

BIOLOGY GRADE 9

UNIT 1

BIOLOGY AND TECHNOLOGY

Biology is the scientific study of life or living things.

Technology:- the application of scientific knowledge to the practical aims of human life or, as it is sometimes phrased, to the change and manipulation of the human environment.

Science is a systematic study of natural and physical world through **observations** and **experiments**. Science shapes the way we understand the universe, our planet, ourselves, and other living things. The scope of biology is also broad and therefore contains many branches and sub branches. The three main branches of Biology are

1. **Botany** - the study of plants
2. **Zoology** - the study of animals
3. **Microbiology**- the study of microorganisms

Some other sub branches of biology are:

Mycology – study about fungi

Protozoology - study about protozoa

Phycology - study about algae and etc.

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The scientific method is an organized way of solving problem or answering questions

Before publication of an idea/Research, several other scientists in the same field read and check or evaluate it, the process is known as **peer review**

Scientist publish their works on special magazine known as **scientific journal**

1.1. Renowned Ethiopian biologist

1. **Dr. Aklilu Lema** - is pioneer Ethiopian biologist

- Discovered a remedy for a disease called **bilharzia/schistosomiasis** that is caused by **flat worm**, which spend part of their life cycle in fresh water snail and part in humans
- The parasitic worms infect the blood vessels, liver, kidneys, bladder and other organs
- It affects 200-300 million people in Africa (including Ethiopia), South America, Asia and parts of the Caribbean
- He made soapberry from local plant known as **endod (phytolacca dodecandra)** to kill the snail, which is the intermediate host for flat worm (if the snail can be controlled, the spread of bilharzias can be reduced)
- Soapberry of Dr. Aklilu Lema is cheap and locally available to buy and use for African countries to eradicate the disease

2. **Dr. Tewolde Birhan Gebre Egziabher** - an ardent lover of nature

- recognized for his work on **environmental protection and biodiversity**
- Works to safeguards the biodiversity and traditional rights of farmers and communities to their genetic resources

3. **Prof. Tilahun Yilma** - professor of veterinary virology at the University of California

- He has developed vaccine for terrible cattle disease known as **Rinder pest** using genetic engineering
- Rinder pest is deadly viral disease, which killed millions of cattle in Africa
- He works to develop vaccine for HIV/AIDS
- His contributions in science and medicine have been recognized by many international organizations.

4. **Prof. Yalemtehay Mekonnen** - the first female professor from Addis Ababa University

She works on:

- Assessment of impact of chemical **pesticides hazards on humans**.
- research on the use of plant as a medicine against human and animal disease
- She has awarded research grant and fellowship from different national and international organization for her contribution in the area.

5. **Dr. Melaku Worede** -

- He has worked for many years to save the **genetic diversity of Ethiopia's domestic plants**.
- set up the plant genetic resources center in Addis Ababa
- developed way of farming to produce high yields without commercial fertilizer
- served as the first chair of African committee for plant genetic resources and chair of UN food and agriculture organization's commission on plant genetic resources

6. Dr. Gebisa Ejeta

- has developed **high yield** and **drought resistance** strain of sorghum
- has awarded national hero award and world food prize for his massive contribution in science and technology

7. Prof. Beyene petros - a biomedical scientists serving at Addis Ababa University

- produced more than **43 publication** in journal and books
- He won **Gold medal award** from Ethiopian health association and fellowship from fulbright and center for disease control and prevention, Atlanta, USA.

8. Prof. Sebsebe Demissew

- **Plant taxonomist**, director of national herbarium and leader of Ethiopian flora project

9. Dr. Zeresenay Alemseged

- **Paleontologist**, who discovered a 3.3 million years old humanoid fossil in 2006

10. Dr. Tsehaynesh Meselle - Leads research in human health, including HIV/AIDS.

11. Dr. Birhane Asfaw - discovered two 160,000 years old human skulls.

- His discoveries were published in famous **scientific journal nurture**

12. Prof. Legese Negash - pioneer in propagation of Ethiopian indigenous tree

- Founder and leader of the **indigenous tree propagation** and biodiversity department in Ethiopia

13. Prof. Mogese Ashenafi - works at Addis Ababa University and leads international research into **food microbiology**

14. Prof. Ensermu Kelbesa - leading systematic botanist

- He has discovered and named different **new plants**

1.2. Biological research in Ethiopia

Biologist conducts different research in different area of biological science. To carryout researches, they need different tool, laboratories and other biologist to discuss idea with and develop theory. Ethiopia has various institutes which are involved in biological research. Biologist come to these institutes and our biologist also travel other countries to take part in different research program.

Addis Ababa University (department of biology)

- One of the major centers for biological research in Ethiopia
- contains much modern and high level equipment that help in their study.
- ✓ Palace for many renowned Ethiopian biologists.

It also manage 2 major units

A. **The national herbarium** which serves as national repository of Ethiopian plant and center for plant identification in the country

B. **The zoological natural history museum (ZNHM)** which contains collection of Ethiopian **fauna** including **endemic** species. It provides visual education for general public, students, and tourists. Other research institution and their focus area of research are summarized in the table below

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Institutions	Focus area of research
Armauer Hansen Research Institute (AHRI)	in first set it carried out research only into leprosy later widened to tuberculosis, leishmaniasis, malaria and HIV/AIDS
Aklilu Lemma Institute of Pathobiology (ALIPB) - previously known as department of pathology at AAU	<ul style="list-style-type: none"> • Microbiology of infectious diseases • Vectors of disease and how to control them • Human parasitic disease • Animal health and disease • Endod and use of other plants as medicines.
Ethiopian Health and Nutrition Research institute (EHNRI)	<p>✓ Health and nutrition issues</p> <p>Other specific area of research includes</p> <ul style="list-style-type: none"> • HIV/AIDs vaccine • tuberculosis (TB) • infectious disease • nutritional status of baby and mother
Ethiopian Institute of Agricultural Research) (EIAR) also known as institute of Agricultural research (IAB)	<ul style="list-style-type: none"> • Crop technology to achieve food security and nutritional quality • breeding, feeding and health improvement of livestock • improving soil fertility • Forestry (rehabilitation, conserving and restoring forest ecosystem) • Crops for mechanized farming
Institute of Biodiversity conservation (IBC)	<ul style="list-style-type: none"> • Issue of biodiversity conservation, especially endemic plant and animal of Ethiopia • Conserving gene of Ethiopian plant • Ecosystem conservation • Biotechnology and safety • Aquatic plant, medicinal plant, forests etc.

UNIT - 2

CELL BIOLOGY

2.1. The microscope

Microscope is a basic tool for biologist, which is used to see/study very small things that can't be seen by our naked eyes.

Types of microscope

1. **Light microscope** is a type of microscope which use **beam of light** to form image. It can be classified in to

A. **Simple light microscope** - contains only one lens system. E.g. Hand lens

B. **Compound light microscope (CLM)** - contains two lens system, **eye pieces/ ocular lens and objective lens**. It magnifies the object/specimen twice and produces **much better magnification**.

The 4 types of objective lenses

- Low power objective lens - provide lowest power of magnification 4x
- Middle power objective lens, provide 10 x magnifications
- High power objective lens, provide 40x magnification
- Oil emersion objective lens, provide the highest magnification (100x)

Magnification and resolution

The two important function or abilities of microscope are **magnification** and **resolution**.

Magnification - is the ability of microscope to increase the **size of an object**.

- **The total magnification CLM = magnification of eye piece lens x particular objective lens**

- Light microscope can magnify an object up to **2000 times**

Resolution - the ability of microscope to see detail or scatter parts of an object

- Approximately light microscope can resolve things about **200 nanometer** (nm) apart

Staining - is a process adding chemical stain or dyes to slide tissues to make the cell or their parts easier to see. Some commonly used stains are:

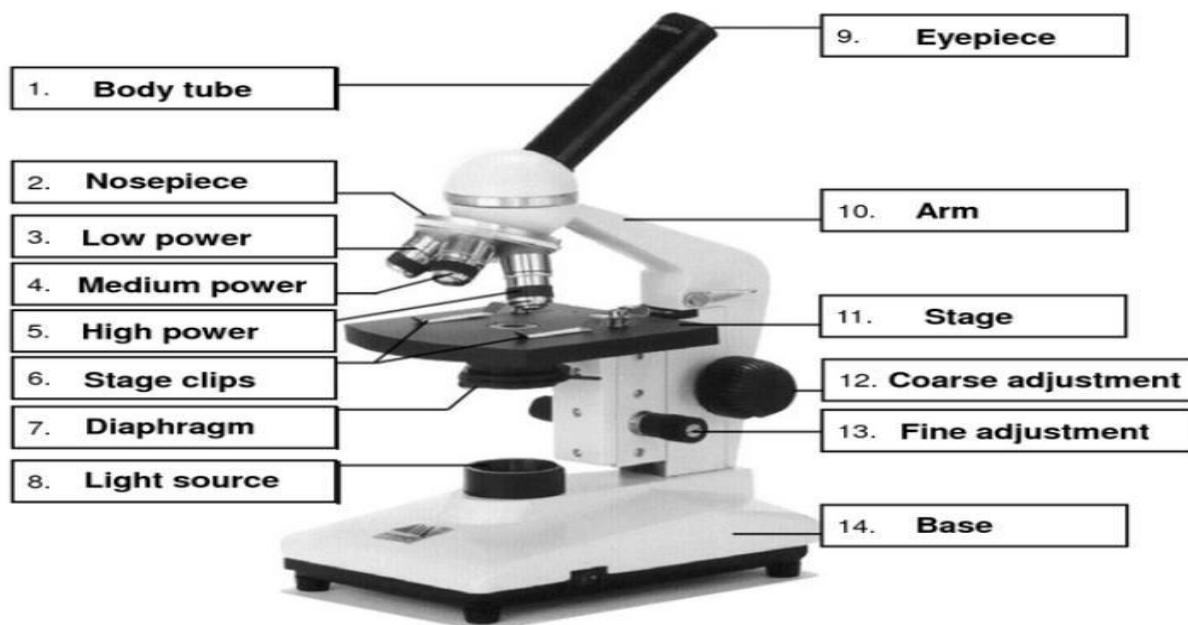
Types of stain	types of cell	main organelles stained
Haematoxylin	animal & plant cell	nuclei stained blue (purple or brown)
Methylene blue	animal cell	nuclei stained blue
Acetocarmine	animal and plant cell	staining the chromosome in dividing nuclei
Iodine	plant cell	any material containing starch

Mounting - is a process of preparing an object or specimens to be seen under a microscope. Mounting process involves the following major steps

- having specimen to be seen under a microscope
- place the object /specimens/ at the center of clean glass slide
- cover the specimens with cover slip
- remove excess fluid from slide
- place the slide (with specimens) on stage to focus

Parts of compound light microscope

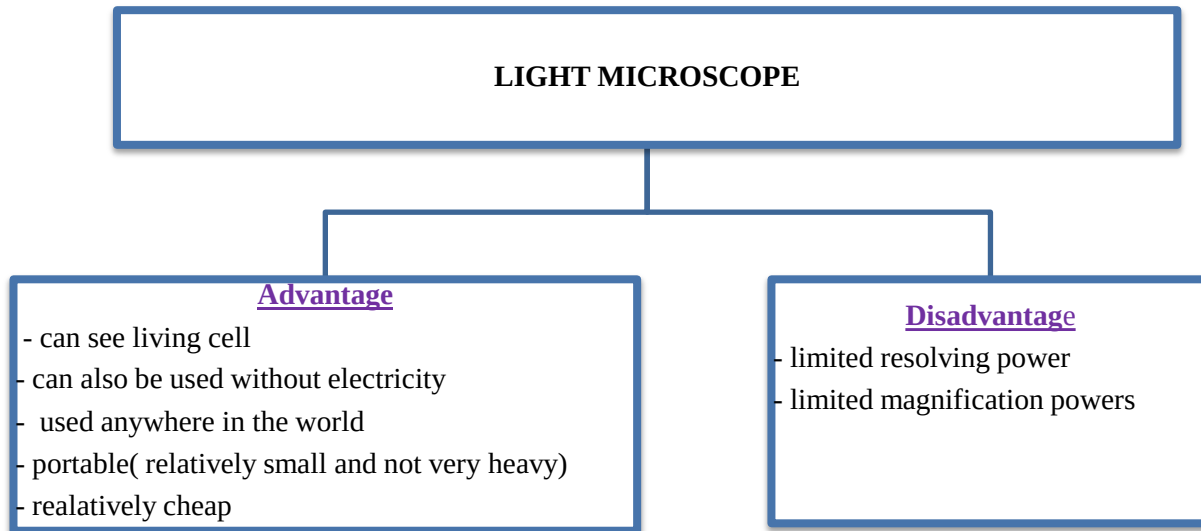
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Parts of compound light microscope	Description and Function
Eye piece/Ocular lens	A lens closer to viewer and used to look through
Objective lenses	Lenses closer to the object which is used to magnify objects
Stage	A flat surface on which slide with specimen is placed to be examined
base/foot	Support the weight of the microscope
Course adjustment knob	used to move the tube up and down for proper focusing
Fine adjustment knob	Used to bring the object in to perfect focus (to get real image)
Nose piece	Revolving part of microscope that hold objective lens
Diaphragm (Iris)	Used to control the amount of light passing through the specimen
Mirror(light source)	Reflects light upward through diaphragm to illuminate the specimens
Arms	Support the tube and connect it to the base
Body tube	Holds nose piece at lower end and eye piece at upper end
Stage clip	Used to fix the slide in place

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Advantage and disadvantage of light microscope



Advantage and disadvantage of election microscope

Advantage	Disadvantage
<ul style="list-style-type: none"> • can see much more detail • higher magnification and resolution 	<ul style="list-style-type: none"> • All the specimens are examined in a vacuum • impossible to look at living material • very expensive • take up a lot of space and are usually kept in a separate room • rely on a constant source of electricity

Comparisons between light and electron microscope

Light microscope	Electron microscope
<ul style="list-style-type: none"> - Low magnification and resolution power - Use beam of light to form an image - Used to study living and nonliving material - It is possible to use it without electricity - Is relatively cheap - Simple to use - Easy to move from place to place - Doesn't require large space - Use glass lens 	<ul style="list-style-type: none"> - Highest magnification and resolution power - Use beam of electron to form an image - doesn't help to study living materials directly - Depend on electricity - Is very expensive - Require large space - Not simple (required professional skills) to use - is not easy to move from place to place - It uses magnetic lens (Electron beams are focused by magnetic lenses)

2. Electron microscope is more powerful types of microscope with highest **magnification** and **resolution**

- power. It uses a beam of electrons rather than light to form an image
- It can magnify objects up to **2,000,000** times and has resolution power up to **0.3 nanometer** (nm) apart
- In electron microscope, the electron behave like light wave
- It has shorter **wavelength** than LM, so it has high resolution power
- As the wave length decrease, resolution power of microscope increase

How does an electron microscope work?

- Under electron microscope, all the specimens are examined in a vacuum because air would scatter the electron beam
- The electron beam is focused by **magnetic lenses**.
- In EM, Complex electronics produce image on screen that can be recorded as a photograph known as **electron micrograph**

There are two types of electron microscope

A. Transmission electron microscope (TEM) in which beam of electrons is transmitted through a specimen/sample and provides detailed three-dimensional images. An image is focused on florescent screen or photographic plate

B. A scanning electron microscope (SEM) which produces images of an object by scanning the surface with a focused beam of electrons and shows only the surface of objects. Image is focused on television-like screen.

2.2. The Cell

- Cell is the basic structural and functional unit of living organism
- It is a smallest unit of life or building block of life
- All forms of life made up of one or more cell
- Some organism are made up of one cell known as **unicellular** (e.g. bacteria and protozoans) others made up of more than one cell known as **multicellular** organism.

Type of cells

- **Prokaryotic cell** - is simple, unicellular (single celled) cell that lack true nucleus
 - **Eukaryotic cell** - is cell that have membrane bounded nucleus (true nucleus)
- ✓ **Organelles** are subcellular structures that have specialized function.

