BIOLOGY AND HEALTH SCIENCES FOR S1

Teacher: SIBOMANA Felix

Contacts: 0783682953

January 2019

Topic area: BIODIVERSITY AND CLASSIFICATION

Sub-topic area: BIODIVERSITY

DEFINITION

Biodiversity or **Biological Diversity** is the sum of all the different **species** of animals, plants, fungi, and microbial organisms living on Earth and the variety of habitats in which they live. Scientists estimate that upwards of 10 million—and some suggest more than 100 million—different species inhabit the Earth. Each species is adapted to its unique **niche** in the environment, from the peaks of mountains to the depths of deep-sea hydrothermal vents, and from polar ice caps to tropical rain forests.

The array of living organisms found in a particular environment together with the physical and environmental factors that affect them is called an **ecosystem**. Healthy ecosystems are vital to life: they regulate many of the chemical and climatic systems that make available clean air and water and plentiful oxygen.

SOME TERMS IN BIODIVERSITY

Ecology:is the branch of biology which studies the relationships existing between living things and their environment.

Habitat: the place where an organism lives. Ex: forest, desert, or wetland.

Biocenosis: All living creaturesof a given area.

Species: Is a set of animals or plants in which the members have similar characteristics to each other and can breed with each other to produce fertile offspring.

Community: Is a group of interacting organisms or species populations living together in particular place.

Population: Is a group of organisms of one species occupying a particular place and usually isolated to some extend from other similar groups by geography or topography.

Biotope: The habitat of all living creatures with its peculiar features and different external influences is called biotope. Ex: ground biotope, Lake Biotope, water biotope.

Ecosystem: The combination of a biotope and its biocenosis (ecosystem= biotope+biocenosis). All the ecosystems of the earth, including all living creatures and their environment (milieu).

Biosphere (or ecosphere): All the ecosystems of the earth, including all living creatures and their environment.

Ecological niche: An area which provides a living creature with the most favourable conditions for its existence both by feeding and protecting it.

Environment: A combination of all physical,chemical aspects and social factors which are likely, at a certain moment, to exert a direct or indirect,immediate or short(long-term) impact, on the living creatures or on the human activities.

Unit1: INTRODUCTION TO BIOLOGY

1.1. Introduction to biology and different branches of biology.

This word**biology** derives from two Greek key terms; **Bios (**life or living thing**)** and **logos (**science, study, knowledge or discourse). Etymologically, biology is the science or study of life (or living organisms).

Biology is a wide field, reason why it requires the use of different domains: mathematics, chemistry, physics, psychology, etc. Biology requires also having branches for a good explanation.

- **Zoology**: A branch of biology that studies animals. Ex: buffalo, cow, goat, fly, birds, chimpanzees, etc. **Zoologist**, a specialist of animals.
- **Entomology**: a branch of biology that studies insects and their impacts on the environment. Entomologist is a specialist of insects.
- **Ornithology**: a branch of biology that studies birds. Ornithologist, a specialist of birds.
- **Botany**: A branch of biology that studies plants. Ex: eucalyptus, avocado plants, banana plants, flowers, etc. **botanist**, a specialist of plants.
- **Microbiology:** a branch of biology that studies microorganisms (microbes).
- **Bacteriology**: a part of biology that studies bacteria. Ex: bacterium that causes tuberculosis. **Bacteriologist**, a specialist of bacteria.

NB: Microbes (microorganisms) are the very small living organisms which are not visible with naked eye; they are seen by using a **microscope**.

- **Physiology**; a branch of biology that studies functioning of a part of the body. A **physiologist** is a specialist.
- **Genetics**; a part of biology that studies heredity. A **geneticist** is a specialist of genes.
- **Anatomy**: a branch of biology that studies structure of a part of the body (cell, tissue, system, organ). **Anatomist**, a specialist of structure of organs, etc.
- **Ecology**; a branch of biology that studies relationship between living organisms and environment. **Ecologist** is a specialist of relationship between organisms and environment.
- **Taxonomy**: is a branch of biology which studies the classification of living organisms. **Taxonomist**, a specialist of classification.
- **Cytology**; is a branch of biology which studies the cell of living thing. **Cytologist**, a specialist of cells.
- **Histology**: is a branch of biology which studies tissues of living things. **Histologist**, specialist of tissues.

1.2. Importance of studying biology

Biology, one of the natural science subjects, is an important discipline that has contributed significantly to the global environment and health transformation through discoveries on the part of biologists. This has led to new technologies in the production of small scale and industrial products that are beneficial to man and his environment. Application of the knowledge of biology is evident in **medicine**, **pharmaceutical** agriculture, fisheries and food processing industries. Biology has played a role in the harmonization of man's needs with the conservation of nature and environment in particular.

Biology plays a role in the Rwandan ambition to:

• Develop a competence based society

• Promote science and technology competitiveness in the regional and global job market

• Address the issue of lack of appropriate skills in the Rwandan education system.

Biology is a worthwhile subject because it prepares students for the real world of work through career pathways such as medicine, agriculture, pharmacy, food science, environmental studies and many others. Biology provides skills that guide the construction of theories and laws that help to explain natural phenomena and manage man and the environment. It helps provide answers for the problems faced by our modern society which empowers students to be creative, innovative and use independent approaches to solve problems in unfamiliar situations.

- Biology helps (enables) human beings to be aware of the interactions between animals and other living organisms.
- Biology also enables us to understand the causes of the diseases that affect the human body, crops and other animals as well as the way they can be prevented or treated. E.g.: The discoveries made in biology reinforce more the medicine field.

- Biology can provide us with career opportunities.
- We can understand the variety of living organisms on Earth, and why we need to look after all of them.
- We can appreciate how all life on Earth is connected.

1.3. Main characteristics of living things

All living organisms procure and digest nutrients (nutrition), carry out metabolism, dispose off wastes, respond to environmental changes (irritability), reproduce and grow, maintain their physical boundaries. All of these criteria are characterized by the following:

1. Feeding or nutrition: All living organisms need to take substances from their environment to obtain energy, to grow and to stay healthy.

2. Movement: All living organisms show movement of one kind or another. All living organisms have internal movement, which means that they have the ability of moving substances from one part of their body to another. Some living organisms show external movement as well - they can move from place to place by walking, flying or swimming, this is **locomotion**.

3. Respirationand gas exchange: All living things exchange gases with their environment. Animals take in oxygen and breathe out carbon dioxide. All living things release energy for their survival.Respiration is the process whereby an organism produces energy by breaking down substances. Oxygen is taken in alongside the food while carbon dioxide, water and energy are released. Some living things can breathe**. Breathing,** is process of inhaling oxygen and exhaling carbon dioxide**.**

4. Excretion: Excretion is the removal of metabolic wastes products from the body. If this waste was allowed to remain in the body it could be poisonous. Humans produce a liquid waste called urine. We also excrete wastes when we breathe out. All living things need to remove wastes from their bodies.

5. Growth and **development**: When living things feed they gain energy. Some of this energy is used in growth. Living things become larger and more complicated as they grow. Living things are also able to have some changes (voice, shapes, psychology, etc.), this is **development**.

6. Sensitivity/irritability or responsiveness: Living things react to changes around them. We react to touch, light, heat, cold and sound, as do other living things.

7. Reproduction: All living things produce young. Humans make babies, cats produce kittens and pigeons lay eggs. Plants also reproduce. Many make seeds which can germinate and grow into new plants.Http://www.saburchill.com/chapters/chap0001.html

8. **Metabolism :** All living things are characterised by having chemical reactions that occur in them, those reactions can be for combining small to give big ones, those are called **anabolism(**ex**:** photosynthesis**)**, or decomposing compounds to give small ones, and those are called **catabolism(**ex: respiration**)**. The sum total of those chemical reactions that occur in the living organism are called metabolism.

1.4. Safety rules and regulations in the laboratory

This manual provides guidelines and general basic rules for safe practices within the Department of Biology. Safety regulations are intended to reduce the chance of an accident. They are required reading for every person working in the Department. It should be emphasized that this manual is suggested simply as a starting point for good practices. It is not intended to establish universal laws, regulations and rules.

Laboratory safety has two principal goals. The first one is **PREVENTION**, the second is **CONTAINMENT**. It is beyond the scope of this manual to cover all potentially dangerous situations. Safety regulations are meant to reduce the chance of an accident and knowledge of the regulations is essential, but it will not prevent all accidents.

Summary of Safety Guidelines

1. Safety glasses or goggles and a laboratory coat should be worn at all times in the laboratory. Use of contact lenses and open footwear is not permitted. Long hair must be suitably confined.
2. Students are not permitted to work alone in the laboratory at any time.
3. No one is allowed to work alone in the laboratory after hours (18:00).
4. Horseplay pranks and unauthorized experiments are prohibited.
5. Eating, drinking and smoking in the laboratory are prohibited.
6. All accidents should be reported immediately to your research supervisor or another member of the staff (teacher).
7. The location of exits, safety showers, eye-baths, fire extinguishers and the nearest telephone should be ascertained before beginning work. Instructions on how to proceed in the event of a fire alarm are posted on every floor and must be read.
8. Reactions left to run unattended for extended periods of time should be labeled with the name and phone number of the appropriate research personnel.
9. Proper use of gas cylinders, vacuum pumps, distillation equipment and waste disposal containers should be reviewed with your research supervisor (teacher).

10. Proper procedures in the use and disposal of chemical compounds which are known to possess hazardous properties such as high toxicity, shock sensitivity, reactivity with water or air etc. should be reviewed with your research supervisor (teacher).

Laboratory safety symbols

Laboratory safety symbols are warning signs that ensure safety while in the laboratory. The signs tell us what to do and what not to do while in the laboratory. Such signs are placed at strategic points in the laboratory, for example on the walls, on various containers with dangerous chemicals and even on particular apparatus. The table below shows some of these signs and their meanings.

Explosive		Hazard: Caution:	This symbol designates substances which may explode under definite conditions. Avoid shock, friction, sparks and heat.
Oxidizing		Hazard: Caution:	Oxidizing substances can ignite combustible material or worsen existing fires and thus make fire-fighting more difficult. Keep away from combustible material
(Highly) Flammable		Hazard: Caution: Hazard: Caution: Hazard: Caution: Hazard: Caution:	1. Spontaneously flammable substances Avoid contact with air. 2. Highly flammable gases Avoid formation of flammable gas-air mixtures and keep away from sources of ignition. 3. Substances sensitive to moisture Chemicals which readily form flammable gases on contact with water. Avoid contact with moisture or water. 4. Flammable liquids Liquids with a flash point below 21°C. Keep away from open fires, sources of heat and sparks.
(Highly) Toxic		Hazard: Caution:	The substances are very hazardous to health when breathed, swallowed or in contact with the skin and may even lead to death. Avoid contact with the human body and immediately consult a doctor in cases of malaise.
Harmful		Hazard: Caution:	When taken up by the body these substances cause slight damage. Avoid contact with the human body, including inhalation of the vapours and in cases of malaise consult a doctor.
Corrosive		Hazard: Caution:	Living tissue as well as equipment are destroyed on contact with these chemicals. Do not breathe vapours and avoid contact with skin, eyes and clothing.
Irritating		Hazard: Caution:	This symbol designates substances which may have an irritant effect on skin, eyes and respiratory organs. Do not breathe vapours and avoid contact with skin and eyes.

1.5. First aid and the first aid kit

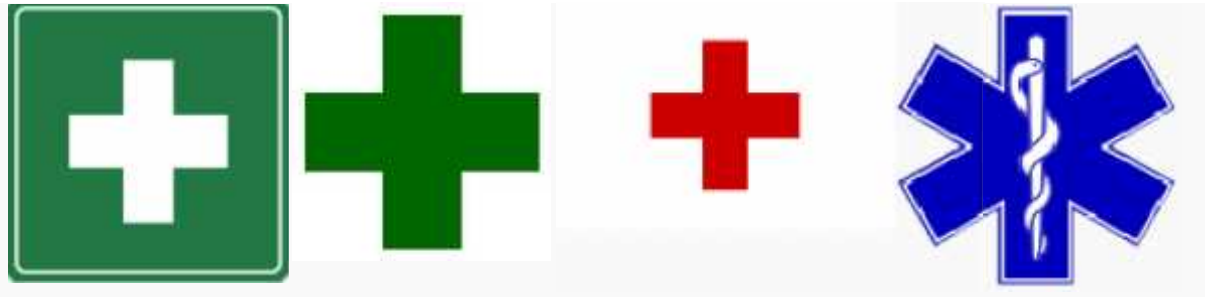
A **first aid kit** is a collection of supplies and equipment for use in giving first aid, and can be put together for the purpose by an individual or organization or purchased complete. There is a wide variation in the contents of first aid kits based on the knowledge and experience of those putting it together, the differing first aid requirements of the area where it may be used and variations in legislation or regulation in a given area.

The international standard for first aid kits is that they should be identified with the **ISO** graphical symbol for first aid (from ISO 7010).

The common kits mostly found in the homes may contain: Alcohol, Band-Aids, Cotton Balls, Cotton Swabs, Iodine, Bandage, and Hydrogen Peroxide.

The International Organization for Standardization (ISO)

It sets symbols to show some first kits



Green symbol with a white cross (ICRC) | green cross | Red Cross | Star of life(emergency medical services)

The various components of a first aid and their functions

First aid for various cases

Injury	**Instructions**
Heat burn	⁾ Cool the burnt area by holding it under cool running water or water in a basin, until the pain lessens. ⁾ Cover thee burn with a sterile, non-stick bandage or clean cloth. ⁾ Give the person pain relief. ⁾ Go to a clinic or doctor.
Chemical burn	⁾ Put on gloves and protective clothing to avoid exposing yourself to

	the chemical. - Flood the burnt area using cool water for at least 20 minutes, making sure that the water does not touch your own skin. - Do not try to neutralize the burn using another chemical. - Cover a small burn with a dry sterile cloth or bandage.
Cut	- Stop the bleeding by applying direct pressure on the area - Clean the area using warm water. - Apply antiseptic ointment - Cover the cut with a sterile bandage or non-stick plaster. - If the cut is deep, go to a clinic or doctor.
Chemical in the eye	- Remove any contact lenses immediately - Flush the eye immediately using cool water, and continue for about 15 minutes. - Go to a clinic or doctor.
Object in the eye	- Wash your hands with soap and water to prevent infection - Flush out the eye using water. - Gently pull the upper eyelid over the lower one. This causes tears to form, which may flush out the object. - If the object cannot be removed, go to a clinic or doctor.

First aid for fainting

Fainting is caused by a sudden fall in blood pressure. This results in inadequate blood pressure. This results in inadequate blood supply to the brain. When the brain cells lack oxygen, the victim collapses. To treat a person who has fainted, do the following:

- Loosen the clothes and other items such as belts, shoes and pants.
- Lay the victim down with the head lower than the face.
- Let the victim have plenty of air. It is advisable to fan the victim.
- Mouth to mouth resuscitation is done if the victim is not improving.
- Let the patient lie at a recovery period.
- If the situation does not improve, seek medical help.

First aid for bone fracture or dislocation

For dislocations:

- Try to manipulate the bone back into place.
- Keep it bandaged firmly in place so that it does not slip out again.
- Avoid forceful use of the limb long enough for the joint to heal completely.

When a bone is broken, keep the bone in a fixed position. This prevents more damage. Before trying to move or carry a person with a broken bone, keep the bones from moving with splints, strips of bark or a sleeve of cardboard. Later a plaster can be put on the limb at a healthcare.

First aid for snake bites

Snakes are poisonous. They release their venom upon biting their victim. They mostly bite the limbs. In case of a snake bite do the following:

- Stay quiet and do not move the bitten part. The more the limb moves, the faster the poison will spread in the body. If the bite is on the foot, the person should not move at all.
- To stop the flow of venom in the bloodstream, tie a wide elastic bandage or clean cloth slightly above the bitten part. Loosen the bandage for 2 minutes after every 15 minutes to allow blood to flow while seeking medical help.
- If the antivenin is needed, leave the bandage on until the injection is ready.

Sub-topic area:CLASSIFICATION OF LIVING THINGS

Unit 2: INTRODUCTION TO CLASSIFICATION

Taxonomyis the science of classification, naming and identification. **Systematics** is the science of taxonomy.There are five main groups: Plants, animals, fungi, protozoa and bacteria are living things

2.1. Importance of classification

These scientific names are necessary whenever precise identification is required, and they enable scientists to communicate accurately with each other.
They are used worldwide and have the merit that everyone knows exactly which organism is being referred to. When precision is not required one generally reverts to common names.
The trouble is that a particular organism may be known by different common names, and sometimes the same name may be given to two quite different organisms. They help to eliminate problems, such as mistaken identity and false assumptions, caused by common names.

2.2. The concept of hierarchical classification.

Carolus (Carl) **Linneaeus** (1707-1788) divided a nested hierarchy of seven different levels of organization. Organisms which have certain large basic features in common are grouped into a kingdom. For example, all multicellular organisms which possess chlorophyll and feed by photosynthesis are placed in the plant kingdom. The kingdom is the largest unit of classification. The kingdom is split into smaller units called phyla (singular phylum) in the animal kingdom and

division in the plant kingdom. Within a phylum or division, each subset is called a class. The class is split into orders, the orders into families, and the family into genera (sing Genus) and the genus into species (the smallest taxonomic unit).

Note: Intermediate divisions are sometimes used, for example: Sub phylum between phylum and class, sub class between the class and order.

Then, the various units of classification are: KINGDOM, PHYLUM or DIVISION, CLASS, ORDER, FAMILY, GENUS and SPECIES are called taxonomic units and together, they make the taxonomic hierarchy. **A species** (the smallest taxon) is a group of organisms which have numerous detailed features in common and **are able to interbreed** (sexual reproduction) and do not normally breed with other species. Sometimes species are divided into subspecies (race) or varieties. These are also capable of interbreeding but can be distinguished by slight structural differences.

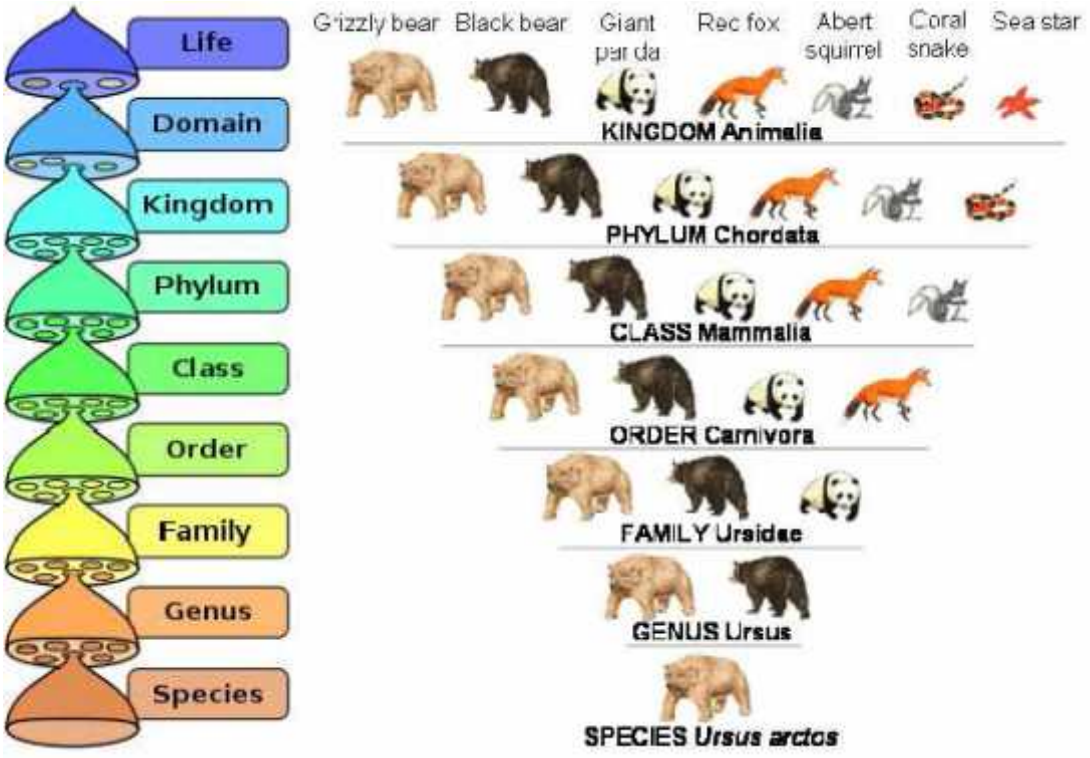


Fig: **Levels of classification**

There is above kingdom a domain. The domain is the broadest category, while species is the most specific available. There are three domains: Archea, Eubacteria, and Eukarya.

2. 3. The binomial system for genus and species.

