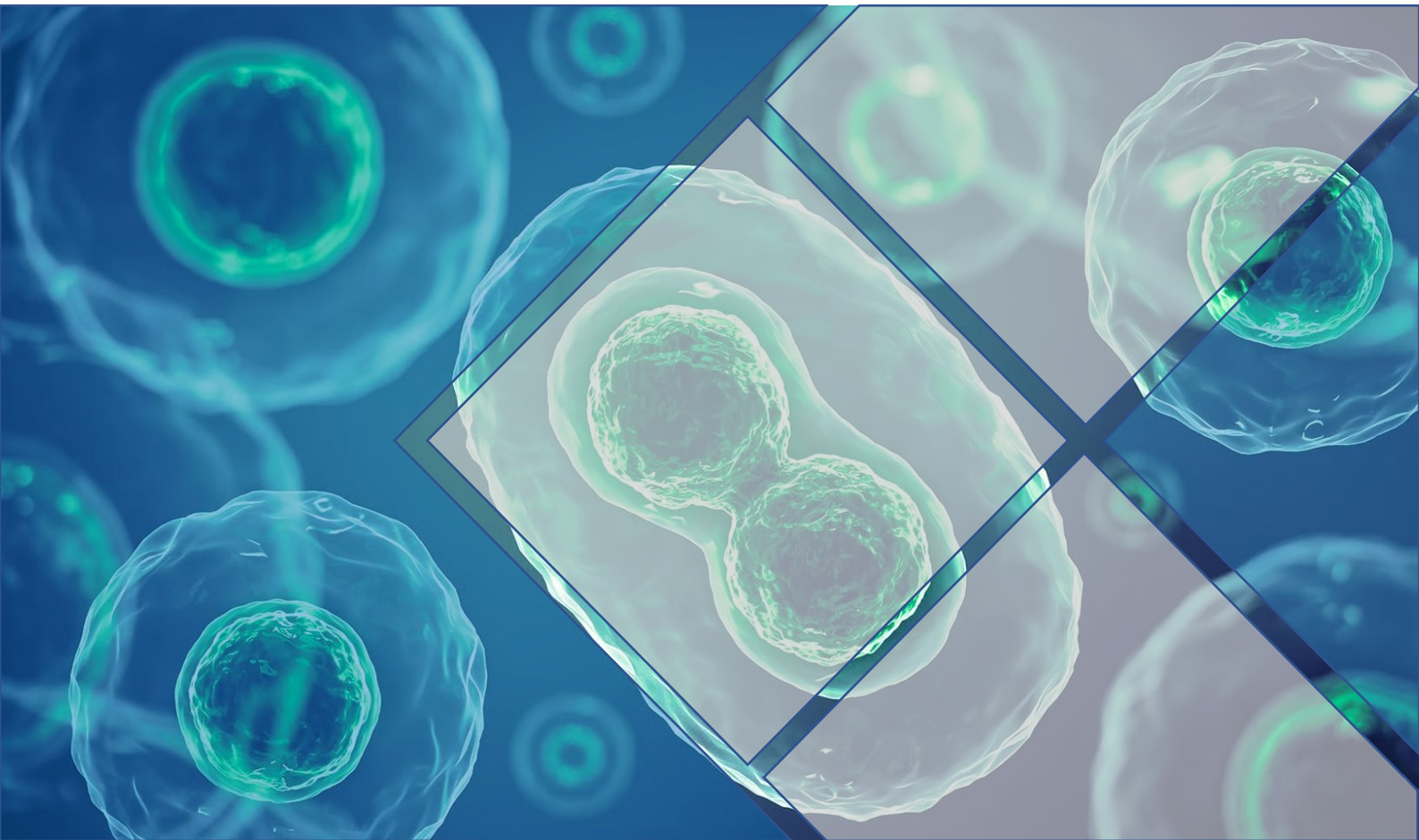


# BIOLOGY



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**2026**

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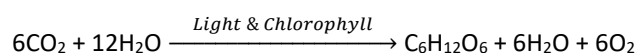
# PHOTOSYNTHESIS

## SYLLABUS

**Photosynthesis:** ♦ The main steps of the process of light reaction, Dark reaction. ♦ Factors influencing Photosynthesis. ♦ Experiments related to photosynthesis.

### 1.1 INTRODUCTION

Photosynthesis is a fundamental **Anabolic** and **Endergonic**\*\*\* **Biochemical Process** through which green plants, algae, and certain bacteria convert **Atmospheric Carbon Dioxide (CO<sub>2</sub>)** and **Water (H<sub>2</sub>O)** into **Glucose (C<sub>6</sub>H<sub>12</sub>O<sub>6</sub>)** using **Solar Energy**. Oxygen (O<sub>2</sub>) is released as a by-product.



- ✎ CO<sub>2</sub> is **reduced** to carbohydrates.
- ✎ H<sub>2</sub>O is **oxidised** to release oxygen.
- ✎ Solar energy is stored in the chemical bonds of glucose.

#### Nature of Reaction

- **Anabolic** = Synthesises complex molecules (glucose) from simpler molecules (CO<sub>2</sub>, H<sub>2</sub>O).
- **Redox** = Involves simultaneous oxidation and reduction.
- **Endergonic** = Requires energy input (light).

