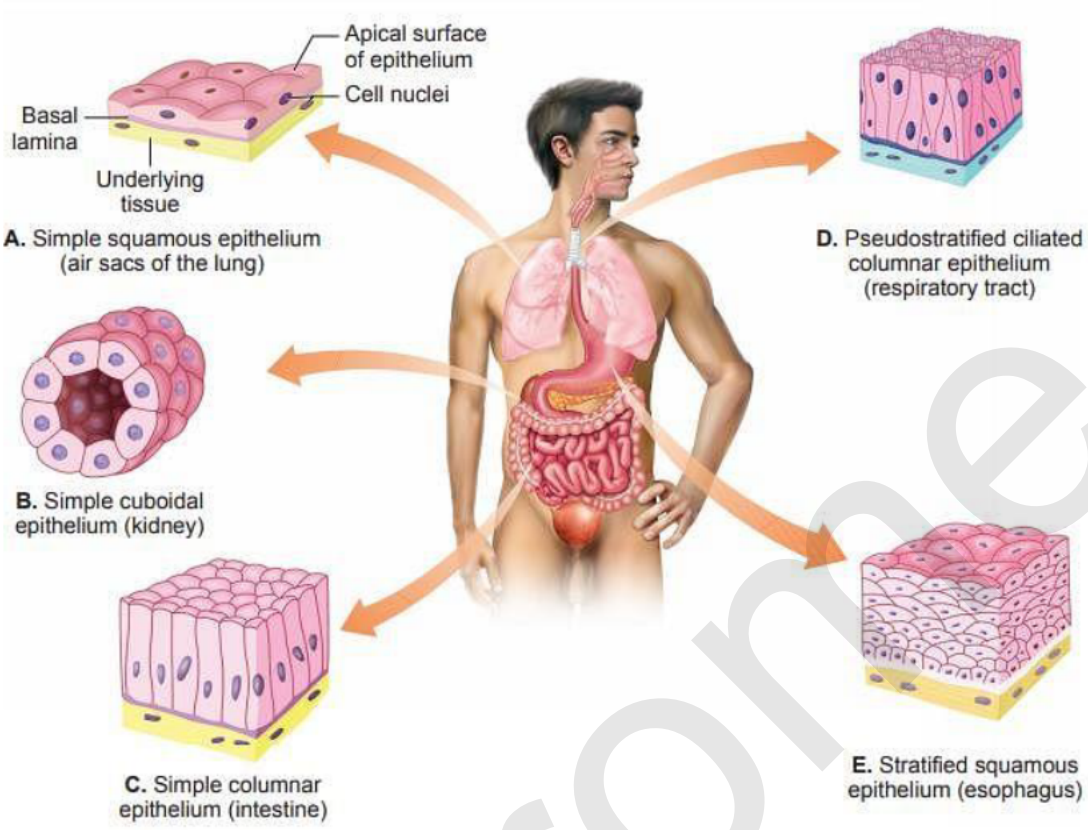
1. Epithelial Tissue

It is a tissue that is made up of **tightly packed cells**. Without much materials within these cells. The reasons for the tightly packed cells are to act as a barrier against mechanical injury, invading microorganisms, and fluid loss. We can define epithetical tissue by considering two points in mind one is the number of cell layers and two the shape of the cells.



(a) On the basis of Cell layers

- When an epithelium has a single layer of cells it is called a **simple epithelium**.
- Whereas multiple tiers of cells are known as the **stratified epithelium**.

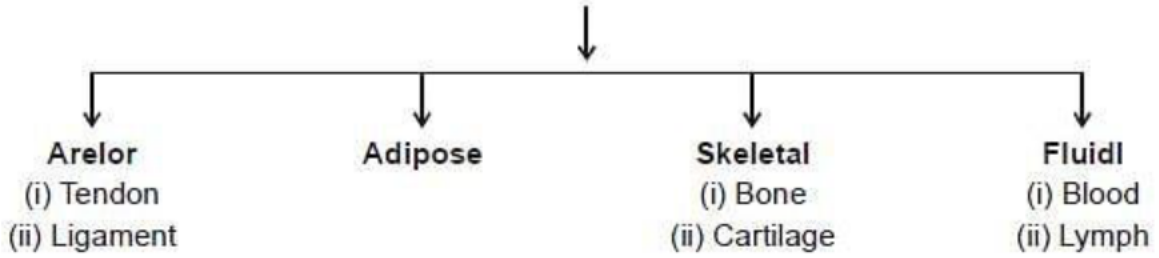


Epithelial tissues in our body

(b) On the basis of the Simple Shape of Cells

- **Cuboidal:** Its occurrence is in kidney tubules, salivary glands, inner lining of the cheek. Its main function is to give mechanical strength.
- **Columnar:** Its occurrence is in sweat gland, tear gland, salivary gland its main function is to gives mechanical strength concerned with secretions.
- **Squamous:** When it forms a living as that of blood vessels, it is called the endothelium. Its main function is to protect the underlying parts from injury, entry of germs, etc.
- **Connective tissue:** Its main function is to bind and support other tissues. They have sparse populations of cells scattered through an extracellular matrix. This extracellular matrix is a web of fibers that is woven in a homogeneous ground substance that can be liquid, solid or jelly-like. There are a few types of connective tissue.

2. Connective Tissue



- **Areolar tissue:** It fills spaces inside organs found around muscles, blood vessels and nerves. Its main function is to join skin to muscles, support internal organs, help in the repair of tissues. Whereas tendon's main function is to connect muscles to bones and ligament connects bones to each other.
- **Adipose tissue:** its occurrence is below skin, between internal organs and in the yellow bone Marrow. Its main function is to store fat and to conserve heat.
- **Skeletal tissue:** Bone & Cartilage cartilage occurrences is in nose pic, epiglottis, and in the intervertebral disc of mammals. Its main function is to provide support and flexibility to the body parts. Whereas bone protects internal delicate organs provides attachments for muscles, bone marrow makes blood cells.
- **Fluid tissue:** Blood & Lymph blood transport O_2 nutrients, hormones to tissues and organs. Whereas leukocytes fight diseases and platelets help in the clotting of blood. Lymph transports nutrients into the heart and it also forms the defense system of the body.

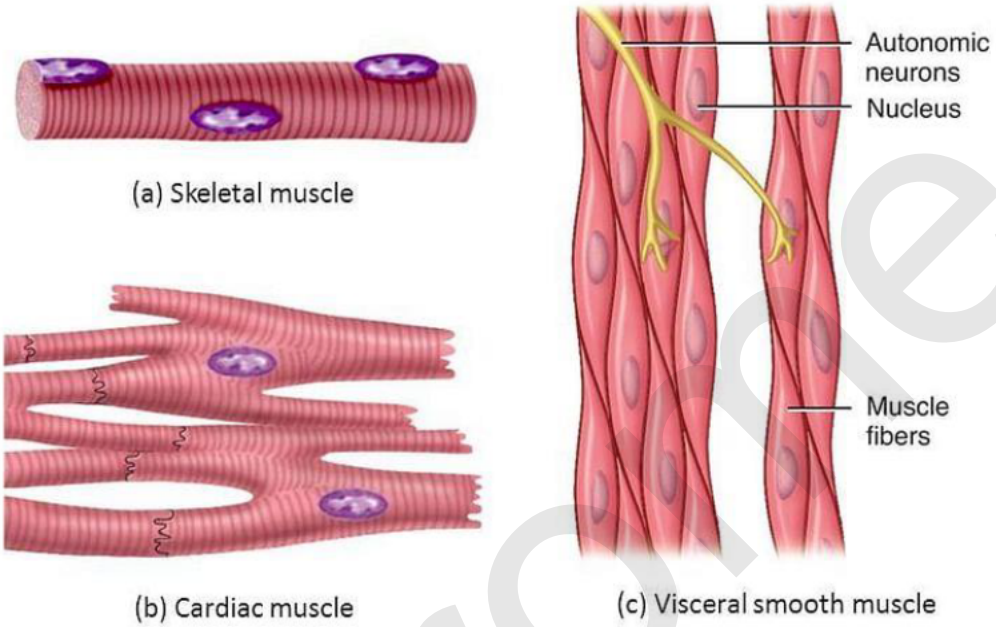
3. Muscular Tissue

It is specialized for the ability to contract muscle cells. These are elongated and referred to as muscle fibers. When a stimulus is received at one end of a muscle cell, a wave of excitation is conducted through the entire cell so that all parts contract in harmony.

There were three types of muscle cells:

- Skeletal
- Cardiac
- Smooth muscles tissue

Three Types of Muscular Tissue



(a) Skeletal muscle

(b) Cardiac muscle

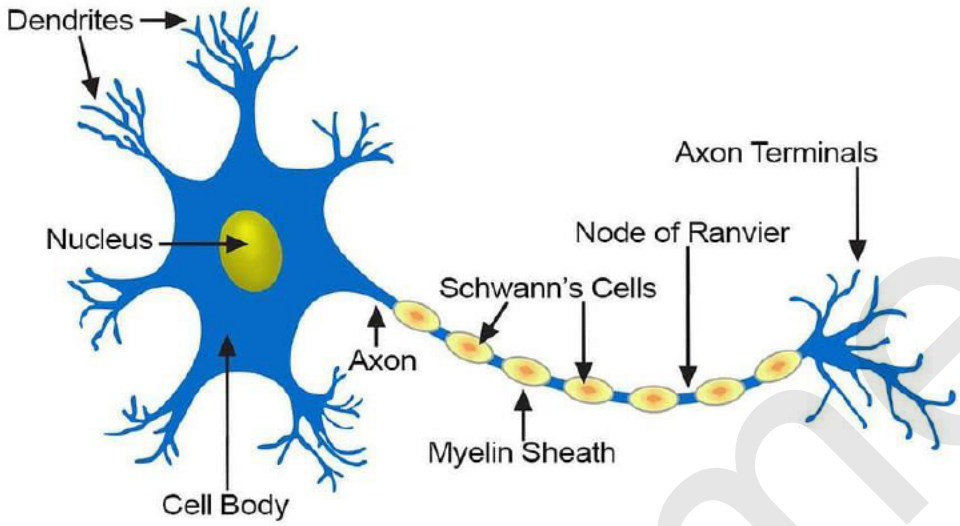
(c) Visceral smooth muscle

(a) Skeletal muscle: It attached primarily to bones. Its main function is to provide the force for locomotion and all other voluntary movements of the body.
(b) Cardiac muscle: It occurs only in the heart. The contraction and relaxation of the heart muscles help to pump the blood and distribute it to the various parts of the body.
(c) Smooth muscles: It can be found in the stomach, intestines, and blood vessels these muscles cause slow and prolonged contractions which are involuntary.
w

4. Nervous Tissue

This tissue is specialized with the capability to conduct electrical impulses and convey information from one area of the body to another. Most of the nervous tissue (98%) is located in the central nervous system. The brain and spinal cord.
There are two types of nervous tissue:
(i) Neurons
(ii) Neuroglia

Structure of a Typical Neuron



- **Neurons:** It actually transmits the impulses, receptor nerve ending of neurons react to various kind of stimuli and can transmit waves of excitation from the farthest point in the body to the central nervous system.

➢ **Important facts regarding the Animal Tissue**

- Muscles contain a special protein called **contractile protein**. Which contract and relax to cause movement.
- Fat storing adipose tissue is found below the skin and between internal organs.
- Two bones are connected to each other by a tissue called a **ligament**. This tissue is very elastic.
- The skin, the living of the mouth, the living blood vessels, kidney tubules are all made up of epithelial tissue.
- **Voluntary muscles** and cardiac muscles are richly supplied with water whereas involuntary muscles are poorly supplied with blood.
- **Muscles tissue** is composed of differentiated cells containing contractile protein.

UPSC

NCERT Summary

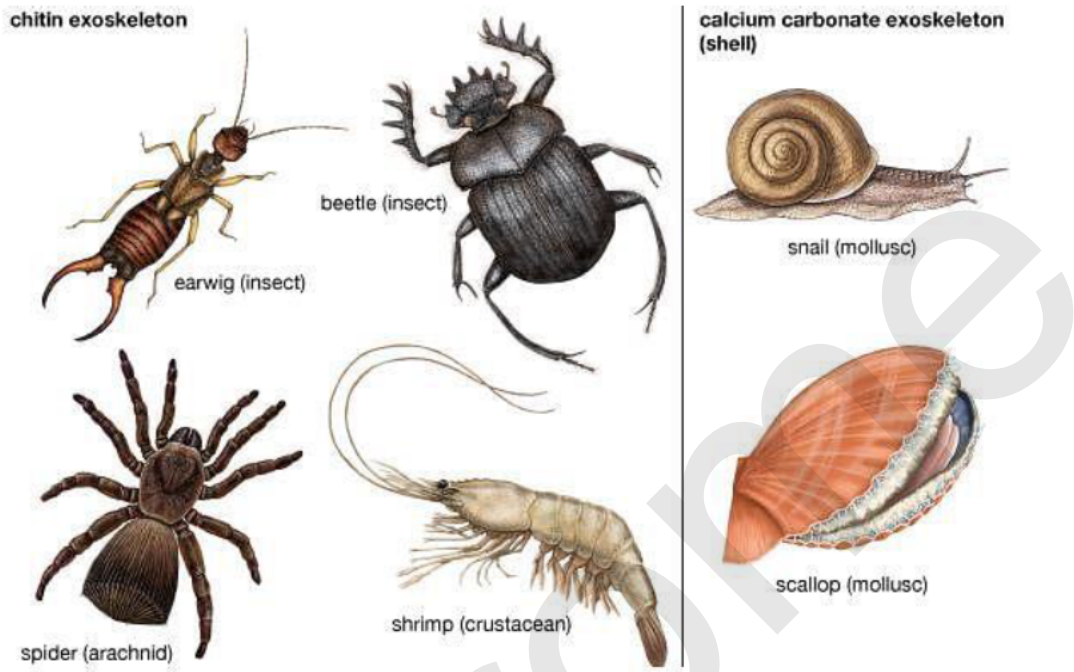
Summary of Biology- 2

Muscular and Skeletal System

➢ Skeletal Systems of Various Animals

- **Movement** is a major characteristic of animals. This movement is a result of the contraction of muscles. The skeleton helps transmit that movement. Skeletons are either a fluid-filled body cavity, exoskeletons, or internal skeletons.
- **Hydrostatic skeletons** consist of fluid-filled closed chambers. Internal pressure generated by muscle contractions cause movement as well as maintain the shape of the animals, such as the sea anemone and worms. The sea anemone has one set of longitudinal muscles in the outer layer of the body and a layer of circular muscles in the inner layer of the body. The anemone can elongate or contract its body by contracting one or the other set of muscles.

- **Exoskeleton** are characteristic of the **Phylum Arthropoda**. Exoskeleton are hard segments that cover the muscles and visceral organs. Muscles for movement attach to the inner surface of the exoskeleton.

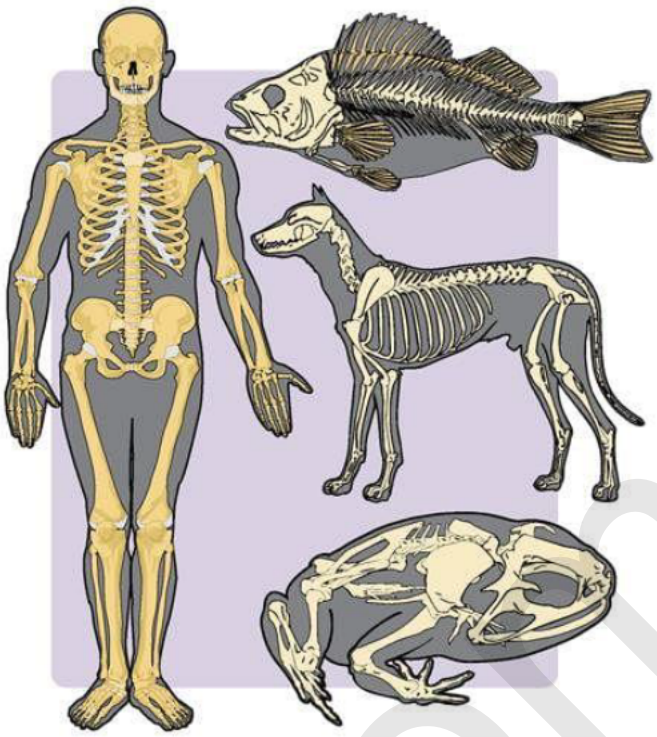


Exoskeletons

- **Exoskeletons** restrict the growth of the animal, thus it must shed its exoskeleton (or molt) to form a new one that has room for growth. The bulk and weight of the exoskeleton and associated mechanical problems limit the size animals can attain.

Note:

» Spiders use a combination of an exoskeleton for protection and fluid pressure for movement.
» Vertebrates have developed an internal mineralized (in most cases) endoskeleton composed of bone and/ or cartilage. Muscles are on the outside of the endoskeleton.
» Cartilage and bone are types of connective tissue.

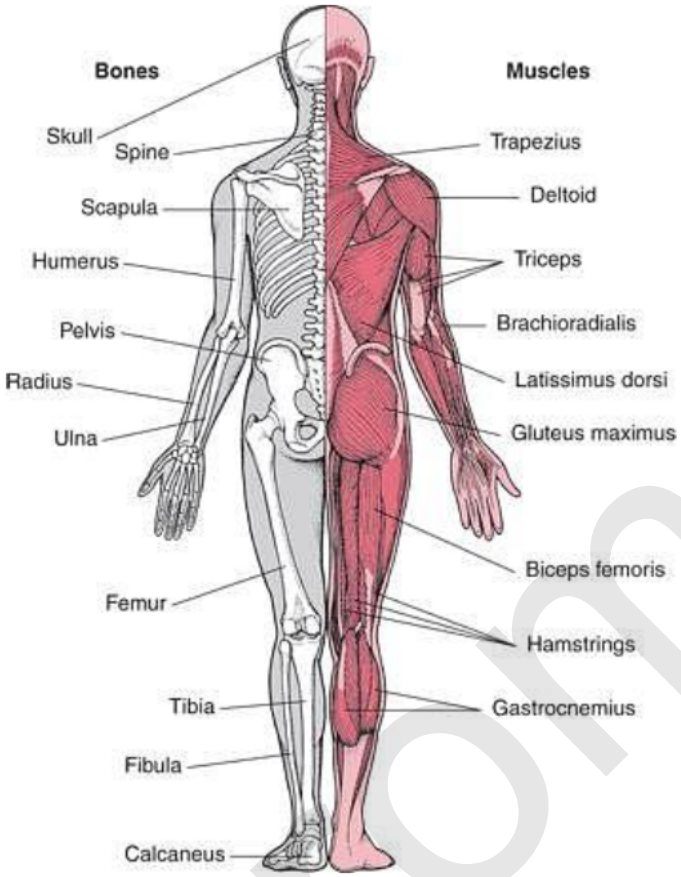


Endoskeletons

- Sharks and rays have skeletons composed **entirely of cartilage**, other vertebrates have an embryonic cartilage skeleton progressively replaced by bone as they mature and develop.
- Some areas of the human body, however, retain cartilage in the adult, in joints and flexible structures such as the ribs, trachea, nose, and ears.

➢ **The Skeleton and Muscles**

- The skeleton and muscles function together as the **musculoskeletal system**. This system (often treated as two separate systems, **the muscular**, and skeletal) plays an important **homeostatic role**: Allowing the animal to move to more favorable external conditions.



Musculoskeletal system

- Vertebrates move by the actions of muscles on bones. **Tendons** attach many skeletal muscles across joints, allowing muscle contraction to move the bones across the joint.
- Muscles generally work in pairs to produce movement: When one muscle flexes (or contracts) the other relaxes, a process known as **antagonism**.
- Muscles have both **electrical** and **chemical** activity. There is an electrical gradient across the **muscle cell membrane**: The outside is more positive than the inside. The stimulus causes an instantaneous reversal of this polarity, causing the muscle to contract (the mechanical characteristic) producing a twitch or movement.

➢ **Skeletal Muscle Structure**

- **Muscle fibers** are multinucleated, with the nuclei located just under the plasma membrane. Most of the cell is occupied by striated, thread-like myofibrils. Within each myofibril there are dense Z lines.
  A **sarcomere** (or muscle functional unit) extends from Z line to Z line. Each sarcomere has thick and thin filaments. The thick filaments are

made of myosin and occupy the center of each sarcomere. Thin filaments are made of action and anchor to the Z line.

- **Muscles** contract by shortening each sarcomere. The sliding filament model of muscle contraction has thin filaments on each side of the sarcomere sliding past each other until they meet in the middle. **Myosin filaments** have club-shaped heads that project toward the actin filaments.
- Myosin heads attach to binding sites on the **actin filaments**. The myosin heads swivel toward the center of the sarcomere, detach and then reattach to the nearest active site of the actin filament. Each cycle of attachment, swiveling, and detachment shortens the sarcomere 1%. Hundreds of such cycles occur each second during muscle contraction.
- Energy for this comes from ATP, the energy coin of the cell. ATP binds to the cross-bridges between myosin heads and actin filaments. The release of energy powers the swiveling of the myosin head. Muscles store little ATP and so must recycle the ADP into ATP rapidly. **Creatine phosphate** is a muscle storage product involved in the rapid regeneration of ADP into ATP.
- **Calcium ions** are required for each cycle of **myosin-actin interaction**. Calcium is released into the sarcomere when a muscle is stimulated to contract. This calcium uncovers the actin-binding sites. When the muscle no longer needs to contract, the calcium ions are pumped from the sarcomere and back into storage.

➢ **Contraction of Non-Muscular Cells**

- Actin and myosin, whose interaction causes muscle contraction, occur in many other cells. Actin is attached to the inner surface of the plasma membrane. The interaction of **cytoplasmic** myosin and this actin causes contraction of the cell, such a the coordinated contractions of intestinal cells to absorb nutrients.
- Some fish have modified muscles that discharge electricity. These fish have electric organs consisting of modified muscles known as **electroplates**. The South American electric eel has more than 6000 plates arranged into 70 columns. The maximum discharge is 100 watts.

➢ **Interaction of the Two Systems**

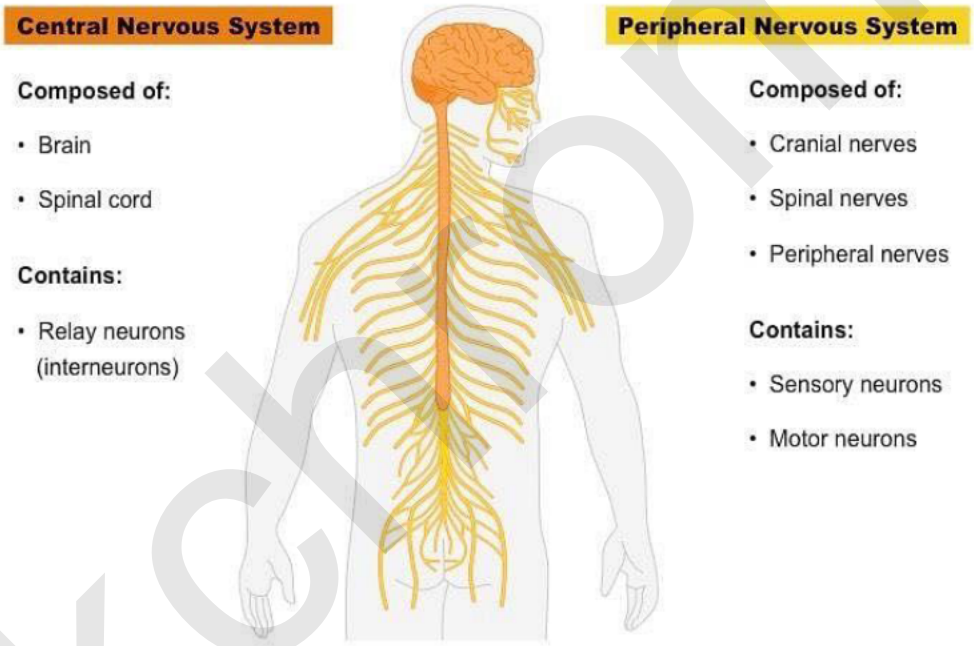
- **Vertebrates** move by application of the **principles of the lever**. Levers amplify or increase the force or velocity of motion.

- The amount of amplification depends on the length of the lever. There are three types of the skeletal system, all interact with muscles using the lever.

The Nervous System

➢ Divisions of the Nervous System

- The nervous system monitors and controls almost every organ system through a series of positive and negative feedback loops.
- The **Central Nervous System** (CNS) includes the brain and spinal cord.
- The **Peripheral Nervous System** (PNS) connects the CNS to other parts of the body and is composed of nerves (bundles of neurons).



- Not all animals have highly specialized nervous systems.
- Those with simple systems tend to be either small and very mobile or large and immobile.
- Large, mobile animals have highly developed nervous systems: The evolution of nervous systems must have been an important adaptation in the evolution of body size and mobility.

➢ Nervous System in Various Organisms

- **Coelenterates**, **cnidarians**, and **echinoderms** have their neurons organized into a nerve net. These creatures have radial symmetry and lack a head. Although lacking a brain or either nervous system (CNS or PNS) nerve nets are capable of some complex behavior.
- **Bilaterally symmetrical** animals have a body plan that includes a defined head and a tail region. The development of bilateral symmetry is associated with **cephalization**, the development of a head with the accumulation of sensory organs at the front end of the organism.
- **Flatworms** have neurons associated into clusters known as **ganglia**, which in turn form a small brain. Vertebrates have a spinal cord in addition to a more developed brain. Chordates have a dorsal rather than **ventral nervous system**. Several evolutionary trends occur in chordates: Spinal cord, continuation of cephalization in the form of larger and more complex brains, and development of a more elaborate nervous system.

