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ECZ GRADE 10 - 12 BIOLOGY SUMMARISED NOTES PT.1 (LIVING ORGANISMS)

Content

UNIT 1: LIVING ORGANISMS

1.1 Introduction

Biology (in Greek Bios = “Life” and logy = “Study”) is the study of living organisms or life.

1.1.1 SEVEN PROCESSES IN LIVING ORGANISMS

Living organisms are distinguished from non-living things (e.g. dead organisms, air, water, rocks) by the processes that they carry out.

1. A living organism takes in materials from its environment for use in its body.

2. From food, living organisms obtain the energy they need to live.

3. This results in permanent increase in size of the living organism, which is accompanied by increase in mass.

4. Living organisms remove harmful substances out of their bodies.

5. Living organisms detect and respond to changes in the environment.

6. This process is more obvious in animals than in plants as they move the whole body from one place to another.

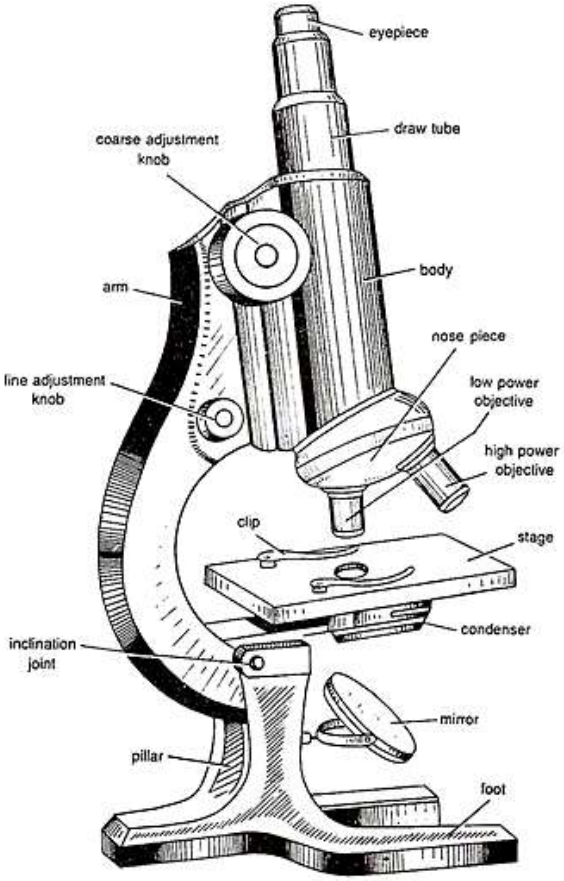
7. Living organisms form younger organisms from older ones. Although it is not necessary for each organism to reproduce, reproduction is necessary for survival of a species. (N.B. A species is a group of organisms so similar to one another that they can interbreed and produce fertile offspring)

1.1.2 THE HAND LENS AND COMPOUND MICROSCOPE

- The detail structures of organisms can be observed by using microscopes. A microscope is an instrument that is used to magnify small objects, which are invisible to the naked eye. There are several types of microscopes.

- A **hand lens** is the simplest, made of a convex lens fixed in a frame with a handle

- A compound **light microscope** consists of two sets of lens. The Lenses are fitted at the opposite ends of a body tube. The lenses closer to the eye are called the **eye piece** and the ones nearer the object are called **the objective lenses.**



A compound microscope.

- The objective lenses are fitted into a revolving nosepiece in order of low power, medium power and high power.

- The most complex microscope is an **electron microscope**, which reveal details not visible with a light microscope.

1.1.3 MAGNIFICATION AND DRAWING

- **Magnification** is the number of times that the image of the object enlarged (magnified) as compared to the specimen.
  There are two different formula of magnification.

1. One is used to obtain the total magnification of the specimen that you observe under a compound microscope.

$$Magnification = Power\ of\ eye\ piece\ lens \times Power\ of\ objective\ Lens$$

2. The other is used to calculate the magnification of drawing after drawing a specimen. *This formula is the one that is used the most in the ECZ Biology practical examination.*

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

Introduction to the Cell (Cell Theory)

- There are three (3) important components in cell theory:

1. A cell is **the basic unit** of structure and function in an organism.

2. All organisms are composed of one (unicellular organism) or more cells (multicellular organisms).

3. Cells are produced only from existing cells.

1.1.4 BASIC STRUCTURES OF AN ANIMAL AND A PLANT CELL UNDER LIGHT MICROSCOPE.

- Although cells differ in shape and size, they all have general characteristics. Figures below generalised cells showing basic structures under light microscope.

Organelles found under a light microscope

- Organelles are structures carrying out specific functions in the cells as shown below.
    1. **Nucleus (plural: Nuclei)** = It is usually spherical in shape. It is bounded by two membranes called **Nuclear membrane**. It contains **chromosomes,** which are made of DNA (Deoxyribonucleic Acid) and proteins and act as carriers of genetic materials. It controls all cellular activities e.g Cell Division.
    2. **Cell membrane** = it is a very thin delicate later made of phospholipids and proteins it completely surrounds all living parts of cell. It is **semi-permeable membrane**, which allows certain small substances like water, oxygen, glucose to enter the cell, and prevents larger molecules like proteins and starch from leaving the cell. Hence it controls the transport of materials in and out of the cell.
    3. **Cytoplasm** = Everything between the cell membrane and the nucleus is the cell's cytoplasm. Organelles are suspended in the cytoplasm. It consists of **cytosol**, a jelly like mixture that consists mostly of water, along with proteins, carbohydrates and other organic compounds. This is where cellular chemical reactions take place.