#### Purpose of Photosynthesis

- It provides food (glucose) for plants and all heterotrophs.
- Releases oxygen, essential for aerobic respiration.
- Maintains CO<sub>2</sub>-O<sub>2</sub> balance in the atm. = Global climate regulation.
- *Converts solar energy into biochemical energy, forming the base of the food chain*\*\*\*

#### Site of Photosynthesis

It takes place inside the **Leaves** specifically in **Mesophyll Cells** where **Chloroplast** is present.

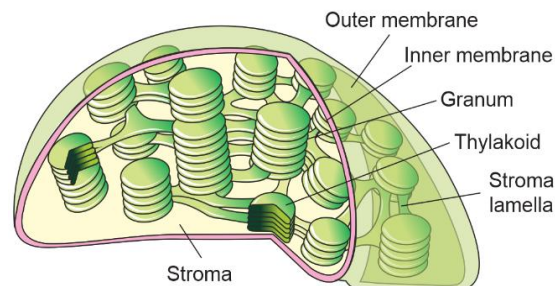
Chloroplasts are **Double-Membrane**-bound organelles found primarily in the mesophyll cells of plants. The inner fluid-filled matrix, called the **Stroma**, contains **Enzymes**, **DNA**, and **Ribosomes (70s)** essential for

## Chapter Outline

- 1.1 Introduction
  - ✎ Purpose of photosynthesis
  - ✎ Site of photosynthesis
  - ✎ Structure of chloroplast
- 1.2 Photosynthetic pigments
  - ✎ Chlorophyll
  - ✎ Carotenoids
  - ✎ Phycobilin's
  - ✎ Phytochrome
- 1.3 Main steps of photosynthesis
  - ✎ Light reaction
  - ✎ Dark reaction
  - ✎ Kranz Anatomy
  - ✎ CAM
  - ✎ Photorespiration
- 1.4 Factors affecting photosynthesis
- 1.5 Experiment related to photosynthesis
- 1.6 PYQs Exercise

chloroplast function. Within the stroma are flattened membrane sacs known as **Thylakoids**, which are organized into stacks called **Grana**. The thylakoid membranes are embedded with photosynthetic pigments that capture light energy for photosynthesis.

- ✎ The **stroma** serves as the site of the **dark\* (light-independent) reactions**, whereas the **thylakoid membranes** are the specialized structures where the **light-dependent reactions** take place.



## 1.2 PHOTOSYNTHETIC PIGMENTS

Photosynthetic pigments are specialized organic molecules that absorb light at specific wavelengths and convert it into chemical energy during the process of photosynthesis. These pigments, **located within the thylakoid membranes of chloroplasts**, play a vital role in capturing and harnessing solar energy for the synthesis of organic compounds

### Types of Photosynthetic Pigments

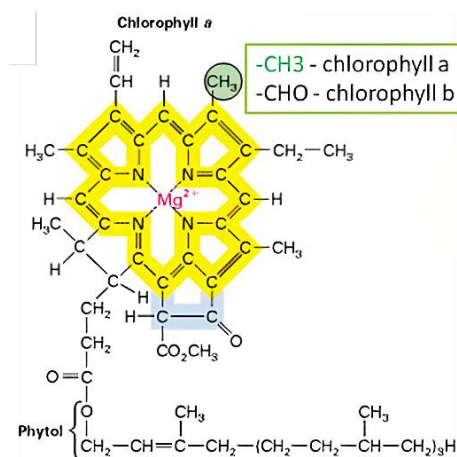
- ▶ **CHLOROPHYLLS** : Chlorophylls are the primary light-absorbing pigments in plants. They are **Fat-Soluble\***, **Magnesium-Containing\*\***, porphyrin-ring compounds responsible for the green colour of plants.

#### ▶ Chlorophyll – A

- Colour : **Bluish green**.
- Molecular formula:  $C_{55}H_{72}O_5N_4Mg^*$ .
- Role : **Primary pigment** in photosynthesis and it forms the reaction centre of the photosystem (Light harvesting complex, LHC). Directly participates in the light reaction.

#### ▶ Chlorophyll – B

- Colour : **Yellowish green**
- Molecular formula:  $C_{55}H_{70}O_6N_4Mg$ .
- Role : Accessory pigment. Transfers absorbed light energy to chlorophyll–A.



A chlorophyll molecule consists of a **Hydrophilic Porphyrin (Pyrrole) Head** containing a central **Magnesium (Mg)** atom, and a **Hydrophobic Phytol tail** that anchors the molecule to the thylakoid membrane.

**Chlorophyll A\*** and **chlorophyll B\*** differ structurally at the **third carbon (C-3) of the second pyrrole ring**, where **chlorophyll A** possesses a **methyl group (-CH<sub>3</sub>)**, whereas **chlorophyll B** has an **aldehyde group (-CHO)** at the same position. This substitution alters their light-absorption properties, enabling complementary absorption spectra during photosynthesis.

**Bacteriochlorophyll (BChl)** is a photosynthetic pigment found in phototrophic bacteria. Structurally similar to plant, algal, and cyanobacterial chlorophyll, it differs in the reduction state of the porphyrin ring, altering its light absorption properties. Unlike **Plant Chlorophyll**, which absorbs **Mainly blue and Red light**, **BChl** absorbs longer, **Infrared Wavelengths (700nm to over 1000nm)**—an adaptation enabling photosynthesis in low-light niches where visible light has been depleted. Bacterial photosynthesis is typically **Anoxygenic**, using electron donors like hydrogen sulfide or organic compounds instead of water, and thus produces no oxygen.

