GOVERNMENT COLLEGE (A), RAJAHMUNDRY

DEPARTMENT OF MICROBIOLOGY

FIRST YEAR

SEMESTER – 1

CLASSICAL BIOLOGY

Semester – 1

Course: 1 **INTRODUCTION TO CLASSICAL BIOLOGY**

Hours/Week: 5 **Credits: 4**

Learning objectives

The student will be able to learn the diversity and classification of living organisms and understand their chemical, cytological, evolutionary and genetic principles.

Learning Outcomes

1. Learn the principles of classification and preservation of biodiversity
2. Understand the plant anatomical, physiological and reproductive processes.
3. Knowledge on animal classification, physiology, embryonic development and their economic importance.
4. Outline the cell components, cell processes like cell division, heredity and molecular processes.
5. Comprehend the chemical principles in shaping and driving the macromolecules and life processes.

Unit 1: Introduction to systematics, taxonomy and ecology.

1.1. Systematics – Definition and concept, Taxonomy – Definition and hierarchy.

1.2. Nomenclature – ICBN and ICZN, Binomial and trinomial nomenclature.

1.3. Ecology – Concept of ecosystem, Biodiversity and conservation.

1.4. Pollution and climate change.

Unit 2: Essentials of Botany.

2.1. The classification of plant kingdom.

2.2. Plant physiological processes (Photosynthesis, Respiration, Transpiration, phytohormones).

2.3. Structure of flower – Micro and macro sporogenesis, pollination, fertilization and structure of mono and dicot embryos.

2.4 Mushroom cultivation, floriculture and landscaping.

Unit 3: Essentials of Zoology

3.1. The classification of Kingdom Animalia and Chordata.

3.2 Animal Physiology – Basics of Organ Systems & their functions, Hormones and Disorders

3.3 Developmental Biology – Basic process of development (Gametogenesis, Fertilization, Cleavage and Organogenesis)

3.4 Economic Zoology – Sericulture, Apiculture, Aquaculture

Unit 4: Cell biology, Genetics and Evolution

4.1. Cell theory, Ultrastructure of prokaryotic and eukaryotic cell, cell cycle.

4.2. Chromosomes and heredity – Structure of chromosomes, concept of gene.

4.3. Central Dogma of Molecular Biology.

4.4. Origin of life

Unit 5: Essentials of chemistry

5.1. Definition and scope of chemistry, applications of chemistry in daily life.

5.2. Branches of chemistry

5.3. Chemical bonds – ionic, covalent, noncovalent – Vander Waals, hydrophobic, hydrogen bonds.

5.4. Green chemistry

References

1. Sharma O.P., 1993. Plant taxonomy. 2nd Edition. McGraw Hill publishers.

2. Pandey B.P., 2001. The textbook of botany Angiosperms. 4th edition. S. Chand publishers, New Delhi, India.

3. Jordan E.L., Verma P.S., 2018. Chordate Zoology. S. Chand publishers, New Delhi, India.

4. Rastogi, S.C., 2019. Essentials of animal physiology. 4th Edition. New Age International Publishers.

5. Verma P.S., Agarwal V.K., 2006. Cell biology, genetics, Molecular Biology, Evolution and Ecology. S. Chand publishers, New Delhi, India.

6. Sathyanarayana U., Chakrapani, U., 2013. Biochemistry. 4th Edition. Elsevier publishers.

7. Jain J.L., Sunjay Jain, Nitin Jain, 2000. Fundamentals of Biochemistry. S. Chand publishers, New Delhi, India.

8. Karen Timberlake, William Timberlake, 2019. Basic chemistry. 5th Edition. Pearson publishers.

9. Subrata Sen Gupta, 2014. Organic chemistry. 1st Edition. Oxford publishers.

ACTIVITIES:

1. Make a display chart of life cycle of nonflowering plants.

2. Make a display chart of life cycle of flowering plants.

3. Study of stomata

4. Activity to prove that chlorophyll is essential for photosynthesis

5. Study of pollen grains.
6. Observation of pollen germination.
7. Ikebana.
8. Differentiate between edible and poisonous mushrooms.
9. Visit a nearby mushroom cultivation unit and know the economics of mushroom cultivation.
10. Draw the Ultrastructure of Prokaryotic and Eukaryotic Cell
11. Visit to Zoology Lab and observe different types of preservation of specimens
12. Hands-on experience of various equipment – Microscopes, Centrifuge, pH Meter, Electronic Weighing Balance, Laminar Air Flow
13. Visit to Zoo / Sericulture / Apiculture / Aquaculture unit
14. List out different hormonal, genetic and physiological disorders from the society

SEMESTER – I
CLASSICAL BIOLOGY
UNIT-1

Systematics – Definition and Concept

Definition:
Systematics is the branch of biology that deals with the identification, classification, and naming of organisms. It involves studying the diversity of life and organizing living things into groups based on shared characteristics.

Key Concepts in Systematics:

1. **Taxonomy:**
   - A part of systematics that focuses on the classification and naming of organisms.
   - Organisms are classified into hierarchical categories such as **Kingdom, Phylum, Class, Order, Family, Genus, and Species**.

   Example:
   - **Human Classification:**
     - Kingdom: Animalia
     - Phylum: Chordata
     - Class: Mammalia
     - Order: Primates
     - Family: Hominidae
     - Genus: Homo
     - Species: Homo sapiens
2. **Phylogenetics:**
   - The study of evolutionary relationships between species. It helps to create a "tree of life" showing how different organisms are related.

   Example:
   - Humans, chimpanzees, and gorillas share a common ancestor, which is reflected in their genetic similarities.
3. **Nomenclature:**
   - The system of naming organisms. The scientific names of organisms follow a binomial system, where each species is given a two-part Latin name: **Genus** + **Species**.

   Example:
   - **Homo sapiens** (Human)
   - **Canis lupus** (Wolf)

Importance of Systematics:

1. **Understanding Evolution:**
   - Helps scientists understand how species evolve and relate to each other.
2. **Conservation:**
   - Helps in identifying and protecting endangered species by understanding their relationship to other organisms.

3. **Identification and Classification:**
    - Systematics aids in correctly identifying and classifying new species discovered in nature.