- Nucleus, cytoplasm and cell membrane together make **protoplasm**, which is the living part of a cell.
  A plant cell consists of the protoplasm and the **cell wall,** which is non-living. An animal cell consists of only protoplasm.

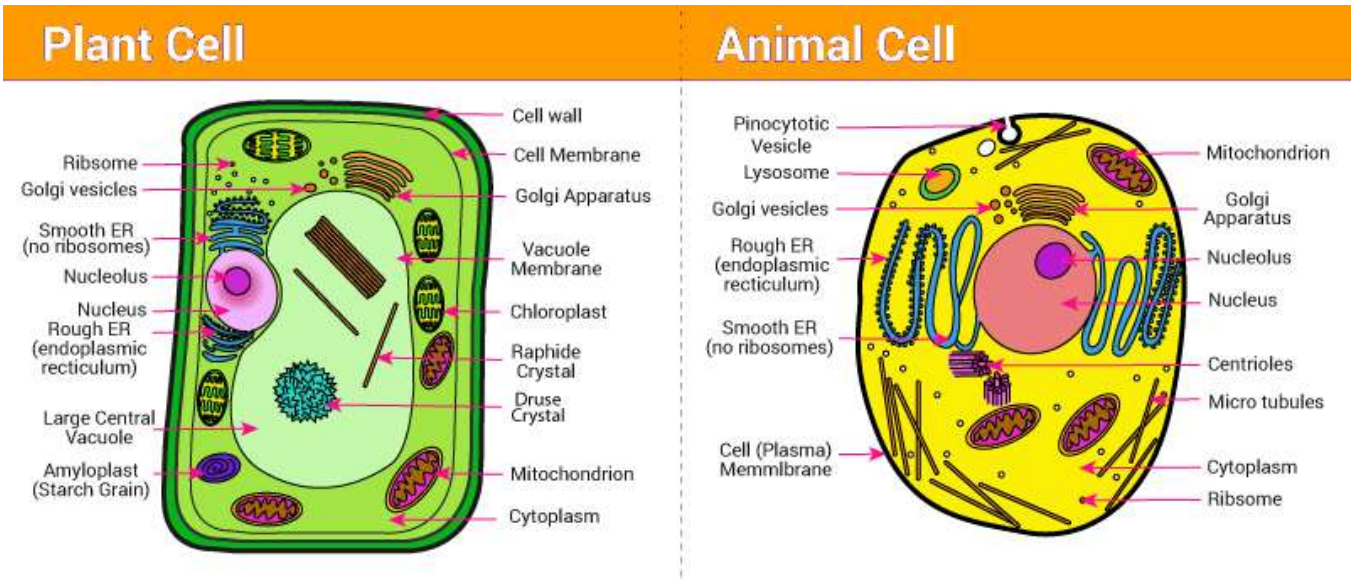
    4. Vacuole = It is a very large compartment in the cytoplasm in plant cells. The sacs are filled with cell sap, which is a watery solution of sugars, salts and pigments. The membrane that surrounds the sap vacuole is called the **tonoplast** and it is also semi-permeable. It is involved in regulation of water balance and helps to maintain the shape of the plant cell.

    5. Cell wall = It is non-living part of the cell that is made of **cellulose**. It is fully permeable. It gives strength and protects the plant cell.

1.1.5 SIMILARITIES AND DIFFERENCES BETWEEN ANIMAL AND PLANT CELLS

	Items	Animal Cells	Plant cells
1	Cell wall	Absent	Present
2	Chloroplast	Absent in all	Present in some
3	Vacuole	Usually very small	Large
4	Shape	Irregular	Regular
5	Size	Smaller	Larger

1.1.6 DETAILED STRUCTURES OF AN ANIMAL CELL AND PLANT CELL



*Organelles seen under an electron microscope.

1. **Mitochondrion (plural: mitochondria)** = It is rod-shape and enclosed in two membranes. It is the site for **aerobic respiration** hence, it generates energy for cellular activity. Hence, it is sometimes referred to as the 'power house' of a cell.

2. **Chloroplast** = It is round-shape and surrounded by two membranes. It contains **chlorophyl**l (green pigment), it captures light energy. Hence, it is involved in **photosynthesis.**

3. **Endoplasmic Reticulum (ER)** = it is a network of membrane-linked channels in the cytoplasm. It is responsible for transporting substances in and out of the cell wall, as well as within the cell.

4. **Golgi body** = It is single-membrane bounded organelle derived from ER. It transports materials like enzymes from ER to the sites of reactions within the cell.

5. **Ribosome =** It is a tiny particle made up of RNA (Ribonucleic Acid) and protein. Some are attached to the membrane of ER to form **rough ER**. It controls **protein synthesis.**

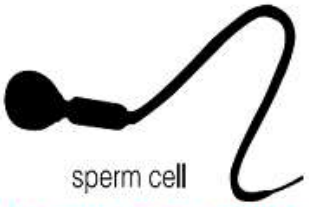
1.1.7 EXAMPLE OF SPECIALIZED CELLS

- Cells are specialized to carry out specific function hence they differ in structure. Within an organism there are various types of specialized cells.