- **CAROTENOIDS** : Carotenoids are *Lipid-Soluble Pigments*\* found in the non-green parts of plants, such as petals, fruits, and some leaves. They are classified as **Tetraterpenoids (40C)**.

**Function** : Absorb light energy and transfer it to chlorophyll-A; also protect chlorophyll from photo-oxidation.

**Types** : ♦ **Carotenes (non-oxygenated carotenoids)** : Carotenes are hydrocarbons containing only carbon and hydrogen, with the general formula  $C_{40}H_{56}$ . They are **orange to yellow pigments** and function as accessory light-harvesting pigments and antioxidants. Common examples include  **$\beta$ -carotene** found in carrots, and **lycopene**, the red pigment present in tomatoes and red peppers.

♦ **Xanthophylls (Oxygenated)** – Xanthophylls are oxygen-containing derivatives of carotenes, having the general formula  $C_{40}H_{56}O_2$  (or higher oxygen content). They appear **yellow in colour** and are also known as **xanthols or carotenols**. These pigments play a crucial role in photoprotection by dissipating excess light energy and preventing photooxidative damage in photosynthetic tissues.

- **PHYCOBILINS** : *Water-soluble* accessory pigments predominantly found in **Cyanobacteria**\* (blue-green algae) and **Red Algae**\*\*\*.

**Examples** : Phycocyanin (blue) and Phycoerythrin (red).

**Function** : They **absorb light energy and efficiently transfer it to chlorophyll-a**, while also **safeguarding chlorophyll from photo-oxidative damage**.

- **PHYTOCHROME** : A blue-green chromoprotein photoreceptor that regulates **Photoperiodism**, **Seed Germination**, and **Flowering** in plants.

Among all photosynthetic pigments, **Chlorophyll a** – is the only primary pigment that directly participates in photochemical reactions. *All other pigments act as accessory pigments\**, absorbing light of different wavelengths and transferring the captured energy to chlorophyll *a* for use in photosynthesis.

**Absorption Spectrum** –A graph illustrating the **absorption efficiency of a pigment across different wavelengths**, a measured using a **spectrophotometer**.

- **Chlorophyll a** – Absorbs mainly in the blue (~430 nm) and red (~662 nm) regions.
- **Chlorophyll b** – Extends the range of absorption towards the blue and orange regions.
- **Carotenoids** – Absorb chiefly in the blue-violet region.

**Action Spectrum** – A graph showing the rate of photosynthesis at different wavelengths of light.

- Discovery: **T.W. Engelmann** using filamentous alga (Cladophora) and aerobic bacteria.
- Observation: **Maximum photosynthetic** activity occurs in **blue**\*\*\* and **red**\*\*\* regions;
- Green light is least effective, as it is largely reflected, giving leaves their green colour.

**Photosynthetically Active Radiation (PAR) –**

The portion of the solar spectrum usable for photosynthesis, spanning **400–700 nm**\*\*\*

- ~50% of total solar radiation falls within this range.
- Only **2–10%**\*\*\* of this PAR is captured by plants.
- Actual conversion to chemical energy is typically **1–2%**\*\*\* in most ecosystems.
- **Blue light**\*\*\* is most effective for photosynthesis, closely followed by **red light**.

### 1.3 MAIN STEPS OF PHOTOSYNTHESIS

Photosynthesis occurs in **two phases**

1. **Light Reaction** (Photochemical Phase) – Light-dependent reactions.
2. **Dark Reaction** (Biosynthetic Phase) – Light-independent reactions.

### LIGHT REACTION (PHOTOCHEMICAL PHASE)

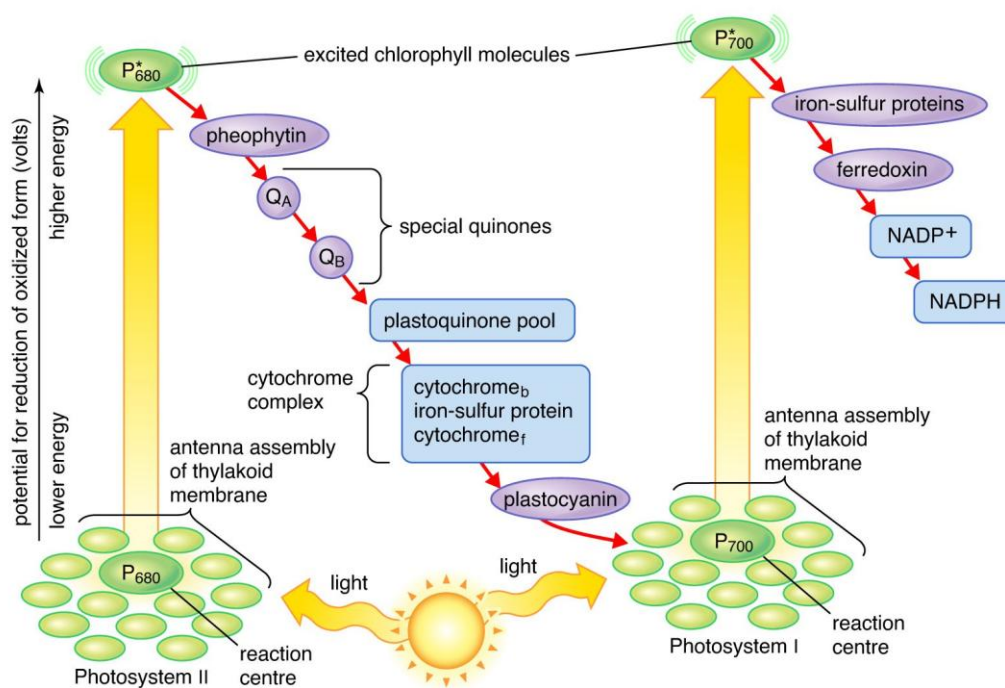
The light reaction, or photochemical phase, occurs in the **Thylakoid membranes of the grana** and requires sunlight. It begins with the absorption of light by **chlorophyll** and accessory pigments, which excites electrons and initiates chain of events including splitting of water molecules, conversion of **light energy into chemical energy in the form of ATP & NADPH + H<sup>+</sup>**, along with the release of **oxygen**.