Binomial nomenclature is a two-term naming system used for classifying organisms and was also introduced by Linnaeus. Each organism is given a two word Latin name. The first name is a

generic name which describes the genus to which an organism belongs followed by the specific name which is the name of species to which an organism belongs. Both generic and specific names are normally printed in **italics** or **underlined** in hand writing.
The **generic** name begins with a **capital letter** and the **specific** name with a **small** letter.
Eg: Many cats belong to the genus *Felis* but there is many species of cats:
A wild cat is *Felissylvestris*
A house cat is *Felisdomesticus*
The scientific name can be also abbreviated, where the genus is shortened to only its first letter followed by a period. In our example, *Lepus europaeus* would become L. *europaeus'*. Taxonomy and binomial nomenclature are both specific methods of classifying an organism.

2. 4. The five kingdom system of classification and the main features of each kingdom.

KINGDOM OF ANIMALS (ANIMALIA)

- Are multicellular, heterotrophic eukaryotes
- Lack the distinctive cell walls of plants & fungi
- Lack of chlorophyll
- They have organ systems
- They can make locomotion or motion
- Animals generally take in their food through ingestion, or eating and swallowing something.

KINGDOM OF PLANTS (PLANTAE)

- Are Multicellular, autotrophic and eukaryotes
- Have Cellulose cell walls
- Contain Chlorophylls

KINGDOM OF FUNGI

- Are unicelllular or multicellular, heterotrophic eukaryotes.
- Have cell walls made by **chitin**. Lack of chlorophyll.
- The body of a fungus is called **mycelium**
- They reproduce by **binary fission**
- Fungi are absorptive heterotrophs; they secrete their digestive enzymes onto their food, and then absorb the resulting nutrients. **Ex:** Mushroom, yeasts, moulds, etc

Fig: Mushroom

ECONOMIC IMPORTANCE OF FUNGI

- Some mushrooms are edible and then source of proteins
- Production of beer and bread by fermentation (***Saccharomyces cerevisiae,*** or yeast).
- For decomposition of organic materials
- For production of medicine. Ex; ***Penicilliumnotatum*** that produces the **Penicillin**.
- They can cause diseases. Ex: ***Trichophyton*** that is causal agent of shearing burr.

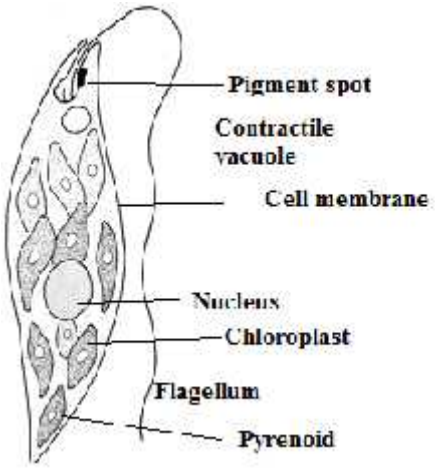
NB: Some fungi are toxic and can cause illness if consumed. Ex: Toadstoods

KINGDOM OF PROTISTA OR PROTOCTISTA

- Contain micro-organisms which are neither animals nor plants.
- Are autotrophic or heterotrophic, eukaryotes
- Unicellular or multicellular organisms
- Are microscopic organisms
- Protists can be **protozoa**(animal like organisms) and **algae**(plant like organisms)

PLANT LIKE ORGANISMS: ALGAE (PROTOPHYTES)

- Are unicellular and microscopic organisms
- Some algae are multicellular
- They are photosynthetic organisms because they have **chlorophyll** (green pigment). They capture solar energy and make their own food through photosynthesis.
- They are exclusively aquatic organisms
- **Euglena** can move by using **flagella**

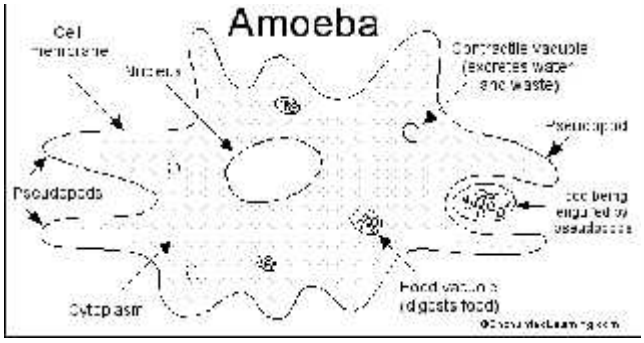


ECONOMIC IMPORTANCE OF ALGAE

- They are food for some aquatic animals
- They release oxygen necessary for respiration of terrestrial animals

ANIMALLIKE ORGANISMS: PROTOZOA

- The protozoa are animal-like,
- Are single-cell organisms (unicellular) generally microscopic
- They are heterotrophic
- They are found in all environments where water is present.
- All Protozoa have membrane-enclosed nuclei (eukaryotes).
- Most are free-living (Ex: **Paramecium**) and there are various methods of locomotion.
- Some are parasites (Ex**: Plasmodium** causing malaria).
- Protozoa are aerobic in their metabolism



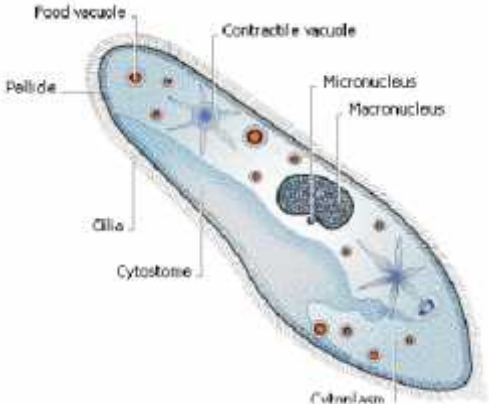


Figure: The structure of Amoeba **Paramecium**

ECONOMIC IMPORTANCE OF PROTOZOA

- Participate in digestion of ruminants
- Cause diseases

Table: Some parasitic diseases and their modes of prevention

Causal agent	Diseases	Methods of prevention
Plasmodium spp	Malaria Vector: female anopheles	-Destruction of mosquito larvae with insecticides -Drainage of breading places of mosquitoes -Use of preventive drugs -Use mosquito nets
Entamoeba histolytica	Amoebiasis or amoebic dysentery	-Hygienic food handling and preparation -Preventing of spread by flies -Cooking food -Boil water
Trypanosomaspp	Trypanosomiasis (sleeping sickness). Vector: is Tsetse fly bite	-Destroy fly larvae with insecticides -Destroy all bushes around house -Use of drugs

KINGDOM OF MONERA. Ex: Bacteria

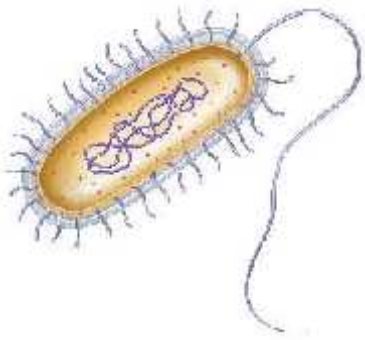


Figure : The structure of a Bacterium

- Are prokaryotic, unicellular organisms
- Are microscopic organisms
- Most use **flagella or cilia** for locomotion
- They are autotrophic or heterotrophic organisms
- Have cell walls made of **peptidoglycagon**, like plant cells
- Members are known as **monerans**

NB: **Archaebacteria (archae),** are bacteria which live in extreme environments, such as salt lakes or hot, acidic springs. They have cell walls without peptidoglycan.

ECONOMIC IMPORTANCE OF BACTERIA

- Recycling wastes
- For scientific researches
- Fixation of atmospheric nitrogen by **Rhizobium**(a kind of bacterium)
- Production of vaccine and antibiotic(Ex:Tuberculosis, etc)
- Ensilage of fodder for conserving them
- Fermenting alcohol(**Acetobacter**), breads, milk(**Lactobacillus**), etc
- Decomposition of organic materials.
- Parasites of organisms that they cause diseases
- Etc.

Table: Some bacterial diseases, causal agents and their prevention

Causal agent	Diseases	Methods of prevention
Neisseria gonorrhoea **(**Gonococcus of Koch)	Gonorrhea	-Avoid sexual intercourse-Use condom-Faithfulness -Avoid unclean cloth
Mycobacterium tuberculosis(Bacillus of Koch)	Tuberculosis	-Vaccination -Avoid the diseased people
Clostridium tetani	Tetanus	-**Toxoid** -Avoid wounds or maintain wounds clean.
Treponema pallidum	Syphilis	-Avoid sexual intercourse -Use condom -Avoid unclean objects(water, hands, cloth)
Vibrio cholera (Choleric vibrio)	Cholera	-Boiling water -Kill flies -Keeping hands clean -Keeping clean latrine
Streptococcus mutans, sanguis**and*****salivarius.***	Dental caries (tooth decay)	-Avoid sugary food -Brush teeth after eating

VIRUSES

These do not belong to any kingdom. It has proved difficult to classify viruses because they possess both features of living things and non-living things.

CHARACTERISTICS OF VIRUSES

- They have no excretion, no feeding, no growth

- Are very smaller than bacteria and can be seen using **electron microscope** (a powerful microscope).
- They have no cellular structures
- Their genetic material is either DNA or RNA but not both
- They reproduce uniquely when they are inside the hosts

2.5. USE OF SIMPLE IDENTIFICATION KEYS.

In biology, an **identification key** is a printed or computer-aided device that aids the identification of biological entities, such as plants, animals, fossils, microorganisms, and pollen grains. Identification keys are also used in many other scientific and technical fields to identify various kinds of entities, such as diseases, soil types, minerals, or archaeological and anthropological artefacts.

Traditionally identification keys have most commonly taken the form of **single-access keys**. These work by offering a fixed sequence of *identification steps*, each with multiple alternatives, the choice of which determines the next step. If each step has only two alternatives, the key is said to be **dichotomous**, else it is **polytomous**. Modern **multi-access** or **interactive** keys allow the user to freely choose the identification steps and their order.

At each step, the user must answer a question about one or more features (*characters*) of the entity to be identified. For example, a step in a botanical key may ask about the color of flowers, or the disposition of the leaves along the stems. A key for insect identification may ask about the number

A biological identification key can use a **dichotomous** key is. The key has a series of concepts each consisting of pair of contrasting statements. It is a type of key that is based on making successive choices between two statements or alternatives.

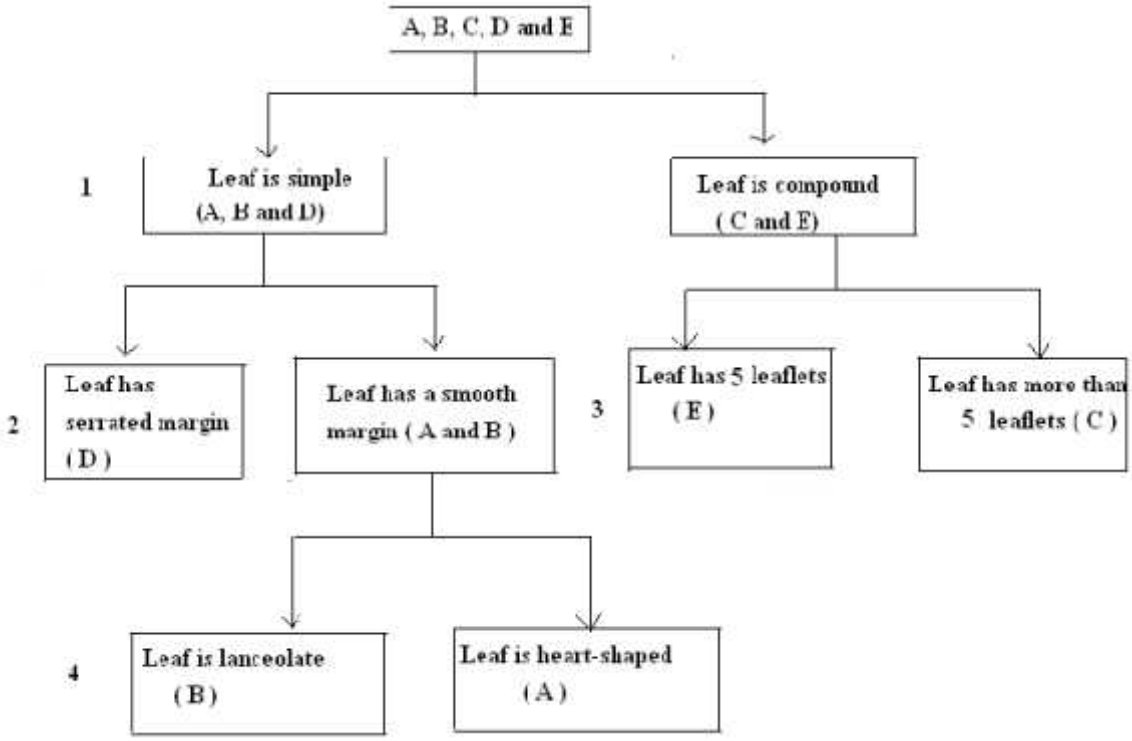
Rules used in the construction of a dichotomous key

· Use morphological characteristics as much as possible.
· Start with major characteristics that divide the organisms into two large groups. Then proceed to lesser variations.
· Select a single characteristic at a time and identify it using a number.
· Use similar forms of words for the two contrasting statements.
· The first statement should be written in the positive form.
· Avoid generalizations or overlapping variations, be specific.

An example of a dichotomous key

Construct a dichotomous key that you can use to identify the following leaves represented by theletters A, B, C, D and E.

A B C D E



Key

1. a) Leaf is simple ..... go to 2
   b) Leaf is compound..... go to 3
2. a) Leaf has serrated margin ..... Specimen D
   b) Leaf has a smooth margin ..... go to 4
3. a) Leaf has 5 leaflets ..... Specimen E
   b) Leaf has more than 5 leaflets ..... Specimen C
4. a) Leaf is lanceolate ..... Specimen B
   b) Leaf is heart-shaped ..... Specimen A

Unit 3: EXTERNAL STRUCTURE AND IMPORTANCE OF FLOWERING PLANTS

A flowering plant has 2 main parts:

- Vegetative body: this contains roots, stem and leaves.
- Reproductive body: contains flower and fruits(seeds)

The angiosperm body shows two main systems:

(1) **The root system**: It contains the underground parts which are roots.
(2) **The shoot system**: It contains the parts which are over the ground or shoot system; this one includes stem, leaves, flowers, nodes, buds and internodes.

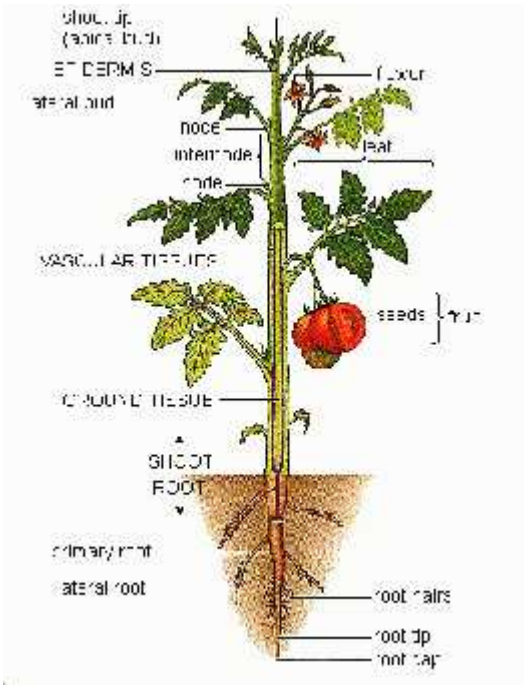


Figure: The structure of a flowering plant

3.1. EXTERNAL STRUCTURE OF THE ROOT SYSTEM

- Characteristics of roots
  - The roots arise from the radical of a germinating embryo.

- They end by a **root cap** ([1]is a thimblike which covers the root tip;[2]it protects physically the delicate meristem as the root elongates through the abrasive soil. [3]It also secrets a polysaccharide slime that lubricates the soil around the growing root tip.) And have absorbing hairs or **root hairs**.
- They have neither leaves nor buds.

Roles or functions of roots

- Supporting or fixing the plant in the soil
- Absorbing minerals and water in the soil
- Transportation of mineral nutrients to the stem
- Some roots can store food. Eg; cassava, sweet potato, yam,etc.

Main types of the roots

(1) Taproot

It is characterised by:

- A main root called **primary** or taproot that grows downwards into the soil.
- Many laterally roots that arise from the main root. Eg; Dicotyledonous plants: sugar beets, bean plants, eucalyptus, avocado plants, etc.

(2) Fibrous root

Ischaracterized by;

- Threadlike roots that spread out below the soil surface
- It gives the plant extensive exposure to soil water and minerals and anchors its tenaciously to the ground.
- The roots are the same dimensions

Note; the system is also called **fasculate roots. Eg;** Monocotyledonous plants; grasses, maize plants, millet, sorghum, wheat, rice, onion, leek, etc.

(3) Adventitious root Is characterised by:

- It grows directly from the stem
- It can grow on the aerial part of the stem
- It helps to support tall stem like in prop root. Eg; corns, millet, sweet potato, grasses, rhizomes, etc.

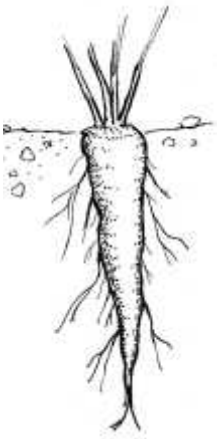
Modification of roots and their functions

Out of the importance stated above, any role that may be taken by the root later becomes considered as a modification. The roots of certain plants present modification for further special functions such as storage, supporting, breathing…

a) Modification of tap root system

- **For storage purposes**

The food substances produced are stored not in other parts of the plant but in the taproot. The tap root becomes swollen and fleshy. The food usually stored is starch.



- **For breathing purpose**

Some plants have branch roots which grow upward out of the swampy or muddy soil into air. The root portion above the muddy soil is spongy and therefore is used for absorbing air from the atmosphere.

b) Modifications of adventitious roots

- **Storage roots**

These roots grow from the nodes of creeping plants. The roots get modification for storage purposes mainly sugar and starch. The roots become swollen and fleshy and are also known as root tubers.

- **Prop roots**

These roots develop from nodes of erect stems and branches. They help support the tree firmly into ground and keep the stem upright. Such roots are also called nodal root.

- **Air roots**

Air roots develop on the stem of some plants which live on the tree branches (parasite plants) and absorb mineral nutrients from the surface of the tree and from the air (atmospheric humidity).
Eg: epiphytic orchid
Air roots are also used for climbing the walls and the trees. Eg: ivy.

- **Stilt roots**

These roots branch from the stems of plants especially those growing in muddy water. Contrary to the breathing roots, the stilt roots provide support to the plant and also help to trap nutritious organic matter. They are common in Red mangrove where they support the plant above water.

- **Buttress roots**

These are thick roots that emerge out from large trees, often found on forest trees. They are stronger raised roots that looks like bony knees held above the water. Buttress roots are types of prop roots modified for support as well as providing additional nutrient to those large trees.

3.2. EXTERNAL STRUCTURE OF THE SHOOT SYSTEM: STEMS, LEAVES AND FLOWERS

- **The shoot system:** It is made up of stem, leaves, nodes, internodes, buds, flowers and fruits.

THE STEM

- It is the erect, cylindrical ascending portion of the plant that develops from the **plumule** of the embryo.
- Stem has nodes, internodes and buds.

Functions

- Support for and the elevation of leaves, flowers and fruits. The stems keep the leaves in the light and provide a place for the plant to keep its flowers and fruits. Leaves and branches are attached on the stem by nodes.
- Transport of fluids between the roots and the shoots in the xylem and phloem. It is a passage of nutrients or translocation.
- The production of new living tissue. The normal life span of plant cells is one to three years. Stems have cells called meristems that annually generate new living tissue.
- Some stems are used for storage of the food.Eg: sugar cane.

- **Types of the stems**

a. **Aerial stems:** Aerial stems grow above the ground, and we have the woody stems and herbaceous stems.

(1) Herbaceous systems

Are soft, juicy, with very little or non woody tissue. A plant with herbaceous stem is supported by the pressure of water in cells of the stem. This pressure causes turgidity which causes the plant to stand upright. In the event of water shortage, the stem loses turgidity and bends down.

Characteristics

- Are soft , juicy, flexible and green
- Are with very little or none woody tissue.
- Stem is supported by the pressure of water in cells of the stem
- Most of them do not grow very tall more than 2 meters. Eg; lily, dandelion, grass, daisy, etc.

Creeping stems or stolon: They grow horizontally underground or above the ground to provide anchorage.**Eg;**Desmodium**,** ground ivy, marrow, sweet potato, strawberry, etc.

Twining or climbing stem

- They possess **tendrils** either on the leaf or form the stem for support. Eg: passion fruits.
- Stems are slanders which twine around other plants for support. Eg; yam.
- Some have **thorns** for protection and clasping or hooking on other plants as they climb.

Eg: Boogainvillae.

(2) Woody stems

- Are aerial stems and **ligneous stems**
- Are hard and rigid and contain a number of strands composed of xylems, etc.
- They include; trees, shrubs, arborescent.