- This **specialization** of cells is more prominent in complex organisms than in simple organs.

- **Differentiation** is the process that allows cells to develop special structures and functions.

Specialized cells

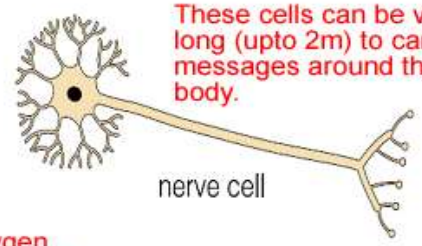


sperm cell

These cells carry half the genetic information. They have tails to swim towards the egg cell

red blood cell

These cells are adapted to carry oxygen to cells and carbon dioxide away from them

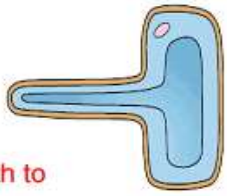


These cells can be very long (upto 2m) to carry messages around the body.

nerve cell

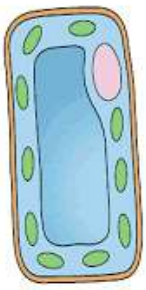
muscle cell

These cells can change their length to help us move.



root hair cell

The root hair gives these cells a bigger surface area to take in water from the soil.



palisade cell

These cells contain chloroplasts to help the plant make food by photosynthesis.

Ciliated Epithelial Cell

These cells are found in tubes leading to the lungs and in the oviduct. The hairs (called cilia) move dirt out of the lungs and help to move eggs along the oviduct.

1.1.8 CELL ORGANIZATION

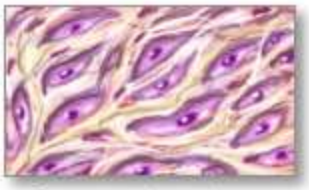
- Cells work together for the benefit of the organism. **A tissue** is a group of similar cells that together perform a particular function. An **organ** is made with two or more types of tissues, and is a distinct part of the body that carries out one or more specific functions. A **system** usually refers to a group of organs whose functions are closely related.

- Organisms can either be unicellular or multicellular. Unicellular organisms (E.g. amoeba) have one cell only. However, the cell is capable of carrying out all cellular functions such as movement, respiration, excretion and reproduction.

- The following summarizes stages in cell organization. Note that organelle is not the basic unit of organisms.

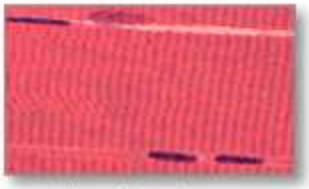
Main tissues in animals:

- Animal tissues are grouped into four basic types: c**onnective, muscle, nervous,** and **epithelial**.



Connective tissue

Epithelial tissue

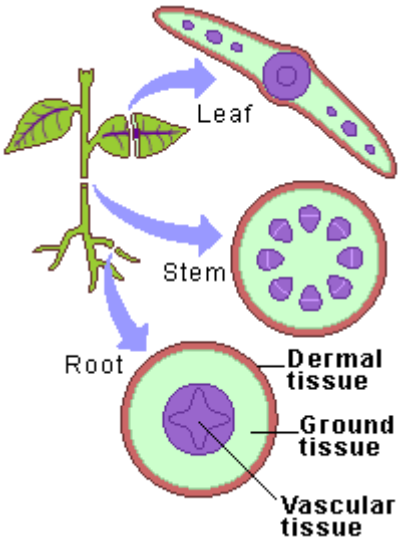


Muscle tissue

Nervous tissue

Main tissues in plants:

- **Epidermis** - Cells forming the outer surface of the leaves and of the young plant body.
- **Vascular tissue** - The primary components of vascular tissue are the xylem and phloem. These transport fluids and nutrients internally.
- **Ground tissue** - Ground tissue is less differentiated than other tissues. Ground tissue manufactures nutrients by photosynthesis and stores reserve nutrients.



Organization of living organisms:

Molecules → Cells → Tissues → Organs → Systems → Organisms

1.2 Classifications of living organisms.

1.2.1 SCIENTIFIC NAMES AND BINOMIAL SYSTEM

- Organisms are known by different common names in different regions of the world. However, each organism only has one correct scientific name that can be used to identify the organism in any part of the world.

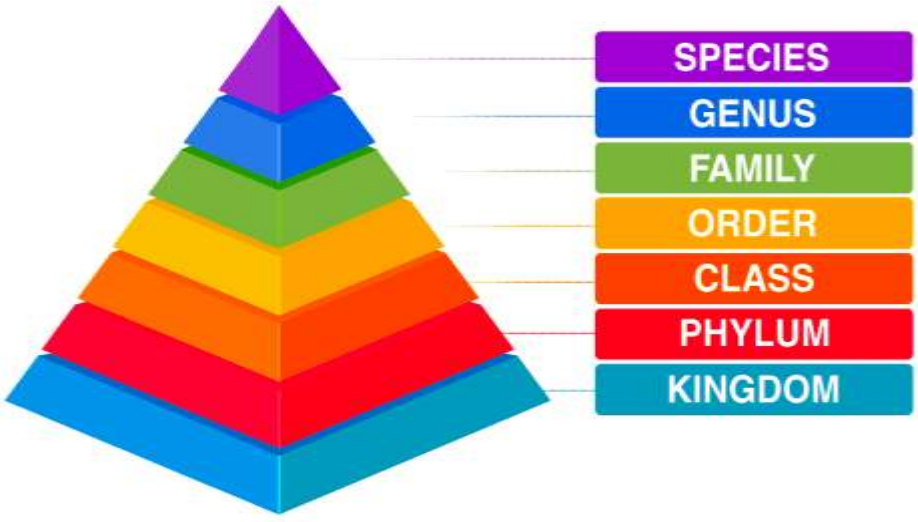
- In this system, a name has two parts. The system is referred to as **binomial system**; The **genus** followed by the **species**.
  For example:
  1. Human: ***Homo sapiens***
  2. Maize: ***Zea mays.***

1.2.2 SEQUENCE OF CLASSIFICATION

- In addition to naming organisms, biologists place organisms into groups. Hence, this is classification.