Taxonomy Hierarchy (Levels of Classification):

Taxonomy organizes organisms into a hierarchical system of categories, from the broadest to the most specific. This system is called the **Linnaean Classification System** and includes the following levels:

1. **Domain:**
    - The broadest level of classification. Organisms are grouped into three domains based on their cell structure and genetics.
    - **Example:**
        - **Bacteria**
        - **Archaea**
        - **Eukarya**
2. **Kingdom:**
    - A group of related phyla. The five main kingdoms are:
        - **Animalia** (animals)
        - **Plantae** (plants)
        - **Fungi** (fungi)
        - **Protista** (single-celled organisms like algae)
        - **Monera** (bacteria and archaea, now split into two separate domains)

    Example:

    - Humans belong to the **Animalia** kingdom, and mushrooms belong to the **Fungi** kingdom.
3. **Phylum:**
    - Groups organisms based on major body plans and structural similarities.
    - **Example:**
        - Humans belong to the phylum **Chordata** (animals with a backbone).
        - Jellyfish belong to **Cnidaria** (animals with radial symmetry).
4. **Class:**
    - Further divides phyla into smaller groups.
    - **Example:**
        - Humans belong to the class **Mammalia** (mammals).
        - Dogs belong to the class **Mammalia** too, but more specifically the order **Carnivora**.
5. **Order:**
    - Groups organisms based on more specific characteristics.
    - **Example:**
        - Humans belong to the order **Primates** (apes, monkeys, and humans).
        - Cats belong to the order **Carnivora** (carnivores).
6. **Family:**
    - Groups species that are closely related.

    - **Example:**
        - Humans belong to the family **Hominidae** (great apes).
        - Cats belong to the family **Felidae** (cats and big cats).
7. **Genus:**
    - A group of closely related species.
    - **Example:**
        - Humans belong to the genus **Homo** (e.g., **Homo sapiens**).
        - Dogs belong to the genus **Canis** (e.g., **Canis lupus** for wolves).
8. **Species:**
    - The most specific level, referring to individual organisms that can interbreed and produce fertile offspring.
    - **Example:**
        - **Homo sapiens** (humans).
        - **Canis lupus** (wolves).

Taxonomy Example (Human Classification):

- **Domain:** Eukarya
- **Kingdom:** Animalia
- **Phylum:** Chordata
- **Class:** Mammalia
- **Order:** Primates
- **Family:** Hominidae
- **Genus:** Homo
- **Species:** Homo sapiens

Importance of Taxonomy:

1. **Identification:** Helps scientists identify and name organisms.
2. **Organization:** Provides a system to classify and organize the immense diversity of life.
3. **Shows Evolutionary Relationships**
4. **Communication:** Enables scientists around the world to refer to organisms by the same names, avoiding confusion.

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ICBN and ICZN

1. **ICBN (International Code of Botanical Nomenclature)**
    - A set of rules for naming plants, algae, and fungi.
    - It ensures that every plant species has a unique name that scientists around the world can recognize and use consistently.
    - **Example**: The ICBN standardizes names like *Mangifera indica* (mango), so that no other plant species is called by this name.
2. **ICZN (International Code of Zoological Nomenclature)**

- A set of rules for naming animals.
- It Provides guidelines for naming animals in a consistent way worldwide.
- **Example**: The ICZN standardizes names like *Panthera leo* (lion), ensuring that all scientists refer to lions with the same name.

These codes prevent confusion in scientific communication and make it easier to study and discuss different species accurately.

Binomial and Trinomial Nomenclature

1. **Binomial Nomenclature**
   - It is a system of naming species with two names: a **genus** name and a **species** name.
   - Developed by Carl Linnaeus, this system uses the genus name first (capitalized) and the species name second (in lowercase). Both names are usually italicized.
   - **Example**: Humans are called *Homo sapiens* where "Homo" is the genus and "sapiens" is the species.
2. **Trinomial Nomenclature**
   - It is a naming system with three parts, used when a species is further divided into **subspecies**.
   - The name includes the genus, species, and an additional subspecies name.
   - **Example**: The Bengal tiger is named *Panthera tigris tigris*; "Panthera" is the genus, "tigris" is the species, and the second "tigris" represents the Bengal subspecies.

Examples

1. **Binomial Nomenclature**:
   - **Lion**: *Panthera leo*
   - **Rose**: *Rosa indica*
   - **House Cat**: *Felis catus*
2. **Trinomial Nomenclature**:
   - **Indian Elephant**: *Elephas maximus indicus*
   - **Gray Wolf**: *Canis lupus lupus*
   - **Snow Leopard**: *Panthera uncia uncia*

Summary

- **ICBN**: Rules for naming plants, algae, and fungi.
- **ICZN**: Rules for naming animals.
- **Binomial Nomenclature**: Names species with two parts (genus + species).

- **Trinomial Nomenclature**: Names subspecies with three parts (genus + species + subspecies).

These naming systems ensure each species has a unique and clear name recognized by scientists globally, making communication about organisms more precise and organized.

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Ecology – Concept of ecosystem, Biodiversity and conservation.

Ecology is the study of how living organisms interact with each other and their environment. It includes understanding ecosystems, biodiversity, and conservation efforts. Here's a simple overview of these concepts:

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1. Concept of Ecosystem

- An ecosystem is a community of living organisms (plants, animals, and microbes) interacting with each other and their non-living environment (air, water, soil) in a specific area.
- **Components**:
    - **Biotic Factors**: All the living things in an ecosystem, such as plants, animals, fungi, and bacteria.
    - **Abiotic Factors**: The non-living parts of an ecosystem, like sunlight, temperature, water, and minerals.
- Organisms in an ecosystem depend on each other for food, shelter, and reproduction. Energy flows through the ecosystem, usually starting from the sun, which plants use to produce food through photosynthesis.
- **Example**: A forest ecosystem includes trees, birds, insects, and soil, all interacting through food chains (e.g., plants → herbivores → carnivores) and nutrient cycles.

BIODIVERSITY – DEFINITION AND CONCEPT

Biodiversity refers to the variety of life forms on Earth, including the diversity of species, ecosystems, and genetic variations within species. It encompasses all living organisms, from microscopic bacteria to large mammals, and the ecosystems they form.

Levels of Biodiversity:

1. **Species Diversity:**
   - Refers to the variety of species in a given area.
   - **Example:**
     - A rainforest may have thousands of different species of plants, animals, and insects, making it a region of high species diversity.
     - The Amazon Rainforest is known for its high species diversity, with millions of species of plants and animals.
2. **Genetic Diversity:**
   - The variation in genetic makeup within a species.
   - **Example:**
     - The different breeds of dogs (e.g., Labrador, Bulldog, Beagle) all belong to the same species but have genetic differences that result in variations in appearance and behavior.
3. **Ecosystem Diversity:**
   - The variety of ecosystems (forests, oceans, wetlands, deserts, etc.) on Earth.
   - **Example:**
     - A coral reef ecosystem is different from a desert ecosystem, each supporting unique species and environmental conditions.