Size and shape of cell

- Most cells are very small or tiny and cannot be seen without the aid of microscope
- Some cells are large enough to be seen by our naked eyes. The biggest known cell is **ostrich egg** cell
- Different cells have **different shape**. They may be flat, spiral, tubular, branched, irregular etc.
- The shape of cells is mostly depends on their function

Cell theory

- Cell were first seen (discovered) and described by English scientists, **Robert Hook** in 1665.
- He observed tiny compartment in the cork, which he called **cellulae** - from Latin word (meaning - **small room**). This term come down to as **cell**. He observed only dead plant cell.
- The first living cell was observed by **Anton Van Leeuwenhoek**. He observed little organism, which he called **animalcules** (meaning - little animal).
- In 1838 **Mathias schleidin** (German Botanist) states that "all plants are made up of cell".
- In 1839 (German zoologist) **Theodore Schwann** stated that "all animals are made up of cell".
- In 1859 **Rudolf Virchow** stated that "cells come from **preexisting** cell". The work of these three scientists contributed to the cell theory.

The cell theory in modern form includes

1. All organisms are made up of one or more cell
2. New cells arise only from other living cells (pre-existing cell) by the process of cell division.
3. Cells are the basic structural and functional unit of life.

All living organisms have certain characteristics, which they carry out. **The seven life processes that are common to most living organism are:**

1. **Nutrition** – all living organisms need food to provide them with the energy used by their cells. Plants make their own food by photosynthesis, whereas animals eat other organisms.
2. **Respiration** – the process by which living organisms get the energy from their food.
3. **Excretion** – getting rid of the waste products produced by the cells.
4. **Growth** – living organisms get bigger. They increase in both sizes and mass, using chemicals from their food to build new material.
5. **Irritability** – all living organisms are sensitive to changes in their surroundings.
6. **Movement** – all living organisms need to move to get near to things they need or away from problems. Animals move using muscles, plants move more slowly using growth.
7. **Reproduction** – producing offspring is vital to the long-term survival of any type of living organism.

Cell structure and function

- Almost all cells (**plant and animal cells**) have a **nucleus, mitochondria, ribosome, cytoplasm, endoplasmic reticulum & cell membrane**.
- Other features that are found in plant cell are **cell wall, large central vacuoles, and plastids**
 - Animal cell also have some unique features such as **lysosomes and centrosome**

Structure and function in unspecialized cell

- All of the process of life takes place within a single cell.
 - Every cell contains sub cellular structure known as **organelles**
 - Each organelle has specific functions within the cell
1. **The nucleus** - it control all activities of cell the (**controlling center of a cell**)
 - It contains genetic material (**chromosome**) which carries genetic information
 2. **The cell membrane/Plasma membrane** - Is thin living layer of both plant and animal cell
 - composed of protein and lipids bilayer (**lipo - protein**)
 - In animal cell, it is the outer most layers whereas in plant cell, it is found next to cell wall
 - It is responsible to regulate the movement of material in and out of cell (**selectively permeable membrane or semi - permeable membrane**); allow some materials to pass through and not others
 3. **The cytoplasm** - is a **jelly-like** substance composed of mainly **water (about 70%)**
 - found between the cell membrane and nucleus
 - Site of most cellular activities (**chemical reactions**)
 4. **The Mitochondria** (singular: mitochondrion)
 - are often referred to as the "**powerhouse**" of the cell"
 - It is a site of **cellular respiration** (energy production)
 5. **Ribosome** - are small organelles found attached to outer surface of endoplasmic reticulum (ER)
 - They can be also **found free** in cytoplasm
 - They are responsible to **synthesis protein (site of protein synthesis)**
 6. **Cell wall** - is a rigid, **non-living** organelle lying just outside the cell membrane of plant cell.
 - It can also found in **fungi** and **bacteria** but not in animal cell.
 - In plant cell, it is composed of complex carbohydrates called **cellulose**
 - It provides structural support, protection, and shape of cell.
 6. **Lysosomes** - are small sac-like structures surrounded by a single membrane
 - They are needed and found only in **animal cell**.
 - contains digestive enzymes which help to break down and remove **old worn out cell** parts
 - It is also known as "**suicide sac (bags)**".
 7. **Plastids** - are organelles found in cytoplasm of plant cell

There are three types of plastids

 - A. **Chloroplast** - is site of photosynthesis
 - It contains the green pigment called chlorophyll, which absorb sunlight
 - B. **Chromoplast** - contains red, yellow or orange pigment
 - It gives the color of fruit and flowers
 - C. **Leukoplast** - it lack pigment (colorless) and serve as storage of starch
 8. **Vacuoles** - are fluid filled organelles enclosed by a single membrane
 - It is used to store fluid called **cell sap**, which contains water, salt, sugar, minerals, and waste products. It provides **turgidity** of plant cell when filled with water
 9. **Endoplasmic reticulum (ER)**
 - A network of membranous tubules, extending through cytoplasm.
 - Connects cell membrane with nuclear membrane and plays a major role in the production, processing, and transport of **proteins** and **lipids**.

There are two types of ER

 - **Rough endoplasmic reticulum (Rough ER)** - contains ribosome attached on its surface and synthesizes **proteins**
 - **Smooth endoplasmic reticulum (Smooth ER)** doesn't have ribosome and synthesizes **lipids**
 10. **Golgi bodies/Golgi apparatus/Golgi complex** - are stacks of flattened membranous.
 - It plays a major role in **modification, packaging** protein for transport.

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Cell specialization in human

- In multi-cellular organism, most cells become specialized to carryout **particular function**
- Cells which adapt to carryout particular function are called **specialized cells**
- A combination of sperm cell and egg cell form embryo (single cell), which divide many times to form mass of **unspecialized/undifferentiated cells**
- As the embryo develops, the cell become differentiated /specialized, this can be shown as

Embryonic stem cell → mass of unspecialized → specialized cell

- **Embryonic stem cells** are unspecialized cell from **cell** early embryo that has potential to form any

specialized cell.

- **Specialized cell** with similar structure and function are grouped together to form **tissue** (eg-Muscle tissue, nerve tissue, etc.)
- Tissues are combined to form **organ** (e.g. heart, lung, kidney etc.)
- Organs are working together to form **organ system** (e.g. digestive system).
- A number of system are working together make up **organism**, this can be shown as

Specialized cell → tissue → organ → organ system → organism

Some example of specialized cell in human

1. **Epithelial cells** specialized cell that cover and protect the internal and external surface of the body (skin, gut, throat etc.)
2. **Reproductive cell (egg and sperm cell)**
 - are specialized cell which involve in reproduction process
 - They contain only **half** the number of chromosome of normal body cells
 - Their nucleus contains genetic material (**chromosome**)

A. Egg cell/ova - is a female reproductive cell (female sex cell), produced in ovaries.

 - Larger in size than male sex cell and have protective **outer coat**.

B. sperm cell - is a male reproductive cell (male sex cell).

 - Have long tail (flagellum) containing muscle like protein that helps to swim towards eggs
 - The middle section contains large number of **mitochondria** which provide energy for tail
 - They have structure known as **acrosome in head**, which store digestive enzyme
 - The enzyme is used to breakdown the **protective coat of egg cell during fertilization**
3. **Nerve cell (neurons)**
 - Specialized cells, responsible to transmit electrical nerve impulse (**signal**) between different parts of the body and control your body system
 - Part of **communication** and control center of your body

Parts of neuron (nerve cell)

- A. **Cell body** - structure which contains cellular structure (like **mitochondria** and **nucleus**)
 - B. **Dendrite** - hair like extension from cell body that **communicates** with other neurons
 - C. **Axon** (nerve fiber) - is long tiny extension of cell body that **carry nerve impulse** long distance
 - D. **Myelin sheath** - is **fatty insulating** layer of axon which help the nerve impulse to travel **fast**
4. **Muscle cell (myocytes)** - are responsible for movements of our body.
 - Rich in proteins like **actin** and **myosin**, these enable the muscle to **relax** and **contract**
 - contains large number of **mitochondria** to provide more energy for muscular movement

2.3. Cell and its environment

Cell obtained Material necessary for life (like O₂ & nutrient) from the environment and waste product (like CO₂) must be removed from the cell. materials can move into and out of a cell through its semi-permeable membrane (**cell membrane**), which allow some materials to pass through and not others. There are two major ways by which materials can move in and out of a cell. These are **passive transport** and **active transport**.

1. **Passive transport** (diffusion and osmosis) - movement of materials without the use of energy
2. **Active transport** - is the movement of materials using energy

A. Diffusion

- Random movement of molecules from area of its higher concentration to area of lower concentration until the molecules tends to be in **equilibrium/distribute uniformly**.
- It occurs along concentration gradient (difference in concentration between two areas)
- Rate of diffusion can be affected by **temperature**, **concentration** gradient, **size** of particle etc.
- Diffusion is an important mode of **nutrient uptake** and **gaseous exchange** in cells

B. **Osmosis** - is a special kinds of diffusion in which **water** (solvent) diffuse (move) from dilute (weak) solution to concentrated (strong) solutions across semi permeable membrane

NB: Dilute solution is a solution with **high solvent/water** concentration and relatively low solute concentration, whereas **concentrated solution** is a solution with **low solvent** concentration and high solute concentration. **There are 3 types of solutions (osmotic conditions). These are:**

1. Hypertonic Solution (hyper - means more)

- If concentration of solution **outside** the cell membrane is greater than inside
- Water molecule move from inside to outside (**loss water**) and causes a cell to **shrink**

2. Hypotonic Solution (hypo - means - less)

- If concentration of solutions **inside** the cell membrane is greater than outside.
- The cell gain water and causes a cell to **swell up** due to osmosis

2. Isotonic Solution:

- If the concentration of solutions inside and outside of cell membrane is **equal**
- There is no net movement of water molecules and **no change in the cell**

Osmosis in animal cell - osmosis is important for movement of water in and out of the animal cell, when needed. However, osmosis can affects animal cell

- If animal cell is placed in **hypertonic** solution, the cell loss water and will **shrivel up (shrink)**. The condition is called **crenation**.

- If animal cell is placed in **hypotonic** solution, the cell gains more water & **swell up** eventually **burst**

Osmosis in plant cell - osmosis is important in plant cell to support the stem and leaves. The swelling up of cell keep stem and leaf of plant **rigid and firm**.

- If plant cell is placed in **hypertonic** solution, the cell loss water. Then vacuole shrink and the cell become less rigid (flaccid), eventually the cytoplasm pulls away from the cell wall. This results in loss of **turgor pressure** and is known as **plasmolysis**

- If plant cell is placed in **hypotonic** solution, the cell gain water and swell up.

- The swelling up of the cell creates pressure that pushes the cell wall outward.

- This pressure is known as **turgor pressure**. On the other hand, the cell wall in plant created wall pressure in opposite to turgor pressure (push inward). This can avoid **bursting** of cell in plant and make them **turgid**.

C. **Active transport** - is a movement of molecules against concentration gradient, molecules move from area of **low concentration** to area of **high concentration**. It required **energy**.

The importance of active transport: E.g.

1. **Absorption of mineral ions from soil by root hair cell.** Concentration of mineral in root hair is greater than in the soil. So it required energy to move against concentration gradient.

2. **Translocation of organic materials in plant** - organic molecules produced by photosynthesis is moved from their leaf to other parts of plants (stem and root).

3. **Glucose in your gut and kidney tubules** moved into your blood against concentration gradient.

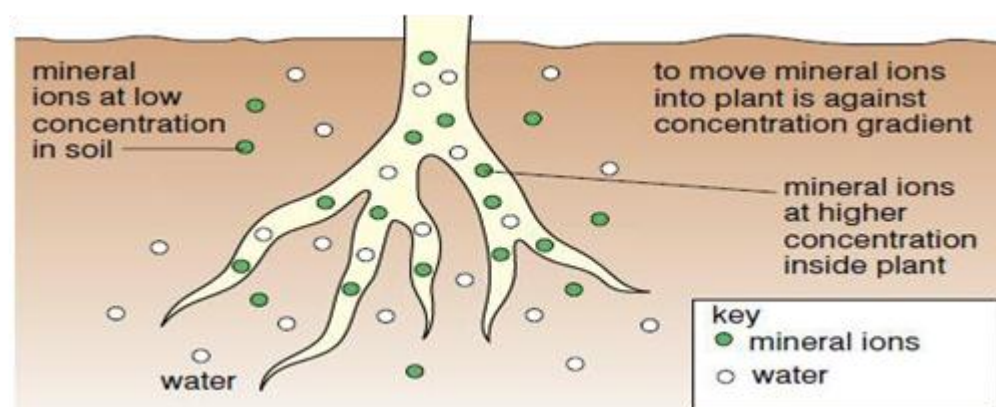


Fig. 2.3. Observations of mineral ions by root hairs of plant (active transport)

UNIT 3

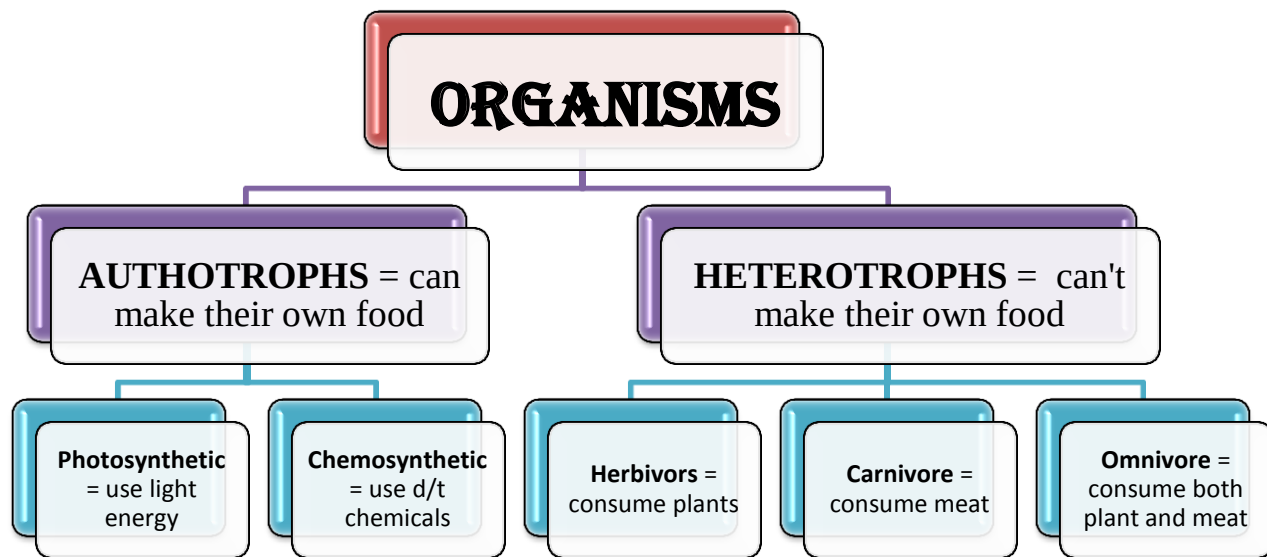
HUMAN BIOLOGY AND HEALTH

3.1 Food and nutrition

All living organisms need a **source of energy** to survive.

Organisms set in different categories depending on their source of food as follows;

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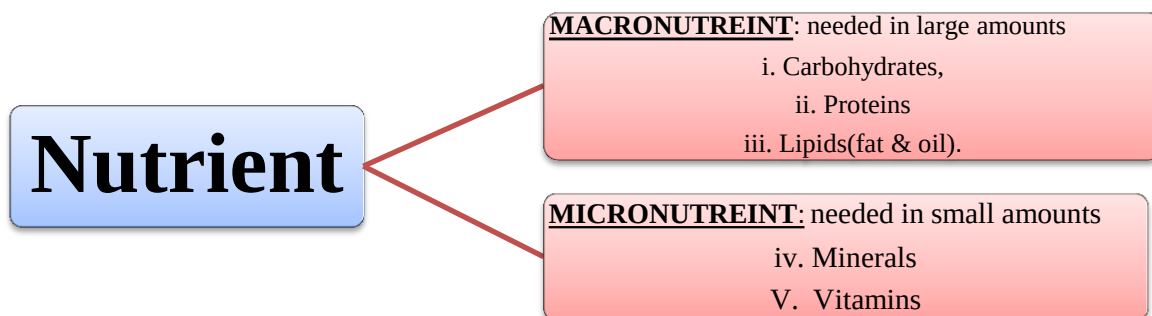
The human diet

Food: is the source of **nutrients** and **energy** for the body

- It has three main use to human
 - A. To **provide energy** for our cells to carry out all the functions of life
 - B. To provide the **raw materials** for the new biological material needed in our bodies to grow and also to **repair and replace** damaged and worn out cells.
 - C. To provide the resources needed to **fight disease** and **maintain a healthy** body.