- Classification of organisms has been based on similarities between organisms.

- Most biologists use a system of classification, which arranges organisms in groups of descending hierarchy as follows:



- Today, most biologists use a system that recognizes five **kingdoms**: Anamalia, Plantae, Fungi, Protista and Monera.

- Examples of **phyla (singular = phylum)** in **Animalia** are:

  1. Anthropoda, which has segmented body and jointed limbs and firm external skeleton (e.g. insects).

  2. Chordata (e.g. fish, birds, humans), which has a subphylum named **vertebrata**.
  Examples of **classes** under Chordata are **fish, amphibian, reptile, bird and mammals.**

Fish	**Poikilothermic** (have variable internal temperature), covered with overlapped scales, have fins for movement, and carry out external fertilization
Amphibians	Poikilothermic, have four limbs, no scale with most skins, have lungs, and spend part of life in water and part of it on land.
Reptiles	Poikilothermic, live on land, have dry scaly skin, and lay eggs.
Birds	**Homoeothermic** (maintain constant internal temperature), have wings for flight and lay hard-shelled eggs
Mammals	Homoeothermic, have hair, and give birth to fully formed offspring

- In the **Plant kingdom**, there are **algae** (seaweeds and filamentous forms; mostly aquatic), **mosses** (simple land plants without specialized conducting tissue; mostly reproduce by spores), and **vascular plants** (well-developed xylem and phloem).

- Vascular of plants have stems, leaves and roots, and can be divided into **ferns** (reproduce by spore), **conifers** (reproduce by seeds but not in flowers), and **angiosperms** (flowering plants)

- **Fungi kingdom** is made up of Eukaryotic, heterotrophic organisms. The organisms in this kingdom are generally saprophytes or parasites. They do not make their own food. Their cell wall is made of chitin.

- **Protista kingdom** contain organisms that are heterotrophic and autotrophic. Most organisms in this kingdom are unicellular and eukaryotic (that is, chromosomes are covered with nuclear membranes).

- **Monera kingdom** contain prokaryotic organism, which are organisms where cells have no nucleus and nuclear membranes.

- Prokaryotes don't have membrane-bounded organelles, such as mitochondrion and chloroplasts. Almost all prokaryotes are smaller than the simplest Eukaryotes. They include both heterotrophs and autotrophs.

1.3 Movement of molecules across the cell membrane

- The human body is mostly made up of water, which constitutes about 60% of its mass. The human cell is made up of approximately 80% of water. Water is essential for keeping the tissue fluids at the correct concentration. Water is also the medium for biological reactions.

- Substances can cross the cell membrane because of the property of being partially permeable, which means that some molecules (like water) are able to pass through it, while other molecules cannot pass.

- Movement of molecules in and out of the cell is controlled by various methods.

- **Passive transport** (e.g **diffusion** and **osmosis**) does not require energy for the movements of molecules, while **active transport** requires energy will have equal concentration. While as a result of active transport, the molecules will have different concentration.

1.3.1 DESCRIPTION OF DIFFUSION

- **Diffusion** is defined as the movement of particles from region of higher concentration to a region of lower concentration down a concentration gradient.

- Diffusion will stop when the state of **equilibrium** (that is the state where the concentration is zero) is reached.

- **Applications of diffusion in biological processes**
  1. Gaseous exchange during respiration and photosynthesis.
  2. Excretion of waste products
  3. Absorption of digested food

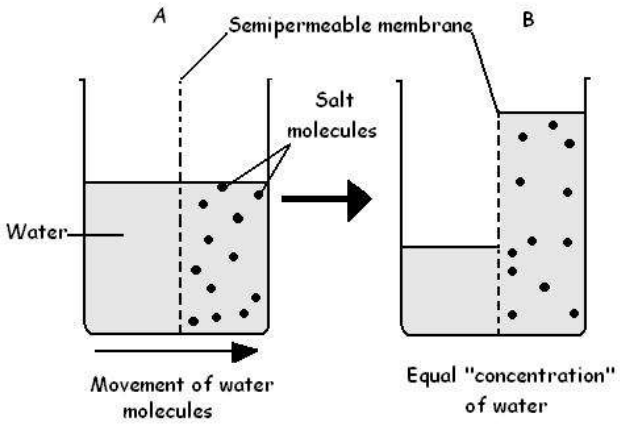
- **Factors affecting rates of osmosis**

Factor	Condition	Rate of diffusion
Temperature in its environment	High (Low) temperature	High (Low)
Size of particles	Large (Small) size	Low (High)
Thickness of cell wall (barrier)	Thick (Thin) cell wall	Low (High)
Concentration gradient	High (Low) gradient	High (Low)
Surface area of cell membrane	Large (small) surface area	High (Low)

1.3.2 DESCRIPTION OF OSMOSIS

- **Osmosis** is defined as the movement of water molecules across a semi-permeable membrane from a region of lower concentration to a region of higher concentration.