Importance of Biodiversity:

1. **Ecosystem Stability:**
   - Greater biodiversity leads to more stable ecosystems that are resilient to changes and disturbances, like diseases or climate change.
   - **Example:**
     - Coral reefs, with their diverse species, can recover better from storms compared to ecosystems with fewer species.
2. **Human Benefits:**
   - Biodiversity provides essential services such as food, medicine, and clean water.
   - **Example:**
     - Many medicines are derived from plants, like the cancer drug **Taxol**, which comes from the Pacific yew tree.
3. **Cultural and Aesthetic Value:**
   - Biodiversity contributes to cultural practices, tourism, and recreational activities.
   - **Example:**
     - Wildlife tourism, like safaris in Africa, brings people from around the world to see diverse animal species.
4. **Pollination and Agriculture:**

- Biodiversity supports pollinators like bees and butterflies, which are essential for crop production.
- **Example:**
  - Bees pollinate flowers and crops like apples, almonds, and tomatoes, ensuring food production.

Threats to Biodiversity:

1. **Habitat Destruction:**
   - Human activities like deforestation, urbanization, and agriculture destroy natural habitats.
   - **Example:**
     - Clearing rainforests for farming leads to the loss of species that rely on that habitat.
2. **Pollution:**
   - Chemicals, plastic waste, and other pollutants harm ecosystems and species.
   - **Example:**
     - Ocean pollution harms marine life, especially species like sea turtles and fish, which ingest plastic.
3. **Climate Change:**
   - Changes in temperature, weather patterns, and sea levels affect ecosystems and species.
   - **Example:**
     - Polar bears are losing their habitat due to melting ice caps in the Arctic.
4. **Overexploitation:**
   - Overhunting, overfishing, and excessive harvesting of natural resources can deplete species.
   - **Example:**
     - Overfishing has led to the decline of many fish species, like the Atlantic cod.

CLIMATE CHANGE AND ITS EFFECTS

Climate change refers to long-term changes in temperature, weather patterns, and other atmospheric conditions on Earth. It is primarily driven by human activities, such as burning fossil fuels, deforestation, and industrial processes, which release greenhouse gases like carbon dioxide (CO_2) into the atmosphere.

Causes of Climate Change:

1. **Greenhouse Gas Emissions:**
    - **Burning fossil fuels** (coal, oil, and natural gas) for energy, transportation, and industrial activities releases carbon dioxide (CO_2) and other greenhouse gases like methane (CH_4) into the atmosphere. These gases trap heat and cause the planet to warm.
    - **Example:**
        - Cars, factories, and power plants emit CO_2, contributing to the warming of the Earth's surface.
2. **Deforestation:**
    - Cutting down forests reduces the Earth's ability to absorb CO_2. Trees act as carbon sinks, so their loss means more CO_2 remains in the atmosphere.
    - **Example:**
        - The Amazon Rainforest, often called the "lungs of the Earth," helps absorb CO_2. Deforestation in this area contributes to climate change.
3. **Industrial Agriculture:**
    - Agricultural practices, such as livestock farming, release methane and nitrous oxide, which are potent greenhouse gases.
    - **Example:**
        - Cattle farming produces methane, a greenhouse gas that is much more powerful than CO_2 in trapping heat.

Effects of Climate Change:

1. **Global Warming (Rising Temperatures):**
    - One of the most noticeable effects of climate change is the increase in average global temperatures.
    - **Example:**
        - In recent decades, many regions have experienced record-breaking heatwaves, affecting agriculture and human health.
2. **Melting Polar Ice and Glaciers:**
    - Rising global temperatures cause polar ice caps and glaciers to melt, leading to rising sea levels.
    - **Example:**
        - The Arctic and Antarctic ice sheets are melting, which contributes to rising sea levels and threatens coastal cities like Miami and Venice.
3. **Extreme Weather Events:**
    - Climate change increases the frequency and intensity of extreme weather events like hurricanes, droughts, and floods.

- **Example:**
  - The intensity of hurricanes, such as Hurricane Katrina (2005) and Hurricane Maria (2017), has been linked to warmer ocean temperatures caused by climate change.

4. **Ocean Acidification:**
   - Increased CO_2 in the atmosphere also dissolves into the oceans, making them more acidic. This harms marine life, especially coral reefs and shellfish.
   - **Example:**
     - Coral reefs, such as the Great Barrier Reef in Australia, are bleaching and dying due to warmer, more acidic oceans.
5. **Loss of Biodiversity:**
   - Climate change can disrupt ecosystems, leading to the extinction of species that cannot adapt to the changing environment.
   - **Example:**
     - Species like the polar bear are threatened by melting sea ice, which reduces their habitat and access to food.
6. **Rising Sea Levels:**
   - As polar ice melts and ocean waters warm, the volume of water in oceans increases, leading to rising sea levels that threaten coastal areas.
   - **Example:**
     - Low-lying islands, such as the Maldives, are at risk of disappearing due to rising sea levels.

Human Impacts of Climate Change:

1. **Agriculture:**
   - Changes in temperature and rainfall patterns can negatively affect crop yields and food security.
   - **Example:**
     - Droughts in areas like Africa have led to crop failures, increasing food shortages.
2. **Health Risks:**
   - Climate change can increase the spread of diseases, such as malaria and dengue, as warmer temperatures allow mosquitoes to thrive.
   - **Example:**
     - Warmer temperatures in places like India have increased the spread of mosquito-borne diseases.
3. **Displacement of Communities:**
   - Rising sea levels, extreme weather, and natural disasters force people to move from their homes, leading to climate refugees.
   - **Example:**
     - Communities in Bangladesh are being displaced due to rising sea levels and flooding.

Solutions to Mitigate Climate Change:

1. **Renewable Energy:**
    - Shifting to renewable energy sources like solar, wind, and hydroelectric power reduces greenhouse gas emissions.
    - **Example:**
        - Solar panels on homes or wind farms replace the need for fossil fuel-based electricity.
2. **Energy Efficiency:**
    - Improving energy efficiency in buildings, transportation, and industries reduces the overall consumption of energy.
    - **Example:**
        - LED light bulbs and electric cars use less energy and emit fewer pollutants.
3. **Reforestation and Afforestation:**
    - Planting trees and restoring forests can absorb more CO_2 from the atmosphere.
    - **Example:**
        - Large-scale reforestation projects in countries like China aim to restore degraded lands and increase carbon sequestration.
4. **Sustainable Agriculture:**
    - Implementing eco-friendly farming practices that reduce emissions and promote soil health.
    - **Example:**
        - Crop rotation and reduced use of synthetic fertilizers help decrease greenhouse gas emissions in agriculture.

Pollution and climate change.

Pollution and climate change are two major environmental issues that impact our planet and all forms of life.