Arborescent stems: are trees like with woody stems normally with a single trunk.

Trees: woody stems that are longer than 5 meters with a main trunk.

THE LEAF

A leaf is the major vegetative organ of photosynthesis. This structure is usually green in color, thin and flat, an adaptation that helps them to capture sunlight for photosynthesis.
Morphologically, a leaf consists of the following parts:
A leaf should have the three main parts:
· **Blade** / lamina composed by leaf apex, margin, vein and midrib.
· **Petiole** or leaf stalk.
· **Leaf base** or sheath.
Note: In many plants, the leaf base bears a pair of outgrowths called stipules.

Leaf blade: This is a flat expanded part of the leaf. In most plants, leaf blade or lamina is green in colour. This shows that it contains chlorophyll. Chlorophyll is the green substance that traps the energy of sunlight for use in making food. The leaf blade consists of the following parts:
- The **margin**
- The **veins**: Are bundles of vascular tissue system of leaves. Veins are continuous with the vascular tissue of the stem and the petiole.
- The **midrib**: this is the main central vein.

The petiole: This is a slender stalk that attaches a leaf to the stem. Leaves with a petiole are called petiolated. Leaves without a petiole are called stalkless or **sessile** leaves.

Leaves base / sheath: This is a point of attachment of the leaf to the stem, which is continuous of the leaf stalk. The leaf base bears a pair of structure growing from stalk. This is called stipules. In some plants such as acacia, the stipules are hardened to form thorns.

Functions of the leaves

The leaves have different functions such as:

0. **The leaves are the primary site for photosynthesis:** Mesophyll cells in leaves use light energy, carbon dioxide and water to make Carbohydrates. Light energy also is used by mesophyll cells to synthesize amino acids, fats and a variety of other organic molecules.

1. **Leaves help in gas exchange**

Plants use the leaves to obtain carbon dioxide for photosynthesis from the air. The stomata on the leaves are opened to receive carbon dioxide and release oxygen; then after, they are closed to prevent water loss through transpiration.

2. **Leaves help in transpiration:** Transpiration is the process by which the plant loses the water in form of water vapour through the stomata and cuticle of the leaf. Transpiration is a major limitation to plant photosynthesis because it causes the water deficiency. However, transpiration may benefit the plant by cooling it and speeding the transport of mineral nutrients through the xylem.
3. **Storage:** Leaves store products of photosynthesis and water mainly in succulent plants like cactus.
4. **Reproduction:** Some leaves are used for plant propagation like in bryophyllum.

Classification of leaves

Leaves arrangement

Leaves may be arranged on the stem in different ways. The main arrangements include:

· **Alternate:** This is when one leaf develops at one node and they keep alternating position on the stem. Eg: tea.

· **Opposite** – Pair of leaves arranged across from each other on stem.

· **Whorled** – Arranged in a ring. There are more than two leaves on one node surrounding

Leaflet Arrangement on Petiole

(a) **Simple –** Leaf blade is one continuous unit (cherry, maple, and elm)
(b) **Compound** – Several ***leaflets*** arise from the same petiole

- **Pinnate compound** – Leaflets arranged on both sides of a common rachis (leaf stalk), like a feather (mountain ash)
- **Palmate compound** – Leaflets radiate from one central
- **Trifoliate compound-** three leaflets
- **Bipinnate compound-** leaflets are connected parallel on the vein

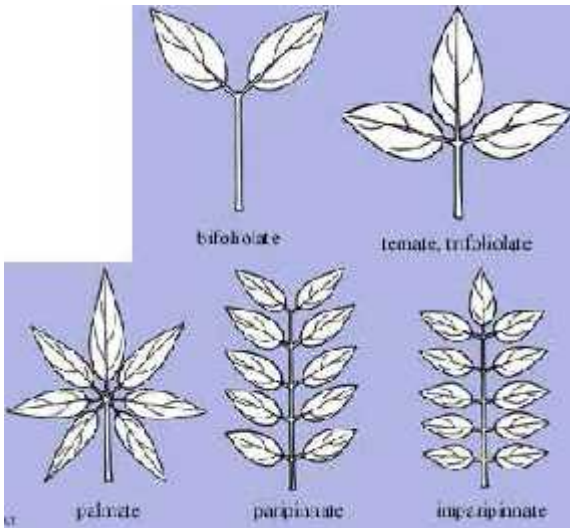
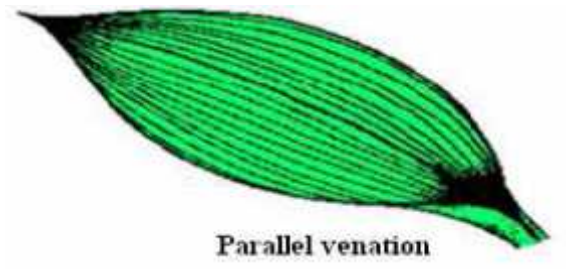


Figure: Overall Leaf Shape
Leaf shape is a primary tool in plant identification. Descriptions often go into minute detail about general leaf shape, and the shape of the leaf apex and base.

Classification of leaves according to the venation

The arrangement of veins is called venation of the leaf. The main kinds of venation are:
i. **Reticulate venation**: the veins are arranged in a network.
ii. **Parallel venation**: there are several main veins running parallel to one another.
iii. **Palmate venation:** is when many large veins originate and spread out from the point where the petiole is attached to the blade.



THE FLOWER

A flower is the reproductive part of a plant. The flower consists of a special part of the stem called a receptacle, and special leaves called floral leaves. The receptacle is very short and is usually borne at the end of a stalk called the pedicel. There are four kinds of floral leaves which are arranged in rings or whorls (corolla, calyx, androecium and gynoecium)

The structure of a flower

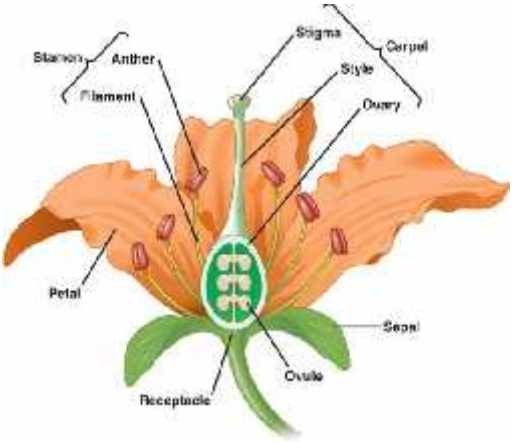


Figure: A bisexual flower (Hermaphrodite)

Flower parts are usually found in four concentric whorls / rings. The figure above shows a flower with all the flower parts:

1. **Sepals**: make up the outermost whorl of flower parts. They surround and protect the other parts of a developing flower before it opens. They make **calyx**.
2. **Petals:** make up the next whorl. These are brightly colored structures. This coloured feature helps to attract the animals for pollination. Flowers pollinated by wind often have no petals at all. They make **corolla**.

Note: Sepals and petals of wind-pollinated plants are usually small or absent.

The two innermost whorls of flower parts contain the reproductive structures: stamens and pistil (carpel).

Note: The sepals (calyx) and petals (corolla) together form the **perianth**

3. **Stamens:** These are male reproductive structures. Each structure consists of an anther and a filament. The stamens make **androecium**. **Another**: contains microsporangia which produce

microspores that develop into pollen grains (male gametes). **Filament**: is a stalk like portion which supports an anther.

Carpels: are the female reproductive structures which form the innermost whorl. One or more carpels fused together make up the structure called a pistil (long and vase-shaped structure). A pistil is composed by: The **ovary**: the enlarged base of pistil in which the ovules are produced and stored. This is the part that develops into the fruit. **Style**: stalk like, rises from the ovary, it provides a passage for pollen grains. Stigma: is the tip of the style. Generally, a stigma is sticky or has hairs, enabling it to trap pollen grains. Pistils make **gynoecium**. The flower is attached to the stem by a **pedicel**. The point of attachment of flower on pedicel is called receptacle.

THE OVARY

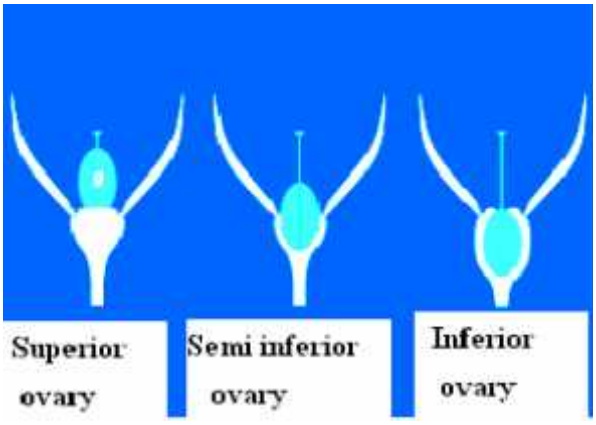
This is the major female part of a flowering plant which is located at the center of the flower, and its position relative to other parts, depends on the shape of the receptacle. The following are the most common types of ovaries.

i) Superior ovary

This is a situation where the ovary is located at the highest point of receptacle. Usually the receptacle is cup-shaped and other floral parts are below the ovary.

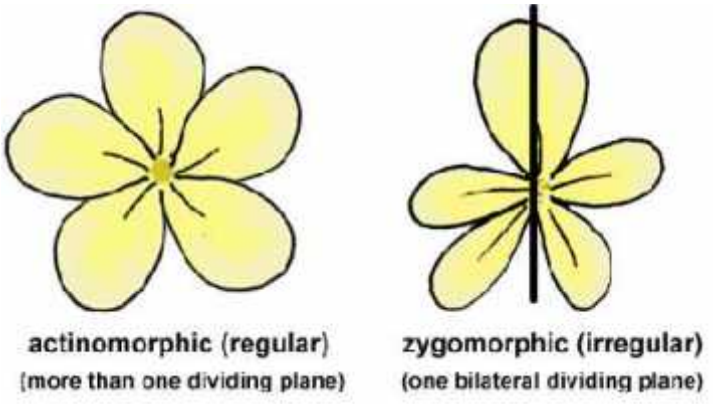
ii) Inferior ovary

This is a situation where the ovary is located a little deeper in the receptacle cup and other floral parts are located above the ovary. The stamen, petals and sepals are arranged around the style. Examples are seen in coffee, sunflowers…



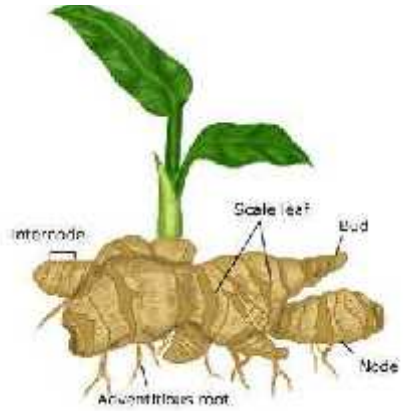
Some terms used in describing flowers

- A **complete flower** is one in which all floral parts are present.
- An **incomplete flower** is one in which one or more of the floral parts are absent.
- The **essential organs** of the flower are the reproductive organs namely the androecium and the gynoecium. As long as one of the essential organs is present, a structure must be called a flower.
- The **non-essential organs** of the flower are the calyx and the corolla.
- Flowers with both stamens and carpels are called **hermaphrodites.**
- Flowers with either stamens or carpels are said to be unisexual. A flower which has stamens only is called **staminate**while one with carpels is called **pistillate.**
- Plants in which pistillate and staminate flowers are borne on the same plant are called**MONOCIOUS** (Eg: maize, bean….). A plant in which the pistillate and staminate flowers are borne on separate flowers is called **DIOECIOUS**. Eg: pawpaw.
- Many flowers can be divided into two parts so that the halves are similar. A flower in which division in any diameter produces two similar halves is called **regular oractinomorphic.** It represents many symmetrical planes which are similar.
- Flowers which can be divided into similar halves in only one plane are called **irregular** or **zygomorphic.** The flower exhibits one symmetrical plane.



3.3. FUNCTIONS OF MODIFIED STEMS, LEAVES AND ROOTS.

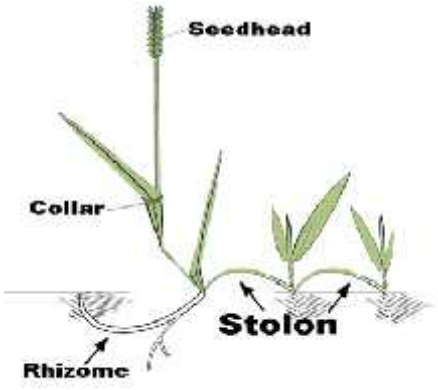
Rhizome: Are underground, horizontally placed stems. Eg: canna lify, couch grass, etc.



(1) **Stolon**

Are above ground and horizontal stems

- Roots are adventitious, growing from nodes. Eg: strawberry.



(2) Tuber -Are enlarged, short and underground stems- Are swollen and storage organs (starch)-They form "**eyes**" (bud and scale leaf). Eg; Irish potato, yam, etc.

(3) **Corms**: Are short swollen underground underground stems which are flattened and storage organs. Buds are formed from axils of the leaves.

(4) **Bulbs**: Onions are good examples of bulbs. They store their food in their fleshy leaves which are swollen. Bulbs are underground stems and have adventitious roots.

(5) **Sugar cane**

- Stem is above the ground and stands erect
- The food substance stored in sugar(stored in stem) that sugar is starch

Leaf modification

Leaf may be modified for easy environmental adaptation to perform different functions other than photosynthesis. In this case, they form other structures.

a) **Tendrils:** these are climbing leaves that can twist around nearby objects. They provide a support to the plant. Eg: peas, cucumbers…

b) **Spines / thorns:** leaves or part of leaves are often modified into spines that protect the plant from being eaten by animals. They are greatly used to reduce transpiration in desert species.

Carnivorous plants: the carnivorous plants present an unusual leaf modification, where leaves function as food traps (capture and digest insects and other small animals). This modification occurs because these plants grow in soil that is poor in several nutrients, especially nitrogen. Eg: pitcher plants, venus flytrap… The digested insects provide the plants with a source of organic nitrogen. Most occur in bogs where the soil is acid and poor in available nitrogen; capturing insects is one way of getting nitrogenous compounds without manufacturing them. At the same time, the green leaves of these plants manufacture carbohydrates.

The two lobes of a Venus's-flytrap leaf form a deceptively safe and attractive landing place for insects and other animals.

d) **Storage leaves:** These are leaves modified for storage purposes. Eg: an onion bulb is made up of fleshy, soft and thick leaves surrounding a shoot stem, where they form an inner layer which stores food and protected by a thin, scaly and dry layer.

e) **Aromatic oils,** poisons or pheromones produced by leaf borne glands deter herbivores (e.g. eucalypts).
f) **Petals** attract pollinators.

- **Modification of the roots and their functions**

Roots are modified in a number of ways to perform very many functions as: storage, climbing, support (prop root), and breathing.

(1) Storage roots or root tubers: Are characterised by:

- Modification of taproot which becomes swallow and fleshy
- It stores starch and excess sugar. Eg: carrot, cassava, etc.

- **Modifications of adventitious roots**

(1) Storage roots: These roots grow from the nodes of creeping plants. The roots get modification for storage purposes mainly sugar and starch. The roots become swollen and fleshy and are also known as root tubers.

- **Prop root:** These roots develop from nodes of erect stems and branches. They help support the tree firmly into ground and keep the stem upright. Such roots are also called nodal root.

(2) Aerating roots or breathing roots

- Modification of taproots for breathing purposes
- They are aerial roots and are found in swampy areas. Eg: white mangrove

(3) Stilt root: Are characterised by:

- They grow in muddy water
- They branch from stems of plants
- They provide support to the plant and help also to trap nutritional organic matter. Eg: red mangrove.


(4) Buttress roots

Are characterised by:

- Thick roots that emerges out from the base of large canopy trees.
- They are often found rain forest trees
- They are storage raised roots
- They provide the support and additional nutrients. Eg: silt cotton trees

(5) Air roots: Air roots develop on the stem of some plants which live on the tree branches (parasite plants) and absorb mineral nutrients from the surface of the tree and from the air (atmospheric humidity). Eg: Epiphytic orchid.

Air roots are also used for climbing the walls and the trees. Eg: ivy.

3.4. IMPORTANCE OF FLOWERING PLANTS.

- Flowering plants are the most diverse group of land plants, with about 350,000 species.
- Agriculture is almost entirely dependent on angiosperms, which provide virtually all plant-based food, and also provide a significant amount of livestock feed.
- Of all the families of plants, the Poaceae, or grass family (grains), is by far the most important, providing the bulk of all feedstocks(rice, corn maize, wheat, barley, rye, oats, pearl millet, sugar cane, sorghum).
- Flowering plants also provide economic resources in the form of wood, paper, fiber (cotton, flax, and hemp, among others), medicines (digitalis, camphor), decorative and landscaping plants, and many other uses.

- Some flowers are good sources of natural dyes and perfumes.
- Flowers of angiosperms flourish an ecosystem and attract a wide range of life to an area providing biodiversity. Flowers also give color to the environment and add beauty to the surrounding.

Topic area: ORGANISATION AND MAINTENANCE OF LIFE

Sub-topic area: CELL STRUCTURE

Unit 4: MAGNIFYING INSTRUMENTS AND BIOLOGICAL DRAWINGS.

4. 1. Need for magnifying instruments in biology.

A **microscope** is an instrument used to see objects that are too small for the naked eye. The science of investigating small objects using such an instrument is called microscopy. Microscopic means invisible to the eye unless aided by a microscope.

There are many types of microscopes. The most common (and the first to be invented) is the optical microscope, which uses light to image the sample. Other major types of microscopes are the electron microscope (both the transmission electron microscope and the scanning electron microscope).

4.2. Features of hand lens (hand glass)

A hand lens is a **simple magnifying** glass for observing **relatively small objects**.
It isa**convex lensmounted** on a frame. The frame may be small (**pocket lens**), or much largerfor aiding dissection (**tripod lens**). The hand lens should be held close to the eye and object brought towards the lens until an enlarged image can be seen. If a drawing is to be made, then the magnification of the drawing in relation to the size of the object must be calculated.

$$\text{Magnification} = \frac{\text{Image size}}{\text{Object size}}$$

Exercice: Imagine, for example, that you know an object is actually 5mm in length and you asked how much it is magnified in a photograph. You should first measure the object in the photograph. Suppose it is 10cm long.

$$M = \frac{\text{si} \quad o \quad \text{in} \quad g}{\text{si} \quad o \quad o} = \frac{10c}{5m}$$

Now convert the measurements to the same units-normally the smallest which in this case is millimeters. There are 100 millimeters in 10 centimeters and therefore the magnification is:

$$M = \frac{\text{si} \quad o \quad \text{in}}{\text{s} \quad o \quad o} = \frac{100\,m}{5m} = \frac{20}{1} = X20 \ (o \quad 20\ \text{ti} \quad)$$

4.3. Parts of a light microscope

Microscope is an instrument that is used to see cells and microorganisms that cannot be seen with a naked eye by producing an enlarged image of the object. Microscopes both enlarge the image and show its details. There are two types of microscopes:

- The light microscope
- The electron microscope

The light microscope uses a beam of light. The electron microscope uses a beam of electrons and is more powerful than a light microscope.