- Observation of osmosis:



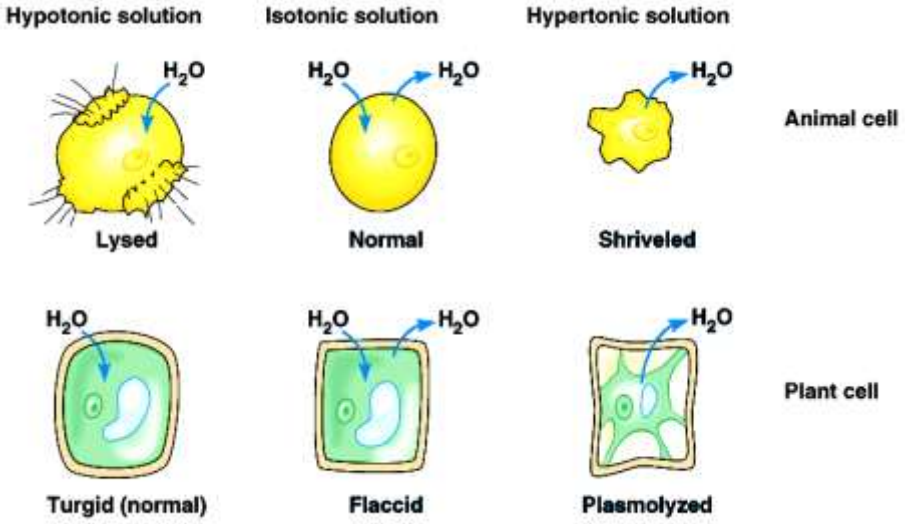
- The **water potential** of a solution is a measure of whether it is likely to lose or gain water molecules from another solution. **Distilled water** has the highest possible water potential; because it is likely to lose water.

- **Hypotonic solution** (shows higher water potential) is more dilute solution than cell; hence water flows into the cell. The cell becomes **turgid.**

- **Isotonic solution** has equal concentration as cell; hence no net flow of water.

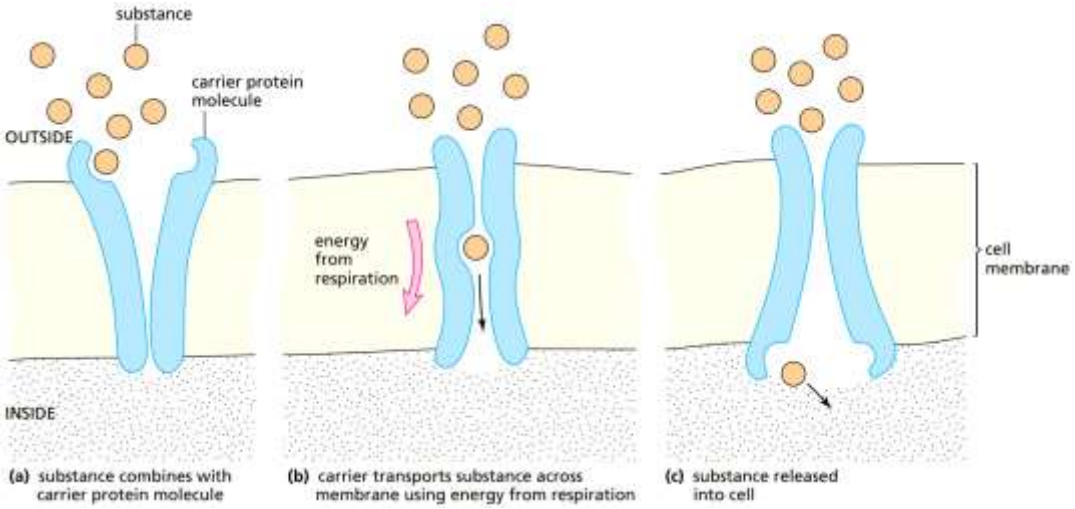
- **Hypertonic solution** shows lower water potential and is more concentrated than the cell; hence it flows out of the cell. The cell becomes **flaccid.**

1.3.3 OSMOTIC EFFECTS IN ANIMAL AND PLANT CELLS



1.3.4 DESCRIPTION OF ACTIVE TRANSPORT

- The carrier molecules shown in the following figure are protein molecules. As shown in **(b)**, they are responsible for transporting substances across the membrane during active transport.



- Cells often move molecules across the membrane against a concentration gradient, from areas of low concentration to high concentration. Moving molecules against the concentration gradient requires energy.

- When energy is used to transport molecules across the membrane, the process is called **active transport.**

- **Active transport** is defined as the movement of molecules through a membrane from a region of high concentration by using energy.

- For example, when plants **absorb mineral salts** from soil, the uptake of ions is assisted by active transport across the root hair cells because **concentration of ions in the soil is less than in the sap vacuole.**

1.4 Enzymes

- In order to carry out life processes, many chemical reactions are constantly taking place in all living cells.