1. Pollution

- Pollution is the introduction of harmful substances or contaminants into the environment, which can cause adverse effects on living organisms and ecosystems.
- **Types of Pollution**:
    - **Air Pollution**: Contaminants in the air, such as smoke, dust, and harmful gases (like carbon monoxide and sulfur dioxide) from vehicles and factories.
        - **Example**: Smog in cities like Los Angeles, caused by vehicle emissions and industrial discharges.
    - **Water Pollution**: Contamination of water bodies (rivers, lakes, oceans) due to chemicals, waste, and sewage.
        - **Example**: Oil spills, such as the Exxon Valdez spill in 1989, which severely harmed marine life.

    - **Soil Pollution**: Contamination of soil by hazardous waste, chemicals, or pesticides.
        - **Example**: The use of pesticides in agriculture can lead to soil pollution, affecting crops and local wildlife.
    - **Noise Pollution**: Excessive noise that can disrupt ecosystems and human life, caused by traffic, construction, and industrial activities.
        - **Example**: Noise from airplanes and trains can disturb wildlife habitats and affect human health.
- **Effects of Pollution**:
    - Harm to human health (respiratory diseases, cancers).
    - Damage to ecosystems (loss of biodiversity, disrupted food chains).
    - Climate change (increased greenhouse gases).

UNIT-2

Classification of plant kingdom.

The plant kingdom, also known as **Plantae**, includes all the plants on Earth. Plants are classified into different groups based on their characteristics, such as whether they have vascular tissues (tubes for transporting water and nutrients), seeds, and flowers. Here's a simplified breakdown of the plant kingdom classification:

1. Thallophyta (Algae)

- Simple, plant-like organisms without true roots, stems, or leaves. They are mostly aquatic and do not have vascular tissues.
- **Examples**: Green algae like *Spirogyra*, brown algae like *Fucus*, and red algae like *Polysiphonia*.

2. Bryophyta (Mosses and Liverworts)

- Small, green plants that grow in moist environments. They don't have true roots, stems, or leaves and lack vascular tissues.
- **Examples**: *Marchantia* (liverwort) and *Funaria* (a type of moss).

3. Pteridophyta (Ferns)

- Have vascular tissues (xylem and phloem) but do not produce seeds. They reproduce through spores and have true roots, stems, and leaves.
- **Examples**: *Dryopteris* (a type of fern) and *Equisetum* (also called horsetail).

4. Gymnosperms (Conifers)

- Seed-producing plants that do not have flowers or fruits. Seeds are “naked” (not enclosed in a fruit) and usually found on cones. They have vascular tissues.
- **Examples**: Pine trees (*Pinus*), fir trees (*Abies*), and cycads (*Cycas*).

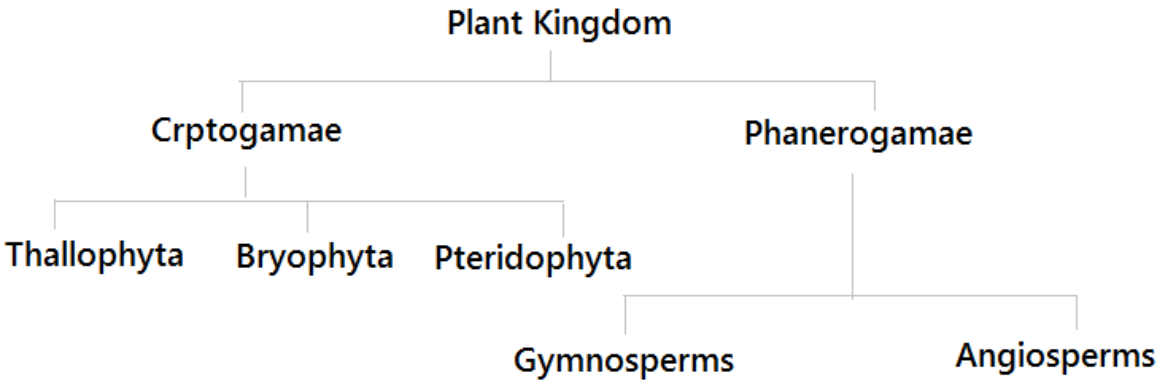
5. Angiosperms (Flowering Plants)

- Seed-producing plants with flowers and fruits. Seeds are enclosed in a fruit. Angiosperms have well-developed vascular tissues and are the most diverse group of plants.
- **Examples**:
  - *Monocots* (one seed leaf): Rice, wheat, grass.
  - *Dicots* (two seed leaves): Roses, sunflowers, mango trees.

Summary Table

Group	Main Features	Examples
Thallophyta	No roots, stems, or leaves; aquatic	*Spirogyra*, *Fucus*
Bryophyta	No roots, stems, or leaves; moist areas	*Marchantia*, *Funaria*
Pteridophyta	Vascular tissues, spores, no seeds	*Dryopteris*, *Equisetum*
Gymnosperms	Vascular tissues, seeds in cones, no flowers	*Pinus*, *Cycas*
Angiosperms	Vascular tissues, flowers, seeds in fruits	Rice, mango, sunflower

This classification helps scientists and students understand plant diversity and evolutionary relationships within the plant kingdom.



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Plant physiological processes (Photosynthesis, Respiration, Transpiration, phytohormones)

Photosynthesis

Definition:
Photosynthesis is the process by which green plants, algae, and some bacteria use sunlight to make their food (glucose) from carbon dioxide and water. Oxygen is released as a byproduct.

Steps of Photosynthesis:

1. **Light-dependent Reactions (in the thylakoid membranes):**
    - Sunlight is absorbed by chlorophyll.
    - Water is split into oxygen, protons, and electrons.
    - Energy is captured in molecules called ATP and NADPH.
    - **Output:** Oxygen (O_2) and energy carriers (ATP, NADPH).
2. **Light-independent Reactions (Calvin Cycle, in the stroma):**
    - ATP and NADPH from the light-dependent stage are used.
    - Carbon dioxide (CO_2) is converted into glucose.
    - **Output:** Glucose ($C_6H_{12}O_6$).

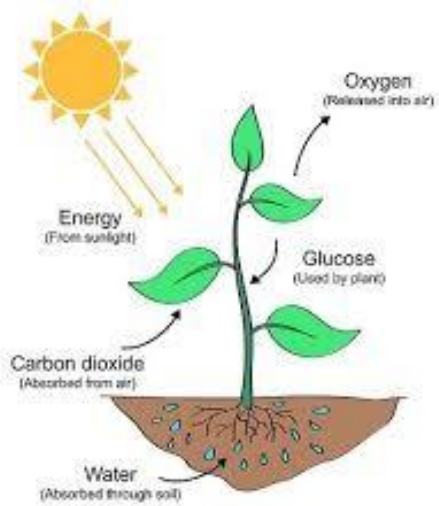
Importance of Photosynthesis:

- **Food Production:** Provides energy in the form of glucose for plants and animals.
- **Oxygen Release:** Supplies oxygen for respiration in living organisms.
- **Ecosystem Balance:** Maintains CO_2 and O_2 levels in the atmosphere.
- **Foundation of Life:** Forms the base of food chains as plants are primary producers.