- **Significance** : Supplies chemical energy and reducing power for the dark reaction (Calvin cycle).

### PHOTOSYSTEMS

Pigments are arranged in functional units called **Photosystems**, of which two types occur: **Photosystem II (PS II)** and **Photosystem I (PS I)**. Each photosystem has a **light-harvesting complex (LHC)** composed of multiple pigments that capture and transfer light energy to a single chlorophyll *a* molecule in the **reaction centre**.

In PS II, the reaction centre *Chlorophyll-A* is known as **P680** (absorbs light at 680 nm) and is primarily located in the appressed regions of the grana, whereas in PS I, the reaction centre is **P700** (absorbs at 700 nm) and is found mainly in the stroma lamellae and grana margins.



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### SPLITTING OF WATER (PHOTOLYSIS)

The splitting of water (**Hill's reaction**) occurs in PS II with the help of the oxygen-evolving complex (OEC) situated on the inner side of the thylakoid membrane. Here, **Water acts as the electron and proton (H<sup>+</sup>) donor\***: electrons replace those lost by P680, protons (H<sup>+</sup>) contribute to the proton gradient for ATP synthesis, and **oxygen is released as a by-product**.

- The **water-splitting complex (Oxygen-evolving complex)** is located on the **lumen side of the thylakoid membrane** of **Photosystem II**. It contains a **tyrosine derivative (TyrZ)** that acts as an intermediate electron carrier and a **metal cluster composed of four manganese (Mn<sup>4+</sup>), two calcium (Ca<sup>2+</sup>), and one chloride (Cl<sup>-</sup>) ion**. This complex catalyses the **photolysis of water**, resulting in the release of **oxygen, protons into the lumen, and electrons** for the photosynthetic electron transport chain.

### THE ELECTRON TRANSPORT

# PLANTS

## REPRODUCTION

### SYLLABUS

◆ Plants reproduction – Introduction, ◆ Asexual reproduction, ◆ Types of asexual reproduction, ◆ Sexual reproduction in plants and process.

Reproduction is a **fundamental biological process** by which living organisms give rise to offspring, ensuring the **continuity of species** across generations. It enables inheritance of parental traits and adaptation to environmental changes.

In plants, reproduction occurs by two major modes :

1. **Asexual Reproduction** – Involves a single parent; no gamete formation or fertilization. Offspring are **genetically identical (clones)**.
2. **Sexual Reproduction** – Involves the fusion of male and female gametes; offspring are **genetically variable**, ensuring evolution and adaptability.

#### Significance of Reproduction in Plants

- Ensures continuity of species.
- Asexual reproduction allows **rapid multiplication** in favourable conditions.
- Sexual reproduction introduces **variation**, which is essential for **evolution and survival**.
- Maintains balance between **stability (cloning)** and **variability (sexual recombination)** in nature.

### 2.1 ASEQUAL REPRODUCTION IN PLANTS

Asexual reproduction involves the formation of new individuals **from a single parent, without the fusion of gametes (fertilization)**. The offspring produced are genetically and morphologically identical to the parent and to one another. Such identical individuals are called **Clones**.

- This type of reproduction is common in unicellular organisms, lower plants, and some simple animals.

#### Key Features

- Involves **only mitotic divisions**.
- No gamete formation or fertilization.
- Rapid multiplication under favorable conditions.
- No genetic variation → **useful for stability but limits adaptability**.

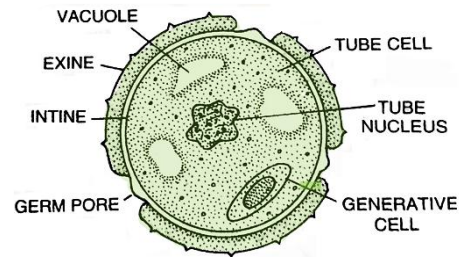
### Chapter Outline

- 2.1 Asexual reproduction
  - ✿ Fragmentation
  - ✿ Sporulation
  - ✿ Vegetative propagation
- 2.2 Sexual reproduction in plants
  - ✿ Structure of flower
  - ✿ Gametogenesis
  - ✿ Pollen viability
  - ✿ Fertilization
  - ✿ Some important terms
- 2.3 Pollination
  - ✿ Self v/s Cross
  - ✿ Pollinating Agencies
- 2.4 Fertilization process
- 2.5 Post-fertilization events
  - ✿ Partheno-caryp
- 2.6 Flowering Periodicity
- 2.7 PYQs