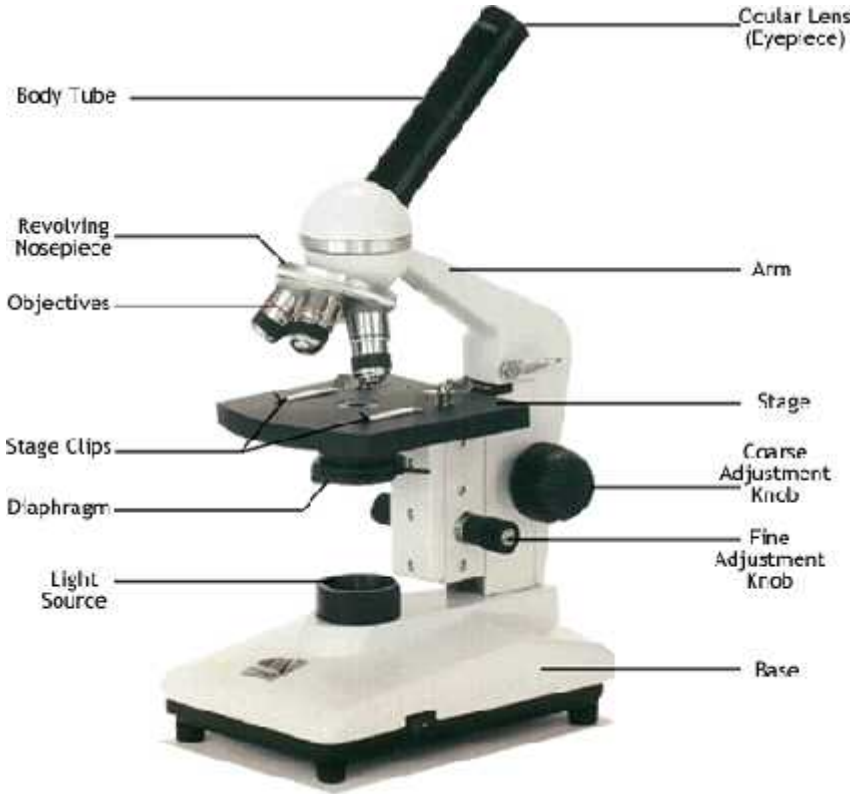


Fig 3.1: Monocular light microscope

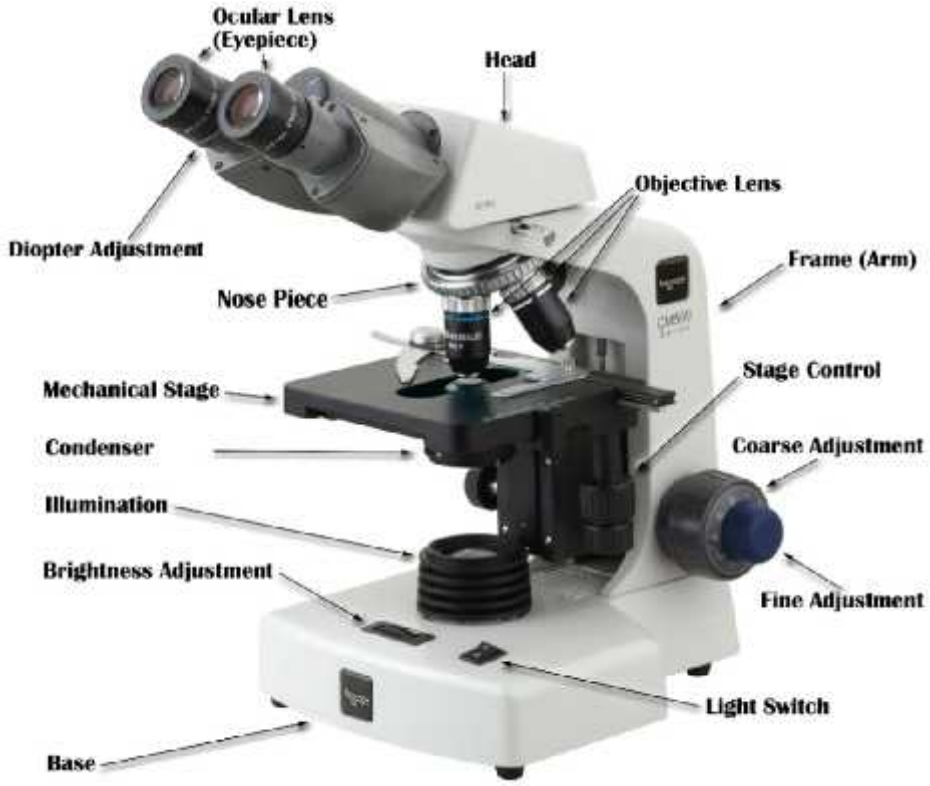


Fig 3.2: Binocular light microscope

1) Light source: is a light source or mirror in the base which produces and directs light upwards.

2) **Condenser lens**: converges the light beam directly to the specimen on the slide mounted on the stage.

3) **Stage:** is a platform used to hold the specimen in position. The stage also holds the slide during observation.

4) **Stage clips:** are pliers used to fix and hold tightly the slide on stage.

5) **Objective lenses:** They enlarge (magnify) the image of the specimen.

6) **Nosepiece:** is a rotated part on which objective lenses are attached.

7) **Body tube:** is a tube through which the magnified image is projected up to ocular lens.

8) Ocular lens (eyepiece): magnifies the object under study. It enables one to look through to observe the specimen.

9) **Slide:** is a transparent pane on which a specimen is placed.

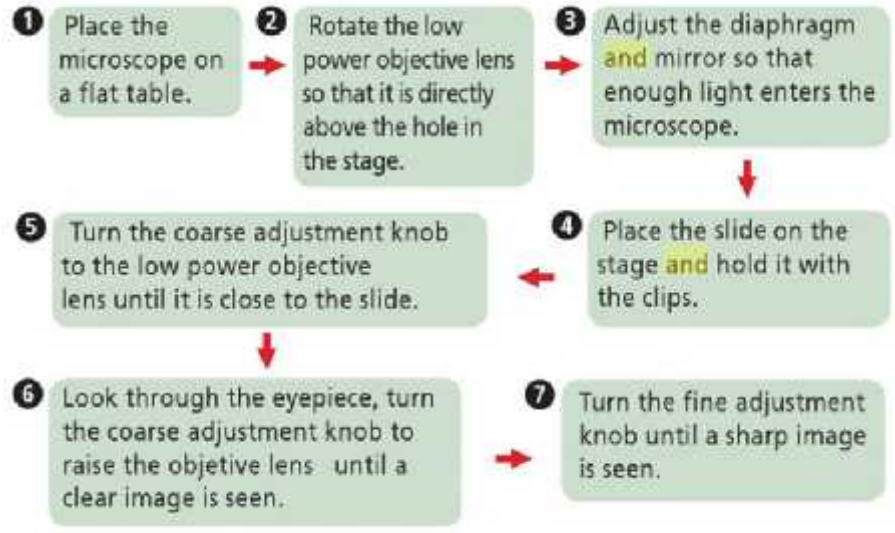
10) **Coarse focus/ coarse adjustment knob:** used to bring the specimen on the stage into right focus/ position.

11) **Fine focus/ fine adjustment knob**: used to bring the specimen image into sharp focus by removing hazy image.

12) **Arm:** used for holding when carrying the microscope and it holds the body tube this bears the lenses.

13) **Stand:** support the microscope.

4.4. Functioning of Microscope



Basic Microscope Technique Rules to Follow: Care of the Microscope

Your microscope is an expensive instrument that must be given proper care. Always follow these general instructions when using a microscope.

1. Carry the microscope with both hands, one hand under the base, and the other on the arm. When getting ready to put the microscope away, always return it to the low power or scanning power setting.
2. When setting the microscope on a table, always keep it away from the edge.
3. It is generally best to clear your lab table of items that are not being used.
4. The lenses of the microscope cost almost as much as all of the other parts together. Never clean them with anything other than lens paper. Paper towels and other paper tissues will scratch the lens.
5. Please inform the instructor or the biology lab technician of any microscope damage or irregularity in its operation as soon as possible. Do not return a faulty microscope without first informing the instructor or lab tech.
6. You are responsible for the microscope while using it— treat it with care!

4.5. Biological drawings

Purpose

- To provide a record of work for future reference
- To encourage you to study more fully and accurately the specimen that you are investigating.

- To aid memory of what you see by actively recording

Principles

(1) Drawing paper of suitable quality must be used. It must be capable of standing some rubbing out of incorrect pencil lines.
(2) Pencil should be sharp and of HB quality. No colored pencils should be used.
(3) Drawing must be:
    a) Large enough- the greater the number of parts, the larger the drawing. The drawing should normally occupy more than half the space available.
    b) Accurate-relative proportions of the various parts of the specimen should be observed and drawn carefully.
    c) Drawn with lines sharp and clear- each line should be considered and then drawn without removing pencil from the paper. Shading and color should be avoided.
    d) Labels should be as complete as possible with label lines that do not cross.
    e) Draw what you see and not what you think you should see, and certainly not textbook copy.
    f) Every drawing should have a title, magnification and the viewpoint of the specimen. These should be placed in a standing position, such as the top right-hand corner of the page. NB: the title is written at the bottom of drawing.
    g) Label lines should finish exactly at the structure named. They should be drawn with a ruler and should not cross each other. Labels should be arranged nearly around the drawing (lined up vertically where possible). All relevant structures should be labeled.

4.6. Calculation of magnification

Microscopes vary in powers of magnification and resolution.
Magnification: is the increase of an object's size.
Magnification is the ratio of image size (apparent size of object) to the real size ofobject.
The power of magnification is the factor of enlargement of any lens.
In a typical light microscope, the most powerful objective lens produces (enlarges) animage 40× the actual size of the specimen.The standard ocular lens magnifies a specimen 10×.
To **compute**: the power of magnification of a microscope (Total power of magnification)
= the power of magnification of the strongest objective lens (40×) multiplied by the power ofmagnification of the ocular lens (10×).
Eg: A microscope with an objective lens magnification of 40× and the ocular lens(eyepiece) magnification of 5×.
The total power magnification = 40 × 5 = 200
-**Resolution**: refers to the power to show details clearly.

Unit 5: PLANT AND ANIMAL CELLS

5.1. The cell as basic unit of life

Although the living organisms have different size, shape and behaviour, all those organisms have one thing in common, they are made of cells. Ex: bean plant, lizard, human, they have all cells.

Definition

A cell is the structural and functional unit of any living being. Indeed, any living being is made of cells.

A cell can be[1]**prokaryotic** cell when it has no nucleus, its genetic material (DNA) is concentrated in a region called the nucleoid, but no membrane separates this region from the rest of the cell. Some living organisms are formed by this kind of cells, they are said **prokaryotes**. Ex: Bacteria, etc. A[2]**eukaryotic** cell has a true nucleus enclosed by a membranous nuclear envelope. Animals, plants, have true nucleus, then are **eukaryotes**.

The number of cells that compose a living organism can divide them into: [1]**unicellular,** the smallest living organisms are made of a single cell. Ex: Bacteria, amoeba, etc.[2]**multicellular,** the most complex are made of several cells. Ex: animals, plants, fungi.

5.2. The structure of a plant cell: to (cellulose) cell wall, nucleus, cytoplasm, chloroplasts, vacuoles and location of the cell membrane.

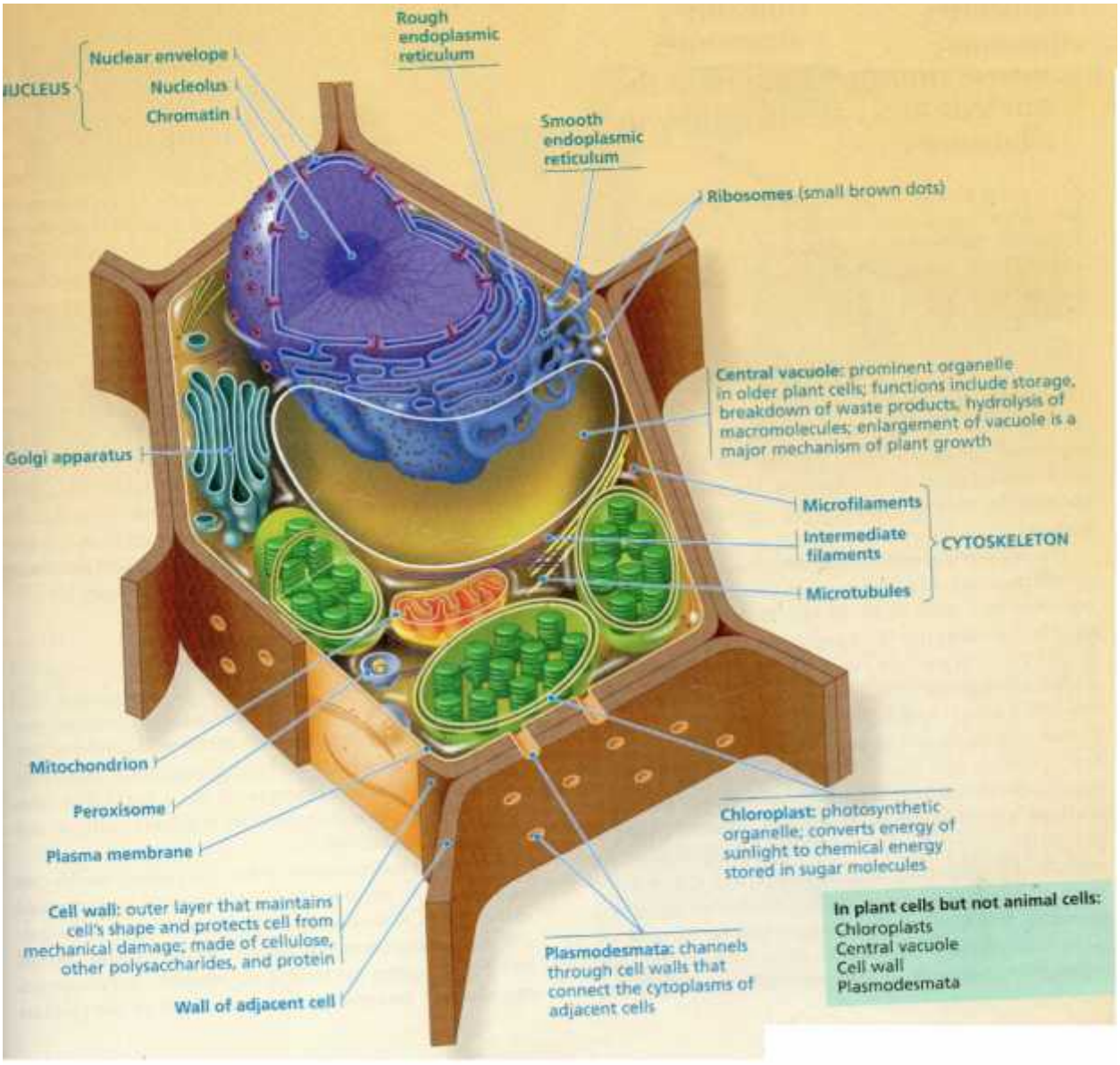


Fig: Plant cell

5.3. The structure of animal cells limited to cell membrane, nucleus, cytoplasm and vacuoles.

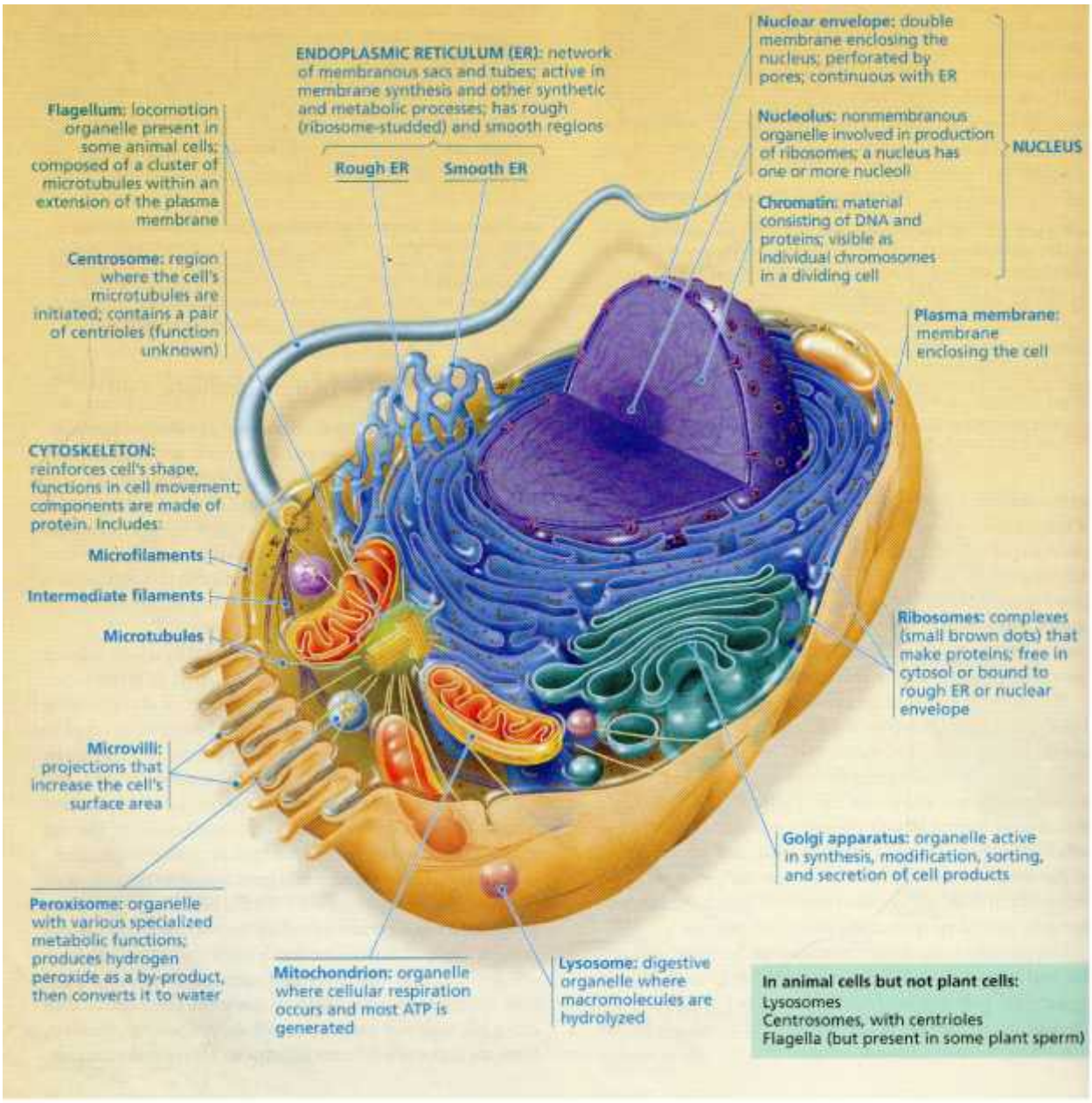
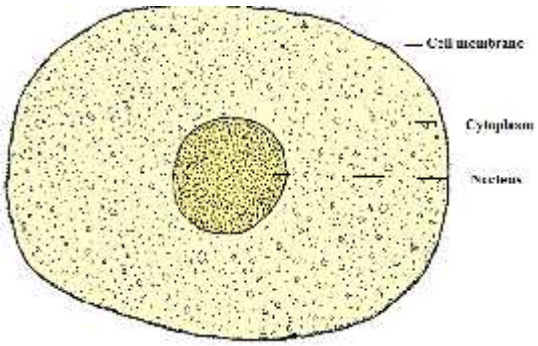


Fig: Animal cell

In general a cell has three main parts: cell membrane. Cytoplasm and nucleus.



In general, a cell has three main parts from outside towards inside: cell membrane, cytoplasm and nucleus.

The cell membrane: is the outermost part that delimits the cell and controls the movement of substances getting in or out the cell.

The cytoplasm: is the watery part the cell where all cell organelles are embedded. It is a site of all chemical reactions (metabolism).

The nucleus: is the main part of the cell for it commands all cellular activities and processes and it contains DNA (Deoxyribonucleic acids) and RNA (Ribonucleic acids).

NB: in plants, in addition of those three parts, the cell contains the rigid and outermost part known as **cell wall.**

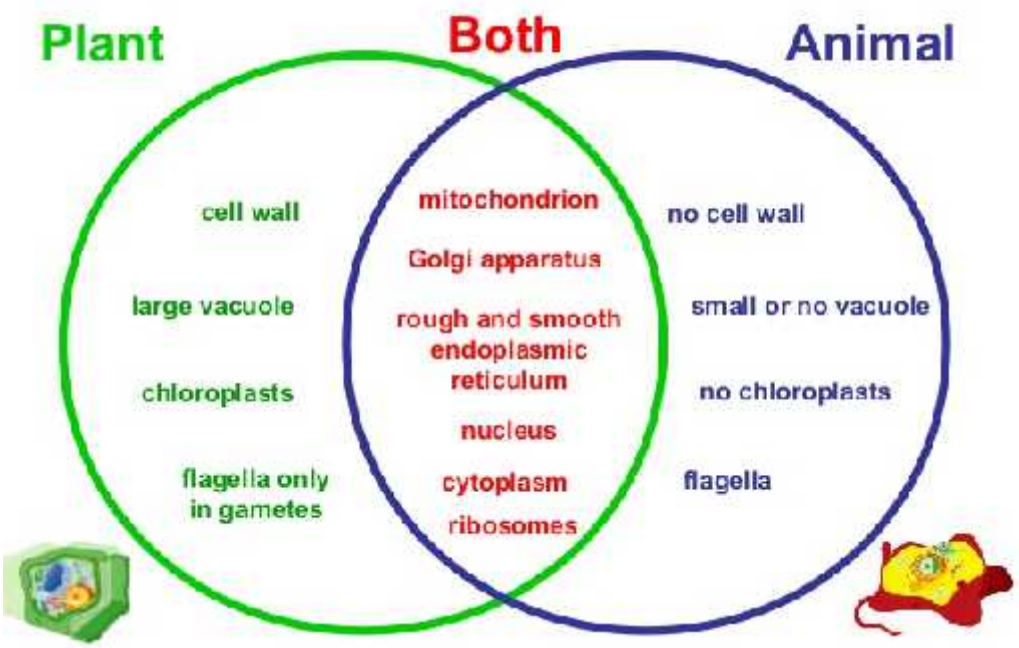
5.4. Uses of the structures seen under the light microscope in the plant and animal cell.

