

CLASS IX

Biology

COMPLETE BOOK NOTES

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Chapter# 01 THE SCIENCE OF BIOLOGY

1. Science:

Science is a systematic way of studying of natural world through observation and experimentation.

2. Branches:

Science is divided into different branches like:

- i. Biology ii. Mathematics
- iii. Physics iv. Chemistry

3. Biology:

Biology comes from two Greek words i.e, “bios” (life) and “logos” (study).

Biology is defined as: “The Study of life”.

4. Fields of biology:

Biology is mainly divided into three fields:

- i. Zoology ii. Botany
- iii. Microbiology

- Zoology: It deals with the study of animals.
- Botany: It deals with the study of plants.
- Microbiology: It deals with the study of microorganisms like bacteria, fungi, yeast, etc.

5. Branches of biology:

Biology is divided into different branches like:

- i. Morphology ii. Anatomy iii. Physiology
- iv. Histology v. Cytology vi. Molecular biology
- vii. Embryology viii. Genetics ix. Paleontology
- x. Taxonomy xi. Ecology

5.1 Morphology:

It deals with the study of terms and shapes of organisms.

5.2 Anatomy:

It deals with the study of internal structure of organisms.

5.3 Physiology:

It deals with the study of functioning of body parts.

5.4 Histology:

It deals with the microscopic study of tissues.

5.5 Cytology:

It deals with the study of cells i.e., the building blocks of life.

5.6 Molecular biology:

It deals with the study of biological molecules like carbohydrates, proteins lipids and nucleic acids.

5.7 Embryology:

It deals with the study of development of organism from embryo.

5.8 Genetics:

It deals with the study of transfer of characteristics from parents to off springs.

5.9 Paleontology:

It deals with the study of fossils i.e. Fossils of dinosaur.

5.10 Taxonomy:

It deals with the classification of organisms into groups on the basis of similarities and differences.

5.10.1 Fossils:

Fossils are the remains of plants and animals that were preserved in rocks.

Example:

Cyanobacterium is the oldest known fossil.

5.11 Ecology:

It deals with the study of relationship of organism with environment. Ecology helps to conserve biodiversity.

5.11.1 Marine biology:

It deals with the study of life in oceans.

Example:

Coral reefs support a wide variety of marine life.

5.11.2 Pathology:

It deals with the study of diseases, their causes and effects.

Example:

Pathologist studies how the uncontrolled division and spread of cells causes cancer.

5.11.3 Immunology:

It deals with the study of components of the diseases immune system and their role against

5.11.4 Pharmacology:

It deals with the study of drugs and their effects on the body.

Example:

Antibiotics used to kill bacteria.

6. Relation of biology with other sciences:

Biology is linked with other sciences like chemistry, physics and Earth sciences. Some examples are given below:

- i. Biochemistry
- ii. Biophysics
- iii. Computational biology
- iv. Biogeography
- v. Biostatistics
- vi. Biotechnology
- vii. Bioeconomics

6.1 Biochemistry:

It deals with study of the structure and reactions of different chemical substances in living systems,

Example:

Study of photosynthesis and respiration.

6.2 Biophysics:

It deals with the study of principles of physics, which apply to biological processes.

Example:

Study of rules of lever and motion to understand the function of muscles, bones and joints.

6.3 Computational biology:

In this branch, scientists use mathematical models to understand biological systems and relationships

6.4 Biogeography:

It is the study of distribution of living organisms in different geographical regions of the world.

Example:

Lions are found in forests of Africa.

6.5 Biostatistics:

It deals with the principles of statistics to analyze and interpret data related to living organisms

6.6 Biotechnology:

It deals with the use of living organisms to develop beneficial products.

Example:

Bacteria are used for the production of insulin.

6.7 Bioeconomics:

It deals with the study of organism from economic point of view.

Example:

Production of new variety of crops.

7. Carriers in Biology:

There are many carriers in the field of biology. Some are given below:

7.1 Medicine:

This profession deals with diagnosis and treatment of diseases.

7.2 Surgery:

In surgery, defective parts of body are repaired, replaced or removed.

7.3 Dentistry:

Dentists specialize in oral health. They diagnose and treat dental diseases.

7.4 Pharmacology:

Pharmacologists study the effects of drugs on human body. For this career, a degree of BS in pharmacy or Doctor of pharmacy is required.

7.5 Veterinary medicine:

It mainly belongs to treatment of diseases in animals.

7.6 Physiotherapy:

It is the therapy that is used to restore movement of body that has been damaged due to disease or injury. Physiotherapists use exercises and massages to improve physical movement.

7.7 Fisheries and wildlife:

Fisheries and wildlife departments offer jobs after BS and MS degree in Zoology, Fisheries, etc.

7.8 Agriculture:

Agricultural scientists improve farming practices, crop production, and sustainable agricultural techniques.

7.9 Animal husbandry:

This field involves caring for livestock to improve their quality and productivity.

7.10 Horticulture:

Horticulturists cultivate fruits, vegetables, flowers and ornamental plants.

7.11 Forestry:

Foresters manage and conserve forests and wildlife.

7.12 Farming:

The farming professionals prepare farms in which they grow crops and raise animals for food and other products.

7.13 Biotechnology:

Biotechnologists use biological processes to develop products and technologies in medicine, agriculture and more.

7.14 Forensics:

Forensic scientists analyze physical evidence from crime scene in criminal investigations

8. Science as collaborative field:

Science acts as a collaborative field in which researchers from various disciplines work together to solve complex problems.

Examples:

Human genome project, climate change research, etc.

8.1 Medical research in science:

Medical research in science, medical research often depends on interdisciplinary collaboration,

For example:

Cancer researchers involve oncologist, biologists and cancer biochemists.

8.2 Human genome project:

Human genome project aimed to sequence and map the entire genome. This project was completed in 2003.

8.3 Climate change research:

Climate change requires collaboration among many disciplines like atmospheric science, ecology, economics and sociology.

8.4 Oncologists:

The persons which are cancer consultants are called oncologists.

8.5 Abbreviation of NASA:

NASA stands for "National Aeronautics and Space Administration".

9. Biological method/scientific method:

The method which is used to solve biological/scientific problem called biological method/scientific method.

Scientific Problem:

Specific issue or phenomenon that scientists want to investigate is called scientific problem.

Example:

A biologist notices that plants in an area are growing taller than usual so it's a problem.

Steps:

Following steps are involved in scientific method:

1. Recognition 2. Observation 3. Hypothesis
4. Deduction 5. Experiments 6. Results

9.1 Recognition:

It involves identifying and defining a scientific problem-defining a problem.

Example:

A biologist notices that plants in an area are growing taller than usual. This problem becomes the starting point.

What molecular biologist do?

Molecular biologist study fundamental life processes, developed drugs, and create genetically modified organisms.

9.2 Observation:

Scientists make observations about the problem. They use five senses for making observation.

Types:

Observations may be:

- i. Qualitative ii. Quantitative

9.2.1 Qualitative:

Qualitative observations involve observations that cannot be measured with number.

9.2.2 Quantitative:

These observations involve measurements or numerical values that can be expressed in terms of quantity.

Example:

Number of birds in a tree.

Important Note:

Quantitative observations are more accurate than qualitative because qualitative observations are invariable, measurable and can be recorded in terms of numbers.

9.3 Hypothesis:

The tentative explanation of an observation is called hypothesis.

Characteristics:

A hypothesis has following characteristics:

- It is a proposed statement.
- It always matches with available observations.
- It can be tested through experiments.

9.4 Deduction:

The logical results developed from hypothesis are called deductions. Usually deductions involve if- then statement.

Example:

If iron deficiency is causing discoloration of leaf then adding iron to soil will improve the colours of leaf.

9.5 Experiments:

It is the most basic step of scientific method. Scientists perform experiments to test hypothesis in which is proved correct and the one alternate are proved incorrect.

➤ Robotics and artificial intelligence:

The field of robotics and AI is an interdisciplinary. It involves computer science, engineering, mathematics and psychology. This led to significant advancements in robotic system.

➤ Experimental group:

The group in an experiment which receives the treatment being tested.

Example:

Patients receiving a new medicine.

➤ Control group:

The group that does not receive the treatment but serves as baseline for comparison.

Example:

Patient receiving a standard treatment.

9.6 Results:

The data obtained after performing an experiment is called its result. Scientists publish their findings in specific journals and books

➤ **Theory:**

When hypothesis continually becomes true after many experiments and is supported by evidences, then it becomes a theory.

Example:

Theory of evolution.

➤ **Law:**

A scientific law is uniform or constant fact of nature. It is an irrefutable theory.

Example:

Hardy-Weinberg law and Mendel's law of inheritance.

10. Malaria:

Malaria is derived from two words "mal" (bad) and "aria" (air) means "bad air."

10.1 Observations for malaria in 19th

Century:

There are four major observations about malaria:

- ❖ Malaria and marshy areas have some relation.
- ❖ Quinine is an effective drug for treating malaria.
- ❖ Drinking water of marshy areas does not cause malaria.
- ❖ Plasmodium was seen in the blood of malarial patient.

10.2 Cause of malaria:

In 1878, a French army physician Laveran noticed a microorganism in blood of malarial patient. This microorganism was Plasmodium.

10.3 Symptoms of malaria:

Symptoms of malaria are given below;

- i. Headache ii. Shivering iii. Fatigue
- iv. High fever v. Redness on skin.
- vi. Muscle and joint pain

10.4 Observations A. F. A King:

In 1883, a physician A. F. A King listed 20 observations. Some are given below:

- People who slept outdoors had more chances to get malaria than those who slept inside.
- People who slept under fine mosquito nets had less chances for getting malaria than those who did not use nets.
- Individuals who slept near a smoky fire usually did not get malaria.

10.5 How plasmodium is transmitted person to other?

Plasmodium is transferred by a female Anopheles mosquito to man. When she bites infected person, plasmodium transferred in her and then when this infected mosquito bites normal person, Plasmodium transferred in him causing malaria. In sparrow, it is transmitted by Culex.

10.6 Treatment of malaria:

Quinine is the only way to treat malaria.

11. Quranic Instructions to Reveal the Study of Life:

11.1 Translation of verse: 14 of Surah Al-Mominoon:

"Then fashioned We the drop a clot, fashioned We the lot a little lump, then fashioned We the little lump bones, then clotted the bones with flesh."

11.2 Translation of verse: 45 of Surah Al-Noor:

"Allah hath created every animal from water. Then some of them creep up over their bellies, others two legs, and others on four. Allah creates what He pleases. Surely, Allah is most capable of everything."

11.3 Incubation period:

"The period between the entry of parasite in host and the appearance of symptoms is called incubation period."

11.4 Translation of verse: 30 of Surah Al-Ambia:

"We made everything from water."

11.5 Translation of verse: 14 of Surah Al-Rehman:

"He made man from clay like the potter."

Chapter# 02 BIODIVERSITY

1. Biodiversity:

Bio means "life" and diversity means "variety". Biodiversity means variety of organisms in a particular area.

1.1 Factors:

Biodiversity depends upon following factors:

- i. Climate ii. Altitude iii. Soil type

Did you know?

International day of biodiversity is celebrated on **22nd May** every year. It is celebrated to promote protection of biodiversity.

1.2 Benefits of biodiversity:

Biodiversity provides many benefits. Some important are:

- Ecosystem stability
- Climate regulation
- Natural resources
- Economic benefits

1.2.1 Ecosystem stability:

Biodiversity helps to maintain the balance of ecosystem. It plays important role in biogeochemical cycles such as carbon cycle, nitrogen cycle, etc.

1.2.2 Climate regulation:

Plants and algae absorb carbon dioxide. It helps to keep the climate balanced.

1.2.3 Natural resources:

Biodiversity provides a vast array of resources, from food and medicine to building materials and fuel.

1.2.4 Economic benefits:

Biodiversity supports different industries, including agriculture, tourism, and pharmaceuticals.

1.3 What is meant by Flora & Fauna:

Flora: The diversity of plants is called flora.

Fauna: The diversity of animals is called fauna.

<u>Taxonomy</u>	<u>Systematics</u>
➤ The branch of biology which deals with the study of classification of organisms into group and subgroup is called taxonomy.	➤ The branch of biology which deals with the study of classification of organisms along with their evolutionary history is called systematics.

2. Classification:

Classification is the process in which organisms are divided into groups and subgroups on the basis of similarities and differences found in them.

