B. PHARMACY 1st Semester - Remedial Biology 🧬

UNIT – 5 🌱

POINTS TO BE COVERED IN THIS TOPIC

- ➤ PLANT RESPIRATION 💪
- ➤ PLANT GROWTH AND DEVELOPMENT 📈
- ➤ CELL – THE UNIT OF LIFE 🔬
- ➤ TISSUES 🧪

PLANT RESPIRATION 💪

INTRODUCTION

Plant respiration is a vital metabolic process that occurs in all living plant cells. It is the process by which plants break down organic molecules, particularly glucose, to release energy in the form of ATP (Adenosine Triphosphate) for various cellular activities. Unlike photosynthesis, respiration occurs continuously in both light and dark conditions.

Respiration involves the oxidation of organic substrates to produce energy, carbon dioxide, and water. The overall equation for aerobic respiration is:

$$C_6H_{12}O_6 + 6O_2 \rightarrow 6CO_2 + 6H_2O + ATP$$

TYPES OF RESPIRATION

Plant respiration can be classified into two main types:

1. AEROBIC RESPIRATION

- Occurs in the presence of oxygen
- Complete oxidation of glucose
- Produces maximum ATP (38 molecules per glucose)
- Takes place in mitochondria
- End products: CO_2, H_2O, and ATP

2. ANAEROBIC RESPIRATION (FERMENTATION)

- Occurs in the absence of oxygen
- Incomplete oxidation of glucose
- Produces less ATP (2 molecules per glucose)
- Takes place in cytoplasm
- End products: Alcohol/Lactic acid + CO_2 + ATP

GLYCOLYSIS ⚡

DEFINITION

Glycolysis is the first stage of cellular respiration where glucose is broken down into pyruvate molecules. It is also known as the Embden-Meyerhof-Parnas (EMP) pathway.

LOCATION

Glycolysis occurs in the cytoplasm of plant cells.

PROCESS

The glycolytic pathway involves ten sequential enzymatic reactions that can be divided into two phases:

PHASE 1: ENERGY INVESTMENT PHASE

- Glucose is phosphorylated and converted to fructose-1,6-bisphosphate
- Requires input of 2 ATP molecules
- Prepares the glucose molecule for splitting

PHASE 2: ENERGY PAYOFF PHASE

- Fructose-1,6-bisphosphate is split into two molecules of glyceraldehyde-3-phosphate
- These molecules are oxidized and phosphorylated
- Produces 4 ATP molecules (net gain of 2 ATP)
- Produces 2 NADH molecules

SIGNIFICANCE

- Provides immediate energy for cellular processes
- Produces pyruvate for further oxidation
- Generates reducing equivalents (NADH)
- Can function under both aerobic and anaerobic conditions

FERMENTATION (ANAEROBIC RESPIRATION) 🍺

DEFINITION

Fermentation is an anaerobic metabolic process where organic compounds are broken down without the use of oxygen, resulting in the production of simpler compounds and energy.

TYPES OF FERMENTATION

Type	End Products	Organisms	Equation
Alcoholic Fermentation	Ethanol + CO_2	Yeast, Some bacteria	$C_6H_{12}O_6 \rightarrow 2C_2H_5OH + 2CO_2$
Lactic Acid Fermentation	Lactic Acid	Bacteria, Muscle cells	$C_6H_{12}O_6 \rightarrow 2C_3H_6O_3$
Acetic Acid Fermentation	Acetic Acid	Acetobacter	$C_2H_5OH + O_2 \rightarrow CH_3COOH + H_2O$

CHARACTERISTICS

- Occurs in the absence of oxygen
- Involves glycolysis followed by fermentation reactions
- Produces only 2 ATP molecules per glucose
- End products vary depending on the type of fermentation
- Less efficient than aerobic respiration

SIGNIFICANCE IN PLANTS

- Helps plants survive in waterlogged conditions
- Provides energy when oxygen is limited

- Important in root tissues where oxygen concentration is low
- Enables germinating seeds to respire before photosynthesis begins

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PLANT GROWTH AND DEVELOPMENT 📈

INTRODUCTION

Plant growth and development are complex processes involving increase in size, mass, and the formation of new structures. Growth refers to the irreversible increase in size and mass, while development involves the differentiation and specialization of cells and tissues.