- All chemical reactions occurring in a cell are collectively known as metabolism. Minimum requirement of energy metabolism maintains vital processes such as breathing, heartbeat, digestion and excretion. **Metabolism** consists of **anabolism** and **catabolism.**

- **Anabolism** = chemical reactions, which involve the building up of small molecules into large complex molecules (e.g. protein synthesis and photosynthesis)

- **Catabolism** = chemical reactions, which involve the breakdown of complex compounds into simple molecules (e.g respiration and digestion). Both chemical reactions are catalysed by **enzymes.**

1.4.1 PROPERTIES OF ENZYMES

- Enzymes are necessary for metabolism to take place, in this way, enzymes are referred to as **biological catalysts.** A catalyst is a chemical substance that speeds up the rate of a chemical reaction, but is not changed itself during the reaction it catalyses.

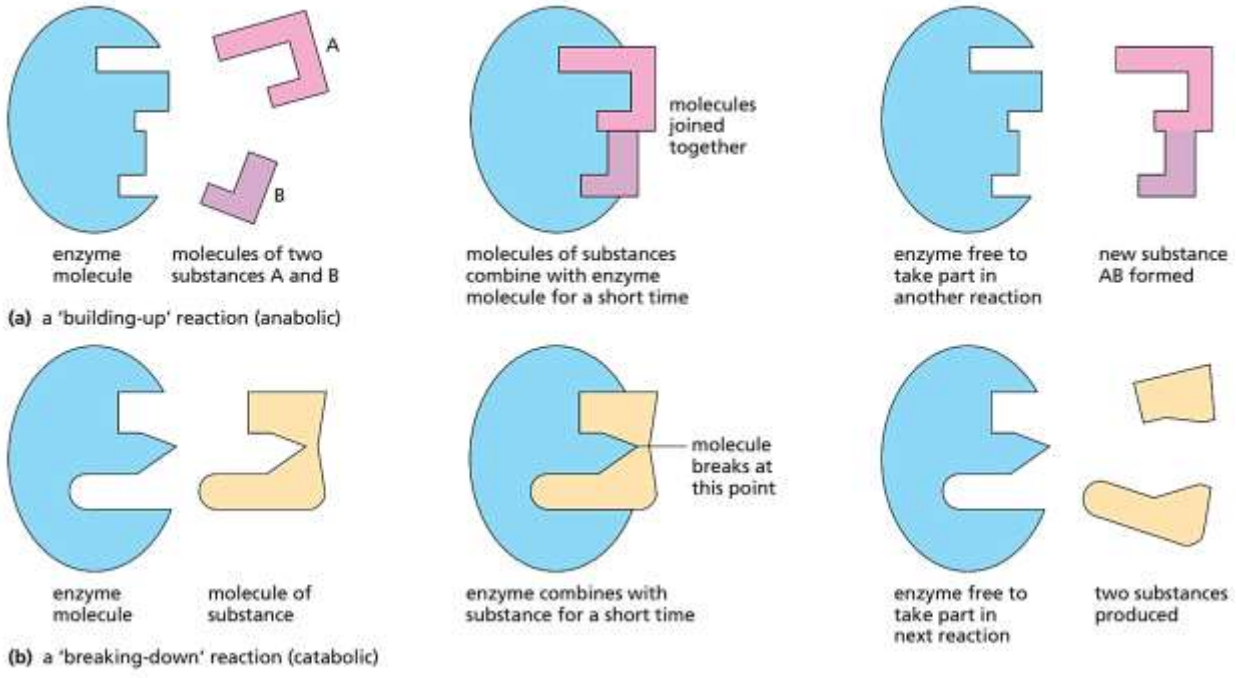
- In reactions, the substance on which enzymes act is called a **substrate**. Enzymes have several physical and chemical properties that are different from other inorganic catalysts as follows;

1. Enzymes are made of proteins, that is organic compounds.

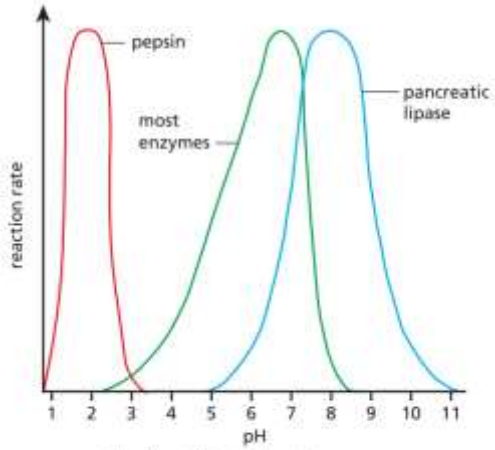
2. All enzymes are catalysts, that is, they speed up chemical reactions, which would otherwise proceed very slowly.

3. Small amounts of enzyme can bring about a chemical change in relative large amounts of another substance.
4. Enzymes are specific in their action called "**Lock and key theory.**" This means that each enzyme is limited to reactions with only one type of substrate.

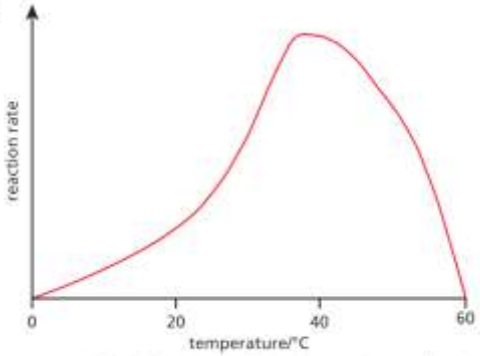
Lock and Key Theory



5. Enzymes are sensitive to heat and pH. Each enzyme has its optimum temperature and **optimum pH** for the action to be fastest.