2.1 Aims of classification:

The main aims of classification are:

- ❖ To determine similarities and differences among organisms so that they can be studied easily

- ❖ To find the evolutionary relationships among organisms.

2.2 Advantages of classification

Classification provides following advantages:

- Classification provides a framework for studying and comparing different species.
- It explains the inter-relationship amongst variomagganisms.

2.3 Most specific level of classification:

Species is the most specific level of classification.

A species is a group of organisms which can interbreed freely and produce fertile offspring.

3. Taxonomic ranks:

The groups into which organisms are classified are known as taxonomic ranks or taxa (singular: taxon).

3.1 Note:

Each kingdom is classified into smaller taxa in the following way:

- ❖ Phylum: Group of related classes
- ❖ Class: Group of related orders
- ❖ Order: Group of related families
- ❖ Family: Group of related genera
- ❖ Genus: Group of related species
- ❖ Species: Group of similar organisms.

3.2 Write Down classification of human and pea:

<u>Taxonomic Rank</u>	<u>Human</u>	<u>Pea</u>
Domain	Eukarya	Eukarya
Kingdom	Animalia	Plantae
Phylum	Chordata	Magnoliophyta
Class	Mammalia	Magnoliopsida
Order	Primates	Fabales
Family	Hominidea	Fabaceae
Genus	Homo	Pisum
Species	Homo Sapiens	Pisum sativum

4. History of classification:

- Primarily, **Aristotle** divided organisms into two groups: i.e.. plants and animals.
- Then, **Abu Exman Al-Jahiz** described characteristics of 350 species of animals. He wrote a lot about life of ants.
- **Andrea Caesalpini** divided plants-into fifteen groups and called them genera.
- **Tournefort** introduced the taxa of class and species.
- **Carl Linnaeus** created a taxonomic hierarchy of organisms with seven taxa.

4.1 Two Kingdom Classification System:

It was the earliest system in which all organisms are classified into two kingdoms i.e. Plantae and Animalia.

4.1.1 Autotrophs:

The organisms which can prepare their own food from inorganic matters are called autotrophs.

Example: Plants

4.1.2 Heterotrophs:

The organisms which cannot prepare their own food are called heterotrophs.

Example: Animals

4.1.3 Shortcomings of Two Kingdom

Classification System:

Two kingdom classification system was found unworkable because many unicellular organisms like Euglena have both plant-like (presence of chlorophyll) and animal-like (heterotrophic mode of nutrition) characteristics.

4.2 Three Kingdom Classification System:

- In 1866, Ernst Haeckel proposed a third kingdom i.e. Protista for Euglena-like organism.
- In this system, he included prokaryotes in kingdom Protista.

4.2.1 Shortcomings of Three Kingdom

Classification System:

Some taxonomists disagreed position of fungi in Plantae. Fungi are heterotrophic and they do not have cellulose in their cell walls.

4.3 Five Kingdom Classification System:

In 1969, **Robert Whittaker** introduced five kingdom system. These kingdoms were

- Monera
- Protista
- Fungi
- Plantae

<u>Prokaryotes</u>	<u>Eukaryotes</u>
➤ The organisms which do not have well-defined nucleus are called prokaryotes. <u>Example:</u> Bacteria	➤ The organisms which have a well-defined nucleus are called eukaryotes. <u>Example:</u> Plants, animals etc

4.3.1 Basis of Whittaker's system:

This system was based on:

- The modes of nutrition i.e. photosynthesis, absorption and ingestion.
- The levels of cellular organization i.e.. prokaryotic (bacteria, archaea), unicellular eukaryotic (Protista) and multicellular eukaryotic (fungi, plants and animals).

4.3.2 Modification of Whittaker's system:

Margulis & Schwartz modified the system, they considered genetics along with cellular organization and mode of nutrition.

4.4 Three Domain Classification System:

In 1977, **Carl Woese** added a taxon i.e. domain and classified organisms into three domains:

1. Archaea
2. Bacteria
3. Eukarya

5. Domains of living classification:

The following are the main characteristics of the three domains of organisms.

5.1 Domain Archaea:

- ❖ These are the most primitive organisms on Earth.
- ❖ They are prokaryotes but lack peptidoglycan.
- ❖ Their cell wall is made of various polypeptides and proteins
- ❖ They usually live in extreme conditions e.g.. hot springs, salt lakes, etc.

5.2 Domain Bacteria:

- This domain contains bacteria and cyanobacteria.
- They are prokaryotes.
- Their cell wall is made of peptidoglycan.
- They are found in all environments.

5.3 Domain Eukarya:

- This domain includes all unicellular and multicellular eukaryotes.
- They have complex eukaryotic cells.
- They have membrane bound organelles. This domain contains kingdom Protista, fungi, plantae and animalia.

6. Classification of domain Eukarya:

6.1 Domain:

Domain is the highest taxonomic rank. All organisms are divided into three domains.

6.2 Kingdom Protista:

Kingdom Protista includes eukaryotes which are unicellular or colonial.

There are three types of protists:

- 1) Plant-like protists
- 2) Animal-like protists
- 3) Fungi-like protists

6.2.1 Plant-like protists:

Plant-like protists have cell walls made of cellulose. They have chlorophyll in chloroplasts and are autotrophs.

Example: Algae.

6.2.2 Animal-like protists:

These are heterotrophs and ingest food. Their cells have no cell wall.

Example: Amoeba and Paramecium.

6.2.3 Fungi-like protists:

Fungus-like protists absorb nutrients from decaying organic matter. Their cell walls are made of cellulose instead of chitin.

Example: Slime molds and water molds,

6.3 Kingdom Fungi:

- This kingdom consists of fungi.
- They are heterotrophic.
- They do not ingest food like animals.
- They absorb food from decaying matter.

6.3.1 Uses of Fungi:

- i. They are used in the production of bread, cheese and beer.
- ii. Some have medicinal properties such as penicillin.

6.3.2 How Fungi different from plants:

- Fungi are heterotrophic while plants are autotrophic.
- Fungi cell wall is made of chitin while plants cell wall is made of cellulose.

6.4 Kingdom Plantae:

- ❖ It includes plants which are eukaryotic multicellular organisms.
- ❖ They are autotrophic.
- ❖ All plants have multicellular sex organs.
- ❖ During sexual reproduction they form embryos.

Example: Mosses, ferns, etc.

6.5 Kingdom Animalia:

- kingdom includes animals which are eukaryotic, multicellular and heterotrophic.
- They develop from embryos.
- They ingest food and digest it.
- Vertebrates and invertebrates are included in kingdom animalia.

7. Status of Virus in Classification:

- ❖ Viruses are at the borderline of living and non-living.
- ❖ They are acellular i.e., they are not made of cells and do not have organelles.
- ❖ Virus consists of nucleic acid surrounded by a protein coat.

Note: Viruses are not included in the classification system because they lack any of the characteristics of the domains of life.

<u>Prions</u>	<u>Viroids</u>
❖ Prions are composed of protein only.	❖ Viroids are composed of circular RNA only.

7.1 Similarity:

Both cause infectious diseases in certain plants. They are also a cause of cancer.

7.2 Corona Virus:

Corona virus is a virus identified in late 2019 in Wuhan, China. It caused a pandemic of respiratory illness, called **COVID-19**.

7.2.1 Symptoms:

Its common symptoms are:

- Fever
- Cough
- Shortness of Breath
- Fatigue
- Body aches
- Sore throat, etc.

7.2.2 Treatment:

There is no specific treatment for corona virus. Vaccines are available to prevent it.

7.2.3 Prevention:

- i. Washing hands frequently with soap for at least 20 seconds.
- ii. Use of sanitizers.
- iii. Vaccine plays a crucial role in preventing corona virus.

8. Binomial Nomenclature:

The system of giving scientific name to organisms is called binomial nomenclature. The binomial name consists of two parts:

✚ First part is of genus to which organism belongs.

✚ Second part is the name of species.

Example: Scientific name of onion is **Allium Cepa** and that of human being is **Homo sapiens**.

<u>Common Name</u>	<u>Scientific Name</u>
Honey Bee	<i>Apis Cerana</i>
Tiger	<i>Panthera tigris</i>
Fruit fly	<i>Drosophilla</i>
Pea	<i>Pisum stium</i>
Potato	<i>Solanum tuberosum</i>

8.1 Rules:

Some important rules of binomial nomenclature are given below:

- Scientific names are taken from Latin language.
- Genus name always comes first followed by species name.
- The first part of the name i.e.. genus name should begin with capital letter. The second part i.e., species name should begin with small letter.

iv. Name should be printed in italics.

v. If handwritten two parts are separately underlined.

8.2 Significance

Various regions have different names for the same organism which cause too much confusion. Therefore, each organism is given a scientific name which is common worldwide and helps to avoid confusion.

Chapter# 03 THE CELL

1. Cells:

Cells are the microscopic structures which are structural and functional unit of life.

2. Structure of Cell:

➤ Discovery of cell:

The term cell was coined by Robert Hooke in 1665 after observing cork under a microscope.

➤ Discovery of nucleus:

The nucleus was discovered by Robert Brown in 1831 while studying plant cells under microscope.

2.1 Cell Wall:

The outermost membrane of many plant cells is called cell wall.

2.1.1 Functions:

It provides shape, strength, protection and support to protoplasm,

2.1.2 Layers of cell wall:

There are three layers of cells wall:

- Primary wall
- Secondary wall
- Middle lamella

2.1.3 What is difference between primary wall & secondary wall?

<u>Primary wall</u>	<u>Secondary wall</u>
- The outer layer of plant cell wall is called primary wall. - It's most common chemical is cellulose.	- Some cells have another wall on the inner side of primary wall, which is called secondary wall. - It's most common chemical is lignin.

2.1.4 What are basic principles of cell theory:

Cell theory include the following basic properties:

- ❖ All organisms are composed of one or more cells.

- ❖ Cells are the smallest living things, the basic unit of organization of all organisms.
- ❖ Cells arise only by divisions previous existing cells.

2.1.5 Plasmodesmata:

The channels in cell walls that allow the exchange of molecules between adjacent cell walls are called plasmodesmata.

2.1.6 What is meant by Middle Lamella:

Middle lamella is present between primary walls of adjacent cells. It contains magnesium, calcium and pectin.

2.1.7 What is difference between plant cell & animal cell?

<u>Plant cell</u>	<u>Animal cell</u>
- Plant cells have cell wall. - Plant cells have chloroplast. - Plant cells have one large central vacuole. - Plant cells do not have centrioles.	- Animal cells do not have cell wall. - Animal cells do not have chloroplast. - Animal cells have many small vacuoles. - Animal cells have centrioles.

2.2 Cell membrane:

Cell membrane is the outermost boundary of animal cells. In plant cells, it is covered by cell wall.

2.2.1 Composition:

Cell membrane is composed of proteins, and lipids and small quantities of carbohydrates.

2.2.2 Fluid mosaic model:

The structure of cell membrane is described as fluid-mosaic model. According to this model there is lipid bilayer in which protein are embedded. The lipid molecules bilayer gives fluidity and elasticity to membrane small amount of carbohydrates are also

found in cell membranes. They are joined with proteins of lipid membrane.

2.3 Cytoplasm:

Cytoplasm is the semi-viscous and semitransparent material present between plasma membrane and nuclear envelope,

2.3.1 Functions:

- ❖ Cytoplasm provides a medium for organelles to move and function.
- ❖ It helps in the transport of materials throughout cells.

2.3.2 Cytosol:

Cytosol is a liquid part of cytoplasm that includes molecules and small particles such as ribosomes, but not membrane-bound organelles.

2.4 Nucleus:

A prominent nucleus occurs in all eukaryotic cells. In animal cells, it is present in the center while in plant cells, due to large central vacuole, it is pushed to side.

2.4.1 Nuclear envelope:

Nucleus is bounded by double membrane. This membrane is called nuclear envelope.

2.4.2 Nuclear pores:

Nuclear membrane is semi-permeable and contains many pores. These pores are called nuclear pores.

2.4.3 Nucleoplasm

A jelly-like fluid is present in nucleus. This is called nucleoplasm.

2.4.4 Nucleolus:

Many small bodies are present in nucleus. These are called nucleoli (singular, nucleolus).

Functions: Nucleoli synthesize ribosomes.