Table: Main parts of a cell and their functions

 **Nucleus** the organelle that contains the cell's DNA and is the control center of the cell	 **Chloroplast** the organelle that uses the energy of sunlight to make food
 **Ribosome** the organelle in which amino acids are hooked together to make proteins	 **Golgi complex** the organelle that processes and transports proteins and other materials out of cell
 **Endoplasmic reticulum** the organelle that makes lipids, breaks down drugs and other substances, and packages proteins for Golgi complex	 **Large central vacuole** the organelle that stores water and other materials
 **Mitochondrion** the organelle that breaks down food molecules to make ATP	 **Lysosome** the organelle that digests food particles, wastes, cell parts, and foreign invaders

Table: Differences between plant and animal cells

	ANIMAL CELL	PLANT CELL
SHAPE	No fixed shape.	Fixed shape.
CELL WALL	Does not have.	Has a cellulose cell wall.
CHLOROPLAST	Does not have.	Has chloroplast which contain chlorophyll.
VACUOLE	Usually exists as numerous small vacoules in lower animal cell.	Usually has a large vacuole.
GRANULES	Contain glycogen granules.	Contain starch granules.



Unit6: LEVELS OF ORGANISATION IN MULTICELLULAR ORGANISMS.

6.1. Structure and function of ciliated cells, root hair cells, xylem vessels, palisade and mesophyll cells, nerve cells, red blood cells, sperm and egg cells.

Cell specialization

Most living things are made up of different kinds of cells that perform specific functions. This is referred to as **cell differentiation**. Cell differentiation leads to **specialization.** Through specialization cells become more efficient at performing particular functions. This is known as division of labour. Cells get modified to perform specific functions in order to meet the physiological demands of an organism. Cell specialization can therefore be defined as the structural modification of a cell to perform a specific function better. Specialized cells include epithelial cells, guard cells, red blood cells…

Cells come in very different shapes.

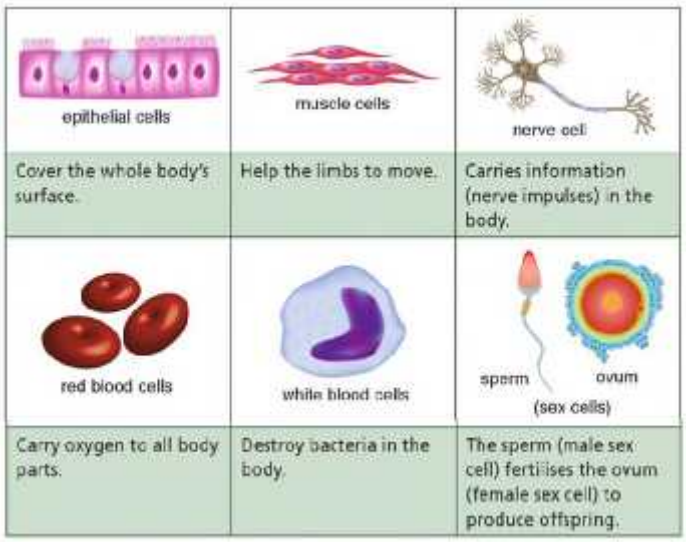


Fig: Some types of cells

Structure	Function
Ciliated cells	For secretion of substances, transport
Root hair cells	Absorption of water mineral salts from the soil to the plant
Xylem vessels	Transportation of mineral salts from the roots to up of the

	plants, Supporting the plant
Palisade mesophyll cells	Contain chloroplasts that enable photosynthesis
Guard cells	Control the opening and closing of stomata.
Nerve cells (neurons)	Transportation of nerve impulses in different parts of the body.
Red blood cells	Transportation of respiratory gases (oxygen and carbon dioxide)
Sperm and egg cells	By their fusion, they allow formation of zygote through fertilization in sexual reproduction.

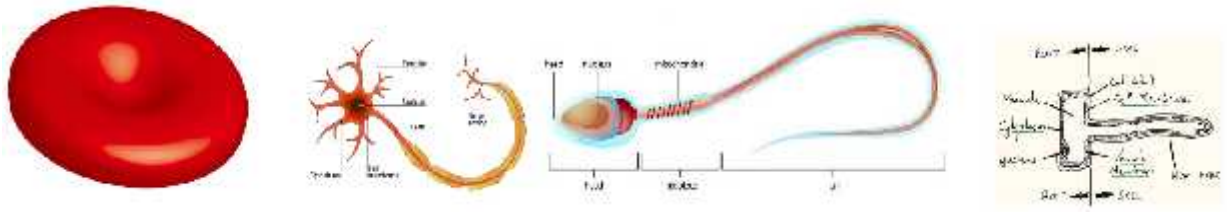


Fig: some specialized cells. Can you identify each of them?

Adaptations of some specialized cells

Red blood cells

- RBC have a biconcave shape to increase their surface area for absorbing oxygen.
- They lack a nucleus to provide more space for packaging of hemoglobin. However, RBC of birds and amphibians have nuclei.
- They are thin-walled to reduce distance of diffusion hence rapid diffusion of gases across the membrane.

Guard cells

- Guard cells have chloroplasts. They therefore carry out photosynthesis. This helps in the regulation of opening and closing of stomata.
- Guard cells are bean-shaped allowing for a space between the two cells. The stoma enables gases to diffuse in and out.

6.2. Advantages of specialisation of cells

Specialization: is the adaptation of an organism or a part of an organism or of the cell to a specific function or condition in response to environmental conditions. Cell specialization enables the cells to obtain nutrients and chemicals and remove waste efficiently. The advantages of specialization include:

- Cells have the potential to become more complex and efficient. This makes the tissue, organs and organ systems to be more efficient.

- Specialization leads to categorization of tasks by compartmentalizing and dividing the work within the organism, This means that some cells can take care of survival tasks, other cells can allow for growth and development of the organism as a whole.
- The more specialized the cells, the more complex the organism, and the more the potential for development. This is seen in eukaryotes versus prokaryotes.

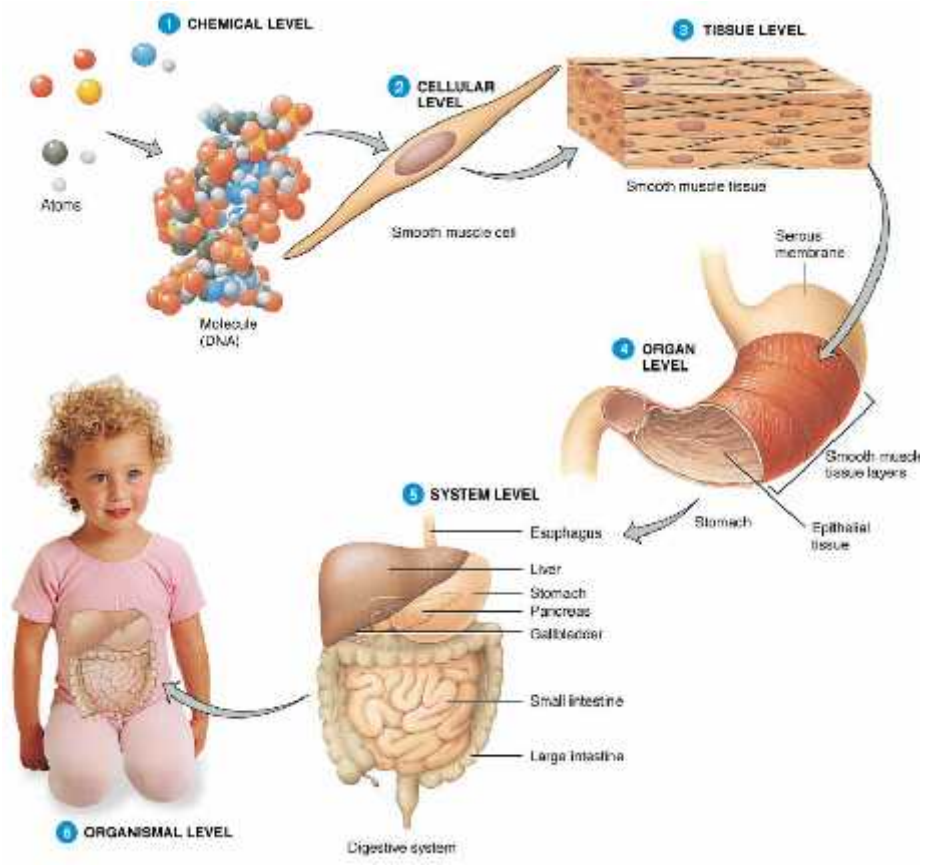
6.3. Levels of organisation in multi-cellular organisms.

CELLS: are the smallest living units of structure and function are **cells**. There are many different types of human cells, though they all have certain similarities. Each type of cell is made of chemicals and carries out specific chemical reactions.

TISSUES: A **tissue** is a group of cells with similar structure and function. There are four groups of tissues: epithelial tissue, connective tissue, muscle tissue and nervous tissue.

ORGANS: An **organ** is a group of tissues precisely arranged so as to accomplish specific functions. Examples of organs are the kidneys, individual bones, the liver, lungs, and stomach. The kidneys contain several kinds of epithelial or surface tissues, for their work of absorption. The stomach is lined with epithelial tissue that secretes gastric juice for digestion. Smooth muscle tissue in the wall of the stomach contracts to mix food with gastric juice and propel it to the small intestine. Nerve tissue carries impulses that increase or decrease the contractions of the stomach.

ORGAN SYSTEMS: an **organ system** is a group of organs that all contribute to a particular function. Examples are the urinary system, digestive system, and respiratory system. For example, the urinary system consists of the kidneys, ureters, urinary bladder, and urethra. These organs all contribute to the formation and elimination of urine.The Human body has 11 organ systems: circulatory, digestive, endocrine, excretory (urinary), the lymphatic, integumentary, muscular, nervous, reproductive, respiratory, and skeletal systems.



Unit 7: FOOD NUTRIENTS AND DIET

Nutrients are chemical substances that organisms need to live. Food nutrients give organisms

- Energy for daily activities
- The building blocks for growth and cell repair
- Substances that enable the organisms to function properly and stay healthy

There are six types or classes of foo nutrients: carbohydrates, proteins, lipids (fats and oils), vitamins, mineral salts and water. Food nutrients are made up of elements such as carbon, hydrogen and oxygen and sometimes nitrogen, phosphorus and Sulphur.

7. 1. Food nutrients and principal sources in food stuffs of food nutrients.

1. CARBOHYDRATES

Carbohydrates are divided into 3 types: monosaccharides, disaccharides and polysaccharides.

Carbohydrate	Examples	Characteristics	Role in organisms
Monosaccharides (monomers)	Glucose (6 carbon)	Small, soluble, sweet and crystalline	Provides energy via respiration
	Deoxyribose (5 carbon)		Part of DNA: information molecule
Dissaccharides (dimers)	Maltose (glucose + glucose)	Small, soluble, sweet and crystalline	A sugar obtained when starch is broken down in hydrolysis reaction.
Polysaccharides (polymers)	Starch and glycogen	Insoluble in water.	Energy storage carbohydrates: starch in plants; glycogen in animals.
	Cellulose	Insoluble in water. Very strong.	Structural. Found only in plants where it forms the cell walls.

Main carbohydrates and their sources

Types of carbohydrate	Main sources
Glucose	Honey, fruit, onion, etc
Maltose	Geminating barley
Sucrose	Sugar cane, beet
Lactose	Milk
Starch	Irish potato, rice, wheat, maize, bread, spaghetti, etc
Glycogen	Mushroom, meat(muscle and liver),eggs, etc

2. PROTEINS

Proteinsare macromolecules made of carbon; hydrogen, oxygen, and nitrogen, an inorganic molecule, the thing that clearly distinguishes them from the other macronutrients. Proteins are the basis of many animal body structures (e.g. muscles, skin, and hair). They also form the enzymes that control chemical reactions throughout the body. Each molecule is composed of **amino acids**.

3. LIPIDS (FATS AND OILS)

Lipids make up about 5 % of the organic matter of a cell. At room temperature (around 20^0C), a solid lipid is called a**fat** and a liquid lipid is called **oil**. Lipids perform a number of functions

within living organisms. They are made by units called **fatty acids** and **glycerol**. Ex: palm oil, olive oil, avocado, meat, egg, fish, etc.

7. 2. Importance of nutrients in human body and of having a balanced diet.

ROLES OF CARBOHYDRATES

(1) They are main source of energy for living organisms. They are therefore energy giving food.
(2) They are important as food reserves which are stored within organisms, in plants the reserved form is called **starch**, and in animals is **glycogen**.
(3) They (fibers) reduce the chance of gastrointestinal problems such as **constipation** and **diarrhea** by increasing the weight and size of stool and softening it.
(4) Insoluble fiber, found in whole wheat flour, nuts and vegetables, especially stimulates **peristalsis** – the rhythmic muscular contractions of the intestines which move digesta along the digestive tract

Note that the body can store only limited amounts of glycogen. However, when this limit has been reached, any excess carbohydrate in the body diet is converted into fat or oil and stored in special tissues liver and muscles. Again, an excess of carbohydrates (sugars) in the body can cause **obesity** and **diabetes**.

ROLES OF PROTEINS

(1) Proteinsform hormones, enzymes, antibodies; it is part of fluid and electrolyte regulation, the buffering effect for pH, and transporter of nutrients. A good example of a protein is the oxygen carrying **hemoglobin** found in red blood cells.
(2) They are used for growth,
(3) They are used for replacing and repairing worn-out and damaged tissues

ROLES OF LIPIDS

(1) Source of energy: Lipids can be respired to release energy to generate ATP. Glycerides are an important source of energy (they produce high energy than carbohydrates when they are oxidised in respiration).
(2) Lipids are stored as fats in **adipose cells** (cells that store lipids) in organisms. The main organs containing adipose tissues are: heart, kidney, muscles, under skin, etc.
(3) They make all biological membranes
(4) They insulate the body against the heat loss

7. 3. Composition of biological molecules limited to carbohydrates, lipids and proteins

Biological molecules	**Chemical elements**	**Units**
Carbohydrates	Carbon, hydrogen and oxygen	Glucose
Lipids	Carbon, hydrogen and oxygen, phosphorus	Fatty acids and glycerol

Proteins	Carbon, hydrogen and oxygen, nitrogen, sulfur even phosphorus, etc.	Amino acids

7.4. Formation of large biological molecules (starch, glycogen, cellulose, proteins and lipids) from small molecules such as glucose, amino acids and fatty acids/glycerol

By polymerization, small unitsalso called monomers give big molecules like starch, glycogen, proteins and lipids. Many **glucoses** link to form starch and glycogen and cellulose, many **amino acids** bond to form proteins, and **fatty acids** and **glycerol** form lipids. Between two units, there is a bond formed to make complex molecule. Those bonds are **glycosidic** bonds in starch, cellulose and glycogen, **peptide** bond in proteins and **ester** bond in lipids.

7.5. Deficiency symptoms limited to vitamins C and D, and calcium, and iron only).

Vitamin/ mineral	Functions	Deficiency
Vitamins C (Ascorbic acid)	Healthy bones and skin Healing of wounds Protein metabolism Strengthening of the blood vessels Formation of connective tissues and healthy gums	**Scurvy** (gums become soft teeth grow loose and wounds fail to heal properly**)**
vitamins D(**Calciferol**)	-Formation of bones and teeth -Enables the body to absorb Calcium and Phosphorus from the food.	**Rickets**(Bone deformation)
Calcium	Growth -Reinforcement of bones and teeth - neutralizes acidity, may help clear toxins -Normal blood clotting and for normal cell functioning -Healthy muscle, heat and digestive system	**-Rickets** -Retarded growth -Loss of bones
Iron	Formation of red blood cells(Haemoglobin) -Formation of Proteins and enzymes	**Anemia**

7.6. Functions of vitamins, water and mineral salts.

ROLES OF VITAMINS

(1) They have no energy value.

(2) Their role is: “to take part in the chemical reactions of metabolism, for the most part in conjunction with enzymes.
(3) They regulate growth and the normal functioning of the body

The lack of a vitamin causes the reaction in which it takes part to slow down. The effects of slowing down are called *deficiency diseases*, or *avitaminosis*

ROLES OF MINERAL SALTS

(1) Building materials (food), they take place in a chemical reaction in the body.
(2) They make up about 4% of our body weight most of them are in skeleton. Eg. P, Ca, etc.

ROLES OF WATER IN A LIVING ORGANISM

(1) Essential constituent of living organisms. The water content of living organisms varies between 60% and 80%.
(2) A solvent for many organic and inorganic molecules
(3) A reaction medium. It is in the water that the chemical reactions of metabolism occur.
(4) A vehicle of substances, many food molecules and a lot of waste are borne, in water: Plasma, urine, sap.
(5) A thermal regulator (temperature regulation)
(6) Water is involved in many metabolic reactions such as photosynthesis, respiration, digestion, etc.

7.7. Malnutrition limited to starvation, obesity, constipation and scurvy.

STARVATION

Causes of starvation

- Undernourishment
- Energy reserves gradually get used up until death results. Glycogen is stored in liver and muscles.

Symptoms

- Thinness
- Death
- Fat stores are used. Fat is broken down in liver to release fatty acids which are used instead of glucose in cell respiration. In average person fat can supply energy for about 50 days.
- **Ketones(acetone)** made from the fatty acids also tend to build up in the blood, causing a condition called ketosis and makes the blood acidic.
- Muscle Protein is used the first week of fasting as source of energy and converted to glucose through a process called **gluconeogenesis**

OBESITY

Causes of obesity

- It is caused by an excess of calories stored in body as fats by consuming much meat, fat and carbohydrates.
- The obese person becomes excessively big because of increase in body weight and can become a real monster.

Symptoms

- Heart diseases, cancer of the bowl (intestine), cancer of breasts and womb (uterus), diabetes, gall bladder diseases.
- Excess of fats and sugar in the diet are the main causers of obesity.

Figure: Obese person and monster

CONSTIPATION

It a condition in which a person or animal has difficulty in eliminating solid waste from the body and the feces are hard and dry. The dryness of feces can be caused by a quick absorption of water in intestines.

SCURVY

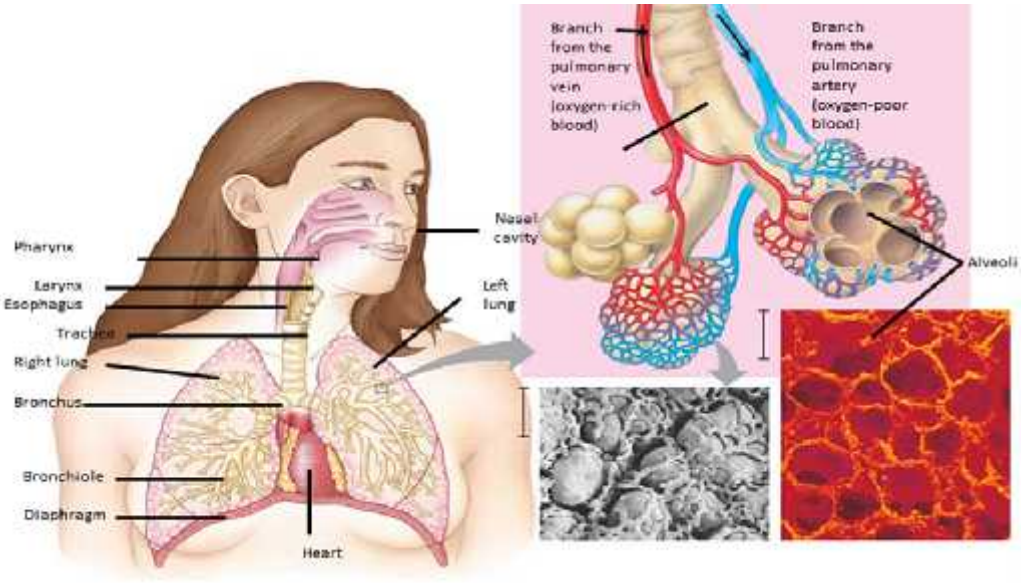
This is the deficiency disease caused by lack of vitamin C (Ascorbic acid) in diet.
It is characterized by:

- Weakening of the skin of gums that bleeds
- Connective tissues fibers fail to form
- Wounds fail to heal
- Heart failure
- Anemia(lack or insufficiency of red blood cells in hemoglobin)

Sub-topic area: GASEOUS EXCHANGE AND SMOKING

UNIT 8: STRUCTURE AND FUNCTIONS OF HUMAN GAS EXCHANGE SYSTEM

8. 1. Structure of human gas exchange system



8. 2. Functions of the parts of the human gas exchange system

Nasal passages

Air entering **through** the nostrils **is** drawn into nasal passages where it is warmed to body temperature and humidified by moisture which evaporates from the warm nasal membrane lining the walls of these passages. In the **nasal cavity**, there is sticky fluid called **nasal mucus.**

The nasal mucus has a role of **trapping dust and germs** inhaled from atmosphere and **carrying** them towards the back of the mouth where they are swallowed.

