Science & TECH Notes BY MR. Kimatu

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NATIONAL GOALS OF EDUCATION

Education in Kenya should:

1. Foster nationalism and patriotism and promote national unity.

Kenya is a country with a lot of people who belong to different communities, races, and religions, but these differences need not to divide them.

Education should help young people acquire this sense of national hood by removing conflicts and promoting positive attitudes of mutual respect which enables them to live together in harmony and foster patriotism.

2. Promote the social, economic, technological and industrial needs for national development.

Education in Kenya should prepare the youth of the country to play an effective and productive role in life of the nation.

a) Social Needs

Education must prepare children for changes in attitudes and relationships which are necessary for smooth progress of a

rapid developing modern economy. Thus education should assist our youth to adapt to this change.

b) Economic Needs

Education in Kenya should produce citizens with skills, knowledge, expertise and personal qualities that are required to support a growing economy.

c) Technological and Industrial Needs

Education in Kenya should provide learners with necessary skills and attitudes for industrial development.

3. Promote individual development and self-fulfilment.

Education should provide opportunities for the fullest development of individual talents and personality. It should help children to develop their potential interest and abilities. A vital aspect of individual development is the building of character.

4. Promote sound moral and religious values.

Education should provide for the development of knowledge, skill and attitudes that will enhance the acquisition of sound moral values and help children to grow up into self-disciplined, self reliant and integrated citizens.

5. Promote social equality and responsibility.

Education should promote social equality and foster a sense of social responsibility within an education system which provides equal educational opportunities for all.

6. Promote respect for and development of Kenya's rich and varied cultures.

Education should instill in the youth of Kenya an understanding of past and present cultures and their valid place in contemporary society.

7. Promote International consciousness and foster positive attitudes towards other nations.

Kenya is part of the international community. Education should lead the youths of the country to accept membership of this international community with all the obligations and responsibilities, rights and benefits that this membership entails.

8**. Promote positive attitudes towards good health and environmental protection**.

Education should inculcate in young people the value of good health in order for them to avoid indulging in activities that will lead to physical or mental ill health. Thus education should foster positive attitudes towards environmental development and conservation

LEVEL LEARNING OUTCOMES

By the end of the course the teacher trainee should be able to:

1. Model appropriate behavior and values for primary school learners to emulate for development of good citizenship.
2. Communicate and collaborate effectively with learners, peers, parents and the community to create a conducive learning environment.
3. Use appropriate pedagogical approaches to facilitate learning for primary school learners in and out of the classroom.
4. Apply inclusive practices to support all primary school learners including those with disabilities and special educational needs.
5. Employ ICT skills in the learning process to enhance digital literacy.
6. Employ appropriate assessment approaches to promote effective learning.
7. Identify and nurture learner's potential and talents for appropriate placement and transition into lower secondary school.
8. Develop environment conservation skills in primary school learners to promote education for suitable development.

9. Create innovative and effective solutions to challenges in the learning process.
10. Integrate pertinent and contemporary issues in learning to enable learners to cope with daily challenges.

ESSENCE STATEMENT

Science and Technology is a learning area which engages int the human pursuit to understand the relationship between the leaving and non-leaving universe. Science is a discipline that deals with explanations and predictions about nature and the universe while technology is a purposeful human activity that expands the dimensions of human possibilities. It is fundamental to understanding, representing and interacting with our physical and social worlds.

The achievement of vision 2030 greatly depends on science, technology and innovation, sessional Paper No. 1 of 2005 highlights the fact that for a breakthrough towards industrialization, achievements of the desired economic growth targets and social development, a high priority needs to be placed on the development of human capital through education and training by promoting the teaching of science and technology. Sessional paper 1 of 2019 equally stresses the need for sustainable basic and higher education, with an emphasis on science, technology and innovation. This makes it necessary for science and technology to be taught in primary education level

hence the need for training diploma primary teacher education (DPTE)

The study of science and technology at diploma level aims at equipping the teacher with the knowledge, attitudes and skillsnecessary for teaching environmental activities, science and technology in primary school. The course also enables the teacher to participate in conserving the environment for sustainable development. This course is linked to other learning areas such as home science, agriculture, physical and health education and social studies.

The suggested methods of instruction include: Inquiry Based Learning (IBL), Project Based Learning (PBL), Problem Based Learning (PBL) and Pedagogical Content Knowledge (PCK) (shulman,1986-87). These modes of instruction are anchored on John Dewey's social constructivist theory, which emphasizes learning through hands on activities and Vygotskian social cultural theory (Vygotsky 1986), which regards teacher knowledge as both dynamic and situated.

GENERAL LEARNING OUTCOMES

By the end of the course, the teacher trainee should be able to:
1 use appropriate pedagogical and professional competences to facilitate learning of science and technology.

2 develop environmental conservation skills and attitudes to promote education for sustainable development.

3 apply problem solving and critical thinking skills acquired from scientific and technological knowledge in life.

4 apply digital literacy skills to ease comprehension of concepts of science and technology.

5 select, develop and utilize appropriate instructional resources in learning.

6 integrate pertinent and contemporary issues to address personal, community and environmental challenges.

7 appreciate the importance of science and technology as a foundation for career formation and further education and training.

COURSE OUTLINE

1.0. PHYLOSOPHY OF SCIENCE

1.1. Nature of Science

2.0. DIGITAL TECHNOLOGY

2.1. Digital devices

3.0. LIVING THINGS

3.1. Classification of Living Things

PHYLOSOPHY OF SCIENCE

Introduction

Philosophy is derived from a Greek word *philosophia* meaning 'love of knowledge', the rational and critical inquiry into basic principles. In ancient Greece, the Greek philosophers described philosophy as the 'pursuit of knowledge for its own sake'.

Through philosophy, forms and fields of knowledge can be analyzed in many ways, but in partially overlapping categories. Philosophy of science refers to the analysis of scientific knowledge empirically, based on experimental experience

The Philosophy of science focuses on certain fundamental questions like:

- What is science?
- What is the nature of science?
- How do scientists or people construct personal knowledge from experience?

In a teaching-learning situation, the philosophy of science explores issues on a learner's perceptions about specific concepts, methods skills acquired in science for instance, the concept of traditional beliefs about weather discussion and observation.

Definition of science

There are many definitions of science because people perceive science differently. The following are some common definitions of science.

- Science is a branch of study that is concerned with intellectual and practical activity encompassing the systematic study of the structure and behavior of physical and natural through observation and experiment.*(The concise Oxford English dictionary)*
- Science is an interconnected series of concepts and conceptual schemes that have developed as a result of experimentation and observation and are fruitful experimentation and observation. *(J B Conant)*
- Science is a body of classified, organized and systemized knowledge
- Science is a discipline that deals with explanations and predictions about the nature and the universe

- Science is the study of nature and behavior of natural things and the knowledge we obtain about them.

However a more encompassing, accurate and manageable definition of science may be given as
'Science is a search for knowledge through experimentation; a search for knowing and understanding; a question of all aspects of the environment; the collection and analysis of data and the interpretation of their significance.'

NB: The approach used to teach science is usually a reflection of one's accepted perception of the same. This is because science is advancing at such a rapid rate that by the time you define an aspect of it, it has moved one and is no longer what it once was. The best way, therefore, is not to look for a dictionary definition but to understand the approaches of science.

NATURE OF SCIENCE

Nature of science (NOS) refers to approaches or views of teaching science.

There are two views; the static view and the dynamic view.

It is a critical component of scientific literacy that enhances students' understandings of science concepts and enables them to make informed decisions about scientifically-based personal and societal issues.

Characteristics of the nature of science

Science education has defined tenets (characteristics) of the nature of science that are understandable by students and important for all citizens to know. Some researchers have refined this list to the following five tenets:

- Scientific knowledge is tentative (subject to change).
- Science is empirically based (based on or derived from observation of the natural world).
- Science is inferential, imaginative and creative.
- Science is subjective and theory laden.
- Science is socially and culturally embedded.

THE STATIC VIEW

The static view perceives science as a way of explaining the universe in which we live. It shows that we are already knowledgeable and the world can still benefit from what has been accumulated over the years and passed on from generation to generation. Therefore, there is no need for further research and we can do science without our laboratories.

Implications of the static view on teaching and learning processes

This view assumes that the teacher has all the knowledge to impart to the learner. The learner is seen as an empty slate, *tabula rasa,* to which the teacher must transfer knowledge. The learner becomes a passive recipient and has no room to question the teacher.

To the learner, therefore, science becomes a group of facts that are best learnt by memorization.

The ‘jug-mug’ type of teacher learner relationship. The teacher is the ‘jug’ with the content (the subject matter) to pour into the empty ‘mug’, the learner.

Strengths of the static view

1. It is a cheaper way of teaching since it requires fewer resources.
2. It has a wider coverage of content areas.
3. Class control is easy because the teacher is the authority.
4. It is also appropriate when the teacher is handling larger classes.

Weaknesses of the static view

1. It is teacher-centered as opposed to the learner-centered strategy. The learners are not motivated and thus lack enthusiasm. It is therefore boring.
2. It is limited because it is major assumption that knowledge us static is not true. Knowledge is constantly changing, growing and continually being revised. A lot of scientific research is going on to find answers and solutions to many problems in the world.
3. Learners are not involved in practical activities. As a result, they do not acquire scientific skills.

THE DYNAMIC VIEW

The dynamic view sees science as an activity with the present knowledge being seen as the building blocks onto which further operations can be laid on. Science therefore needs laboratories for further investigations and re-examination of new propositions.

Implications of the dynamic view on teaching and learning processes

This approach advocates for the learner-centered strategies. In the teaching of science, the learner is the focal point of learning as teaching is based on the nature of learners, stages of development and interest. The role of the teacher is to provide a conducive environment which enhances learner's participation and perception of the ideas or concepts being studied.

Strengths of the dynamic view.