2.4.5 Chromatin:

A fine thread-like material present inside nucleus is called chromatin. Chromatin is composed of DNA and protein.

2.4.6 Chromosomes:

During cell division, chromatin condenses and becomes chromosomes.

2.4.7 Why DNA is called hereditary material?

DNA is responsible for the transmission of characteristics from one generation to next. That's why DNA is called hereditary material.

2.5 Cytoskeleton:

It is a network of thin tubes and filaments present throughout the cytoplasm.

Parts:

It contains three parts.

- Microtubules
- Microfilament
- Intermediate filaments

2.5.1 Microtubules:

These are hollow tubes made of tubulin protein. This holds organelles in place, and maintains cell's shape.

2.5.2 Micro filaments:

Microfilaments are finer than microtubules. These are made up of contractile proteins mainly actin. They help in cell movement.

2.5.3 Intermediate filaments:

Intermediate filaments are rods made of variety of proteins, mainly keratin and vimentin. They anchor the nucleus and some other organelles in cell.

2.6 Ribosomes:

Ribosomes are tiny granular structures which are the sites of protein synthesis,

2.6.1 Subunits:

It consists of two subunits:

- i. Larger subunit
- ii. Smaller subunit

2.7 Endoplasmic Reticulum:

It is a network of membrane-bounded channels present throughout the cytoplasm of eukaryotic cells.

2.7.1 Types:

- i) Rough endoplasmic reticulum (RER)
- ii) Smooth endoplasmic reticulum (SER)

i) Rough Endoplasmic Reticulum (RER):

Rough endoplasmic reticulum is named because of its rough appearance due to numerous ribosomes that are attached to it. RER serves a function in protein synthesis.

ii) Smooth Endoplasmic Reticulum (SER):

Smooth endoplasmic reticulum lacks ribosomes and is involved in lipid metabolism and in the transport of materials from one part of cell to other. It also detoxifies harmful chemicals that have entered cell.

2.8 Golgi Apparatus:

In 1898, an Italian physician **Camille Golgi** discovered a set of flattened sacs that stacked over each other, and make structure. This structure is known as Golgi Apparatus.

2.8.1 Cisternae:

Golgi apparatus consists of flattened sacs. These sacs are called cisternae.

2.9 Lysosomes:

Lysosomes were discovered by Belgian scientist **Christian Rene de Duve**. These are small membrane bound vesicles that contain digestive enzymes.

2.9.1 Function:

- ❖ Lysosome fuses with food vacuoles and its digestive enzymes break down the food present in vacuole.
- ❖ They engulf damaged organelles and break them.

2.10 Mitochondria:

Mitochondria are the powerhouse of cell because they produce energy. They are double membrane bounded organelles present in eukaryotes,

2.10.1 Functions:

They perform aerobic respiration and release energy in the form of ATP.

2.10.2 Cristae:

The outer membrane of mitochondria is smooth while inner forms many folds. These folds are called cristae.

Functions:

It plays a vital role in cellular respiration by providing larger surface area.

2.11 Plastids:

Plastids are membrane bounded organelles present in the cells of plants and photosynthetic protists (algae).

2.11.1 Types:

These are three main types of plastids.

- i. Chloroplast
- ii. Chromoplast
- iii. Leucoplast

i) Chloroplast:

Chloroplasts are the sites of photosynthesis in plants. They contain green pigment called chlorophyll.

ii) Chromoplast:

They contain pigments associated with bright colours and are present in the cells of flower petals and fruits.

Function: Their function is to give colours to these parts and helps in pollination.

iii) Leucoplast:

These colourless and store starch, proteins and lipids. They are present in the cells of those parts where food is stored.

- **Thylakoids:** Some sac-like structures are present in chloroplast. These are called thylakoids.
- **Stroma:** A fluid present in chloroplasts that surrounds thylakoid is called stroma.
- **Grana:** The sacs stack on each other and make a structure called granum (plural grana).

2.12 Vacuoles:

These are simple membrane bound sacs filled with fluid. Large Animals cells have many small vacuoles while plant cells have only one central vacuole.

2.12.1 Tonoplast:

The membrane of vacuole is called tonoplast. It maintains turgor pressure.

2.12.2 Turgor pressure:

The outward pressure of the vacuole on cytoplasm and cell wall makes plant cells turgid. This pressure is called turgor pressure. The turgor pressure helps in maintaining cell shape.

2.13 Centrioles:

Centrioles are barrel-shaped organelles found in cells of animals and most protist.

2.13.1 Composition:

There is a pair of centrioles which both centrioles are at right angle to each other. Each centriole is formed of a triplets of microtubules made up of tubulin protein.

2.13.2 Basal bodies:

The cells which have cilia or flagella contain centriole near cell membranes. These centrioles are called basal bodies. They are responsible for the formation of cilia and flagella

3. Structural Advantages of Plant & Animal Cell:

3.1 Advantages of plant cell structures:

- ❖ plant cells have rigid cell wall which provides structural support and protection.
- ❖ They contain chloroplasts, which responsible for photosynthesis.
- ❖ The large central vacuole stores water, nutrients, and waste products.
- ❖ Plant cells are interconnected by plasmodesmata that allow transport of substances.

3.2 Advantages of animal cell structures:

- ❖ Animal cells have centrioles which make spindle fibers.
- ❖ They contain lysosomes that contribute to cellular cleanup and recycling.

- ❖ Some animal cells have structures called flagella and cilia, which are involved in movement.
- ❖ They lack a rigid wall which allows them to change shape easily.

4. Cell Specialization:

4.1 Mesophyll cells:

- These are green cells present in leaves.
- They are specialized for photosynthesis.
- They contain chloroplasts.
- Their shape and arrangement is suitable for maximum absorption of light.

4.2 Epidermal cells:

- They are flat and tightly packed cells that make outer layer.
- Epidermis protects the internal structures.
- Epidermis of root contains root hairs which increase surface area to absorb water and minerals.
- The lower epidermis of leaves contains guard cells which regulate opening and closing of stomata.

Name the chemical compounds that make up:

Cell membrane	Proteins, lipids & carbohydrates
Fungal cell wall	Chitin
Plant cell wall	Cellulose
Bacterial cell wall	Peptidoglycan
Ribosomes	Proteins & ribosomal RNA
Chromosomes	DNA & Proteins

4.2 Muscle cells:

- Muscle cells are specialized animal cells that can contract.
- They are elongated cells filled with actin and other contractile proteins.

4.2.1 Skeletal muscles:

Skeletal muscle cells are long and striated. They are attached to bones and help to move skeleton and in locomotion.

4.2.2 Cardiac muscles:

Cardiac muscle cells are branched and striated. They are found in heart walls and their contractions result in the pumping action of heart.

4.2.3 Smooth muscles:

Smooth muscle cells are spindle shaped and non-striated. They are involuntary in action and present in the walls of many internal organs.

4.3 Neurons:

- These are the specialized cells of the nervous system.
- They are responsible for transmitting messages throughout the body.
- A typical neuron consists of cell body, dendrites and axons.

4.3.1 Dendrites:

The shorter extensions that receive nerve impulses and transmit them to cell body are called dendrites.

4.3.2 Axons:

The longer extensions that carry nerve impulses away from cell body are called axons.

4.4 Red blood cells (Erythrocytes):

- These blood cells are specialized to carry oxygen from the lungs to the body's tissues.
- They are biconcave disk-shaped cells.
- This shape provides more surface area to absorb and release oxygen.
- They are filled with hemoglobin that actually carries oxygen.

4.5 Liver cells:

- They are also called hepatocytes.
- They have prominent nuclei for maximum activities.
- There are larger number of peroxisomes which contain enzymes to neutralize toxic substances.
- Small ducts are present between liver cells which collect and transport their secretion.

4.6- Within cells:

Within a cell, each organelle carries out distinct functions necessary for the cell's survival.

Example:

Mitochondria generate energy, endoplasmic reticulum synthesizes proteins and lipids, etc.

4.7 Across cells:

In multicellular organisms, the division of labour extends across cells. Each type of cell performs a specific role and contributes to overall functions of organism.

Example:

Muscle cells are specialized for contraction and movement, nerve cells for transmitting messages, etc.

5. Stem Cells:

Some unspecialized cells that have ability to make a variety of specialized cell types are called stem cells.

Example: Zygote is an unspecialized cell but it has ability to make new cells..

5.1 Can stem cells be used to regenerated?

Yes, stem cells have ability to regenerate damaged tissues.

For example: Stem cells in skin help in wound healing.

5.2 Function of stem cells:

- The stem cells can divide and differentiate into specific cells as the body needs them.
- They can also regenerate damaged tissue under right conditions.

Chapter# 04 CELL CYCLE

1. Cell Cycle:

The cell follows a regular series of events during its life. This series is called cell cycle.

1.1 Stages:

This series includes three stages:

- i. Growth
- ii. Preparation
- iii. Cell division

1.2 Ways of cell division:

Cell division occurs in two ways i.e.

- 1) Mitosis
- 2) Meiosis

2. Cell Cycle:

It is the series of events that take place in eukaryotic cell from its formation to its division into two daughter cells.

2.1 Phases:

The cell cycle can be divided into two main phases:

- Interphase
- Mitotic phase

2.2 Interphase:

During interphase the cell performs the life functions according to its specialty and prepares itself for next division.

2.2.1 Phases of Interphase:

Interphase consists of the following phases:

- i. G1 Phase
- ii. S Phase
- iii. G2 Phase

i. G1 Phase (First gap phase):

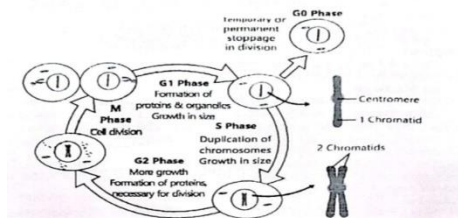
During this phase cell makes proteins and organelles and so grows in size. Cell also makes enzymes that are required in S-phase.

ii. S-phase (Synthesis phase):

During this phase DNA is replicated and chromosomes become doubled. The total number of chromosomes remains same.

iii. G2-phase (Second gap):

In this phase, cell continues to grow and produces proteins necessary for cell division. The cell checks for any DNA damage that may occur and repairs it. It begins to recognize its steps.



2.2.2-G0-Phase:

Many cells-stop dividing and start performing their specific functions. This phase is called G0 phase. Example: Neurone cells and some cells of kidney, liver etc.

3. Mitosis:

Mitosis is the type of cell division in which cell divides into two daughter cells, each with the same number of chromosomes as were present in the parent cell.

3.1 Discovery of Mitosis:

Mitosis was discovered in **1880s** by **Walther Flemming**.

3.2 Phases of Mitosis:

There are two major phases of mitosis:

- Karyokinesis
- Cytokinesis

3.2.1 Karyokinesis:

Division of nucleus is called karyokinesis.

Phases: It is divided into four phases:

- i. Prophase
- ii. Metaphase
- iii. Anaphase
- iv. Telophase

i. Prophase:

During prophase, the thread like chromatin condenses and coiled into visible chromosomes. Nuclear envelope and nucleolus disappear. The centrosome duplicates and two centrosomes migrate to opposite poles of the nucleus. When they are migrating, they make a network of microtubules called spindle fibres.

(a) Mitotic spindle:

A structure made up of spindle fibres which develops during cell division and helps in proper segregation of chromosomes into daughter cells, called mitotic spindle.

ii. Metaphase:

During this phase, spindle fibres bundle with chromosomes. They attach at the point of centromere. As a result chromosomes are pushed towards the equator.

(a) Mitotic spindle:

The chromosomes are attached to spindle fibres arranged themselves along the equator of the cell. In this way a plate is formed called metaphase plate.

iii. Anaphase:

The spindle fibres attached with chromosomes pull toward the poles. Due to this pulling the chromosome's sister chromatids separate. In this way, there are two similar sets of chromatids, which move towards the poles of cell.

iv. Telophase:

In this phase, new nuclear envelope forms around each set of separated chromosomes and nucleolus reforms. Both sets of chromosomes unfold back into chromatin.

3.2.2 Cytokinesis:

(a) Cytokinesis in animal cells:

In animal cells, a furrow develops in the cell membrane at the equator. At this furrow, cytoplasm has a ring of microfilaments contracts and moves the furrow. In this way parent cell pinched into two.