Examples:

- **Trees:** Provide oxygen and food through photosynthesis.
- **Crops:** Plants like wheat and rice use photosynthesis to grow.
- **Aquatic Plants:** Oxygenate water bodies for fish and other organisms.

Equation:



RESPIRATION

Respiration is the biological process in which organisms break down glucose (or other food molecules) to release energy. This energy is stored in the form of ATP (adenosine triphosphate), which powers various cellular activities.

Types of Respiration

1. Aerobic Respiration - Respiration that occurs in the presence of oxygen.

- **Equation:**

$$C_6H_{12}O_6 + 6O_2 \xrightarrow{\text{Cellular respiration}} 6CO_2 + 6H_2O + ATP$$

- (*Glucose* + *Oxygen* → *Carbon dioxide* + *Water* + *Energy*)
- It occurs In the mitochondria of cells.
- **Examples:**
  - Humans and animals use aerobic respiration to generate energy for daily activities.

2. Anaerobic Respiration

- Respiration that occurs without oxygen, producing less energy than aerobic respiration.
- **Equation :**
  (*Glucose* → *Lactic Acid* + *Energy*)
- It occurs In the cytoplasm of cells.
- **Examples:**
  - **In humans:** During intense exercise, muscles switch to anaerobic respiration, leading to lactic acid buildup (causing cramps).
  - **In yeast:** Anaerobic respiration (fermentation) produces alcohol and carbon dioxide, used in baking and brewing.

Stages of Aerobic Respiration:

1. **Glycolysis (in the cytoplasm):**
    - Glucose is broken into pyruvate, producing some ATP and NADH.
2. **Krebs Cycle (in mitochondria):**
    - Pyruvate is further broken down, releasing CO_2 and producing more energy carriers.
3. **Electron Transport Chain (in mitochondria):**
    - Energy carriers are used to produce a large amount of ATP.

Importance of Respiration:

1. **Energy Production:** Provides energy for all cellular processes like movement, growth, and repair.
2. **Waste Elimination:** Removes byproducts like carbon dioxide and water.
3. **Survival:** Enables all living organisms to maintain life processes.

Examples in Daily Life:

- **Breathing** provides oxygen for aerobic respiration.
- **Exercise** leads to anaerobic respiration in muscles.
- **Baking Bread:** Yeast undergoes anaerobic respiration, releasing CO_2 to make bread rise.
- **Alcohol Production:** Fermentation by yeast produces alcohol in beer and wine.

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TRANSPIRATION

Transpiration is the process by which plants lose water vapor from their aerial parts, especially through tiny pores called stomata on leaves. This process helps in water and nutrient transport and cooling the plant.

Types of Transpiration:

1. **Stomatal Transpiration:**
    - Occurs through stomata, which are small openings on leaves.
    - Accounts for the majority of water loss in plants.
    - **Example:** Evaporation of water from the leaves of a mango tree.
2. **Cuticular Transpiration:**
    - Happens through the waxy layer (cuticle) covering the leaves.
    - Less significant compared to stomatal transpiration.
    - **Example:** Water loss from the surface of cactus leaves.
3. **Lenticular Transpiration:**
    - Occurs through small openings called lenticels on stems and branches.
    - **Example:** Water vapor escapes from the stems of apple trees.

Factors Affecting Transpiration:

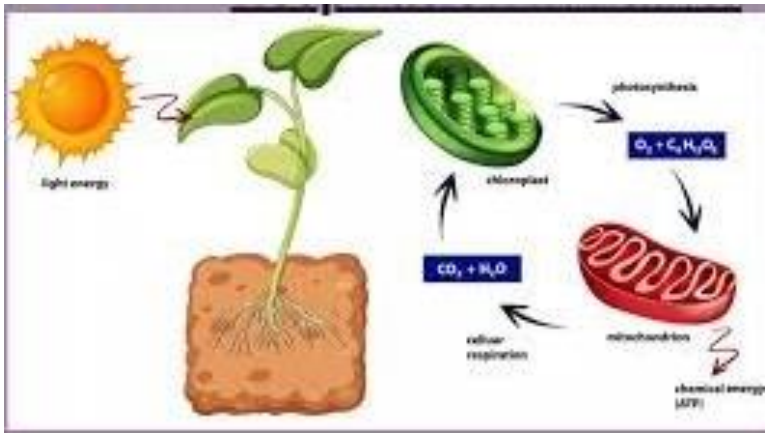
1. **Environmental Factors:**
    - **Temperature:** Higher temperatures increase transpiration.
    - **Humidity:** High humidity reduces transpiration, while dry air increases it.
    - **Wind:** Wind removes water vapor, enhancing transpiration.
    - **Light:** More light opens stomata, increasing transpiration.
2. **Plant Factors:**
    - Number of stomata.
    - Size and thickness of leaves.

Functions/Importance of Transpiration:

1. **Water Movement:**
    - Pulls water and nutrients from the roots to leaves through the xylem.
2. **Cooling Effect:**
    - Evaporation of water cools the plant, preventing overheating.
3. **Maintaining Turgidity:**
    - Helps maintain cell turgor for proper functioning and growth.
4. **Photosynthesis Support:**
    - Keeps water supply constant for photosynthesis.

Examples :

- **It provides Cooling Shade**.
- **Wilting of Plants**:



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Phytohormones (Plant Hormones)

Phytohormones are naturally occurring chemicals in plants that regulate growth, development, and responses to environmental stimuli. They play crucial roles in plant processes such as germination, flowering, fruit ripening, and stress responses.

1. Auxins

- **Functions**:
  - Promote cell elongation in stems and roots.
  - Stimulate apical dominance (suppresses growth of lateral buds).
  - Involved in phototropism (growth towards light) and geotropism (growth in response to gravity).
  - Help in root initiation and development.
- **Examples**:
  - **Indole-3-acetic acid (IAA)**: A naturally occurring auxin.
  - **Indole-3-butyric acid (IBA)**: Used for root formation in plant cuttings.

2. Gibberellins

- **Functions**:
  - Promote stem elongation and cell division.
  - Stimulate seed germination and breaking of seed dormancy.
  - Induce flowering in certain plants and increase fruit size (e.g., in grapes).
- **Examples**:
  - **Gibberellic acid (GA3)**: Widely used in agriculture to enhance crop growth and yield.

3. Cytokinins

- **Functions**:
  - Promote cell division (cytokinesis) and delay leaf senescence (aging).