The effect of pH on digestive enzymes



Graph showing the effect of temperature on the rate of an enzyme-controlled reaction

6. Certain enzymes require the presence of vitamins of the B complex before they can function. These vitamins are known as co-enzymes.

7. The rate of enzyme-controlled reactions depends on the concentration of the enzyme and substrate. The more enzymes, the faster the reaction will proceed as far as enough substrates are available.

8. Similarly, an increase in the substrate concentration will speed up the reaction if there are enough enzymes to cope with the additional substrates.

1.4.2 BIOLOGICAL AND NON-BIOLOGICAL CATALYSTS.

- Although enzymes and non-biological catalysts are similar in that they both increase rates of chemical reactions, there are some differences between enzyme and non-biological catalysts shown below.

Biological catalysts (Enzymes)	Non biological catalysts
They are proteins and they are made from organic substances.	They are non-living and inorganic
They are affected by pH	They are not affected by pH
They are denatured at high temperature	They work better at high temperatures
They are specific in their action. They can catalyse only particular substrates	They are non-specific. They can be used in many reactions

1.4.3 CLASSIFICATION OF ENZYMES

- Most reactions (e.g respirations and protein synthesis) in organisms occur within cells. The enzymes, which catalyse reactions within cells, are called **intra-cellular enzymes.**

- However, some reactions take place outside the cell membrane (e.g digestion). Those that catalyse reactions outside cells are called **extra-cellular enzymes**. Enzymes, which are found in the alimentary canals, are called **digestive enzymes**. All digestive enzymes are extra-cellular enzymes. For example;

    1. **Lipase** catalyses the breakdown of fat into fatty acid and glycerol.

    2. **Protease** (e.g. pepsin and trypsin) catalyses the breakdown of protein into peptides.

    3. **Amylase** catalyses the breakdown of starch into maltose.

    4. **Maltase** catalyses the breakdown of maltose into glucose.

    5. **Lactase** catalyses the breakdown of lactose into glucose and galactose.

6. **Sucrose** catalyses the breakdown of sucrose into glucose and fructose.

1.4.4 INDUSTRIAL APPLICATION OF ENZYMES

a. Research in enzymes from plant and animal tissues had led to the discovery of their uses in industry.

i. **Biological washing powder**: contain proteases, lipases, amylases to remove dirty stains.

ii. **Brewing:** breakdown of sucrose to alcohol.

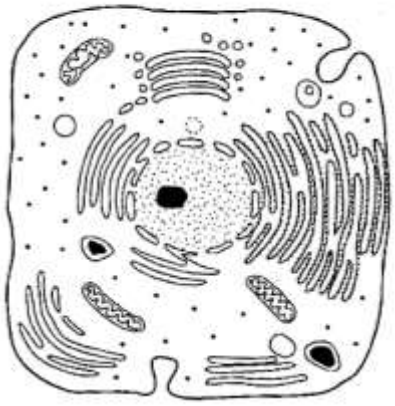
iii. **Tanning:** soften the animal skins into leather by tannic acid.

iv. **Baking:** enzymes in the yeast act on the sugar to produce carbon dioxide, which is trapped in the dough and makes it rise.

QUESTIONS

1.

The diagram represents a cell as seen under the electron microscope.



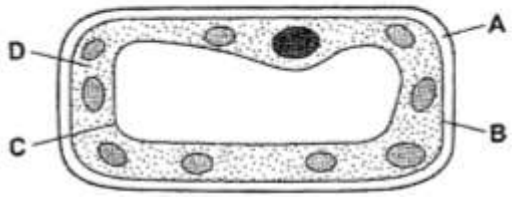
What type of cell is this?

	type of cell	reason
A	animal cell	outer layer is the cell membrane
B	bacterium	no chromosomes are visible
C	plant cell	cytoplasm is visible
D	plant cell	cell wall is visible

2.

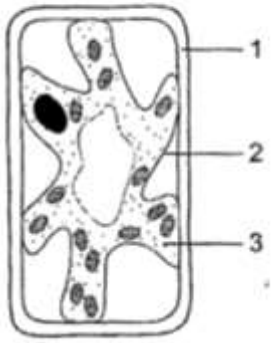
The diagram shows a plant cell.

Which structure controls the passage of substances into and out of the cell?



3.

The diagram shows a typical plant cell after being placed in a concentrated salt solution for ten minutes.



Which numbered structures are partially permeable?

A 1 and 2 only
B 1 and 3 only
C 1 only
D 2 only

4.

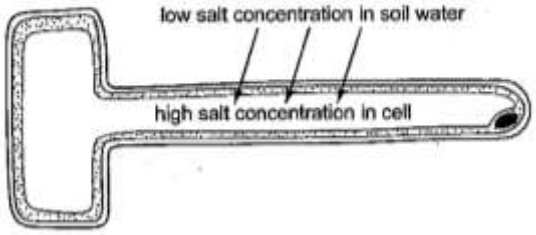
When a red stain is added to a culture containing both living and dead cells, only the dead cells take up the stain.

Which structure prevents the stain entering the living cells?

A cell membrane
B cell wall
C cytoplasm
D vacuole

5.

The arrows represent the movement of salts into a root hair cell.



What describes the movement of the salts?