(b) Cytokinesis in plant cells:

In plant cells, Golgi apparatus makes vesicles. These vesicles move to the middle and fuse to form a plate called phragmoplast. The plate fuses with cell membrane. The result is two daughter cells.

(c) Phragmoplast:

A structure of microtubules and vesicles that forms in the plant cells during cytokinesis and guides the formation of the new cell plate is called phragmoplast.

3.3 Significance of mitosis:

- ❖ Mitosis plays an important role in growth by producing new cells.
- ❖ Mitosis replaces the older cells with new cells.
- ❖ Mitosis helps to regenerate different parts of body.
- ❖ Mitosis helps in budding

3.3.1 Regeneration:

The ability of an organism to regain its lost body parts is called regeneration.

Example:

Sea star can regenerate its lost arms,

i. Tumors:

If mutation occurs in mitosis, cells continue to divide. Due to this uncontrolled cell division, masses of cells are formed. These masses are called tumors.

ii. Benign tumors:

If tumors remain in their original location, they are called benign tumors.

iii. Malignant tumors:

If tumors migrate and attack other cells, they are called malignant tumors.

iv. Metastasis:

The process in which the tumor cells migrate and attack other cells is called metastasis. i.e. spreading of disease.

4. Meiosis:

It is the type of cell division in which daughter cell receives half the number of chromosomes as compared to parent cell.

 **Diploid:** The cells in which chromosomes are in pairs are called diploid.

 **Haploid:** The cells which have half number of chromosomes are called haploid.

4.1 Discovery of Meiosis:

Meiosis was discovered in 1876 by a German biologist Oscar Hertwig.

4.2 Divisions of Meiosis:

There are two divisions of meiosis:

- i. Meiosis-I ii. Meiosis-II

4.2.1 Meiosis-I:

In meiosis-I the homologous chromosomes in diploid cell separate and so two haploid daughter cells are produced.

Phases of Meiosis:

It is subdivided into four phases:

- i. Prophase-I ii. Metaphase-I
iii. Anaphase-I iv. Telophase-I

Prophase-1:

During this stage chromatin condenses and forms chromosomes. Each chromosome consists of two sister chromatids.

<u>Prophase of Mitosis</u>	<u>Prophases-I of Meiosis</u>
• It has shortest duration. • Homologous chromosomes remain separate • No crossing over occurs	• It has longest duration. • Homologous chromosomes come close together to form a pair. • Crossing over occurs.

- **Synapsis:**

During prophase-1 homologous chromosomes move close together. They pair up in a process called synapsis.

- **Tetrad:**

Each pair of homologous chromosomes is called tetrad.

- **Chiasmata:**

Non-sister chromatids of homologous chromosomes become zipped together forming X-shaped structures called chiasmata.

- **Crossing over:**

The process in which non-sister chromatids exchange their segments is called crossing over.

ii. Metaphase-I:

The tetrads attached with spindle fibres align along the equator and form metaphase plate. In metaphase plate, spindle fibres from both poles attach with one pair of homologous chromosomes.

iii. Anaphase-I:

Each spindle fibre pulls towards opposite poles. In this way chromosomes are separated, and move towards opposite poles. Each chromosome still contains two sister chromatids.

iv. Telophase-I:

Spindle disappears and a new nuclear envelope is made around each haploid set. Nucleolus also reforms during telophase-I. The chromosomes uncoil into chromatin. Cytokinesis occurs and two daughter cells are made.

How mitosis different from meiosis with respect to chromosome number?

- **Mitosis** Produce two daughter cells with same number of chromosomes.
- **Meiosis** Produced four daughter cells with half number of chromosomes.

4.2.1 Meiosis-II:

Meiosis-II resembles mitosis. All the events of meiosis-II are similar to mitosis,

✓ **What are gametes and spores?**

i. Gametes:

Reproductive cells that fuse during fertilization to form a zygote.

Examples: Sperm and egg cells in animals.

ii. Spores:

Reproductive cells that can develop into new organisms without fusing.

Examples: Fungal spores, endospores.

✓ **How meiosis brings genetic variety?**

Crossing over creates new combinations of genes on chromosomes. Each chromosome carries a unique set of genes. When diverse gametes from two parents combine, the resulting zygote is genetically different from both parents. In this way, meiosis contributes to genetic diversity in population.

(a) Disjunction:

The process in which chromatids separate properly is called disjunction.

(b) Non-disjunction:

The process in which the chromatids are not separated is called non-disjunction. It could lead to disorders in humans.

5. Similarities between Mitosis and Meiosis:

5.1 Write four similarities between mitosis and meiosis:

- DNA replication occurs during interphase (s phase) before both divisions.
- Both occur in cells that have chromosomes in pairs.
- In both divisions' chromosomes become visible during prophase.
- Both involve the formation of spindle apparatus.

5.2 Difference between mitosis and meiosis:

<u>Mitosis</u>	<u>Meiosis</u>
❖ Two daughter cells are produced.	❖ Four daughter cells are produced.
❖ Variations do not occur.	❖ Variations occur during crossing over.
❖ Occurs in somatic cells	❖ Occurs in germ line cells.
❖ No crossing over occurs	❖ Crossing over occurs during prophase-I.

Chapter# 05 TISSUES, ORGANS & ORGANS SYSTEMS

1. Levels of Organization:

The levels of organization in a multicellular organism begins with the simplest and smallest level

i.e., the atom, and progresses to the largest and most complex level i.e., the organism.

a) Atoms:

Atoms are the smallest unit of matter that maintain the property of an element.

Example: Carbon, Hydrogen, Oxygen.

b) Molecule:

Atoms combine to form molecules which can have entirely different properties than the atoms they contain,

Example: Water, Protein, Nucleic acid.

c) Organelle:

Molecules combine in specific ways and make the subcellular level i.e., organelle. Each organelle is specialized to a particular function.

Example: Mitochondria are responsible for cellular respiration and ribosomes for protein synthesis.

d) Cell:

When organelles assemble and interact with each other they make a cell with characteristics of life.

e) Tissue:

A tissue is the group of similar cells that work together to perform one or more specific functions.

Example: Epithelial tissue, muscular tissue, etc.

(i) Epithelial tissue:

This tissue covers body surface and lines cavities (e.g., skin).

(ii) Muscle tissue:

This tissue enables movement (e.g., cardiac muscle in heart).

(iii) Epidermal tissue:

This tissue protects the underlying parts (e.g., epidermis of leaf).

(iv) Vascular tissue:

This tissue transports water and nutrients (e.g., xylem and phloem).

f) Organ:

Different tissues that work together to perform specific function, make a structure called organ.

Example: Heart, Leaves, etc.

g) Organ system:

An organ system consists of multiple organs that work together to perform related functions.

Example: circulatory system, root system etc.

(i) Circulatory system:

The system that transports nutrients and oxygen is called circulatory system.

h) Organism:

An organism is a living being that can function independently on behalf of proper functioning of its organ systems.

Examples: Humans. Trees, etc.

1.1 Emergent properties:

In organisms, the components at each level do not work solely. Instead they interact. Due to these interactions, they create new functions called emergent properties.

(i) Emergent properties from organelles to cells:

Individual organelles have specific functions. However, when these organelles interact within a cell, they create a complex system capable of carrying out various cellular processes, such as division, protein synthesis and energy production.

(ii) Emergent properties from cells to tissues:

Individual cells do not have properties that are present in the tissues which they make. For example: Muscle cells combine to form muscle tissue which can contract and generate force.

(iii) Emergent properties from tissues to organs:

An organ performs complex functions that its individual tissues cannot perform.

For example: Heart is composed of various tissues whose coordinated interaction allows heart to pump blood throughout the body.

(iv) Emergent properties from organs to organ systems:

Multiply organs working together form organ systems which carry out vital functions.

For example:

Digestive system is composed of organs like mouth, oesophagus, stomach, intestine and liver. These individual organs cannot digest food but the coordinated actions of these organs enable the digestion and absorption of nutrients.

(v) Emergent properties from organ systems to organisms:

In an individual, the interactions of various organ systems bring emergent properties such as thinking and ability to adapt environment.

2. Organs in Plants:

2.1 Roots:

Roots anchor the plant in the soil and absorb water and essential minerals from soil. Roots also store nutrients that the uses for their growth.

2.2 Stems:

Stems support leaves, fruits and flowers. Stems contain vascular tissues that facilitate the movement of water, minerals and nutrients between roots and leaves.

2.3 Leaves:

Leaves are the primary sites of photosynthesis and transpiration.

2.4 Transpiration:

The loss of water in the form of vapours through small pores in leaves is called transpiration.

2.5 Stomata:

Small pores present in leaves through which water and gases enter or exit are called stomata.

2.6 Flowers:

Flower is the reproductive part of plant. It plays a crucial role in sexual reproduction.

3. Leaf as an organ:

In plants, leaf is a complex organ made of various related tissues. The major tissues of leaf are:

1. Epidermal tissue
2. Mesophyll tissue
3. Vascular tissue

3.1. Epidermal tissue:

The outermost layer of leaf is made of epidermal tissue.

a. Upper epidermis:

The upper epidermis is usually covered by waxy cuticle which reduces water loss and provides protection.

b. Lower epidermis:

The lower epidermis contains guard cells which protect stomata.

3.2 Mesophyll tissue:

Mesophyll tissue is present between upper and lower epidermis. It is filled with cells rich in chloroplasts. It is the site of photosynthesis.

Types of mesophyll:

There are two types of mesophyll in leaf:

1. Palisade mesophyll
2. Spongy mesophyll

1. Palisade mesophyll:

It is just located beneath upper epidermis. It consists of tightly packed elongated cells.

2. Spongy mesophyll:

It is present below the palisade mesophyll. It is composed of loosely arranged cells with air spaces

between them. These air spaces facilitate the diffusion of gases throughout the leaf.

3.3 Vascular tissue:

This tissue is located in the midrib and veins of leaf. It is called a complex tissue.

1. Xylem tissue:

The xylem tissue of leaf conducts water and minerals from the xylem of stem to leaf cells.

2. Phloem tissue:

Phloem tissue transports the products of photosynthesis (sugars) from leaf cells to the phloem of stem.

What does gastric juice contain?

Gastric juice contains pepsinogen for protein digestion and HCl to activate pepsinogen to pepsin.

4. Organ systems in plants:

An organ system consists of organs that work together to perform associated functions,

4.1 Why organ system of plants is less complex as compared to animals?

Due to their immobility, simple nutritional needs, through photosynthesis and fewer specialized functions, plants organ system is less complex than animals.

4.2 Root system:

The root system consists of roots which anchor the plant in soil. Roots also absorb water and salts needed from soil and in some cases store food.

4.3 Shoot system:

The shoot system includes stems, branches, leaves and flowers. These organs work to enable processes like photosynthesis and reproduction.

5. Organs in human body:

Various organs are present in human body. Some are

- ❖ Heart
- ❖ Lungs
- ❖ Brain
- ❖ Liver
- ❖ Kidney
- ❖ Stomach
- ❖ Intestines
- ❖ Pancreas

5.1 Heart:

The heart is a muscular organ that pumps blood throughout the body. It is essential for delivering oxygen and nutrients to cells and removing waste products.

5.2 Lungs:

The lungs are responsible for breathing. They facilitate the exchange of oxygen and carbon dioxide between body and environment.

5.3 Brain:

The brain is the control center of the body. It is responsible for coordination among other organs, thinking and decision making.

5.4 Liver:

The liver performs many vital functions including filtering blood, producing bile and storing glucose.

5.5 Kidneys:

The kidneys are responsible for filtering waste products from blood and producing urine.

5.6 Stomach:

The stomach is a muscular organ that breaks down food using digestive enzymes.

5.7 Intestines:

The intestines are long tubular organs that digest food and absorb nutrients from the digested food.

5.8 Pancreas:

The pancreas produces digestive enzymes. It also produces hormones such as insulin and glucagon.

Function of mucus?

The mucus lines the inner wall of stomach and protects it from acid.

6. Stomach as an Organ:

The stomach is an important organ of the digestive system. It is responsible for the partial digestion of proteins. It also stores food.

Tissues of stomach:

It is composed of following tissues:

- ❖ Epithelial tissue
- ❖ Muscle tissue
- ❖ Connective tissue
- ❖ Outer connective tissue

6.1 Epithelial tissue:

The inner wall is made of epithelial tissue. It is regular in nature and secretes mucus. The mucus lines the inner wall and protects it from acid.