    - Work with auxins to regulate organ formation (e.g., shoot and root growth).
    - Help in nutrient mobilization within plants.
- **Examples**:
    - **Zeatin**: A natural cytokinin found in maize and other plants.
    - **Kinetin**: A synthetic cytokinin used in tissue culture.

4. Abscisic Acid (ABA)

- **Functions**:
    - Acts as a growth inhibitor by inducing dormancy in seeds and buds.
    - Promotes stomatal closure during water stress.
    - Helps plants cope with environmental stress (e.g., drought and salinity).
- **Examples**:
    - **Abscisic Acid (ABA)**: Found naturally in plants; no synthetic forms are commonly used.

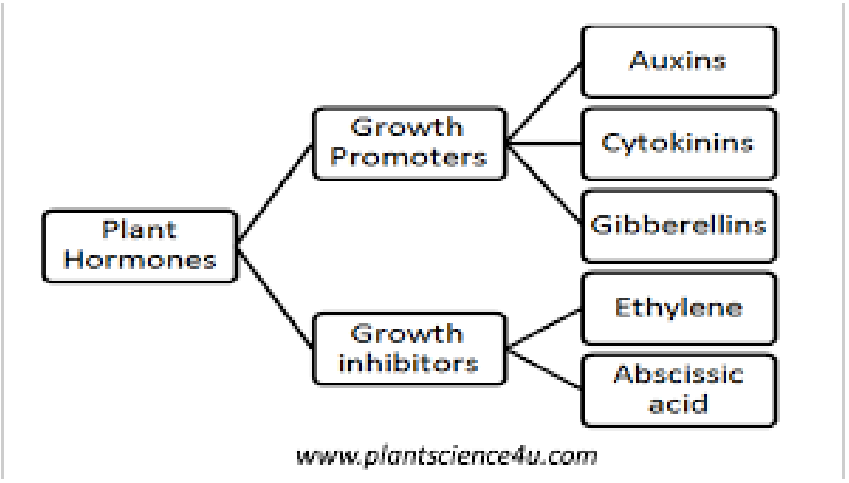
5. Ethylene

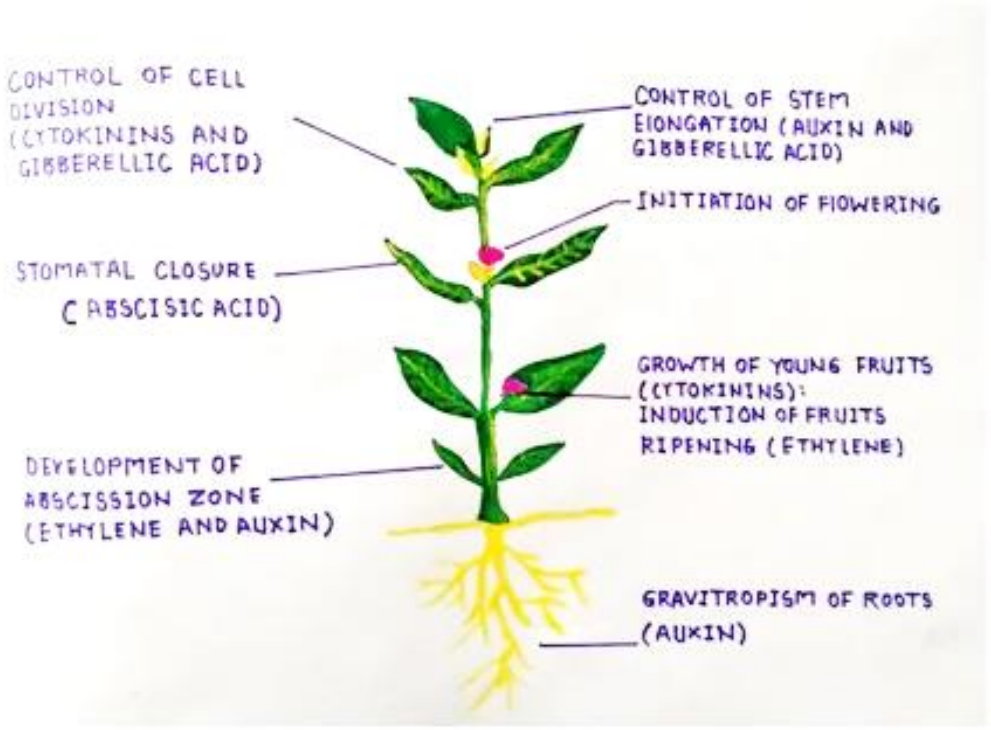
- **Functions**:
    - Promotes fruit ripening (e.g., bananas and tomatoes).
    - Stimulates leaf and flower senescence and abscission.
    - Enhances resistance to stress conditions.
- **Examples**:
    - **Ethylene (C_2H_4)**: A gaseous hormone naturally produced in plants.
    - **Ethephon**: A synthetic compound releasing ethylene, used to ripen fruits.

Applications of Plant Hormones

- **Agriculture**:
    - Auxins for weed control and rooting in cuttings.
    - Gibberellins to increase fruit size and break dormancy.
- **Horticulture**:
    - Cytokinins to delay aging in cut flowers.
    - Ethylene to ripen fruits artificially.
- **Tissue Culture**:
    - Balanced use of auxins and cytokinins for organogenesis.

These hormones are essential for plant growth regulation and have diverse agricultural and research applications.





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Structure of flower – Micro and macro sporogenesis, pollination, fertilization and structure of mono and dicot embryos .

Structure of a Flower

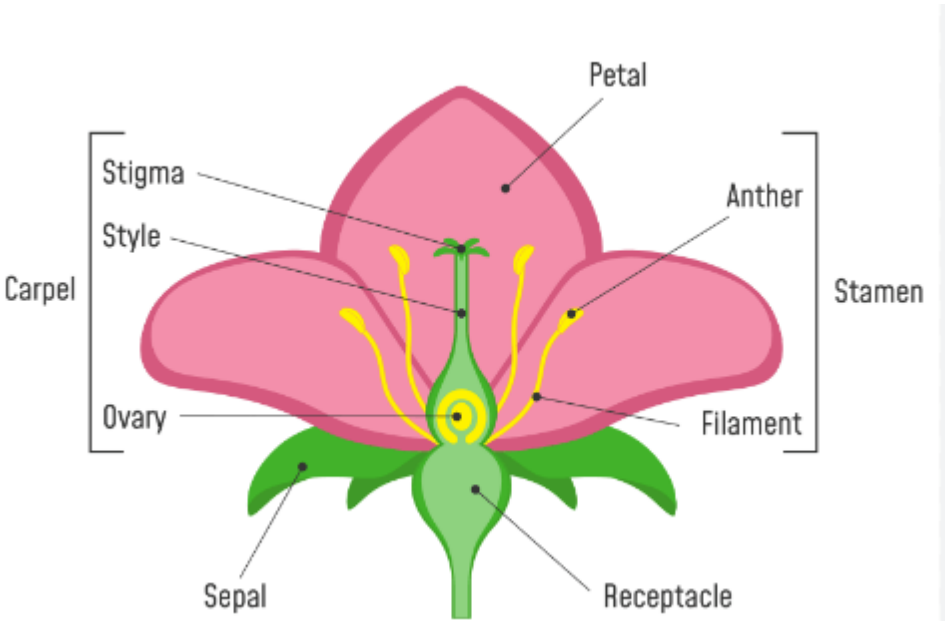
A flower has several parts that help it reproduce. These parts are divided into male and female structures:

- **Male part (Stamen)**: Consists of the anther (where pollen is made) and filament (supports the anther).