**Pollen Grain (Male gametophytes)**

It develops within the anther and is **microscopic**, typically **spherical** or **oval** in shape, and enclosed by two protective layers:

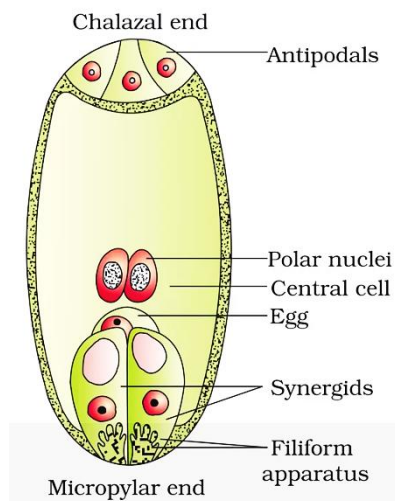
- **Exine** : Outer thick, tough and sculptured wall made of **sporopollenin<sup>\*\*\*</sup>**, a highly durable substance **resistant to decay<sup>\*\*\*</sup>** (Physical or Chemical damage).
- **Intine** : Inner thin wall composed of **cellulose** and **pectin**.



At maturity, the pollen grain contains two cells: ♦ **Generative cell**: Small, divides mitotically to form **2 male gametes (sperm cells)**. ♦ **Vegetative (Tube) cell**: Large, responsible for forming the **pollen tube** that carries male gametes to the ovule during fertilization.

- ▷ **Megasporogenesis (Female Gamete Formation)** : occurring inside the **ovule**, which lies within the ovary of the carpel. Within the nucellus of the ovule, a diploid **Megaspore Mother Cell (Megasporeocyte, 2n)<sup>\*\*\*</sup>** undergoes **meiosis** to produce **4 haploid megaspores (n)**.

Out of these four, **only one megaspore becomes functional**, while the remaining three degenerate. The functional megaspore undergoes three successive **mitotic** divisions, producing **8 nuclei**, which are arranged into **seven cells**, forming the embryo sac (female gametophyte).



**Structure of the Embryo Sac (Polygonum Type – most common)**

Composed of **seven cells with eight nuclei**, arranged as follows,

- At the micropylar end : 1 Egg cell (n) and 2 Synergids (n).
- At the chalazal end : 3 antipodal cells (n).
- In the center : 2 polar nuclei, which later fuse to form a diploid (2n) secondary nucleus.

**POLLEN VIABILITY**

**Pollen viability** refers to the capability of pollen grains to **remain alive, metabolically active, and able to germinate** on a compatible stigma to achieve successful fertilization and seed set.

▷ **Duration of Pollen Viability**

Pollen viability varies greatly among plant species depending on environmental and physiological factors. Generally, Species with **large, wet (sticky), thin-walled pollen with high moisture content** (e.g., **rice, wheat, Mango, Rubber**) show short viability, 30 minutes to a few hours, while those with **dry, thick-walled (sporopollenin rich), often wind-pollinated pollen** (e.g., **Sunflower, Date Palm, Chir Pine, Oak**) exhibit longer viability up to Several days.

▷ **Factors Affecting Pollen Viability**

- **Temperature** : High temperature accelerates desiccation and reduces viability; optimum moderate temperature Favors longevity.
- **Humidity** : High humidity promotes fungal attack and reduces viability; controlled humidity improves persistence.
- **Storage conditions** : Proper drying and low-temperature storage enhance viability.

► **Pollen Storage (Cryopreservation)**

To maintain viability for long durations, pollen grains can be preserved through **cryopreservation**

- Stored in **liquid nitrogen at  $-196^{\circ}\text{C}$** .
- Used for **conservation of germplasm, plant breeding, and hybridization programs**.
- Allows crossing between plants flowering in different seasons.

► **Applications of Pollen Viability**

- Development of high-yielding hybrids
- Crop improvement programs
- Long-term pollen banking for plant breeding research.
- Pollen grains of many species act as allergens, causing – Asthma, Bronchitis, and Other respiratory disorders.
  - ✎ ***Parthenium hysterophorus*** (Carrot grass), an introduced weed in India through wheat imports, is a major cause of pollen allergy and respiratory problems.

► **Nutritional Importance**

- Pollen grains are **rich in proteins, lipids, vitamins, minerals, and antioxidants**.
- Used as **nutritional supplements** in the form of tablets and syrups, especially in Western countries.
- Believed to enhance **athletic and race-horse performance** (though scientific support varies).



- ✎ Cross-pollinated crops generally show short pollen viability
- ✎ Cryopreservation =  $-196^{\circ}\text{C}$  (liquid nitrogen)
- ✎ Parthenium = allergenic weed, introduced contaminant in wheat imports

**2.3 POLLINATION**

**Pollination** is the process of transfer of pollen grains from the **anther (male reproductive organ)** to the **stigma (female reproductive organ)** of a flower.

It is the **first essential step in sexual reproduction** in flowering plants.

**Types of Pollination**

- **Self-Pollination (Autogamy)** : Transfer of pollen to the stigma of the **same flower** or **another flower on the same plant**. O-pollinated plants are often **genetically uniform** (no genetic variation → Homozygosity).