6.2 Connective tissue:

It lies beneath epithelial tissue. It provides structural support and contains blood vessels, nerves and lymphatic vessels.

6.3 Muscle tissue:

There are three layers of smooth muscles: the outer longitudinal, the middle circular layer and the inner oblique layer. These muscles contract and relax to mix food with gastric juice.

6.4 Outer connective tissue:

It is the outermost layer that encircles the stomach and supports it.

7. Organ systems in human body:

Few organ systems of human body are given below:

- ❖ Skeletal system
- ❖ Muscular system
- ❖ Digestive system
- ❖ Nervous system
- ❖ Respiratory system
- ❖ Blood circulatory system

7.1 Skeletal system:

It consists of bones, cartilages and tendons. It provides structure, support and protection to body. It also stores minerals.

7.2 Digestive system:

It consists of organs such as mouth, oesophagus, stomach, small intestine and large intestine. This system is responsible for digestion and absorption of food.

7.3 Respiratory system:

It includes the lungs, trachea (windpipe), and bronchi. This system is involved in exchange of gases between body and environment.

7.4 Muscular system:

It includes skeletal muscles attached to bones. These muscles contract to move bones. It allows movement and locomotion in body.

7.5 Nervous system:

It includes brain, spinal cord and nerves. The nervous system coordinates and controls body functions through nerve impulses.

7.6 Blood circulatory system:

It includes heart, blood vessels and blood. This system transports oxygen, nutrients, hormones and waste products throughout the body.

8. Homeostasis:

Homeostasis is defined as:

"The ability of an organism to maintain a stable internal environment of the body despite changes in external environment."

Example: Regulating temperature. Blood pressure etc.

8.1 How homeostasis maintains temperature?

When we do hard work, our muscles produce heat that raises the body temperature. In such situation the temperature regulatory centre in brain sends messages to sweat glands. As a result, sweating occurs and temperature of the body falls to normal.

When the body temperature falls, the temperature regulatory centre sends message to muscles. As a result, shivering occurs to generate heat.

8.2 How homeostasis maintains glucose level?

When we drink juice, blood glucose level rises. In this situation, pancreas releases a hormone insulin in blood. This hormone lowers blood glucose level to normal.

8.3 How homeostasis maintains breathing and heartbeat?

When we do hard exercise, our muscles need more oxygen. In such condition the rate of breathing and heartbeat increased. Accelerated breathing and heartbeat supply more oxygen and food to muscles for continuous work.

8.4 Role of nervous system and endocrine system in homeostasis:

Nervous system and endocrine system regulate and coordinate activities such as heartbeat, respiration and metabolism. They also respond to changes in environment.

8.5 Role of respiratory system in homeostasis:

The respiratory system ensures that the body receives enough oxygen for respiration. It also expels excess carbon dioxide from body.

8.6 Role of cardiovascular system in homeostasis:

The cardiovascular system plays a vital role in regulating body temperature and pH levels. It also ensures that all cells receive the necessary substances for proper functioning.

8.7 Role of digestive system in homeostasis:

Digestive system works to provide proper distribution of nutrients to cells for energy growth and repair.

8.9 Role of skeletal system in homeostasis:

Muscular and skeletal system help to maintain body posture, support and movement.

8.10 Role of urinary system in homeostasis:

Urinary system eliminates waste materials from body. It also regulates water and salt balance in body tissues.

8.11 Role of integumentary system in homeostasis:

Integumentary system acts as a barrier to protect body from external factors. It helps to regulate temperature through sweating.

Chapter# 06 BIOMOLECULES

1. Biochemistry:

Biochemistry is the study of the chemical processes that occur within living organisms.

Example: Photosynthesis and cellular respiration.

2. Molecular biology:

Molecular biology is the study of the structure and function of biomolecules.

Example: Carbohydrates, Proteins, etc.

3. Biomolecules:

The molecules produced by living organisms are called biomolecules.

Example: Carbohydrates, lipids, proteins, nucleic acids, etc.

3.1 Macromolecules:

The molecules having high molecular weight are called macro molecules.

Example: Starch, proteins, lipids, etc.

3.2 Micromolecules:

The molecules having low molecular weight are called micromolecules.

Example: Glucose, water, etc.

3.3 Composition of dry mass of protoplasm:

Biomolecules make the 93% of the dry mass of protoplasm. The remaining 7% of dry mass comprises of vitamins and inorganic substances like carbon dioxide, acids, bases, and salts.

3.4 Metabolism:

All the chemical reactions that occur in a living organism are collectively called metabolism.

Categories:

Metabolism is divided into two categories:

- Anabolism
- Catabolism

3.4.1 Anabolism:

The type of metabolism in which simpler substances are combined to form complex substances, is called anabolism. (e.g. Photosynthesis)

3.4.1 Anabolism:

The type of metabolism in which complex substances are broken down into simpler ones is called catabolism. (e.g. Respiration)

3.5 Write percentage of biomolecules in dry mass of protoplasm:

<u>Biomolecules</u>	<u>% Dry Mass</u>
Proteins	50
Nucleic Acid	18
Carbohydrates	15
Lipids	10

4. Carbohydrates:

"Carbohydrate" means "**hydrated carbons**." They are the organic compounds in which the ratio of H and O is 2: 1. They are also known as "**saccharides**." (meaning sugar).

4.1 General formula:

They have the general formula $C_n(H_2O)_n$, where n is the number of carbon atoms.

4.2 Classes of carbohydrates:

There are three classes of carbohydrates:

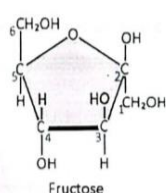
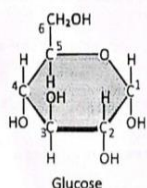
- ❖ Monosaccharides
- ❖ Disaccharides.
- ❖ Polysaccharides

4.2.1 Monosaccharides:

Monosaccharides are made of single sugar molecule. They are easily soluble in water and have sweet taste. They may have 3 to 7 carbon atoms.

Example: Ribose, glucose, fructose, etc.

- i. Cyclic formula of glucose ii. Cyclic formula of Fructose

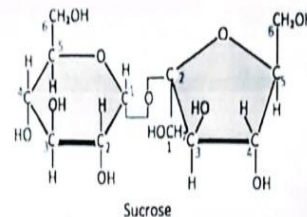


4.2.2 Disaccharides:

They are made of two monosaccharides units. They are less soluble in water and are sweet in taste.

Example: Maltose, sucrose, etc.

i. Formation of sucrose:



4.2.3 Polysaccharides:

Polysaccharides are large molecules composed of hundreds to thousands of monosaccharides units. They are insoluble in water and are tasteless.

Example: Starch, glycogen, etc.

i. Starch:

Starch is a storage polysaccharide found in plants. It is composed of straight as well as branched chains of glucose units.

ii. Glycogen:

Glycogen is the animal starch mainly stored in liver and muscles. It consists of highly branched chains of glucose which are broken down when is needed energy.

iii. Cellulose:

Cellulose is a polysaccharide that also consists of straight chains of glucose units. It is found in the cell walls of plants.

iv. Chitin:

Chitin is modified form of cellulose. It is found in the exoskeletons of crabs, lobsters and insects. It also makes the cell wall of fungi.

4.3 Sources of Carbohydrates:

4.3.1 Sources of Monosaccharides:

Some sources of monosaccharides are given below:

Glucose, fructose and galactose are found in fruits, vegetables, honey and cereals.

4.3.2 Sources of Disaccharides:

Some sources of disaccharides are given below:

Sucrose is found in sugar beet, sugar cane and fruits.

Lactose is found in milk and dairy products. Maltose is found in cereals.

4.3.3 Sources of Polysaccharides:

Some sources of polysaccharides are given below:

Starch is found in cereal crops. Wheat, barley, maize, rice, etc.

4.4 Important functions of Carbohydrates:

4.4.1 Function of Carbohydrates:

Carbohydrates are the primary source of energy. Glucose is used by cells to produce energy through cellular respiration.

4.4.2 Function of Dietary Fibre:

Dietary fibre contains undigestible carbohydrates (e.g. cellulose). It helps for the proper bowel movements.

4.4.2 Function of Cellulose:

Cellulose provides support to plant cells and ultimately to whole plant.

5. Proteins:

Proteins are the most abundant biomolecules in cell. Most abundant biomolecule is protein. They are defined as:

"The polymers of amino acids."

5.1 Structure of proteins:

Proteins are made up of monomers called amino acids. Different proteins contain different number of amino acids.

Example: Hemoglobin has 574 amino acids.

5.1.1 Amino acids:

Amino acids are the organic molecules that join in specific number and sequence to make About 170 types of amino acids in organisms.

i. Essential amino acids:

The amino acids which cannot be synthesized by our body and are supplied by food are called essential amino acids.

Example: Histidine, Lysine, etc.

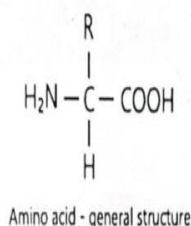
ii. Non-essential amino acids:

The amino acids which can be synthesized by our body are called non-essential amino acids.

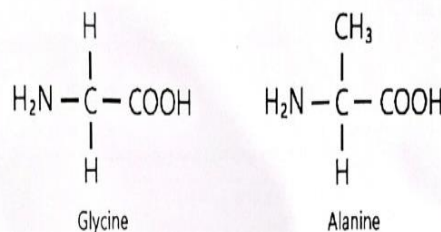
Example: Alanine, Arginine, etc.

5.1.2 Structure of Amino acid:

An amino acid is an organic molecule made of an amino group ($-NH_2$), a carboxyl group ($COOH$), hydrogen group (H) and a side group (R) which are attached to a central carbon atom.



5.1.3 Structure of glycine & Alanine:



4.3 Some sources of Proteins:

- Good sources of protein include meat (mutton, beef, chicken), fish eggs, milk, pulses, beans etc.
- Actin & myosin are main components of muscle cells. They are responsible for muscle contraction.

4.4 Some functions of Proteins:

Proteins perform various functions. Some are given below:

- Proteins are an important part of all cell membranes.
- Some proteins are hormones. They regulate body processes.
- Hemoglobin protein transports oxygen in the blood.

4.4.1 Function of Fibrin:

Fibrin is a blood clotting protein that makes blood clot to prevent loss of blood after injury.

4.5 What are antibodies?

Antibodies are the proteins which kill or stop the reproduction of harmful pathogens.

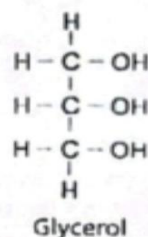
Example: Penicillin protects from fungal infection.

6. Lipids:

Lipids are organic compounds that are insoluble in water but are soluble in organic solvents (e.g. alcohol, ether, benzene). They are compound of glycerol and fatty acids.

6.1 Glycerol:

Glycerol is an alcohol 3 having carbon atoms. Each carbon has a hydroxyl group. Its general formula given below:



6.2 Fatty acids:

Fatty acids are long hydrocarbon chains with carboxyl group ($COOH$) at the end.

Types of fatty acids:

There are two types of fatty acids:

- Saturated fatty acids
- UnSaturated fatty acids.

6.2.1 Saturated fatty acids:

The fatty acids in which the valencies of carbon atoms are fully satisfied are called saturated fatty acids. They are solid at room temperature. They do not have double bond.

Example: Fats, ghee, etc.

6.2.2 Unsaturated fatty acids:

The fatty acids in which the valencies of carbon atoms are not fully satisfied are called unsaturated fatty acids. They may have one more double bonds. They are liquid at room temperature.

Example: Oils.

6.3 Main groups of Lipids:

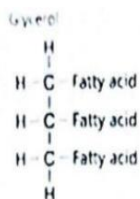
Similarities:

- ❖ Fats and oils are most familiar lipids.
- ❖ Both contain one glycerol and three fatty acids.

Differences:

<u>Oils</u>	<u>Fats</u>
➤ Oils contain unsaturated fatty acids. ➤ These are liquid at room temperature. <u>Example:</u> Olive oil, Corn oil etc.	➤ Fats contain saturated fatty acids. ➤ These are solid at room temperature. <u>Example:</u> Animal fats etc.

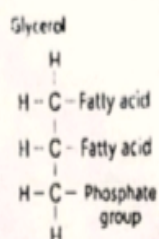
General formula for fats and oils:



6.3.2 Phospholipids:

A phospholipid molecule consists of one glycerol, two fatty acids and phosphate group. These lipids make the core of all membranes.