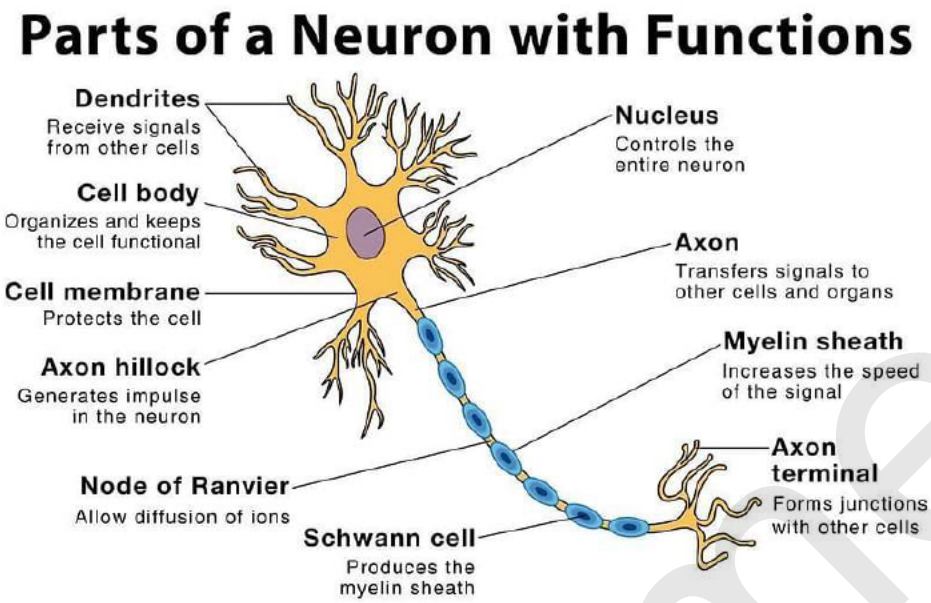
➢ The Neuron

- Nervous tissue is composed of two main cell types:
  (i) Neurons
  (ii) Glial cells
- Neurons transmit **nerve messages**. Glial cells are in direct contact with neurons and often surround them.
- The neuron is the functional unit of the nervous system. Humans have about 100 billion neurons in their brain alone! While variable in size and shape.

1. Parts of Neuron

All neurons have three parts:

- **Dendrites** receive information from another cell and transmit the message to the cell body.
- **The cell body** contains the nucleus, mitochondria and other organelles typical of eukaryotic cells.
- **The axon** conducts messages away from the cell body.



2. Types of Neuron

Three types of neurons occur:

(i) Sensory neurons typically have a long dendrite and short axon and carry messages from sensory receptors to the central nervous system.

(ii) Motor neurons have a long axon and short dendrites and transmit messages from the central nervous system to the muscles (or to glands).

(iii) Interneurons are found only in the central nervous system where they connect neuron to neuron. Some axons are wrapped in a myelin sheath formed from the plasma membranes of specialized glial cells known as **Schwann cells**. Schwann cells serve as supportive, nutritive, and service facilities for neurons. The gap between Schwann cells is known as the **Node of Ranvier** (refer to above figure) and serves as points along the neuron for generating a signal. Signals jumping from node to node travel hundreds of times faster than signals traveling along the surface of the axon. This allows our brain to communicate with our toes in a few thousandths of a second.

➢ **The Nerve Message**

- The plasma membrane of neurons, like all other cells, has an unequal distribution of ions and electrical charges between the two sides of the membrane. The outside of the membrane has a **positive charge**, inside has a **negative charge**.
- **Resting potential** results from differences between sodium and potassium positively charged ions and negatively charged ions in the cytoplasm.
- Sodium ions are more concentrated outside the membrane, while potassium ions are more concentrated inside the membrane. This

imbalance is maintained by the active transport of ions to reset the membrane known as the **sodium-potassium pump**.

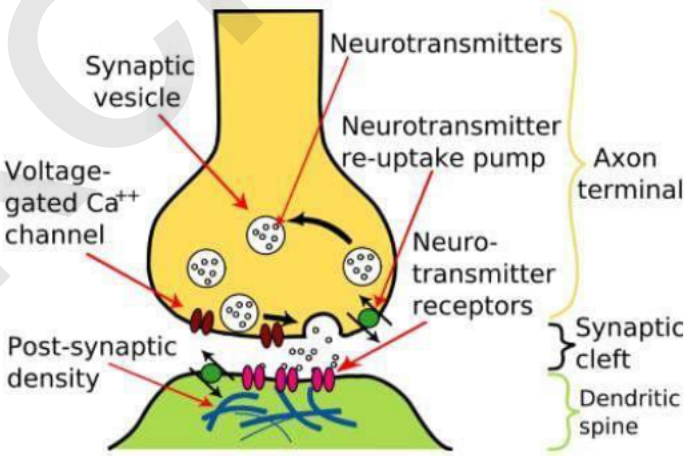
- The sodium-potassium pump maintains this unequal concentration by actively transporting ions against their concentration gradients. The action potential begins at one spot on the membrane, but spreads to adjacent areas of the membrane, propagating the message along the length of the cell membrane.
- After the passage of the action potential, there is a brief period, the **refractory period**, during which the membrane cannot be stimulated. This prevents the message from being transmitted backward along the membrane.

➢ Steps in an Action Potential

- At rest, the outside of the membrane is more positive than the inside.
- **Sodium** moves inside the cell causing an action potential, the influx of positive sodium ions makes the inside of the membrane more positive than the outside.
- **Potassium ions** flow out of the cell, restoring the resting potential net charges.
- **Sodium ions** are pumped out of the cell and potassium ions are pumped into the cell, restoring the original distribution of ions.

➢ Synapses

- The junction between a nerve cell and another cell is called a synapse



CNS Synapse

- Messages travel within the neuron as an electrical action potential. The space between the two cells is known as the synaptic cleft. To cross the synaptic cleft requires the actions of neurotransmitters. **Neurotransmitters** are stored in small synaptic vesicles clustered at the tip of the axon. Neurotransmitters tend to be small molecules, some are even hormones.
- The neurotransmitters cross the cleft, binding to receptor molecules on the next cell, prompting transmission of the message along that cell's membrane. Diseases that affect the function of signal transmission can have serious consequences.
- **Parkinson's disease** has a deficiency of the neurotransmitter dopamine. Progressive death of brain cells increases this deficit, causing tremors, rigidity and unstable posture.

JK Chrome

NCERT Summary

Gist of Biology – 3

Endocrine System

NERVOUS SYSTEM: THE TELEGRAPHIC SYSTEM OF COMMUNICATION AND CO-ORDINATION

- The structural of the nervous system is a neuron. It has a nucleus and cytoplasm, forming the cell body. The cell body has elongated extension of cytoplasm. Those extension which are specialized for transmitting messages to two neuron are called 'dendrites' and the extension that transmits message from the neuron is called an 'axon'. A reflex action, or simply a reflex is a fundamental function of the nervous system.
- The chain of neurons that participants in a reflex action is called a 'reflex arc'. It consist of at least two neuron (1) Sensory or afferent neuron which conveys the information about the stimulus to the central nervous system. (2) Motor or afferent neuron – which conveys the message from the central neuron system to the organ (effector organ) which has to respond to the stimulus.
- The function between two neurons is called a 'ganglion'.

THE ENDOCRINE SYSTEM

Hormones

The endocrine system is a collection of glands that secrete chemical messages we call hormones. These signals are passed through the blood to arrive at a target organ, which has cells possessing the appropriate receptor. Exocrine glands (not part of the endocrine system) secrete products that are passed outside the body. Sweat glands, salivary glands, and digestive glands are examples of exocrine glands. Hormones are grouped into three classes based on their structure:

a. steroids
   b. peptides
   c. amines

1. STEROIDS

Steroids are lipids derived from cholesterol. Testosterone is the male sex hormone. Estradiol, similar in structure to testosterone, is responsible for many female sex characteristics. Steroid hormones are secreted by the gonads, adrenal cortex, and placenta.

2. PEPTIDES AND

3. AMINES

Peptides are short chains of amino acids; most hormones are peptides. They are secreted by the pituitary, parathyroid, heart, stomach, liver, and kidneys. Amines are derived from the amino acid tyrosine and are secreted from the thyroid and the adrenal medulla. Solubility of the various hormone classes varies.

Synthesis, Storage, and Secretion

- Steroid hormones are derived from cholesterol by a biochemical reaction series. Defects along this series often lead to hormonal imbalances with serious consequences. Once synthesized, steroid hormones pass into the bloodstream; they are not stored by cells, and the rate of synthesis controls them.
- Peptide hormones are synthesized as precursor molecules and processed by the endoplasmic reticulum and Golgi where they are stored in secretory granules. When needed, the granules are dumped into the bloodstream. Different hormones can often be made from the same precursor molecule by cleaving it with a different enzyme.
- Amine hormones (notably epinephrine) are stored as granules in the cytoplasm until needed.

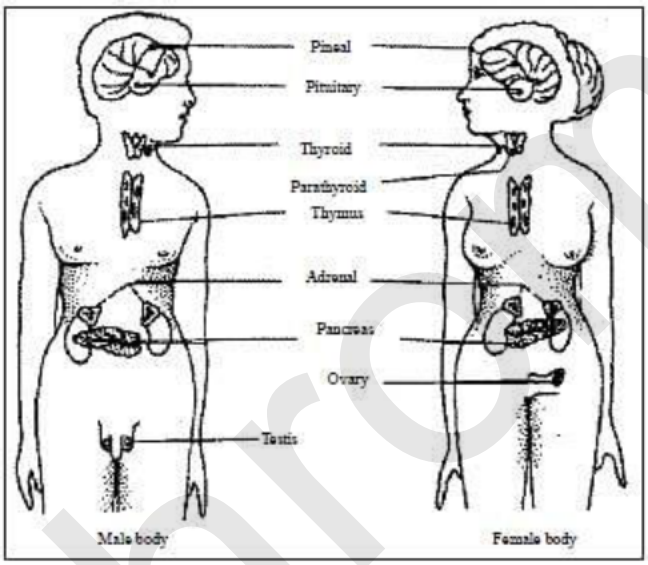
Evolution of Endocrine Systems

Most animals with well-developed nervous and circulatory systems have an endocrine system. Most of the similarities among the endocrine systems of crustaceans, arthropods, and vertebrates are examples of convergent evolution. The vertebrate endocrine system consists of glands (pituitary, thyroid, adrenal), and diffuse cell groups secreted in epithelial tissues. More than fifty different hormones are secreted. Endocrine glands arise during development for all three embryologic tissue layers (endoderm, mesoderm, ectoderm). The type of endocrine product is determined by which tissue layer a gland originated in. Glands of ectodermal and

endodermal origin produce peptide and amine hormones; mesodermal-origin glands secrete hormones based on lipids.

i. Endocrine Systems and Feedback Cycles

The endocrine system uses cycles and negative feedback to regulate physiological functions. Negative feedback regulates the secretion of almost every hormone. Cycles of secretion maintain physiological and homeostatic control. These cycles can range from hours to months in duration.



ii. Mechanisms of Hormone Action

The endocrine system acts by releasing hormones that in turn trigger actions in specific target cells. Receptors on target cell membranes bind only to one type of hormone. More than fifty human hormones have been identified; all act by binding to receptor molecules. The binding hormone changes the shape of the receptor causing the response to the hormone. There are two mechanisms of hormone action on all target cells.

ii. Nonsteroid Hormones

Nonsteroid hormones (water soluble) do not enter the cell but bind to plasma membrane receptors, generating a chemical signal (second messenger) inside the target cell. Five different second messenger chemicals, including cyclic AMP have been identified. Second messengers activate other intracellular chemicals to produce the target cell response.

iv. Steroid Hormones

The second mechanism involves steroid hormones, which pass through the plasma membrane and act in a two step process. Steroid hormones bind, once inside the cell, to the nuclear membrane receptors, producing an activated hormone-receptor complex. The activated hormone-receptor complex binds to DNA and activates specific genes, increasing production of proteins.

The Nervous and Endocrine Systems

The pituitary gland (often called the master gland) is located in a small bony cavity at the base of the brain. A stalk links the pituitary to the hypothalamus, which controls release of pituitary hormones. The pituitary gland has two lobes: the anterior and posterior lobes. The anterior pituitary is glandular. The hypothalamus contains neurons that control releases from the anterior pituitary. Seven hypothalamic hormones are released into a portal system connecting the hypothalamus and pituitary, and cause targets in the pituitary to release eight hormones.

I. Anteriol Pituitoly

Growth hormone (GH) is a peptide anterior pituitary hormone essential for growth. GH releasing hormone stimulates release of GH. GH inhibiting hormone suppresses the release of GH. The hypothalamus maintains homeostatic levels of GH. Cells under the action of GH increase in size (hypertrophy) and number (hyperplasia). GH also causes increase in bone length and thickness by deposition of cartilage at the ends of bones. During adolescence, sex hormones cause replacement of cartilage by bone, halting further bone growth even though GH is still present. Too little or two much GH can cause dwarfism or gigantism, respectively. Hypothalamus receptors monitor blood levels of thyroid hormones. Low blood levels of Thyroid-stimulating hormone (TSH) cause the release of TSH-releasing hormone from the hypothalamus, which in turn causes the release of TSH from the anterior pituitary. TSH travels to the thyroid where it promotes production of thyroid hormones, which in turn regulate metabolic rates and body temperatures. Gonadotropins and prolactin are also secreted by the anterior pituitary. Gonadotropins (which include follicle-stimulating hormone, FSH, and luteinizing hormone, LH) affect the gonads by stimulating gamete formation and production of sex hormones. Prolactin is secreted near the end of pregnancy and prepares the breasts for milk production.

II. The Posterior Pituitary

The posterior pituitary stores and releases hormones into the blood. Antidiuretic hormone (ADH) and oxytocin are produced in the hypothalamus and transported by axons to the posterior pituitary where they are dumped into the blood. ADH controls water balance in the body and blood pressure. Oxytocin is a small peptide hormone that stimulates uterine contractions during childbirth.

Biological Cycles

Biological cycles ranging from minutes to years occur throughout the animal kingdom. Cycles involve hibernation, mating behavior, body temperature and many other physiological processes.
Rhythms or cycles that show cyclic changes on a daily (or even a few hours) basis are known as circadian rhythms. Many hormones, such as ACTH-cortisol, TSH, and GH show circadian rhythms.
Thyroid secretion is usually higher in winter than in summer. Childbirth is hormonally controlled, and is highest between 2 and 7 AM. Internal cycles of hormone production are controlled by the hypothalamus, specifically the suprachiasmic nucleus (SCN). According to one model, the SCN is signaled by messages from the light-detecting retina of the eyes. The SCN signals the pineal gland in the brain to signal the hypothalamus, etc.

Endocrines: The Postal System of Communication and Co-Ordination

- Hormones are chemical substances manufactured by organs called endocrine glands or ductless glands. Ductless glands are also sometimes called ‘exocrine glands

ENDOCRINE GLAND OF THE BODY

- Thyroid is situated in the neck in front of the wind pipe. It manufactures two hormones: triodothyro (T_3) and tetraiodothysonine (T_4), are called tyrosine. Both these hormones contain iodine.
- Hypothyroidism (hypo, ‘under’)– diminished thyroid activity. Hypothyroidism in childhood gives rise to a conditions called cretinism.

Goiter – is called enlargement of the thyroid gland. It manifests itself as a swelling in the neck. A goiter may be associated with increased, normal or descreased activity of the thyroid gland.

- Government of India launched the Universal salt iodisation programme in 1986.

Pancreas — the endocrine department of the pancreas is scattered throughout its substance in the form of tiny islands. The islands have been named as 'islets of Langerhans'. The islets have two major type of cells called A and B. The A cells secrete the hormone 'glucagon' while the B cells secrete insulin. Insulin has discovered by Frederick Grand banting and Charles Herbert Best. Reduction on the quantity of effective insulin gives rise to diabetes mellitus (diabetes, siphon, mellitus of honey) commonly called simply diabetes. Food and glucose to be blood, while exercise and insulin remove it.
The six endocrine glands of the body are.
a. Thyroid
b. Pancreas
c. Adrenals
d. Gonads
e. Parathyroids
f. Pituitary

Processing of Food

- The process of digestion and absortion of food takes place in the alimentary canal.
- The alimentary canal is a 9-metre long tube extending from the hips to the anus-
- Saliva is secreted by a set of three pairs of glands situated near the month. It helps in the process a digestion. It contain an enzyme called 'anylax' which breaks down the starch in food into maltose.
- The food in the stomach is homogenised by the action of the acidic juice. The juice also contains an enzyme called pepsin, which splits proteins into smallest units called peptides.

Small Intestine:– The food, after being digested in the stomach is transferred; but by bit from the stomach into the small intestine. The first portion of the small intestine which the food enters is called the 'duodenum'. Juices from pancreas and gall bladder are discharged into the duodenum.

- Pancreatic juice contains enzymes for digestion of carbohydrates, protein as well as fat.

Bite is an essential supplement to the recreations enzyme for digestion of fats.

- Discharge of Pancreatic and binary recentions into the intestine is under the control of two hormones: 'secretin' and cholecystokinin'.

Large Intestine (colon)– The absorption of water is an important function

Region	Juice	Enzyme	Enzyme action	Enzyme action produces
Mouth	Saliva	Amylase	Starch	Maltose
Stomach	Gastric Juice	Pepsin	Proteins	Protein fragments
Duodenum	Pancreatic Juice	Amylase	Starch	Maltose
Duodenum	Pancreatic Juice	Trypsin	Product protein fragments	Small protein fragments
Duodenum	Pancreatic Juice	Chymotrypsin	Product protein fragments	Small protein fragments and amino acids
Duodenum	Pancreatic Juice	Lipase	Fat	Fatty acids and glycerol
Small intestine	—	Disaccharisases	Maltose	Glucose and similar substances
		Amnopeptidose small protein fragments	Lactose- and Sucrose++	Very fragments and small poling amino acids.
	—	Dipeptidase	2-amino acid fragments	Amino acids

Kidneys, The Fascinating Filters

- Kidneys are often described as bean shaped.
- Each kidney is make up a about a million narrow tube-like structures called 'nephrons'. The urine formed by a kidney in a sum total of a the urine formed by its neprpons.
- A Nephron consists of a receptacle (Bowman's capsule) enclosing a bunch of capillaries (glomerular) like a closed fist. The glomerulus and Bowman's capsule filter the blood.

Filtration: The glomerular capillaries are fed blood by a blood vessel called 'afferent arteriole' and drained by a marrower blood vessel called the 'efferent arteriole.

- By secreting acids, the kidneys help in maintaining the acidity of the body fluids constant.
- Urine excreted is the result of these basic processes: filtration, reabrorption and secretion.
- Excessive eating (polyphagia), excessive drinking (polydipsia) and too much of urine (polyusia) are three cardinal symptoms of diabetes. The 'hypothesis' produces a chemical substance called 'antidivretic hormone

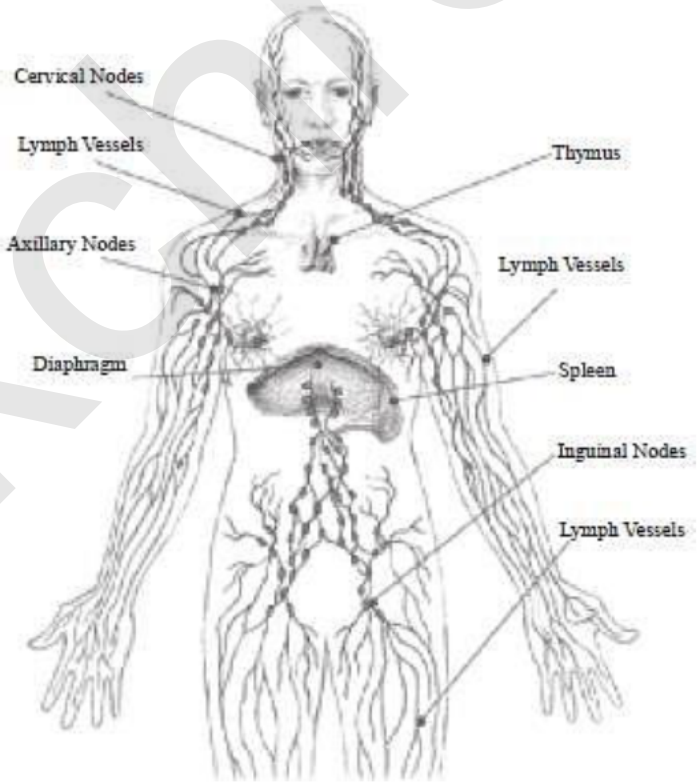
(ADH). This substance travels in the bloodstream to the kidneys and increases the reabsorption of water so that the blood gets a little thinner.

- The Adrenal gland maintains the regulating salt in the body and is located in an organ lying just over the kidney. As soon as the salt (sodium) concentration become just a little less than normal, it release into the blood stream a substance called 'aldosterone'.
- Renal transplantation or dialysis (artificial kidney) are the supportive measure when the damage to kidney reaches a certain point.

LYMPHATIC SYSTEM AND IMMUNITY

The Lymphatic System

- The lymphatic system is composed of lymph vessels, lymph nodes, and organs. The functions of this system include the absorbtion of excess fluid and its return to the blood stream, absorption of fat (in the villi of the small intestine) and the immune system function.
- Lymph vessels are closely associated with the circulatory system vessels. Larger lymph vessels are similar to veins. Lymph capillaries are scatted throughout the body. Contraction of skeletal muscle causes movement of the lymph fluid through valves.



- Lymph organs include the bone marrow, lymph nodes, spleen, and thymus.
- Bone marrow contains tissue that produces lymphocytes. B-lymphocytes (B-cells) mature in the bone marrow.
- T-lymphocytes (T-cells) mature in the thymus gland.
- Other blood cells such as monocytes and leukocytes are produced in the bone marrow.
- Lymph nodes are areas of concentrated lymphocytes and macrophages along the lymphatic veins.
- The spleen is similar to the lymph node except that it is larger and filled with blood.
- The spleen serves as a reservoir for blood, and filters or purifies the blood and lymph fluid that flows through it.
- If the spleen is damaged or removed, the individual is more susceptible to infections.
- The thymus secretes a hormone, thymosin, that causes pre-T-cells to mature (in the thymus) into T-cells.

Immunity

- Immunity is the body's capability to repel foreign substances and cells.
- The nonspecific responses are the first line of defense.
- Highly specific responses are the second line of defense and are tailored to an individual threat.
- The immune response includes both specific and nonspecific components. Nonspecific responses block the entry and spread of disease-causing agents.
- Antibody-mediated and cell-mediated responses are two types of specific response.
- The immune system is associated with defense against disease-causing agents, problems in transplants and blood transfusions, and diseases resulting from over-reaction (autoimmune, allergies) and under-reaction (AIDS).

(A) GENERAL DEFENSES

Barriers to entry are the skin and mucous membranes.

1. The skin is a passive barrier to infectious agents such as bacteria and viruses. The organisms living on the skin surface are unable to penetrate the layers of dead skin at the surface. Tears and saliva secrete enzymes that breakdown bacterial cell walls. Skin glands secrete chemicals that retard the growth of bacteria.

2. Mucus membranes lining the respiratory, digestive, urinary, and reproductive

tracts secrete mucus that forms another barrier. Physical barriers are the first line of defense.

3. When microorganisms penetrate skin or epithelium lining respiratory, digestive, or urinary tracts, inflammation results. Damaged cells release chemical signals such as **histamine** that increase capillary blood flow into the affected area (causing the areas to become heated and reddened). The heat makes the environment unfavorable for microbes, promotes healing, raises mobility of white blood cells, and increases the metabolic rate of nearby cells. Capillaries pass fluid into intelstinal areas, causing the infected/injured area to swell.

4. Clotting factors trigger formation of many small blood clots. Finally, monocytes (a type of white blood cell) clean up dead microbes, cells, and debris.

5. If this is not enough to stop the invaders, **the complement system** and **immune response** act.

6. Protective proteins that are produced in the liver include the complement system of proteins. The complement system proteins bind to a bacterium and open pores in its membrane through which fluids and salt move, swelling and bursting the cell. The complement system directly kills microbes, supplements inflammatory response, and works with the immune response. It complements the actions of the immune system. Complement proteins are made in the liver and become active in a sequence (C_1 activates C_2, etc.). The final five proteins form a **membrane attack complex (MAC)** that embeds itself into the plasma membrane of the attacker.

7. Salts enter the invader, facilitating water to cross the membrane, swelling and bursting the microbe. Complement also functions in the immune response by tagging the outer surface of invaders for attack by phagocytes.

8. Interferon is a species-specific chemical produced by cells that are viral attack. It alerts nearby cells to prepare for a virus. The cells that have been contacted by interferon resist all viral attacks.

(B) SPECIFIC DEFENSES

- The immune system also generates specific responses to specific invaders.
- The immune system is more effective than the nonspecific methods, and has a memory component that improves response time when an invader of the same type (or species) is again encountered.
- Immunity results from the production of antibodies specific to a given antigen (antibody-generators, located on the surface of an invader).

- Antibodies bind to the antigens on invaders and kill or inactivate them in several ways.
- Most antibodies are themselves proteins or are a **mix of protein and polysaccharides**. Antigens can be any molecule that causes antibody production.

JK Chrome

NCERT Summary

Summary of Biology- 4

Lymphocytes:

White blood cells known as lymphocytes arise from mitosis of stem cells in the bone marrow. Some lymphocytes migrate to the thymus and become **T cells** that circulate in the blood and are associated with the lymph nodes and spleen.
B cells remain in the bone marrow develop before moving into the circulatory and lymph systems. **B cells produce antibodies.**
1. Antibody-mediated (humoral) immunity is regulated by B cells and the antibodies they produce. Cellmediated immunity is controlled by T cells.
2. Antibody-mediated reactions defend against invading viruses and bacteria. Cell-mediated immunity concerns cells in the body that have been infected by viruses and bacteria, protect against parasites, fungi, and protozoans, and also kill cancerous body cells.

Antibody-mediated Immunity:

Stages in this process are:
(i) antigen detection
(ii) activation of helper T cells
(iii) antibody production by B cells

Each stage is directed by a specific cell type.