- **Female part (Pistil/Carpel)**: Includes the stigma (where pollen lands), style (a tube that connects stigma to the ovary), and ovary (contains ovules that develop into seeds).
- **Other parts**: Petals (attract pollinators) and sepals (protect the bud).

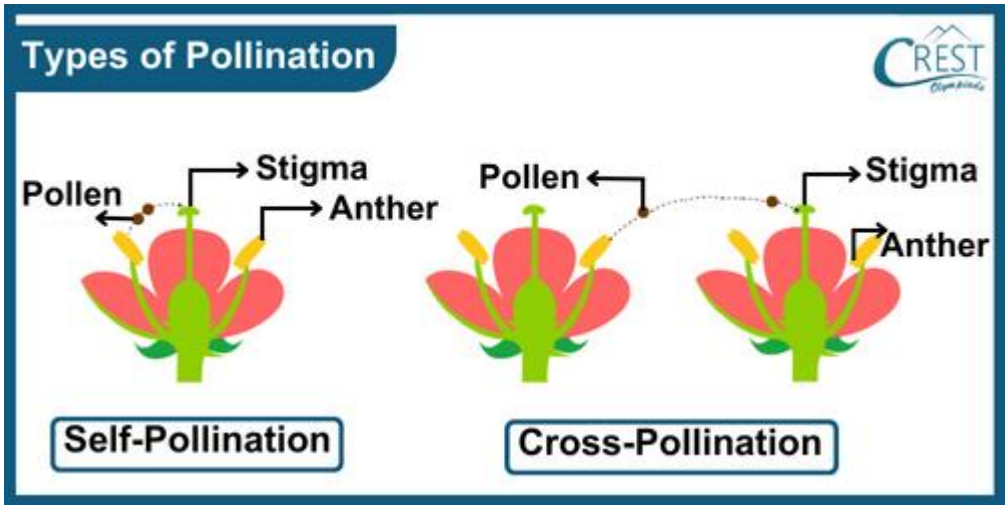
Microsporogenesis and Megasporogenesis

1. **Microsporogenesis** (formation of pollen):
    - This process occurs in the anther, where cells divide to form pollen grains (the male reproductive cells).
    - Inside the anther, special cells called **microspore mother cells** undergo meiosis (cell division) to produce **microspores**, which eventually become pollen grains.
    - **Example**: In flowers like lilies, pollen grains carry male genetic material to the stigma.
2. **Megasporogenesis** (formation of ovules):
    - This process happens in the ovary of the flower, where female reproductive cells (ovules) are formed.
    - Within each ovule, a **megaspore mother cell** divides by meiosis to produce four cells, but only one survives as the **megaspore**. This megaspore divides to form an **embryo sac** with the egg cell inside.
    - **Example**: In a rose flower, each ovule can develop into a seed after fertilization.



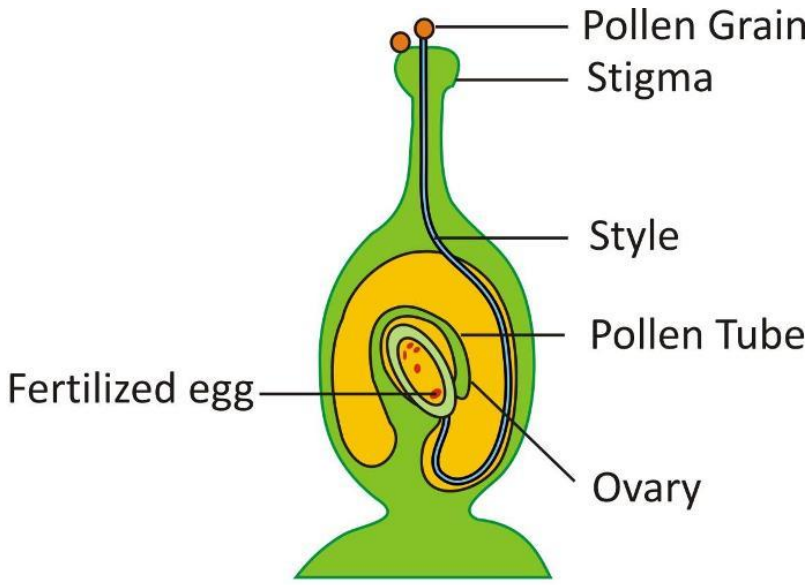
Pollination

- The transfer of pollen from the anther (male part) to the stigma (female part) of a flower. This can happen within the same flower (self-pollination) or between different flowers (cross-pollination).
- **Types of pollination**:
  - **Self-pollination**: Pollen from the same flower lands on its own stigma. **Example**: Pea plants.
  - **Cross-pollination**: Pollen from one flower lands on a different flower's stigma, usually carried by wind, insects, or animals. **Example**: Apple trees rely on bees for pollination.



Fertilization

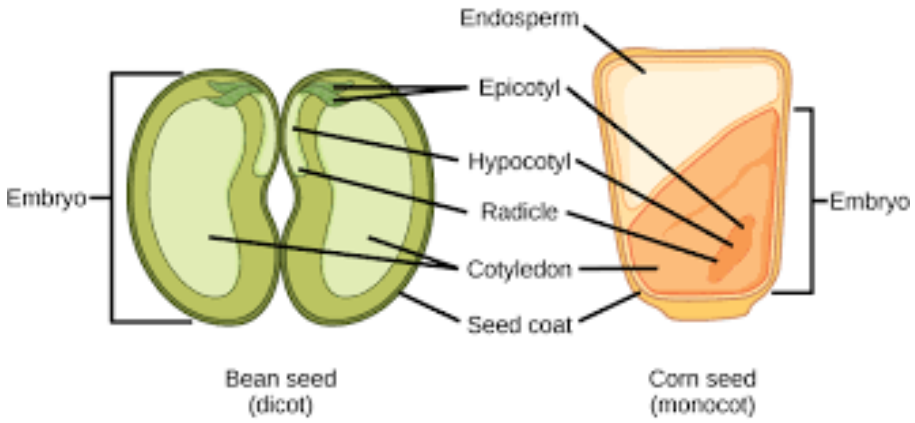
- The process where the male gamete (sperm cell in the pollen) fuses with the female gamete (egg cell in the ovule) to form a zygote, which will grow into a seed.
- After pollination, the pollen grain germinates on the stigma and grows a tube down the style toward the ovary. The male gamete travels through this pollen tube and reaches the egg cell in the ovule. They fuse to form a **zygote**.
- **Example**: In sunflowers, once the pollen reaches the ovule and fertilization occurs, seeds start to form.