Pharynx

Or throat is pathway for both food and air.

Trachea or windpipe

A tube for air while an esophagus is for food. The two tubes are located in pharynx. Trachea is a flexible tube held open at all times by incomplete rings of cartilage. The trachea divides into the left and right **bronchi** which then enter the lungs.

Larynx or voice box

Is a cavity at the top of the trachea which contains the vocal cords. The **larynx** is formed from **cartilage** which formed the gills of our fossil ancestors. It is connected to the **trachea**

The bronchial tree

Is made by two **bronchi** (bronchus in singular); left and right bronchus, each enters in the lungs.

Lungs and their anatomy

Human has two lungs (respiratory organ is the **lung)**, left and right lungs; the right lung is divided into three parts called **lobes**, while the left one into two lobes. Those together with the heart are situated in the **thoracic cavity** or **thorax**. The walls of thorax are strengthened by the ribs, and its floor consisting of a sheet of a muscle called **diaphragm.** Inside the lungs, each bronchus is divided into again and again to form a mass of very fine branches called **bronchioles.** Bronchioles are ended by **air sacs** or **alveoli** (alveolus in singular).It is in the alveoli that gas exchange actually occurs. Lungs are formed by a big number of alveoli, 600 million alveoli, for adult human, giving a total surface area of about 100m², so the area is huge. Each lung is covered by a network of capillaries where the gases exchange occurs.

The lungs receive the **deoxygenated blood** from the heart (Right ventricle) via the **pulmonaryarteries** and after its purification, return the oxygenated blood to the heart (left atrium) through **pulmonary veins**.

Sub-topic area: COORDINATION IN PLANTS

Unit 9: TROPIC RESPONSES

9.1. THE NEED FOR TROPISMS IN PLANTS (PHOTOTROPISM AND GRAVITROPISM).

Tropisms

A tropism is a movement of part of a plant in response to, and directed by, an external stimulus. The movement is always a growth movement. Tropic responses are described as positive or negative depending on whether growth is towards or away from the stimulus respectively.

Phototropism is directional growth in which the direction of growth is determined by the direction of the light source. In other words, it is the growth and response to a light stimulus. Phototropism is most often observed in plants, but can also occur in other organisms such as fungi. The cells on the plant that are farthest from the light have a chemical called auxin that

reacts when phototropism occurs. This causes the plant to have **elongated cells** on the farthest side from the light. Phototropism is one of the many plant tropisms or movements which respond to external stimuli. Growth towards a light source is a **positive phototropism**, while growth away from light is called **negative phototropism**. Most plant shoots exhibit positive phototropism, while roots usually exhibit negative phototropism, although gravitropism may play a larger role in root behavior and growth. Some vine shoot tips exhibit negative phototropism, which allows them to grow towards dark, solid objects and climb them.

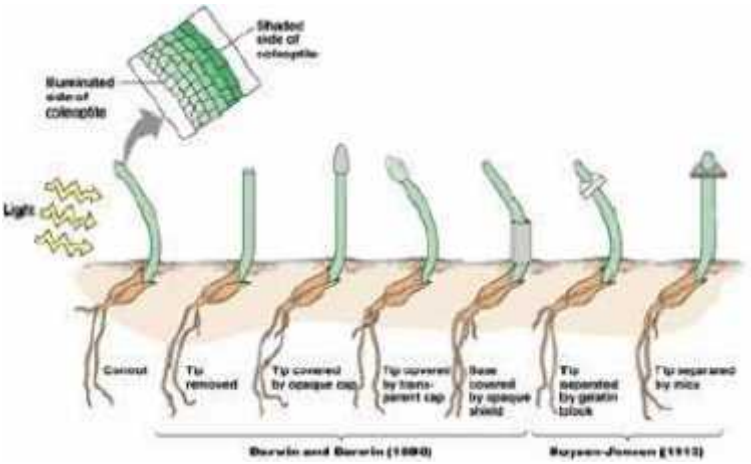


Fig: Phototropism

Gravitropism (geotropism)

Itis a turning or growth movement by a plant in response to gravity. Charles Darwin was one of the first to scientifically document that roots show *positive gravitropism* and stems show *negative gravitropism*. That is, roots grow in the direction of gravitational pull (i.e., downward) and stems grow in the opposite direction (i.e., upwards). This behavior can be easily demonstrated with a potted plant. When laid onto its side, the growing parts of the stem begin to display negative gravitropism, growing upwards.

Chemotropism

Itis growth of part of a plant towards a chemical. The response by the plant is termed ‘positive’ if the growth is towards the stimulus or ‘negative’ if the growth is away from the stimulus.

Thigmotropism(Haptotropism**)**

Itis a movement in which an organism moves or grows in response to touch or contact stimuli. The prefix **thigmo**comes from the Greek for "touch". Usually thigmotropism occurs when plants grow around a surface, such as a wall, pot, or trellis.

Fig: Thigmotropism

Why do plants respond to light and gravity?

Plants need light for photosynthesis. Photosynthesis is a process in plants that is used to make food using light energy, carbon dioxide and water. The green pigment, chlorophyll, is also needed. Near the tips of plant shoots, there are special chemicals that are sensitive to light. These chemicals cause shoots to grow towards light.
Plant roots grow downwards into the soil to find water and minerals. There are special cells near the tips of roots that cause the root to grow in the direction of gravity.

Stimulus	**Types of tropism**	**examples**
Light	Phototropism	Shoots and coleoptiles positively phototropic. Some roots negatively phototropic. e.g.: adventitious roots.
Gravity	Geotropism	Shoots and coleoptiles negatively geotropic. Roots positively geotropic. Rhizomes, runners, dicotyledonous leaves, lateral roots, stem branches plagiogeotropic.
Chemical	Chemotropism	Hyphase of some fungi positively chemotropie. e.g: mucor.Pollen tube positively chemotropic in response to chemical produced at microphyle of ovule.
Water	Hydrotropism	Roots and pollen tubes positively hydrotropic.
Solid surface or touch	Haptotropism Thigmotropism	Tendrils positively haptotropic e.g. leaves of pea.
Air	Aerotropism (special kind of chemotropism)	Pollen tube negavelyaerotropic

Sub- topic area: SUPPORT AND LOCOMOTION

Unit 10. SKELETAL SYSTEMS OFORGANISMS

Need for locomotion

Animals need for locomotion for a variety of reasons, such as **to find food**, **a mate**, **a suitable habitat, or to escape predators.** For many animals, the ability to move is essential for survival and, as a result, natural selection has shaped the locomotion methods and mechanisms used by moving organisms. For example, migratory animals that travel vast distances (such as the arctic tern) typically have a locomotion mechanism that costs very little energy per unit distance, whereas non-migratory animals that must frequently move quickly to escape predators are likely to have energetically costly, but very fast, locomotion.

10. 1. Types of skeletons (hydrostatic, exoskeleton, endoskeleton).

A skeleton is a supportive framework in an animal's body. Most skeletons are made up of rigid materials. Basically there are three types of skeletons: **hydrostatic skeleton, endoskeleton and exoskeleton.**

Hydrostatic skeleton: is the most primitive form of skeletal structure, found in animals such as jellyfish and worms (earthworm), which consists of layers of muscle around a fluid-filled body cavity.

Exoskeleton: is a hard covering on the outside of organisms such as **crustaceans** (crayfish, crab, etc.), **insects** (locust, grasshopper, flies, mosquito, etc.) that provides support and protection.

Endoskeleton: internal skeleton of animals especially in **vertebrates** (fish, frog, snake, cow, human, hen, etc.).

Hydrostatic skeleton	Exoskeleton	Endoskeleton
Inside the body	Outside the body	Inside the body
Made of fluid	Made of non-living material	Made of living material
Muscles around the fluid can press against it	Muscles are attached to the inside of the skeleton	Muscles are attached to the outside of the skeleton
	Does not grow, so it needs to be shed to enable the animal to grow	Grows inside the animal
Examples: earthworms, snail	Examples: insects, spiders	Examples: all vertebrates

THE HUMAN SKELETON

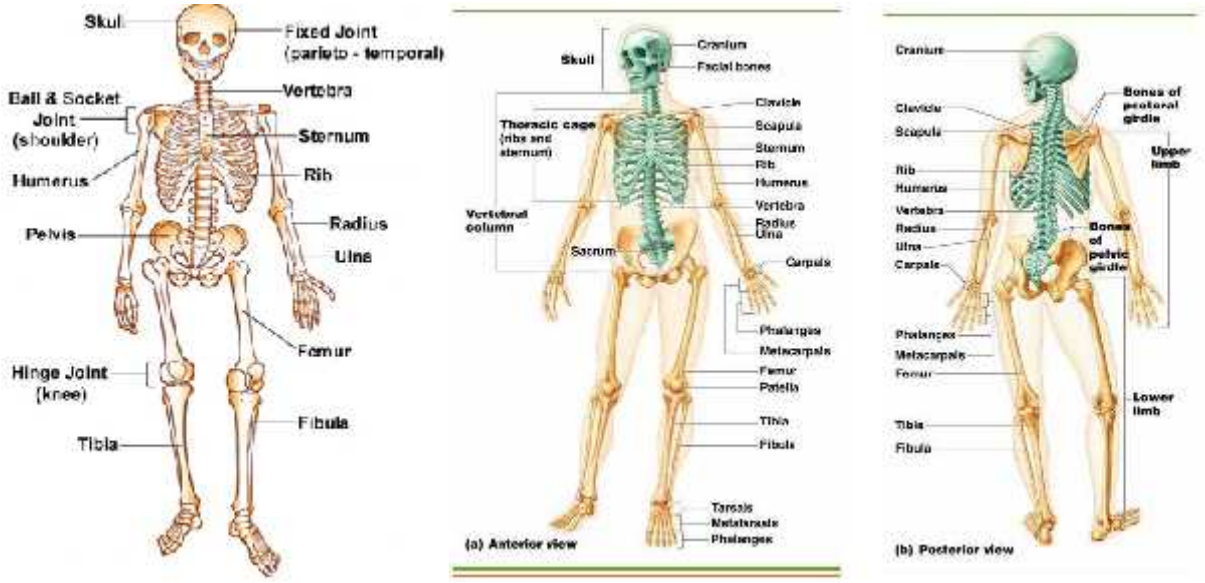
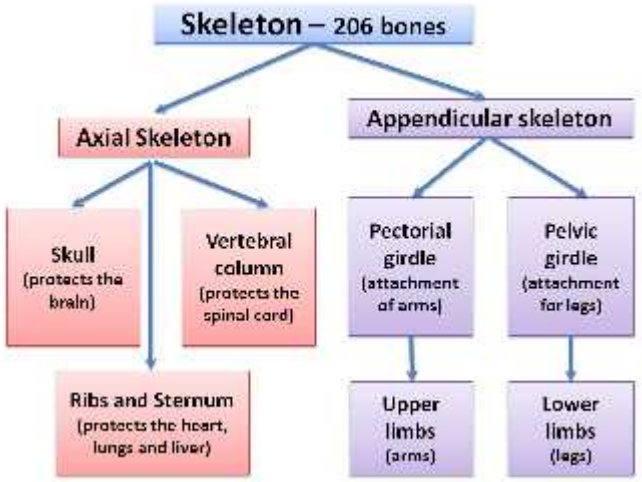


Figure: the human skeleton

The adult human body consists of approximately **206 bones**, which are organized into an internal framework called the skeleton. Because the human skeleton is an internal structure, biologists refer to it as an endoskeleton. The variation in size and shape among the bones that make up the skeleton reflects their different roles in the body. This skeleton comprises two main parts: **axial (central)** skeleton and **appendicular**(peripheral) skeleton.



The **axial skeleton** includes the bones of the head, vertebral column, ribs and sternum. There are **80 bones in the axial skeleton**. The **appendicular skeleton** includes the bones of the limbs (arms and legs) along with the scapula and the pelvis. There are approximately **126 bones in the appendicular skeleton.**

10.2. Parts of human skeleton: central skeleton (the skull, vertebral column and thoracic cage)

The head bones (skull and facial bones)

The thoracic cage

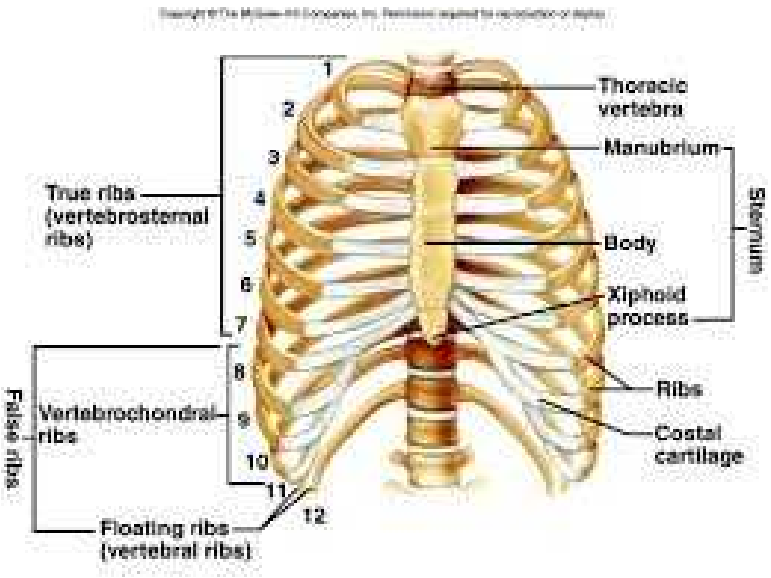
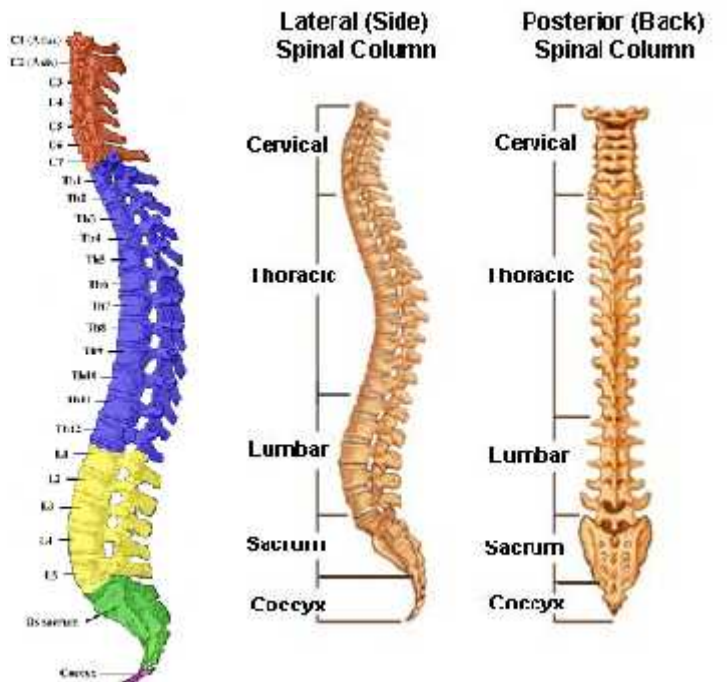


Figure: The thoracic cage

Thoracic vertebrae are made up 12 pairs of ribs and sternum. The ribs work closely with the intercostal muscles to help in breathing.

Vertebral column or backbone



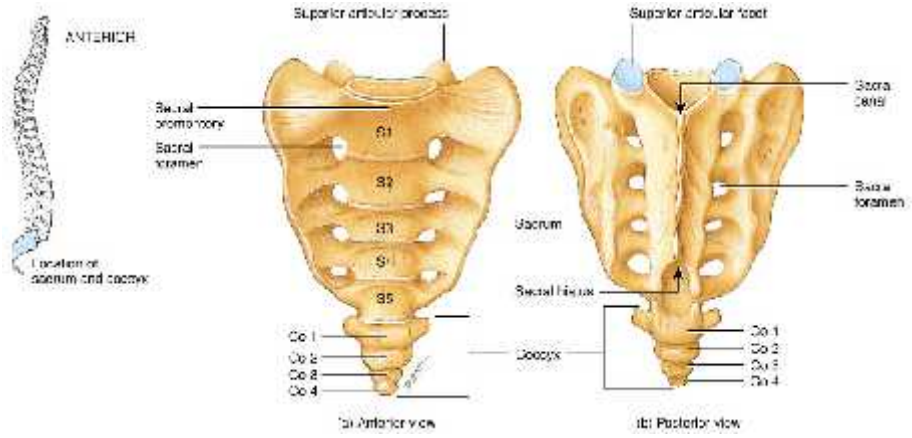


Figure: The backbone

This backbone contains:

- 7 cervical vertebrae
- 12 thoracic vertebrae
- 5 lumbar vertebrae
- 5 Sacral vertebrae
- 4 Caudal or coccygeal vertebrae

The peripheral skeleton consisting of the upper and lower limbs, the shoulder and pelvic girdles.

Bones of upper limb

The humerus attaches the two upper limbs to the pectoral girdle. It supports the arm and coordinates arm movements. The bicep and triceps muscles are attached to the humerus to bring about powerful movements. The radius and ulna are jointed to the humerus at the elbow joint. They are then joined to the carpals, metacarpals and phalanges. The hand contains a total of 27 bones.

- The humerus is the second largestbone in the body and it is the longest bone of the upper limb.
- The carpals/wrist bones- there are 16 bones
- The metacarpals provide the support for palm of the hand- there are 5 metacarpals for each hand.
- The phalanges support the fingers- there are 14 on each hand.

Bones of the lower limb

- The femur is the largest bone in the body. It is located in the thigh and connects to the pelvic girdle in a socket called an **acetabulum**. On the lower side it connects to the knee cap- **patella** and **tibia**.

- The patella is the small rounded bone that helps to protect the front of the knee, between the upper and lower bones.
- The tarsals are 7 bones forming the ankle. The largest tarsal is called the **carcaneus**.
- The metatarsals from the food, and there are 5 in total.
- The phalanges form the toes. There are 14 in each foot. Each toe has 2 bones.
- The pelvic bone consists of 2 bones called coxal or hip bones

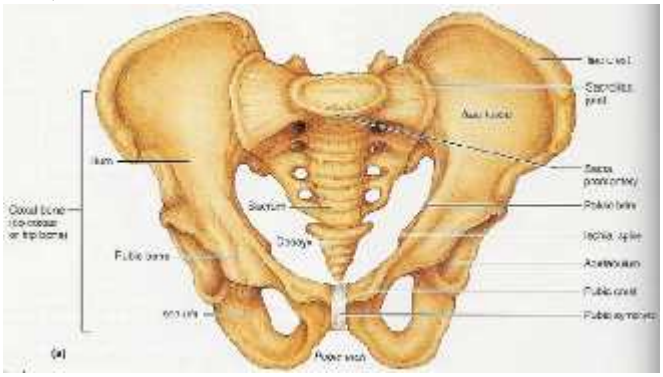


Figure: The pelvic girdle

10.3. Functions of human skeletons

- **Structural Support of the Body**: The skeleton supports the body against the pull of gravity. The large bones of the lower limbs support the trunk when standing.
- **Protection of Internal Organs**: The skeleton provides a rigid frame work that supports and protects the soft organs of the body. The fused bones of the cranium surround the brain to make it less vulnerable to injury. Vertebrae surround and protect the spinal cord and bones of the rib cage help protect the heart and lungs.
- **Attachment of the Muscles**: The skeleton provides attachment surfaces for muscles and tendons which together enable movement of the body.
- **Movement of the Body**: Bones work together with muscles as simple mechanical lever systems to produce body movement.
- **Production of Blood Cells**: The formation of blood cells takes place mostly in the interior (marrow) of certain types of bones.
- **Storage of Minerals**: Bones contain more calcium than any other organ in the form of calcium salts such as calcium phosphate. Calcium is released by the bones when blood levels of calcium drop too low. Phosphorus is also stored in bones.

10.4. Practices that favour good health of the skeletal system.

- Doing Physical exercices, sport, etc.
- Good feeding, especially of vitamin D
- Adopt exposure on sunlight every morning
- Avoid bleeding and bone exposure

- Avoid bad positions such as: sitting bad on desk, chair, walking, etc
- Etc

Topic area: HEALTH AND DISEASE

Sub-topic area: INFECTIOUS AND NON-INFECTIOUS DISEASES

Unit 11: CLASSIFICATION OF DISEASES

The World health organization has defined health as a state of complete physical, mental and social well-being and not merely the absence of disease or infirmity. Disease is a bodily disorder or a disordered state of an organ or organism.