- **Macrophages:** Macrophages are white blood cells that continually search for foreign (nonself) antigenic molecules, viruses, or microbes. When found, the macrophages engulfs and destroys them. Small fragments of the antigen are displayed on the outer surface of the macrophage plasma membrane.
- **Helper T Cells:** Helper T cells are macrophages that become activated when they encounter the antigens now displayed on the macrophage surface. Activated T cells identify and activate B cells.
- **B Cells:** B cells divide, forming plasma cells and B memory cells. Plasma cells make and release between 2000 and 20,000 antibody molecules per second into the blood for the next four or five days. B memory cells live for months or years, and are part of the immune memory system.

- **Antibodies:** Antibodies bind to specific antigens in a **lock-and-key fashion**, forming an antigen-antibody complex. Antibodies are a type of protein molecule known as immunoglobulins. There are five classes of immunoglobulins: IgG, IgA, IgD, IgE, and IgM.

Antibodies are Y-shaped molecules composed of two identical long polypeptide (Heavy or H chains) and two identical short polypeptides (Light or L chains).
Function of antibodies includes:
(i) Recognition and binding to antigens
(ii) Inactivation of the antigen
A unique antigenic determinant recognizes and binds to a site on the antigen, leading to the destruction of the antigen in several ways. The ends of the Y are the antigen-combining site that is different for each antigen.
Helper T cells activate B cells that produce antibodies. Supressor T cells slow down and stop the immune response of B and T cells, serving as an off switch for the immune system. Cytotoxic (or killer) T cells destroy body cells infected with a virus or bacteria. Memory T cells remain in the body awaiting the reintroduction of the antigen.
A cell infected with a virus will display viral antigens on its plasma membrane. Killer T cells recognize the viral antigens and attach to that cell's plasma membrane. The T cells secrete proteins that punch holes in the infected cell's plasma membrane. The infected cell's cytoplasm leaks out, the cell dies, and is removed by phagocytes. Killer T cells may also bind to cells of transplanted organs. The immune system is the major component of this defense. Lymphocytes, monocytes, lymph organs, and lymph vessels make up the system.
The immune system is able to distinguish self from non-self. Antigens are chemicals on the surface of a cell. All cells have these. The immune system checks cells and identifies them as "self" or "nonself". Antibodies are proteins produced by certain lymphocytes in response to a specific antigen. Blymphocytes and T-lymphocytes produce the antibodies. B-lymphocytes become plasma cells which then generate antibodies. T-lymphocytes attack cells which bear antigens they recognize. They also mediate the immune response.

Blood Types, Rh, and Antibodies

There are 30 or more known antigens on the surface of blood cells. These form the blood groups or blood types. In a transfusion, the blood groups of the recipient and donor should match.
If improperly matched, the recipient's immune system will produce antibodies causing clotting of the transfused cells, blocking circulation through capillaries and producing serious or even fatal results. Individuals with blood type 'A' have the A antigen on the surface of their red blood cells, and antibodies to type B blood in

their plasma. People with blood type 'B' have the B antigen on their blood cells and antibodies against type A in their plasma.
Individuals with type 'AB' blood produce have antigens for A and B on their cell surfaces and no antibodies for either blood type A or B in their plasma. Type O individuals have no antigens on their red blood cells but antigens of both A and B are in their plasma. People with type AB blood can receive blood of any type, So it is called as Universal Receptar.
Those with type O blood can donate to anyone. So it is called as Universal Donor.
Hemolytic disease of the newborn (HDN) results from Rh incompatibility between an Rh- mother and Rh+ fetus. Rh+ blood from the fetus enters the mother's system during birth, causing her to produce Rh antibodies. The first child is usually not affected, however subsequent Rh+ fetuses will cause a massive secondary reaction of the maternal immune system.
To prevent HDN, Rh- mothers are given an Rh antibody during the first pregnancy with an Rh+ fetus and all subsequent Rh+ fetuses.

Organ Transplants and Antibodies

Success of organ transplants and skin grafts requires a matching of histocompatibility antigens that occur on all cells in the body.
Chromosome 6 contains a cluster of genes known as the **human leukocyte antigen** complex (HLA) that are critical to the outcome of such procedures. The array of HLA alleles on either copy of our chromosome 6 is known as a **haplotype**. The large number of alleles involved mean no two individuals, even in a family, will have the same identical haplotype.
Identical twins have a 100% HLA match. The best matches are going to occur within a family. The preference order for transplants is identical twin > sibling > parent > unrelated donor.
Chances of an unrelated donor matching the recipient range between 1 in 100,000-200,000. Matches across racial or ethnic lines are often more difficult. When HLA types are matched survival of transplanted organs dramatically increases.

Body Defences

The specialised cells which deal with germs and forcing particles by eating them up are called 'phagocytes' (phagein 'to eat'; cyte 'cell'). They are present in all tissues but are particularly concentrated in liver, spleen and bone marrow.

- Monocyter in the blood are the circulating counterparts of these cells.
- Specific acquired immunity can be categorised into two groups: humoral immunity and cellular immunity.

- Lymphoid organs produce lymphocytes. These organs include principally bone marrow, thymus, lymph, nodes, spleen and some 'patches' in the wall of the small intestine.
- The two types of lymphocytes — B lymphocytes concerned with humoral immunity, and T lymphocytes concerned with cellular immunity.
- Antibody production takes place in Numoral immunity. It is triggered by a protein called the antigen. It is the plasma cells which manufacture antibodies specific for the antigen presented.
- Theories which sring to explain the synthesis of specific antibodies—'in structure' and 'selective' theories. Instructive thrones postulate that all plasma cells are alike, it is the antigen that directs the plasma cells to manufacture a specific protein (antibody).
- Selective theories originally proposed by Busnet, assume that there are as many types of B cells as the antigens.

Antibodies are proteins belonging to a class called 'gamma globulins' or immunoglobulins.

Hepatitis Vaccine — Three doses are required: the interval between the first and second dose being one month, and that between the second and third being six months.
Oral typhoid vaccine is available in the form of capsule under the brand name 'Typhoral'.

Blood: The Vital Fluid

Blood looks like a homogenous red fluid to the uncover edge. But when spread into a thin layer, it is found to be a suspension of different type of cells in a liquid called the 'plasma'. Most of the cells are faint yellow and without a nucleus. A dense accumulation of these cells is responsible for the red colour of the blood. These cells are called 'erythrocytes' or red blood cells. These are also another two types of cells—the 'leucocytes' or white blood cells and 'thrombocytes' or platelets.
Plasma— is a straw coloured liquid, about 90 percent of which is water. The chief salt dissolved in plasma is sodium chloride, or common table salt. The salinity of plasma is onethird that of sea water.

- Fibrinogen is a protein which is essential for clotting of blood, another protein globulins aid in the defense mechanisms of the body.
- **Red Blood Cells:**– are the most numerous of the blood cells, they neither have a nucleus nor mitochondria, RBC are a reddish coloured protein containing iron.

- It is hemoglobin which makes it possible to deliver oxygen to tissue which need it.
  The normal quantity of hemoglobin present in blood in 12-15 g in every 100 ml of blood. A decrease in this quantity is called 'anemia'.
- The nucleus membrane of the roof of the mouth (palate) is the best region to access the quantity of hemoglobin.
- The average life span of a red cell is about four months. They are produced in the hollow of the bones (bone marrow).
- **White Blood Cells:**– WBC are far less numerous than the RBC, the ratio being one white cell to every 600 red cells. They are slightly larger than the red cells, and differ in three aspects—first, they have nuclei, secondly, they do not contain hemoglobin, and are therefore nearly colourless, finally, some white cells can move and engulf particles or bacteria the process in called 'phagocytosis'.

WBC are further subdivided in five groups.
(1) Neutroplis
(2) Eosinophils
(3) Basrophils
(4) Lymphocytes
(5) Monocytes

Platelets: are much smaller than red or white blood cells and are devoid of nuclei. They check the bleeding from an injury (harmostasis: haime 'blood'; stages 'standing' Platelets contribute to this process of harmostasis by liberating a chemical called 'sesolonies'.

- A, B, AB and O are the four blood groups. The classification is based on the type of substance present on the surface of red blood cells.

Lungs: The Life Linke

The bronchial tree consists of larynx, trachea, bronchus left lung, right lung.
Alveoli – is a cluster of thin walled air sacs which end in tiny air cells. It is covered with a tracery of capillaries. A men has about 600 million alveoli.

- Oxygen move from the alveoli into the blood and carbondioxide move out of the capillaries to entre the alveoli.

THE RESPIRATORY SYSTEM

Respiration in Single Cell Animals

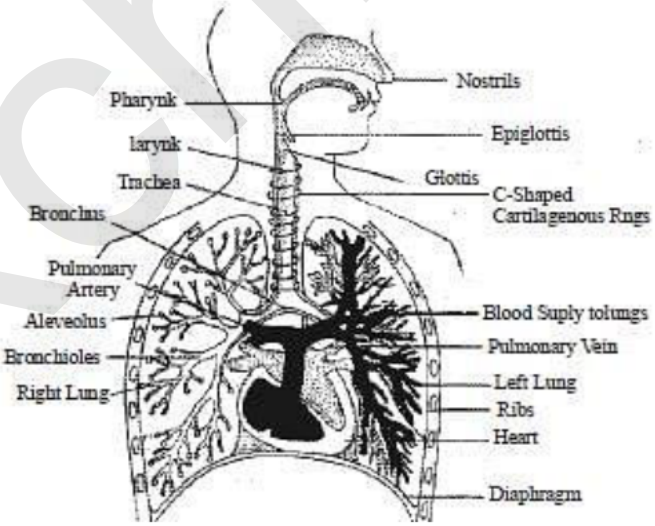
Single-celled organisms exchange gases directly across their cell membrane. However, the slow diffusion rate of oxygen relative to carbon dioxide limits the size of single-celled organisms. Simple animals that lack specialized exchange surfaces have flattened, tubular, or thin shaped body plans, which are the most efficient for gas exchange. However, these simple animals are rather small in size.

Respiration in multicellular animals

Large animals cannot maintain gas exchange by diffusion across their outer surface. They developed a variety of respiratory surfaces that all increase the surface area for exchange, thus allowing for larger bodies. A respiratory surface is covered with thin, moist epithelial cells that allow oxygen and carbon dioxide to exchange. Those gases can only cross cell membranes when they are dissolved in water or an aqueous solution, thus respiratory surfaces must be moist.

Respiratory System Principles

1. Movement of an oxygen-containing medium so it contacts a moist membrane overlying blood vessels.



2. Diffusion of oxygen from the medium into the blood.
3. Transport of oxygen to the tissues and cells of the body.
4. Diffusion of oxygen from the blood into cells.
5. Carbon dioxide follows a reverse path

THE CIRCULATORY SYSTEM

Circulatory Systems in Single-celled Organisms

Single-celled organisms use their cell surface as a point of exchange with the outside environment. Sponges are the simplest animals, yet even they have a transport system. Seawater is the medium of transport and is propelled in and out of the sponge by ciliary action. Simple animals, such as the hydra and planaria lack specialized organs such as hearts and blood vessels, instead using their skin as an exchange point for materials. This, however, limits the size an animal can attain. To become larger, they need specialized organs and organ systems.

Circulatory Systems in Multicellular Organisms

Multicellular animals do not have most of their cells in contact with the external environment and so have developed circulatory systems to transport nutrients, oxygen, carbon dioxide and metabolic wastes. Components of the circulatory system include

i. Blood: a connective tissue of liquid plasma and cells
ii. Heart: a muscular pump to move the blood
iii. Blood vessels: arteries, capillaries and veins that deliver blood to all tissues

Vertebrate Cardiovascular System

The vertebrate cardiovascular system includes a heart, which is a muscular pump that contracts to propel blood out to the body through arteries, and a series of blood vessels.
The upper chamber of the heart, the atrium (pl. atria), is where the blood enters the heart. Passing through a valve, blood enters the lower chamber, the ventricle. Contraction of the ventricle forces blood from the heart through an artery.
The heart muscle is composed of cardiac muscle cells.
Arteries are blood vessels that carry blood away from heart. Arterial walls are able to expand and contract. Arteries have three layers of thick walls. Smooth muscle fibers contract, another layer of connective tissue is quite elastic, allowing the arteries to carry blood under high pressure.
The aorta is the main artery leaving the heart.
The pulmonary artery is the only artery that carries oxygen-poor blood. The pulmonary artery carries deoxygenated blood to the lungs. In the lungs, gas exchange occurs, carbon dioxide diffuses out, oxygen diffuses in
Arterioles are small arteries that connect larger arteries with capillaries. Small arterioles branch into collections of capillaries known as capillary beds.

Capillaries, are thin-walled blood vessels in which gas exchange occurs.
In the capillary, the wall is only one cell layer thick.
Capillaries are concentrated into capillary beds. Some capillaries have small pores between the cells of the capillary wall, allowing materials to flow in and out of capillaries as well as the passage of white blood cells.
Changes in blood pressure also occur in the various vessels of the circulatory system.
Nutrients, wastes, and hormones are exchanged across the thin walls of capillaries.
Capillaries are microscopic in size, although blushing is one manifestation of blood flow into capillaries. Control of blood flow into capillary beds is done by nerve-controlled sphincters.
The circulatory system functions in the delivery of oxygen, nutrient molecules, and hormones and the removal of carbon dioxide, ammonia and other metabolic wastes.
Capillaries are the points of exchange between the blood and surrounding tissues.
Materials cross in and out of the capillaries by passing through or between the cells that line the capillary. The extensive network of capillaries in the human body is estimated at between 50,000 and 60,000 miles long. Thorough fare channels allow blood to bypass a capillary bed. These channels can open and close by the action of muscles that control blood flow through the channels.
Blood leaving the capillary beds flows into a progressively larger series of venules that in turn join to form veins. Veins carry blood from capillaries to the heart. With the exception of the pulmonary veins, blood in veins is oxygen-poor. The pulmonary veins carry oxygenated blood from lungs back to the heart. Venules are smaller veins that gather blood from capillary beds into veins. Pressure in veins is low, so veins depend on nearby muscular contractions to move blood along. The veins have valves that prevent backflow of blood

Blood pressure: Ventricular contraction propels blood into arteries under great pressure. Blood pressure is measured in mm of mercury; healthy young adults should have pressure of ventricular systole of 120mm, and 80 mm at ventricular diastole.
Higher pressures (human 120/80 as compared to a 12/1 in lobsters) mean the volume of blood circulates faster (20 seconds in humans, 8 minutes in lobsters).
As blood gets farther from the heart, the pressure likewise decreases. Each contraction of the ventricles sends pressure through the arteries. Elasticity of lungs helps keep pulmonary pressures low. Systemic pressure is sensed by receptors in the arteries and atria. Nerve messages from these sensors communicate conditions to the medulla in the brain. Signals from the medulla regulate blood pressure.

Diseases of the Heart and Cardiovascular System

Heart Attack: Cardiac muscle cells are serviced by a system of coronary arteries. During exercise the flow through these arteries is up to five times normal flow. Blocked flow in coronary arteries can result in death of heart muscle, leading to a heart attack. Blockage of coronary arteries. is usually the result of gradual buildup of lipids and cholesterol in the inner wall of the coronary artery. Occasional chest pain, angina pectoralis, can result during periods of stress or physical exertion. Angina indicates oxygen demands are greater than capacity to deliver it and that a heart attack may occur in the future. Heart muscle cells that die are not replaced since heart muscle cells do not divide. Heart disease and coronary artery disease are the leading causes of death today.
Hypertension, high blood pressure (the silent killer), occurs when blood pressure is consistently above 140/90. Causes in most cases are unknown, although stress, obesity, high salt intake, and smoking can add to a genetic predisposition. Luckily, when diagnosed, the condition is usually treatable with medicines and diet/exercise.

The Vascular System

Two main routes for circulation are the pulmonary (to and from the lungs) and the systemic (to and from the body). Pulmonary arteries carry blood from the heart to the lungs. In the lungs gas exchange occurs. Pulmonary veins carry blood from lungs to heart. The aorta is the main artery of systemic circuit. The vena cavae are the main veins of the systemic circuit. Coronary arteries deliver oxygenated blood, food, etc. to the heart.
Animals often have a portal system, which begins and ends in capillaries, such as between the digestive tract and the liver. Fish pump blood from the heart to their gills, where gas exchange occurs, and then on to the rest of the body. Mammals pump blood to the lungs for gas exchange, then back to the heart for pumping out to the systemic circulation. Blood flows in only one direction.

UPSC

NCERT Summary

Summary of Biology- 5

Blood

Blood is a bright red viscous fluid which flows through all the vessels except the lymph vessels. It constitutes 8% of the total body weight.
Blood is composed of two portions:

- Formed elements(cell and cell-like structures)
- Plasma (liquid containing dissolved substances)

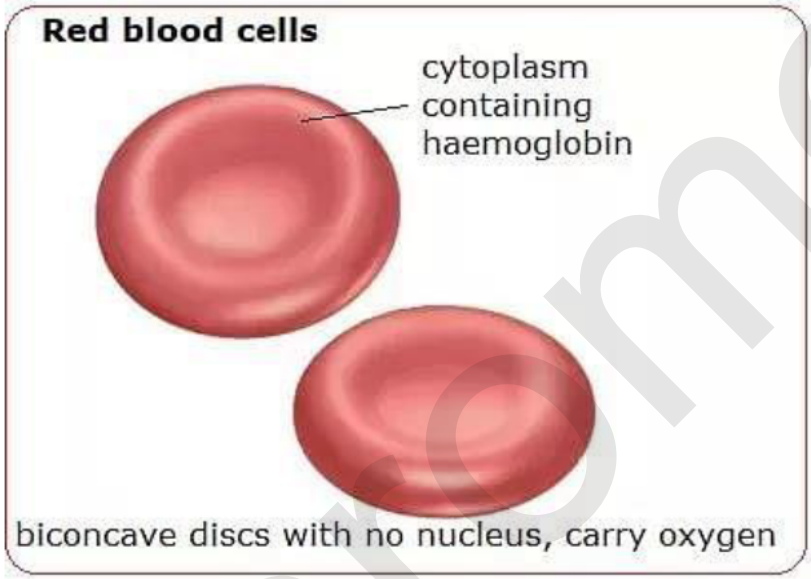
Blood

➢ Plasma

- Plasma is the **liquid component** of the blood. Mammalian blood consists of a liquid (plasma) and a number of cellular and cell fragment components.

- Plasma is about 60% of the volume of blood, cells and fragments are 40%. Plasma has 90% water and 10% dissolved materials including proteins, glucose, ions, hormones, and gases.
- It acts as a buffer, maintaining pH near 7.4. Plasma contains nutrients, wastes, salts, proteins, etc. Proteins in the blood aid in transport of large molecules such as cholesterol.

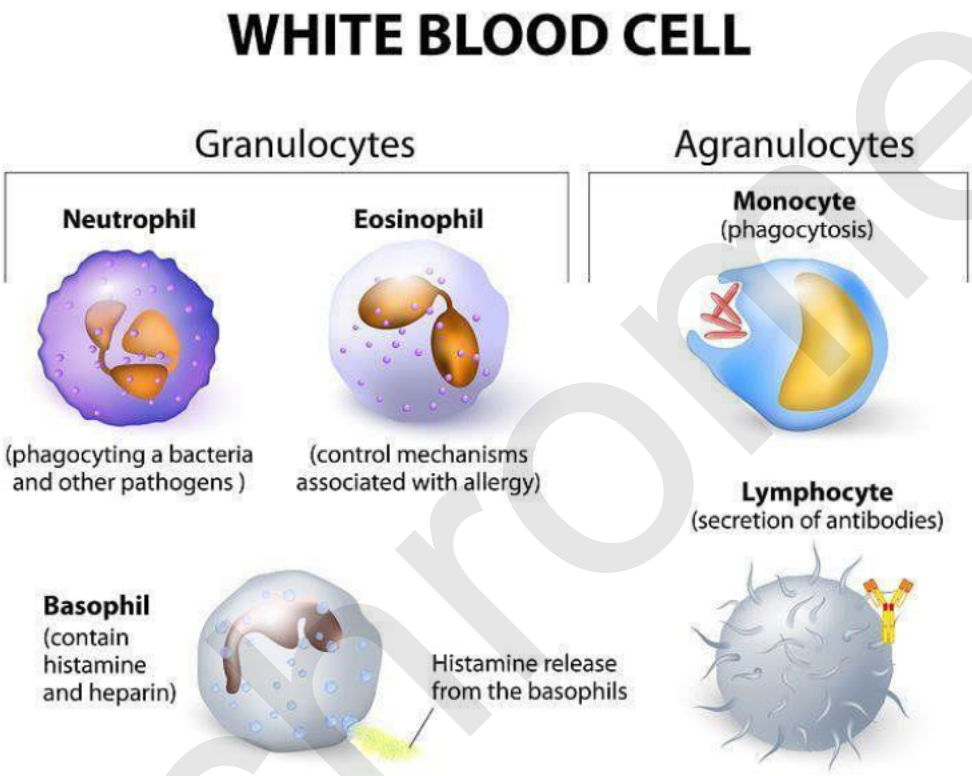
1. Red Blood Cells



- **Red blood cells**, also known as **erythrocytes**, are flattened, doubly concave cells about 7 μm in diameter that carry **oxygen** associated in the cell's **hemoglobin**.
- **Mature erythrocytes** lack a nucleus. They are small, 4 to 6 million cells per cubic millimeter of blood, and have 200 million hemoglobin molecules per cell.
- Humans have a total of 25 trillion **red blood cells** (about 1/3 of all the cells in the body).
- **Red blood cells** are continuously manufactured in red marrow of long bones, ribs, skull, and vertebrae.
- The lifespan of an erythrocyte is only **120 days**, after which they are destroyed in the liver and spleen.
- Iron from hemoglobin is recovered and reused by **red marrow**. The liver degrades the heme units and secretes them as pigment in the bile, responsible for the color of feces.
- Each second two million red blood cells are produced to replace the dead red blood cells.

2. White Blood Cells

White blood cells, also known as **leukocytes**, are larger than erythrocytes, have a nucleus and lack hemoglobin. They function in the cellular immune response. White blood cells (leukocytes) are less than 1% of the blood's volume. They are made from **stem cells** in the bone marrow.



There are five types of leukocytes, which are important components of the immune system:

(i) Neutrophils enter the tissue fluid by squeezing through capillary walls and phagocytizing foreign substances.

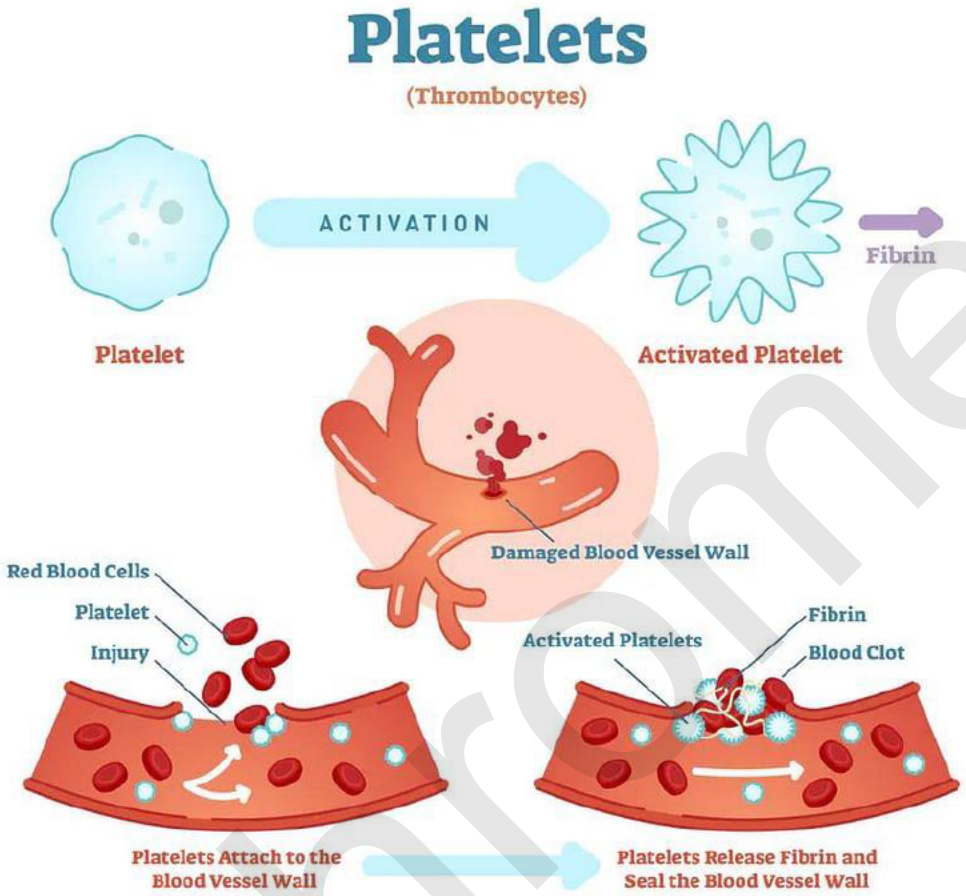
(ii) Macrophages release white blood cell growth factors, causing a population increase for white blood cells.

(iii) Lymphocytes fight infection.

(iv) T-cells attack cells containing viruses.

(v) B-cells produce antibodies. Antigen-antibody complexes are phagocytized by a macrophage. White blood cells can squeeze through pores in the capillaries and fight infectious diseases in intestinal areas.