1. The learners are active participants since it is learner-centered.
2. There is development and acquisition of many science skills.
3. Nearly all scientific attitudes are enhanced.
4. It caters for individual differences because the learners advance at their own pace thus providing room for scientific discovery.
5. There is room for a variety of activities and creativity, making learning more interesting and motivating.

6. It enhances the use of teaching and learning aids hence it encourages improvisation,
7. It enhances high retention of scientific knowledge since it is activity-based.

Weaknesses of the dynamic view

1. It consumes a lot of time and may lead to poor coverage of the syllabus
2. It can be expensive if all the materials are to be bought
3. It places a very heavy task on the teacher's shoulders in terms of looking for the learning materials.
4. It is difficult to use when handling large classes.

Scientific skills and attitudes

A scientist uses an orderly approach of scientific methods to learn new information that may enable him or her to solve problems.

Science topics in the syllabus are generally used as a means of learning and developing certain **scientific skills and attitudes.**

A skill is the ability to do something well. On the other hand, an attitude is a pattern of thought, feeling or way of regarding things, objects, situations or persons.

The primary objective of teaching science is to assist the learners to acquire competence in desired skills. Emphasis is on what a scientist does to understand science as opposed to focusing on content as accumulated by scientists.

Scientific skills

Skills that are used in the process of carrying out scientific experiments or investigations are referred to as **scientific skills.** They include **science process skills and manipulative skills.**

Science process skills are intellectual operations that are used by a scientific/learner to solve problems during scientific investigations.

Manipulative skills are psychomotor skills that enable the learners to use and carefully handle Science apparatus, materials, substances and specimens correctly and carefully, drawing specimens and apparatus, cleaning science apparatus and storage, all fall under manipulative skills.

The following are the scientific skills:

I. Observation
II. Recording
III. Asking questions
IV. Sorting and classifying
V. Formulating hypothesis
VI. Drawing conclusions
VII. Controlling variables
VIII. Measuring
IX. Communicating
X. Counting
XI. Predicting

xii. Experimenting
xiii. Inferring
xiv. Manipulating

Observation

To observation is to explore or study an object or a substance closely while taking note of its properties. The properties may be its colour, odours, taste, texture, volume, weight or shape. Objects in any environment may be observed using any of the five senses; sight, smell, taste, touch or hearing.

The ability to observe is the most basic skill in science and is essential to the development of other science process skills such as inferring, predicting, measuring, communicating and classifying.

A science teacher should help the learners develop the skill of observation to enable them to use their senses to gather relevant information during their investigation. The learner should be able to make as many observations as possible.

In observation, the teacher should ensure that the learners:

- Pay attention to both detail and features.
- Focus on similarities and differences for classification
- Interpret the observation based on evidence. For example, types of soil is a concept that may be used to enhance the development of observation skill in learners.

Problem-solving process

The problem solving process refers to the application of existing knowledge and understanding to a new situation with the aim of coming up with possible solutions.

The process of scientific problem solving is continuous chain of the following steps:

1.Problem Identification

It is the initial stage of the problem solving process and arises from a point of observation such as *“Lack of school fees contributing a lot to mass school dropout.”*

2.Asking questions

A scientist asks specific questions that are based on his/her observation. In this way, the scientist learns a lot from responses. The scientist may ask, *“Does lack of school fees contribute to mass school dropout?”*

3.Formulating a hypothesis

It is an intelligent guess that tries to explain an observation. Therefore, it is a mere suggestion meant to give direction of investigation. Hypothesis forms the framework for the findings, conclusion and solutions. For example, *“Lack of school fees contributes to mass school dropout”*

4.Experimenting

It is a test that is performed under controlled conditions and data is collected. The experiment is aimed at determining whether a formulated hypothesis is true or false. It therefore has variables that can change or be changed.

5.Data collection

At this stage, data is collected and recorded as observed. The results are also organized at this stage. Data may be tabulated in preparation of analysis as in the example below.

6.Data interpretation

After data has been recorded, organized and processed, it is interpreted. Data interpretation involves finding possible trends in the result. An explanation could also be given.

7.Data interpretation

This step involves the use of mathematical concepts such as pie charts, graphs and formulae.

8.Drawing conclusion

A summary of the results of the experiment is made at this stage. The conclusion either proves or disapproves the hypothesis.

Importance of the problem solving process.

Problem solving process is advocated for in science because:

i) It encourages acquisition of thinking skills ii) It is a more effective way of learning because learners are active and motivated.

iii) Learners make sense of their knowledge and experiences and construct meaning out of them

iv) By encountering problems, learners are challenged to find possible solutions. v) Learners develop different skills or processes.

vi) Learners develop ideas and make sense of the world around them.

vii) It inspires learners to investigate viii) It leads to valid results which can be verified by other scientists.

Practical approach to solving problems

One of the major roles of science is to solve problems in a scientific way so that the result can be relied upon. In order to solve these problems, a practical approach has to be sought.

The teacher must inspire the learners to find answers to their questions through their own accurate observations and experiments. The results can be generalized. The role of the teacher is to effectively direct the learning process and spell out the direction to take to enable the learners to arrive at possible answers. The teacher must make the problems real

and give the learners time to make plans to solve them. At times, learners may make errors. However, the teacher's role is to encourage them to do corrections.

LIVING THINGS

CLASSIFICATION OF LIVING THINGS

In the past, living organisms used to be classified into two kingdoms; Plant kingdom (plantae) and animal kingdom (Animalia). The plant kingdom consisted of all organisims that make their own food from simple inorganic materials i.e autotrophs, while the animal kingdom consisted of organisims that feed on other organisims i.e heterotrophs.

It was then realized that a few organisims do not fit well in the two kingdoms because of certain characteristics e.g bacteria which have both plant-like and animal-like characteristics.

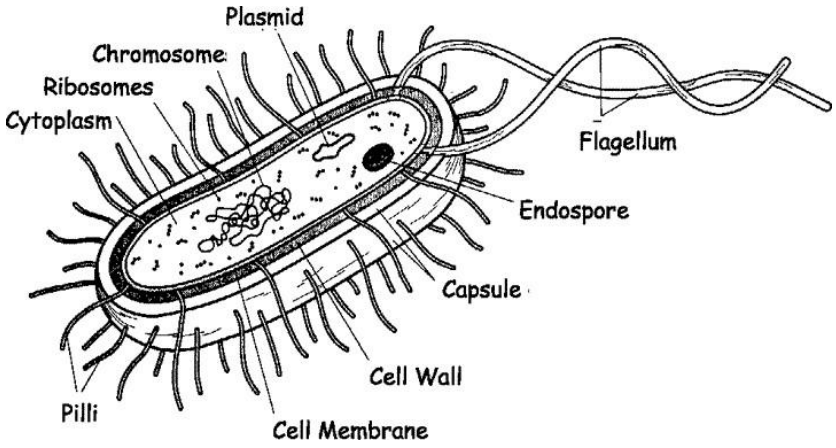
In 1982, a different form of classification in which organisims were grouped into **five** kingdoms;

1. Kingdom monera
2. Kingdom protoctista (prototisa)
3. Kingdom fungi
4. Kingdom plantae
5. Kingdom Animalia

General characteristics of the five kingdoms

1.Kingdom monera

- Single celled (unicellular) animals.
- Lack nuclear membrane (prokaryotes)



2.Kingdom protoctista (protisa)

- Simple organisms, some unicellular such as amoebae, other multi-cellular such as algal seaweeds.
- They have nucleus enclosed by a nuclear membrane (eukaryotes)
- There are two groups of Protista: the algae, which are simple plant like organisims e.g chlamydomonas, and the protozoa which are single celled and animal like e.g amoebae.

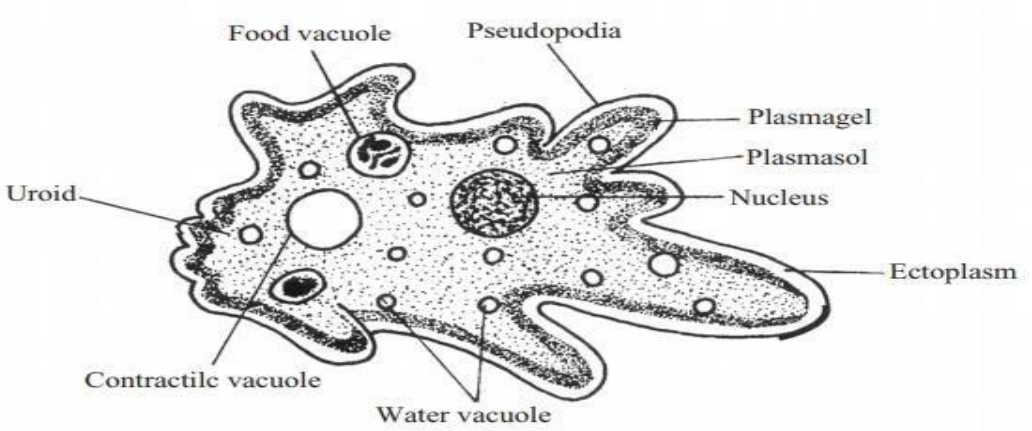
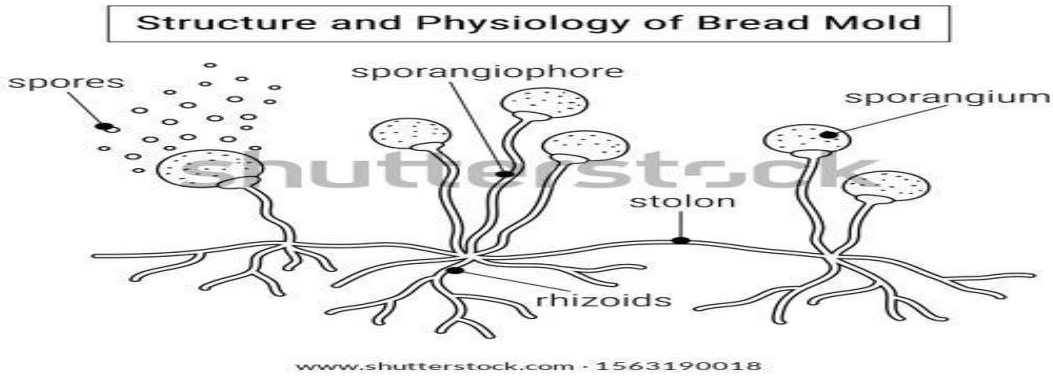


Fig. Structure of Amoeba scen under microscope

Fig: 8.1

3.Kingdom fungi

- These are plant like organisms but with no chlorophyll.
- The plant like body is made of thread-like structures called hyphae. They are found on decaying matter such as fruits and bread.
- The cells have nuclei. Examples are bread mould (Rhizopus), yeast and mushrooms.