Type	Description	Key Examples	Important Points
<b>Autogamy</b>	Pollen transfer within the <b>same flower</b>	<i>Peas, Wheat, Rice</i>	Requires bisexual flowers; closed flowers can ensure autogamy
<b>Cleistogamy</b>	Pollination in <b>closed flowers</b>	<i>Viola</i> (pansy), <i>oxalis</i> (wood sorrel)	Ensures <b>100% self-pollination</b> ; no need for pollinators
<b>Geitonogamy</b>	Pollen transfer to <b>another flower on same plant</b>	<i>Madhuca longifolia</i> (Mahua),	Functionally cross-pollination but <b>genetically like self-pollination</b> ; requires pollinating agents

- ✎ Teak is predominantly cross-pollinated but may show limited autogamy.

# ANIMAL REPRODUCTION

## SYLLABUS

- ✿ Types of reproduction Asexual reproduction
- ✿ Parthenogenesis
- ✿ Sexual reproduction
- ✿ Human reproductive system
- ✿ Reproductive health

**Reproduction** is a fundamental biological process through which living organisms give rise to new individuals of their own kind. It ensures the continuity of species from one generation to the next, as the lifespan of every organism is limited. Without reproduction, the existence of any species would eventually come to an end. (Non-defining property)

### SIGNIFICANCE OF REPRODUCTION :

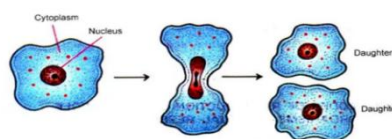
1. **Continuity of Species** : By producing offspring, organisms maintain the existence of their species over time.
2. **Transmission of Heredity** : Genetic material (DNA) is passed from parents to offspring, ensuring inheritance of characters.
3. **Source of Variation and Evolution** : Reproduction introduces genetic variation, which serves as the basis for evolution.
4. **Adaptation to Environment** : Variability among offspring helps species adapt and survive in changing environments.

### 3.1 ASEQUAL REPRODUCTION

Asexual reproduction involves the formation of offspring from a single parent without the fusion of gametes. The offspring are genetically and morphologically identical to the parent and are referred to as **clones**. This method is common in unicellular organisms, simple plants, and some invertebrate animals.

#### TYPES OF ASEQUAL REPRODUCTION :

**FISSION** : The parent cell divides (cell division) into two or more individuals. E.g. Protists and Monerans. Fission is 2 types :



## Chapter Outline

- 3.1 Asexual reproduction
  - ✿ Fission
  - ✿ Budding
  - ✿ Fragmentation
  - ✿ Sporulation
  - ✿ Vegetative propagation
  - ✿ Parthenogenesis
- 3.2 Sexual reproduction
- 3.3 Sexual reproduction in plants
  - ✿ Structure of flower
  - ✿ Pollination
  - ✿ Fertilization
  - ✿ Some important terms
- 3.4 Human reproduction
  - ✿ Male reproductive system
  - ✿ Female reproductive system
  - ✿ Fertilization
  - ✿ Embryonic development
  - ✿ Parturition
- 3.5 Sex determination
- 3.6 Reproductive health
  - ✿ Components of reproductive health
  - ✿ Contraception
  - ✿ ART

- Small risk of miscarriage, infection, or injury to the foetus.
- Should be performed only when there is a clear medical indication.

**Ethical Concerns :**

In India, amniocentesis was earlier misused for *sex determination leading to female feticide*. To prevent this, the *Pre-Conception and Pre-Natal Diagnostic Techniques (PCPNDT) Act, 1994* was enacted, which strictly prohibits the use of amniocentesis for *sex determination*.