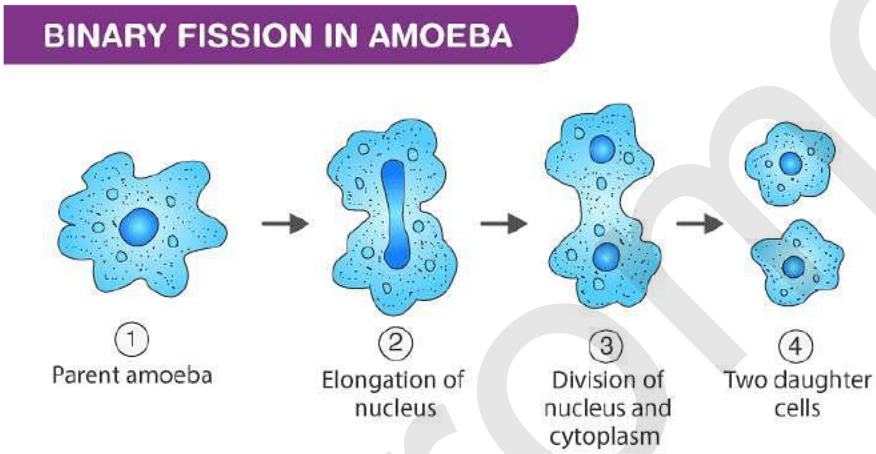
3. Platelets

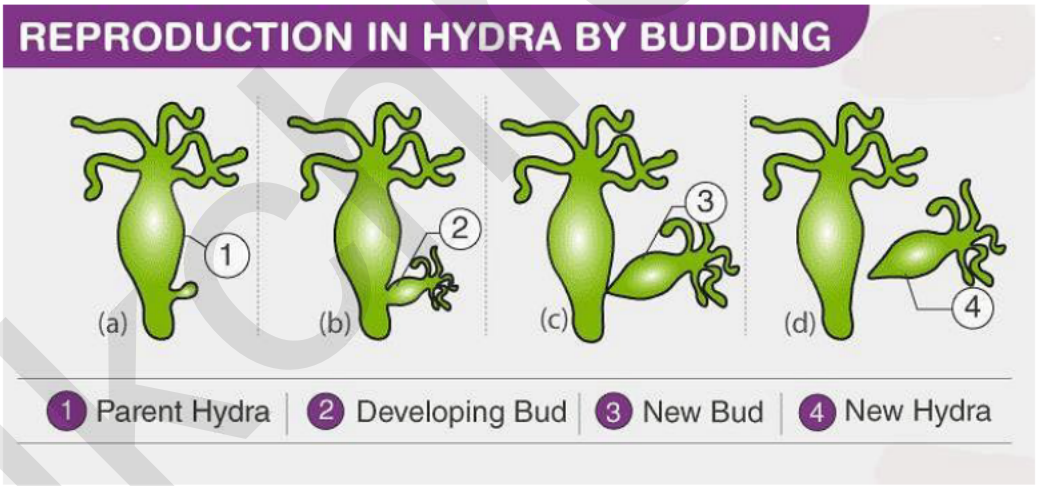


- Platelets result from cell fragmentation and are involved with clotting.
- Platelets are cell fragments that bud off megakaryocytes in bone marrow. They carry chemicals essential to blood clotting.
- Platelets survive for 10 days before being removed by the liver and spleen.
- There are 150,000 to 300,000 platelets in each milliliter of blood.
- Platelets stick and adhere to tears in blood vessels, they also release clotting factors. A hemophiliac's blood cannot clot. Providing correct proteins (clotting factors) has been a common method of treating hemophiliacs. It has also led to HIV transmission due to the use of transfusions and use of contaminated blood products.

The Reproductive System
1. Asexual Reproduction

- Asexual reproduction allows an organism to **rapidly produce many offspring** without the time and resources committed to courtship, finding a mate, and mating.
- **Fission**, **budding**, **fragmentation**, and the **formation of rhizomes and stolons** are some of the mechanisms that allow organisms to reproduce asexually.





- **Starfish** can regenerate an entire body from a fragment of the original body.
- The lack of genetic variability in asexually reproducing populations can be detrimental when environmental conditions change quickly.

2. Sexual Reproduction

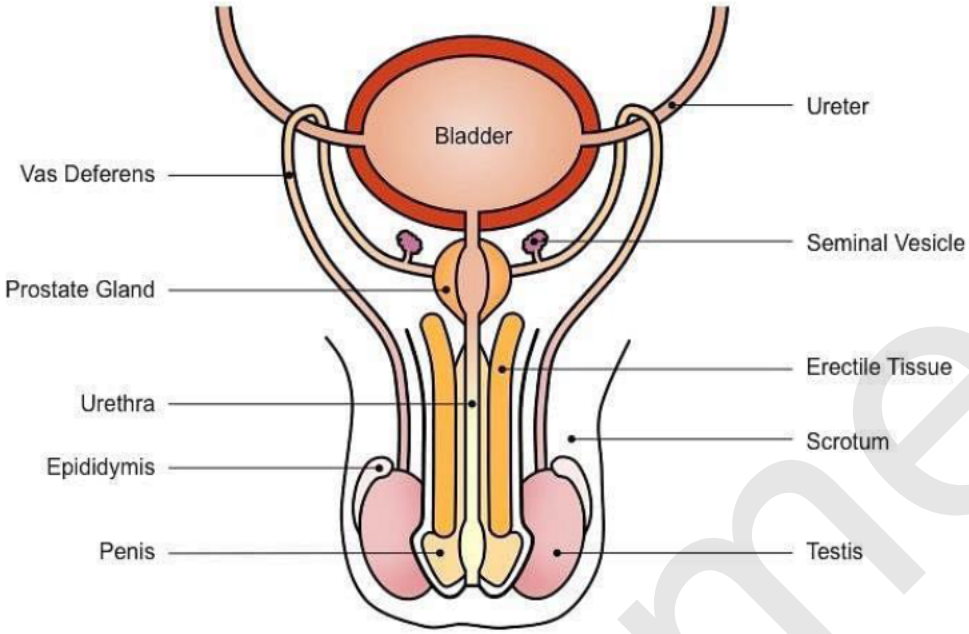
- In sexual reproduction, new individuals are produced by the fusion of haploid gametes to form a **diploid zygote**.
- Sperm are male gametes, ova (ovum singular) are **female gametes**.
- Meiosis produces cells that are genetically distinct from each other.
- Fertilization is the fusion of two such distinctive cells.
- **Rotifers** will reproduce asexually when conditions are favorable by having females produce eggs by mitosis. When conditions deteriorate, rotifers will reproduce sexually and encase their zygotes inside a resistant shell. Once conditions improve, these eggs hatch into diploid individuals. Rotifers thus use sexual reproduction as way to survive a deteriorating environment.
- Sexual reproduction offers the benefit of generating genetic variation among offspring, which enhances the chances of the population's survival.
- Costs of this process include the need for two individuals to mate, courtship rituals, as well as a number of basic mechanisms described later.

3. Human Reproduction and Development

- Human reproduction employs internal fertilization and depends on the integrated action of hormones, the nervous system, and the reproductive system
- Gonads are sex organs that produce gametes. Male gonads are the testes, which produce sperm and male sex hormones. Female gonads are the ovaries, which produce eggs (ova) and female sex hormones.

(a) The Male Reproductive System

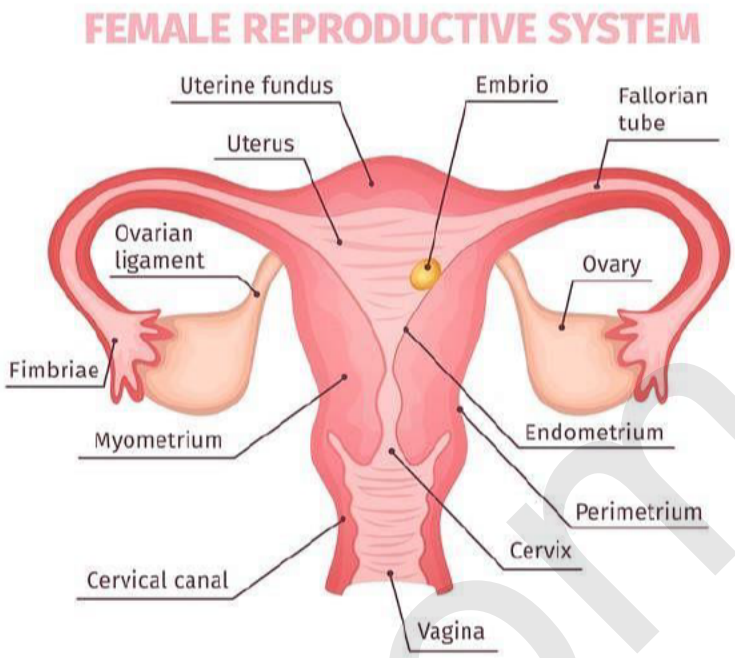
- **Testes** are suspended outside the abdominal cavity by the **scrotum**, a pouch of skin that keeps the testes close or far from the body at an optimal temperature for sperm development.
- **Seminiferous tubules** are inside each testis and are where sperm are produced by meiosis. About 250 meters (850 feet) of tubules are packed into each testis.



Male Reproductive System

- **Spermatocytes** inside the tubules divide by meiosis to produce **spermatids** that in turn develop into mature sperm.
- Sperm production begins at puberty and continues throughout life, with several hundred million sperm being produced each day. Once sperm form they move into the epididymis, where they mature and are stored.
- **Male Sex Hormones:** The anterior pituitary produces follicle-stimulating hormone (FSH) and **luteinizing hormone** (LH). Action of LH is controlled by the **gonadotropin-releasing hormone** (GnRH). LH stimulates cells in the seminiferous tubules to secrete testosterone, which has a role in sperm production and developing male secondary sex characteristics. FSH acts on cells to help in sperm maturation. Negative feedback by testosterone controls the actions of GnRH.
- **Sexual Structures:** Sperm pass through the vas deferens and connect to a short ejaculatory duct that connects to the urethra. The urethra passes through the penis and opens to the outside. Secretions from the seminal vesicles add fructose and prostaglandins to sperm as they pass.
- The **prostate gland** secretes a milky alkaline fluid. The bulbourethral gland secretes a mucus-like fluid that provides lubrication for intercourse. Sperm and secretions make up semen.

(b) The Female Reproductive System



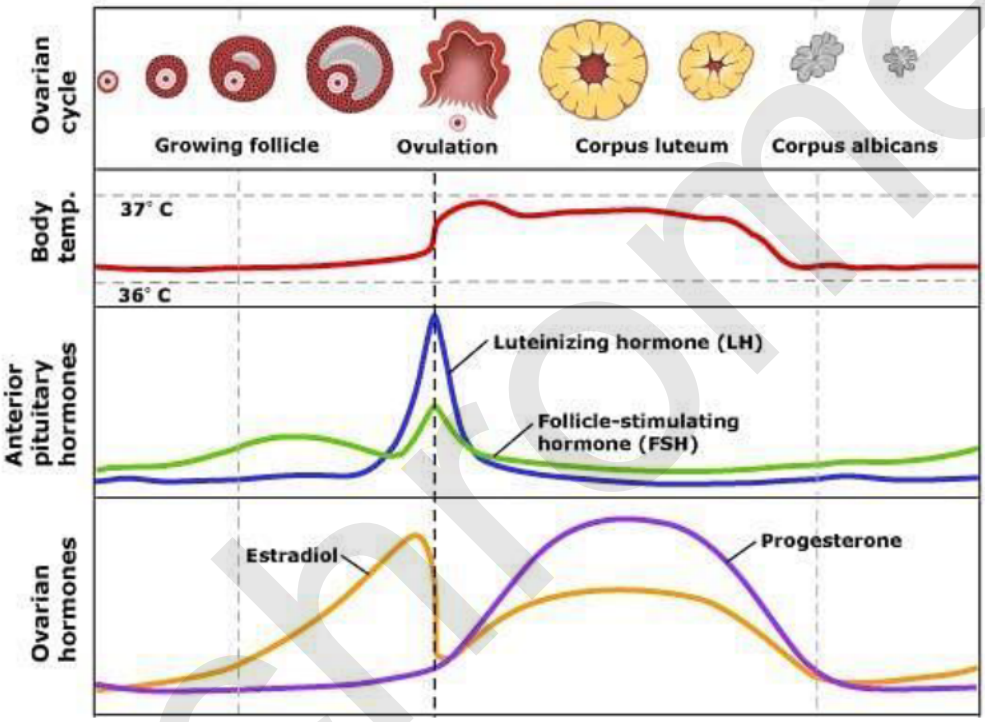
- The female gonads are ovaries, which are located within the lower abdominal cavity.
- The ovary contains many follicles composed of a developing egg surrounded by an outer layer of follicle cells.
- At birth, each female carries a lifetime supply of developing oocytes, each of which is in Prophase I.
- A developing egg (secondary oocyte) is released each month from puberty until menopause, a total of 400-500 eggs.

➢ Ovarian Cycles

- After puberty the ovary cycles between a **follicular phase** (maturing follicles) and a **luteal phase** (presence of the corpus luteum).
- These cyclic phases are interrupted only by pregnancy and continue until menopause when reproductive capability ends.
- The ovarian cycle lasts usually 28 days.
- During the **first phase**, the oocyte matures within a follicle. At the midpoint of the cycle, the oocyte is released from the ovary in a process known as **ovulation**. Following ovulation, the follicle forms a corpus

luteum which synthesizes and prepares hormones to prepare the uterus for pregnancy.

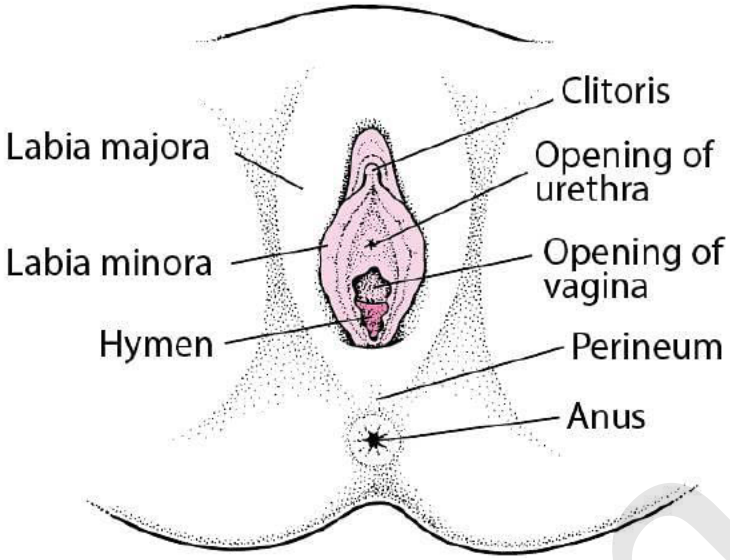
- The **secondary oocyte** passes into the oviduct (fallopian tube or uterine tube). The oviduct is connected to the uterus.
- The uterus has an inner layer, the endometrium, in which a fertilized egg implants. At the lower end of the uterus, the cervix connects the uterus to the vagina. The vagina receives the penis during intercourse and serves as the birth canal.



Ovarian Cycle

➢ **External Genitals**

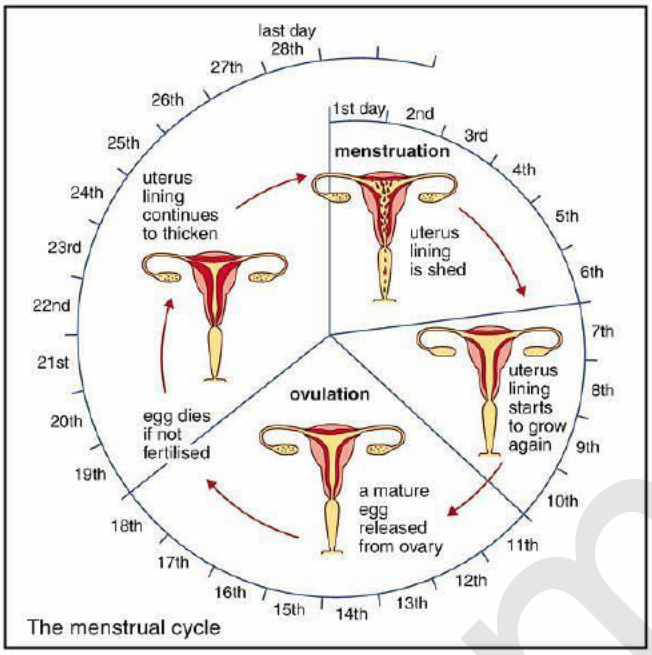
- The female external genitals are collectively known as the **vulva**.
- The **labia minora** is a thin membrane of folded skin just outside the vaginal opening.
- The **labia majora** cover and protect the genital area.
- A **clitoris**, important in arousal, is a short shaft with a sensitive tip covered by a fold of skin.



Female External Genital

(c) Hormones and Female Cycles

- The ovarian cycle is hormonally regulated in **two phases**. The follicle secretes estrogen before ovulation, the corpus luteum secretes both estrogen and progesterone after ovulation.
- Hormones from the hypothalamus and anterior pituitary control the ovarian cycle. The ovarian cycle covers events in the ovary, the menstrual cycle occurs in the uterus.
- Menstrual cycles vary from between 15 and 31 days. The first day of the cycle is the first day of blood flow (day 0) known as **menstruation**.



The menstrual cycle

- During menstruation, the uterine lining is broken down and shed as menstrual flow.
- FSH and LH are secreted on day 0, beginning both the menstrual cycle and the ovarian cycle.
- Both FSH and LH stimulate the maturation of a single follicle in one of the ovaries and the secretion of estrogen. Rising levels of estrogen in the blood trigger secretion of LH, which stimulates follicle maturation and ovulation (day 14, or midcycle). LH stimulates the remaining follicle cells to form the corpus luteum, which produces both **estrogen** and **progesterone**.
- Estrogen and progesterone stimulate the development of the **endometrium** and preparation of the **uterine inner lining** for implantation of a zygote. If pregnancy does not occur, the drop in FSH and LH cause the corpus luteum to disintegrate. The drop in hormones also causes the sloughing off of the inner lining of the uterus by a series of muscle contractions of the uterus.

(d) Sexual Responses

- Humans do not have a mating season, females are sexually receptive to the male at all times of the year.
- <u>There are four stages in mating:</u>
  (i) Arousal
  (ii) Plateau

(iii) Orgasm
(iv) Resolution

- During male arousal, blood flows into the three shafts of spongy erectile tissue inside the penis, causing it to become elongated and erect. The female arousal has the swelling of the areas around the vagina, erection of the clitoris and nipples, and secretion of lubricating fluids in the vagina.
- After insertion of the penis into the vagina, pelvic thrusts by both partners stimulate sensory receptors in the penis, vaginal walls, and clitoris. The sperm leave the epididymis and secretions of glands from the semen. Orgasm involves contractions of muscles of the penis (male) or vagina (female) and waves of pleasurable sensations.
- **Resolution reverses the previous phases**: Muscles relax, Breathing slows, The penis returns to its normal size.

4. Sexually Transmitted Diseases

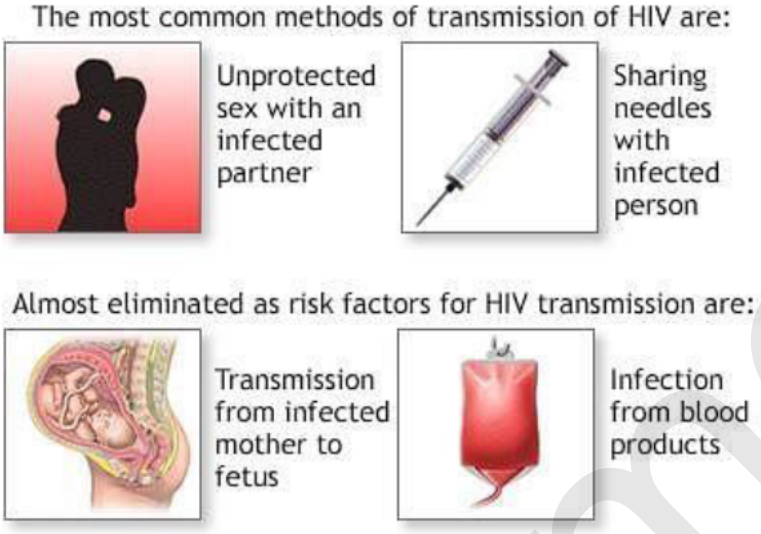
<u>STDs can affect sex partners, fetus, and newborn infants. STDs are grouped into three categories:</u>

(a) Category One: STDs that produce inflammation of the urethra, epididymis, cervix, or oviducts. Gonorrhea and chlamydia are the most common STDs in this category. Both diseases can be treated and cured with antibiotics, once diagnosed.

(b) Category Two: STDs that produce sores on the external genitals. **Genital herpes** is the most common disease in this class. Symptoms of herpes can be treated by antiviral drugs, but the infection cannot be cured. **Syphilis** is a bacterially caused infection, and can, if left untreated, cause serious symptoms and death. However, the disease is curable with antibiotics.

(c) Category Three: This class of STDs includes viral diseases that affect organ systems other than those of the reproductive system. AIDS and hepatitis B are in

this category. Both can be spread by sexual contact or blood. Infectious individuals may appear symptom-free for years after infection.



5. Reproduction: Various Contraceptive Methods

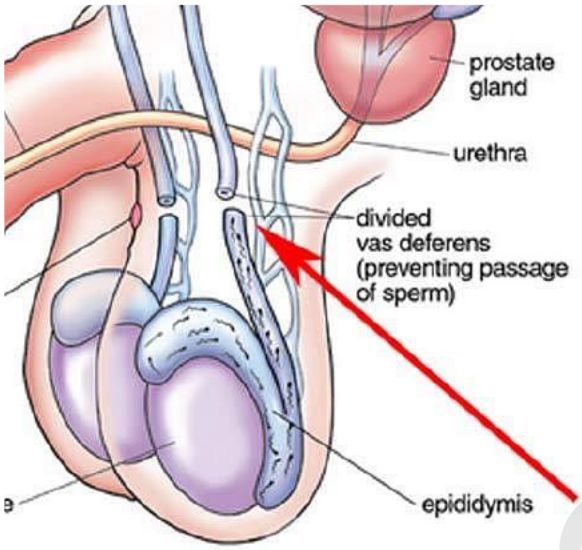
- New techniques have been developed to enhance or reduce the chances of conception. Social conventions and governing laws have developed far slower than this new technology, leading to controversy about moral, ethical, and legal grounds for the uses of such technologies.
- <u>The separation of intercourse from pregnancy uses methods blocking one of the three stages of reproduction:</u>
  (i) Release and transport of gametes
  (ii) Fertilization
  (iii) Implantation

➢ **Effectiveness**

- Various contraceptive methods have been developed, none of which is 100% successful at preventing pregnancy or the transmission of STDs. Abstinence is the only completely effective method.

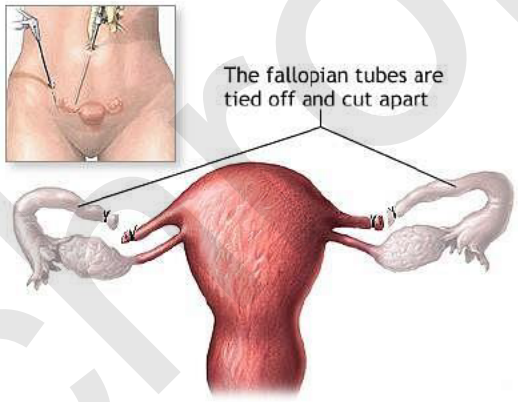
➢ **Methods**

- **Physical prevention** (most effective) include vasectomy and tubal ligation.
- **Vasectomy:** The vas deferens connecting the testes with the urethra is cut and sealed to prevent the transport of sperm.



Vasectomy

- **Tubal ligation:** The oviduct is cut and ends tied off to prevent eggs from reaching the uterus.



Tubal Ligation

- **Oral contraceptives:** (birth control pills) It usually contain a combination of hormones that prevent release of FSH and LH, inhibiting development of the follicle so that no oocytes are released. Time-release capsules (Norplant) can be implanted under the skin and offer long-term suppression of ovulation. RU-486, the so-called morning after pill, interferes with implantation of the blastula into the uterine wall. Its use as a contraceptive is very controversial.
- **Barrier methods:** It employ physical (condom, diaphragm) or chemical (spermacides) means to separate the sperm from the egg. **Male condoms** are fitted over the erect penis, **female condoms** are placed inside the vagina. Only latex condoms prevent the spread of

STDs. **Diaphragms cap** the cervix and block passage of the sperm into the uterus. **Spermicidal jellies** or foams kill sperm on contact and must be placed in the vagina prior to intercourse.

6. Infertility

About 1 in 6 couples is infertile due to physical or physiological conditions preventing gamete production, implantation, or fertilization.

➢ Cause of Infertility

- Blocked oviducts (often from untreated STDs) are the leading cause of infertility in females. Low sperm count, low motility, or blocked ducts are common causes of male infertility.
- Hormone therapy can cause increased egg production. Surgery can open blocked ducts. About 40 of the cases are due to male problems, 40 due to female problems, and the remaining 20% are caused by some unknown agent(s). In vitro fertilization (test-tube babies) is a widely used technique to aid infertile couples.

7. Fertilization and Cleavage

➢ Fertilization Has Three Functions

(i) Transmission of genes from both parents to offspring.
(ii) Restoration of the diploid number of chromosomes reduced during meiosis.
(iii) Initiation of development in offspring.