4.Kingdom plantae

It is composed of multicellular green plants. Most of the plants contain a green pigment, chlorophyll, which traps sunlight. They manufacture their own food using sunlight as a source of energy.

The cells of the plant are enclosed by cellulose cell-wall. The kingdom plantae has a number of divisions or phyla;
Bryophyta (mosses and liverworts),
Filicinophyta/Pteridophyta (Ferns),
Spermatophyta, Gymnospermae/ Coniferophyta (conifers),

Angiospermae (flowering plants)

CLASSIFICATION OF PLANTS

Classification is the arrangement or grouping of animals based on their similarities and relationships.

Plants are classified into green and non-green plants.

Green plants are divided into two major groupings **non-flowering and flowering plants.**

Flowering plants are further classified into **monocotyledons and dicotyledons.**

Non-flowering plants.

Non-flowering plants do not produce flowers. However, they contain chlorophyll and are therefore able to make their own food during photosynthesis. They include the algae, mosses, liverworts and ferns. **Algae**

Algae are simple microscopic green plants. They have the following features:

i) They have chlorophyll
ii)They have no true stems, roots or leaves. iii)They grow mostly in water, for example sea weeds.

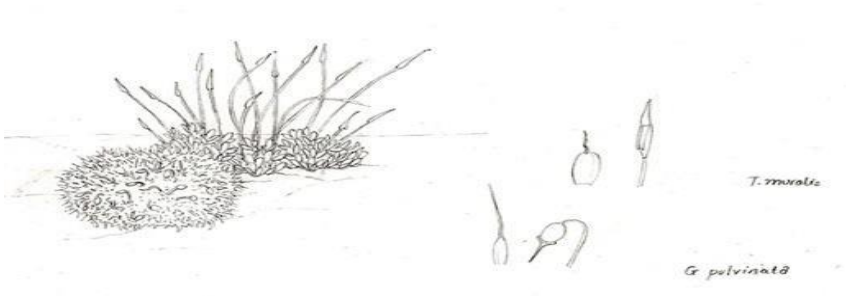
Mosses

These are simple green plants, but unlike algae, they have simple leaves and stems.

The following are the features of mosses:

i)They have chlorophyll.

i) They grow mostly on damp places, tree trunks and near water or stones.
ii) They reproduce by means of spores.
iii) They have rhizoids which serve as roots.



Ferns

These are complex non-flowering plants. The following are features of ferns;

i) They have true roots, stems and leaves.
ii) They reproduce by means of spores, which are found under their leaves. These spores are contained in fronds.

Liverworts

Liverworts are closely related to mosses. Most liverworts grow either in fresh water or damp places. They have leaf-like shape and grow flat on the ground.

Flowering plants.

Flowering plants produce flowers which become fruits and seeds. New plants grow from the seeds. They may also grow from vegetative parts of their mother plant. A flowering plant has roots, a stem and flowers.

Classification of flowering plants

Note that flowering plants are divided into monocotyledons and dicotyledons.

Monocotyledons

Maize, grasses, sugarcane and lilies are examples of monocotyledons. They have following characteristics:

i. They have one cotyledon in their seed.
ii. They have narrow long leaves.
iii. Their veins run parallel to the leaf margin.

iv. Most monocotyledons are herbaceous, that is, they are non-woody.

v. They have many small fibrous roots.

vi. Their flowers have three or six petals.

vii. Their cotyledons remain in the soil after seed germination

Dicotyledons

Sunflowers, beans and potatoes are examples of dicotyledons. They have the following characteristics:

i) They have two cotyledons in the embryo of the seed.
ii) They have broad leaves iii)Their veins are arranged in a network fashion.
iv) Have a central taproot with smaller roots branching from it
v) Their cotyledons come above the soil surface after seed germination.

KINGDOM ANIMALIA

- All multicellular animals belong to the kingdom Animalia.
- Animals do not make their own food but feed on other animals or plants, and are therefore known as heterotrophs. Their cells lack cellulose cell walls but are covered by cell membranes. **General characteristics of the main groups of animals**

Animals are placed in two large groups:

i. Invertebrates
ii. Vertebrates

VERTEBRATES

These are animals with backbones. There are five main classes of vertebrates.

i. Fish
ii. Reptiles
iii. Amphibians iv. Birds
v. Mammals

Fish

Fish are aquatic in nature. They have streamlined bodies which are covered with scales.

There are many different types of fish. The following are common characteristics of fish.

i) They are all aquatic animals

ii)They breathe by means of gills

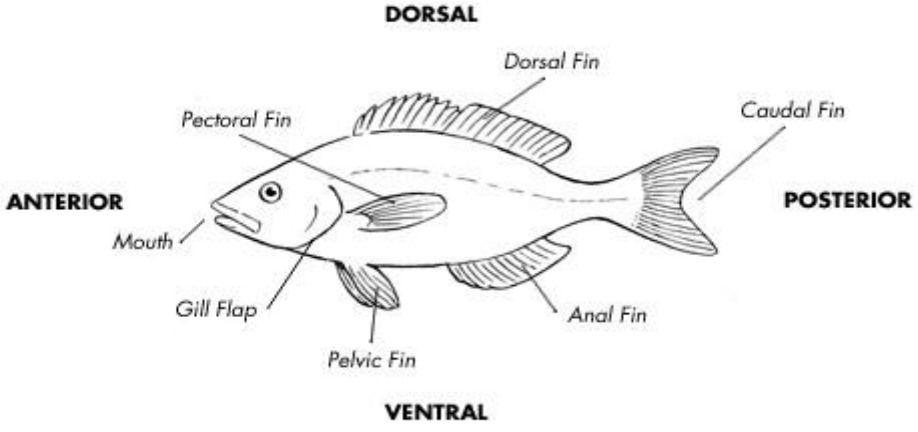
iii)The body is covered with scales

iv)They lay eggs which are fertilized outside the body (external fertilization)

v)They have fins and tails for movement

vi)They have a lateral line which runs along the body to detect movement and vibrations in water.

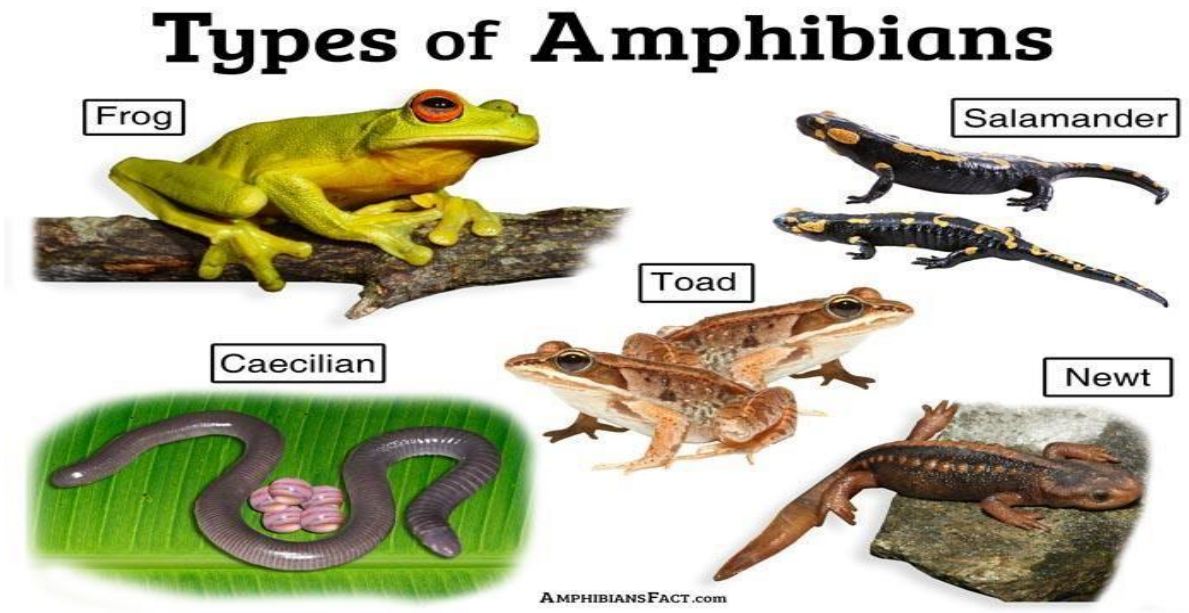
vii)Their body temperature changes with the surrounding environment (cold blooded)



AMPHIBIANS

Amphibians are cold blooded vertebrates. They live both in water and on land. However, they are not usually found in salty water. All adult amphibians share the following main characteristics:

1. They have moist skin.
2. They live both in water and on land
3. They lay eggs in water which are fertilized externally.
4. They have gills for breathing when they are young and lungs when they are adults.
5. They do not have scales on their body.



REPTILES

Reptiles are cold blooded (poikilothermic) in nature.

Majority of them are egg-layling (oviparous).