11.2. Classification of diseases

When the body is infected by a disease, the normal functioning of some parts of the body (cell, tissues or organs) is disturbed. There are many types of diseases which can be broadly divided into two categories:

- Infectious diseases
- Non-infectious diseases

Infectious diseases

They are also known as **communicable diseases**. These are diseases which can be transmitted from one person to another. They are usually caused by microorganisms like viruses, bacteria, fungi and protozoa. The diseases include cholera, malaria, typhoid, HIV and AIDS…

Non-infectious diseases

They are also known as **non-communicable** diseases. These are the diseases that cannot be transmitted from one person to another for example albinism, kwashiorkor, cancer, diabetes…

Classification of diseases based on their causative agents

Diseases can also be classified based on their causative agent i.e. bacterial, viral, protozoan, fungal, genetic, malnutrition disorders, worm diseases, environmental, degenerative, hormonal and allergies.

- **Bacterial diseases**: these are diseases caused by bacteria. They include cholera, typhoid, tetanus, tuberculosis…
- **Viral diseases:** these are diseases caused by viruses. They include AIDS, polio, measles, ebola…
- **Protozoan diseases:** these are diseases caused by protozoa. They include malaria, sleeping sickness, trichomoniasis…
- **Fungal diseases:** these are diseases caused by fungi. They include candidiasis, athlete's foot, ring worms….
- **Genetic diseases:** these are diseases that are inherited from parents or grandparents. They are incurable. They include albinism. Haemophilia, sickle cell anemia…
- **Worm diseases:** these are diseases caused by worms. They include elephantiasis, bilharzia…
- **Degenerative diseases:** these are diseases caused by ageing. They include baldness, arthritis…
- **Malnutrition disorders:** these are diseases caused by either lack of enough food, lack of the right type of food or eating too much calories in food. They include marasmus, obesity, kwashiorkor…
- **Environmental diseases** and **allergies**. An allergy is a condition in which the body produces an abnormal immune response to some substances. These substances are normally harmless in the environment. These substances are called allergens. They include dust, pollen, certain foods, sprays, animal hair and drugs. Examples of drugs that are cause by allergens include asthma, hay fever.
- **Vitamin** and **mineral salts deficiency.** These are diseases caused by lack of a certain vitamin or mineral in the diet. For example goitre is due to lack of iodine in the diet, anaemia is due to lack of enough iron in the diet, scurvy is due to the lack of vitamin C in the diet, rickets is due to the lack of vitamin D in the diet…
- **Sexually transmitted diseases:** these are diseases transmitted through sexual contact. They include HIV-AIDS, syphilis, gonorrhoea…

Mental diseases: include a wide range of mental conditions that affect mood, thinking and behaviour. Examples include depression, anxiety…

Disease	Causal agents	Mode of transmission	Symptoms	Prevention
Tuberculosis	*Mycobacterium tuberculosis*	By inhaling the bacteria into the lungs (droplet infection).	Loss appetite Loss of weight and excessive sweating, Coughing Appearance of blood in the sputum Chest pains Shortness of breath	Immunisation for children against TB with BCG the patient should avoid sharing utensils with other people, TB patients should sleep or stay in isolated rooms or houses, people should live
AIDS(Acquired Immune Deficiency Syndrome)	*Human Immunodeficiency Virus(HIV)*	Unprotected sex with infected person Infected blood transfusion Infected mother to child Sharing sharp materials with infected persons	Low immunity causing various opportunistic infections(tuberculosis, pneumonia, candidiasis, and other sexually transmitted diseases)	Avoid unprotected sex intercourse. Screen blood before transfusion. Infected mother should avoid pregnancy Avoid sharing sharp materials with infected persons. Being faithful to uninfected partner
Cholera	***Vibrio cholerae***(Choleric vibrio)	Consuming infected food or infected water	Watery diarrhoea Pains in digestive tract Dehydration Loss of nutrients(minerals)	Boiling water -Kill flies -Keeping hands clean -Keeping clean latrine - Wash hand before eating - Wash food and clothes - Boil water - Wash and have appropriate handling of dishes
Ebola	***Ebola virus***	Transmission through blood and fluid	Severe headache, fever, chills, sore throat, muscle	Vaccine,

			aches, and weakness. vomiting, abdominal pain, diarrhea, and conjunctivitis (inflammation of the mucous membranes in the eye).bleeding from body openings	
Malaria(Paludism)	*Plasmodium*	Biting of infected female Anopheles mosquito	Fever, pains, headache, nausea and vomiting.	Sleeping under mosquito nets. Use of insecticides Cuts bushes around houses. Avoid stagnant water

Non-infectious diseases

Social diseases

They are diseases brought by humans individually or collectively. Many are associated with modern industrialized societies. Eg. Coronary heart diseases, alcoholism, drug abuse, lung cancer, domestic and industrial accidents, industrial diseases: asbestosis and pollution-related disorders, brain damage, asthma, etc.

Deficiency diseases

They are caused by absence of certain nutrients in the diet. Eg. Marasmus, kwashiorkor, pellagra, etc.

Genetic (congenital) disorders

They are inherited from birth from parent to child.Genetic disorders are caused by errors in genetic information that produce diseases in the affected people. The origin of these genetic errors can be:

- Spontaneous errors or mutations to the genome:
- A change in chromosome numbers, such as Down syndrome.
- A defect in a gene caused by mutation, such as Cystic fibrosis.
- An increase in the amount of genetic information, such as Chimerism or Heterochromia.

Eg. Down's syndrome.

Ageing and degenerative diseases

They are caused by degeneration of body tissues. Eg. Weakening of the eye muscles.

Mental diseases

Eg: schizophrenia,etc.

11.3. The spread and prevention of infections

Decrease your risk of infecting yourself or others:

1) **Wash your hands often.** This is especially important before and after preparing food, before eating and after using the toilet.
2) **Get vaccinated.** Immunization can drastically reduce your chances of contracting many diseases. Keep your recommended vaccinations up-to-date.
3) **Use antibiotics sensibly.** Take antibiotics only when prescribed. Unless otherwise directed, or unless you are allergic to them, take all prescribed doses of your antibiotic, even if you begin to feel better before you have completed the medication.
4) **Stay at home if you have signs and symptoms of an infection.** Don't go to work or class if you're vomiting, have diarrhea or are running a fever.
5) **Be smart about food preparation.** Keep counters and other kitchen surfaces clean when preparing meals. In addition, promptly refrigerate leftovers. Don't let cooked foods remain at room temperature for an extended period of time.
6) **Disinfect the 'hot zones' in your residence.** These include the kitchen and bathroom — two rooms that can have a high concentration of bacteria and other infectious agents.
7) **Practice safer sex.** Use condoms. Get tested for sexually transmitted diseases (STDs), and have your partner get tested— or, abstain altogether.
8) **Don't share personal items.** Use your own toothbrush, comb or razor blade. Avoid sharing drinking glasses or dining utensils.
9) **Travel wisely.** Don't fly when you're ill. With so many people confined to such a small area, you may infect other passengers in the plane. And your trip won't be comfortable, either. Depending on where your travels take you, talk to your doctor about any special immunizations you may need.

11.4. Non-infectious diseases: sickle cell, allergies, ageing, osteoporosis, cancer, cardiovascular diseases, eating disorders, deficiency diseases.

(1) Sickle cell

Sickle-Cell Anaemia, genetic disorder of the blood leading to frequent and severe infections, damage to major organs, and episodes of unpredictable pain in the back, chest, abdomen, and extremities.

(2) Allergies

Allergy, exaggerated and sometimes harmful reactions to external substances, called allergens. Allergy may result from exposure to such common allergens as plant pollens from grasses, trees,

or ragweed; animal danders, which are tiny scales shed from the skin and hair of cats and other furred animals; arachnids and insects, such as house dust mites, bees, and wasps; and drugs, such as penicillin. The most common food allergies are caused by crustacean shellfish, eggs, fish, milk, peanuts, soybeans, tree nuts, and wheat.

(3) Ageing

Ageing is an irreversible biological changes that occur in all living things with the passage of time, eventually resulting in death. Although all organisms age, rates of aging vary considerably. Fruit flies, for example, are born, grow old, and die in 30 or 40 days, while field mice have a life span of about three years. Dolphins may live to age 25, elephants to age 50, and Galápagos tortoises to 100. These life spans pale in comparison to those of some species of giant sequoia trees, which live hundreds of years.

(4) **Cancer**

Cancer (medicine), any of more than 100 diseases characterized by excessive, uncontrolled growth of abnormal cells, which invade and destroy other tissues. Cancer develops in almost any organ or tissue of the body, but certain types of cancer are more life-threatening than others. In the United States and Canada cancer ranks as the second leading cause of death, exceeded only by heart disease.

(5) Cardiovascular diseases

One disease of the coagulation system is hemophilia, a genetic bleeding disorder in which one of the plasma clotting factors, usually factor VIII, is produced in abnormally low quantities, resulting in uncontrolled bleeding from minor injuries. Although individuals with hemophilia are able to form a good initial platelet plug when blood vessels are damaged, they are not easily able to form the meshwork that holds the clot firmly intact. As a result, bleeding may occur sometime after the initial traumatic event.

(6) **Eating disorders**

Eating Disorder, abnormal behavior patterns with regard to food, not including simple overindulgence and resulting obesity. Two serious eating disorders are anorexia nervosa and bulimia. Eg: self-starvation, Being eating and voiding, *see* Bulimia, Overview of eating disorders, *see* Mental Illness: Eating Disorders, Eating of nonfood items, *see* Pica, Disorders of the hypothalamus as one cause of eating disorders.

(7) **Deficiency diseases**

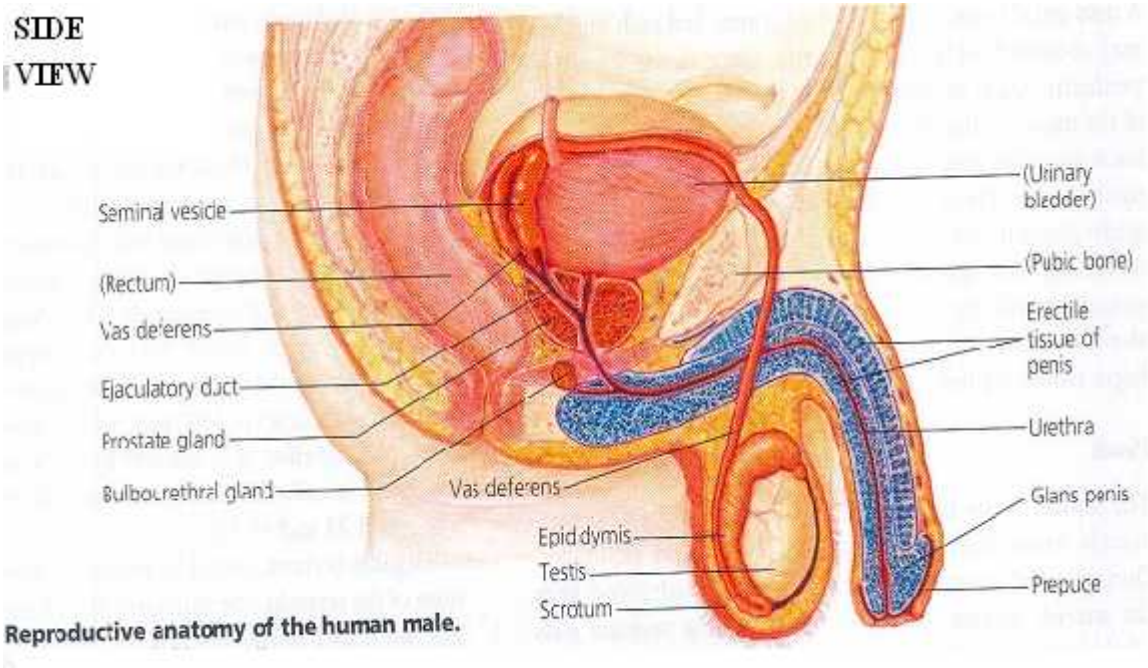
Deficiency Diseases, disorders caused by lack of specific essential substances such as vitamins, minerals, or amino acids. More broadly, the term applies to conditions in which the essential substances are present but not absorbed, or in which the organism fails to produce a natural and

essential substance (*see* Hormone). Such diseases as beriberi, scurvy, pellagra, and rickets are caused by lack of particular vitamins, and recovery is dramatically prompt when adequate quantities of the vitamins are supplied in the diet. Certain types of anemia may be caused by a dietary lack of iron in usable form. At least ten amino acids, ten minerals, and ten vitamins are indispensable nutritional elements in the human diet, and the absence of any one causes a specific deficiency disease.

Sub-topic area: REPRODUCTIVE HEALTH

Unit 12: HUMAN REPRODUCTIVE SYSTEM

12.1. External and internal male reproductive organs

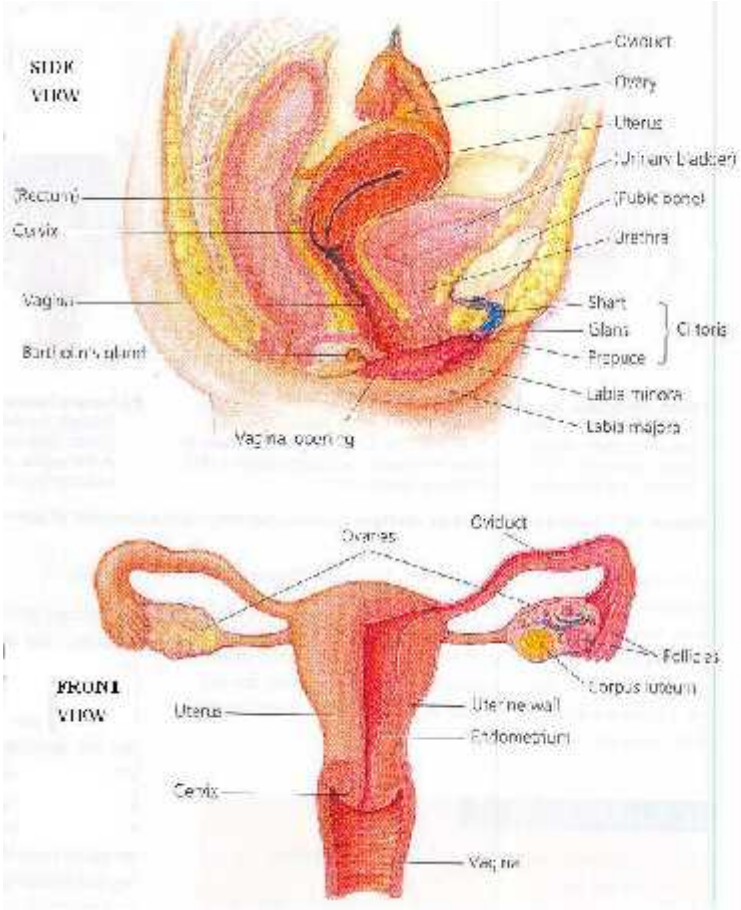


Reproductive anatomy of the human male.

Parts of the male reproductive system and their functions

Structure	Function
testes	• produce sperm cells • produce the hormone testosterone
seminiferous tubules	• produce immature sperm cells
epididymis	• matures and stores sperm cells in coiled tubules
vas deferens	• carries sperm from the epididymis to its junction with the urethra
seminal vesicle	• secretes fructose into the semen, which provides energy for the sperm
prostate gland	• secretes an alkaline buffer into the semen to protect the sperm from the acidic environment of the vagina
Cowper's gland	• secretes mucus-rich fluids into the semen that may protect the sperm from acids in the urethra
urethra	• carries semen during ejaculation • carries urine from the bladder to the exterior of the body
penis	• deposits sperm into the vagina during ejaculation • contains the urethra

External and internal female reproductive organs



Parts of the male reproductive system and their functions

Structure	Function
ovaries	• produce the hormones estrogen and progesterone • site of ova (egg cell) development and ovulation
fallopian tubes (oviducts)	• carry the ovum from the ovary to the uterus • usually the site of fertilization
fimbria	• sweep the ovum into the oviduct following ovulation
uterus (womb)	• pear-shaped organ in which the embryo and fetus develop • involved in menstruation
cervix	• separates the vagina from the uterus • holds the fetus in place during pregnancy • dilates during birth to allow the fetus to leave the uterus
vagina	• extends from the cervix to the external environment • provides a passageway for sperm and menstrual flow • functions as the birth canal

12.2. The process of sperm and ovum production

- **SPERMATOGENESIS (production of sperm)**
  - It starts at puberty age (13 to 14years) goes in both testicles up old age.
  - Spermatozoids are produced in basis of germinal cells called **spermatogonia** of seminiferous tubes wall.
  - This process(spermatogenesis) takes place in 4phases:
    1. **Multiplication phase**: **spermatogonia** multiply by means of successive mitosis and the cells obtained are **spermatogonia** with 2n chromosomes (diploids).
    2. **Growth phase**: each **spermatogonium** undergoes a slight increase that transforms it into 2 **spermatocytes I** (diploid).
    3. **Maturation phase or meiosis**: Each spermatocyte I undergoes two meiotic divisions. At the end of the first division, the spermatocyte I gives two **spermatocytes II** having n chromosomes (haploids). At the equational division of meiosis (meiosis II) each spermatocyte II gives 2 **spermatids** with n chromosomes. This means that from spermatocytes II, there is formation of 4 spermatids.
    4. **Spermiogenesis phase or Differentiation:** it is a phase during which each spermatid transforms into **spermatozoid** by means of changing the shape and structure as it follows:
       - Spermatid is ovoid cell changes in lengthened cell
       - Spermatid reduces the volume of its cytoplasm
       - Spermatid obtains flagellum(spermatozoid)
- **OOGENESIS(production of ova)**

- It starts during **gestation** (before birth) by production of **oogonia,** it continues at pubertyand stops at **menopause (**about 50 years**)**.
- Oogenesis takes place in ovary from follicles, ova are formed.
- This process(oogenesis) takes place in 4 phases:
    1. **Multiplication phase**: oogonia undergo 3 successive mitosis and the obtained oogonia are diploids.
    2. **Growth phase**: each oogonium undergoes considerable growth and becomes primary oocyte or **oocyte I** (2n) that accumulates in its cytoplasm several nutrients called **vitellus**.

NB:

- The two phases above occur at embryonic stage (before birth) and the produced **oocytes I** remain at **prophase of mitosis I** throughout childhood.
- The oocytes I are enclosed of single layer cells called **granulose cells (**or follicle cells**),** andform structures known as a **primordial follicles.**
- About two million of these follicles exist in female before birth, but only 450 ever develop secondary oocytes which are released from the ovary during the menstrual cycle.

3. Maturation or meiosis: each oocyte I undergoes two meiotic divisions.

- ✓ The first division gives two cells with different size:
    - One **oocyte II** (n chromosomes) that takes the whole cytoplasm, and a small cell that has no cytoplasm and that degenarates, it is first **polar globule (polar body).**

4. **Cytodifferentiation phase;** it takes place during fertilisation and it affects oocyte II which increases considerably the volume of cytoplasm. By the entry of sperm, oocyte II that meiotic division remained at prophase of meiosis II, takes back and it continues **metaphase II**:
    - One ootidthat inherits the whole cytoplasm (**ovum**) and the second **polar globule** (polar body) that degenerates as well.

NB: During woman's fertile years, one primordial follicle per month develops into a mature follicle called **Graafian follicle**. This contains: oocyte II, antrum (fluid), granulosa cells, theca and zona pellucida.

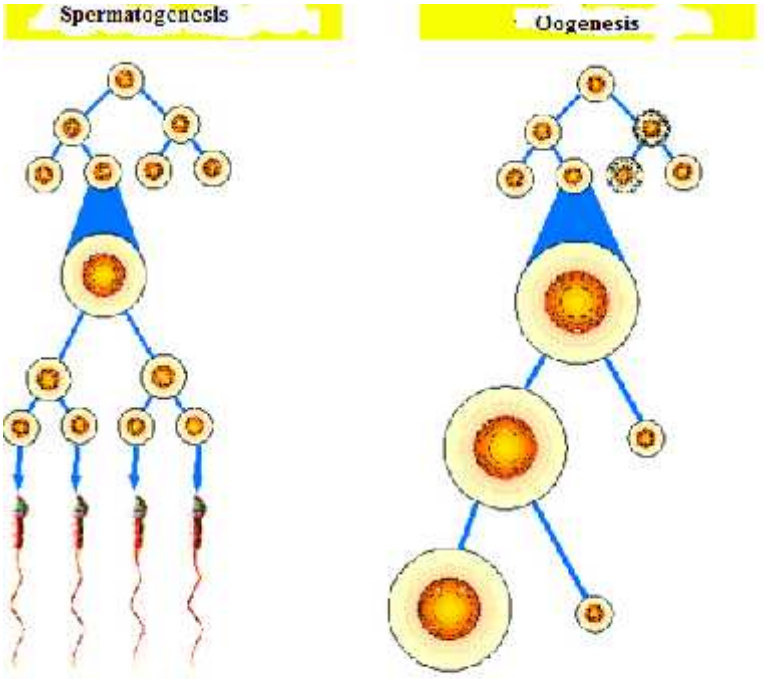


Table: Difference between spermatogenesis and oogenesis

Spermatogenesis	**Oogenesis**
It starts at puberty	It starts before birth
It is short	It is long
One spermatocyte I produces 4 spermatozoids	One oocyte I produces one ovule and 2 or 3 polar globules
It is a continuous process from puberty to the death	It is a discontinuous process from embryonic stage to the menopause
It has a mobile cell(spermatozoid) containing a flagellum	Ovum is Immobile cell without flagellum
Spermatozoid is in small size and lengthened	Ovum is in big size and spherical shape
The cell is poor in nutrients	Ovum is rich in nutritive substances

12.3. Determination of sex.

Recall that in humans the diploid number of chromosomes is 46, or 23 pairs. There are 44 or 22 pairs of matching homologous called **autosomes.** Homologous **autosomes** look exactly alike. The 23rd pair of chromosomes differs in males and females. These two chromosomes (**Heterosomes**or **heterochromosomes**), which determine the sex of are an individual, are called **sex chromosomes.** In humans, the chromosomes that control the inheritance of the inheritance of

sex characteristics are indicated by the letters X and Y. For female sex chromosome is XX and for male is XY and are contained respectively in ovum and spermatozoon.