Nutrient: usable chemical compound found in food

Roughage: indigestible substance that do not provide energy

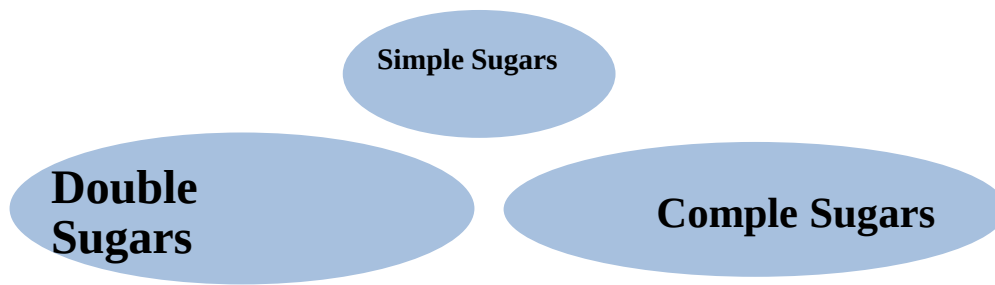


i. CARBOHYDRATE:-

- They are made up of **carbon, hydrogen and oxygen**
- provide us with energy
- broken down to form glucose which is used in cellular respiration to produce energy
- Stores in the form **glycogen**, which is found in your liver, muscles and brain.
- excess carbohydrate that you eat is converted to fat
- **glucose** is the sugar made by plants in photosynthesis and it is vital in cells for energy
- **starch** is more complex carbohydrate stored in plants
- **Obtained from food like injera, honey, Potatoes, rice, bread, etc**
- They divide into **three main types**, depending on the **complexity of the molecules**

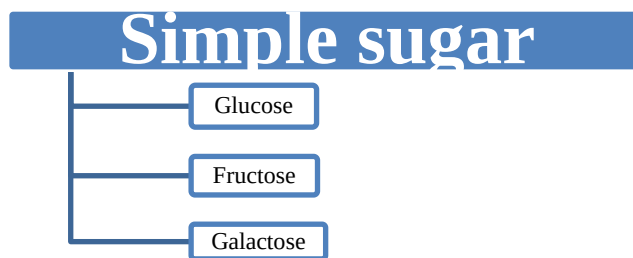
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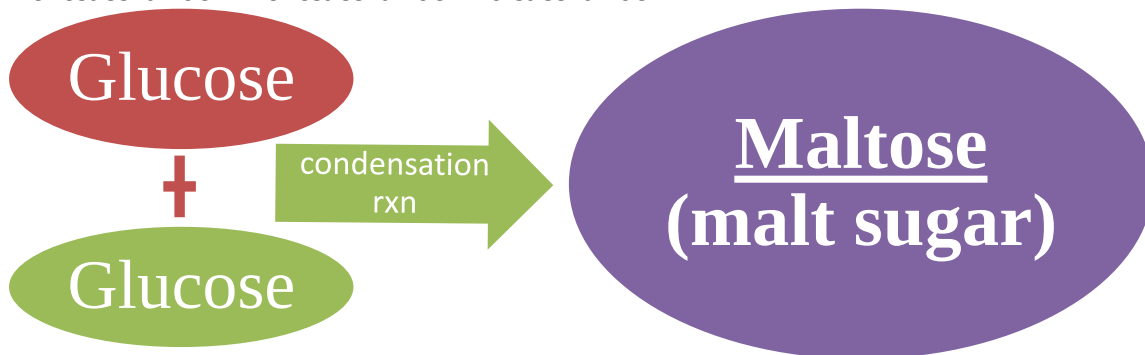
The Simple Sugars/Monosaccharide/

- There is 1-oxygen atom and 2-hydrogen atoms for each carbon atom present in the molecule.
- $(CH_2O)_n$ is general formula
- Example: $C_6H_{12}O_6$ is general formula for Glucose.

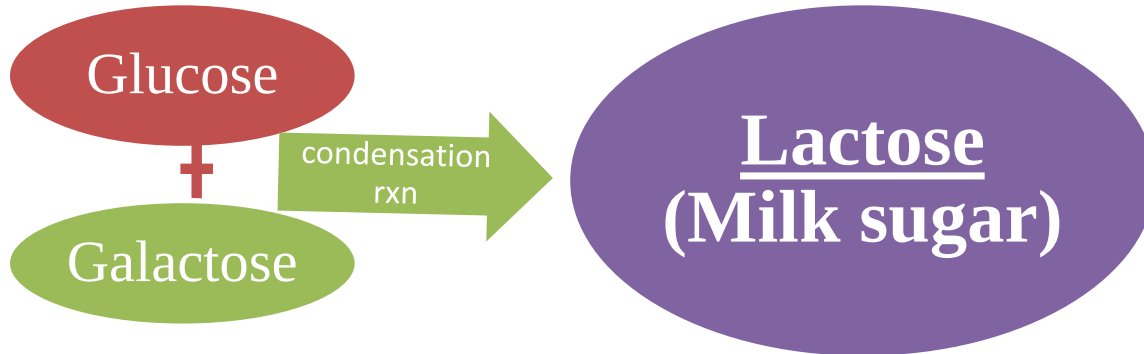
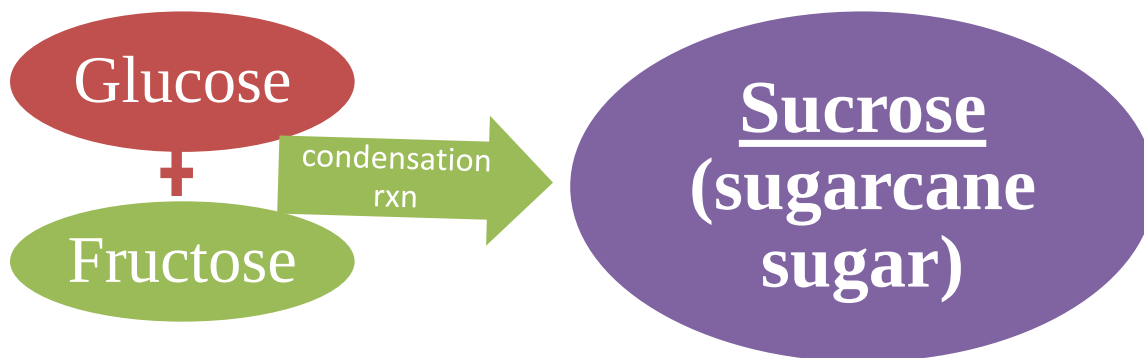


The Double Sugars/Disaccharide

- made up of two simple sugars join together
- When two simple sugars join together to form a double sugar, a molecule of water (H_2O) is removed (condensation reaction).
- ❖ monosaccharide + monosaccharide → disaccharide



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➤ Most simple and double sugars have properties to dissolve in water and they taste sweet.

The Complex Sugars/Polysaccharide

- Many single sugar units are joined to form a long chain.
- properties of complex sugar are;
 - very compact molecules (for storing energy)
 - physically and chemically very inactive
 - sweet test is lost
 - do not dissolve in water
- here are some examples of complex sugar
 - a. **Starch:** energy store in plants
 - The sugars produced by photosynthesis are rapidly converted to starch
 - b. **Glycogen:** sometimes referred to as '*animal starch*'
 - it is energy store found in animals
 - found mainly in muscle and liver tissue
 - c. **Cellulose:** important structural material in plants
 - the main constituent in plant cell walls
 - consists of long chains of glucose
 - Human beings cannot break down its linkages and so they cannot digest cellulose.

Test for Carbohydrate

Starch test

- help to test presence of starch
- **reagent** → iodine
- **result/color change** → change to blue black

Benedict's test (reducing, glucose)

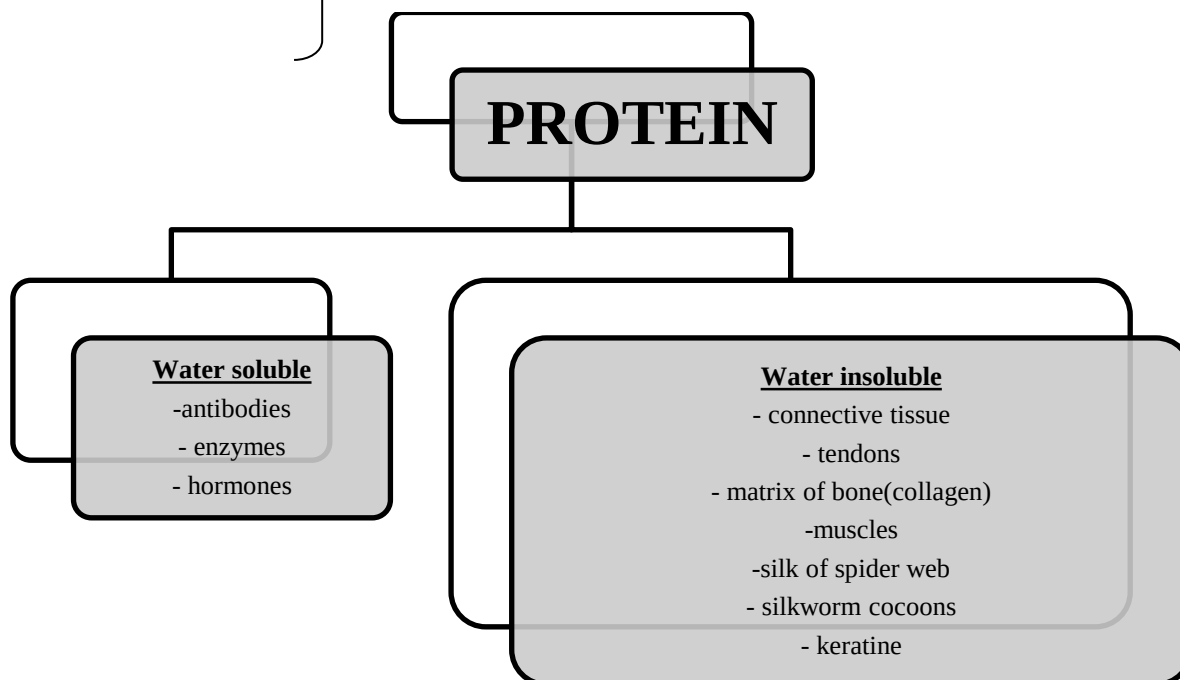
- help to test for simple sugars
- **reagent** → benedict reagent/solution
- **result/color change** → change to yellow

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ii. **PROTEINS:-**

- Made up of the carbon, hydrogen, and oxygen, in addition they all contain nitrogen.
- Some proteins also contain sulphur
- Are polymers, made up of many small units joined together called amino acids.
- There are about 20 different naturally occurring amino acids
- The bond found between two amino acid is peptide bond.

- proteins are coil, twist, spiral and fold amino acid
- proteins differ in:
 - type
 - number
 - sequence
 - shape



- protein make 17-18% of human body
- importance of protein are:
 - ✚ provide less energy than carbohydrate and lipid
 - ✚ for repair and damaged tissue and body building
 - ✚ to make enzymes
- the difference in temperature and PH denature the protein
- lack of protein causes **Marasmus** and **Kwashiorkor**
- Meat, fish, dairy product, white pea bean, egg, etc. are protein rich food.

Test for Protein

- ☐ **Biuret test**
- **reagent** – Potassium hydroxide
- and copper II salphate
- **result/color change** – purple (mauve) colour

iii. LIPID (FATS AND OILS):-

Fat	Oil
Solid at room temperature	liquid at room temperature
Mainly Animal product	Mainly Plant Product

- lipids are made up of carbon, hydrogen and oxygen, but, lower proportion of oxygen than carbohydrates.
- the simplest form of lipid is **Glycerol** and **fatty acids**.
- fatty acids have a long hydrocarbon chain
- One glycerol combines with three fatty acids
- high levels of fat and Cholesterol in our diet are not good for health

Fatty acid branches into:

- **Saturated** → each carbon atom is joined to another by single bond
- **Unsaturated** → carbon chains have one or more double bonds

- **source of energy** in your diet and they are the most effective energy store
- they contain **more energy** per gram than carbohydrates or proteins

- Combined with other molecules, it has vital roles as **hormones**, in your **cell membranes** and in the **nervous system**.
- All lipids are insoluble in water, but dissolve in organic solvents.
- Meat, oily fish, eggs, butter, beef fat, sesame oil, niger seed oil (nig) and olive oil are sources of lipid.
- **Cholesterol**: most made in your liver and some come from food we eat
 - carried around your body in your blood
 - Without cholesterol, you wouldn't survive.
 - It makes the cells membranes, sex hormones and the hormones which help your body deal with stress.
 - High levels of cholesterol in your blood seem to increase your risk of getting **heart disease or diseased blood vessels**.

Test for Lipid

- **Reagent**: Ethanol
- Place a small sample of fat/oil in a test tube
- add ethanol
- Shake the test tube
- add water
- **Result**: White cloudy layer formed

Testing for vitamin C

- ✓ DCPIP (dichlorophenol indophenol) reagent
- ✓ Pour about 3 cm³ of DCPIP into a clean test tube
- ✓ Using a dropper, add orange or lemon juice drop by drop to DCPIP in the test tube.
- ✓ Positive result: gradual fading of the blue color of DCPIP

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iv. MINERALS:

- minerals are needed in small amount

Mineral	Approximate mass in an adult body (g)	Location or role in body	Example of foods rich in mineral	Effects of deficiency
Calcium	1000	Making bones and teeth	Dairy products, fish, bread, vegetables	Rickets
Phosphorus	650	Making teeth and bones; part of many chemicals, e.g. DNA	Most foods	Improve formation of teeth and bones; failure of metabolism
Sodium	100	In body fluids, e.g. blood	Common salt, most foods	Muscle cramps
Chlorine	100	In body fluids, e.g. blood	Common salt, most foods	Muscle cramps
Magnesium	30	Making bones; found inside cells	Green vegetables	Skeletal problem; cell chemistry affected, defects in metabolism
Iron	3	Part of haemoglobin in red blood cells; helps carry oxygen	Red meat, liver, eggs, green leafy vegetables, e.g. spinach	Anaemia

V. VITAMINS:

Vitamins	Food rich in Vitamins	Deficiency disease
Retinole (V _A)	Green pepper, carrot, leafy vegetables, cod liver oil	Poor sight, poor growth
Thiamin (V _{B1})	Cereals, milk, liver, sprouted beans	Beriberi, loss of appetite, disease of muscle
Riboflavin (V _{B2})	Green vegetables, liver, milk, meat, peas	Slow growth, eye disease, tongue inflammation
Niacin (V _{B3})	Milk, meat, vegetables	Pellagra
Ascorbic Acid (V _C)	Green pepper, lemons, orange, vegetables	Scurvy, bleeding gum, slow healing
Calciferol (V _D)	Fish liver oils; also made in skin in sunlight	Ricket
Tocopherol (VE)	Cereal oil, milk, egg, yolk, lettuce, seeds	Sterility
Phylloquinine (V _K)	Green leaf vegetables	Prolonged blood clotting time

v. The role of Water

- your body is 60%-70% water
 - ❖ it is vital solvent
 - ❖ Transport substance in the body. *example. urea, sweat*
 - ❖ For body temperature regulation. *example. sweat*
 - ❖ for removal of waste material
 - ❖ it is a reactant in many important reaction in the body
 - ❖ needed for osmotic stability of the body

Balanced diet

- Is taking food from all food groups in order to maintain a healthy body.

Malnutrition: when diet lacking in important elements needed for a healthy body.

Over nutrition: when too much food is eaten

Under nutrition: when too little food is eaten

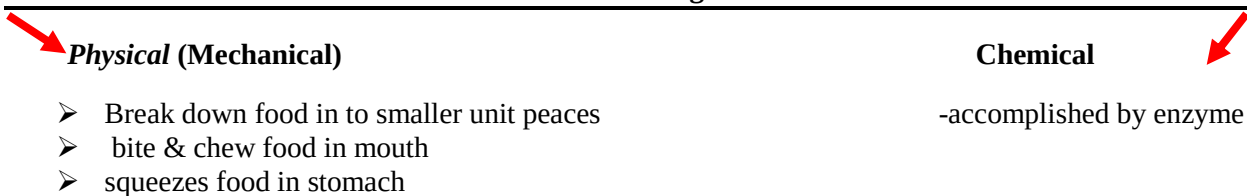
$$\text{BMI} = \frac{\text{Weight}}{(\text{height})^2}$$

3.2 The Digestive System

Digestion: breakdown large, insoluble molecules in to smaller, simplest, & soluble molecule

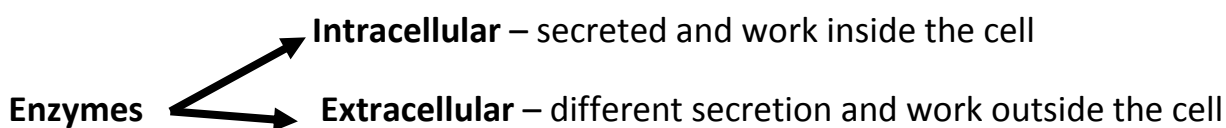
- It provides energy & new biological molecules.