Their main characteristics are:

1. Their bodies are covered with dry scales. However, some like tortoises have shells.

2. They use lungs for breathing.

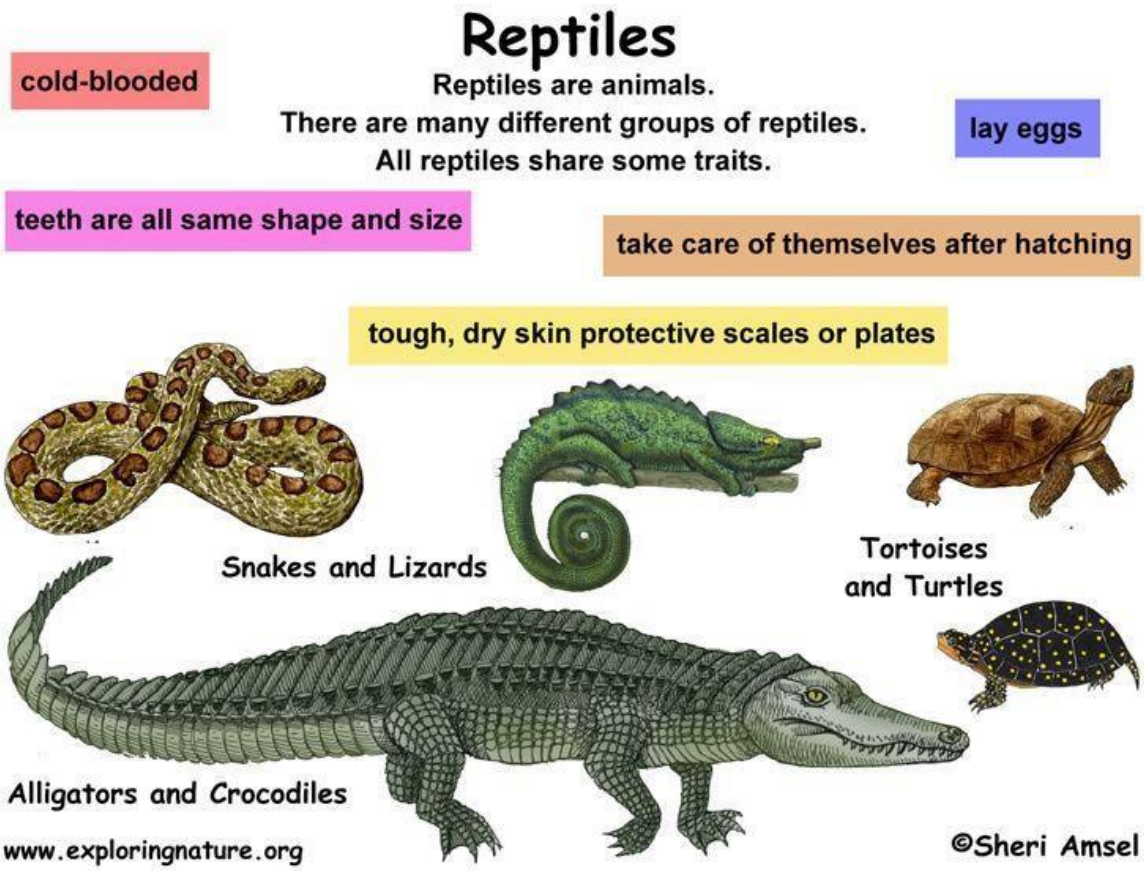
3. They are cold blooded.

4. Most reptiles have four short limbs except snakes.

5. They reproduce by laying eggs which are internally fertilized.

6. A few reptiles however give birth to live young ones.

7. They live mainly on land, although some can live in water.



BIRDS

Birds are endothermic vertebrates. Endothermic means warm-blooded. Birds are the only feathered animals. Some of their main characteristics are:

1. They have two pairs of limbs. The forelimbs are adapted fro flying while the hindlimbs are for walking.
2. Most birds can fly. A few are flightless.
3. They are warm blooded.
4. Their bodies are covered with feathers.

5. They have beaks and no teeth.
6. They lay eggs which are covered in a hard shell.
7. Most birds build nests in which they lay their eggs and raise their young ones.

MAMMALS

This is the group of warm blooded vertebrate to which human being belong. Mammals are most developed of all animals because they have complex brains.

Most mammals are land animals. Their main characteristics are:

1. They have fur or hair on their bodies.
2. They have mammary glands and feed their young ones on milk.
3. They are warm-blooded meaning that their body temperatures do not change depending on the surrounding.
4. They have two pairs of limbs.
5. They use lungs for breathing.
6. They have large complex brains.
7. They have teeth of different types.
8. Their heart and lungs are separated from the abdomen by the diaphragm.
9. All mammals give birth to live young ones apart from the duck-billed platypus and spiny anteater which lay eggs.
10. Mammals have internal fertilization.

There are different subgroups-

Hoofed mammals, carnivorous mammals, rodents. Insect eating mammals, flying mammals, marsupials, egg laying mammals, sea mammals and primates.

INVERTEBRATES

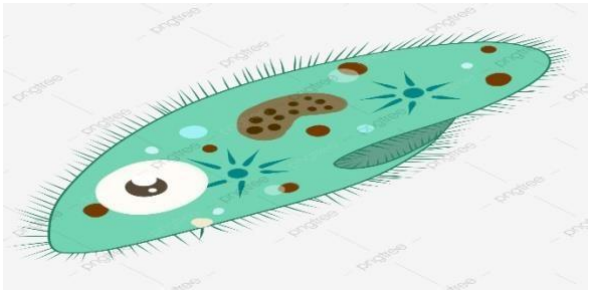
These are animals which do not have backbones. Worms, snails, spiders and butterflies are examples of invertebrates. Invertebrates are further subdivided into smaller groups:

i)Protozoa
ii)Metazoa

Protozoa

Single celled animals, that is, they are animals made up of only one cell. Some are so tiny that they can only be seen with the help of a microscope. Examples are amoeba, paramecium, plasmodium and euglena.

1 Euglena



2 Paramecium

They can be found in fresh water, the sea and damp soils, as well as in the blood of animals and humans. Each animal or cell can get food from other microscopic organs, digest food, reproduce through cell division, move from place to place and excrete waste products.

Metazoa

Invertebrates with more than one cell in their structure.

They can be divided into eight main groups; i) Porifera ii) Coelenterates iii) Echinoderms iv) Molluscs v) Annelids

vi) Nematodes

vii) Platyhelminthes (flatworms)

viii)Arthropods

Molluscs

Soft bodied, unsegmented animals, they can live in the sea, in fresh water or on land. Some have shells while others do not. Molluscs with one shell are called univalves for example the snail, those with two cells are called bivalves like the oyster. Other examples are cuttlefish, squids and octopuses.

Arthropods

Arthropod means jointed limbs. They are the largest species within the animal kingdom and have the following characteristics:

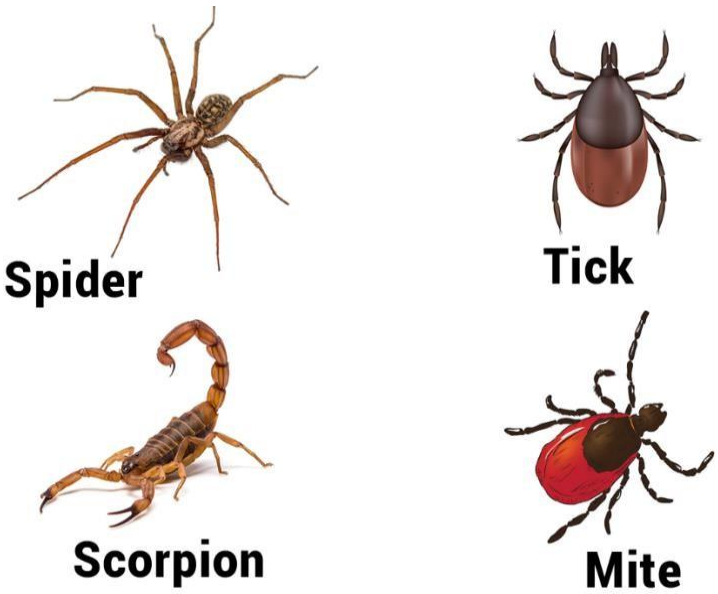
1. Segmented bodies
2. Chitinous exoskeleton or cuticle that covers the entire body. The cuticle can be thin and flexible, as in insect larvae but is usually thick and rigid.

3. Athropods move by jointed appendeges with each joint bearing a pair.
4. Periodic shedding of the exoskeleton. This process is called moulting or ecdysis which allows growth to take place. The stages between moults are known as instars and the length of instars becomes longer as the animals become older.
5. Vascular system is composed of a heart, vessels and haemocoel.
6. Possess two types excretory organs: malphigian tubules and saccules.
7. Well developed sensory organs. Most have eyes, some with simple eyes others compound eyes.
8. Fertilization is always internal in land arthropods but may be external in water (aquatic forms)

There are four classes of arthropods;

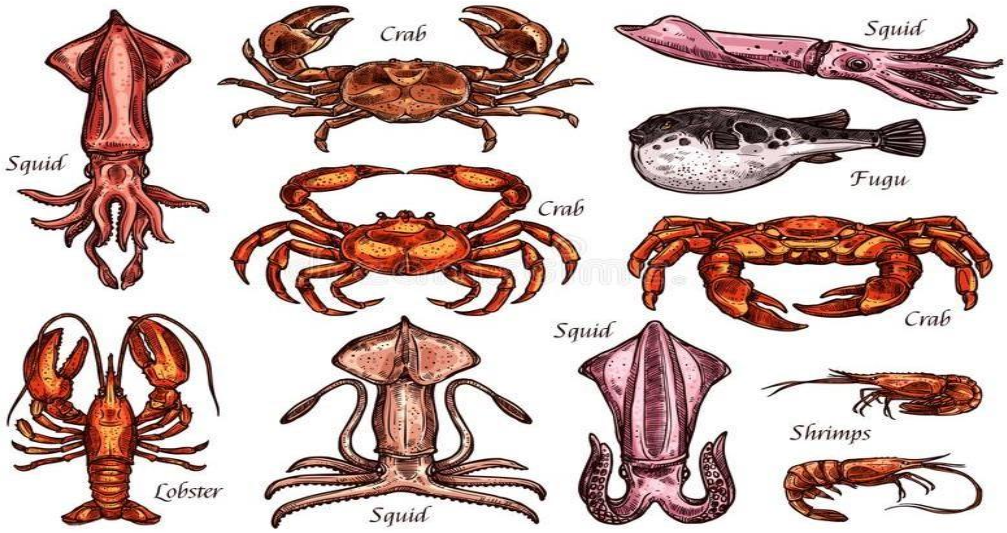
i) **Arachnida**

Examples are scorpions, spiders, mites and ticks.



ii) **Crustacea**

Examples are crayfish, shrimps, lobster and crabs.