PHASES OF PLANT GROWTH 🌱

1. MERISTEMATIC PHASE

- Characterized by active cell division
- Cells are small, thin-walled, and densely packed
- High metabolic activity
- Located at root and shoot apices

2. ELONGATION PHASE

- Cells increase in size through water uptake
- Cell walls become more flexible
- Vacuoles enlarge significantly
- Limited cell division occurs

3. MATURATION PHASE

- Cells differentiate into specialized tissues
- Cell walls thicken and become rigid
- Metabolic activities decrease
- Cells acquire their final shape and function

RATE OF PLANT GROWTH

MEASUREMENT OF GROWTH RATE

Growth rate can be measured using various parameters:

Parameter	Formula	Units
Absolute Growth Rate	$\Delta W/\Delta t$	g/day, cm/day
Relative Growth Rate	$(W_2-W_1)/(W_1 \times t)$	g/g/day
Specific Growth Rate	$\ln(W_2/W_1)/t$	per day

Where: W = Weight/Length, t = Time, Δ = Change

FACTORS AFFECTING GROWTH RATE

- **Internal Factors**: Genetic makeup, hormones, nutritional status
- **External Factors**: Temperature, light, water, nutrients, oxygen

CONDITIONS OF GROWTH 🌞

ESSENTIAL CONDITIONS

Plant growth requires specific environmental conditions:

LIGHT 🌼

- Required for photosynthesis
- Affects photomorphogenesis
- Influences flowering and germination
- Photoperiodism controls seasonal growth

TEMPERATURE 🌡️

- Affects enzyme activity
- Optimal range: 25-35°C for most plants
- Low temperatures slow growth
- High temperatures can denature enzymes

WATER 💧

- Essential for cell expansion
- Maintains turgor pressure
- Required for metabolic processes
- Transports nutrients and minerals

NUTRIENTS 🌿

- **Macronutrients**: N, P, K, Ca, Mg, S
- **Micronutrients**: Fe, Mn, Zn, Cu, B, Mo
- Required for enzyme function and structural components
- Deficiency causes growth abnormalities

OXYGEN 🫁

- Required for aerobic respiration

- Essential for root growth
- Waterlogged soils limit oxygen availability
- Affects nutrient uptake

INTRODUCTION TO PLANT GROWTH REGULATORS 🧪

DEFINITION

Plant Growth Regulators (PGRs) are naturally occurring or synthetic compounds that influence plant growth and development at very low concentrations.

CLASSIFICATION OF PGRs

Type	Examples	Primary Functions
Auxins	IAA, NAA, 2,4-D	Cell elongation, apical dominance, root formation
Gibberellins	GA_3, GA_1	Stem elongation, seed germination, flowering
Cytokinins	Zeatin, Kinetin	Cell division, shoot formation, delay senescence
Abscisic Acid	ABA	Dormancy, stomatal closure, stress response
Ethylene	C_2H_4	Fruit ripening, senescence, abscission

FUNCTIONS OF PGRs

- **Growth Promotion**: Stimulate cell division and elongation
- **Growth Inhibition**: Control excessive growth
- **Differentiation**: Direct cell specialization

- **Stress Response**: Help plants cope with environmental stress
- **Developmental Timing**: Control flowering, fruiting, and senescence

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CELL – THE UNIT OF LIFE 🔬

INTRODUCTION

The cell is the fundamental structural and functional unit of all living organisms. All life processes occur within cells, making them the basic building blocks of life. Plants are composed of specialized cells that work together to perform various functions.