Digestion



More about enzyme:-

1. enzymes are protein
2. enzymes are catalyst – *remain unchanged*
3. enzymes are specific – *one enzyme catalyze only one reaction*
4. enzymes are sensitive to temperature – *all human enzymes are best at 37c⁰*
5. enzymes are sensitive to PH – *each enzymes have their own range of PH*



Digestion in mouth

- Both chemical and physical digestion occur here
- **Ingestion:** the act of taking in food
- **Mouth:** select taste, smell and texture of food
 - Bite, chew and chop the food by teeth known as **mastication**
 - mix food with enzyme



The Human Teeth

- there are 4 types of teeth
 - ➔ **Incisors** – *front teeth*
 - ➔ **Canine** – *long and pointed teeth*
 - ➔ **Premolars** – *flat teeth*
 - ➔ **Molars** – *found at the back*

Structure of human teeth

- **Enamel** → the outer cover
 - The strongest part (hardest)
 - white color that resist decaying

- non-living part
- **Dentine** → found next to enamel
 - very hard, similar to bone
- **Pulp Cavity** → the center of the teeth
 - contain nerve and blood vessels
 - sensitive to heat, cold and pain
- **Cement** → keep teeth firm with jaw (set in to your jaw)

Moving the food:-

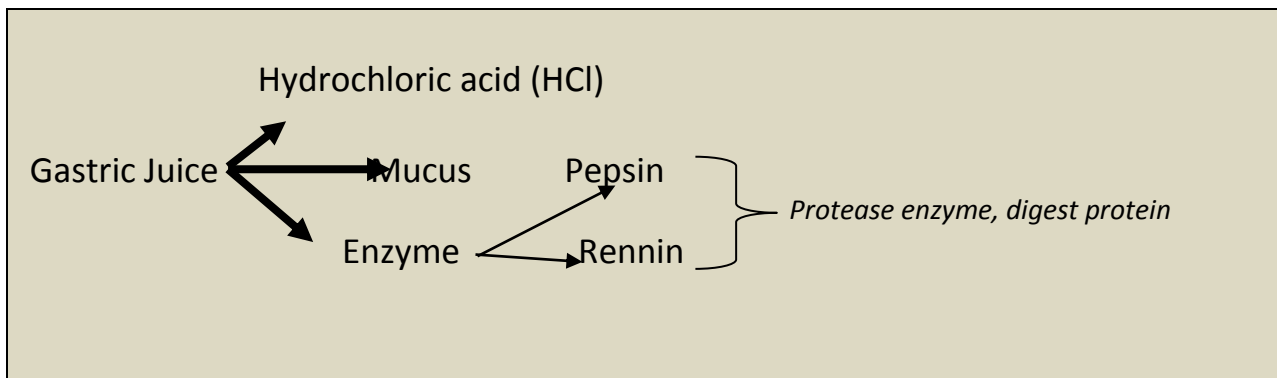
Bolus: ball shaped saliva coated chunk of chewed food

Peristalsis: wave like muscle contraction to move food along the throat

Epiglottis: the flap that covers the trachea during swallowing so that food does not enter the lungs.

Digestion in Stomach

- Digestion in stomach take 1-4 hours
- **Sphincter:** ring of muscle found at the first and last parts of the stomach
- open only during swallowing and being sick
- In stomach food mixed with **gastric juice**



- **HCl:** Make the food suitable for action of pepsin
 - kill some bacteria
- **Mucus:** Protect wall of stomach from attack by HCl.
- **Pepsin:** the major gastric juice enzyme
 - work best in acid

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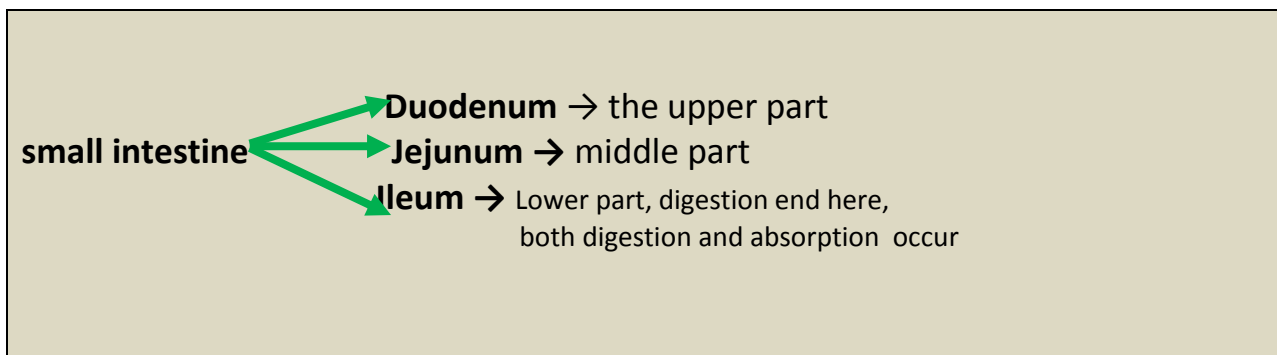


- **Rennin:** Mostly found in mammals
 - Curdle milk protein
- **Chyme:** is grey soup like mixture pass to the intestine from the stomach

Digestion in Intestine

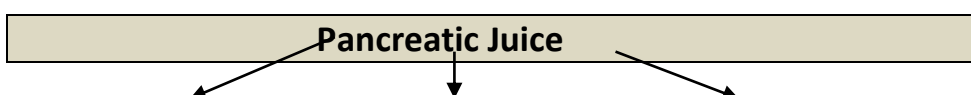
Small Intestine: is about 6-8m coiled tube

- Produce protease, carbohydrase and lipase enzyme



a. In Duodenum

- it contain **bile** and **enzyme**
- pancreas secrete **pancreatic juice**



Trypsin

Lipase

Pancreatic amylase

- ❖ Peptone $\xrightarrow{\text{trypsin}}$ peptide
- ❖ fat and oil $\xrightarrow{\text{lipase}}$ fatty acid and glycerol
- ❖ starch $\xrightarrow{\text{amylase}}$ maltose

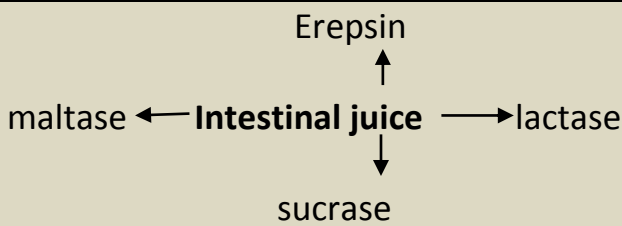
- **Bile:** secreted from liver, has no enzyme

- it is alkaline (base)
- stored in gall bladder
- help to neutralize acid

Fat $\xrightarrow{\text{Bile}}$ **Fat droplet (emulsify fat)**

b. In Jejunum and Ileum

- **Intestinal juice** is secreted here



- ✓ Peptides $\xrightarrow{\text{Erepsin}}$ Amino acid
- ✓ Maltose $\xrightarrow{\text{maltase}}$ Glucose and glucose
- ✓ Lactose $\xrightarrow{\text{lactase}}$ Glucose and galactose
- ✓ Sucrose $\xrightarrow{\text{sucrase}}$ Glucose and Fructose

Absorption: glucose, amino acid and fatty acid and glycerol leave the small intestine by diffusion and go in to the blood supply.

- Small intestine have finger like projection called **Villi** that absorbs food
- glucose and amino acid directly go in to the blood
- fatty acid and glycerol, move in to the lacteals
- lacteals is part of lymph system with lymph fluid it goes to blood supply
- Digested food in small intestine move in to the liver through hepatic portal vein then to each individual cell.

Assimilation: taking in and uses of digested food by the cell

Engestion: removal of the faeces from your body

Issue of digestive health

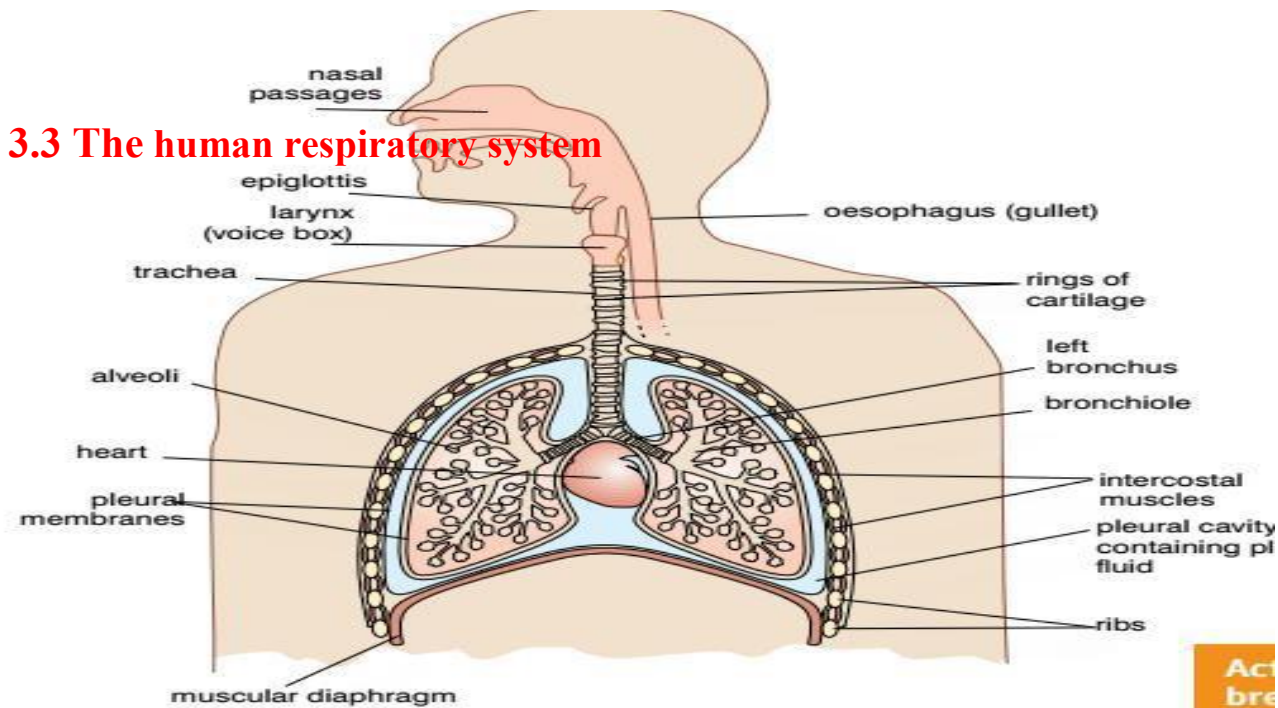
Constipation: compacted, hard and difficult to evacuate faeces, because of loss of water (lack of fiber)

- treated by: eating more fiber
 - drinking plenty of water
 - taking laxatives

Diarrhoea: very loose and watery faeces

- treated by: drinking water with rehydration salt

3.3 The human respiratory system



Structure of human respiratory system

- The respiratory system is a vital in order to get **oxygen** to oxidize food and release **energy** for proper functioning of the body.

The human respiratory system consisting of the following structures:

- Mouth:** is an organ through which the air enters into respiratory structures
- Nose/nasal cavity:** is additional structure through which the air enters into respiratory tract.

Nose contains the nasal passages, which have:-

- a large surface area,
- a good blood supply,
- Lots of hairs and a lining that secretes mucus.

→ The **hairs** and **mucus** filter out much of the dust and small particles that we breathe in, Whilst **moist surfaces increase** the humidity of the air we breathe into our bodies and the rich blood supply warms it

→ This means that the air we take in is **warm, clean, and moist** before it gets into the delicate tissue of our lungs.

- Pharynx:** is the structure that serves as a common passage for both food and air
- Larynx or voice box:** the upper part of trachea by directing air leaving the lungs over the vocal cords.
- Trachea:** is the wind pipe which is made from **C-shaped** cartilage that supports it and holds it open.

The lining of the trachea secretes **mucus**, which collects bacteria and dust particles.

The cells that line the trachea are also covered in hair-like **cilia** that beat to move the mucus with any trapped micro-organisms and dirt away from the lungs and towards the mouth.

✓ The opening of trachea is called **glottis**.

The entrance of food and dust particles into the glottis is prevented by **epiglottis**.

- Bronchi (singular bronchus):** are the branches that arise from the trachea, one leading to each lung.
- Bronchioles:** are small tubes branching from each bronchus in the lung. They are much smaller than bronchi.
- Alveoli (singular alveolus):** are tiny air sacs which are used for exchange of gases between the lungs and the blood capillaries, they are called functional unit of the lung.

The lung is the major breathing organ of human; it is surrounded by membranous structure called **pleural membrane**.

The lung is spongy and elastic organ which is protected by ribs, vertebral column, diaphragm and intercostal muscle.

Diaphragm: muscle separating heart and lung from abdomen.

Intercostal muscle: are muscles that are found between the ribs and used in breathing.

There are two sets of intercostal muscle in normal quite breathing only external intercostal muscle is involved, however if we need to breath deliberately internal intercostal muscle is involved

How is air brought into the lungs?

- **The** process of breathing involves the process of inhalation and exhalation.
- The breathing movements are brought about by two different sets of muscles that change the pressure in the chest cavity.

The mechanism of breathing

Structure	Inhalation (breathing in)	Exhalation (breathing out)
Diaphragm	Contract & flatten	Relax & become dome shaped
External intercostal muscle	Contract	Relax
Internal intercostal muscle	Relax	Contract
Ribcage	Moves up & outwards	Moves down & inwards
Chest cavity	Looks bigger	Looks smaller
Pressure	Decreases	Increases
Lung	Inflated (filled with air)	Constricts(defleats)
The volume of thorax	Increases	Decreases

The process of gaseous exchange

- breathing in supplies us with the oxygen we need for cellular respiration
- when we breathe out waste carbon dioxide is removed from the body
- When the air is breathed into the lungs, O₂ passes into the blood by diffusion along a concentration gradient.
- At the same time CO₂ passes out of the blood into the air of the lungs, also by diffusion along a concentration gradient.
- This exchange of gases takes place in the alveoli, the tiny air sacs with a large surface area that make up much of the structure of the lungs.
- The movement of O₂ into the blood and CO₂ out of the blood takes place at exactly the same time
- There is a swap or exchange between the two and so this process is known as gaseous exchange

- The mechanism of gas exchange in the alveoli depends on:-
 - a large surface area
 - moist surfaces
 - short diffusion distances
 - a rich blood supply These maintain steep concentration gradient

Factor affect breathing rate

The breathing rate is determined by the rate of breathing and depth of breathing

The normal rate of breathing in adult human being is 12-14 times per minute

Depth of breathing: is the amount of air inhaled or exhaled per breath

Tidal volume: is the amount of air that one can be breathed in & out at normal resting situation

Vital capacity: is the maximum amount of air that is breathed in and out:

The rate of breathing can be affected by the following major factors. These are:

A. Exercise

- During exercise when muscular activity increases, the breathing rate and depth of breathing increases to supply more oxygen to release energy for the body.

B. Anxiety

- During anxiety the body reacts as it is in danger, extra oxygen needed to more energy in order to survive danger, therefore the rate & depth of breathing increases.

C. Drugs

- Stimulant drugs such as khat and cocaine can increases the rate and the depth of breathing.

D. Altitude

- At places of higher altitude; the level of oxygen becomes lower & lower. This makes breathing

difficult thus the rate and depth of breathing becomes higher.

E. Weight

- Excess weight can also affect the breathing rate.
- It can be difficult to breathe deeply because of the fat around the abdominal organs, which makes it difficult for the diaphragm & other structures around the lungs to relax properly.