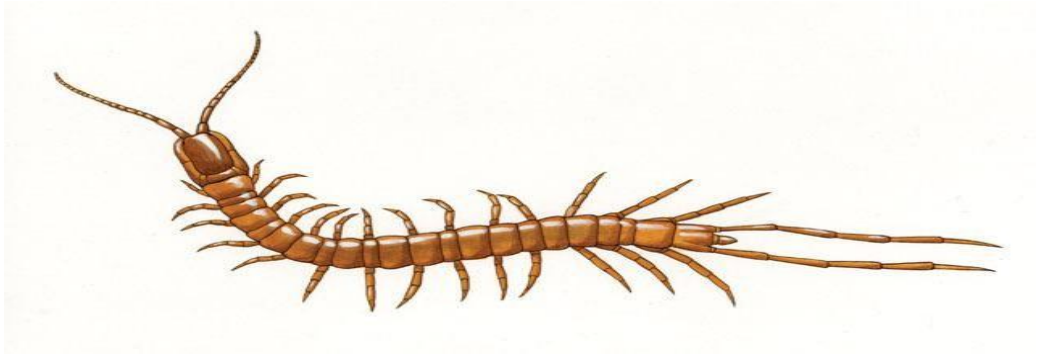


iii) Diplopoda

Includes millipedes.

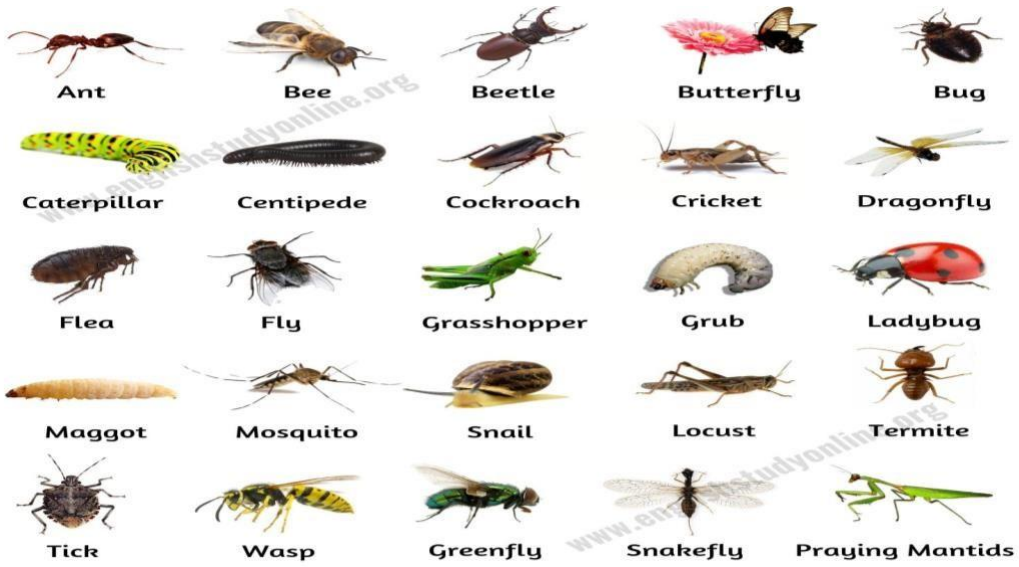
iv) Chilopoda

Includes centipedes.



v) Insecta

Examples are mosquitoes and butterflies.



THE CELL

The cell is the basic structural and functional unit of an organisim. Multicellular organisims are made of numerous cells.

Cells carry out processes that make an organisim live, for example, respiration to produce energy.

All cells have a basic structure and some become modified to carry out specific functions in the body.

Cells are composed of three main parts:

i) **The cytoplasm**

This is a medium containing chemicals and complex structures referred to as **organells.** There are small granules that store food for activities of the cell.

ii) **The nucleus**

A body that controls all the activities that take place in the cell. The information is contained in a substance known as **Deoxyribonucleic acid (DNA)** found in thread-like structures called chromosomes.

iii)**The cell membrane**

Encloses the cell, allows some substances to pass through it while preventing others from doing so

(selectively permeable). It allows oxygen and food to enter the cell, but does not allow poisonous substances

CELL STRUCTURE

DIFFERENCES BETWEEN PLANT AND ANIMAL CELLS

ANIMAL CELL	**PLANT CELL**
1.Surrounded by a cell membrane	A cell wall covers the cell membrane
2.Nucleus located at the center of the cell	Nucleus found on the periphery
3.Lacks chloroplasts	Chloroplasts present
4.Vacuoles, if present are small, temporary and scattered in the cytoplasm	One large central vacuole present.
5.Animal cells have variety of shapes	Definite shape
6.Food stored in the cell is mainly in form of glycogen and fats	Food stored mainly in form of oils and starch

7.Animal cells are small in size	Plant cells are large in size
8.Lack plasmodesmata	Has plasmodesmata

CELLULAR COMPONENTS

i) Cell membrane

- This very thin layer is made of protein and lipid encloses the cell components.
- It has pores to allow movement of substances in and out of the cell.
- It is described as semi permeable, that is, allows some substances to pass through it but not others.

ii) Cytoplasm

- Cytoplasm is a clear jelly substance, containing 70% water with many substances dissolved and suspended in it,
- Some of the substances dissolved in it include sugars, enzymes, and mineral salts.
- The organelles include mitochondria, golgi bodies, endoplasmic reticulum and chloroplasts.
- The cytoplasm is a fluid medium in which chemical reactions take place.

- Some of the substances suspended in it include cell organells and cell inclusions, such as starch grains, glycogen granules and oil/fat droplets.

iii)Endoplasmic reticulum (ER)

- This is a system of membrane – bound cavities that run through the cytoplasm.
- There are two types; rough endoplasmic reticulum and smooth endoplasmic reticulum.
- The rough ER has ribosomes on its surface while the smooth ER has smooth services,
  i.e. surfaces devoid of ribosomes
- Ribosomes are the center for the manufacture of proteins
- Smooth ER is mainly for transport of proteins and lipids

iv) Golgi bodies

- These are tubular or sac-like structures or organelles found near the cell membrane and are closely associated with secretory vesicles. They secrete various substances such as enzymes, mucus and waxes which may be transported out of the cell.

v) Mitochondria

- These are rod shaped or sausage shaped organelles that are sites of respiratory reactions. For this reason they are referred to as power houses of the cell
- They are covered with two membranes; an outer membrane and an inner highly folded membrane.
- The folds, referred to as cristae increase the surface area for attachment of the respiratory enzymes thus increasing the rate of respiration.
- Energy produced is stored in form of a chemical compound, adenosine triphosphate (ATP) which breaks down easily to release energy.

vi) Lysosomes

- Spherical organelles that contain digestive enzymes
- They digest old worn out organelles and destroy foreign particles.
- Products of digestion are absorbed in the cell cytoplasm
- Capable of destroying a whole cell if their membrane is accidentally punctured hence their name ‘suicide bags’

vii) Cell vacuoles

- Very small and almost invisible in animal cells
- In plant cells, they occupy most of the space inside the cell

- Bound by single membrane called tonoplast. They contain cell sap which is a mixture of salt and sugar
- In plant cells, they store pigments in certain parts of the plants for example petals
- They also store waste products produced by the cell
- In unicellular organisims e.g. amoeba are of two types; contractile vacuole and food vacuole. Contractile vacuole maintains the water content of the cell while the food vacuole is used for digestion

viii) Chloroplasts

- Colored bodies containing a green pigment known as chlorophyll
- They are only found in plant cells
- Their function is to absorb light energy to make food in the plant (photosynthesis)

CELL PHYSIOLOGY

Cells need food materials, water and mineral salts for life's processes. They also need to release waste products such as carbon (ii) oxide.

The materials or substances enter or leave the cell through the cell membrane

Control of movement of substances across the cell membrane or cell wall is therefore one of the important functions carried out by the cell.

The study of such functions in relation to the cell structure is referred to as **cell physiology**

CELL MEMBRANE

The cell membrane separates the cell from immediate environment and controls substances that enter or leave the cell.

It is made up of three layers; two lipid layers and a protein layer between them (lipoprotein)

The membrane is not continuous; there are pores that form tiny channels connecting the inside and outside of the cells.

PHYSIOLOGICAL PROCESSES

Movement in and out of the cells the cell membrane occurs by three main processes;

1. Diffusion
2. Osmosis
3. Active transport

Diffusion

Movement of molecules or ions from a region of comparatively high concentration to a region of low concentration

Movement occurs in the direction of decreasing concentration; therefore a concentration gradient exists in the direction of movement.

Diffusion continues until the ions or molecules are uniformly distributed throughout the medium, that is an equilibrium is reached.

Diffusion continues until the ions or molecules are uniformly distributed throughout the medium, that is, an equilibrium is reached.