CELL THEORY

The cell theory states:

- All living organisms are composed of one or more cells
- The cell is the basic unit of life
- All cells arise from pre-existing cells

STRUCTURE AND FUNCTIONS OF PLANT CELL 🌱

CELL WALL

- **Structure**: Rigid outer covering made of cellulose, hemicellulose, and pectin
- **Functions**:
  - Provides structural support and protection
  - Maintains cell shape

- Prevents over-expansion during water uptake
- Acts as a barrier against pathogens

CELL MEMBRANE (PLASMA MEMBRANE)

- **Structure**: Phospholipid bilayer with embedded proteins
- **Functions**:
  - Controls entry and exit of substances
  - Maintains cell shape
  - Site of various metabolic processes
  - Cell recognition and communication

NUCLEUS

- **Structure**: Spherical organelle surrounded by nuclear envelope
- **Functions**:
  - Controls cell activities
  - Contains genetic material (DNA)
  - Regulates gene expression
  - Site of DNA replication and transcription

CYTOPLASM

- **Structure**: Gel-like matrix containing water, salts, and organic molecules
- **Functions**:
  - Medium for metabolic reactions

- Suspends organelles
- Facilitates intracellular transport
- Site of glycolysis

CELL ORGANELLES AND THEIR FUNCTIONS ⚙️

CHLOROPLASTS

- **Structure**: Double-membraned organelles containing chlorophyll
- **Functions**:
  - Site of photosynthesis
  - Convert light energy to chemical energy
  - Produce glucose and oxygen
  - Contain their own DNA and ribosomes

MITOCHONDRIA

- **Structure**: Double-membraned organelles with cristae
- **Functions**:
  - Powerhouse of the cell
  - Site of aerobic respiration
  - Produce ATP through oxidative phosphorylation
  - Contain their own DNA and ribosomes

VACUOLE

- **Structure**: Large membrane-bound sac filled with cell sap
- **Functions**:

- Maintains turgor pressure
- Storage of water, ions, and metabolites
- Provides structural support
- Waste disposal

ENDOPLASMIC RETICULUM (ER)

- **Rough ER**:
  - Studded with ribosomes
  - Protein synthesis and modification
  - Formation of transport vesicles
- **Smooth ER**:
  - Lacks ribosomes
  - Lipid synthesis
  - Detoxification processes

GOLGI APPARATUS

- **Structure**: Stack of flattened membrane sacs (cisternae)
- **Functions**:
  - Processing and packaging of proteins
  - Formation of lysosomes
  - Synthesis of polysaccharides
  - Modification of lipids

RIBOSOMES

- **Structure**: Small organelles composed of RNA and proteins
- **Functions**:
  - Protein synthesis
  - Translation of mRNA
  - Found free in cytoplasm or attached to ER

CELL DIVISION 🔄

IMPORTANCE OF CELL DIVISION

Cell division is essential for:

- Growth and development of organisms
- Replacement of worn-out cells
- Repair of damaged tissues
- Reproduction in organisms
- Maintaining chromosome number

TYPES OF CELL DIVISION

1. MITOSIS

- **Definition**: Division of somatic cells resulting in two identical diploid cells
- **Phases**:
  - **Prophase**: Chromatin condenses into chromosomes
  - **Metaphase**: Chromosomes align at cell equator
  - **Anaphase**: Sister chromatids separate and move to poles

- **Telophase**: Nuclear envelopes reform around chromosome sets

- **Significance**: Growth, repair, and asexual reproduction

2. MEIOSIS

- **Definition**: Division of gametic cells resulting in four genetically different haploid cells
- **Phases**: Two successive divisions (Meiosis I and II)
- **Significance**: Sexual reproduction and genetic variation

CELL CYCLE

The cell cycle consists of:

- **G_1 Phase**: Cell growth and normal metabolic activities
- **S Phase**: DNA synthesis and replication
- **G_2 Phase**: Protein synthesis and organelle duplication
- **M Phase**: Mitosis and cytokinesis
- **G_0 Phase**: Quiescent phase (non-dividing cells)

TISSUES 🧪

DEFINITION

A tissue is a group of cells with similar structure and function that work together to perform specific activities. Plant tissues are organized systems that enable efficient functioning of the plant body.

TYPES OF TISSUES 🌿

I. MERISTEMATIC TISSUES

Tissues composed of actively dividing cells responsible for plant growth.