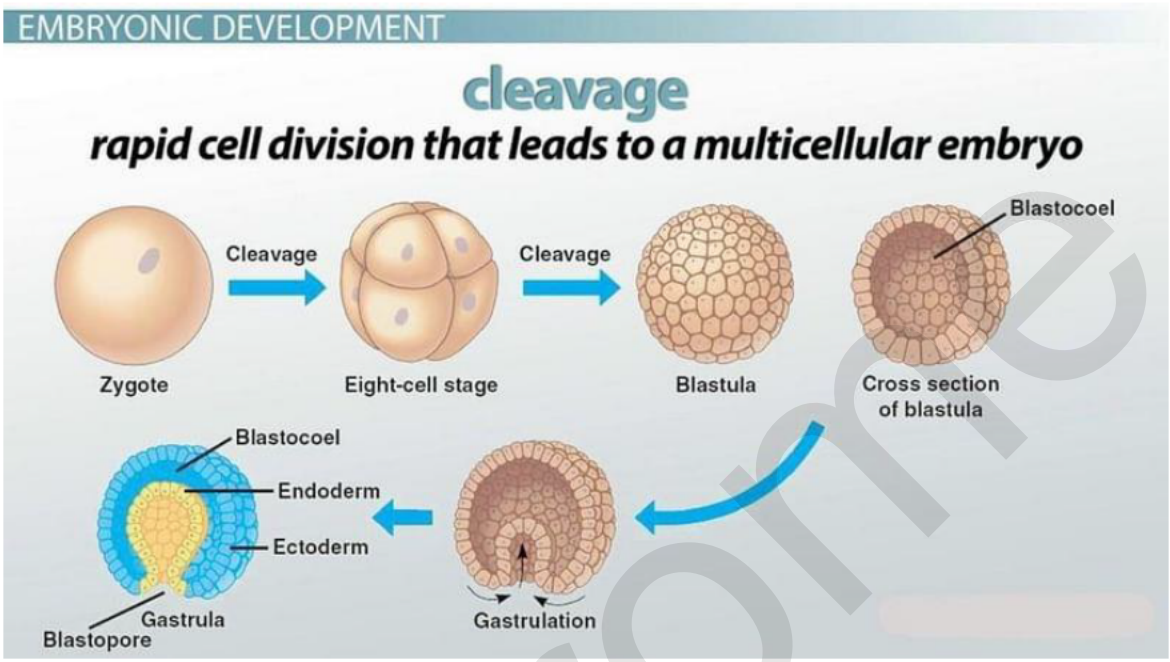
➢ Steps in Fertilization

- Contact between sperm and egg
- Entry of sperm into the egg
- Fusion of egg and sperm nuclei
- Activation of development

➢ Cleavage

- Cleavage is the first step in **development of all multicelled organisms**. Cleavage converts a single-celled zygote into a multicelled embryo by mitosis. Usually, the zygotic cytoplasm is divided among the newly formed cells. Frog embryos divide to produce 37,000 cells in a little over 40 hours. The blastula is produced by mitosis of the zygote, and is a ball of cells surrounding a fluidfilled cavity (the blastocoel).
- The decreasing size of cells increases their surface to volume ratio, allowing for more efficient oxygen exchange between cells and their

environment. RNA and information carrying molecules are distributed to various parts of the blastula, and this molecular differentiation sets the stage for the layering of the body in the next phases of development.



➢ **Gastrulation**

Gastrulation involves a series of cell migrations to positions where they will form the three primary cell layers:

- **Ectoderm (forms the outer layer):** Ectoderm forms tissues associated with outer layers: skin, hair, sweat glands, epithelium. The brain and nervous system also develop from the ectoderm.
- **Mesoderm (forms the middle layer):** The mesoderm forms structures associated with movement and support: body muscles, cartilage, bone, blood, and all other connective tissues. Reproductive system organs and kidneys from mesoderm.
- **Endoderm (forms the inner layer):** The endoderm forms tissues and organs associated with the digestive and respiratory systems. Many endocrine structures, such as the thyroid and parathyroid glands, are formed by the endoderm. The liver, pancreas, and gall bladder arise from endoderm.

➢ **Invagination**

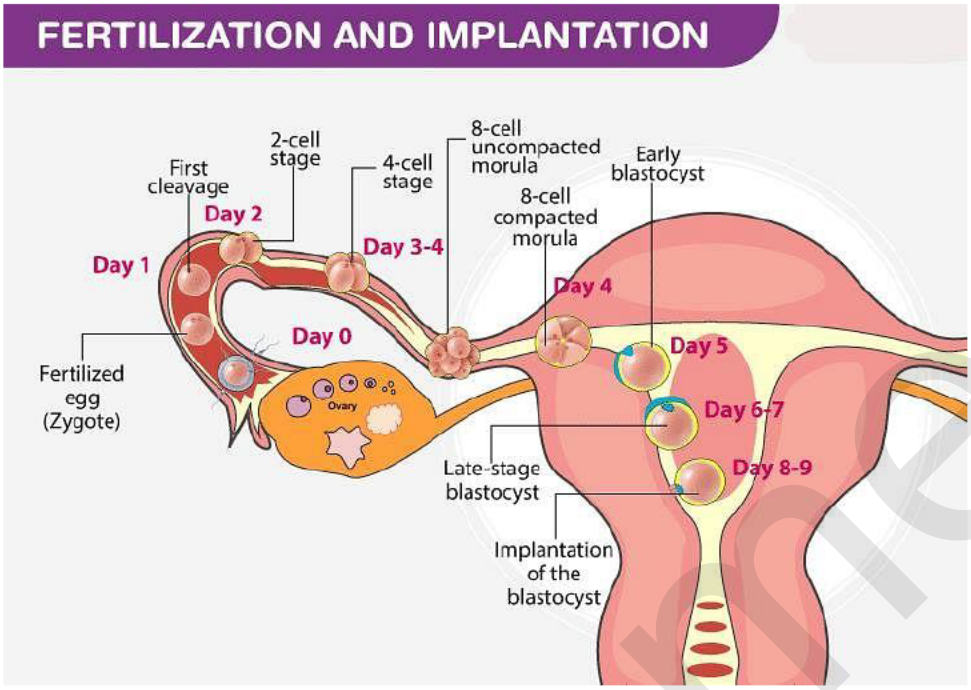
- Immediately after gastrulation, the body axis of the embryo begins to appear. Chordates have the cells that will form the nervous system fold into a neural tube (which will eventually form the spinal cord).
- The mesoderm forms the notochord (which will eventually form the vertebrae). The mesoderm at this time forms somites, which form segmented body parts, such as the muscles of the body wall.

➢ **Pattern Formation and Induction**

- Blastulation and gastrulation establish the main body axis. Organ formation occurs in the next stage of the development of the embryo. During organ formation, cell division is accomplished by migration and aggregation. Pattern formation is the result of cells "sensing" their position in the embryo relative to other cells and to form structures appropriate to that position.
- **Gradients of informational molecules** within the embryo have been suggested to provide the positional information to cells. **Homeobox genes** are pattern genes, they coordinate with gradients of information molecules to establish the body plan and development of organs. Induction is the process in which one cell or tissue type affects the developmental fate of another cell or tissue.
- As a cell begins to form certain structures, certain genes are turned on, others are turned off. Induction affects patterns of gene expression through physical contact or chemical signals. The formation of the **vertebrate eye** is a well-known example.

➢ **Various Stages of Fertilization**

- Fertilization, the fusion of the sperm and egg, usually occurs in the upper third of the oviduct.
- Thirty minutes after ejaculation, sperm are present in the oviduct, having traveled from the vagina through the uterus and into the oviduct. Sperm traverse this distance by the beating of their flagellum.
- Of the several hundred million sperm released in the ejaculation, only a few thousand reach the egg. Only one sperm will fertilize the egg. One sperm fuses with receptors on the surface of the secondary oocyte, triggering a series of chemical changes in the outer oocyte membrane that prevent any other sperm from entering the oocyte.
- The **entry of the sperm initiates Meiosis II** in the **oocyte**. Fusion of the egg and sperm nuclei forms the diploid zygote.



(a) Travels of a Young Zygote

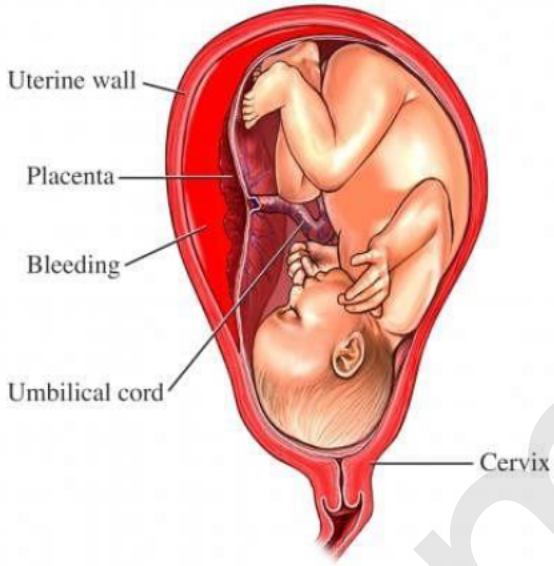
- Cleavage of the zygote begins while it is still in the oviduct, producing a solid ball of cells (morula). The morula enters the uterus, continuing to divide, and becomes a **blastocyst**.

(b) Implantation

- The **uterine lining** becomes enlarged and prepared for implantation of the embryo in the trophoblast layer.
- Twelve days after fertilization, the **trophoblast** has formed a two-layered **chorion**. Human chorionic gonadotropin (hCG) is secreted by the chorion and prolongs the life of the corpus luteum until the placenta begins to secrete estrogen and progesterone.
- Home pregnancy tests work by detecting elevated hCG levels in the woman's urine.

(c) Placenta

Maternal and embryonic structures interlock to form the placenta, the nourishing boundary between the mother's and embryo's systems.



Placenta

- The **umbilical cord** extends from the placenta to the embryo, and transports food to and wastes from the embryo.

UPSC

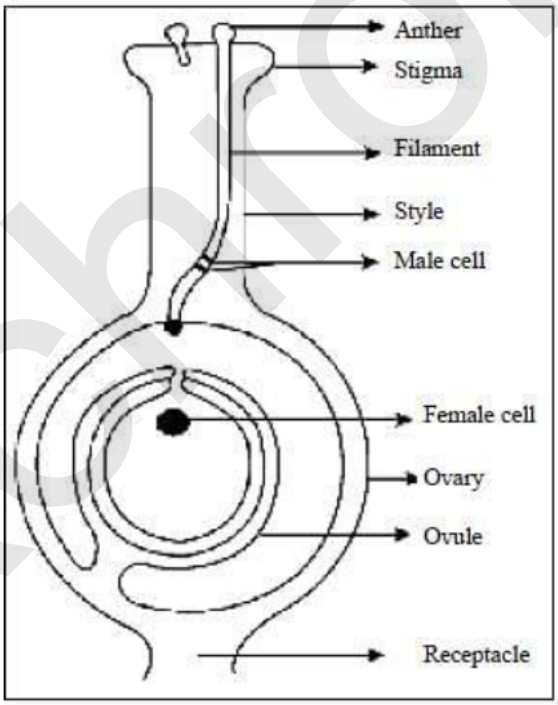
NCERT Summary

Gist of Biology – 6

PLANT REPRODUCTION

Flowering plants

Flowering plants, the angiosperms, were the last of the seed plant groups to evolve, appearing over 100 million years ago during the middle of the Age of Dinosaurs (late Jurassic). All flowering plants produce flowers and if they are sexually reproductive, they produce a diploid zygote and triploid endosperm.



Flowers

Flowers are collections of reproductive and sterile tissue arranged in a tight whorled array having very short internodes. Sterile parts of flowers are the sepals and petals. When these are similar in size and shape, they are termed tepals. Reproductive parts of the flower are the stamen (male, collectively termed the

androecium) and carpel (often the carpel is referred to as the pistil, the female parts collectively termed the gynoecium).

Pollen

Pollen grains (from the greek palynos for dust or pollen) contain the male gametophyte (microgametophyte) phase of the plant. Pollen grains are produced by meiosis of microspore mother cells that are located along the inner edge of the anther sacs (microsporangia). The outer part of the pollen is the exine, which is composed of a complex polysaccharide, sporopollenin. Inside the pollen are two (or, at most, three) cells that comprise the male gametophyte. The tube cell (also referred to as the tube nucleus) develops into the pollen tube. The germ cell divides by mitosis to produce two sperm cells. Division of the germ cell can occur before or after pollination.

Pollination

The transfer of pollen from the anther to the female stigma is termed pollination. This is accomplished by a variety of methods. Entomophyly is the transfer of pollen by an insect. Anemophyly is the transfer of pollen by wind. Other pollinators include birds, bats, water, and humans. Some flowers (for example garden peas) develop in such a way as to pollinate themselves. Others have mechanisms to ensure pollination with another flower. Flower color is thought to indicate the nature of pollinator: red petals are thought to attract birds, yellow for bees, and white for moths. Wind pollinated flowers have reduced petals, such as oaks and grasses.

Gynoecium

The gynoecium consists of the stigma, style, and ovary containing one or more ovules. These three structures are often termed a pistil or carpel. In many plants, the pistils will fuse for all or part of their length.

The Stigma and Style

The stigma functions as a receptive surface on which pollen lands and germinates its pollen tube. Corn silk is part stigma, part style. The style serves to move the stigma some distance from the ovary. This distance is species specific.

The Ovary

The ovary contains one or more ovules, which in turn contain one female gametophyte, also referred to in angiosperms as the embryo sac. Some plants, such

as cherry, have only a single ovary which produces two ovules. Only one ovule will develop into a seed.

Double Fertilization

The process of pollination being accomplished, the pollen tube grows through the stigma and style toward the ovules in the ovary. The germ cell in the pollen grain divides and releases two sperm cells which move down the pollen tube. Once the tip of the tube reaches the micropyle end of the embryo sac, the tube grows through into the embryo sac through one of the synergids which flank the egg. One sperm cell fuses with the egg, producing the zygote which will later develop into the next-generation sporophyte. The second sperm fuses with the two polar bodies located in the center of the sac, producing the nutritive triploid endosperm tissue that will provide energy for the embryo's growth and development.

Fruit

The ovary wall, after fertilization has occurred, develops into a fruit. Fruits may be fleshy, hard, multiple or single.

Note:- View the Seeds of Life site for illustrations and information about fruits and seeds. Seeds germinate, and the embryo grows into the next generation sporophyte.

THE DIGESTIVE SYSTEM

Digestive System in Various Organism

Single-celled organisms can directly take in nutrients from their outside environment. Multicellular animals, with most of their cells removed from direct contact with the outside environment, have developed specialized structures for obtaining and breaking down their food.

Animals Depend on Two Processes: Feeding and Digestion

- Animals are heterotrophs, they must absorb nutrients or ingest food sources.
- Ingestive eaters, majority of animals, use a mouth to ingest food.
- Absorptive feeders, such as tapeworms, live in a digestive system of another animal and absorb nutrients from that animal directly through their body wall.
- Filter feeders, such as oysters and mussels, collect small organisms and particles from the surrounding water.

- Substrate feeders, such as earthworms and termites, eat the material (dirt or wood) they burrow through.
- Fluid feeders, such as aphids, pierce the body of a plant or animal and withdraw fluids.

Stages in the Digestive Process

Food for the most part consists of various organic macromolecules such as starch, proteins, and fats. These molecules are polymers made of individual monomer units Breaking these large molecules into smaller components involves:

1. movement: propels food through the digestive system

2. secretion: release of digestive juices in response to a specific stimulus

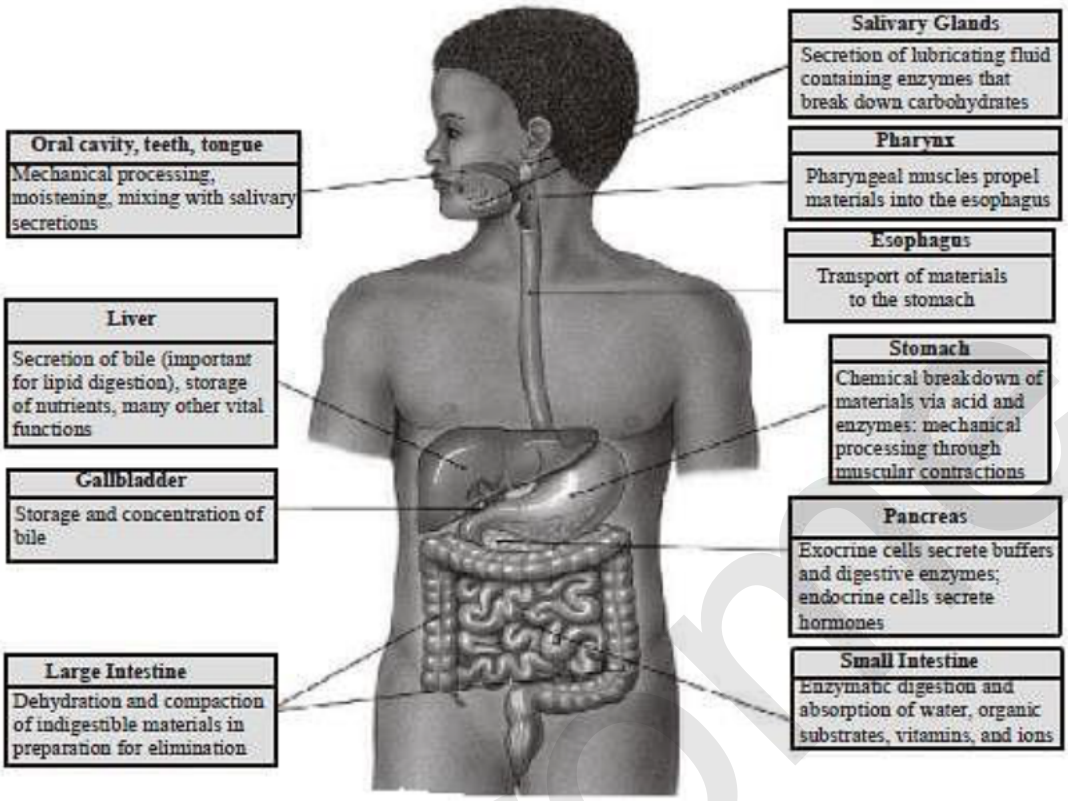
3. digestion: breakdown of food into molecular components small enough to cross the plasma membrane

4. absorption: passage of the molecules into the body's interior and their passage throughout the body

5. elimination: removal of undigested food and wastes.
Three processes occur during what we loosely refer to as "digestion".
Digestion proper, which is the mechanical and chemical breakdown of food into particles/molecules small enough to pass into the blood.
Absorption is the passage of food monomers into the blood stream. Assimilation is the passage of the food molecules into body cells.

The Human Digestive System

The human digestive system, is a coiled, muscular tube (6-9 meters long when fully extended) stretching from the mouth to the anus. Several specialized compartments occur along this length: mouth, pharynx, esophagus, stomach, small intestine, large intestine, and anus. Accessory digestive organs are connected to the main system by a series of ducts: salivary glands, parts of the pancreas, and the liver and gall bladder (bilary system).



(A) The Mouth and Pharynx

Mechanical breakdown begins in the mouth by chewing (teeth) and actions of the tongue. Chemical breakdown of starch by production of salivary amylase from the salivary glands. This mixture of food and saliva is then pushed into the pharynx and esophagus. The esophagus is a muscular tube whose muscular contractions (peristalsis) propel food to the stomach.

In the mouth, teeth, jaws and the tongue begin the mechanical breakdown of food into smaller particles. Most vertebrates, except birds (who have lost their teeth to a hardened bill), have teeth for tearing, grinding and chewing food. The tongue manipulates food during chewing and swallowing; mammals have tastebuds clustered on their tongues.

Salivary glands secrete salivary amylase, an enzyme that begins the breakdown of starch into glucose.

Mucus moistens food and lubricates the esophagus. Bicarbonate ions in saliva neutralize the acids in foods.

Swallowing moves food from the mouth through the pharynx into the esophagus and then to the stomach.

(b) The Stomach

During a meal, the stomach gradually fills to a capacity of 1 liter, from an empty capacity of 50-100 milliliters. At a price of discomfort, the stomach can distend to hold 2 liters or more.
Epithelial cells line inner surface of the stomach, and secrete about 2 liters of gastric juices per day.
Gastric juice contains hydrochloric acid, pepsinogen, and mucus; ingredients important in digestion.
Secretions are controlled by nervous (smells, thoughts, and caffeine) and endocrine signals. The stomach secretes hydrochloric acid and pepsin. Hydrochloric acid (HCl) lowers pH of the stomach so pepsin is activated. Pepsin is an enzyme that controls the hydrolysis of proteins into peptides.
The stomach also mechanically churns the food. Chyme, the mix of acid and food in the stomach, leaves the stomach and enters the small intestine.
Hydrochloric acid does not directly function in digestion: it kills microorganisms, lowers the stomach pH to between 1.5 and 2.5; and activates pepsinogen.
Pepsinogen is an enzyme that starts protein digestion. Pepsinogen is produced in cells that line the gastric pits. It is activated by cleaving off a portion of the molecule, producing the enzyme pepsin that splits off fragments of peptides from a protein molecule during digestion in the stomach.
Carbohydrate digestion, begun by salivary amylase in the mouth, continues in the bolus as it passes to the stomach. The bolus is broken down into acid chyme in the lower third of the stomach, allowing the stomach's acidity to inhibit further carbohydrate breakdown. Protein digestion by pepsin begins.

Note: (Alcohol and aspirin are absorbed through the stomach lining into the blood.)
Epithelial cells secrete mucus that forms a protective barrier between the cells and the stomach acids. Pepsin is inactivated when it comes into contact with the mucus. Bicarbonate ions reduce acidity near the cells lining the stomach. Tight junctions link the epithelial stomach-lining cells together, further reducing or preventing stomach acids from passing.

Ulcers

Peptic ulcers result when these protective mechanisms fail. Bleeding ulcers result when tissue damage is so severe that bleeding occurs into the stomach.
Perforated ulcers are life-threatening situations where a hole has formed in the stomach wall.
At least 90% of all peptic ulcers are caused by Helicobacter pylori. Other factors, including stress and aspirin, can also produce ulcers.

(C) The Small Intestine

The small intestine, is where final digestion and absorption occur.
The small intestine is a coiled tube over 3 meters long. Coils and folding plus villi give this 3m tube the surface area of a 500-600m long tube.
Final digestion of proteins and carbohydrates must occur, and fats have not yet been digested.
Villi have cells that produce intestinal enzymes which complete the digestion of peptides and sugars.
The absorption process also occurs in the small intestine. Food has been broken down into particles small enough to pass into the small intestine.
Sugars and amino acids go into the bloodstream via capillaries in each villus.
Glycerol and fatty acids go into the lymphatic system.
Absorption is an active transport, requiring cellular energy.
Food is mixed in the lower part of the stomach by peristaltic waves that also propel the acid-chyme mixture against the pyloric sphincter.
Increased contractions of the stomach push the food through the sphincter and into the small intestine as the stomach eempties over a 1 to 2 hour period.
High fat diets significantly increase this time period. The small intestine is the major site for digestion and absorption of nutrients. The small intestine is up to 6 meters long and is 2-3 centimeters wide.
The upper part, the duodenum, is the most active in digestion. Secretions from the liver and pancreas are used for digestion in the duodenum. Epithelial cells of the duodenum secrete a watery mucus.
The pancreas secretes digestive enzymes and stomach acid-neutralizing bicarbonate. The liver produces bile, which is stored in the gall bladder before entering the bile duct into the duodenum.
Digestion of carbohydrates, proteins, and fats continues in the small intestine.
Starch and glycogen are broken down into maltose by small intestine enzymes.
Proteases are enzymes secreted by the pancreas that continue the breakdown of protein into small peptide fragments and amino acids.
Bile emulsifies fats, facilitating their breakdown into progressively smaller fat globules until they can be acted upon by lipases. Bile contains cholesterol, phospholipids, bilirubin, and a mix of salts.
Fats are completely digested in the small intestine, unlike carbohydrates and proteins. Most absorption occurs in the duodenum and jejeunum (second third of the small intestine). The inner surface of the intestine has circular folds that more than triple the surface area for absorption.
Villi covered with epithelial cells increase the surface area by another factor of 10.
The epithelial cells are lined with microvilli that further increase the surface area; a 6 meter long tube has a surface area of 300 square meters.
Each villus has a surface that is adjacent to the inside of the small intestinal opening

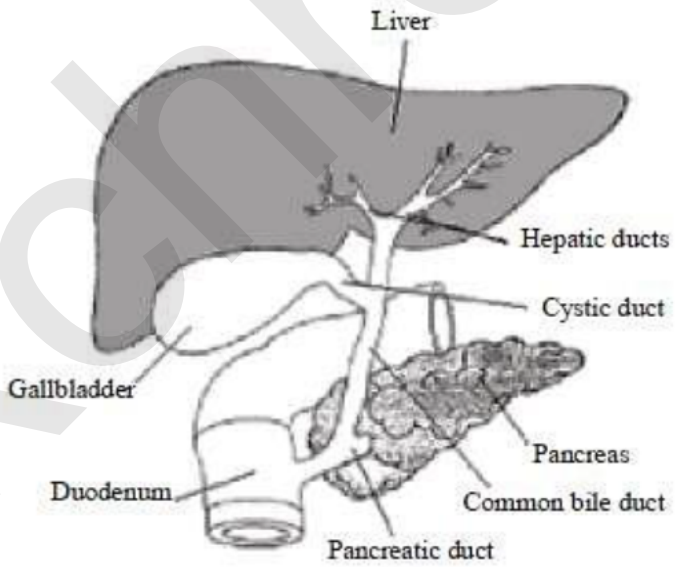
covered in microvilli that form on top of an epithelial cell known as a brush border. Each villus has a capillary network supplied by a small arteriole. Absorbed substances pass through the brush border into the capillary, usually by passive transport.

Maltose, sucrose, and lactose are the main carbohydrates present in the small intestine; they are absorbed by the microvilli. Starch is broken down into two-glucose units (maltose) elsewhere. Enzymes in the cells convert these disaccharides into monosaccharides that then leave the cell and enter the capillary. Lactose intolerance results from the genetic lack of the enzyme lactase produced by the intestinal cells.

Peptide fragments and amino acids cross the epithelial cell membranes by active transport. Inside the cell they are broken into amino acids that then enter the capillary. Gluten enteropathy is the inability to absorb gluten, a protein found in wheat.

Digested fats are not very soluble. Bile salts surround fats to form micelles, that can pass into the epithelial cells. The bile salts return to the lumen to repeat the process. Fat digestion is usually completed by the time the food reaches the ileum (lower third) of the small intestine. Bile salts are in turn absorbed in the ileum and are recycled by the liver and gall bladder. Fats pass from the epithelial cells to the small lymph vessel that also runs through the villus.