Diffusion can be demonstrated using a crystal of potassium permanganate or copper sulphate introduced into a half-full beaker of water using a glass tubing

The crystal dissolves and gradually the color spreads throughout the water

a)Importance of diffusion

- Carbon (ii) oxide required by plants for photosynthesis diffuses from the air into the leaves through the stomata. Carbon (ii) oxide concentration is low inside the leaves where it is constantly being used up, and higher in the surrounding air.
- Gaseous exchange in animals takes place by diffusion. Oxygen at a higher concentration in the surrounding air and low in the tissues. It therefore diffuses across the gaseous exchange surfaces into the blood. Carbon (ii) oxide moves by diffusion in the opposite direction
- Food is absorbed in the small intestine into the blood by diffusion
- Some mineral ions or salts are absorbed by plants' roots

b)Factors affecting rate of diffusion

i). Temperature

High temperatures increase kinetic energy of molecules, thereby increasing the rate of diffusion. This is why crystals dissolve faster in water when solution is warmed.

ii).s Size of diffusing particles

Small particles diffuse faster than large particles

iii) Concentration gradient

The rate of diffusion is dependent of the maintenance of a concentration gradient between one region and another. The greater difference in concentration the faster the rate of diffusion.

iv) Surface area to volume ratio

The higher the surface area to volume ratio of a body the higher the rate of diffusion in and out of it. A single celled animal like amoeba has a larger surface area to volume ratio than an earthworm, therefore the rate of diffusion across the amoeba's cell membrane is very high

OSMOSIS

Defined as movement of water molecules from region where they are in high concentration to a region of lower concentration through a semi-permeable membrane.

Osmosis is demonstrated using water and sucrose solution separated by a membrane that is similar in property to cell membrane

- The water molecules are very small, hence sugar molecules in the tubing are several times bigger
- The visking tubing has holes that represent the pores of semi permeable membrane
- The holes in the visking tubing are large enough to allow water molecules to pass through but not sugar molecules
- The movement of water molecules occurs along a concentration gradient.
- The water molecules are more concentrated in the beaker than in the visking tube

Due to higher concentration of water molecules on one side of the membrane, the net movement of water into the sucrose solution will continue until an equilibrium is attained. The tendancy of water molecules to move from one place to another is measured by **water potential,** thus the water molecules move by osmosis from a region of higher water potential to a region of lower potential. Water potential is the pressure difference between pure water and a solution with water as a solvent.

If a concentrated sugar solution is separated from a dilute solution by a partially permeable membrane, water will move by osmosis from dilute solution by a partially permeable membrane, water will move by osmosis from a dilute solution, which has a higher water potential to the concentrated solution.

The pressure developed by a solution when permitted to take up water by osmosis is referred to as **osmotic pressure.** It is also defined as the tendancy of water to move into a solution by

osmosis through semi-permeable membrane. When a cell is surrounded by pure water or a dilute sugar solution by osmosis.

The osmotic pressure outside the cell is therefore lower than that inside the cell. The solution is therefore said to be **hypotonic** to the cell contents. If the cell is surrounded by a concentrated solution whose osmotic pressure is higher than the cell contents, water molecules would move out of the cell to the surroundings by osmosis. The solution is then said to be **hypertonic** to the cell contents.

When the concentration inside the cell is same as that of the solution outside the cell, the external solution is said to be **isotonic** to the cell. There is therefore no net flow of water in any direction.

Osmosis and Living cells

Animal cells such as blood cells are surrounded by cell membrane (plasma membrane), which is semi-permeable. Plant cells have additional cellulose cell wall surrounding the cell membrane. Solutes are dissolved mainly in the sap vacuole, which is separated from the surrounding medium by two membranes namely the **vacuolar membrane (tonoplast) and plasma membrane.**

If animal cell is surrounded by water or a solution that is hypotonic to its cytoplasm, water or a solution that is hypotonic to its cytoplasm, water molecules would enter the cell by osmosis. The osmotic pressure of the cell contents is higher than of surrounding water. The animal cell swells as it takes up water and may eventually burst due to pressure exerted on the cell membrane.

An example is when a red blood cell is placed in water or dilute solution (hypotonic solution) the cells take up water, swells and eventually bursts, a phenomenon known as **haemolysis.** If the blood cells are palced in a hypertonic solution, for example, 2% sodium chloride, they lose water by osmosis and cell membrane wrinkles as the cell shrinks, this is referred to as **crenation.**

- When a plant cell is placed in a medium whose concentration is lower than that of the cell sap (hypotonic) water enters the cell by osmosis
- The cell continues to expand as it takes up water, but due to the tough cell wall, the plant cell does not burst, it becomes firm (turgid) as more water is taken up
- The cytoplasm pressure against the cell wall and an internal pressure known as **turgor pressure** develops. This pressure presses the protoplasm against the cell wall
- The cell becomes fully turgid when osmotic pressure is equal to turgor pressure. At this point, the cell cannot expand any more. Turgidity is important in supporting plants in an upright position and maintaining their shape and form.

- If the plant cell is immersed in hypertonic solution, water moves out of the cell by osmosis
- The sap vacuole gradually deceases in size as water is lost.
- The cytoplasm also shrinks and the entire protoplasm gets detached from the cellwall, a condition referred to as plasmolysis. This leaves a gap between the cell wall and plasma membrane
- The beginning of detachment of protoplasm from the cell wall is called incipient plasmolysis. A fully plasmolysed cell is described as **limp or flaccid.**
- When cells of a stem and leaves of a plant lose too much water to surroundings through transpiration, the cells lose turgor and became flaccid. The plant visibly droops a phenomenon known as wilting and is usually observed on hot and dry days when water loss exceeds water uptake by roots from the soil.

Role of osmosis in living organisms

Osmosis is important in regulation of the amount of water and ions in animal cells (osmoregulation)

In plants, water is absorbed from the soil through osmosis.

Transport of water from one cell to another and within the plant tissues occurs through osmosis.

Cells in plants absorb water and develop turgor. The cell turgidity provides mechanical support and help in maintaining shape and form, especially in herbaceous (non-woody plants)

Factors affecting rate of osmosis

Concentration gradient - The rate of osmosis is affected by the difference in the concentration of two solutions separated by a partially permeable membrane. The greater the difference, The higher the rate of osmosis and vice versa.

Width of membrane - Osmosis is faster when membrane is thin and slower through a thick membrane.

Demonstrating the process of osmosis in living cells

- There are various ways of demonstrating the process of osmosis using plant material. The most common plant materials used are Irish potatoes and pawpaws . Yam tubers can be used in place of Irish potatoes.

- The purpose of the experiments is to demonstrate the movement of water in or out of the cells through the process of osmosis.
- Using a cork borer, potatoe cylinders are made by perforating whole potatoes and cutting them to a required length of about 45-50 mm,
- The cylinders are placed in beakers or petri dishes containing sugar solutions at different concentrations and one containing distilled water. The set up is left for one hour.
- At the end of the experiments, the cylinders' lengths are measured to ascertain if there is any change.
- Cylinders placed in water, will have increased length whole those placed in concentrated solution will have reduced length. The increase in length is due to absorption of water from the beaker (hypotonic medium) into the potato cells by osmosis.
- Another method of demonstrating osmosis in living cells is by use of eggs, which has a partially permeable membrane beneath the eggshell (use hen's eggs)
- The egg shells can be dissolved by placing the eggs in dilute hydrochloric acid for several hours (preferably overnight)
- The eggs are then washed with tap water
- One egg is placed in a beaker containing distilled water and the other in concentrated sucrose solution. The set up is left for 10-24hrs
- The egg placed in distilled water feels very hard while the once placed in concentrated sucrose solution feels soft. Water molecules pass through the egg membrane by osmosis, making the egg turgid

Active Transport

- In diffusion and osmosis molecules move from region of high concentration to a region of low concentration, that is the molecules move along a concentration gradient
- **Active transport** is the movement of molecules or ions from a region of low concentration to a region of high concentration (the movement is against a concentration gradient)
- The process requires a supply of energy in form of ATP, supplied through the process of respiration. Active transport therefore takes place only in a living system that actively produces energy
- Besides the energy supply, chemicals known as carriers are involved in transfer of molecules across membranes.

Factors affecting rate of active transport

•Oxygen supply and energy production

The rate of active transport is dependent on the amount of oxygen available for respiration and energy production. The greater the oxygen supply, the higher the rate of active transport.

•Temperature

If temperature is too high or too low, the rate of active transport is reduced. This is because enzymes involved in respiration are denatured at high temperature and their action slowed down at low temperatures. Active transport is therefore fast at optimum range of temperature.

Importance of active transport in living organisims

- Absorption of the end-products digestion as glucose, amino acids as well as mineral salts take place by active transport, in addition to diffusion.
- Gluocse and mineral ions are reabsorbed back into the blood from kidney tubules by active transport.
- Some minerals are taken up by root hairs from the soil by the process of active transport, for example seaweeds accumulate high concentration of iodine in their tissues from the surrounding sea water.
- Some plants, especially those growing in saline soils take up high concentration of salts to increase osmotic pressure in their cells. This reduces the amount of water reaching the leaf surfaces.

THE HUMAN BODY

The human body system

Body system can be defined as a collection of parts able to work together to serve a common purpose:- growth, reproduction and survival.

The human body is made up of multiple systems that work together to form life.

Body systems are an organized group of tissue that forms a particular function. These functions work with other systems in the body.

Some of the main systems of the body are digestive, circulatory, nervous, respiratory and muscular.

Understanding these systems helps people know how the body functions and why the health of each of them is important for overall quality of life.

In biology, **an organ** (from the Latin "organum" meaning an instrument or tool) is a collection of tissues that structurally form a functional unit specialized to perform a particular function. Your heart, kidneys, and lungs are examples of organs.

Cells are the basic, fundamental unit of life. Therefore, if we were to break apart an organism to the cellular level, the smallest independent component that we would find would be the cell.

Tissues are groups of cells that have a similar structure and act together to perform a specific function. The word tissue comes from a form of an old French verb meaning, “to weave”. There are four different types of tissues in animals: connective, muscle, nervous, and epithelial.