NB: The man is one who determines the sex.

12.4. Role of hormones in growth, development and the regulation of reproductive organs and sexual functions

Hormones are chemical messengers secreted by endocrine glands. They have an effect on other definite organs called target organs. Hormones are regarded as chemical messages, and most of the mechanism in the body which operates to maintain a steady homeostatic mechanism is controlled by hormones.

a. Regulating the body functions. Eg: urination, digestion, etc.
b. Regulating metabolic activities; eg: metabolism of blood sugar(**glucagon** and **insulin**),
c. Control growth. Eg: reproduction (progesterone, FSH), birth (oxytocin), etc.
d. Some hormones act directly on effectors organs as do nerves impulse. Eg: Adrenaline,
e. Control endocrine gland. Eg: FSH, LH.

12.5. Influence of culture, tradition and religious practices on one's thinking about sex, gender and reproduction.

Most societies expect people of a particular gender to perform certain tasks. This happens for cultural reasons or as a result of customs, traditions and religious views. For example, hunting was traditionally assigned to men and mourning to women. As our society has changed, the role of the different genders has also changed. Gender equality means that males and females are equal.

Unit 13. PUBERTYAND SEXUAL MATURATION

13.1. Puberty

Puberty is the time when boys and girls become sexually mature. Biological changes take place in the person's boy in preparation for reproduction. Puberty involves both physical and emotional changes. Some changes can be stressful, but it helps to realize that puberty is a natural step in the development of every person.

Puberty occurs at different times for different people. And it has different effects on boys and girls. Puberty occurs sometimes between the ages of nine and sixteen. All organisms have features or characteristics that make them male or female. **Primary sexual characteristics** are physical characteristics that indicate whether a person is male or female. These characteristics

are present from birth, for example a penis or vagina. **Secondary sexual characteristics** develop only at puberty.

In males, the testes begin to produce the hormone testosterone during puberty. It brings about the development of male secondary characteristics. In females, the ovaries begin to produce the hormone estrogen during puberty. It brings about the development of female secondary sexual characteristics.

Changes in boys	Changes in girls
⁾Facial, pubic and underarm hair starts to grow ⁾Voice deepens ⁾Body size increases and becomes more muscular ⁾Sex organs increase in size ⁾Sperm are produced in the testes ⁾Acne may occur	⁾ Pubic hair starts to grow ⁾ Breasts enlarge ⁾ Fatty tissue is deposited on the hips and thighs ⁾ Hips broaden ⁾ Menstruation starts ⁾ Ova are released from the ovaries ⁾ Acne may occur

Table: secondary sexual characteristics

13.2. Male and female hormones

They differ and have a major influence on the emotional and physical changes that occur over one's lifetime.

The brain changes too as you make the transition from girl to woman. A girl or a boy becomes more independent, more questioning and starts to look out beyond their parents. They can also feel young and insecure, confused or angry for no real reason. It is all part of growing up, and changing hormone levels are part of the cause.

13.3. Hormones can affect

They affectbody shape and size, body hair growth, development and other changes.

- ⁾ Pubic hair and body hair (underarms) begin to grow.
- ⁾ The breasts in girls develop and become enlarged
- ⁾ The external genitals become larger and the colour of the skin around them darkens.
- ⁾ The hips widen in girls and fat is deposited on the hips, buttocks and thighs to form the characteristic female body shape. In boys chest develops, organs and the body becomes muscular.
- ⁾ The ovaries begin the production of mature ova and menstruation begins.
- ⁾ The uterus grows in girls and begins to produce a thickened lining each month in response to hormones from the ovary. In boys, the testes and penis develop.

13.4. The menstrual cycle.

Menstrual Cycle

The human female menstrual cycle, which is repeated throughout a woman's reproductive lifetime, takes an average of 28 days, although variation in this cycle is common. The menstrual cycle can be divided into four distinct phases: flow phase, follicular phase, ovulatory phase, and luteal phase. The shedding of the endometrium, or menstruation, marks the flow phase. This is the only phase of the female reproductive cycle that can be determined externally. For this reason, the flow phase is used to mark the beginning of the menstrual cycle. Approximately five days are required for the uterus to shed the endometrium.

Phase	Description of events	Hormone produced	Days
flow	• menstruation		1–5
follicular	• follicles develop in ovaries • endometrium is restored	estrogen produced by follicle cells	6–13
ovulation	• oocyte bursts from ovary		14
lutcal	• corpus luteum forms and endometrium thickens	estrogen and progesterone	15–28

The menstrual cycle comprises two cycles: ovarian cycle and uterine cycle.

1) Ovarian cycle, ovarian cycle occurs in ovaries and contains three phases:
   - ✓ Follicular phase is characterized by the rapid growth of follicles under the increasing of the secretion of **FSH.**
   - ✓ Ovulation phase
   - ✓ Luteal phase: Is characterized by:
     - o The remaining part of Graafian follicle stimulated by LH to develop into the **corpus luteum(**a **yellow body** containing a yellow orange pigment**)** which secretes **progesterone** and **oestrogen.**

NB: As long as the corpus luteum persists, no follicle can develop into ovaries. If the released ovum has not been fertilized, the corpus luteum reduces (it becomes too small) and a new cycle starts over.

2) The uterine cycle,it happens in uterus

The uterine cycle takes place concurrently with the ovarian cycle. The first day of the cycle begins with the **menstruation (**periods) or **menses** that lasts around 2 to 5 days. After those periods, the uterine mucous undergoes important changes.

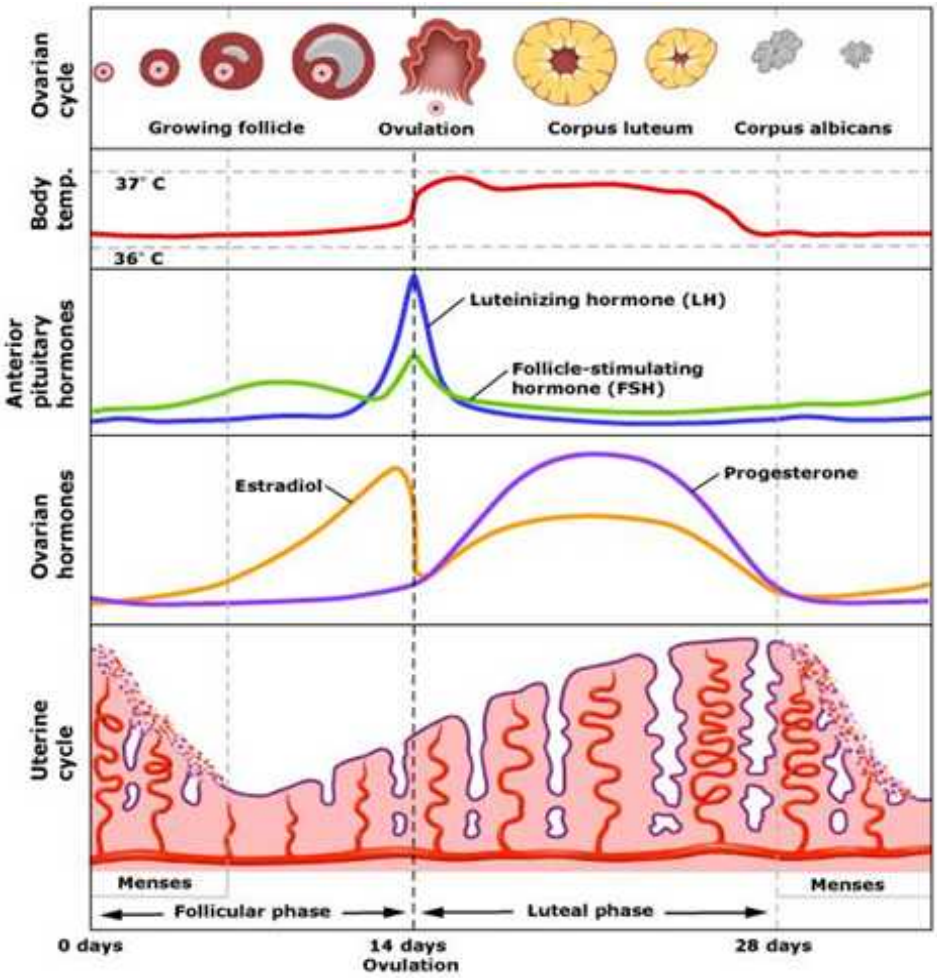
- ✓ Menstrual flow phase which is also called "bleeding phase" or " menstrualperiod" is characterized by:

- Menstrual bleeding during form 2 to 5 days
  The menstruation consists of dead endometrial cells, blood, vaginal cells, mucous from the cervix and other necrotic tissues.

✓ Follicular phase or proliferative phase : is characterized by:
- Reconstitution of endometrium from its glandular cul-de-sac
- The thickness of the endometrium moves from 1 to 5mm,
- Great vascularity of endometrium and glands stretch out sinuous,
- Secretion of cervical mucus by cervical gland which facilitates the progression of spermatozoa by cleaning them.

✓ Luteal phase or secretory phase: is characterized by:
- The continuation of proliferation of endometrium under the effect of progesterone, and it reaches its maximal thickness of 8mm.
- Presence of several developed glands,
- Secretion of mucus and glycogen,
- Vascularisation(penetration of vessels) of glands,

NB: The duration of the luteal phase remains 14days



The main hormones involved in menstrual cycles

Hormone	Location	Description of function
estrogen	follicle cells (ovary)	inhibits growth of facial hair, initiates secondary female characteristics, and causes thickening of the endometrium
progesterone	corpus luteum (ovary)	inhibits ovulation, inhibits uterine contractions, and stimulates the endometrium
follicle-stimulating hormone (FSH)	pituitary	stimulates the development of the follicle cells in the ovary
luteinizing hormone (LH)	pituitary	stimulates ovulation and the formation and maintenance of the corpus luteum

Unit 14: REPRODUCTION, PREGNANCY AND CHILDBIRTH

14.1. Reproduction male and female reproductive systems.

For details about the male and female reproductive systems cfr unit 12.

14.2. Intercourse and fertilisation

For the spermatozoa to be introduced into the female tract, it is necessary for the penis to be inserted to the vagina in the act known as **copulation** or **coitus**. In order for the penis to penetrate the vagina, it must become hard and erect. In man, this is accomplished by increasing the amount of blood in the soft tissues around the urethra thus producing turgidity or stiffness.

Penetration is also made easier by the secretion of lubricating mucus by cells lining the vaginal wall and vulva (external genital area). The penetration of penis the vagina is called **intromission**. The physiological and psychological sensations associated with the climax in both male and females are called **orgasm**. At this step spermatozoa are released into vagina, about 2 to 3 hundred million are poured in the female reproductive organ, the process called **ejaculation**.

FERTILISATION

Also known as **conception**, **fecundation** and **syngamy**is a process in which male and female gametes fuse to produce a zygote that develops in a new offspring. Fertilization can be defined as the fusion of the **sperm nucleus** with the **egg nucleus** to form a diploid cell known as the **zygote**.

NB: The fertilization occurs in the posterior third of the fallopian tube where the spermatozoa join ova.

14.3. Pregnancy and its signs

Pregnancy or gestation starts when a male's sperm fertilizes a female's ovum (egg), and the fertilized ovum implants in the lining of the uterus.It starts by conception and ends at the day of birth. In human, Gestation or pregnancy lasts about 266days or 9 months on average. The pregnancy is divided into **three trimesters**.

Placenta and Related Structures

The **placenta** is a temporary organ in which nutrients and wastes are exchanged between the mother and the embryo or fetus. The placenta begins to form in the second week after fertilization. It continues to develop and grow to meet the needs of the growing fetus. A fully developed placenta is made up of a large mass of blood vessels from both the mother and fetus. The maternal and fetal vessels are close together but separated by empty space. This allows the mother's and fetus's blood to exchange substances without actually mixing.

How the Placenta Works

Blood from the mother enters the maternal blood vessels of the placenta under pressure, forcing the blood into the empty spaces. When the mother's blood contacts the fetal blood vessels, gases are exchanged. Oxygen from the mother's blood is exchanged with carbon dioxide from the fetus's blood. A release of pressure brings the mother's blood back from the placenta and into her veins.

The fetus is connected to the placenta through the **umbilical cord**, a tube that contains two arteries and a vein. Blood from the fetus enters the placenta through the umbilical arteries, exchanges gases with the mother's blood, and travels back to the fetus through the umbilical vein.

In addition to gas exchange, the placenta transfers nutrients, hormones, and other needed substances from the mother's blood to the fetus's blood. The placenta also filters many harmful substances out of the mother's blood so they are not transferred to the fetus. In addition, the placenta secretes hormones that maintain the corpus luteum in the mother's ovary. Recall that the corpus luteum secretes progesterone, which is needed to keep the endometrium of the uterus from breaking down.

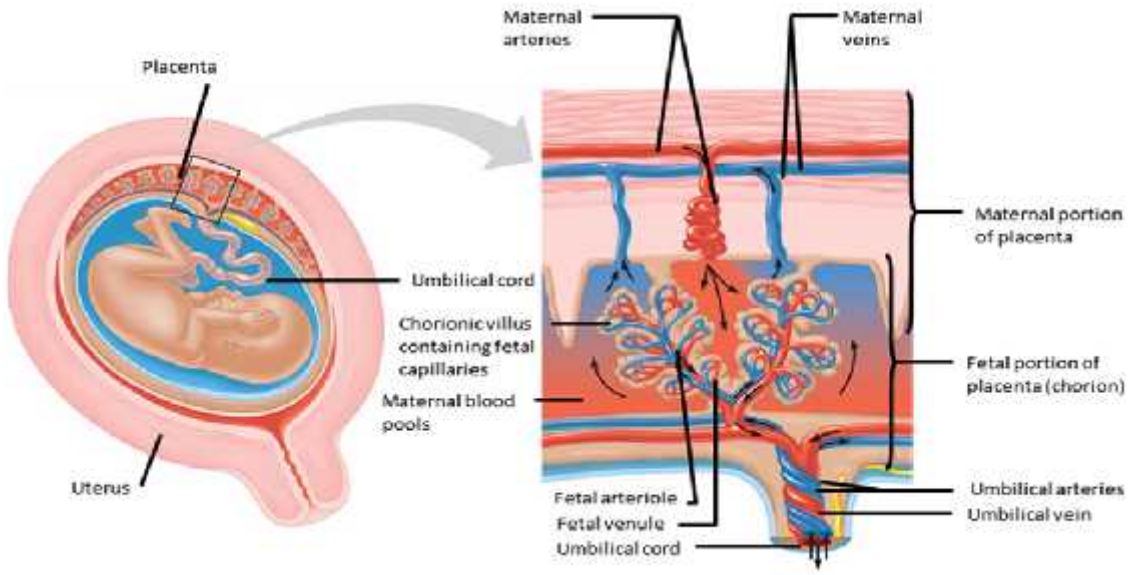


Fig 12.7: The structure of the placenta

Materials passed from fetus to mother within the placenta	**Materials passed from mother to fetus within the placenta**
Carbon dioxide	Oxygen
Urea	Nutrients (glucose, amino acids, etc.)
Water	Water
Hormones (e.g. HCG)	Hormones
	Vitamins, minerals
	Alcohol, many drugs, nicotine (if taken by mother during pregnancy)
	Some viruses such as German measles, HIV (if mother is infected)

Amniotic Sac and Fluid

Attached to the placenta is the **amniotic sac**, which surrounds and protects the embryo or fetus. It begins to form in the second week after fertilization. It soon fills with water and dissolved substances to form **amniotic fluid**. **The fluid allows the fetus to move freely until the**

fetusgrows to fill most of the available space. The fluid also cushions the fetus and helps protect it from injury.

14.3. 2. Signs of pregnancy

1) Changes a woman's normal hormone patterns,
2) One of the first signs of pregnancy is a missed menstrual period (Menstruation).
3) Other symptoms include breast tenderness
4) Swelling,
5) Fatigue,
6) Nausea or sensitivity to smells,
7) Increased frequency of urination,
8) Mood swings, and weight gain.
9) Some women also experience cravings for unusual substances such as ice, clay, or cornstarch; this condition, called pica, can indicate a dietary deficiency in iron or other nutrients. By the 12th week of pregnancy many of these symptoms have subsided, but others appear.
10) A woman's breasts usually increase in size,
11) Her nipples darken.
12) The most obvious symptom is weight gain; most physicians now recommend a gain of about 9 to 12 kg (about 22 to 26 lb) by the end of pregnancy.

14.4. Fetal development, ante-natal care, childbirth and healthy risks associated with teenage pregnancy and early childbirth.

Human development begins with conception, the fertilization of an egg by a sperm. Over the next nine months, astonishing advances in physical growth occur. The fertilized egg becomes a complex newborn capable of surviving (with assistance) outside of the womb. The prenatal months are not only a time of dramatic developmental changes, but also the most hazardous period of the life course. A developing being is the most vulnerable to harm during periods of very rapid growth. However, hazards to prenatal development can be reduced through the mother's conscientious care of herself and her developing child.

During the *fetal period,* from the ninth week until birth, major organs grow in size and complexity, the muscular and nervous systems develop, and the sex organs form. By the fourth or fifth month, mothers can begin to feel the fetus moving within them. The fetus startles in response to sudden, loud noises outside the womb, and its hiccupping can be detected. Brain development is dramatic. Nearly all nerve cells that the brain will use throughout life are formed, and brain regions become specialized in function. As birth approaches, the fetus grows significantly in size and adds protective fat stores in preparation for life outside the womb.

Childbirth

During the last month (often only some days before birth, for the second or the third birth) the child goes down into maternal pelvis. The ovary becomes more and more sensitive to the oxytocin that allows the contraction of cervix. The parturition follows three following stages. Those stages are called **labour**.

1. **Dilation of the cervix**
   - Under secretion of oxytocin
   - Contraction of uterus
   - The woman feels a slight cramp in the lumbar region and then the cramp vanishes. 10 to 30 minutes later, a new cramp comes about and it interrupts after a few seconds.
   - Contractions progressively become stronger, longer, and more frequent indicating that the uterus labour has begun.
2. **Expulsion of the baby: is characterised** :
   - Intense contractions of uterus
   - Dilatation of cervix(the neck of uterus)
   - The child is pushed through the neck
   - The release of the child out the vaginal orifice

3. **Expulsion of placenta or deliverance**

10 to 20 minutes after expulsion of the child, the placenta with umbilical cord is released outside

Fig: The three stages of labor

14.5. Steps to promote safe pregnancies and childbirth

(1) Teenagers should be educated on the dangers and risks associated with early pregnancies and childbirth. They should be able to make wise decisions that will not lead to early pregnancies.

(2) Pregnant mothers are advised
   - To attend ante-natal clinics without fail.
   - Take balanced meals

- Sleep under mosquito nets to avoid the risk of acquiring malaria
- Seek post-natal care after delivery

(3) Women and man in couple, should know their menstrual cycles
(4) A new child should be planed and discussed between partners
(5) Sexual partners should abstain during fertile periods for the wife
(6) Different contraceptive methods should be used in couple to prevent pregnancies

NB: TWINS

Fraternal twins or **dizygotic twins** are the result of two separate ova fertilized by separate sperm. This may occur when two ovarian follicles reach maturity and rupture at the same time. Fraternal twins may be of the same sex or different sexes. Even if of the same sex, however, they are as genetically different as any siblings might be.

Identical twins or **monozygotic twins** are the result of the splitting of the very early embryo before the cells start to become specialized (usually within 8 days after fertilization).
For example, if a 16-cell stage becomes separated into two groups of 8 cells each, each group will usually continue to develop in the usual way. Another possible cause is the development of two inner cell masses within the blastocyst. This, too, is before significant specialization has taken place and each inner cell mass may develop into a complete individual. Twins of this type may be called monozygotic, meaning that they have come from one fertilized egg. ***Identical twins are always of the same sex, are very much alike in appearance, and in other aspects are genetically identical.***