The Liver:



The liver produces and sends bile to the small intestine via the hepatic duct. Bile contains bile salts, which emulsify fats, making them susceptible to enzymatic breakdown.

In addition to digestive functions, the liver plays several other roles:

(1) detoxification of blood;

(2) synthesis of blood proteins;

(3) destruction of old erythrocytes and conversion of hemoglobin into a component of bile;
(4) production of bile;
(5) storage of glucose as glycogen, and its release when blood sugar levels drop; and
(6) production of urea from amino groups and ammonia.

Gall Bladder

The gall bladder stores excess bile for release at a later time. We can live without our gall bladders, in fact many people have had theirs removed. The drawback, however, is a need to be aware of the amount of fats in the food they eat since the stored bile of the gall bladder is no longer available.
Glycogen is a polysaccharide made of chains of glucose molecules. In plants starch is the storage form of glucose, while animals use glycogen for the same purpose. Low glucose levels in the blood cause the release of hormones, such as glucagon, that travel to the liver and stimulate the breakdown of glycogen into glucose, which is then released into the blood(raising blood glucose levels). When no glucose or glycogen is available, amino acids are converted into glucose in the liver. The process of deamination removes the amino groups from amino acids. Urea is formed and passed through the blood to the kidney for export from the body. Conversely, the hormone insulin promotes the take-up of glusose into liver cells and its formation into glycogen.

(A) Liver Diseases: Jaundice occurs when the characteristic yellow tint to the skin is caused by excess hemoglobin breakdown products in the blood, a sign that the liver is not properly functioning. Jaundice may occur when liver function has been impaired by obstruction of the bile duct and by damage caused by hepatitis.

(B) Hepatitis A, B, and C are all viral diseases that can cause liver damage. Like any viral disease, the major treatment efforts focus on treatment of symptoms, not removal of the viral cause.

- **Hepatitis A** is usually mild malady indicated by a sudden fever, malaise, nausea, anorexia, and abdominal discomfort.
- The virus causing Hepatitis A is primarilly transmitted by fecal contamination, although contaminated food and water also can promote transmission.
- **Hepatitis B** may be transmitted by blood and blood products as well as sexual contact. The risk of HBV infection is high among promiscuous homosexual men although it is also transmitted hetereo sexually. Correct use of condoms is thought to reduce or eliminate the risk of transmission.

- Individuals with chronic hepatitis B are at an increased risk of developing primary liver cancer.
- **Hepatitis C** affects approximately 170 million people worldwide. The virus is transmitted primarily by blood and blood products.

Sexual transmission can occur between monogamous couples (rare) but infection is far more common in those who are promiscuous.
In rare cases, Hepatitis C causes acute disease and even liver failure. with cirrhosis from Hepatitis C also bear increased chances of developing primary liver cancer.

(C) Cirrhosis: Cirrhosis of the liver commonly occurs in alcoholics, who place the liver in a stress situation due to the amount of alcohol to be broken down. Cirrhosis can cause the liver to become unable to perform its biochemical functions. Chemicals responsible for blood clotting are synthesized in the liver, as is albumin, the major protein in blood. The liver also makes or modifies bile components. Blood from the circulatory system passes through the liver, so many of the body's metabolic functions occur primarily there including the metabolism of cholesterol and the conversion of proteins and fats into glucose. Cirrhosis is a disease resulting from damage to liver cells due to toxins, inflammation, and other causes.
Liver cells regenerate in an abnormal pattern primarily forming nodules that are surrounded by fibrous tissue. Changes in the structure of the liver can decrease blood flow, leading to secondary complications.
Cirrhosis has many cuses, including alcoholic liver disease, severe forms of some viral hepatitis, congestive heart failure, parasitic infections (for example schistosomiasis), and long term exposure to toxins or drugs.

The Pancreas

The pancreas sends pancreatic juice, which neutralizes the chyme, to the small intestive through the pancreatic duct. In addition to this digestive function, the pancrease is the site of production of several hormones, such as glucagon and insulin. An recently recognized condition which is known as prediabetes, in which the body gradually loses its sensitivity to insulin, leading eventually to Type II diabetes medications, diet and behavior (in other words EXERCISE!!!) changes are thought to delay if not outright postpone the onset of diabetes if corrected soon enough.

(D) The Large Intestine

The large intestine is made up by the colon, cecum, appendix, and rectum. Material in the large intestine is mostly indigestible residue and liquid.

Movements are due to involuntary contractions that shuffle contents back and forth and propulsive contractions that move material through the large intestine. The large intestine performs three basic functions in vertebrates:
(1) recovery of water and electrolytes from digested food;
(2) formation and storage of feces; and
(3) microbial fermentation:

The large intestine supports an amazing flora of microbes. Those microbes produce enzymes that can digest many of molecules indigestible by vertebrates. Secretions in the large intestine are an alkaline mucus that protects epithelial tissues and neutralizes acids produced by bacterial metabolism.
Water, salts, and vitamins are absorbed, the remaining contents in the lumen form feces (mostly cellulose, bacteria, bilirubin). Bacteria in the large intestine, such as E. coli, produce vitamins (including vitamin K) that are absorbed.

Nutrition

Nutrition deals with the composition of food, its energy content, and slowly (or not at all) synthesized organic molecules. Chemotrophs are the organisms (mostly bacteria) that derive their energy from inorganic chemical reactions. Phototrophs convert sunlight energy into sugar or other organic molecules. Heterotrophs eat to obtain energy from the breakdown of organic molecules in their food.
Macronutrients are foods required on a large scale each day. These include carbohydrates, lipids, and amino acids. Water is essential, correct water balance is a must for proper functioning of the body.

Carbohydrate: The diet should contain at least 100 grams of carbohydrate every day. Recently, however, new recommendations have been developed that suggest a lowering of the amount of carbohydrate.

Protein: Proteins are polymers composed of amino acids. Proteins are found in meat, milk, poultry, fish, cereal grains and beans. They are needed for cellular growth and repair. Twenty amino acids are found in proteins, of which humans can make eleven. The remaining nine are the essential amino acids which must be supplied in the diet.
Normally proteins are not used for energy, however during starvation (or a low-carb diet) muscle proteins are broken down for energy. Excess protein can be used for energy or converted to fats.

Lipids and fats: Lipids and fats generate the greatest energy yield, so a large number of plants and animals store excess food energy as fats.

Lipids and fats are present in oils, meats, butter, and plants (such as avocado and peanuts). Some fatty acids, such as linoleic acid, are essential and must be included in the diet. When present in the intestine, lipids promote the uptake of vitamins A, D, E, and K.

Vitamins: Vitamins are organic molecules required for metabolic reactions. They usually cannot be made by the body and are needed in trace amounts. Vitamins may act as enzyme cofactors or coenzymes. Some vitamins are soluble in fats, some in water.

Minerals: Minerals are trace elements required for normal metabolism, as components of cells and tissues, and for nerve conduction and muscle contraction. They can only be obtained from the diet. Iron (for hemoglobin), iodine (for thyroxin), calcium (for bones), and sodium (nerve message transmission) are examples of minerals. There is a quantitative relationship between nutrients and health. Imbalances can cause disease. Many studies have concluded nutrition is a major factor in cardiovascular disease, hypertension, and cancer.

Digestion in Animals Facts from NCERT

- Starfish feeds on animals covered by half shells of calcium carbonate. After opening the shell, the starfish pops out its stomach through its mouth to eat the soft animals inside the shell. The stomach the goes back into the body and the food is slowly digested.
- The saliva breakdown the starch into sugar.
- Liver situated in the upper part of the abdomen on the right side. It is the largest gland in the body.
- In the process of digestion carbohydrates get broken down into simple sugars such as glucose. Fats into fatty acid and glycerol. Proteins into amino acid.
- Grass eating animals chewing continuously even when they are not eating because they quickly swallow the grass and store it in a separate part of the stomach called rumen. Here the food get partially digested and is called cud, later the cud returns to the mouth in small lumps and the animal chews it. This process is called rumination and these animals are called ruminants.
- The grass is rich in cellulose a type of carbohydrates human cannot digest cellulose.
- Amoeba is a microscopic single celled organism found in pond water. When it sense food, it pushes out one or more finger like projection (pseudopodia) around the food particles and engulf it and then the food becomes trapped in a food vacuole.

JK Chrome

NCERT Summary

Summary of Biology- 7

THE EXCRETORY SYSTEM

Excretory Systems in Various Animals

Excretory systems regulate the chemical composition of body fluids by removing metabolic wastes and retaining the proper amounts of water, salts, and nutrients. Components of this system in vertebrates include the kidneys, liver, lungs, and skin. Not all animals use the same routes or excrete their wastes the same way as humans do. Excretion applies to metabolic waste products that cross a plasma membrane. Elimination is the removal of feces.

A. Nitrogen Wastes

Nitrogen wastes are by product of protein metabolism. Amino groups are removed from amino acids prior to energy conversion. The NH_2 (amino group) combines with a hydrogen ion (proton) to form ammonia (NH_3).
Ammonia is very toxic and usually is excreted directly by marine animals.
Terrestrial animals usually need to conserve water. Ammonia is converted to urea, a compound the body can tolerate at higher concentrations than ammonia. Birds and insects secrete uric acid that they make through large energy expenditure but little water loss.
Amphibians and mammals secrete urea that they form in their liver. Amino groups are turned into ammonia, which in turn is converted to urea, dumped into the blood and concentrated by the kidneys.

(B) Water and Salt Balance

The excretory system is responsible for regulating water balance in various body fluids. Osmoregulation refers to the state aquatic animals are in: they are surrounded by freshwater and must constantly deal with the influx of water. Animals, such as crabs, have an internal salt concentration very similar to that of the surrounding ocean. Such animals are known as osmocon-formers, as there is little water transport between the inside of the animal and the isotonic outside environment. Marincompositione vertebrates, however, have internal

concentrations of salt that are about one-third of the surrounding seawater. They are said to be osmoregulators. Osmoregu-lators face two problems: prevention of water loss from the body and prevention of salts diffusing into the body. Fish deal with this by passing water out of their tissues through their gills by osmosis and salt through their gills by active transport.
Cartilaginous fish have a greater salt concentration than seawater, causing water to move into the shark by osmosis; this water is used for excretion. Freshwater fish must prevent water gain and salt loss. They do not drink water, and have their skin covered by a thin mucus. Water enters and leaves through the gills and the fish excretory system produces large amounts of dilute urine. Terrestrial animals use a variety of methods to reduce water loss: living in moist environments, developing impermeable body coverings, production of more concentrated urine.
Water loss can be considerable: a person in a 100 digree F temperature loses 1 liter of water per hour.

Excretory System Functions

1. Collect water and filter body fluids.
2. Remove and concentrate waste products from body fluids and return other substances to body fluids as necessary for homeostasis.
3. Eliminate excretory products from the body.

Invertebrate Excretory Organs

Many invertebrates such as flatworms use a nephridium as their excretory organ. At the end of each blind tubule of the nephridium is a ciliated flame cell. As fluid passes down the tubule, solutes are reabsorbed and returned to the body fluids.
Body fluids are drawn into the Malphigian tubules by osmosis due to large concentrations of potassium inside the tubule. Body fluids pass back into the body, nitrogenous wastes empty into the insect's gut. Water is reabsorbed and waste is expelled from the insect.

The Human Excretory System

The urinary system is made-up of the kidneys, ureters, bladder, and urethra. The nephron, an evolutionary modification of the nephridium, is the kidney's functional unit. Waste is filtered from the blood and collected as urine in each kidney. Urine leaves the kidneys by ureters, and collects in the bladder. The bladder can distend to store urine that eventually leaves through the urethra.

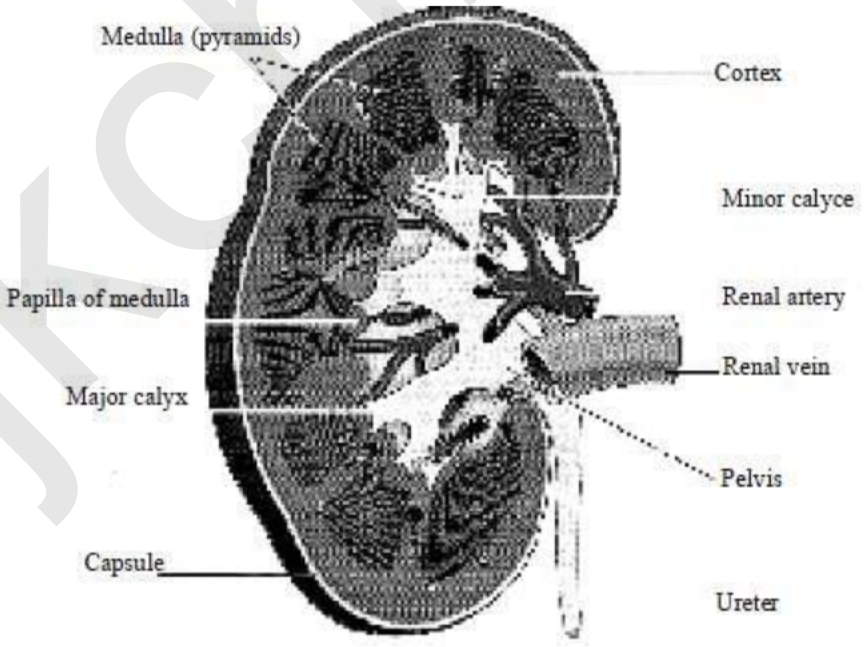
(a) The Nephron

The nephron consists of a cup-shaped capsule containing capillaries and the glomerulus, and a long renal tube. Blood flows into the kidney through the renal artery, which branches into capillaries associated with the glomerulus. Arterial pressure causes water and solutes from the blood to filter into the capsule. Fluid flows through the proximal tubule, which include the loop of Henle, and then into the distal tubule. The distal tubule empties into a collecting duct. Fluids and solutes are returned to the capillaries that surround the nephron tubule.
The nephron has three functions:
1. Glomerular filtration of water and solutes from the blood.
2. Tubular reabsorption of water and conserved molecules back into the blood.
3. Tubular secretion of ions and other waste products from surrounding capillaries into the distal tubule.

Nephrons filter 125 ml of body fluid per minute; filtering the entire body fluid component 16 times each day. In a 24 hour period nephrons produce 180 liters of filtrate, of which 178.5 liters are reabsorbed. The remaining 1.5 liters forms urine.

(B) Urine Production

1. Filtration in the glomerulus and nephron capsule.
2. Reabsorption in the proximal tubule.
3. Tubular secretion in the Loop of Henle.



(C) Cmponents of the NEPHRON

- **Glomerulus:** mechanically filters blood
- **Bowman's Capsule:** mechanically filters blood
- **Proximal Convoluted Tubule:** Reabsorbs 75% of the water, salts, glucose, and amino acids
- **Loop of Henle:** Countercurrent exchange, which maintains the concentration gradient
- **Distal Convoluted Tubule:** Tubular secretion of H ions, potassium, and certain drugs.

(D) Kidney Stones

In some cases, excess wastes crystallize as kidney stones. They grow and can become a painful irritant that may require surgery or ultrasound treatments. Some stones are small enough to be forced into the urethra, others are the size of huge, massive boulders.

(E) Kidney Functions

Kidneys perform a number of homeostatic functions:
1. Maintain volume of extracellular fluid
2. Maintain ionic balance in extracellular fluid
3. Maintain pH and osmotic concentration of the extracellular fluid.
4. Excrete toxic metabolic by-products such as urea, ammonia, and uric acid.

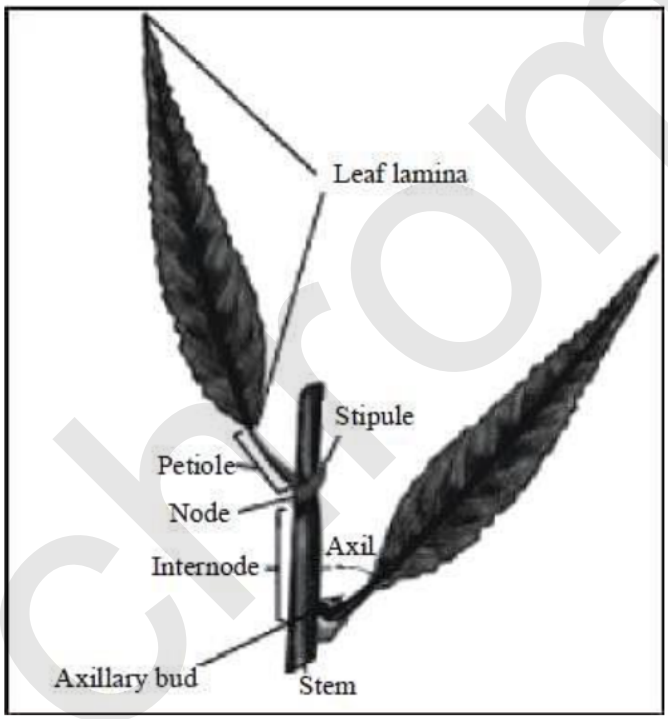
Hormone Control of Water and Salt

Water reabsorption is controlled by the antidiuretic hormone (ADH) in negative feedback.
ADH is released from the pituitary gland in the brain. Dropping levels of fluid in the blood signal the hypothalamus to cause the pituitary to release ADH into the blood. ADH acts to increase water absorption in the kidneys. This puts more water back in the blood, increasing the concentration of the urine. When too much fluid is present in the blood, sensors in the heart signal the hypothalamus to cause a reduction of the amounts of ADH in the blood. This increases the amount of water absorbed by the kidneys, producing large quantities of a more dilute urine. Aldosterone, a hormone secreted by the kidneys, regulates the transfer of sodium from the nephron to the blood. When sodium levels in the blood fall, aldosterone is released into the blood, causing more sodium to pass from the nephron to the blood. This causes water to flow into the blood by osmosis. Renin is released into the blood to control aldosterone.

PHOTOSYNTHESIS

Structure of leaf

- Plants are the only photosynthetic organisms to have leaves (and not all plants have leaves). A leaf may be viewed as a solar collector crammed full of photosynthetic cells.
- The raw materials of photosynthesis, water and carbon dioxide, enter the cells of the leaf, and the products of photosynthesis, sugar and oxygen, leave the leaf.



- Water enters the root and is transported up to the leaves through specialized plant cells known as xylem.
- Land plants must guard against drying out (desiccation) and so have evolved specialized structures known as stomata to allow gas to enter and leave the leaf. Carbon dioxide cannot pass through the protective waxy layer covering the leaf (cuticle), but it can enter the leaf through an opening (the stoma; plural = stomata; Greek for hole) flanked by two guard cells.
- Likewise, oxygen produced during photosynthesis can only pass out of the leaf through the opened stomata.

- Unfortunately for the plant, while these gases are moving between the inside and outside of the leaf, a great deal water is also lost.
- Cottonwood trees, for example, will lose 100 gallons of water per hour during hot desert days. Carbon dioxide enters single-celled and aquatic autotrophs through no specialized structures.

Chlorophyll and Accessory Pigments

- A pigment is any substance that absorbs light. The color of the pigment comes from the wavelengths of light reflected (in other words, those not absorbed).
- Chlorophyll, the green pigment common to all photosynthetic cells, absorbs all wavelengths of visible light except green, which it reflects to be detected by our eyes.
- Black pigments absorb all of the wavelengths that strike them.
- White pigments/lighter colors reflect all or almost all of the energy striking them. Pigments have their own characteristic absorption spectra, the absorption pattern of a given pigment.
- Chlorophyll is a complex molecule. Several modifications of chlorophyll occur among plants and other photosynthetic organisms. All photosynthetic organisms (plants, certain protistans, prochlorobacteria, and cyanobacteria) have chlorophyll a. Accessory pigments absorb energy that chlorophyll a does not absorb. Accessory pigments include chlorophyll b (also c, d, and e in algae and protistans), xanthophylls, and carotenoids (such as beta-carotene). Chlorophyll absorbs its energy from the Violet-Blue and Reddish orange-Red wavelengths, and little from the intermediate (Green-Yellow-Orange) wavelengths.

The Carbon Cycle

- Plants may be viewed as carbon sinks, removing carbon dioxide from the atmosphere and oceans by fixing it into organic chemicals. Plants also produce some carbon dioxide by their respiration, but this is quickly used by photosynthesis. Plants also convert energy from light into chemical energy of C-C covalent bonds. Animals are carbon dioxide producers that derive their energy from carbohydrates and other chemicals produced by plants by the process of photosynthesis.
- The balance between the plant carbon dioxide removal and animal carbon dioxide generation is equalized also by the formation of carbonates in the oceans. This removes excess carbon dioxide from the air and water (both of which are in equilibrium with regard to carbon dioxide). Fossil fuels, such as petroleum and coal, as well as more recent fuels such as

peat and wood generate carbon dioxide when burned. Fossil fuels are formed ultimately by organic processes, and represent also a tremendous carbon sink. Human activity has greatly increased the concentration of carbon dioxide in air.

DIVERSITY IN LIVING ORGANISMS

Differentiation in Plants

(i) Thallophyta

- Plants that do not have well differentiated body design fall in this group.
- The plants in this group are commonly called algae. These plants are predominantly aquatic.
  Example: Spirogyra, cladophora and chara.

(ii) Bryophyte

- These are called the amphibians of the plant kingdom. There is no specialized tissue for the conduction of water and other substances from one past of the plant body to another.
  Example: moss (fumaria) and marchantia

(iii) Pteridopheysta

- In this group plant body is differentiated into roots, stem and leaves and has specialized tissue for the conduction of water and other substances from one plant of the plant body to another.
  Example: marsilea, ferns, and horse tails.

(iv) Gymnosperms

- The plant of this group bear naked seeds and one usually perennial and evergreen and woody.
  Example: pines such as deodar.

(v) Angiosperms

- The seeds develop inside an organ which is modified to become a fruit. These are also called flowering plants.

- Plant embryos in seeds have structures called cotyledons. Cotyledons are called seed leaves because in many instances they emerge and become green the seed germinates.
- The angiosperms are divided into two groups on the basis of the number of cotyledons present in the seed.
- Plants with seeds having a single cotyledon are called monocotyledons or monocots.
  Example: paphiopedilum.
- Plants with seeds having two cotyledons are called dicots.
  Example: ipomoce.

Differentation of Animals

(i) Porifera

- These are non mobile animals attached to some solid support. There are holes or pores all over the body. These lead to a canal system that helps in circulating water throughout the body to bring in food and O_2. They are commonly called sponges mainly found in marine habitats.

(ii) Coelenterata

- These are animals living in water. The body is made up of two layers of cells. One makes up cells on the outside of the body and the other makes the inner living of the body.
- Some of these species live in colonies while others have a solitary life **Example:** span (Hydra) jellyfish are common example.

(iii) Platyhelminthes

- There are three layers of cells from which different tissues can be made. This allow outside and inside body linings as well as some organs to be made.
- Thus there is some degree of tissues formation.
- They are either free living or parasitic.
  Example: Planarians, liver flukes.

(iv) Nematode

- These are very familiar as parasitic worms causing diseases such as the worms causing elephantiasis (filaria worms) or the worms in the intestine (round or pin worms)

(v) Annelida

- 8 They have true body cavity. This allows true organs to be packaged in the body structure. There is thus an extensive organ different ion. This differentiation occurs in a segmental fashion with the segment lined up one after the other from head to tail.
  Example: Earthworms, leeches.

(vi) Arthropods

- There is an open circulatory system and so the blood does not flow in well defined blood vessels. They have joint legs.
  Example: prawns, butterflies, houseflies, spiders, scorpions and crabs.

(vii) Mollusca

- They have an open circulatory system and kidney like organs for excretion. There is a little segmentation. There is a foot that is used for moving around.
  Example: nails, and mussels, octopus.

(viii) Echinodermate

- There are spiny skinned organisms. These are exclusively free living marine animals. They have peculiar water driven tube system that they use for moving around. They have hard calcium carbonate structure that they use as skeleton.
  Example: starfish, sea cucumber.

(ix) Protochordats

- They are marine animals.
  Example: balanoglossus, hardemania and amphioxus.

(x) Vertebratia

These animals have a true vertebral column & internal skeleton. These are grouped into five classes.

Pisces

- These are fish. They are cold blooded and their hearts have only two chambers unlike the four that human have.

- Some with skeletons made entirely of cartilage, such as shark. 8 Some with skeleton made of both bones and cartilages such as tuna or rohu.

(xi) Amphibian

- They have mucus glands in the skin and a three chambered heart. Respiration is through either gills or lungs.
  Example: frogs, toades, and salamanders.

(xii) Reptilia

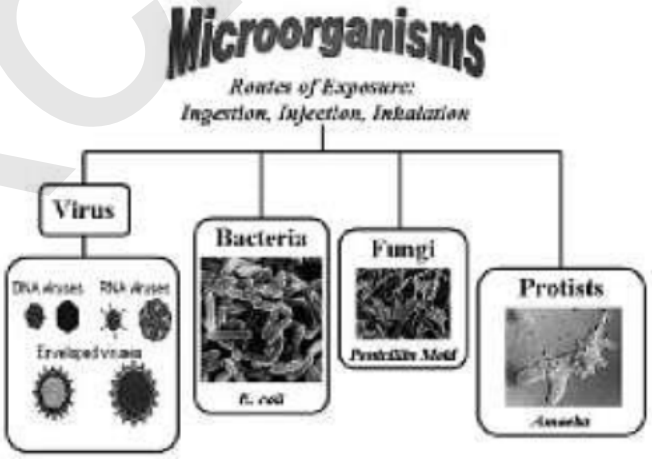
- These animals are cold blooded have scales and breathe through lungs. While most of them have a three chamber heart while crocodile have four heart chambers.
  Example: snakes, turtles, lizards and crocodiles.

(xiii) Aves

- These are warm blooded animals and have a four chambered heart. They lay eggs. They breathe through lungs. All birds fall in this category.