A gland is an organ, which produces and releases substances that perform a specific function in the body.

We have various types of body systems, which include the following

i. Respiratory system
ii. Cardiovascular system
iii. Urinary system iv. Endocrine system
v. Nervous system
vi. Digestive system
vii. Muscular
viii. Skeletal
ix. Integumentary system/ exocrine system
x. Lymphatic system
xi. Immune system

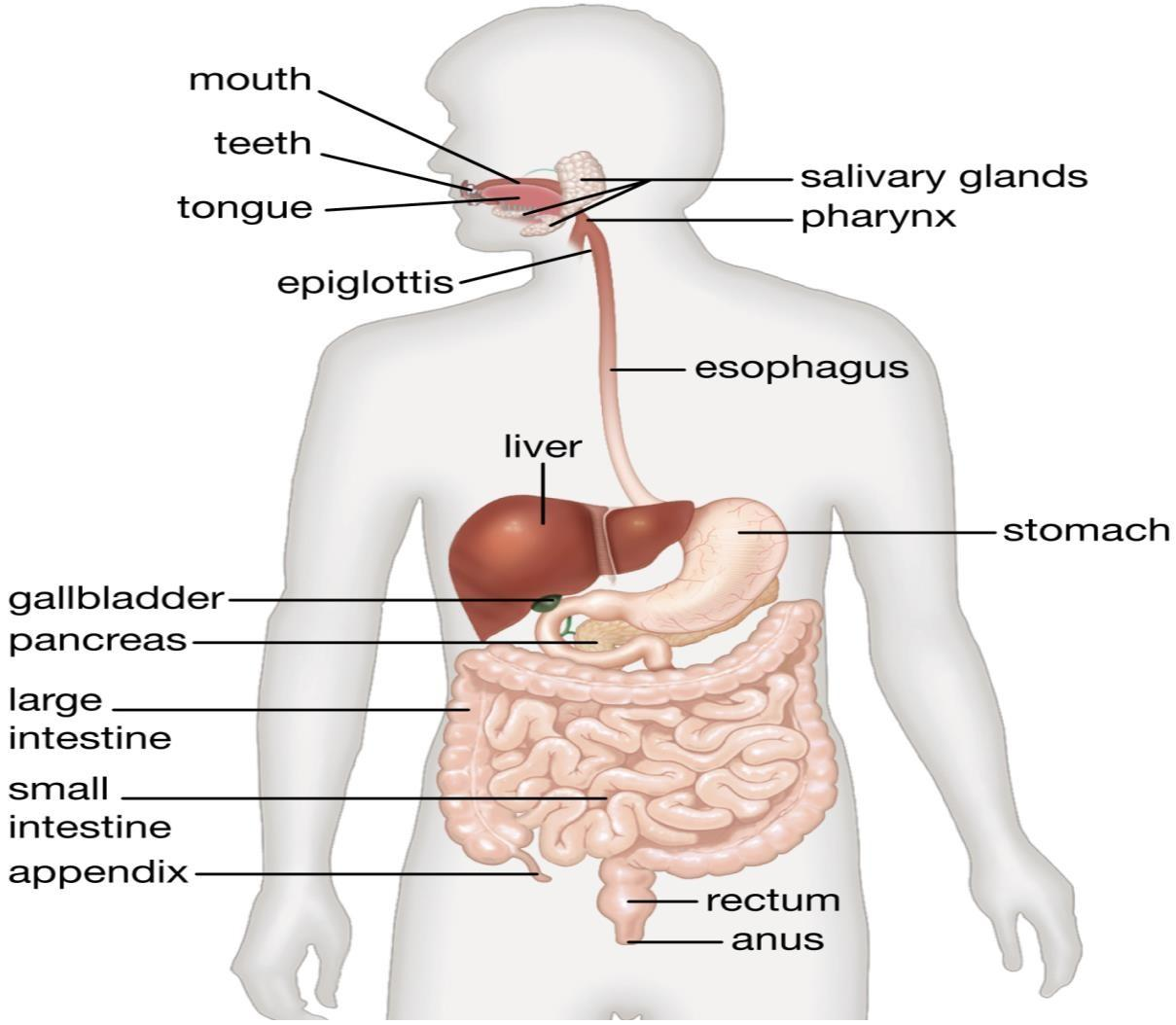
The Digestive System

The human digestive system is a complex series of organs and glands that process food.

In order to use the food we eat, our body has to break it down into smaller molecules that it can process.

It also has to excrete the waste.

The digestive system is therefore a system of converting complex food substances into simple substances, which the body can absorb into the blood system for metabolism.



Mouth

The digestive process begins in the mouth.

Food is partly broken down by the process of chewing and mixed with saliva from the salivary glands.

Saliva contains enzyme **ptyalin** that converts starch to dextrins (a variety of products obtained by heating a starch in the presence of small amounts of moisture and an acid.) and some of it into maltose (malt sugar).

Food is then formed into a ball by the tongue and swallowed where it is passed onto

the oesophagus. **Oesophagus**

Down the oesophagus, food moves by **peristalsis.** This is a rhythmic wave line muscle movement that squeezes the food boluses down the oesophagus until they go to the stomach.

Stomach

A large sac-like organ where food is stored churned and mixed with gastric juice. Gastric juice is secreted by the gastric glands in the walls of the stomach.

The food is formed into a thick soup known as **chyme.**

Gastric juice contains enzymes **rennin, lipase, and pepsin.**

Hydrochloric acid contained in the stomach.

- **Renin** clots milk.
- **Lipase** emulsifies fat that is in the food.
- **Pepsin** breaks down proteins into peptones and proteose.
- **Hydrochloric** acid kills germs and provides an acidic environment necessary for enzyme action.

Food is held in the stomach for a period of between one and four hours. It is then released in small portions through the duodenum into the small intestines.

Small intestines

A long tube, which allows for a lot of digestion. Here the food is acted upon by **pancreatic juice** from the pancreas, **bile** from the liver and **intestinal juice** from the intestine walls.

a) **Bile** contains alkaline bile salts that emulsify fat and active pancreatic lipase.

b) **Pancreatic juice** has three enzymes *trypsin* that breaks down protein and peptones to amino acids, *amylase* which breaks down starch (polysaccharides) to maltose (disaccharides) and some to glucose (monosaccharides) and *lipase* which splits up fats into fatty acids and glycerol.

c) **Intestinal juice** contains enzymes erepsin, amylase, maltase, sucrose and lipase. All these enzymes complete the conversion of substances of the food into simple and soluble substances that are absorbed into the blood capillaries. For example; **Erepsin** converts proteins (peptidase) to amino acids.
Amylase converts maltose to glucose and galactose.
Maltase converts maltose to glucose and galactose.
Sucrose converts sucrose to glucose and fructose.
Lipase converts glycerides to fatty acids and glycerol

Absorption in small intestines

The small intestines is the longest portion of the digestive tract. It is 6 meters long and is located within the middle of the abdomen.

It has three sections; the duodenum, the jejunum and the ileum.

Absorption of digested food occurs through the villi, which are tiny projections on the inner surface of the small intestines. Each villus contains a small lymph vessel (a lacteal) and a network of blood capillaries.

Amino acids, glucose, minerals, vitamins, glycerol, some fatty acids, and the fat-soluble vitamins pass into the lacteals. These lymphatic vessels take their contents through the liver where some is kept but the rest goes to the thoracic duct via a large vein in the neck to general circulation.

The nutrients, which are absorbed into the blood capillaries, pass into mesenteric vein to portal vein that takes them to the liver. From the liver, the nutrients pass in the hepatic veins to the inferior vena cava then to the heart into the general circulation.

Large intestines.

The large intestines consists of the caecum and colon.

It starts in the **iliac** region of the pelvis, just above the appendix below the right waist, where it is joined to the bottom end of the small intestine.

The peristaltic waves push the remaining contents into the large intestine where there are no digestive juices but there is plenty of bacteria.

These food materials are now indigestible and move forwards and backwards while water and mineral salts are absorbed, leaving a semi-solid or solid faecal mass.

The bacteria in the large intestines produce some of the B vitamins to augment what is supplied by the food. The faecal matter is eventually swept by strong peristalsis until it reaches the rectum in readiness for defaecation (emptying). The rectum is usually empty until there is need to eliminate the faeces.

THE CIRCULATORY SYSTEM

The circulatory system is made up of vessels and the muscles that help and control the flow of blood around the body. It includes the heart, the blood and blood vessels.

Blood components and functions

An average adult has about 5 liters of blood that is about 7.7% of the body weight. This essential fluid carries out the critical function of transporting oxygen and nutrients and body cells and getting rid of carbon (ii) oxide, ammonia and other waste products. It also plays a vital role in the body's immune system and in maintaining a relatively constant body temperature.

Blood can be divided into two main components: Plasma- 55% and cells-45%

a) Plasma is pale yellow fluid composed of 90% water , 6-7% plasma protein and 0.9% inorganic substances like minerals. The rest are waste materials like urea, nutritive materials like amino acids and glucose and gases like oxygen and carbon (ii) oxide. The plasma, being the fluid part of the blood facilitates transport of the substances stated above, together with the blood cells to the parts of the body where they are required to be. Plasma also contains blood and clotting factors. b) Cells

Blood cells are of three types

- White blood cells defend the body against harmful microorganisms. Their count is about 5000 – 10000 per cubic millimeters of blood
- Red blood cells transport oxygen and carbon (ii) oxide. Their count is about 4.2 – 6.4 million per cubic millimeter.
- Platelets (thrombocytes) are important for normal clotting of blood. Their count is about 250000 – 500000 per cubic millimeter.

Types of blood vessels and their functions

Blood vessels are tubes through which blood flows. They are of three categories – arteries, veins and capillaries.