General Formula for Phospholipids:



6.4 Sources & Functions of Lipids:

6.4.1 Some sources of lipids:

Sources of lipids from animals are meat and dairy products, while the source of lipids from plants are nuts, seeds, olive oil, etc.

6.4.2 Some important functions of lipids:

- Lipids are the most energy-rich compounds.
- Lipids are essential components of all cell membranes.
- Lipids act as insulators and protect vital organs.
- Some lipids help in the synthesis of hormones.

6.5 Use of lipids as an insulator:

Lipid act as insulator and protects vital organs.

Example: Adipose, tissue, provides insulation.

7. Nucleic Acids:

Nucleic acids are composed of units called nucleotides. A nucleotide is made up of three components:

- 1- Pentose sugar
- 2- Nitrogenous base
- 3- Phosphate group.

How lipids serve as energy reserve?

Lipids store energy in the form fats of adipose tissues. When body requires energy, the stored lipids are broken down to release fatty acids and glycerol, which can be used as fuel for energy.

Types of nucleic acids:

There are two types of nucleic acids:

- 1) Deoxyribonucleic acid (DNA).
- 2) Ribonucleic acid (RNA)

7.1 Deoxyribonucleic acid (DNA):

DNA is made of deoxyribonucleotides. In this nucleotide, the pentose sugar is deoxyribose while the nitrogenous bases may be adenine (A), thymine (T), cytosine (C), or guanine (G).

7.1.1 Why did GC base pair is more stable than AT?

GC has three hydrogen bonds while AT has two. Therefore GC is more stable.

7.1.2 Watson-crick model:

In 1953, James Watson and Francis Crick proposed double helix model of DNA. According to this model:

- DNA is a double helix molecule made of two strands.
- Both strands are coiled around each other
- The nitrogenous bases of one strand make hydrogen bonds with nitrogenous bases of opposite strand.

iv. The pairing is very specific i.e. adenine of one strand makes two hydrogen bonds with thymine of other and, cytosine makes three hydrogen bonds with guanine of other strand.

7.1.3 When did Watson and Crick received noble prize"

In 1962, James Watson and Francis Crick received noble prize for the discovery of double helix structure of DNA.

7.1.4 Function of DNA:

DNA contains the hereditary information. This information is in the form of sequence of nucleotides. During reproduction, DNA is passed from one generation to the next. In this way, DNA carries heredity information from one generation to the next.

7.2 Ribonucleic acid (RNA):

RNA is single stranded. Its strand consists of ribonucleotide's. a ribonucleotide contains ribose sugar instead of deoxyribose. In DNA, uracil is present in the place of thymine.

Types of RNA:

There are three types of RNA:

1. Messenger RNA (mRNA)
2. Transfer RNA (tRNA)
3. Ribosomal RNA (rRNA)

7.2.1 mRNA:

It carries the genetic information from DNA to the ribosomes during protein synthesis.

7.2.2 tRNA:

It transfers specific amino acids to the ribosome ensuring the correct sequence during protein synthesis.

7.2.3 rRNA:

It contributes the structural and functional components of ribosomes, the cellular machinery of for protein synthesis.

8. The Working of DNA & RNA:

8.1 Transcription:

The process of making mRNA copy from DNA is called transcription

8.2 Translation:

The process of translating information mRNA to proteins is called translation.

8.3 Difference between DNA & RNA

<u>DNA</u>	<u>RNA</u>
❖ It consists of double strand.	❖ It consists of single strand.
❖ It consists of deoxyribose sugar.	❖ It consists of oxyribose sugars.

8.4 Central dogma:

The central dogma of molecular biology is the fundamental concept that describes the flow of genetic information is passed from DNA to RNA and from RNA to proteins.

Why vitamins are considered as food components?

Because body cannot synthesize vitamin. They must be supplied through diet while carbohydrates proteins and fats are prepared by body.

Chapter# 07 ENZYMES

1. Metabolism:

Metabolism is the sum of all chemical reaction that occur within an organism to sustain life.

1.1 Types:

There are two types of metabolism:

- ❖ Catabolism
- ❖ Anabolism

1.1.1 Catabolism:

Catabolism involves the breakdown of complex molecules into simpler ones, releasing energy.

Example: Cellular respiration.

1.1.2 Anabolism:

Anabolism involves building up of complex molecules from simpler ones. This process consumes energy.

Example: Photosynthesis.

1.2 What is Lipolysis:

Lipolysis is a process in which lipid is broken into fatty acids and glycerol, which can be used for getting energy

2. Enzymes:

Enzymes are the biological catalyst that speed up chemical reactions in living organisms without being consumed in process.

2.1 Characteristics:

Some important characteristics of enzymes are given below:

- Enzymes are primarily proteins.
- They possess a three-dimensional globular structure.

- Enzymes are highly specific to their substances.
- Many enzymes speed up reactions.

2.1.1 Describe chemical nature of enzymes:

Enzymes are primarily proteins. Typically, they contain 100 to 1000 amino acids.

2.1.2 Structure of enzyme:

Enzymes possess a three-dimensional globular structure. This structure allows them to form active sites that can bind specifically to substrates.

2.1.3 Describe specificity of enzymes:

Enzymes are highly specific to the reactions they catalyze. They are also very specific for the nature of substrate.

Example: Amylase specifically catalysis the breakdown of starch into simple sugars.

2.1.4 Classification enzymes on the basis of location:

Enzymes can be classified on the basis of location where they function as:

- Intracellular enzymes
- Extracellular enzymes.

i. Intracellular enzymes:

Intracellular enzymes operate within cells, Le. enzymes of cellular respiration

ii. Extracellular enzymes:

Extracellular enzymes are secreted outside the cells to catalyze reactions. i.e. enzymes secreted from stomach wall in stomach cavity.

2.1.5 Co-factors:

Some enzymes require additional non-protein molecules to be fully active. Such non-protein parts are called co-factors.

- Categories of co-factors:

There are two categories of co-factors:

- Inorganic
- Organic

i. Inorganic:

Inorganic cofactors include metal ions like iron and magnesium.

ii. Organic:

Organic cofactors are of two types:

- Prosthetic group
- Coenzymes

a) Prosthetic group:

The cofactors that are tightly bind to enzymes are called prosthetic group.

Example: Vitamins (biotin) and haem group.

b) Coenzymes:

The cofactors that are loosely attached with enzymes and may be released during reaction are called coenzymes.

Example: Vitamins and nucleotides.

2.1.6 Uses of enzymes:

Enzymes are extensively used in various industries like:

- Food industry
- Paper industry
- Biological industry
- Fermentation industry

i. Uses of enzymes in food industry:

Enzymes that break starch into simple sugars are used in production of white bread, buns and rolls. Enzymes are also used for the production of cheese.

ii. Uses of enzymes in paper industry:

Enzymes degrade starch to lower its viscosity that aid in making paper.

iii. Uses of enzymes in biological detergent:

Protease enzymes are used for the removal of protein stains from clothes. Amylase enzymes are used in dish washing to remove resistant starch residues.

iv. Uses of enzymes in fermentation industry:

Enzymes degrade starch and proteins to produce simple sugar, amino acids and peptides. These substances are used by microorganisms e.g. yeast in fermentation to produce different products of human use.

3. Mechanism of Enzymes Action:

3.1 Active site:

The place on the surface of enzyme where substrate attaches is called active site. The active sites are directly involved in catalysis.

3.2 Models for enzyme action:

Two models have been proposed to explain the mechanism of enzyme action:

- Lock and key model
- Induced fit model

3.2.1 Lock and Key Model:

This model was proposed German chemist **Emil Fischer** in **1984**. According to this model active sites of enzyme are rigid structures on which only specific substrates can attach.

3.2.2 Induced Fit Model:

This model was proposed by an American biologist Daniel Koshland in 1958. According to this model, the active site of enzyme is not rigid. When

substrate interacts with enzyme, its active site is reshaped to perform its function.

4. Factors that Affect the Activity of Enzyme:

The activity of an enzyme is affected by following factors:

- ❖ Temperature
- ❖ PH
- ❖ Substrate Concentration

4.1 Optimum temperature:

Each enzyme works at its maximum rate at a specific temperature. This temperature is called optimum temperature.

Example:

Optimum temperature for most of the human enzymes is 37°C.

4.2 How temperature affects enzyme action:

Each enzyme works at its maximum rate at specific temperature. When temperature rises to a certain limit the heat adds in the movement of molecules. So, the rate of enzyme action increases.

4.3 Denaturation of enzyme:

When temperature is raised well above optimum temperature, heat breaks the bonds in enzyme molecule. In this way, the globular structure of enzyme is lost. This is called denaturation of enzyme.

4.4 Optimum pH:

Enzymes show maximum activity at a specific pH called their optimum pH.

Example:

Pepsin in stomach works in acidic medium (pH 1.5 to 2.0), pH of amylase is around 7.

4.5 Effect of change in pH:

Enzymes are very sensitive to pH of fluid in which they work. Change in pH can affect the ionization of amino acids at the active site of enzyme. It slows down enzyme activity or blocks it completely.

4.6 Effect of substrate concentration:

An increase in substrate concentration increases the rate of reaction.

4.7 Saturation of active site:

At high substrate concentration, all active sites of the enzymes are occupied. In this condition, any more substrate molecules do not find free active sites. This state called saturation of active sites and reaction rate does not increase.

Why do humming birds have high metabolic rate?

Humming birds have highest metabolic rate. They need to eat constantly to keep up their energy level.

5. Enzyme Inhibition:

Certain substances, bind to enzyme and decrease its activity. This phenomenon is called enzyme inhibition.

5.1 Inhibitors:

The substances which bind to enzymes and block the activity are called Inhibitors.

Example: Cyanide, poison, etc.

5.2 Activator:

Molecules that increase the activity of enzyme are called activators.

5.3 Competitive inhibitors / inhibition:

Some inhibitors have structural similarity with substrate. Due to structural similarity with substrate, they may be selected by the binding sites but are not able to activate the catalytic sites. Thus, product(s) are not formed. This process is called competitive inhibition.

Example: Antibiotics

5.4 Non-competitive inhibitors/ inhibition:

These inhibitors form enzyme inhibitor complex at a point other than the active site. They alter the structure of enzyme in such a way that even if genuine substrate binds the active site, catalysis fails to take place.

Example: Heavy metals like mercury.

Chapter# 08 BIOENERGETICS

1. Bioenergetics:

Bioenergetics is the study of how living organisms acquire, convert, store, and utilize energy to fuel their life processes. **OR** Bioenergetics is the study of energy transformations in living organisms,

2. ATP: The Cell's Energy Currency:

2.1 Why ATP is considered as energy currency of cell?

ATP is called the energy currency of cell because it stores and releases energy through its high phosphate bonds, powering various cellular processes.

2.2 Define ATP:

ATP is abbreviated as adenosine triphosphate, It serves as energy currency of cell. It has three subunits:

- i. Adenine (a nitrogen containing base)
- ii. Ribose (a five-carbon sugar).
- iii. three phosphate groups.

2.3 How much energy is released when one phosphate bond breaks?

The breaking of one phosphate bond releases about 7.3kcal (7300 calories) per mole of ATP.

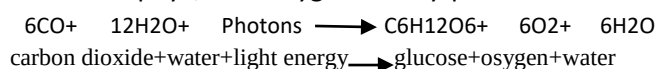


2.4 How ATP transfers energy between metabolic reactions?

Cells get energy from the oxidation of food. They store this energy by combining ADP with P_i to form ATP. Hence, ATP is made during energy-releasing processes and is broken down during energy-consuming processes. In this way ATP transfers energy between metabolic reactions.

2. Photosynthesis:

Photosynthesis is the synthesis of glucose from carbon dioxide and water in the presence of sunlight and chlorophyll, with oxygen as a by-product.



➤ Phases of Photosynthesis:

Photosynthesis occurs in two phases:

- Light reactions
- Dark reactions

2.1 Light reactions:

During light reactions, light energy is used to make high energy molecules ATP and NADPH. Light reactions take place on the thylakoid membranes of chloroplast.

2.1.1 NAD:

It is abbreviated as "Nicotinamide adenine dinucleotide". It is a coenzyme. One form of this also carries phosphate.