F. Smoking

- Smoking is a habit that directly affects your respiratory system as well as other areas of your body

The effect of smoking on The health:

The cigarette smoke consists of around **4000** chemicals that are inhaled into the lungs. **some of these include:**

Nicotine: is the addictive drug found in tobacco smoke.

Carbon monoxide: is a very poisonous gas found in cigarette smoke .It takes up some of the oxygen carrying capacity of the blood.

Tar: is a sticky black chemical in tobacco smoke and causes irritation of nose , throat & lung.

Carcinogenic substances: are cancer causing substances; the most commonly carcinogenic are arsenic & benzene.

Smoking-related diseases

- Smoker health may get affected in various ways :
- **Tar** is a **sticky** black chemical in tobacco smoke that is not absorbed into the bloodstream.
- It simply accumulates in the lungs, turning them from pink to grey.
- In a smoker, the cilia which move things away from the lungs are anaesthetized by each cigarette and stop working for a time, allowing dirt and bacteria down into the lungs.
- Tar makes smokers more likely to develop **bronchitis** -inflammation and infection of the bronchi.
- The build-up of tar in the delicate lung tissue can also lead to a breakdown in the alveolar structure.
- In these **chronic obstructive pulmonary diseases (COPD)** the structure of the alveoli break down and much larger air spaces develop.
- Cancers of lung, lips, and throat can be caused due to carcinogenic substances
- Smoking also affects heart & blood vessels which increases the risk of the heart attack and stroke.

Smoking and the family:

- Smoking may have individual, family & the society; some of its effects include:
 - Economic crisis
 - Increased risk of respiratory diseases
 - Psychological problems
 - Conflict in the family

Breathing hygiene:

- There are mechanisms that can be used to keep the breathing system into a healthy state:
 - Good oral hygiene
 - Covering the mouth during cough & sneezing
 - Consult a doctor for any problems related to respiratory organs

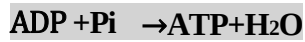
3.4 Cellular respiration

The digestive system, breathing, and circulation systems all exist to provide the cells of the human body with what they need for respiration.

- **Respiration:** is the process in which energy is released from the breakdown of organic substances in the body.
- The energy that is used by the cells is stored in the form of a molecule known as **ATP**,
- Which stands for **adenosine triphosphate**. This is an adenosine molecule with three phosphate groups attached to it.
- When energy is needed for any chemical reaction in the cell, the third phosphate bond is broken in a hydrolysis reaction.



- **ATP** is formed by the bond between **adenosine diphosphate &** a free inorganic phosphate group (**Pi**) and the all-important energy needed in the cell.



The importance of ATP to the body:

- to build up large molecules from smaller ones to make new cell material (**anabolism**). And
- also break large molecules down into smaller molecules (**Catabolism**).

Anabolism + Catabolism = Metabolism

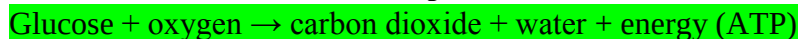
- **To enable muscle contract and relax**
- Provide energy for the active transport of some substances across cell boundaries

Types of Respiration

I. Aerobic respiration

- during the process of cellular respiration, glucose reacts with oxygen to release energy that can be used by the cell. Carbon dioxide and water are produced as waste products.

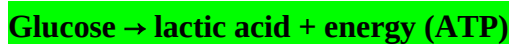
The reaction can be summed up as follows:



- Aerobic respiration takes place in the mitochondria in cells.
- These are tiny rod-shaped bodies (organelles) that are found in almost all cells.
- Cells that use a lot of energy contain lots of mitochondria

II. Anaerobic respiration

- breaking down of food to release energy without oxygen
- it is a type of respiration that **does not use oxygen**.
- Anaerobic respiration produces **far less ATP** than aerobic respiration.
- It also produces a different waste product called lactic acid.



3.5 The circulatory system

- The transport system is required to supply the needs of the body cell & remove the waste products they produce.

The human transport system is the blood circulation system. It has three elements: the **pipes** (blood vessels), the **pump** (the heart), and the **medium** (the blood)

A double circulation:

Human circulatory system is called a double circulation. it consists:

- One carrying blood from the heart to the lungs and back again to exchange oxygen and carbon dioxide with the air. This is called **pulmonary circulation**
- The other carrying blood all around the rest of the body from the heart and back again. This is called **systemic circulation**

A. The blood vessels

- A very important element of any transport system is the pathways along which the transport takes place.
- In the human body there are three main types of blood vessels:-

Arteries, Veins & Capillaries

Arteries: carry blood away from the heart

The largest artery is called aorta

The smallest artery is called arterioles

- It have thick walls that contain muscle and elastic fibres
- It have a **pulse:** the pulse is the surge of blood from the heart when it beats
- they have no valves
- Most arteries carry oxygenated blood **‘except:**

- **Pulmonary artery** which carry the blood away from your heart to your lungs
- **Umbilical artery** which carries blood away from a foetus into the placenta

Veins: carry blood towards the heart.

The largest vein is called venacava

The smallest vein is called venules

- ▲ They have much **thinner** walls than arteries & less elastic wall\
- ▲ They do not have a pulse but they often have valves
- ▲ Most veins carry deoxygenated blood except:
 - ✓ **Pulmonary vein**, which carry oxygenated blood back from lungs to the left-hand side of heart
 - ✓ **Umbilical vein**, which carries oxygenated blood from the placenta back to the developing foetus.

Capillaries

- ▲ They are narrow, thin walled blood vessels
- ▲ It help to connect arteries with veins and take blood to the tissues & cells
- ▲ They have no valve
- ▲ They are site of the exchange of substances within the body.
- ▲ Blood from the arteries passes into the capillaries, which have thin walls & massive surface area.

B. The Human heart

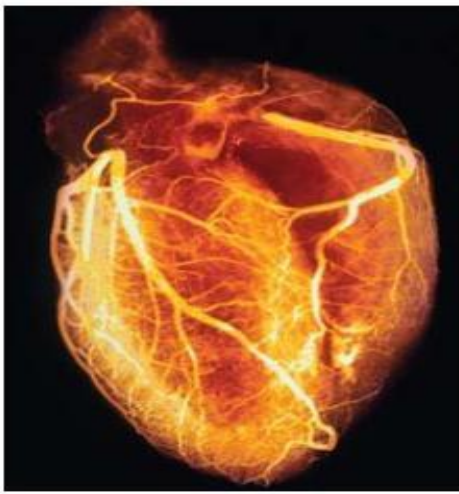
- The human heart is a bag of reddish-brown muscle that beats right from the early days of development until the end the life, sending blood around the body.
- It is made up of a unique type of muscle known as **cardiac muscle**
- The walls of the heart are almost entirely muscle.
- These muscular walls are supplied with blood by the **coronary arteries** (supply oxygenated blood to cardiac muscle).
- The deoxygenated blood is carried away in the coronary veins, which feed back into the right **atrium (atria)**.
 - **Human heart is divided into 4 chambers**
 - **The two upper chambers are the right & left atria**
 - **The two lower chambers are the right & left ventricles**
 - The walls of the atria are relatively thin, so they can stretch to contain a lot of blood.
 - The walls of the **ventricles are much thicker**, as they have to pump the blood out through the major blood vessels.
 - The muscle walls of the left-hand side of the heart are thicker than on the right. This is because the left hand side of the heart has to pump blood around the whole body whilst the right-hand side pumps only to the lungs.

The working of the heart

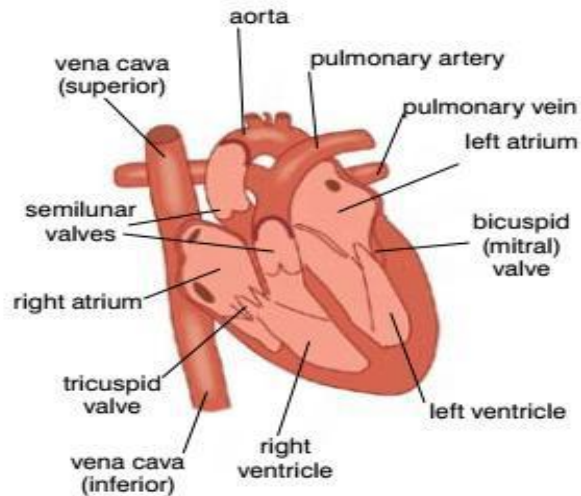
- ✓ The two sides of the heart fill and empty at the same time to give a strong, coordinated beat

Mechanism of blood circulation

Deoxygenated blood, which has supplied oxygen to the cells of the body and is loaded with carbon dioxide, comes into the right atrium of the heart from the veins of the body. The atrium contracts and forces blood into the right ventricle. The right ventricle contracts and forces blood out of the heart and into the lungs where it is oxygenated - it picks up oxygen. Oxygenated blood returns to the left-hand side of the heart from the lungs and the left atrium fills up. The left atrium contracts forcing blood into the left ventricle. The left ventricle contracts forcing oxygenated blood out of the heart and around the body



a) External view to show coronary arteries



b) Vertical section through the heart

Valves

Valves: mechanism in the veins that allows blood to flow in one direction only.

- inside the heart there are many different valves.
- their names describe their appearance;
- **bicuspid (two parts):** are found between the left atrium & left ventricle
- **Tricuspid (three parts)** are valves between the right atrium & right ventricles.
- **Semilunar (half-moon):** valve found at the base of aorta and pulmonary artery

Septum: - wall separating the right and left sides of the heart

- **Diastole** is when the heart muscles relax and it fills with blood.
- **Systole** is when the heart muscles contract and force the blood out of the heart

The pressure at which the blood travels around our arteries varies as the heart beats.

- ➔ A normal blood pressure is about **120 mmHg/80 mmHg** -the nominator is systolic & the denominator is diastolic pressure.
- ➔ **Sphygmomanometer:** is an instrument that is used to measure blood pressure.

C. The blood

- Blood is a complex mixture of cells and liquid that carries a huge range of substances around the body
 - Blood consists of a liquid called the plasma.
 - **Plasma:** - is a **pale yellow** liquid that transports all the blood cells & also number of other things.
- There are components of blood cells.** These are:

Red blood cells (Erythrocytes)

- They are more in number than other types of blood cells
- They are disc shaped & non-nucleated cells.
- They are made in bone marrow, when they mature they lose their nucleus.
- The RBC only live 100-120days so they are constantly being replaced.
- They are used to carrying O₂ around our body. Because they are packed with a special **red** substance called **haemoglobin**, which picks up oxygen.
- **Hemoglobin** is a special red pigment, a large protein molecule folded around four iron atoms.
- In a high concentration of oxygen, such as in the lungs, the **hemoglobin** reacts with oxygen to form oxyhaemoglobin. This is bright, which is why most arterial blood is bright red.
- In areas where the concentration of oxygen is lower, such as the cells and organs of the body, the

reaction reverses

- The **oxyhaemoglobin** splits to give purple-red haemoglobin (the colour of venous blood) and oxygen
- The oxygen then passes into the cells where it is needed by diffusion.

White blood cells (leukocytes)

- They are much bigger than the red cells but they are fewer of them.
- They have a nucleus and form part of the body's defense system against microbes
- They can be classified as:

Lymphocytes- form antibodies against microbes

Phagocytes-engulf invading microorganisms

Platelets (thrombocytes)

- They are small fragments of cells and very important in helping blood to clot at the site of a wound.
- Platelets have thread like protein fiber called fibrin for blood clotting to trap blood cells, platelets and fluid through a complex series of enzymes controlled reactions.
- The clotting of the blood prevents from bleeding to death from a simple cut
- It also protects the body from the entry of bacteria and other pathogens

Human blood groups

- ✚ There are special proteins called **antigens** are found on the surface of all cells.
- ✚ They allow cells to recognize each other and also to recognize cells from different organisms
- ✚ If the cells of an immune system recognize a foreign antigen on a cell in the body, they will produce **antibodies** & it destroy the foreign cells.
- ✚ A number of different antigens are found specifically on the surface of the RBC, which gives different human blood groups.
- ✚ The blood grouping system is called **ABO** system.
- ✚ Based on presence and absence of these antigens, there are four types of blood groups
- ✚ There are two possible antigens : Antigen A & antigen B
- ✚ There are also two types of antibodies:- antibody A & antibody B
- The below table describe the compatibility of Different blood groups

Blood group	Antigen on RBC	Antibody in the plasma	Donate to	Receive from
A	A	B	A & AB	A & O
B	B	A	B & AB	B & O
AB	AB	None	AB only	All groups
O	None	A and B	All groups	O only

- Blood group 'O' is called **universal Donor**, because it has no antigens so, it can be given to anyone.
- Blood group 'AB' is called universal recipient, which has no antibodies can receive any type of blood
- If the blood from different blood groups is mixed together, there may be a reaction b/n the antigen & the complementary antibody which makes the red blood cells stick together, this is called **agglutination**.

Two common problems of the circulatory system:

A. **Anemia**: it is caused when there are:

- ✓ too few red blood cells in the body, or too low levels of hemoglobin in the blood.
- ✓ It is most commonly due to lack of **iron** in the diet so it is treated by iron rich diet.

B. **Hypertension (High Blood Pressure)**:

- Is considered high if the systolic pressure is **>140mmHg** or the diastolic pressure is **>90mmHg**
- There are a number of factors that can increase the risk of hypertension.
- Many of these factors mean that blood vessels are likely to be getting narrower, or becoming more rigid

These factors include: -

- Increasing age,
- being overweight,
- Excessive salt intake,
- sedentary (inactive) lifestyle,
- smoking,
- kidney diseases, diabetes and
- certain medicines such as steroids

- Excessive consumption of alcohol,
- **Treatment of hypertension**
 - Losing weight
 - Life style adjustment
 - Lower salt level in diet
 - using medicines like:

Diuretics: which increase frequency of urination to decrease the blood volume and

Beta blockers: - these **blocks** the nerves w/c narrows the arteries

UNIT: 4

MICROORGANISMS AND DISEASES

4.1. Micro-organisms

Micro-organisms are tiny living organisms that are usually too small to be seen with the naked eye, these includes bacteria, viruses, yeast and mould

Many of microorganisms are very useful while other cause diseases.

Bacteria

- Are single celled organisms
- They are much smaller than the smallest plant& animal cells.
- They contain cytoplasm surrounded by a membrane
- They have non cellulose cell wall
- Some bacteria have flagella to help to them move
- They also come in a variety of different shape and size

Viruses

- ✓ are even smaller than bacteria
- ✓ They usually have regular geometric shapes, and
- ✓ They are made up of a protein coat surrounding genetic material containing relatively few genes.
- ✓ They do not carry out any of the functions of normal living organisms except reproduction
- ✓ They are obligate intracellular parasites
- ✓ They have either DNA or RNA as genetic material

Fungi (Yeast and mould)

- **Yeast** are single -celled organisms
- Each yeast cell has a nucleus, cytoplasm, and a membrane surrounded by a cell wall.
- They reproduce is by asexual budding - splitting to form new yeast cells.

Moulds

- ❖ They are made up of, threadlike structures called **hyphae**.
- ❖ The hyphae are not made up of individual cells - they are tubes consisting of a cell wall containing cytoplasm and lots of nuclei.
- ❖ They reproduce asexually by spore formation.

The germ theory of disease

- ✚ Germs are micro-organisms responsible for cause of some diseases
- ✚ The development of microscope Anton van Leeuwenhoek in 17th century helped different biologists to explain the relationship between infectious diseases & micro organisms
- ✚ The development of knowledge about micro-organisms is actually related to the theory of spontaneous generation.

The theory of spontaneous generation

- States that living things could arise from non-living things spontaneously. This theory is opposed by many biologists & a French biologist **Louis Pasteur** disproved it finally by using an **S-shaped flask** that traps dust & microorganisms.
- Pasteur was convinced that any growths that appeared -for example, **mould** on food as it decayed - came from microscopic organisms already present in the air.
- First he showed that the theory of spontaneous generation was wrong. Then he showed that if he boiled broth and sealed the container, the broth would stay clear until he introduced material which had been exposed to the air.
- At this point micro-organisms grew and the broth turned cloudy

- Pasteur went on to identify the micro-organisms that caused a number of diseases including anthrax, rabies, and diphtheria.