Arteries convey blood from the heart. They are made up of strong elastic muscle fibers to withstand the pressure of moving blood as the heart pumps it. In order to supply blood to the organs and limbs, arteries branch out, forming narrower vessels known as **arterioles.** Arterioles branch out to form a network of very small vessels known as **capillaries.**

Veins convey blood back to the heart from all over the body. They have valves to prevent the backflow of blood because they carry blood under low pressure.

Veins also form capillary network at the points where they meet the arteries. Veins like arteries branch out to form venules.

Capillaries are the smallest blood vessels. They are formed ate the ends of arteries and veins.

Arterioles branch out to form capillaries and the capillaries unite to form venules. It is only from the capillaries where blood can release the nutrients and oxygen to the body tissues and take up waste products and carbon (ii) oxide from the tissues.

The other blood vessels, which are either arteries or veins, are:

Aorta, which is the largest artery in the body. It receives oxygenated blood from the heart and conveys it to the rest of the body. It forms various branches to supply blood to the head and other organs. For example, it branches into vessels like hepatic artery to the liver, celiac artery to the intestines, renal artery to the kidneys and other branches to the lower limbs. Aorta receives blood from the left ventricle of the heart.

Inferior vena cava is the largest vein in the body. It runs parallel to the aorta returning deoxygenated blood to the heart. It also forms branches like the renal vein, which drain blood from the kidneys, and the hepatic vein which draws blood from the liver. It pours the blood into the heart via the right auricle.

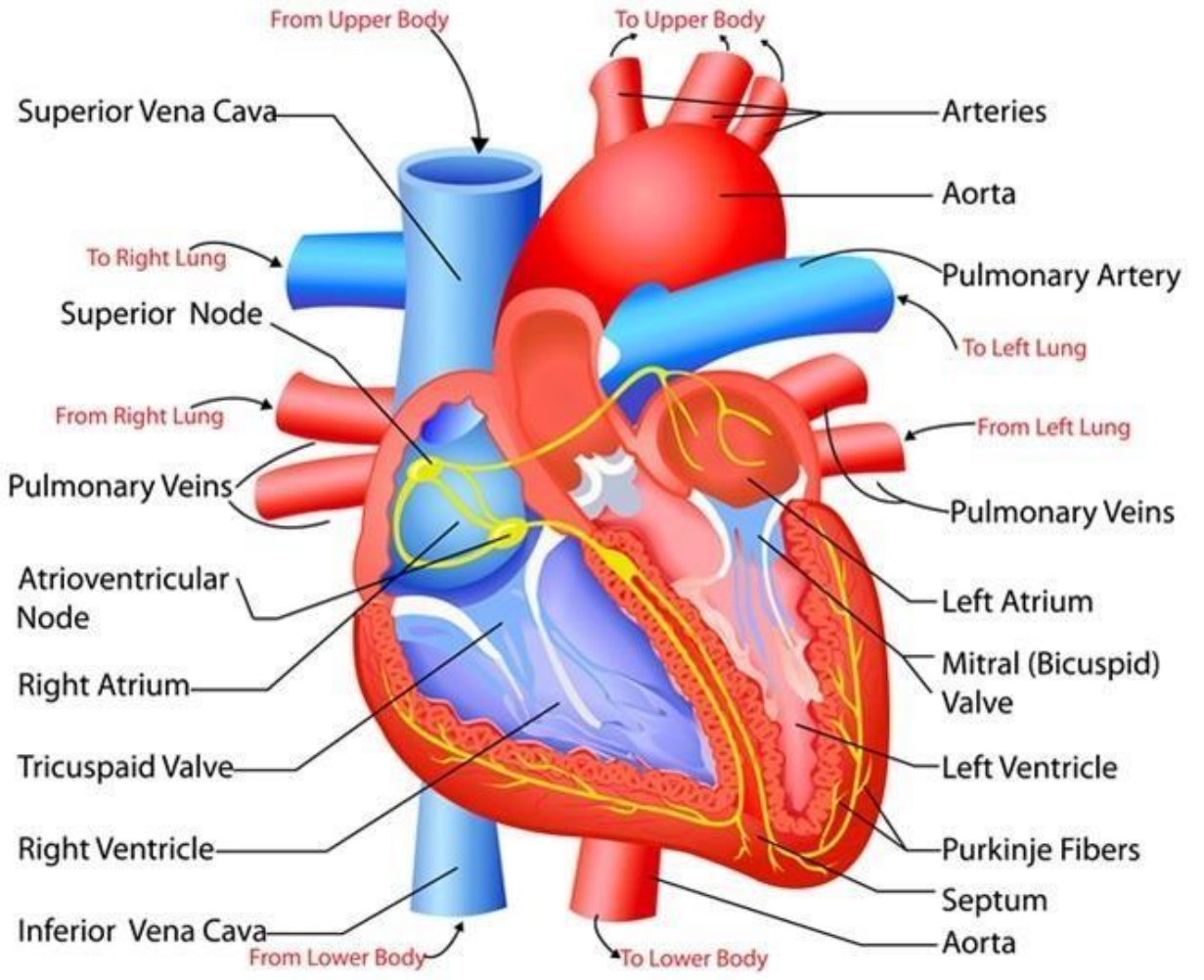
From the small intestines there is the hepatic portal vein which conveys deoxygenated blood to the liver. This blood has nutrients as well.

Superior vena cava is a vein that brings deoxygenated blood from the head and upper limb. It pours its blood into the heart via the right auricle.

Pulmonary artery conveys deoxygenated blood from right ventricle of the heart to the lungs while **pulmonary vein** conveys oxygenated blood from the lungs to the left auricle of the heart.

Note: Large vessels carrying blood away from the heart are all arteries. Those bringing it to the heart are veins.

Structure of the heart



The heart is a tough muscular organ with the shape of a cone whose apex points downwards towards the left-hand side. It is enclosed in a port cardial sac that is lined with parietal layers of a serous membrane. It acts as a pump that provides the force necessary to circulate the blood to the tissues in the body. The heart of a normal adult pumps about 5 liters of blood every minute throughout life. If it loses its pumping effectiveness for even a few minutes the individual's life is jeopardized.

The heart has 4 compartments – two larger ones and two smaller ones. The two larger ones are ventricles and are surrounded by very tough muscles. They are situated at the bottom of the heart. The top ones are the smaller ones and are called auricles. Between the top and the bottom compartments are two valves, the tricuspid and bicuspid valves which prevent blood in the ventricles from flowing back into the auricles.

Functions of parts of the heart

Left ventricle pumps the oxygenated blood out of the heart through the semilunar valve into the aorta hence to the rest of the body

Right ventricle pumps deoxygenated blood through the semilunar valve into the pulmonary artery to the lungs to be re-oxygenated.

Left auricle receives oxygenated blood from the lungs through the pulmonary vein. The auricle contracts to pump the blood into the left ventricle through a non-return valve called the bicuspid valve.

Right auricle receives deoxygenated blood from the lower parts of the body via inferior vena cava and also from the head and upper parts of the body via the superior vena cava. The right auricle contracts and squeezes the blood through a non-return valve called tricuspid valve into the right ventricle to be pumped to the lungs.

Blood circulation

Blood circulation is the movement of blood as it distributes oxygen, nutrients, heat and so on to tissues and collects waste products from the same to the excretory organs.

The organs involved in the circulatory system are the **heart, arteries, veins and capillaries.**

Oxygenated blood from the lung enters the left auricle via pulmonary vein. The left auricle pumps it to the left ventricle through a non-return valve (bicuspid valve) situated between the two compartments.

The left ventricle pumps the oxygenated blood through the semilunar valve into the aorta. Aorta enlarges for a short while because the blood passing through it is under pressure. All arteries have thick muscular walls to withstand the pressure of blood as it passes when the heart pumps it. As arteries get further from the heart, they branch continuously, getting into smaller arterioles each time till they finally form capillaries. At this time they are either at the tissues or organs.

Capillaries form a large network so that each single cell in the body is near a capillary. The blood in the capillaries move very slowly so as to allow the cells to get more oxygen and nourishment and release carbon (ii) oxide and waste products to the blood.

Capillaries reunite to form venules which also unite with others to form bigger veins. These veins carry the deoxygenated blood and convey it into the vena cava which pours it into the right auricle.

The right auricle contracts, squeezing the deoxygenated blood into the right ventricle via the tricuspid valve. The right ventricle then pumps the deoxygenated blood into the pulmonary

artery to take it into the lungs so that carbon (ii) oxide can be excreted by the lungs and blood be re-oxygenated. Once reoxygenated, blood flows through the pulmonary vein into the left auricle and cycle starts again.

The pumping pressure of the heart becomes too low as the blood gets to the capillary network. So, to travel back to the heart, the blood is assisted by muscular movement and valves.

Blood groups and blood transfusion

As we said earlier, blood is basically composed of plasma and cells.

Individuals differ in some of the arrangements and proportions of the chemicals in their red blood cells and plasma. There are four different groups based on these different chemicals and clotting agents known by letters A, B, AB and O

When two different groups of blood are mixed the blood mixture sometimes clots or clumps. This is because protein molecules called **agglutinogens** in the red blood cells and **agglutinins** in the plasma react causing the red blood cells to clump together.

If this happens after different blood is transfused into someone, clots form in the capillaries thus blocking the blood flow. This can cause death if it happens in the vital organs. But id red blood cells are removed in the blood, the remaining plasma can be transfused to anybody regardless of his/her blood group.

The four blood groups stated above can be sub grouped further according to the presence or absence of yet another protein molecule called **rhesus (Rh)** factor. This means that all human blood can be grouped into two other groups, as **Rh+ and Rh-.** So an individual whose blood is group **B+** cannot receive blood from group B-. Their blood is incompatible.

In ancient days, if a woman with Rh- blood married a man with Rh+ blood, their rhesus factors could react in the baby's blood and cause death to the body. Nowadays doctors replace all the baby's blood at birth to save his/her life when such combination occurs.

Donor's blood group	**Recipient blood group**			
	A	B	AB	O
A				
B				
AB				
O				