2.1.2 Contributions of Fritz Lipmann:

In 1941, the Nobel prize winner, Fritz Lipmann proposed that ATP is the main energy-transfer molecule in the cell.

2.1.3 Importance of oxidation-reduction reactions:

Oxidation reduction reactions are fundamental to the metabolism of organisms. In these reactions, electrons are transferred between molecules. In oxidation, molecule loses electrons and in reduction

it gains electrons. This electron flow is essential for generating energy in the form of ATP.

i. Oxidation:

The loss of electrons or H^+ ions is called oxidation.

ii. Reduction:

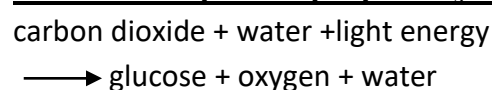
The gain of electrons or H^+ ions is called reduction.

2.1.4 Uses of ATP:

Some uses of ATP are given below:

- i. Muscle contractions and movement.
- ii. Replication of DNA and mitosis.
- iii. Synthesis of biomolecules.

2.1.5 Word equation for photosynthesis:



2.1.6 Importance of chlorophyll in photosynthesis:

Chlorophyll is the green pigment located in the chloroplasts that are the site for photosynthesis. Chlorophyll-a absorbs light of blue and red wavelength and converts it to make high energy molecules that is used to make the food of the plants.

2.1.7 Photolysis:

The breakdown of water molecules using light energy during light reactions of photosynthesis is called photolysis.

2.1.8 How oxygen is produced during photosynthesis?

During light reactions, sunlight absorbed by chlorophyll breaks water molecule. When hydrogen atoms give electrons to chlorophyll and become hydrogen ions, then oxygen is produced.

2.2 Dark reactions:

During dark reactions, carbon dioxide is reduced to make glucose. The details of dark reactions were discovered by **Melvin Calvin**.

2.2.1 Summary of Dark reactions:

Summary of dark reactions is given below:
 CO_2 combine with 5-carbon compounds to form 6-carbon compounds which split into two 3-carbon compounds. The 3-carbon compounds are reduced to 3-carbon carbohydrates by using ATP and NADPH. The 3-carbon carbohydrates are used to make glucose. The 3-carbon carbohydrates are also used to regenerate the original 5-carbon compound.

2.2.2 Pigments:

Pigments are the substances that absorb visible light. Different pigments absorb light of different wavelengths (colours).

3. Cellular Respiration:

The oxidation of food inside the cell to break CH bonds of food for the purpose of energy is called cellular respiration.

➤ Types of respiration:

There are two types of respiration:

- ❖ Aerobic respiration
- ❖ Anaerobic respiration

3.1 Aerobic respiration:

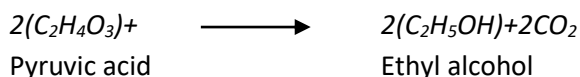
The cellular respiration that takes place in the presence of oxygen is called aerobic respiration. It is the complete oxidation of glucose with maximum release of energy.

3.2 Anaerobic respiration:

Cellular respiration that takes place in the absence of oxygen called anaerobic respiration. In anaerobic respiration, glucose incompletely oxidized with less amount of energy released.

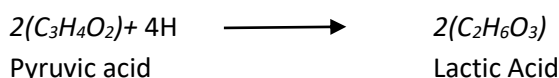
3.2.1 Alcoholic fermentation:

During anaerobic respiration, pyruvic acid is further broken down into alcohol (C_2H_5OH) and CO_2 . This type is called alcoholic fermentation.



3.2.2 Lactic acid fermentation:

During anaerobic respiration in animals, pyruvic acid is converted into lactic acid ($C_2H_6O_3$) This type of anaerobic respiration is called lactic acid fermentation.



3.2.3 An-aerobes:

The organism which can live and respire without oxygen are called anaerobes.

Example: Yeast, certain, bacteria, etc.

3.2.4 Importance of fermentation:

i. When skeletal muscles of human work hard, but oxygen supply is not sufficient to fulfill demand, the skeletal muscles carry out anaerobic respiration to get energy.

ii. Scientists have used fermentation in fungi and bacteria for making useful products.

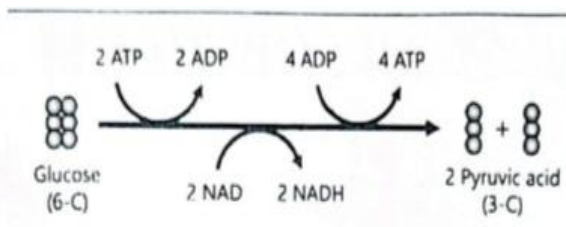
4. Steps of Aerobic Respiration:

There are three main steps of aerobic respiration:

- ❖ Glycolysis
- ❖ Krebs cycle
- ❖ Electron Transport Chain

4.1 Glycolysis:

The breakdown of glucose into two molecules of pyruvic acid is called glycolysis. It does not require oxygen.



4.2 Krebs Cycle:

The Krebs cycle was discovered by **Sir Hans Krebs** in **1937**. It is a key metabolic pathway that generates energy through the breakdown of acetyl-CoA in the presence of oxygen. It's a crucial step in cellular respiration producing ATP, NADH and FADH

4.3 Electron transport chains:

During this step, NADH and $FADH_2$, change back to NAD and FAD releasing electrons and hydrogen ions. The released electrons pass through an electron transport chain and release energy. This energy is used to make ATP. At the end of chain, electrons and hydrogen ions combine with oxygen and form water.

5. Differentiate between Aerobic respiration & Anaerobic respiration:

Aerobic respiration	Anaerobic respiration
✓ Oxygen is used.	✓ Oxygen is not used.
✓ 36 ATPs are formed.	✓ 02 ATPs are formed.
✓ Occur in cytoplasm & mitochondria.	✓ Occur in cytoplasm.
✓ Final products are CO_2 , H_2O .	✓ Final products are lactic acid or ethanol + CO_2

6. Differentiate between Photosynthesis & Respiration:

Photosynthesis	Respiration
❖ It is an anabolic process.	❖ It is a catabolic process.
❖ Energy is stored in the form of bond energy.	❖ Bond energy of food is transformed into ATP.
❖ Some bacteria, all algae, and all	

plants are capable of performing this.

❖ All organisms are capable of performing this.

❖ Occurs only during daytime, in the presence of sunlight.

❖ occurs all the time

Chapter# 09 PLANT PHYSIOLOGY

1. Autotrophic Organisms:

The organisms which obtain water, carbon dioxide and minerals from their environment and prepare their food are called autotrophic organisms
Example: Some bacteria, all algae and all plants.

2. Heterotrophic organisms:

The organisms which obtain their food from other organisms are called heterotrophic organisms,
Example: Most bacteria, all protozoans, fungi and animals.

3. Nutrition in Plant:

3.1 Nutrition:

The process in which food is prepared or obtained and converted into body substances for growth and energy is called nutrition.

3.2 Nutrients:

Nutrients are the substances required by organism for energy, growth, repair and maintenance.

3.3 Mineral nutrients:

The chemical elements absorbed from soil that are essential for plant growth are called mineral nutrients.

Example: Carbon, hydrogen, iron, etc.

3.4 Macro nutrients:

The minerals which are required in larger quantities are called macronutrients.

Example: Carbon, hydrogen, oxygen, etc.

3.5 Micronutrients:

The minerals which are required in small quantities are called micronutrients.

Example: Iron, copper, zinc, etc.

3.6 Role of phosphorus in plant life:

- ❖ Phosphorus is the major component of ATP, nucleic acids and coenzymes.
- ❖ It is necessary for seed germination and photosynthesis

3.7 Role of magnesium in plant life:

- ❖ Magnesium is the main component of chlorophyll.
- ❖ It activates many enzymes.

3.8 Role of nitrogen in plant life:

- ❖ Nitrogen is the main component of proteins, chlorophyll and enzymes.
- ❖ It helps plants for rapid growth.

3.9 write role of iron in plant life:

- ❖ Iron is necessary for photosynthesis.
- ❖ It activates many enzymes.

3.10 Write role of manganese in plant life:

Manganese is involved in activities of enzymes of photosynthesis and respiration.

3.11 Effect of deficiency of nitrogen in plants:

- ❖ Nitrogen deficiency slows down the growth of plant.
- ❖ It results in insufficient production of chlorophyll and so leaves begin to turn yellow.

3.12 Effect of deficiency of magnesium:

- ❖ If sufficient amount of magnesium is not available, plants begin to break the chlorophyll in leaves.
- ❖ After prolonged magnesium deficiency, leaves may also drop.

3.13 Chlorosis:

Due to deficiency of minerals, chlorophyll becomes insufficient. Due to insufficient chlorophyll leaves turn yellow. This condition is called chlorosis,

4. Transport in Plant:

4.1 Transport:

The movement of substances within an organism is called transport. This movement is essential for cellular functions, growth and responses to environmental changes.

4.1.1 Passive transport:

The movement of ions or molecules from higher concentration to lower concentration without requiring energy is called passive transport.

Example: Diffusion and osmosis,

4.1.2 Active transport:

The movement of ions or molecules from lower concentration to higher concentration using energy is called active transport.

4.1.3 Osmosis:

The movement of water molecules from lower solute concentration to high solute concentration is called osmosis. This movement does not require energy.

4.2 Xylem:

Xylem is the part of vascular tissue which is responsible for the transport of water and salts.

4.3 Phloem:

Phloem is the part of vascular tissue which is responsible for the transport of food.

4.4 Epidermis of root:

The outermost covering of root is a single layer of cells which is called epidermis.

Function: It protects the internal tissues from outside environment.

4.5 Root hairs:

Many cells of epidermis have tiny hair-like extension into the spaces among soil particles. These extensions are called root hairs.

Function: Root hairs have large surface area and help to absorb maximum salts from soil.

4.6 Cortex:

It is the broad zone of cells just inside the epidermis. Water moves from epidermis to cortex

4.7 Endodermis:

The innermost boundary of cortex that receive water from cortex is called endodermis.

4.8 Pericycle:

The narrow layer of cells present on the inner side of endodermis is called pericycle.

4.9 Vascular tissues:

Xylem and phloem are present in the innermost region of root. Water from pericycle moves into xylem of root from where it will be transported to xylem of stem.

5. Transpiration:

The loss of water in the form of vapours from plant surface is called transpiration. This loss may occur through stomata or cuticle, or lenticels.

5.1 Lenticels:

The special openings present in the stems of some plants are called lenticels. Lenticels help in transpiration.

5.2 Stomatal transpiration

Most of transpiration occurs through stomata. Such transpiration is called stomatal transpiration.

5.3 How transpiration is necessary evil?

Transpiration is a necessary evil. Although transpiration is the loss of water from plant but, yet it creates a pull on the water columns in xylem tissue of leaves, stem and root. This pull is responsible for the transport of water and salts from root to leaves.

How does balance between photosynthesis and respiration affect gas exchange during day and night?

During day, leaves are releasing oxygen and taking CO₂.

During night, all cells carry out respiration while taking O₂ and releasing CO₂.

5.4 Guard cells:

The sausage-shaped cells present in epidermis that contains chloroplasts are called guard cells. When guard cells become turgid, they become bean-shaped.

5.5 Role of potassium ions in stomatal opening and closing:

Potassium ions increase the solute concentration in guard cells leading to water uptake to regulate turgor pressure. Water enters guard cells by osmosis, and they become turgid. Thus, stomata open. Similarly, in night, stomata close due to lower solute concentration.

5.6 Role of cuticle in gaseous exchange:

The cuticle is a waxy layer on epidermis of leaves and stems, It allows the exchange of gases.

5.7 Types of transpiration:

There are three types of transpiration:

- Cuticular transpiration.
- Lenticular transpiration.
- Stomatal transpiration.

6. Factors Affecting Transpiration:

Factors affecting transpiration are given below:

- Temperature
- Humidity
- Wind
- Surface area and distribution of stomata,

6.1 Temperature:

Increase in temperature results in an increase in the rate of transpiration. At high temperature water evaporates more quickly.

6.2 Wind:

Wind sweeps up transpiration by carrying away humid air surrounding the leaves, allowing more water to evaporate.

6.3 Humidity:

The higher the humidity (the percentage of water vapour in atmosphere) the lower the rate of transpiration

6.4 Surface area and distribution of stomata:

Leaves with more surface area and more stomata, transpire more.

7. Transport of Water in Plants:

7.1 Transpirational pull:

A pulling force in leaves is created by the transpiration of water from their surfaces. This pulling force is called transpirational pull.