The immune system

- **Immune system**:- the system in the body which protects the body against invading microorganisms and foreign proteins.
- Like all living cells, pathogens carry unique protein molecules called **antigens** on their cell surfaces. When a pathogen gets into the body the antigens on the surface stimulate a response by the immune system.
- White blood cells (lymphocytes) produce antibodies to disable the pathogen. Other white blood cells (the phagocytes) then engulf and digest the disabled pathogens.
- Once someone have had a disease, the immune system 'remembers' the antigen and the right antibody to deal with it.

Control of microorganisms

- **Sterilization** is the killing of all micro-organisms in a material or on the surface of an object, making it safe to handle. These include the use of:
- **High temperatures or heat**
 - It is highly efficient means of sterilization
 - ✓ **Autoclaving**: it involves the killing of microorganisms by boiling in water at 121 °C. under high pressure for 15-45 minutes of 'cooking' at these temperatures
 - ✓ **Ultra high temperature (UHT)** is a way of treating food to kill all the micro-organisms on it. The temperatures used range from around 135 °C to 150 °C
 - ✓ **Dry heat sterilization**: Dry heat, over a long time, kills all micro-organisms. Special ovens used in **microbiology** use temperatures of 171 °C for an hour, or 160 °C for 2hours,.
 - ✓ **Incineration** - burning substances at high temperatures in the air - also kills micro-organisms
 - ✓ **Pasteurization**: it involves boiling or heating of milk, beer and other foodstuffs at 71.6 °C for at least 15 seconds or 62.9 °C for 30 minutes.

A chemical approach to controlling micro-organisms

- Possible pathogens can be attacked **chemically** in a number of ways .for e.g.
- 1. A **disinfectant** is a chemical or physical agent that is applied to an inanimate object to kill micro-organisms. Disinfection means reducing the number of living micro-organisms present in a sample This method discovered **by Joseph Lister**. some of example of disinfectant include: house hold bleach, Dilute bleach and calcium hypochlorite
- 2. **Antiseptics**: are chemical agents that are applied to living tissue to kill micro-organisms -disinfectants for the skin.
 - it help to protect entrance of germs if the skin is cut or wounded.

Growing of microorganisms

- Micro-organisms can be grown in laboratories under controlled condition.
- It is important for various purposes; these include:
 - To know how to killed them
 - To develop vaccines
 - To identify their useful & harmful aspects

For growing microorganism's biologist need to fulfill the following precondition:

- Isolating type of microorganisms to be studied
- developing suitable nutrient like agar and broth
- **Agar**: is a solid nutrient medium which is extracted from red algae
- Broth**: is a liquid nutrient medium

Antibiotics

- ✓ Drugs which kill bacteria but do not harm human cells
- ✓ Penicillin was the first antibiotic to be discovered

Artificial immunity

Our body has its own natural ability to protect itself against artificial disease, however if the immune system of the body fails to defend some dangerous disease it will be treated by artificial immunity.

Artificial immunity is given in the form of vaccine

Artificial active immunity: involves introduction of weakened or dead pathogen in the body which stimulates the body to produce its own antibodies.

It can be natural from mother to child (**natural passive**) until the child produces its own natural active immunity

Artificial passive immunity: it involves giving specific antibodies in the form of infection. It provides a high type of resistance but last only for short time.

Natural active immunity:- acquired from exposure to the disease organism through infection with the actual disease.

Vaccination (immunization):

- ✓ is the use of dead or weakened strains of pathogens to produce immunity to dangerous diseases
- ✓ the vaccination work through the following ways
 - a weak or dead form of the infecting organism is put into the body by injection or by mouth
 - once in the body, the white blood cells respond by producing antibodies
 - If the living micro-organism enters the body in the future, antibodies are produced very rapidly to destroy it and so the disease does not develop.

4.2. Diseases

- Disease is any form of disorder in or on the body distorts its normal functioning
- Some of the most commonly known diseases which are caused by pathogenic organisms among them include:

i. Tape worm (cestoda)

- ▶ Flat shaped worm that parasitizes the wall of intestine of humans
- ▶ They have no digestive system & but have cuticle to absorb nutrients
- ▶ The most common are beef tape worm (*Taenia saginata*) & the pork tapeworm (*Taenia solium*)
- ▶ They have complex life cycle which involves at least two different hosts.
 - **Transmission:** eating improperly cooked or raw meat
 - **Symptoms:** feeling weakness, weight loss, segments of tape worm in faeces
 - **Control & prevention:** avoid eating raw meat, use antiworm drug & proper disposal of faeces
 - **Life cycle of beef tape worm**
 - Cows raised in unsanitary conditions may contain **cysticerci** 'bladder worms' embedded in their muscles.
 - These consist of a capsule containing a **scolex**. When a bladderworm is ingested (e.g. in undercooked beef), The scolex turns inside out and attaches by suckers and hooks to the wall of intestine.
 - It then begins to produce buds, called **proglottids**, which remain attached to each other for a time and, as they mature, each develops both male and female sex organs.
 - The most mature proglottids eventually break loose and are passed out in the faeces. If conditions are such that cows get access to the human faeces, they take in the eggs and the whole cycle starts again.

ii. Tuberculosis

- ➔ It is caused by a bacterium called *Mycobacterium tuberculosis*
- ➔ It can affect anyone of any age, but People with weakened immune systems (such as people suffering from HIV/AIDS) are at increased risk

Transmission :

- Droplet infection, but need prolonged exposure to someone with TB for infection to

occur. work in overcrowded conditions

Symptoms

- Some people may not have obvious symptoms (asymptomatic), however the symptoms of TB include:

- a low-grade fever
- Night sweats
- fatigue
- weight loss and
- a persistent cough

Control and prevention

- In social terms avoiding overcrowded conditions
- Good ventilation
- Covering the nose & mouth during coughing
- vaccination

Treatment

- People with active TB disease must complete antibiotic for four months or more

The role of vectors in disease:

- A **vector** is an organism that transmits disease-forming micro-organisms from one host to another
- well-known example is the *Anopheles* mosquito, which carries the malarial parasite

iii. Mosquitoes and malaria

- **Malaria** is a disease where mosquitoes are the vector
 - The mosquito vector is the female *Anopheles* mosquito
 - The disease itself is caused by the single-celled parasite *Plasmodium*
 - It spends part of its life cycle in a mosquito and part in the human body

Life cycle

- ✓ Female needs two meals of human blood to provide protein for her developing egg and this is when she passes on her load of malarial parasites.
- ✓ If the first feed the mosquito takes is from someone infected with malaria, the *Plasmodium* parasites called *Plasmodium falciparum* remain in her mouthparts
- ✓ the next time she feeds, the *Plasmodium* parasites pass into the blood of the victim along with the saliva - and someone else is infected with malaria

Symptoms: These include fevers, chills, and sweats

Control and prevention: Methods of controlling malaria must involve controlling the *Anopheles* mosquitoes. This can be done by: Using mosquito repellents

- **having** screens on doors and windows
- insecticide-treated mosquito nets
- Proper disposal of sewage
- Minimize any opportunities for the mosquitoes to breed

iv. Gastroenteritis/acute watery diarrhea (AWD)

Intestinal infection causing acute watery diarrhea

Some of the causative organisms include rotaviruses, the bacteria *Salmonella* and *Escherichia coli* (*E. coli*), or the protoctists *Giardia* and *Amoeba*.

Transmission

- eating contaminated food or water
- prepares or handles food without washing their hands after going to the toilet
- poor sanitation
- poorly cooked and raw eggs if they are infected with bacteria such as *Salmonella*

symptoms

- violent abdominal cramps and pain
- feeling nauseous, vomiting or often both
- watery diarrhoea which does not usually have blood in it

- slight fever
- general muscle aches and headache

Control and prevention

- Good personal hygiene
- Avoid eating undercooked or raw food

v. Cholera

✓ It is caused by bacteria called *Vibrio cholera* & it infects intestine

Transmission: eating or drinking food or water contaminated by the faecal waste of an infected person

Symptoms: include the pale, watery diarrhea, vomiting and dehydration, muscle cramps

Treatment: taking more fluid to replace the lost through diarrhea & antibiotics, rehydration salt (ORS)

Control and prevention: avoid consumption of uncooked food

- Proper disposal of faeces ,
- Good personal hygiene and environmental sanitation
- Taking cholera vaccine

vi. Typhoid (Typhoid fever)

is a bacterial infection caused bacterium called *Salmonella typhi* - typhoid only affects humans

transmission : Like other diarrhoea diseases they are spread by eating foods or drinking water contaminated by faeces from an infected individuals

symptoms: it may include :A very high fever - 39-40 °C, A painful abdomen

Sore throat and headache, an enlarged **spleen** and **liver** , Constipation or diarrhoea

Treatment: antibiotics are used as a very effective treatment. Plenty of fluids to replace the ones they lose

Control and prevention: careful hand washing after toilet visits,

- clean drinking water and good sewage disposal
- good food hygiene in kitchens and care in eating raw or lightly cooked foods

vii. Sexually transmitted diseases (STDs)

- **STDs** are Infectious diseases spread by sexual contact it is also known as **venereal diseases (VD)**
- are a growing problem in Ethiopia -partly because sexual activity often starts relatively young
- the most commonly known STDs are:

A. Gonorrhea (gonococcal infection)

- Is caused by the bacterium *Neisseria gonorrhoeae*.
- Gonorrhea germs are found in the mucus areas of the body (the vagina, penis, throat and rectum).
- **Transmission :**It is spread through sexual contact, Having unprotected sex, having many sexual partner ○
- Symptoms:** burning sensation while urinating and a yellowish-white discharge from the genital organ
- ✓ If a pregnant woman has untreated gonorrhea, she can pass the infection on to her baby result in blindness

Treatment: it can be treated effectively in the early stages using antibiotic ○

Prevention& control:

- Infected individual do not have sex until your course of treatment is completed.
- Use a male or female condom
- Be faithful to sexual partner.

B. Syphilis

✓ Is bacterial infection, caused by the spiral-shaped *Treponema pallidum*

✓ Any sexually active person can be infected

Transmission: like gonorrhea It is spread through sexual contact

It is congenital syphilis, which is spread from mother to foetus. This can cause very serious problems for the baby when it is born.



Structure of *Treponema pallidum*

Symptoms: Syphilis progresses in distinct stages

- The symptoms occur in stages called primary, secondary and tertiary (late)
- **Primary stage (the first six weeks):** painless sores around reproductive organ, rectum, & mouth
- **Secondary stage (six weeks after):** The most common symptom during this stage is a rash. Other symptoms can include:
 - Tiredness
 - sore throat
 - hoarseness
 - patchy hair loss
 - Fever
 - headaches
 - loss of appetite
 - swollen glands

Untreated the disease then goes into a long quiet phase

- **Tertiary stage (late syphilis):**

Involve illness in the skin, bones, central nervous system and heart.

It causes severe and irreversible problems that cannot be treated successfully.

If a pregnant woman has untreated syphilis she may transmit the disease to her unborn child. This may result in death or deformity of the child.

Treatment: It is treated easily with antibiotics such as penicillin or tetracycline

- Pregnant women can be treated with antibiotics to cure them and protect their baby

Prevention& control: similar with gonorrhea

C. Chancroid

- It is a bacterial STD that is caused by the bacterium *Haemophilus ducreyi*
- It is more commonly seen in men than in women.

Transmission: having sex with an infected person & increase risk of becoming HIV-positive

Symptoms:

- The first symptoms of chancroid are sore ulcerations on the genitals, particularly penis, it is soft and filled with pus.
- The second stage of the infection is that the lymph glands in the groin also become infected,
- Permanent loss of penis

Treatment: it can be treated easily with a dose of antibiotics

Prevention & control:

- be faithful sexual partner
- Use a male or female condom
- Good genital hygiene & male circumcision

Using medicines correctly

Traditional medicines are very &alternative form medicine in developing countries like Ethiopia

- It is often holistic, based on treating the whole patient, but limiting their dose is very important.
- It is based on extracts of plants including herbs and spices.

Modern medicines: are responsible for cure various diseases &made in very carefully controlled doses

- The most common include: antibiotic & vaccine
- However care should be taken while using modern medicine: so the following precaution should be considered:
 - Do not take more than you are prescribed,
 - Do not take less than you are given

- Make sure you finish taking all the medicine
- Follow the instruction if not antibiotic-resistant bacteria may evolve which can be very serious indeed

4.3. HIV and AIDS

Acquired Immune Deficiency Syndrome (AIDS) is the medical term for a combination of illnesses that result when the immune system is weakened or destroyed.

It is caused by **Human Immuno deficiency Virus (HIV)**, a virus that attacks the immune system.

Transmission:

- ✓ sexual intercourse which is un protected
- ✓ It can pass from a mother to her baby in the womb, during birth or when she breastfeeds
- ✓ Infected blood on needles used for injecting illegal drugs, or knives used for female genital mutilation.

Symptoms

Patients often have few symptoms to begin with but eventually their weakened immune system means they get many diseases.

Treatment

Antiretroviral drugs can slow down the progress of HIV/AIDS and protect unborn babies from infection.

- ✓ The sooner people can start taking antiretroviral after infection, the longer they will stay healthy.

Prevention & control

- It can be controlled by **ABC** rule means that: •

A: abstain from sex

B: be faithful to sexual partner

C: condom use

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HIV and the immune system

How does HIV attack the immune system?

- There are two main types of white blood cells in the immune system. These are:
 1. **T-cells** actually bind to the antigens on the invading micro-organism and destroy it.
 2. **B-cells** make antibodies which bind to the antigen and destroy it.
- HIV attacks the T-cells of immune system. It gets inside them and so they can no longer work.
- As more T-cells are invaded by the virus, the immune system is less and less effective.
- This is why people with HIV/AIDS get so many other infections

Stigma and discrimination

- **Stigma** is a mark of disgrace on people with HIV, while **discrimination** is an act of neglecting some from the group or other. & are the most serious cases that affects people living with HIV/AIDS

Care and support

It is important for people living with HIV/AIDS since it helps them live longer & healthier

Unit 5:

Classification

5.1. Principles of classification

On Earth today there are many types of living things. This great variety of life is called **biodiversity**.

Classification: is grouping of similar living things.

Taxonomy: is study of classification of organisms (Greek, taxis-to arrange, nomos-law)

Need for classification

Biologists classify living things for the following reasons:

- To simplify their study
- To bring order out of chaos or confusion
- To try to understand how life originated

What is a species?

- ✓ A group of organisms that can breed successfully with one another to produce fertile offspring.

How are living things classified?

- Living things are classified according to how similar they are
- One example is animals that are put in a group together because their limbs are built on the same basic plan.
- The limbs of a bat, horse, bird, human and whale all have the same basic pattern though they are used in different ways these limbs are called **homologous** structures. (Similar structure with d/t function)
- Today there are more sophisticated ways of comparing organisms. The fundamental chemicals of life - such as DNA, RNA and proteins - are found in almost all organisms

The classification system

- ▲ **Taxonomy:** is the process of classifying living organisms'
- ▲ **Taxa:** category in classification
- ▲ **The main taxonomic categories are kingdom, phylum (or for plants, division), class, order, family, genus and species.**
 - The largest groups into which living organisms are divided are the kingdoms.
 - Kingdoms are subdivided into phyla,
 - Each phylum into classes, each class into orders,
 - Each order into families, each family into genera and each genus into species.
 - The species is the smallest unit of classification

Naming living things

Different method of classification was introduced by different biologists at different times:

Aristotle: Greece a philosopher .who tried to create a classification system for the living world, and grouped animals by: animals that live on land' and 'animals that live in water

The modern classification method is introduced by Swedish botanist **Carl Linnaeus** in 18th century.

- He developed the binomial system of nomenclature for organisms
- He published in a book called *The System of Nature*
- **Binomial** means two names. The two names of an organism are in Latin

Simple rules for writing scientific names

- The first name is the name of the genus name & it starts with capital letter. e.g. *Homo sapiens*,
- The second name is the name of a species & it is written with a small letter.
- The two names are underlined when handwritten or in italics when printed.

Table 5.1 Examples of scientific names of some common organisms

common name	Scientific name
Human beings	<i>Homo sapiens</i>
A dog	<i>Canis familiaris</i>
A housefly	<i>Musca domestica</i>
Domestic cat	<i>Felis domesticus</i>
Maize	<i>Zea mays</i>
Bean	<i>Phaseolus vulgaris</i>
Lion	<i>Panthera leo</i>

Living things are classified and named for the following main reasons.

- To create an internationally accepted way of referring to a particular living thing.
- To avoid confusion created by different languages.
- To help in simplifying classification and study of living things.