**3.7 Previous Year Questions (PYQs).**

1. Binary Fission occurs in: / बाइनरी विखंडन होता है:  
[MPPSC Forest Service (Mains) 2018, 2019]
  - (a) Amoeba / अमीबा में
  - (b) Paramecium / पैरामीशियम में
  - (c) Euglena / यूग्लीना में
  - (d) All of these / इनमें से सभी
2. A boy would be born on meeting of which chromosome in human? / मनुष्य में गुणसूत्र के कौन से संयोजन के मिलने से बालक का जन्म होगा? [MPPSC (Pre) 2003-04]
  - (a) Male X and Female X / पुरुष का X और स्त्री का X
  - (b) Male X and Female Y / पुरुष का X और स्त्री का Y
  - (c) Male Y and Female X / पुरुष का Y और स्त्री का X
  - (d) Male Y and Female Y / पुरुष का Y और स्त्री का Y
3. A surge of which hormone stimulates ovulation in human females? / मानव मादाओं में प्रजननीय (अण्डाणु उत्पादन) में कौन सा हार्मोन तेजी से वृद्धि करता है? [MPPSC (Pre) 2009]
  - (a) Luteinizing hormone / ल्यूटिनाइजिंग हार्मोन
  - (b) Oestrogen / एस्ट्रोजन
  - (c) Follicle stimulating hormone / फालिकल स्टिमुलेटिंग हार्मोन
  - (d) Progesterone / प्रोजेस्टेरोन
4. Total number of autosomes in fertilized egg of human being is / मानव के निषेचित अण्डे में ऑटोसोम की संख्या होती है [MPPSC Forest Service (Mains) 2019]
  - (a) 23
  - (b) 46
  - (c) 22
  - (d) 44
5. Leydig cells are found in which mammalian organ? / स्तनधारियों के किस अंग में लेडिग कोशिकाएँ पाई जाती हैं? [MPPSC Forest Service (Mains) 2019]
  - (a) Liver / यकृत
  - (b) Kidney / वृक्क
  - (c) Stomach / अमाशय
  - (d) Testis / वृषण
6. Which one of the following cells secrete Androgen hormone in human being? / निम्न में से कौन सी कोशिकाएँ मनुष्य में एंड्रोजन हॉर्मोन को स्रावित करती है? [MPPSC (Pre) 2019]
  - (a) Sertoli cells / सर्टोली कोशिकायें
  - (b) Cells of Leydig / लेडिग कोशिकायें
  - (c) Germinal cells / जर्मिनल कोशिकायें
  - (d) Mucous cells / म्यूकस (श्लेष्म) कोशिकायें
7. In which organ sertoli cells are found? / सर्टोली कोशिकाएँ किस अंग में पाई जाती हैं? [MPPSC Forestry & Gen Science 2022]
  - (a) Ovary / अण्डाशय
  - (b) Kidney / वृक्क
  - (c) Liver / यकृत
  - (d) Testis / वृषण
8. Five oogonia yield ten primary oocytes, then how many ova are produced by the completion of oogenesis? पाँच अंडधानी (ऊगोनिया) दस प्राथमिक अंडक (ऊसाइट) का निर्माण करती हैं, तब अण्डाणुजनन के पूर्ण होने पर कितने अंडाणु (ओवा) निर्मित होंगे? [MPPSC Forest Service (Main) 2019]
  - (a) 5

# ANIMAL NUTRITION

## SYLLABUS

- ✿ Introduction
- ✿ Types of nutrition
- ✿ Autotrophic and heterotrophic nutrition (Holozoic, Parasitic, Saprophytic, symbiotic.)
- ✿ Human digestive system and digestive process
- ✿ Digestion in unicellular cell animal [amoeba] and multi-cellular animal grasshopper.

### NUTRITION :

Nutrition is the biological process by which living organisms **obtain food, digest and absorb nutrients, and utilize them for energy production, growth, repair of tissues, regulation of metabolic activities, and maintenance of life.**

### TYPES OF NUTRITION :

#### 1. AUTOTROPHIC NUTRITION :

In this mode, organisms produce their own food from inorganic substances (such as CO<sub>2</sub> and H<sub>2</sub>O), using energy derived from sunlight or chemical reactions.

- ❖ **Examples :** Green plants, algae, and certain bacteria.
- ❖ **Note :** Animals do not perform autotrophic nutrition; instead, they depend on autotrophs (directly or indirectly) for their energy and organic matter.

There are two main types of autotrophic nutrition:

#### 1. Photoautotrophic nutrition :

In this type, organisms use sunlight as an energy source to convert carbon dioxide and water into glucose (a form of sugar) and oxygen through the process of **photosynthesis**.

**Chemical Equation :**



**Examples :** Green plants, algae cyanobacteria etc.

#### 2. Chemoautotrophic nutrition :

In this type, organisms obtain energy by oxidizing inorganic

## Chapter Outline

- 4.1 Nutrition
  - ✿ Autotrophic nutrition
  - ✿ Heterotrophic nutrition
  - ✿ Nutrition in amoeba
- 4.2 Human digestive system and process
  - ✿ Alimentary canal
  - ✿ Secretory glands of intestine
  - ✿ Common digestive disorder
  - ✿ Some important terms
- 4.3 Nutrients
  - ✿ Macronutrients
  - ✿ Micronutrients
- 4.4 Digestion in grasshopper
- 4.5 Insectivorous plants
- 4.6 Digestion in ruminants

**SYLLABUS**

- ✿ Definition
- ✿ Respiratory organs of animals breathing and respiration
- ✿ Types of respiration
- ✿ Respiratory system of human being and mechanism of respiration
- ✿ Respiratory quotient [RQ] of carbohydrate, fat and protein

**RESPIRATION AND BREATHING**

**RESPIRATION** : It is a vital biochemical process that occurs in the living cells of organisms, wherein the nutrients mainly glucose and other organic compounds—are oxidized enzymatically to release energy. This energy is stored in the form of adenosine triphosphate (ATP), which is utilized for various biological activities.

**BREATHING (EXTERNAL RESPIRATION)** : It also referred to as external respiration, **exchange of gases** or ventilation, it is the process of taking in oxygen-rich air into the lungs (inhalation) and releasing carbon dioxide-rich air out of the lungs (exhalation). It is a physical and mechanical process that helps in the exchange of gases between the body and the environment. This gaseous exchange occurs through specialized respiratory organs depending on the organism.