(xiv) Mamalia

- They are warm blooded animals with four chambered hearts.
- They have mammary glands for the production of milk to nourish their young. They produce live young ones.
- However a few of them like platypus and the echidna lay eggs.



MICRO ORGANISMS: FRIEND AND FOE

FACTS FROM NCERT

Micro organisms are classified into four major groups. These groups are bacteria, fungi, protozoa and algae.

- **Viruses:** They reproduce only inside the cells of the host organisms which may be bacterium, plants or animal.
- Common cold, influnenza and most coughs are caused by viruses.
- Serious diseases like polio and chicken pox are also caused by viruses.
- Micro organisms may be single celled like bacteria, Some algae and protozoa. Multicellular such as algae and fungi.
- Micro organisms like amoeba can live alone, while fungi and bacteria may live in colonies.

Friendly Micro Organisms

- Making of curd and breed:-milk is turned into curd by bacteria. The bacterium lacto bacillus promotes the formation of curd.
- Yeast reproduces rapidly and produces CO_2 during respiration. Bubbles of the gas fill the dough and increase its volume; this is the basis of the use of yeast in the booking industry for making breads, pastries and cakes.
- Yeast is used for commercial production of alcohol and wine. For this purpose yeast is grown as natural sugars present in grains like barley, wheat, rice, crushed fruit juice etc.
- This process of conversion of sugar into alcohol is known as fermentation Luwis Pasteur discovered fermentation.

Medicinal Use of Micro Organisms

- The medicine which kills or stops the growth of diseases causing microorganism is called antibiotics.
- Streptomycin, tetracycline and erythromycin are some of the commonly known antibiotics. Which are made from fungi and bacteria.
- Alexander Fleming discovered penicillin.
- Antibiotics are not effective against cold and flu as these are coused by virus.

Vaccine

- When a disease carrying microbe enters our body, the body produces antibodies to fight the invader.
- The antibodies remain in the body and we are protected from the disease causing microbes. This is how a vaccine work.

- Several diseases including cholera, TB, small pox and hepatitis can be prevented by vaccination.
- Edward Jenner discovered the vaccine for small pox.

Increasing Soil Fertility

- Some bacteria and blue green algae are able to fix nitrogen from the atmosphere to enrich the soil with nitrogen and increase its fertility.
- These microbes are commonly called biological nitrogen fixer.

Harmful Microorganisms

- Microbial diseases that can spread from an infected person to a healthy person through air water, food, or physical contact are called communicable diseases. i.e.- cholera, common cold, chicken pox and TB.
- There are some insects and animals which act as carrier of disease causing microbes like house fly. Another is female anopheles mosquito which caries the parasite of malaria.
- Female aedes mosquito acts as carrier of dengu virus.
- Robert Koch discovered the bacteria (bacillus anthracis) which causes anthrax disease.
- It is a dangerous human & cattle disease.

Common Methods of Preserving Food in our Homes.

- **Chemical method**: salt and edible oils are the common chemical generally use.
- Sodium benzoate and sodium metabisulphite are common preservatives. These are also used in the James and squashes to check their spoilage.

Preservation by sugar:

- Sugar reduces the moisture context which inhibits the growth of bacteria which spoil food.
- Use of oil and vinegar prevents spoilage of pickles become bacteria cannot live in such an environment.
- **Pasteurized milk**: the milk is heated to about 70oc for 15 to 30 seconds and then suddenly chilled and stored.
- This process was discovered by lowise Pasteur. It is called pasteurisation.

Some Common Plant Disease Caused by Microorganisms

Plant disease	Microorganisms	Mode of transmission
Citrus canker	Bacteria	Air
Rust of wheat	Fungi	Air, seeds
Yellow vein mosaic of bhindi	Virus	insect

Some Common Human Disease Caused by Micro Organisms

Human disease	Causative microorganisms	Mode of transmission	Preventive measure
Tuberculosis	Bacteria	Air	Keep the patient in complete isolation.
Measles	Virus	Air	Keep the person belonging of the patient away from those of others Vaccination at suitable age.
Chicken pox	Virus	Air/contact	
Polio	Virus	Air/Water	
Cholera	Bacteria	water/food	Maintain personal
Typhoid	Bacteria	water	hygiene and good sanitary habits. consumed properly cooked food and boiled drinking water vaccination
Hepatitis B	Virus	Water	Drink boiled drinking water vaccination.
Malaria	Protozoa	Mosquito	Spray insecticides and control breeding of mosquito.

FACTS FROM HUMAN MACHINE

- Camels have long legs which help to keep their bodies away from the heat of the Sand. They excrete small amount of urine, their dung is dry and they do not sweat. Since Camels lose very little water from their bodies, they can live for many days without water.
- Fish have slippery scales on their bodies. These scales protect the fish and also help in easy movements through water. The presence of specific features of certain habits, which enable a plant or an animal to live in its Surroundings, is called adaptation.
- There are some sea animals like squids and octopus, which do not have this streamlined shape. These animals have gills to help them use oxygen dissolved in water.

- There are some sea animals like dolphins and whales that do not have gills. They breathe in air through nostrils or blowholes that are located on the upper parts of their heads. This allows them to breathe in air when they swim near the surface of water. They can stay inside the water for a long time without breathing. They come out to the surface from time to time, to breathe in air.
- When we breathe out, the air moves from inside out body to outside. Breathing is part of a process called respiration. In respiration, some of the oxygen of the air we breathe, in used by the living body. We breathe out the Carbon dioxide produced in this process.

JK Chrome

NCERT Summary

Gist of Biology – 8

THE ANIMAL KINGDOM

Invertebrates

Of the million or more animal species in the world, more than 98% are invertebrates. Invertebrates don't have an internal skeleton made of bone. Many invertebrates have a fluidfilled, hydrostatic skeleton, like the jelly fish or worm. Others have a hard outer shell, like insects and crustaceans. There are many types of invertebrates. The most common invertebrates include the protozoa, annelids, echinoderms, mollusks and arthropods. Arthropods include insects, crustaceans and arachnids.

(i) Protozoa

Protozoa are simple, single-celled animals. They are the smallest of all animals. Most protozoa are microscopic in size, and can only be seen under a microscope. However, they do breathe, move and reproduce like multicelled animals.
There are several types of protozoa. The amoebas are clear, shapeless cells. Flagellates have a body shape looking like a hair. Although we can't see them, protozoa do a lot for us. Protozoa play a useful role in the food chain as a source of food for fish and other animals. Some protozoa are helpful to humans by eating dangerous bacteria. Unfortunately, other protozoa are parasites and can be harmful to humans by transmitting disease.
Protozoa eat tiny algae and bacteria. Some protozoa absorb food through their cell membrane. Others surround and engulf their food or have openings to collect food. They digest their food in stomach-like compartments called vacuoles. Protozoa take in oxygen and give off carbon dioxide through the cell membrane. Protozoa reproduces by splitting in half.

(ii) Worms and Leeches

There are about 9,000 species of Annelids known today, including worms and leeches. They can be found almost anywhere in the world. Annelids have existed on Earth for over 120 million years.

Annelids have bodies that are divided into segments. They have very well-developed internal organs. One common characteristic of annelids is that they don't have any limbs. Some annelids may have long bristles. Others have shorter bristles and seem smooth, like the earthworm.
There are many types of worms. Commonly known worms include earthworms, roundworms and flatworms. Most worms are small, measuring fractions of an inch to several inches long. Other worms, such as the ribbon worm, can grow up to 100 feet in length. Some worms are considered parasites, in that they live inside the human body.

(iii) Mollusks

Mollusks were among the first inhabitants of the Earth. Fossils of mollusks have been found in rocks and date back over 500 million years. Mollusk fossils are usually well preserved because of their hard shell. Most mollusks have a soft, skin-like organ covered with a hard outside shell. Some mollusks live on land, such as the snail and slug. Other mollusks live in water, such as the oyster, mussel, clam, squid and octopus.
Land living mollusks, like the snail, move slowly on a flat sole called a foot. Ocean living mollusks move or swim by jet propulsion. They propel themselves by ejecting water from their body. For example, the squid ejects water from a cavity within its body, and the scallop ejects water to move by clamping its shell closed. Other ocean living mollusks, like the oyster, attach themselves to rocks or other surfaces, and can't move. They feed by filtering small food particles from water that flows through them.

Snail and Slug

The snail family consists of marine snails and land snails all over the world. Land snails live in many habitats from gardens and woodlands, to deserts and mountains. Marine snails are native to all the worlds oceans and seas, and many freshwater rivers and lakes. Along with slug, snails make up the gastropod class of the mollusk phylum. Snails have an external shell, large enough to withdraw their body into it. Gastropods without a shell are known as slugs.

Octopus

There are about 300 different species of octopus native to many of the world's oceans, especially coral reefs. The octopus doesn't have an internal or external skeleton, allowing it to squeeze into very small places. The octopus has eight arms or tentacles, that it uses for crawling, exploring things and catching prey. The octopus' arms have suckers capable of grasping and holding objects, such as their

prey. The octopus has a hard beak in the center of its arms that it uses to tear apart its prey for eating. Like the squid, the octopus can suck water into its mantle and expel it out in a fast, strong jet. This jet propulsion provides fast, forward movement. Also like the squid, the octopus can eject a thick cloud of ink to help it escape from predators.

(iv) Squid

There are about 300 species of squid. They are native to most of the world's oceans. The squid has a distinct head, eight arms and two tentacles. The mouth of the squid has a sharp horny beak used to kill and tear its prey into small pieces. The main body of the squid is enclosed in the mantle, which has a swimming fin along each side. However, the swimming fin is not the squid's main way of moving through the water. The squid can suck water into the mantle and expel it out in a fast, strong jet. This jet propulsion provides fast, forward movement. Although most squid are less than 2 feet in length, the giant squid can grow up to 43 feet in length.

(v) Cuttlefish

Despite their name, the cuttlefish is not a fish, but a mollusk. The cuttlefish is native to all of the oceans of the world, but are more common in shallow coastal temperate and tropical waters. The cuttlefish has an internal shell or bone, called the cuttlebone, that helps them to be buoyant. Attached to this body structure is the head with eight arms and two feeding tentacles. The cuttlefish can easily camouflage itself by changing its skin color and pattern to blend in with its background. This helps the cuttlefish to hide from predators, and the sneak up on its prey. Like the squid and octopus, the cuttlefish can eject ink in an effort to escape from predators. This ink, called sepia, was once used as a dye to create ink used by artists.

(vi) Nautilus

The nautilus is native to deep ocean waters. It has a multi-chambered shell. Each chamber is sealed and contains gas which provides the nautilus with buoyancy to float. Like the octopus, squid and cuttlefish, the nautilus uses jet propulsion to move forward. It sucks in water, then expels it in a fast, strong stream to propel itself forward. The nautilus has as many as 90 small tentacles that it uses to catch food, such as shrimp, fish or small crustaceans. It then uses its powerful beak to crush the food. The nautilus is considered a living fossil because its form has remained unchanged for over 400 million years.

(vii) Echinoderms: Starfish, Sea Urchin And Family

Echinoderms are marine animals that live in the ocean. Common echinoderms include the sea star, sea urchin, sand dollar and sea cucumber. Most echinoderms have arms or spines that radiate from the center of their body. The central body contains their organs, and their mouth for feeding.
Sea stars, commonly known as the starfish, have 5 or more arms attached to their body.
On the bottom of the Starfish are small tube feet to help with movement and feeding. The starfish's mouth is underneath, and is capable of eating other sea life such as clams and mussels. Another type of echinoderm is the sea urchin. Sea urchins have many spines connected to their body. These spines help to protect them from predators.

(a) Starfish

The starfish or sea star is native to all of the world's oceans. There are about 1,800 different species of starfish with the greatest variety living in the tropical Indo-Pacific region. Most starfish have five arms, although some have fewer or more arms. Like other enchinoderms, starfish have small tube feet on their underneath body to help with movement and feeding. The starfish's mouth is underneath, and it has two stomachs in the mouth. The stomach sack can come out through the mouth to engulf and digest food, such as clams and mussels.

(b) Crustaceans

Crustaceans are a type of Arthropod. The name may not sound familiar, but you probably know them. You may even have eaten one.
Crustaceans live mostly in the ocean or other waters. Most commonly known crustaceans are the crab, lobster and barnacle. Crustaceans have a hard, external shell which protects their body. Crustaceans have a head and abdomen. The head has antennae which are part of their sensory system. The abdomen includes the heart, digestive system and reproductive system.
The abdomen also has appendages, such as legs, for crawling and swimming. Many crustaceans also have claws that help with crawling and eating.

(viii) CRAB

There are about 10,000 different species of crab. The crab is native to all of the world's oceans. There are also freshwater crabs, and even some crabs that live on land. Crabs have a large, hard shell. Extending from the front of its shell are the eyes, mouth and two pairs of antennae. The crab has 5 pairs of legs extending from the

side of its shell. The first pair of legs have claws or pincers used to catch and hold food. The other pairs of legs are used for walking. Most crabs don't swim, they use their legs to walk. However, some crabs such as the Blue Crab can use their legs as paddles to swim.

(a) Lobster

Lobsters are native to most oceans of the world. The lobster habitat is rocky, sandy or muddy ocean bottom and they are generally found hiding in crevices or in burrows under rocks. Lobsters have five pairs of legs, the first pair of legs are claws used to catch and hold food. Lobsters have a large exoskeleton. As lobsters grow, the must molt to shed their old exoskeleton as they grow a larger new shell.

(b) Shrimp

Shrimp are native to many of the world's oceans and lakes. They are generally found in shallow water. Their habitat includes both fresh and salt water. Although most shrimp are small, some can grow up to 9 inches in length. The shrimp has a very simple body consisting of the head and thorax, and a muscular abdomin for swimming. They have 8 pairs of legs, 5 for swimming and 3 for feeding. They also have 2 pairs of antennae use for taste and smell to find food. As a crustacean, the shrimp has a thin, almost transparent, exoskeleton. The shrimp is a popular food. In addition to commercial fishing for shrimp, shrimp are also grown in shrimp farms. Shrimp are also commonly found in aquariums.

(ix) Arachinds: Spiders, Ticks And Scorpions

Arachnids are a type of arthropod. You know many of them as spiders. Common arachnids are spiders, scorpions, ticks and mites.
Like other arthropods, the arachnids have a hard exoskeleton and jointed appendages for walking. Most arachnids have 4 pairs of legs. In some, the first pair of legs may be used for holding their prey and feeding. Unlike other arthropods, arachnids do not have antennae.
Spiders are easily recognized with their 8 legs. All legs are used for walking. The first pair of legs is also used for holding prey and feeding. The second pair of legs may also be used for holding and killing their prey. Most spiders have 8 eyes.
Spiders have fangs that are used to inject poison to paralyze or kill their prey. Many spiders can produce silk threads to spin webs for catching prey, and for building an egg sack to hold and protect their eggs.
Scorpions are large arachnids, some reaching over 8 inches in length. They have 4 pairs of legs, and a pair of pincers for catching and holding their prey. Scorpions also have a sharp stinger at the end of their tail that is used to paralyze or kill insects and

small animals. Mites and ticks are small arachnids that are parasites living on the blood and tissue fluid of other animals. They can occasionally transmit disease. The abdomen also has appendages, such as legs, for crawling and swimming. Many crustaceans also have claws that help with crawling and eating.

(a) Scorpion

Scorpions are native to many parts of the world. There are about 1,400 different species of scorpion. They prefer warm or hot climates, but can even be found in cold, snowy areas. Their habitat includes deserts, grasslands and savannahs, forests, intertidal zones, mountains and caves. Scorpions are best known for their long, segmented tail with its venom-injecting barb. The scorpion will use its venomous stinger to capture prey and defend against predators. Scorpions have four pairs of legs and a pair of pincer-like pedipalps. These pincers can also be used to catch prey and defend against predators. Scorpions are nocturnal animals. They prefer to find shelter during the day in underground holes or under rocks where it is cool. They come out at night to hunt and feed. Most scorpions prey on insects, spiders, centipedes, and other scorpions. Large scorpions may also prey on small lizards, snakes and mice.

(b) Spider

Spiders are found world-wide on every continent except for Antarctica. There are approximately 40,000 different species of spiders. Spiders vary in size from quite small to relatively large. The Goliath Bird eater can grow up to 10 inches measuring its leg span. Most people can easily recognize a spider by its eight legs. One spider, the Daddy Long Legs, is even named after its eight long legs.
Another recognizable feature related to the spider is its web. Spiders have spinneret glands they use to build webs. These webs provide shelter and help catch food. Spiders also have fangs. Many spiders can inject a venomous liquid through their fangs. This venom is capable of paralyzing or killing predators or prey. Some venom, such as from the Brown Recluse or Black Widow, can even be dangerous or deadly to humans. Although some people are scared of spiders, most spiders will only bite humans in self-defense. Fear of spiders is called arachnophobia. Most spiders have four pairs of eyes. This provides them with very good vision. Some spiders, such as the Tarantula, can be very hairy. While many people are scared of the tarantula, this spider is generally quite harmless. Some people even keep a tarantula as a pet.

(c) Tarantula

The tarantula is a large, hairy spider found in tropical to temperate regions of the southwestern United States, Mexico, Central America, South America, southern

Europe, Asia, Africa and Australia. Tarantulas can go up to 4 inches in body size, and have a leg span of up to 12 inches.
Like other arachnids, the tarantula has eight legs, arranged in four pairs. It also has another pair of appendages used for feeling and gripping prey. The tarantula has two fangs used to inject venom into its prey, or in defense against predators.
Tarantulas prefer to hunt at night. They will lay a web, but not to catch their prey. They lay strands of web on the ground to act as a trip wire. When an insect, frog, toad or mouse steps on the strand, alerting the tarantula, it will pounce on the unsuspecting victim.
Although many people find the tarantula scary, it is generally harmless to humans. They will not bite unless provoked, and if bitten the pain is usually similar to that of a bee sting. Some tarantulas have even become a popular pet.

(d) Spider Web

Spiders can produce silken thread using spinneret glands on their abdomen. This thread is very strong. It is stronger than a similar size thread of steel. Spiders use this silken thread for many things. A spider will spin a web to protect the entrance of their home from birds or wasps. A web is also used to catch insects or other food. The thread is sticky, and once an insect touches the web, it gets caught. Vibration of the web tells the spider an insect has flown or crawled into the web.
The spider will then wrap its prey in silken thread so it can't escape. The thread is also be used to attach an egg sack to the web. This protects the eggs until the young are born. Sometimes a web is used as a path between places where it is difficult to crawl. There are many different shaped spider webs. Some spiders spin a circular web, or orb web. Other webs look like funnels or tubes. Some webs look like a sheet.

(x) Insects

Insects are the largest group of arthropods. There are over 800,000 different types of insects. Insects are very adaptable, living almost everywhere in the world. Common insects include the fly, beetle, butterfly, moth, dragonfly, bee, wasp and praying mantis.
Insects have an exoskeleton that covers their entire body. An insect's body consists of 3 parts: the head, thorax and abdomen. The insect's head has a pair of antennae, and a pair of compound eyes. Compound eyes are different from human eyes which have a single lens for each eye. Compound eyes have many lenses for each eye. For example, the fly has about 4,000 lenses in a single eye. This provides them with very good eyesight.
The thorax contains the legs for walking, swimming, jumping or digging. The thorax may also have wings for flying. The abdomen contains many body organs, such as the heart, respiratory system, digestive system and reproductive system. The

insect's hard, exoskeleton makes it difficult for the insect to grow and get larger. This is because the exoskeleton can't grow and get larger. Many insects must molt in order to grow. Molting is the process where an insect sheds it outer skeleton. It wriggles out of this old skin, and a new, larger exoskeleton develops. Invertebrates were the first animals to evolve. The first invertebrates evolved from single-celled, food eating microorganisms. Invertebrates are often most noted for what they lack: a backbone and a bony skeleton. Invertebrates account for 97 percent of all known species. The simplest invertebrates, in fact the simplest animals, are sponges. Most invertebrates change form as they grow, going through a process known as metamorphosis. Some species of invertebrates form large colonies. Invertebrates will eat almost anything that was or is alive. Many of the world's parasites are invertebrates.

Vertebrates

Animals with an internal skeleton made of bone are called vertebrates. Vertebrates include fish, amphibians, reptiles, birds, mammals, primates, rodents and marsupials. Although vertebrates represent only a very small percentage of all animals, their size and mobility often allow them to dominate their environment.

(i) Fish

Almost three-forths of the world's surface is covered in water. This water is home to over 20,000 different species of fish. The earliest fossils of fish date back over 400 million years. There are a wide variety of fish — from the goby which is less than one half an inch long, to the whale shark which can be over 60 feet long. Most fish breathe through gills. Gills perform the gas exchange between the water and the fish's blood. They allow the fish to breathe oxygen in the water.
Fishes are vertebrates that have a skeleton made of either bone or cartilage. About 95% of fishes have skeletons made of bone. These bony fishes have a swim bladder, a gas-filled sac, that they can inflate or deflate allowing them to float in the water even when not swimming. Fishes with a cartilage skeleton tend to be heavier than water and sink. They must swim to keep afloat. Cartilaginous (cartilage) fish include the ray and the shark.
Most fish swim using a tail fin. Muscles in the tail fin move it from side to side, forcing water backward, and propeling the fish forward. Other fins help the fish change direction and stop. Pectoral fins on their side help them swim up and down. Dorsal and anal fins on the top and bottom keep the fish upright. Pelvic fins on the underside help steer left and right. Many fish eat plants, while others such as the shark, eat other fish.

Flying Fish

There are about 50 species of flying fish. They are found in all major oceans of the world, particularly in the warm tropical and subtropical waters of the Atlantic, Pacific, and Indian oceans. As their name implies, these fish can fly. They can't fly as well as a bird, but they can take short flights through the air. Most flying fish use their large pectoral fins as wings. The fish can take short gliding flights above the surface of the water in order to escape from predators

(a) Paddlefish

There are two different species of paddlefish: the Chinese paddlefish and the American paddlefish. The Chinese paddlefish lives in the Yangtze River in China. The American paddlefish lives in the Mississippi, Missouri, Des Moines, Yellowstone, Ohio and Oklahoma Rivers in the United States. The most recognizable feature of the paddlefish is its large mouth and long snout or bill. The spatula-like snout can be half the length of its body. This is why the paddlefish is sometimes called the spoon fish.

Facts About Fish

Fish are divided into three basic groups which include cartilaginous fish, bony fish, and lobe-finned fish. Fish were the first animals to evolve backbones. The ray-finned fish are the largest group of fish. Fish move by creating a wave motion that moves the length of its body. Fish are cold-blooded (ectothermic) animals.
Many species of cichlids brood their eggs in their mouth. After the eggs hatch the parent continues to use their mouth to provide shelter for their young.
Cartilaginous fish include the sea's largest and most skilled marine predators. These include sharks, skates, rays, and chimeras. These fish have skeletons made from cartilage, not bone. The cartilaginous skeletons are more flexible than bone. The lateral line system on some fish detects variations in water pressure. This helps fish detect prey and avoid predators.

(ii) Amphibians

Amphibians lay their eggs in water, and young amphibians tend to resemble small fish. The tadpole, or newborn frog, is born and lives in water. It has a tail that allows it to swim like a fish. It also has gills so that it can breathe under water. As the tadpole grow into a frog, it loses its gills and tail, and develops legs for moving on land. Most amphibians can both walk and swim in water.
Depending on the species of amphibian, breathing can take place in gills, lungs, the lining of the mouth, the skin, or some combination of these.
Amphibians body temperature changes with its environment. In cold climates, amphibians hibernate during the winter. There are over 6,400 species of amphibians found worldwide, except in Antarctica and Greenland. Amphibians are vertebrates and include animals such as frogs, toads, salamanders, newts and worm-like caecilians. They can be found on land, and in fresh water. They live in a variety of habitats from deserts to rain forests, permanent ponds or high mountain meadows. Most amphibians have four limbs, but some amphibians don't have any limbs. Amphibians are cold-blooded meaning they use the environment to regulate their body temperature. Amphibians spend part of their life in water, and part of their life on land.

(iii) Reptiles: African Clawed Frog

The African Clawed Frog is native to South Africa, the sub-Saharan in east and southern Africa, and Namibia and Angola in western Africa. Their habitat includes warm stagnant pools and quiet streams. Their name comes from the three short claws on each of its hind feet. It spends most of its time underwater, only coming to the surface to breathe. African clawed frogs don't have tongues. The frog's uses its front limbs and unwebbed fingers to push food into its mouth.

(a) Poison Dart Frog

The poison dart frog is a family of frogs native to Central and South America. Their habitat is humid, tropical areas such as tropical rainforests. They may live on the ground as well as in trees. Most poison dart frogs are brightly colored, which makes

them easily recognizable and warns potential predators to stay away. Why do the predators stay away? As their name implies, this frog is highly poisonous. They secrete a toxin through their skin that is capable of killing a predator. Many species are critically endangered

(b) Frog

There are over 5,000 species of frogs. They are native to most of the world, except Antarctica. Generally, we think of frogs as having a short, stout body with long hind legs ideal for jumping. Most of us can recognize a frog's call as the familiar croaking or ribbit sound. Another common characteristics is that frogs don't have tails. The various species also have a wide range of different characteristics. Some frogs are small, such as the Coqui. Other frogs can be quite large. Some frogs are even poisonous, such as the Poison Dart Frog.

(c) Reptiles: Lizards, Snakes, and Others

Reptiles have been around for 300 million years, even during the dinosaur age. The most common reptiles include alligators, crocodiles, lizards, snakes, tortoises and turtles. Reptiles are air-breathing animals, although many live not only on land but in water. The most noticeable feature of reptiles are the scales that cover their body. The majority of reptiles lay eggs to give birth to their young. Although reptiles breathe through lungs, some reptiles can also absorb oxygen in water through membranes in their mouth.