	Human	Honeybee	Teff	Mushroom
Kingdom	Animalia	Animalia	Plantae	Fungi
Phylum	Chordata	Arthropoda	Angiospermophyta	Basidiomycot
Class	Mammalia	Insecta	Liliopsida	Basidiomycetes
Order	Primates	Hymenoptera	Cyperales	Agaricales
Family	Hominidae	Apidae	Poaceae	Agaricaceae
Genus	Homo	Apis	Eragrostis	Agaris
Species	sapiens	mellifera	teff	campestris

Table 5.2 Hierarchy of groups

5.2. The five kingdoms

- ▲ A kingdom is the largest taxon and consists of all the other taxa. In the modern classification, there are five kingdoms namely:

- 1• Kingdom Monera
- 2• Kingdom Protista
- 3• Kingdom Fungi
- 4• Kingdom Plantae
- 5• Kingdom Animalia

- This system of classification is known as the **five-kingdom system**
- Viruses are not classified in any of the above kingdom. This is because viruses do not have all the seven characteristics of life, although most scientists now classify them as living organisms.

1. Kingdom Monera

- The representative groups are Eubacteria (**true bacteria**) & the blue-green algae (**Cyanobacteria**).
- They are unicellular & **prokaryotic** (have no distinctive nucleus).
- They are all microscopic and they reproduce by simply splitting in two (binary fission)
- They have either autotrophic or heterotrophic mode of nutrition
- Examples include *Mycobacterium tuberculosis* and *Haemophilus ducreyi* which are pathogenic while others are useful.

2. Kingdom Protista

- Consists usually unicellular & eukaryotic (do have nucleus)
- They include plant-like organisms that can move around and animal-like organisms that cannot move
- Representative groups of this kingdom are subkingdom protozoa & subkingdom algae

A. Subkingdom protozoa

- They are microscopic & have no chloroplasts
- They live as parasite or free living
- Have locomotory structure. e.g. Amoeba- **pseudopodia** , Paramecium:-**cilia**

B. subkingdom algae

- They are photosynthetic & eukaryotic
- They live either in aquatic habitat or on land
- They have undifferentiated body called thallus.
- E.g. **Dinoflagellates, red algae, & green algae**

3. Kingdom Fungi

- Fungi are eukaryotic and usually multicellular.
- They are heterotrophic
- Many fungi are **saprotrophs**, which means they feed on dead material.
- They play a vital role within ecosystems as decomposers
- Examples of this type of fungus are *Rhizopus* , *Mucor* and *Penicillium*
- They can be parasites, feeding on living organisms. Such as *Candida albicans* (thrush) and *Tinea pedis* (athlete's foot) affect people and other animals.
- Some fungi are **mutualists**. This means they live in close association with another organism

- and both benefit. Examples are **lichens**, which are a combination of a fungus and green algae
- **Mycorrhizae**, an association between a fungus and the roots of a plant.
- There are also single celled fungi like **yeast**.

4. Kingdom Plantae

- The plants - includes a great variety of organisms, which range from tiny mosses to giant trees & 80% of these are flowering plants
- The main characteristics of all plants include
 - They have eukaryotic cells.
 - They are multicellular organisms
 - They contain chlorophyll and carry out photosynthesis.
 - They are predominantly land dwelling.
 - Their cell wall composed of cellulose
 - Most have a waxy cuticle that helps to prevent drying out
- The kingdom is split into a number of divisions. Plant divisions are the same as animal phyla. The four most important divisions are:

A. Division Bryophyta (mosses and liverworts)

- They are the simplest land plants.
- They do not have a true leaf, stem & root system
- They are non-vascular (do not have xylem and phloem).
- The best examples of bryophytes are mosses like *Etodon concinnus*, and *Funaria* species.

A moss plant:

- has a simple, slender stem.
- They also have thin simple leaves
- also have simple root-like structures called **rhizoids** and attach the mosses to the soil & used for absorption of water.
- The other example is the liverworts, which only grow in very wet places.
- Bryophytes are commonly found in rainforests and at high altitudes on mountains



Figure 5.8 Mosses like this can be found in damp places in Ethiopia.

B. Division Pteridophyta (Filicinopyta)-ferns

- ❖ They have true leaves, stems, and roots.
- ❖ Fern stems have **rhizomes**, which grow horizontally just below the surface of the soil.
- ❖ They have vascular tissue
- ❖ They have large prominent leaves called fronds
- ❖ Their spore produced in the fronds & dispersed by wind
- ❖ They reproduce by **alternation of generation** (the sporophyte is well developed their gametophyte stage is reduced)
- ❖ most ferns live in damp, shady places - they are very common in tropical rainforests

- ❖ However, some ferns - such as *Pteridium* spp (commonly known as bracken) can grow and do well in full sunlight.
- ❖ Another example of a pteridophyte is the fern *Dryopteris* spp.



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Ferns

C. Spermatophytes(seed-bearing plants)

They are the most successful because of the following characteristic features that they possess:

- They have well-developed roots, stem and leaves.
- They have well-developed vascular tissues.
- The male gametes are contained within pollen grains and female gamete is contained within the embryo sac.
- The product of fertilisation in sexual reproduction is a seed that may or may not be enclosed in a fruit.
- The spermatophyta are divided into two divisions. These are:
 - i. Division Gymnospermae(coniferopyta)- non-flowering plants
 - ii. Division Angiospermae(flowering plants)

i. Division Gymnospermae(coniferopyta)- non-flowering plants

- These are more commonly known as the conifers or 'naked seed plants'. Pine trees, spruces and cedars
- ▲ The main characteristics of the gymnospermae are:
 - Their seeds are not enclosed in fruits.
 - They have small needle-shaped leaves with a thick waxy cuticle that reduces water loss and minimises damage by excess heat or cold.
 - They are evergreen so they can photosynthesize all year long
 - The reproductive structures are found in cones.
 - They different types of cone. The male cone forms huge numbers of pollen grains that are blown by wind to a female cone.
 - Fertilisation results in a small winged seed.
 - The genus *Pinus* (for example, *Pinus sylvestris*, *Pinus resinosa*,) is a good example of a conifer



Figure 5.10 *Gymnosperms have very typical leaves and cones with naked, exposed seeds.*

ii. Division Angiospermae (flowering plants)

- They are the biggest group of land plants on the Earth.

The main characteristics of the angiosperms are

- They have flowers as reproductive organs.
- They have their seeds enclosed in a fruit.
- They have well-developed **xylem** and **phloem** tissue
- Angiosperms are subdivided into two main classes according to the number of cotyledons they have in their seeds. These are:

I. Class Monocotyledons (monocots)

- are a group of enormous importance because they are cereal plants that form the staple diet

The main characteristics of the monocotyledons are:

- The embryo has a single seed leaf (cotyledon).
- Leaves are generally long and thin with parallel veins.
- The stem contains scattered vascular bundles.
- They do not reach great sizes (palms are the exception to this).
- They are often wind pollinated
- Example grasses, orchids and maize. Maize & Teff

II. Class Dicotyledons (dicots)

They make up most of the trees, as well as many vegetable plants.

The main characteristics of the dicotyledons are:

- The embryo has two seed leaves (cotyledons).
- The leaves are often relatively broad and have a network of veins.
- The stem contains a ring of vascular tissue.
- Some dicots reach great sizes.
- They are often insect pollinated.
- Some common examples of dicots include sunflowers, peas, roses and beans. Most trees, such as *Jacaranda*, *Eucalyptus*, *Cassia* and mangos are dicotyledons. Shrubs include *Hibiscus*, *Lantana camara*, *Bauhinia* and oranges

5. Kingdom Animalia

- This kingdom includes the animals. There are at least two million species of animals alive today.
- They are multicellular, eukaryotic and heterotrophic
- They exhibit locomotion, that is, can move their bodies from one place to another, and
- Their cells do not have cell walls.

- They have nervous systems so they are sensitive to their surroundings.
- They are either invertebrates (not have a backbone.) or the vertebrates(- all the animals which have a spinal cord enclosed in a backbone of vertebrae)
- There are 33 animal phyla but the main ones are

1. Phylum Porifera (the sponges)

- They are the simplest invertebrates. Most of them are hermaphroditic
 - They have hollow filter feeders, and the body cavity is connected to its external environment by pores.
 - There is little co-ordination or control.
 - They range in size from a few millimetres to two metres and are supported by a calcareous spicules.
- ➔ Sponges are an evolutionary dead end and have no other close living relatives



Figure 5.14 Sponges do not look much like animals, but that is what they are.

2. Phylum Coelenterata(cnidaria)

- They include some exceptionally beautiful creatures and also
- Some very poisonous ones. Sea anemones, hydra, jelly fish and coral are among the members of this phylum.
- They have soft bodies with a ring of tentacles for capturing prey.
- They have stinging cells on their tentacles for poisoning or immobilising prey and predators.
- They have two layers of cells in their bodies that surround a central cavity.
- They have only one opening, the mouth, and their bodies have radial symmetry
- Radial symmetry : is a body that can be divided into many halves.

3. Phylum Platyhelminthes - flatworms

- They show a relatively high level of organization
- They have flattened bodies with a mouth but no anus.
- They have no body cavity and rely on diffusion for everything.
- They are hermaphrodites
- They live in other animals as parasites or are free-living in fresh water.

Examples of Platyhelminthes include *Planaria* spp, which live in fresh water, tapeworms and liver flukes like *Fasciola hepatica*

4. Phylum nematoda(round worm)

- They have narrow, thread-like bodies,
- Their bodies are not segmented and are round in cross-section.
- They don't have a circulatory system but they do have a complete digestive system.
- Bilaterally symmetrical.
- They contains many important parasites, such as *Ascaris*, which infects the guts of both humans and pigs, and the family Filariidae -which cause elephantiasis

5. Phylum Annelida(segmented worm)

- They have segmented body.
- They have a closed blood circulatory system.
- They are hermaphrodites, with male and female reproductive organs and
- They have bristle like structures called **chaetae** to help them move.
- They are found in moist soil and water and most are free-living.
- The common earthworm, *Lumbricus terrestris*, & leech



Earthworm



Snail (mollusc)



e.g. of Echinoderms

6. Phylum Mollusca

- The most intelligent of the invertebrate species.
- Octopi and squid have well developed brains.
- They may have shells or be shell-less, live in the sea, or in fresh water or on land.
- They have a soft muscular foot with a soft body
- Their bodies are divided into head, foot and visceral mass and they are not segmented.
- They breathe through gills. Examples of molluscs include slugs and snails.

7. Phylum Echinodermata

- They are spiny skinned animals
- they have a mouth, a gut and an anus
- They are all marine animals, and move around using **tube feet**.
- The adults have five arms, but the larval stages do not.
- Examples include *Asteris*, the common starfish, *Echinus*, the common sea urchin and *Paracucumana tricolor*, a brightly coloured sea cucumber known as a sea apple.

8. Phylum Arthropoda

- This phylum gets its name from two Greek words, *arthron* - joint, and *podos* - foot.
- They have an external exoskeleton made of chitin that prevents excessive water loss.
- They are animals with segmented bodies and jointed limbs.
- They have a well-developed nervous system and a complete gut from the mouth to anus.
- They divided into a number of classes according to the number of limbs, presence and number of antennae and number of body parts.

Class insecta

- They live almost everywhere although most are land-based.
- They have a body divided into three body parts; head, thorax and abdomen.
- They have three pairs of jointed legs on the thorax along with one or two pairs of wings.
- On their head they have a pair of antennae and one pair of compound eyes.
- Insects include flies, butterflies and moths, beetles, wasps and bees and many other common groups.

Class crustacea

- They are mainly aquatic.
- They vary in size from very small, for example water fleas, to quite large, for e.g. lobsters and crabs.
- Their body is made up of two parts - a cephalothorax (head fused with thorax) and abdomen.
- The body is often protected by a tough covering called a carapace.
- They have more than four pairs of jointed legs, two pairs of antennae and simple eyes.
- They include *Daphnia*, crab, prawn, shrimp, barnacle, water flea, lobsters, woodlice and crayfish.

Class chilopoda (the centipedes)and the diplopoda (the millipedes)

They both have long bodies with many segments and lots of leg

Centipedes	Millipedes
Have flattened bodies	Cylindrical bodies
Have brightly coloured bodies	Dull-coloured bodies
Have few or less segments	Have more segments
Have one pair of limbs per segment	Have two pairs of limbs per segment
Carnivorous (feed on other animals)	Herbivorous
Have poisonous claws for paralysing their prey	Have claws for biting and chewing plant material

Table 5.3 Differences between centipedes and millipedes

Class Arachnida (the spiders)

- They are mainly terrestrial although some are aquatic.
- They have two body parts - a cephalothorax and the abdomen - with no antennae.
- They have eight legs in four pairs.
- They have simple eyes
- Spiders spin silken webs. Examples of arachnids include spiders, ticks, scorpions, and mites.

9. Phylum Chordata

- The term Chordata is derived from the term notochord
- **Notochord** flexible rod like structure of cartilage running along the dorsal side of the body.

They have the following three features in common:

- ✚ They have a notochord at some stage of their lifecycle.
- ✚ They have a hollow nerve cord
- ✚ They have gill slits during early stages of development that are later replaced by lungs and gills.

Vertebrates

The **chordates**, the best known of which are the **vertebrates** (animals with vertebral column/backbone)

In addition, they also have the following features:

- An internal skeleton (endoskeleton) made of bone or cartilage.
- A closed blood circulatory system consisting of blood vessels.
- A well-developed nervous system.
- Two pairs of limbs.
- Kidneys as excretory organs
- Phylum Chordata divided five classes

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i. Class pisces- fishes

- They are aquatic
- They have streamlined bodies with scales on their skin.
- They use gills for gaseous exchange and have fins for swimming

They are **ectothermic** - they rely on heat from their environment to regulate their body temperature.

Table 5.5 Differences between bony fish and cartilaginous fish

Bony fish (teleosts)	Cartilaginous fish (elasmobranchs)
Have bony skeleton	Have cartilaginous skeleton
Have round-shaped scales	Have scales that are not round shaped
Have opercula (gill covers) covering their gills	Have no opercula (gill covers) but have gill slits
Have homocercal tails (even size fins)	Have heterocercal tails (one part is larger than the other)
Are usually smaller in size	Are usually larger in size
e.g. <i>Tilapia</i> , Nile perch, mackerel and catfish	E.g. Sharks, skates and rays.

ii. Class Amphibia

- Spend part of their lives in water and part of it on land.
- They were the first vertebrates to colonise the land.
- They have simple sac-like lungs (which are not very efficient) and smooth, moist skin
- Their lifecycle includes metamorphosis, and they need water for successful reproduction as fertilization is external and the larval form (tadpole) is aquatic.

- Gills are only present in the larval forms & they are ectothermic Example: frogs, toads, newts and salamanders

Frog	Toad
Has a smooth skin	Has a rough skin
Has a moist skin	Has a dry skin
Has more webbed feet	Has less webbed feet
Has a brightly coloured body	Has a dull-coloured body
Has a more streamlined body	Has a less streamlined body
Has extra-long hind legs	Has hind legs that are not extra long

Table 5.6 Differences between a frog and a toad

iii. Class Reptilia

- The **reptiles** are mainly terrestrial animals
- They have bony skeleton
- They have dry skin with scales and their gas exchange takes place exclusively in the lungs
- They have developed internal fertilisation
- Some reptiles even keep the eggs within their body and give birth to fully developed young.
- They are poikilothermic (ectothermic) & have no external ears
- Examples , snakes, crocodiles
- Two pair of pentadactyl limbs usually present

iv. Class Aves(birds)

- Have skin that bears feather & scales on legs.
- Have bony skeleton
- Two pairs of pentadactyl limbs, front pair forms wings
- They are homoeothermic (endothermic)
- Example: domestic fowl, the wattled ibis, white collared pigeon and the Ethiopian eagle owl.

v. Class Mammalia

- They are the best known of all animals
- Their skin bears hair , the skin consists of glands like sebaceous& sweat
- They produce live young which have developed for a time within the body of the mother in a structure called the uterus
- They have bony skeleton & Have external ear
- Have two pairs of pentadactyl limbs
- They use lungs for gas exchange
- A true mammal produces milk for its young in mammary glands

Subdivisions of mammals

Mammals are classified according to the way their young are produced. There are three sub-classes of mammals:

i. Egg-laying mammals - lay eggs, e.g. duck-billed platypus.

ii. Marsupials - produce immature young, which are nourished by milk in the pouch,
E.g. Kangaroo, koala bear, opossum

iii. Higher mammals - produce fully developed young, which are nourished by milk from the mammary glands, e.g. cows, elephants, cats, monkeys, and humans.