**RESPIRATORY ORGANS IN ORGANISM :**

- In the animal kingdom, a wide range of respiratory structures have evolved to suit diverse habitats and body organizations.
- In lower invertebrates such as sponges, coelenterates, and flatworms, the general body surface serves as the site of gas exchange due to the absence of specialized organs and the small size or flat body that allows diffusion to suffice.
  - In organisms such as earthworms and leeches, the skin or moist cuticle functions as the respiratory surface—a process called cutaneous respiration.
  - Amphibians also use their skin as a secondary respiratory organ besides lungs.
  - In arthropods such as **insects, cockroach\*\***, centipedes, millipedes, and spiders, air is directly transported to tissues through a network

*Chapter Outline*

- 5.1 Respiration and breathing
  - ✿ Respiratory organs in organism
- 5.2 Human respiratory system
  - ✿ Structure and functions of lungs
  - ✿ Steps of respiration
  - ✿ Mechanism of breathing
  - ✿ Respiratory volume and capacities
  - ✿ Gaseous exchange
  - ✿ Transportation of gaseous
  - ✿ Regulation of respiration
  - ✿ Disorders
- 5.3 Types of respiration
  - ✿ Aerobic respiration
  - ✿ Anaerobic respiration
- 5.4 Phosphorylation
  - ✿ Substrate level phosphorylation
  - ✿ Oxidative phosphorylation
- 5.5 Respiration quotient
- 5.6 Respiration in plants

# CIRCULATORY SYSTEM

## SYLLABUS

- ✿ Composition and function of blood
- ✿ Coagulation of blood
- ✿ Structure and function of blood vessels
- ✿ Structure and working of heart
- ✿ Blood group, blood transfusion & blood bank
- ✿ Function of lymph system
- ✿ Diseases related to heart

## INTRODUCTION :

The circulatory system is a highly organized and dynamic transport system that plays a fundamental role in the maintenance of **physiological homeostasis** in multicellular organisms. In humans, it ensures the continuous circulation of blood, enabling efficient exchange of gases, nutrients, metabolic wastes, signalling molecules, and heat between the blood and body tissues. By integrating transport, regulation, and protection, the circulatory system supports cellular metabolism and overall organismal survival.

In humans, the circulatory system consists of the **heart, blood,** and **blood vessels**. The heart functions as a muscular pump that maintains continuous blood flow, blood serves as the transport medium, and blood vessels—arteries, veins, and capillaries—form a closed network for circulation.

## TYPES OF CIRCULATORY SYSTEM : OPEN AND CLOSED

Based on the structural arrangement of blood vessels and the mode of circulation, the circulatory system is broadly categorized into two types: open circulatory system and closed circulatory system.

## OPEN CIRCULATORY SYSTEM :

The open circulatory system is a primitive and less efficient form of circulation found in many invertebrates. In this system, the blood is not always enclosed within blood vessels. Instead, the heart pumps the blood into a **body cavity or haemocoel**, where it comes in direct contact with the tissues and organs. This blood, more accurately termed as

## Chapter Outline

- 6.1 Circulatory system
  - ✿ Open and close circulation
  - ✿ Double circulation
  - ✿ Portal circulation
  - ✿ Chambered heart across the vertebrates
- 6.2 Blood
  - ✿ Composition of blood
  - ✿ Blood grouping
  - ✿ Clotting of blood
  - ✿ Erythroblastosis
  - ✿ Blood vessels
- 6.3 Heart
  - ✿ Structure of heart
  - ✿ Conducting system of heart
  - ✿ Cardiac cycle
  - ✿ ECG
- 6.4 Lymphatic system
- 6.5 Disorders of heart

# TRANSPORTATION IN PLANTS

## SYLLABUS

- ✿ Direction of transport: unidirectional and bidirectional
- ✿ Movement of water, mineral ions, and organic food materials within the plant body
- ✿ Means of transport: passive transport and active transport
- ✿ Plant water relations: water potential, imbibition, and plasmolysis
- ✿ Long-distance transport of water and uptake of minerals
- ✿ Ascent of sap and transportation of food through phloem (Mass Flow Theory)
- ✿ Comparative study of xylem and phloem transport

## INTRODUCTION :

Transportation in plants refers to the movement of water, minerals, and organic substances (like food) within the plant body. Unlike animals, plants do not possess a circulatory system with a heart and blood vessels, yet they have evolved efficient internal systems to manage transport across short and long distances. These systems ensure that each part of the plant receives necessary nutrients and water, and that the food produced in leaves reaches non-photosynthetic tissues. The transport occurs mainly through specialized **vascular tissues** called **xylem and phloem**.

## DIRECTION OF TRANSPORT :

**UNIDIRECTIONAL TRANSPORT :** The transport of water and mineral nutrients through the **xylem** is **unidirectional\***, occurring exclusively from the **roots to the aerial parts** of the plant, including the **stem, leaves, and reproductive organs**. This upward movement ensures the continuous supply of water and dissolved minerals required for photosynthesis, transpiration, and metabolic activities in the above-ground tissues.

**MULTIDIRECTIONAL TRANSPORT :** The transport of **photosynthates (organic solutes)** through phloem occurs in multiple directions, depending on the plant's metabolic needs (**from source to sink**).

## Chapter Outline

- 7.1 Direction of transport
  - ✿ Unidirectional
  - ✿ Bidirectional
- 7.2 Means of transport
  - ✿ Passive transport
  - ✿ Active transport
- 7.3 Plant water relations
  - ✿ Water potential
  - ✿ Imbibition
  - ✿ Plasmolysis
- 7.4 Long distance transport of water
- 7.5 Uptake and transport of minerals
- 7.6 Ascent of sap
- 7.7 Transportation of food
- 7.8 comparison: xylem and phloem transport

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