7.2 Give reasons for continuous water column in xylem:

A continuous water column is created in xylem due to three reasons:

- i. The forces of attraction among water molecules..
- ii. The narrow diameter of xylem vessels.
- iii. The force by which water molecules are adhered to the walls of xylem vessels.

8. Translocation of Food in Plants:

8.1 Pressure flow mechanism:

The mechanism of transport of food in plants is called pressure flow mechanism. According to this mechanism dissolved food flows from source to a sink.

8.2 Source:

The parts of plant body where food is synthesized and stored are called sources.

Example: Photosynthetic tissues and storage tissues.

8.3 Sink:

The parts of plant body where food is utilized or stored are called sinks.

Example: Growing tips of roots and stems.

8.4 How sucrose enters phloem:

At the source site, food (sucrose) enters the sieve tubes of phloem by active transport. Companion cells provide energy.

9. Gaseous Exchange in Plants:

9.1 Gaseous exchange:

The process of exchanging O_2 and CO_2 between an organism and its environment is called gaseous

exchange. Gaseous exchange may occur through stomata, cuticle or lenticels.

10. Mechanism for Excretion in Plants:

10.1 Excretion of extra CO_2 from plant:

Plants release the excess CO_2 through their general surfaces and stomata.

10.2 Excretion of extra O_2 from plant:

Excess of oxygen in plants is released in atmosphere through stomata.

How carnivorous plant fulfil their need of hydrogen?

Carnivorous plants trap and digest small animals. Such plants fulfil their needs of hydrogen from their prey animals.

10.3 Excretion of extra water:

Plants remove excess water in two ways:

- ❖ Guttation
- ❖ Transpiration

10.3.1 Guttation:

The release of water droplets through small pores located at the tips of edges of leaves, is called guttation.

10.3.2 How guttation is different from dew:

Dew drops are the water drops on the surface of leaves formed by condensation of water vapours present in air while guttation is release of water droplets from leaves through special pores.

10.4 Excretion of metabolic wastes:

- i. Plants adopt different methods to remove metabolic wastes
- ii. Some plants excrete their wastes through special pores.
- iii. Some plants excrete their wastes in the form of crystals

10.5 Give the useful products obtained from plants which they excrete as waste.

- Rubber plant excretes latexes.
- Keekar tree excretes gums.
- Coniferous trees excrete resins.
- Ladyfinger excretes mucilage.

11. Osmotic Adjustments in Plants:

11.1 Hydrophytes:

Hydrophytes are freshwater plants. In these plants surface area of leaves is very large to transpire water excessively. Extensive stomata are present on the upper side to promote loss of water.

Example: Water Lilly.

11.2 Mesophytes:

Mesophytes have moderate water availability. In sufficient supply of water stomata kept open to promote loss of water, however in restricted supply, stomata close to prevent the loss.

Example: Rose, mango, etc.

11.3 Xerophytes:

Xerophytes live in extremely dry environment. They have deep roots to absorb water from soil. They

are covered with thick waxy cuticle to reduce loss of water

Example: Cactus.

11.4 Halophytes:

Halophytes live in habitats with salty waters. These plants absorb salts from outside and make their bodies hypertonic. In this way, water does not move out of cells. The excess salt can be stored in cells and excreted out from salt glands on leaves.

Example: Sea grasses.

Chapter# 10 REPRODUCTION IN PLANTS

1. Reproduction:

The process in which organisms produce new organisms of their own kind is called reproduction.

1.1 Kinds of reproduction:

There are two kinds of reproduction:

- ✓ Sexual reproduction
- ✓ Asexual reproduction

1.1.1 Sexual reproduction

The reproduction that involves the fusion of male and female gametes and the offsprings have variations, is called sexual reproduction.

1.1.2 Asexual reproduction:

The reproduction in which the offsprings produced are exact copies of their parents is called asexual reproduction. It does not involve gametes.

2. Types of Asexual reproduction:

Some types of asexual reproduction are given below:

- i. Binary fission ii. Budding
- iii. Spore formation
- iv. Vegetative propagation

2.1 Binary fission:

Binary fission means division into two. During binary fission, the bacterial DNA replicates and daughter DNA moves to opposite sides. Cell membrane pinches inward and new cell walls are synthesized. Hence two identical bacteria are reproduced.

2.1.1 Organisms which undergo binary fission:

Bacteria, many protists, amoeba, Euglena, etc are organisms which reproduce by binary fission.

2.2 Budding:

During budding, a part of parent organism grows out from body which is called bud. This bud grows to form a new organism.

Example: Yeast and hydra mostly undergo budding.

2.3 Spore formation:

Most fungi like Rhizopus reproduce by forming thick-walled asexual reproductive cells which are called spores.

2.3.1 Sporangia:

The sac-like structures in which fungi produce spores are called sporangia.

2.3.2 Endospores:

Sometimes spores are produced inside the cells which protect them from external unfavorable conditions. These spores are called endospores.

3.4 Vegetative propagation:

It is a method of asexual reproduction in plants. In this method, a new plant is produced from the vegetative part of the parent plant.

3.4.1 Types of vegetative propagation:

These are two types of vegetative propagation:

- i. Natural vegetative propagation.
- ii. Artificial vegetative propagation.

i. Natural vegetative propagation:

A process in which plants reproduce on their own, using structures like stems, roots or leaves, is called natural vegetative propagation.

ii. Artificial vegetative propagation:

The process in which humans use the vegetative parts of plants for their reproduction by methods like cutting, grafting, etc, as is called artificial vegetative propagation

3.4.2 In natural propagation, plant use which parts?

Plants use following parts to produce new plants:

- a) Stem b) Suckers
- e) Modified leaves

a) Natural propagation through Stem:

The following types of stems take part in vegetative propagation i.e.

- i. Stolon (Runner) ii. Tuber

iii. Rhizome

iv. Bulb

v. Corm

i. Stolon (Runner):

A horizontal stem that grows above the ground is called stolon. It has nodes where new leaves and roots grow to form a new plant.

Example: Strawberry reproduces by using stolon.

ii. Tuber:

It is fleshy stem that grows underground. It has "eyes" which are actually its buds. Eyes can grow into new plants

Example: Potatoes reproduce by tubers.

iii. Rhizome:

A horizontal stem that grows below the ground is called rhizome. It has nodes from where new plants grow.

Example: Ferns, ginger and sugarcane reproduce by rhizome.

iv. Bulb:

It is very short stem that grows underground. It has bud and fleshy leaves. Bulbs grow naturally to produce new plants.

Example: Tulips, onions and lilies reproduce by bulbs.

v. Corm:

It resembles bulb but does not have fleshy leaves. Almost all of a corm consists of stem, with a few brown non-functional leaves on the outside.

Example: Dasheen and garlic reproduce by corms

b) Natural propagation through Suckers:

Suckers are new shoots that emerge from the base of parent plant or from its underground roots.

Example: Banana

c) Natural propagation by Modified Leaves:

The leaves of some plants. (e.g. Bryophyllum) are modified for vegetative propagation such leaves have buds at their margins. When leaf falls on ground, the bulb grows into new plants.

3. Methods of Artificial Propagation:

There are two most common methods of artificial propagation:

- ❖ Cutting
- ❖ Grafting

3.1 Cutting:

In some plants, a piece of stem or a piece of root can form a new plant. Such a piece of stem or root that are cut from a plant and used to grow new plant is called cutting.

Example: Roses and grapevines are grown from stem cuttings.

3.2 Grafting:

Grafting is the joining of two more plant parts of the same type to form a single plant. Grafting enables to combine the beneficial characteristics of two plants.

Example: Almond, plum, cherries, etc. are grown by grafting.

3.3 Advantages of vegetative propagation:

- i. Vegetative propagation allows to produce many new plants in a short time.
- ii. New plants have the same good characters in parents.
- iii. Useful qualities remain safe and pass to next generation.

3.4 Disadvantages of vegetative propagation:

Plants produced through vegetative propagation do not have genetic differences due to which they are equally sensitive to environmental changes and prone to same diseases of pests.

4. Sexual Reproduction in Plants:

4.1 Alternation of generations:

The phenomenon of alternation of gametophyte and sporophyte in the life-history of plants is called alternation of generations.

4.2 How many types of generations plants have during sexual reproduction?

Plants have two types of generations during sexual reproduction:

- Sporophyte generation
- Gametophyte generation

4.2.1 Sporophyte generation:

Sporophyte generation is diploid (2n). Sporophyte generation produces spores which grow and make new gametophyte generation.

4.2.2 Gametophyte generation:

Gametophyte generation is haploid. It produces gametes which unite to form a new sporophyte generation.

4.3 Parts of an angiosperm flower.

4.3.1 Receptacle:

The swollen tip of large stalk where all the floral parts are attached is called receptacle.

Function: It serves as the base that supports plant structure.

4.3.2 Parts of Flower:

Floral parts of flower are in the form of four concentric whorls or rings:

- i. Calyx ii. Corolla
- iii. Androecium
- iv. Gynoecium

i) Calyx:

The outermost whorl of flower is called calyx. It is made of green leaflike sepals. Sepals protect the inner parts of a developing flower before it opens.

ii) Corolla:

The second whorl of flower is corolla. It is made of petals. Most flowers have coloured petals.

iii) Androecium:

The third whorl of flower is androecium and is made of male reproductive structures.

- Stamens: The male reproductive structures of a flower are called stamens.
- Parts of stamen: There are two parts of stamen:
 - a) Anther b) Filament

a) Anther:

Anther contains pollen sacs, which produce microspores i.e. pollen grains.

b) Filament:

The stalk-like structure that support the anther are called filaments.

iv) Gynoecium:

The innermost whorl of a flower is called gynoecium. It is made of female reproductive structures.

- **Carpels:** The female reproductive structures of flower called carpels.
- **Parts of carpel:** There are three parts of carpel:
 - a) Ovary b) Style
 - c) Stigma

a) Ovary: The enlarged base of carpel where ovules are produced is called ovary.

b) Style: A stalk-like part attached to ovary is called style.

c) Stigma: The tip of style is called stigma.

- ❖ **Pistil:** In some flowers, one or more carpels are fused to form a structure called pistil.

5. Stages of Lifecycle of Angiosperm:

The main stages in the life cycle of an angiosperm are given below

- Development of female gametophyte
- Development of male gametophyte

- Pollination
- Fertilization
- Seed and fruit formation
- Development of sporophyte

5.1 Development of female gametophyte (Embryo Sac):

In an ovule, a diploid megaspore-mother-cell undergoes meiosis to form four haploid megaspores, one survives, and develops by mitosis into female gametophyte (embryo sac) containing the egg cell and polar nuclei

5.2 Development of male gametophyte (Pollen Grain):

A diploid microspore-mother-cell in the anther undergoes meiosis to form haploid microspores, each of which undergoes mitosis to become a two-celled pollen grain (male gametophyte) comprising a tube cell and a generative cell.

5.3 Pollination:

The transfer of pollen grains from anther to stigma is called pollination.

Types of pollination:

There are two types of pollination:

- Self-pollination
- Cross pollination

5.3.1 Self-pollination:

The transfer of pollen grains from the anther to the stigma of the same flower or another flower of same plant is called self-pollination.

5.3.2 Cross-pollination

The transfer of pollen grains from the anther of one plant to the stigma of a flower on a different plant of the same species, is called cross pollination.

5.4 Fertilization:

The fusion of male and female gametes to form a zygote is called fertilization.

5.4.1 Double fertilization:

In flowering plants, one male gamete fuses with the egg cell to form a zygote and another male gamete fuses with the fusion nucleus (two polar nuclei) to form a triploid endosperm cell. This process is called double fertilization.

5.4.2 Seed:

When the ovule gets matured, it develops into seed.

5.4.3 Fruit:

When the ovary gets matured, it develops into fruit.

5.5 Development of sporophytes:

When seeds mature and get suitable conditions, their embryos develop into new plants (the sporophytes of next generation).

5.5.1 Parthenocarpy:

In some plants, ovaries develop into fruits without fertilization of egg. This process is called parthenocarpy. These fruits have no seed.

Example: Bananas and seedless varieties of grapes.

Cloning:

It is the latest method of vegetative propagation.

It is the technique to produce identical offsprings from small pieces of tissue taken from shoot tips or other suitable parts of plants.