- ✓ There are even flying mammals, as bats have been adapted to fly through the air on their leathery wings!

UNIT 6

ENVIRONMENT

6.1. Ecosystems

Ecosystem: all the animals and plants that live in an area along with the things that affect them. It is the home or **habitat** of the living organisms within it

- ✓ Habitats may be on land - when they are known as **terrestrial habitats** or they may be in water, when they are called **aquatic habitats**.

- ✓ There are two main types of aquatic habitat - the **marine habitat**, which is the salt water of the seas and oceans, and the **freshwater habitat** of lakes, ponds, rivers, and streams
- They are affected by both the **abiotic components** and the **biotic components** of the ecosystem

A. Abiotic components

- Abiotic factors are the non-living elements of an ecosystem
- The **climate** and **weather** produce several important abiotic components. They include the amount of **sunlight**, and the amount of **rainfall**.
- **Temperature** is a factor which often affects whether animals and plants can survive in an ecosystem.
- Other abiotic factors include the type of soil and rocks, the drainage of the soil and the pH (acidity).

B. Biotic components

- Are factor of the living organisms within an ecosystem which affect the ability of an organism to survive
- Each organism is the part of another organisms environment thus they interact in various ways: these are:

I. Intraspecific: occur between members of the same species, such as **Competition** for food, **territory**, & **finding mate**.

II. Interspecific f: occur between members of different species. **This** include predator-prey relationship & symbiosis

Predator-prey relationship (predation): in which predator animal like lion, tiger feed on other animal (**prey**) like buffalo, rabbit, etc.

Symbiosis: is relationship between two organism of different species in which one or both get benefited from the relationship: this can classified as:

- **Commensalism:** is the relationship in which one organism is benefited while the other is neither benefited nor harmed. E.g. The r/ship between big trees& epiphytes
- **Mutualism:** is relationship in which get benefited & it's an obligatory relationship
For example: lichen (algae & fungi).
- **Parasitism:** is the relationship in which one organism is benefited (the parasite) & another organism is harmed (host). **e.g.** R/ship between human & parasite like tape worm.
- **Protocooperation:** the relation which both organism are benefited but it is not an obligatory relationship. **e.g.** the r/ship between teeth cleaning bird & crocodile

6.2 Food relationships

According to their mode of nutrition organism can be classified as: **autotrophs and heterotrophs**

A. Autotrophs: organism that can synthesize their own food to release energy from the raw material in their surrounding environment. they can be classified as :

- ▲ **Phototrophs:** organisms that feed off light to synthesize their organic food .This group of organisms are called **producers**. **E.g.** green plants, algae,& photosynthetic bacteria.
- ▲ **Chemotrophs:** organisms that get energy from the breakdown of inorganic chemical
E.g . Nitrifying bacteria

B. heterotrophs: organisms that rely on eating other organisms. They cannot produce their own food so they are called **Consumer**. They can be grouped as:

- **Herbivores:** animals that eat plants only. **E.g.** cow, buffalo, sheep, etc.
- **Carnivores:** animals that feed on other animals only. **e.g.** tiger ,lion
- **Omnivores:** animals whose diet includes both plants and animals. **e.g.,** human
- **Decomposers:** organism that break down the remains of animals and plants and return the mineral nutrients to the soil **e.g. bacteria & fungi**

Food chains

- **Food chain:** is simple & direct feeding interrelationship which involves transfer of energy & nutrients from one organism to another.
- in a food chain energy flow is unidirectional (from producer to consumer)
- Each organisms occupies particular tropic level within a food chain

- **Trophic levels:** levels in a food chain to which an organism belongs.

The main trophic levels are:

i. Producer (first trophic level): are green plants & algae.

- All organisms depend directly or indirectly on producer.
- The sun is ultimate source of energy for all food chains.

ii. Primary consumers (second trophic level): includes herbivores & omnivores.

iii. Secondary consumers (third trophic level): are carnivores which mostly eat herbivores & omnivores.

iv. Tertiary consumers (fourth trophic level): are carnivores (sometimes called top carnivores) which mostly eat other carnivores

✓ **Decomposer are found at the of each food chain**

✓ Many aquatic food chains start with the microscopic photosynthetic organisms known as **phytoplankton (plant plankton)**.

✓ These tiny organisms are eaten by the equally microscopic **zooplankton (animal plankton)** and these two groups of organisms underpin food chains which involve almost every animal in the water, from tiny shrimps to enormous whales.

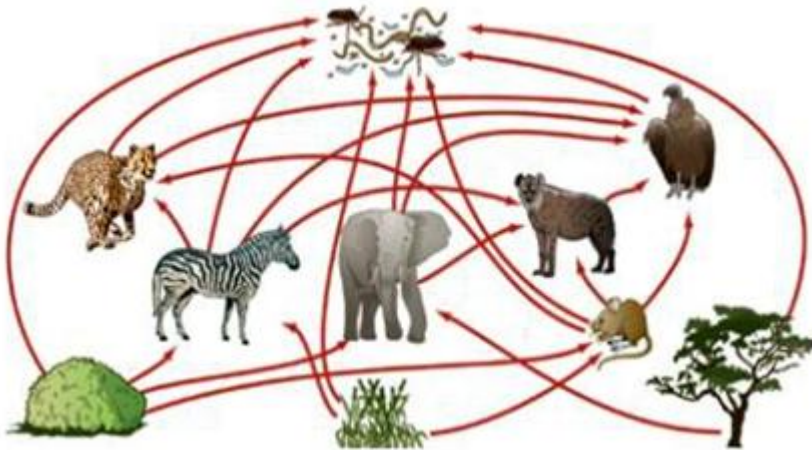
Examples food chain

- Oak (**Leaves**) → grasshopper → rodent → leopard
Producer primary consumer 2^{ndary} consumer tertiary consumer
- Grass → zebra → lion
- Phytoplankton → zooplankton → fish → man

• **Food web**

- ✓ Food web is network of food chains
- ✓ In a food web the interactions between many different food chains can be shown

Example of food web



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Pyramid of Biomass

Biomass: Is a term that describes all the organic material produced by living organisms.

It all comes originally from plants as they photosynthesize at the beginning of all food chains.

- ✓ This biomass is then passed on through a food chain or web into the animals which eat the plants and then on into the animals which eat other animals.
- ✓ The total amount of biomass in the living organisms stage of the food chain can be drawn to scale and shown as a pyramid of biomass
- ✓ The biomass supported at each trophic level decreases as it goes from one trophic level to the next.
- ✓ **At each trophic level biomass is lost in various forms:** heat from respiration, urine, faeces, to provide energy

Pyramid of numbers

- ✓ The number of organism decreases it moves from one trophic level to the next.

- ✓ In most ecosystems producers contain large number of organisms than consumer, however sometimes this may not work

For e.g. the breadfruit tree can grow to around 20 m tall, yet it can be attacked by mealybugs. They in turn are eaten by ladybirds. However, the pyramid of numbers for this food chain doesn't look like a pyramid at all.

Pyramid of energy

- ✓ In ecosystem there is always be transfer of energy from one tropic level to the next tropic level
- ✓ There is progressively less energy available for organisms further down a food chain. Energy is cannot be **recycled** in an ecosystem; it always flows in one directly.

6.3 Recycling in nature

- ✓ Living things are constantly removing materials from the environment.
- ✓ The recycling of substances provide an important link between the biotic and abiotic component.
- ✓ The materials are returned to the environment from the waste products of animals and the dead bodies of plants and animals.
- ✓ Nutrient in organisms are back into the soil by action of group of organisms known as the decomposer. Decomposer(bacteria & fungi) play a huge role in recycling of nutrients :

Important of decomposers

They are important in various ways to the environment:

- Break & digest dead bodies of plants, animals & waste materials or dropping of animals & add them into the soil. This increases the fertility of the soil which is useful for plants.
- Removes unpleasant waste materials from an environment
- Used to make compost in garden

Recycling of substances in an ecosystem includes chemical, physical, & biological processes.

i. The nitrogen cycle

- ▲ Nitrogen is a vital part of the structure of amino acids and proteins, DNA and RNA
- ▲ It involves the conversion of nitrogen gas by various processes into usable form by plants
- ▲ Green plants absorb nitrogen in the form of nitrates dissolved in the soil water.
- ▲ They use these nitrates to make proteins, and then this protein is passed along the food chain.
- ▲ The atmospheric nitrogen is fixed by microorganisms living in a symbiotic relationship certain plants, specially **legumes, it includes pea**, beans and clover - have nodules on their roots which are full of nitrogen-fixing bacteria

The nitrogen cycle involves the following bacteria

A. Nitrogen fixing bacteria-convert free atmospheric nitrogen into nitrate

Note: lightning has also a role in fixing atmospheric nitrogen

B. Nitrifying bacteria : convert ammonium to nitrite then to nitrate

Ammonium $\longrightarrow$ Nitrite
 Nitrite $\longrightarrow$ Nitrate

C. Putrefying (amonifying) bacteria: they convert protein in the dead bodies & decay of plants into ammonium compounds.

D. Denitrifying bacteria -are bacteria that convert nitrates into free atmospheric nitrogen

ii. The carbon cycle

Carbon cycle: cycling of carbon compounds between the living and the nonliving world.

- ➔ The main molecules of life are based on carbon atoms.
- ➔ It mainly involves the conversion of the inorganic molecule carbon dioxide to form organic molecules which are formed within the tissues of organisms.
- ➔ Carbon dioxide is removed from the air by green plants in the process of photosynthesis.
- ➔ Then when the plants are eaten by animals the carbon is passed on and becomes part of the animal bodies
- ➔ when animals respire they release carbon dioxide as a waste product into the air
- ➔ Finally when both plants and animals die, their bodies are broken down by the action of decomposers.
- ➔ Carbon dioxide is also released into the atmosphere in the process of combustion.

→ This build-up of carbon dioxide gas in the atmosphere is generally believed to contribute to the **greenhouse effect**, also referred to as **global warming**

- ✓ Methane is another greenhouse gas which causes air pollution and the levels of this gas are rising too.

6.4 Adaptation

- ❖ Features organisms develop which make it possible for them to survive in particular habitats.
- ❖ Organisms in different climatic condition have different adaptation mechanisms to survive in their ecosystem.

I. Animals in cold climates

- Animals in very cold climates have other adaptation:
 - ✓ Thick layer of fat under the skin to keep to store more internal heat & a thick fur coat on the outside
 - ✓ Reduced surface area to volume ratio
 - ✓ Usually have Very small ears
 - ✓ **camouflage** of an Arctic animal in summer would stand out against the snow in winter
 - ✓ E.g. Arctic fox change the greys and browns of their summer coats for pure white in the winter.

II. Adaptation in dry climates

- Many animals which live in hot or dry conditions have other adaptations for cooling down
- They are often most active in the early morning and late evening
- They often have large, thin ears as well to increase their surface area for losing heat
- They don't have much fur & relatively little body fat stored under the skin.

III. Some adaptation of plants

- Plants take in water through their roots in the soil & lose water all the time through their leaves.
- There are small openings called **stomata** in the leaves of a plant. These open to allow gases in and out for photosynthesis and respiration.
- When it is hot and dry, photosynthesis and respiration take place fast
- most plants that live in dry conditions have reduced the surface area of their leaves so they lose less water e.g. cacti
- plants can cope with dry conditions to store water in their tissues
- Plants which store water in their fleshy leaves, stems or roots are known as **succulent**
- Animal dispersed plants have seeds which have hooks & spines

IV. Some animal adaptation

- Carnivores animals have sharp & pointed canines to tear flesh.
- Porcupine has skin surface which is covered with long stiff parts like needle called quills, which it can raise to protect itself when it is attacked by enemy

6.5 Tree-growing project

- Ecosystem our country has been changing dramatically because of deforestation. Now Only 3% of land is covered with forests.
- Trees produce oxygen and remove carbon dioxide from the air. They help to reduce the effects of air pollution and also reduce global warming.
- It hold the soil in place and without them our soil is becoming unstable and blowing away.
- it also help absorb water - they prevent soil erosion and help to prevent the formation of great areas of Desert

Tree planting procedure

To plant a tree successfully:-

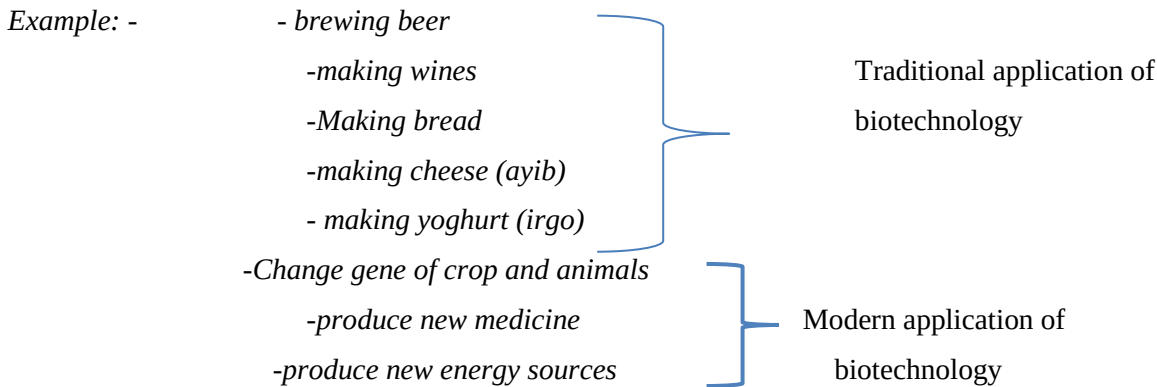
- The soil must be prepared,
- a big hole must be dug and
- Water must be put into the hole before the tree is planted.
- Once the sapling is in place, the soil must be pressed very firmly around it and
- Often a stake is used to support the young tree as it starts to grow and get established.
- The young trees need to be cared.

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Biotechnology is the use of micro-organism to make things that people want

Or the use of living organisms to make what people want, often involve industrial production.

-It helps to **make** and **preserve** food and alcoholic drinks.



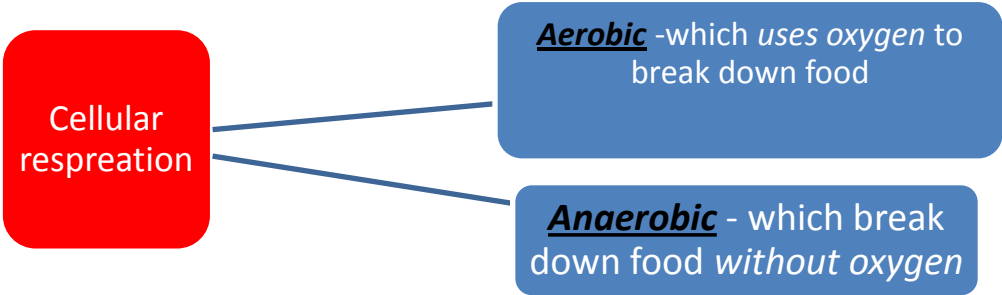
→Biotechnology is based on **microbiology**. i.e. the study of micro-organisms and their effects on human.

-**Bacteria** and **fungi** are the main micro-organisms used in biotechnology.

1.2. TRADITIONAL TECHNOLOGY USING YEAST.

Yeast: - Is the single cell.

- Has nucleus, cytoplasm, cell membrane, and cell wall.
- 1gram of yeast contains about 25 billion cells. This expresses that how much they are small.
- Yeast can respire **aerobically** and **anaerobically**.
- yeast reproduces by asexual budding (split in to two)



Aerobic respiration of yeast – produce more energy.

Sugar + oxygen → water + carbon dioxide + energy.

Anaerobic respiration of yeast- it is called **Fermentation** (anaerobic).

Fermentation converts sugar into acid such as lactic acid, alcohol, and co₂ using yeast and bacteria, under anaerobic conditions.

Sugar → ethanol + Carbon dioxide + energy

- Yeast can respire aerobically in bread making, but must respire anaerobically to make alcoholic drink.
- too much alcohol kills yeast and stops fermentation.

- Yeast is used in making – injera, bread, tell, tej ...etc.

Food production using bacteria