Reptiles are often called cold-blooded because they can't regulate their own body temperature. Their body temperature depends on the external temperature. They will lay in the sun to heat their body, or hide in the ground, under a rock or in water to cool their body.

Crocodiles and alligators are large reptiles that spend much of their time on land and in water. They can walk on land using their webbed feet. They can also use their long tail to swim in water. Crocodiles feed on large animals they catch on land or in water. They have powerful jaws and teeth to tear apart their prey. Lizards and snakes are the largest group of reptiles. Lizards are four legged animals with a long tail. Many lizards can shed their tail to escape from predators. They can then grow a new tail. Some lizards, such as the chameleon, can change colors to blend into their environment. This camouflage helps to protect them from predators. Snakes don't have limbs. They move by slithering along the ground. Some snakes are poisonous, or venomous, such as the rattle snake, cobra, and eastern green mamba. They have fangs which bite into their prey and inject poison into the victim. Other snakes, such as the boa constrictor and the python kill their prey by crushing it. Most snakes can dislocate their jaw, allowing them to swallow prey much larger than themselves.

(d) Alligator

The alligator is native to the United States and China. Alligators are covered with scales, head to toe. They can grow up to fifteen feet long and weigh over one thousand pounds. Based on fossils, the alligator has been on earth for 200 million years. They have a very strong jaw, capable of crushing their prey. Alligators are cold-blooded. They lay eggs to produce their young.

(e) Anaconda Snake

The anaconda is a large, non-venomous snake native to tropical South America and Northern Africa. They mostly live in swampy or watery areas. The green anaconda is the biggest snake in the world, with the largest measuring up to 37.5 feet in length. The anaconda is related to the boa constrictor snake. They kill their prey by constriction or squeezing. They wrap themselves around their prey and squeeze to prevent the prey from breathing. They then swallow the animal whole.

(f) Chameleon

The chameleon is a member of the lizard family native to Africa, Madagascar, southern Europe, and Asia. There are about 135 different species of chameleon. Their habitat includes rain forest, savanna, semi-desert, and steppe land. Chameleons are best known for their ability to change color. However, they don't really change color to match their surroundings, but based on mood, such as fear or anger, and based on temperature and humidity. They are also known for their ability to move each eye separately, and for their long, sticky tongue. Their eye can rotate 360 degrees to view its prey, they its fast, sticky tongue can catch its prey.

(g) Cobra Snake

The cobra is a venomous snake native to Africa and Asia. There are about 30 different species of cobra, with the King Cobra being the world's largest venomous snake. The cobra's habitat ranges from tropical rain forests and swamps to savannas and deserts. The name cobra is Portuguese for "snake with hood." Cobra's are most famous for this hood, which is created by elongated ribs that extend the loose skin of the neck behind the snake's head. Cobras will raise the front part of their bodies and display their hood when threatened or disturbed. They will also make a hissing sound.

(h) Crocodile

The crocodile is native to tropical areas in Africa, Asia, the Americas and Australia. The crocodile is an ancient, prehistoric creature, believed to have inhabited earth

for over 200 million years. The name crocodile comes from an Ancient Greek word meaning “lizard of the river.” Crocodiles prefer freshwater habitats like rivers, lakes and wetlands. Crocodiles are similar to alligators and caiman. They are very fast over short distances, even out of water. They catch their prey by waiting for fish or land animals to come close, then rushing out to attack.

(i) Coral Snake

The coral snake is a venomous snake native to southern United States including Arizona and from Louisiana to North Carolina, including all of Florida. Coral snakes are small in size, averaging 3 feet in length. They are a very beautiful snake with their red, yellow/white, and black colored banding. They are the second most venomous snake in the United States, behind the rattlesnake.

Iguan

The iguana is a family of lizards native to tropical areas of Central and South America and the Caribbean. The green iguana, which is a popular pet, lives in tropical rainforest areas near water, such as rivers or streams. Other iguanas live in the dry, hot desert. Like other reptiles, the iguana is cold blooded meaning they do not produce their own body heat. If an iguana is cold, it will lie on warm rocks to soak up the sun’s heat. Green iguanas are omnivorous meaning they eat both plants and meat, but they mostly eat plants.

(j) Komodo Dragon

The komodo dragon is a lizard native to islands in Indonesia. They are a member of the monitor lizard family. They are the largest of the lizards, growing up to 10 feet in length and weight over 200 pounds. It is carnivorous, eating animals such as pig and deer. It is also cannibalistic, eating other komodo dragons. The komodo dragon has even been known to attack and kill humans. They are now an endangered species.

(k) Lizard

There are over 5,000 different types of lizards in the world. They are native to every continent, except Antarctica. Most lizards are small and harmless to humans. But, the large Komodo Dragon has been known to attack and kill humans. Lizards have some of the strangest characteristics. Some lizards can walk on water. Others can lose their tail to escape a predator. Others can squirt blood from their eyes. The Chameleon can change colors to match its surroundings. The Chinese Water Dragon can not only swim to escape predators, but it can remain under water for up to 25 minutes. Some lizards are small, but others such as the Monitor Lizard can grow up

to 6 feet in length. Lizards such as the Gila Monster are venomous. And, some lizards such as the Gecko and the Iguana are common pets.

(l) Mamba Snake

The black mamba is native to Africa. Their habitat is open grasslands, savannahs and woodlands. It is the largest venomous snake in Africa and the second largest venomous snake in the world. They are considered the deadliest snake in Africa. They are also considered fastest land snake in the world, able to reach speeds of 12 miles per hour. Although they are called the black mamba, they are generally gray, gray brown, or olive green in color. The name black mamba comes from the black color inside their mouth.

(m) Viper Snake

The viper is a family of venomous snakes found all over the world, except in Australia and Madagascar. Vipers range in size from the small dwarf viper which is 10 inches in length, to the large bushmaster at 10 feet in length. Vipers have a pair of fangs that are used to inject venom from glands in the rear of the upper jaws. These fangs are hinged, and when not in use fold back against the roof of the mouth.

(n) Turtle

Turtles are a reptile found in most parts of the world. Some turtles live on land, while others live in the sea. They are easily recognized by their shell. The turtle's shell is covered with scales made keratin, the same material as human fingernails. Many turtles can retract their head and limbs into their shell for protection. The largest turtle, the leatherback sea turtle, can have a shell length of 80 inches. A small turtle may be only 3 inches long. Turtles have a beak, not teeth. Female turtles lay eggs to reproduce their young.

(o) Tortoise

The tortoise is a reptile, closely related to the turtle. The tortoise is often described as a land turtle. Turtles usually live in water and have large blade-shaped flippers for swimming. Therefore, turtles find it hard to walk on land. Whereas, the tortoise has legs rather than flippers and can walk quiet well on land. Like the turtle, the tortoise has a large protective shell. Tortoises can have longer life span that humans, sometimes living to be over 150 years old.

(p) Sea Turtle

Sea turtles are native to all the world's ocean, except the Arctic Ocean. The largest

sea turtles are seven feet in length and five feet in width, weighing up to 1300 pounds. Some sea turtles are believed to live to be 80 to 100 years old. Sea turtles spend much of their time under water, but must return to the surface to breathe air. All species of sea turtles are listed as threatened or endangered. (q) Sea Snake Sea snakes are found in warm, tropical, coastal waters of the Indian Ocean and Pacific Ocean. A few species are also found in Oceania. Sea snakes are venomous snakes, and have fangs. Sea snakes are highly adapted to living in the water. For example, they have a paddle-like tail for swimming. Although these snakes spend most of their time in the water, they must come to the surface to breathe air

(r) Pitviper Snake

The pitviper is a family of venomous snakes found in Eastern Europe, Asia and the Americas. Their habitat ranges from desert to rainforests. Pitvipers have a deep pit between the eye and the nostril on either side of the head. This is an organ that detects heat from warm-blooded prey. Common pitvipers include the bushmaster, copperhead and rattlesnake

(s) Python Snake

The python snake is native to Africa, Asia and Australia. Burmese pythons were introduce to the Florida Everglades National Park in the 1990s. The python is one of the largest snakes in the world. The reticulated python may grow to over 30 feet long and weight over 300 pounds. The python generally feeds on small reptiles and mammals, but has been know to eat deer and other large animals. The python kills its prey by constriction. It wraps itself, or coils around its prey suffocating the animal by preventing it from breathing.

(t) Rattlesnake

Rattlesnakes are venomous snakes native to North America and a few other parts of the Northern Hemisphere. They get their name from the rattle located at the tip of their tails that is used as a warning device when threatened. The rattle is a set of rings on the tip of their tail. When vibrated, the rattle creates a hissing sound that warns off predators. Rattlesnakes use their venomous bite to catch and kill prey such as mice, rats, small birds and other small animals.

FACTS ABOUT REPTILES

There are about 8,000 species of known reptiles alive today. The first reptiles appeared approximately 340 million years ago during the Carboniferous Period. Reptiles are cold-blooded. Reptiles have scales. The Mesozoic Era is the ‘Age of

Reptiles'. In many reptiles, the sex of the young is determined by the temperature the embryos are exposed to during incubation. Some of the largest reptiles alive today include the leatherback turtle, the Komodo dragon, and the saltwater crocodile.

(IV) BIRDS

There are over 8,000 species of birds. Birds have 3 major differentiating characteristics: wings for flight, feathers, and a beak rather than teeth. Birds have adapted their vertebrate skeleton for flight. Their bones and skull are very thin, making their bodies extremely light. To support flight also required other changes to their skeleton. Obvious changes are the addition of wings. Other changes are less obvious. The claws and muscles of a bird's foot are designed to lock and hold onto a perch even while the bird is sleeping. A bird's respiratory system is also adapted to make it easier to breathe at high elevations, where air is thinner. More information on birds

(a) Albatross

The Albatross is a large sea bird found near the Southern Ocean and North Pacific. The albatross is among the largest flying birds, and has the largest wing span. Its large wings are excellent for flying, but can make taking off and landing quite difficult.

(b) Swan

Swans are a family of birds native to many parts of the world including the Americas, Europe, Asia, Africa and Australia. Swans are the largest of the waterfowl compared to ducks and geese. The largest swan in the world is the trumpeter swan of North America whose wingspan can reach 10 feet. The habitat of the swan is ponds, lakes, coastal bays and rivers. They are easily recognized by their very long necks which are often held in a graceful curve. Their long necks allow them to feed underwater without diving

(c) Vulture

Vultures are native to the Americas, Africa, Asia, and Europe. They are scavenging birds feeding mostly on carrion, that is carcasses of dead animals. Vultures have a good sense of smell, and can smell a dead animal from great heights. One recognizable characteristic of many vultures is their bald head with no feathers

(d) Ruby-Throated Hummingbird

The ruby-throated hummingbird is native to: the Canadian prairies; eastern Canada, United States and Mexico; Central America; and, parts of South America. Its habitat is deciduous and pine forests and forest edges, orchards, and gardens. The hummingbird has strong flight muscles and blade-like wings allowing it to fly not only forward, but also straight up and down, sideways, and backwards, and to hover in front of flowers as it feeds on nectar and insects.

(e) Parrot

Parrots are native to most warm and tropical parts of the world including Australia and the islands of the Pacific Ocean, India, southeast Asia, southern regions of North America, South America and Africa. There are about 372 different species of parrot. Parrots are one of the smartest birds. Not only can they mimic human speech, studies have shown they can associate words with their meanings and form simple sentences

(f) Ostrich

The ostrich is a large flightless bird native to Africa. It is easily recognized by its long neck and legs. The ostrich is a fast runner, capable of reaching speeds up to 45 miles per hour. A large male ostrich can weight up to 350 pounds. Matching its size, ostrich eggs are the largest of all eggs. Penguins are a group of aquatic, flightless birds mostly living in the Southern Hemisphere, particularly the Antarctica. However, the Galápagos Penguin prefers a more temperate climate living near the equator. Penguins are easily recognizable by their black and white coloring, and their unusually upright, waddling gait. The penguin looks like it is formally dressed in a man's tuxedo. These birds have adapted for life in the water. Their wings have become flippers allowing them to swim fast in the water.

(g) Peacock

Peacocks are large colorful pheasants. Although most people know this bird by the name peacock, this name specifically refers to the male bird. The female is called a peahen. Collectively they are referred to as peafowl. There are three species of peafowl. The blue peacock lives in India and Sri Lanka, the green peacock lives in Java and Myanmar, and the Congo peacock lives in African rain forests. The peacock is best known for its known and valued for its brilliant tail feathers. This iridescent blue-green or green colored tail plumage, also called the train, has bright spots on it called "eyes"

(h) Kiwi

The kiwi is a flightless birds native to New Zealand. It is an endangered species. They are an interesting looking bird with a plump body and a long bill. Kiwi are shy and usually nocturnal. The kiwi is a national symbol of New Zealand. They are so well known to the world, and representative of New Zealand, that all New Zealanders are called “Kiwis”.

(i) Hornbill

Hornbills are a family of birds native to tropical and sub-tropical Africa and Asia. They can be found in open country as well as forested areas. The most distinctive feature of the hornbill is their heavy bill. It is long and down-curved, and often brightly-colored. Hornbills are omnivorous birds meaning they will eat fruit, insects and small animals. They cannot swallow food from the tip of the beak because their tongue is too short. They must toss it to the back of their throat.

(j) Great Blue Heron

The great blue heron is a large wading bird common over most of North and Central America, as well as the West Indies and the Galápagos Islands. They live near bodies of water such as fresh and saltwater marshes, mangrove swamps, flooded meadows, lake edges, or shorelines. They build their nest in trees or bushes near the water. They are often seen standing in shallow water or at the water’s edge. They use their long legs to wade through the water, and they spear fish or frogs with their long, sharp bill.

(k) Golden Eagle

The Golden Eagle is a large bird of prey living in North American and other parts of the northern hemisphere. It is one of the best known birds of prey in the Northern Hemisphere. It is powerful and strong with a wingspan of over 7 feet.
The golden eagle’s eyesight is about 8 times more powerful than a human, and can spot prey from a long distance. Their talons are well designed for killing and carrying their prey. They also have a powerful beak for tearing into its food.

(l) Flamingo

The flamingo can be found in many parts of the world including Africa, Asia, North America, Central America, South America, and Europe. They live near large, shallow lakes or lagoons. They are best know for their pink color. They also have distinctive long legs and neck, and a curved, pink bill colored black on the end.

(m) Falcon

The falcon is a species of raptor found on every continent, except Antarctica. They live in a wide variety of habitats from tropics, deserts, and maritime to the tundra. They have excellent vision allowing them to see prey from high in the sky. Once spotting its prey, the falcon dives down after it. Falcons have thin tapered wings enabling them to fly at high speed and to change direction rapidly. Peregrine Falcons can dive at speeds over 200 miles per hour (322 km/hr), making them the fastest-moving animal on Earth.

FACTS ABOUT BIRDS

The earliest known bird, Archaeopteryx lithographica, lived about 150 million years ago during the Jurassic Period. Birds are not the only animals that are capable of flight.
Flight is not a characteristic restricted to birds. Bats, which are mammals, fly with great agility and insects, which are arthropods, were fluttering through the air several million years before birds Birds do not have teeth. The largest of all birds is the ostrich.

(V) MAMMALS

Mammals have several unique characteristics that differentiate them from other animals. Most mammals have hair, or fur, covering their body. They are also capable of regulating their body temperature. The mammals metabolism controls heat production, and the sweat glands help cool the body. These allow the mammal to maintain a constant body temperature, regardless of the environmental

temperature. One other difference is that mammals give birth to fully formed babies, and the female mammals produce milk to feed their young. Most mammals walk on 4 legs, with only the humans walking upright on 2 legs. Aquatic mammals have flippers, or fins, for swimming rather than legs. Common mammals include: primates, such humans and monkeys; marsupials; rodents; whales; dolphins; and, seals.

(a) Marsupials

Marsupials are best known for the Australian members of the family, the kangaroo, wallaby and the koala. The only marsupial native to North America is the Virginia opossum. There are also some marsupials native to Central America and South America. Marsupials are members of the mammal family. However, they are different from other mammals because they have an abdominal pouch to carry their young. The marsupial female gives birth very early and the baby animal climbs from the mother's birth canal to her pouch. Here the baby marsupial continues to develop for weeks, or even months, depending on the species. At birth, marsupial babies are not fully developed. The baby's hind legs are just nubs. The baby lives and continues to develop in the mother's pouch. The pouch, or marsupium, also has the mother's mammary glands for feeding the baby. A baby kangaroo may live in its mother's pouch for 6 months. Koalas and wombats are a little different from Kangaroos. The kangaroo's pouch is on the front, while the koala and wombat pouches are on the back.

(b) Kangaroo

The kangaroo is native to Australia. It is the largest of the marsupials, and a national symbol of Australia. As a marsupial, the kangaroo differs from other mammals in having a pouch on its stomach for carrying its young. Early European explorers in Australia said the kangaroo had a head like a deer (without antlers), stood upright like a man, and hopped like a frog. Kangaroos have large, powerful hind legs, and large feet, well adapted for jumping. They can hop along at 25 miles per hour, and are capable of reaching speeds up to 45 miles per hour for short distances.

(c) Primates

Humans are part of the primate family. Other common primates include the monkey, baboon, orangutan, chimpanzee and gorilla. While humans inhabit much of the world, most other primates live in tropical or subtropical regions of the Americas, Africa and Asia.

Primates have several distinctive features that separate them from other mammals. Primates have well developed hands and feet, with fingers and toes. Their opposable thumb makes it easy for them to grab things.
Primate eyes are forward in the head giving them stereoscopic vision. This allows them to judge distance. Primates also have large, highly developed brains. Their intelligence allows them to control and manipulate their environment. The highly developed visual center of the brain helps primates distinguish colors. Their large brain also allows them to develop complex language and communication skills. Monkeys and apes walk on all four limbs, but they may run upright using only their hind legs.
Although primates are born fully formed, they tend to have a long gestation period in their mother's womb. Parents also care for and educate their young much longer than other animals. This results in a strong bond between a baby and the mother. Primates are very social animals, and tend to form strong bonds with family and friends.
While humans are similar to monkeys in many ways, there are also several significant differences. The human brain is more than twice the size of other primates. This makes humans the most intelligent primate, with the most developed communication, language and reasoning skills. Humans are able to make and use complex tools to help control their environment. Humans also walk upright on two legs. Although primates are born fully formed, they tend to have a long gestation period in their mother's womb.

(d) Rodents: Squirrels, Mice, Porcupines and Others

The largest family of mammals are the rodents. These mammals are named rodent, which means "gnawing animal," because of their large incisor teeth and the way they eat. The two long pairs of incisors are used like chisels to gnaw on hard foods like nuts and wood. These incisors must grow continuously since they are worn down by gnawing. There are 3 major types of rodents, represented by squirrels, mice and porcupines.
Squirrel-like rodents such as the squirrel and gopher, have bushy long tails and large eyes. They can live in trees or underground in tunnels. They may hibernate during the winter. Mouse-like rodents include the mouse, rat and hamster. Some have a long, thin tail with short legs. Others have a short tail. They mostly live above ground, although some burrow under ground. They may also hibernate during the winter. Rats and mice often live near humans, sometimes in their buildings, so they can live off human food and garbage. Porcupines differ from other mammals because they have long, sharp quills on their backs for protection.

(e) Whales and Dolphins

Although they live in the water — whales, dolphins and porpoises are mammals. Since whales and dolphins are mammals, they cannot breathe under water. They must come to the surface to breathe air. They breathe through a blowhole, or nostrils, on the top of their head. Babies are born under water and must be pushed to the surface, by the mother, so that they can take a breath. Whales and dolphins also look different from many other mammals because they don't have fur. Although, they do have a sparse covering of hair. The circulatory and respiratory systems have adapted to living in water. Whales and dolphins can dive deep in the water on a single breath.Whales and dolphins also have a highly developed brain. They are consider to be very intelligent. Dolphins, and some whales, can use echolocation to find food and identify objects around them. They make loud clicking and squeaking sounds that bounce off objects and echo back to the dolphin. This echo tells the dolphin about the nearby object.

(f) Whale

The whale is a marine mammal found many ocean areas from arctic and sub-arctic to warmer waters. Whales are best known for their size, which can be up to 110 feet long. The Blue Whale is the largest known mammal to ever live, up to 110 feet long and weighing 150 tons. The whale breathes air into its lungs through a blowhole on the top if its head.

(g) Orca

The Orca, also known as the Killer Whale, is the largest of the dolphin family. It can be found in most of the world's oceans. Orca's have very distinction coloring with a black back, white chest and sides, and a white patch above and behind the eye. The orca is considered very intelligent and trainable. The orca's playfulness and sheer size make them a popular exhibit at aquariums and aquatic theme parks.

(h) Dolphin

Although dophins live in the water, they are a mammal. They are related to the whale and porpoise. They breathe air through a blow hole on the top of their head. They must routinely return to the surface for air. Dolphins are very friendly to humans, and are considered to be very intelligent.

(i) Seals, Seal Lions and Walrus

The seals are marine mammals. The seal family includes the seal, sea lion and the walrus.
A seal's respiratory system is adapted for water. A seal can go for 40 minutes without a breath. This allows them to dive to a depth of over 2,000 feet. Seals are well designed to swim in water. Their bodies are very streamlined and their flippers propel them quickly through the water. Seals also spend considerable time lying around on rocky islands and beaches. But they are clumsy and move slowly on land using their flippers. Baby seals are born on land after a long, 12 month gestation period. The pups develop rapidly, with some able to swim within a few hours of birth. Walruses differ from seals in that they are larger and have large tusks. They can be over 10 feet long and over 3,000 pounds.

Facts About Mammals

The first Mammals are tetrapods. Mammals have four limbs, a characteristic that places them among the group of animals known as tetrapods. It should be noted that although some mammals such as whales, dugongs, and manatees have lost their hind limbs during the course of evolution, they are tetrapods by descent. mammals appeared approximately 200 million years ago during the Jurassic Period. Mammals are warm-blooded. All mammals have hair. The Cenezoic Era is the 'Age of Mammals'. The largest mammal is the blue whale. The smallest mammal is the bumblebee bat.
The Basics of Vertebrate Evolution

FROM JAWLESS FISH TO MAMMALS

- Evolution
- Vertebrates

  Vertebrates are a well-known group of animals that includes mammals, birds, reptiles, amphibians, and fish. The defining characteristic of vertebrates is their backbone, an anatomical feature that first appeared in the fossil record about 500 million years ago, during the Ordovician period.

Jawless Fish (Class Agnatha)

The first vertebrates were the jawless fish (Class Agnatha). These fish-like animals had hard bony plates that covered their bodies and as their name implies, they did not have jaws. Additionally, these early fish did not have paired fins. The jawless fish are thought to have relied on filter feeding to capture their food, and most likely

would have sucked water and debris from the seafloor into their mouth, releasing water and waste out of their gills.
The jawless fish that lived during the Ordovician period all went extinct by the end of the Devonian period. Yet today there are some species of fish that lack jaws (such as lampreys, and hagfish). These modern day jawless fish are not direct survivors of the Class Agnatha but are instead distant cousins of the cartilaginous fish.

Armored Fish (Class Placodermi)

The armored fish evolved during the Silurian period. Like their predecessors, they too lacked jaw bones but possessed paired fins. The armored fish diversified during the Devonian period but declined and fell into extinction by the end of the Permian period.

Cartilaginous Fish (Class Chondrichthyes)

Cartilaginous fish, better known as sharks, skates, and rays evolved during the Silurian period. Cartilaginous fish have skeletons composed of cartilage, not bone. They also differ from other fish in that they lack swim bladders and lungs.

Bony Fish (Class Osteichthyes)

Members of the Class Osteichthyes first arose during the late Silurian. The majority of modern fish belong to this group. Bony fish diverged into two groups, one that evolved into modern fish, the other that evolved into lungfish, lobe-finned fish, and fleshy-finned fish. The fleshy finned fish gave rise to the amphibians.

Amphibians (Class Amphibia)

Amphibians were the first vertebrates to venture out into land. Early amphibians retained many fish-like characteristics but during the Carboniferous period amphibians diversified. They retained close ties to water though, producing fish-like eggs that lacked a hard protective coating and requiring moist environments to keep their skin damp. Additionally, amphibians underwent larval phases that were entirely aquatic and only the adult animals were able to tackle land habitats.

Reptiles (Class Reptilia)

Reptiles arose during the Carboniferous period and quickly took over as the dominant vertebrate of the land. Reptiles freed themselves from aquatic habitats where amphibians had not. Reptiles developed hard-shelled eggs that could be laid on dry land. They had dry skin made of scales that served as protection and helped

retain moisture. Reptiles developed larger and more powerful legs than those of amphibians. The placement of the reptilian legs beneath the body (instead of at the side as in amphibians) enabled them greater mobility.

Birds (Class Aves)

Sometime during the early Jurassic, two groups of reptiles gained the ability to fly and one of these groups later gave rise to the birds. Birds developed a range of adaptations that enabled flight such as feathers, hollow bones, and warm bloodedness.

Mammals (Class Mammalia)

Mammals, like birds, evolved from a reptilian ancestor. Mammals developed a four chambered heart, hair covering, and most do not lay eggs and instead give birth to live young (the exception is the monotremes).

Progression of Vertebrate Evolution

The following table shows the progression of vertebrate evolution (organisms listed at the top of the table evolved earlier than those lower in the table).

Animal Group	Key Features
Jawless Fish	no jaws- no paired fins- gave rise to placoderms, cartilaginous and bony fish
Placoderms	no jaws- armored fish
Cartilaginous fish	cartilage skeletons- no swim bladder- no lungs- internal fertilization
Bony fish	gills- lungs- swim bladder- some developed fleshy fins (gave rise to amphibians)
Amphibians	first vertebrates to venture out onto land- remained quite tied to aquatic habitats- external fertilization- eggs had no amnion or shell- moist skin
Reptiles	scales- hard-shelled eggs- stronger legs positioned directly beneath body
Birds	feathers- hollow bones
Mammals	fur- mammary glands- warm blooded