CHARACTERISTICS

- Small, thin-walled cells
- Dense cytoplasm with large nucleus
- Absence of vacuoles
- High metabolic activity
- Totipotent cells

TYPES BASED ON LOCATION

Type	Location	Function
Apical Meristem	Root and shoot tips	Primary growth (length)
Lateral Meristem	Cambium layers	Secondary growth (girth)
Intercalary Meristem	Base of internodes	Growth in grasses

II. PERMANENT TISSUES

Tissues composed of cells that have stopped dividing and acquired specialized functions.

A. SIMPLE PERMANENT TISSUES

1. PARENCHYMA

- **Structure**:
  - Thin-walled cells with intercellular spaces

- Living cells with prominent vacuoles
- Various shapes (spherical, oval, polygonal)

- **Location**: Throughout the plant body
- **Functions**:
  - Storage of food and water
  - Photosynthesis (in leaves)
  - Gaseous exchange
  - Wound healing and regeneration

2. COLLENCHYMA

- **Structure**:
  - Thick-walled cells with cellulose and pectin
  - Living cells with chloroplasts
  - Elongated cells with tapering ends
- **Location**: Beneath the epidermis in stems and leaves
- **Functions**:
  - Mechanical support to young organs
  - Flexibility during growth
  - Photosynthesis

3. SCLERENCHYMA

- **Structure**:
  - Very thick, lignified walls
  - Dead cells at maturity

    - Two types: Fibers and Sclereids
- **Location**: Throughout the plant body
- **Functions**:
    - Mechanical support and strength
    - Protection of internal tissues
    - Provides rigidity to plant parts

B. COMPLEX PERMANENT TISSUES

1. XYLEM

- **Components**:
    - **Tracheids**: Elongated cells with pits
    - **Vessels**: Tube-like structures with perforations
    - **Xylem Parenchyma**: Storage cells
    - **Xylem Fibers**: Supportive elements
- **Functions**:
    - Transport of water and minerals
    - Mechanical support
    - Storage of food materials

2. PHLOEM

- **Components**:
    - **Sieve Tubes**: Conducting elements
    - **Companion Cells**: Associated with sieve tubes
    - **Phloem Parenchyma**: Storage cells

- **Phloem Fibers**: Supportive elements

- **Functions**:
  - Transport of food materials
  - Storage of food
  - Mechanical support

III. SECRETORY TISSUES

Specialized tissues that secrete various substances.

TYPES

- **Laticiferous Tissues**: Secrete latex
- **Glandular Tissues**: Secrete oils, resins, and other compounds
- **Nectaries**: Secrete nectar
- **Hydathodes**: Secrete water

TISSUE SYSTEMS

Plant tissues are organized into three main tissue systems:

1. DERMAL TISSUE SYSTEM

- **Components**: Epidermis and periderm
- **Functions**: Protection, gas exchange, water regulation

2. GROUND TISSUE SYSTEM

- **Components**: Parenchyma, collenchyma, and sclerenchyma
- **Functions**: Storage, support, photosynthesis

3. VASCULAR TISSUE SYSTEM

- **Components**: Xylem and phloem
- **Functions**: Transport of water, minerals, and food

FUNCTIONS OF TISSUES ⚡

STRUCTURAL FUNCTIONS

- Providing mechanical support and rigidity
- Maintaining plant shape and form
- Protection from external environment
- Creating barriers against pathogen entry

PHYSIOLOGICAL FUNCTIONS

- Transportation of materials
- Storage of nutrients and water
- Photosynthesis and respiration
- Secretion of various compounds

DEVELOPMENTAL FUNCTIONS

- Growth and differentiation
- Wound healing and regeneration
- Adaptation to environmental conditions
- Reproductive processes

CONCLUSION 🎯

The study of plant respiration, growth and development, cell structure, and tissues provides a comprehensive understanding of plant biology. These interconnected processes work together to ensure the survival, growth, and reproduction of plants. Understanding these fundamental concepts is crucial for students pursuing pharmaceutical sciences, as many drugs are derived from plants, and knowledge of plant biology helps in understanding drug action, metabolism, and therapeutic applications.