A active transport against the concentration gradient

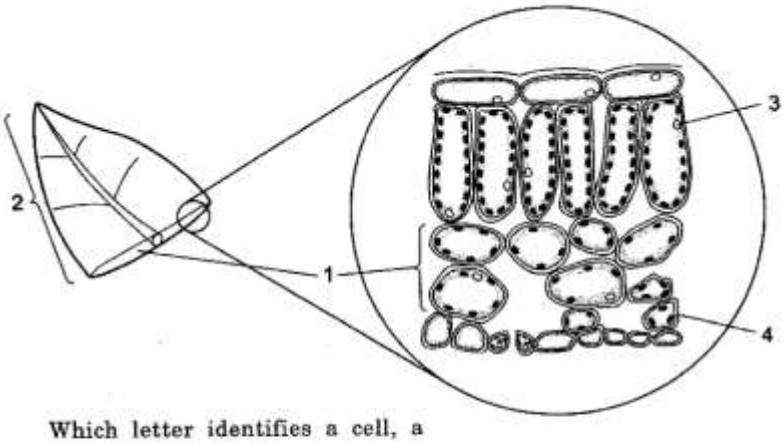
B active transport down the concentration gradient

C diffusion against the concentration gradient

D diffusion down the concentration gradient

6.

The diagram shows the structure of a leaf.



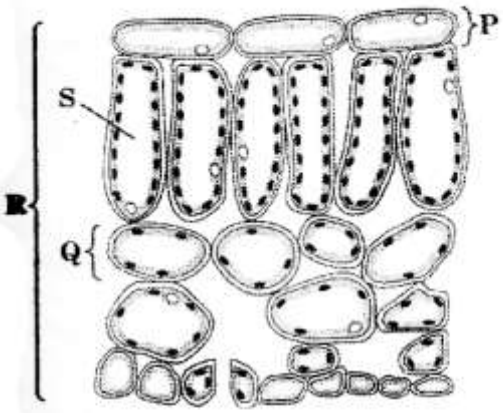
Which letter identifies a cell, a tissue and an organ?

	cell	tissue	organ
A	3	2	4
B	1	4	3
C	4	1	2
D	2	3	1

[N08/P1/Q1]

7.

The diagram shows a section through a leaf.



Which is an organ and which is a tissue?

	organ	tissue
A	**P**	**R**
B	**Q**	**S**
C	**R**	**P**
D	**S**	**Q**

8.

Which processes can take place in a root hair cell when oxygen is **not** available?

A active transport only
B diffusion only
C active transport and osmosis only
D diffusion and osmosis only

9.

The table shows the concentrations of some mineral ions in the root hair of a plant and in the soil around it.

mineral ion	concentration in the root hair (arbitrary units)	concentration in the soil (arbitrary units)
magnesium	75	15
nitrate	126	47

How are these mineral ions absorbed from the soil by the plant?

	magnesium	nitrate
A	active transport	active transport
B	active transport	diffusion
C	diffusion	active transport
D	diffusion	diffusion

10.

Which liquid has the highest water potential at atmospheric pressure?

A distilled water
B leaf cytoplasm
C root hair cell sap
D soil water

11.

Diagram 1 shows an onion cell that has been placed in pure water.

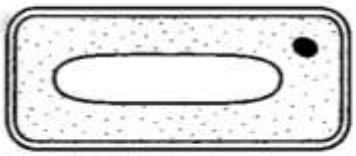


diagram 1

The cell is now placed in a concentrated sugar solution.

It changes to appear as in diagram 2.

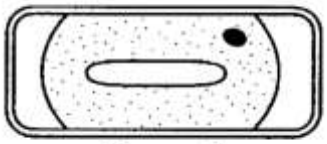


diagram 2

Which statement explains the change?

A Sugar has moved into the cell.
B Sugar has moved out of the cell.
C Water has moved into the cell.
D Water has moved out of the cell.

12.

Protease breaks down proteins into amino acids.

In the 'lock and key' hypothesis, what is the lock and what is the key?

	lock	key
A	amino acid	protease
B	protease	amino acid
C	protease	protein
D	protein	protease

13.

Four test-tubes containing egg white are incubated for ten minutes at 35 °C. Different substances are then added to the four test-tubes.

In which test-tube is the egg white first digested?

	substances added
A	1 cm^3 lipase solution and three drops of sodium hydroxide solution
B	1 cm^3 protease solution and three drops of dilute hydrochloric acid
C	1 cm^3 protease solution and three drops of water
D	1 cm^3 lipase solution and three drops of water

14.

Four tubes containing 10cm^3 of 1% starch solution were treated in different ways and then mixed with saliva. After 30 minutes, 1cm^3 of iodine in potassium iodide solution was added to each tube.

In which tubes were the contents a yellow-brown colour?

	tube incubated at 35°C	tube incubated at 75°C	tube incubated at pH 2.5	tube incubated at pH 6.9
A	✓		✓	
B	✓			✓
C		✓		✓
D		✓	✓	

15.

According to the lock and key hypothesis, which is the lock and which is the key for the enzyme lipase?

	key	lock
A	fatty acids	lipids
B	lipase	lipids
C	lipase	fatty acids
D	lipids	lipase

answers

1. A 2. B 3. D 4. A 5.A 6. C 7. C 8. D 9. A 10. A

11. D 12. C 13. B 14. B 15. D