Fertilization in a flowering plant

Structure of Monocot and Dicot Embryos

- **Monocot Embryo** (one seed leaf):
  - Monocots, like grasses and lilies, have embryos with a single cotyledon (seed leaf).
  - Their embryo structure includes a **coleoptile** (protects the shoot) and **coleorhiza** (protects the root).
  - **Example**: Corn seeds have a monocot embryo that develops into a single-leaf seedling.
- **Dicot Embryo** (two seed leaves):
  - Dicots, like beans and sunflowers, have embryos with two cotyledons.
  - The embryo structure includes a **plumule** (develops into the shoot) and **radicle** (develops into the root).
  - **Example**: A bean seed has a dicot embryo that sprouts with two leaves initially.



Summary Table

Process	Purpose	Key Example
Microsporogenesis	Formation of pollen grains	Lily flowers producing pollen
Megasporogenesis	Formation of ovules in the ovary	Rose flower ovules
Pollination	Transfer of pollen to stigma	Bees pollinating apple flowers
Fertilization	Fusion of male & female gametes	Sunflower seed formation
Monocot Embryo	Single seed leaf	Corn seed
Dicot Embryo	Two seed leaves	Bean seed

These processes ensure that flowers can produce seeds, leading to the growth of new plants. This is crucial for the survival and reproduction of plant species.

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MUSHROOM CULTIVATION, FLORICULTURE, LANDSCAPING

These are important agricultural practices that contribute to food production, aesthetic beauty, and economic growth.

1. Mushroom Cultivation

The process of growing edible mushrooms for food and medicinal purposes.

Process:

1. **Selection of Mushroom:** Common types include **Button mushrooms**, **Oyster mushrooms**, and **Shiitake mushrooms**.
2. **Substrate Preparation:** Mushrooms are grown on materials like straw, sawdust, or compost.

3. **Inoculation:** Adding mushroom spores (seeds) to the prepared substrate.
4. **Growth Conditions:** Maintaining proper temperature, humidity, and darkness for growth.
5. **Harvesting:** Mushrooms are ready for harvest in a few weeks.

Examples:

- **Button Mushrooms:** Used in pizzas, soups, and salads.
- **Medicinal Mushrooms:** Shiitake mushrooms boost immunity.

Benefits:

- Provides a nutritious food source rich in protein and vitamins.
- Easy to cultivate on a small scale for home or commercial use.

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2. Floriculture

The cultivation of flowering and ornamental plants for gardens, decoration, and the floral industry.

How It Works:

1. **Plant Selection:** Flowers like roses, marigolds, and lilies are commonly grown.
2. **Care:** Plants are grown under controlled conditions in gardens, greenhouses, or fields.
3. **Harvesting:** Flowers are collected at the right stage for sale or use.

Examples:

- **Bouquet Flowers:** Roses and carnations for gifting.
- **Marigolds:** Widely used in festivals and religious ceremonies.
- **Indoor Plants:** Orchids and peace lilies for homes.

Benefits:

- Boosts the economy through the sale of flowers and ornamental plants.
- Adds aesthetic value to homes, offices, and public spaces.

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3. Landscaping

The design and arrangement of outdoor spaces to enhance natural beauty and functionality.

Process:

1. **Planning:** Designing gardens, parks, or outdoor areas.
2. **Plant Selection:** Choosing plants suited to the environment and aesthetics.

3. **Implementation:** Arranging plants, pathways, water features, and other elements.

Examples:

- **Gardens:** Creating flower beds and lawns in homes or parks.
- **Corporate Landscaping:** Green spaces around offices to improve the environment.
- **Public Spaces:** Designing parks with trees, benches, and fountains.

Benefits:

- Improves air quality and reduces heat in urban areas.
- Enhances mental well-being through access to green spaces.
- Increases property value.

Simple Summary:

- **Mushroom Cultivation:** Growing edible mushrooms for food and health benefits (*e.g., button mushrooms in pizzas*).
- **Floriculture:** Growing flowers and ornamental plants for beauty and commercial purposes (*e.g., roses for bouquets, marigolds for festivals*).
- **Landscaping:** Designing outdoor spaces for beauty and functionality (*e.g., home gardens, public parks*).

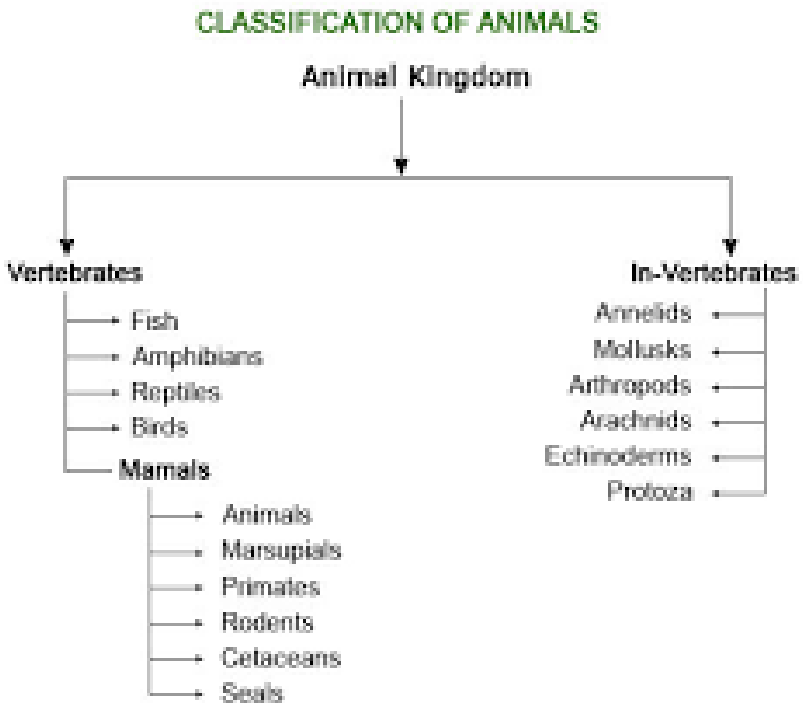
UNIT-3

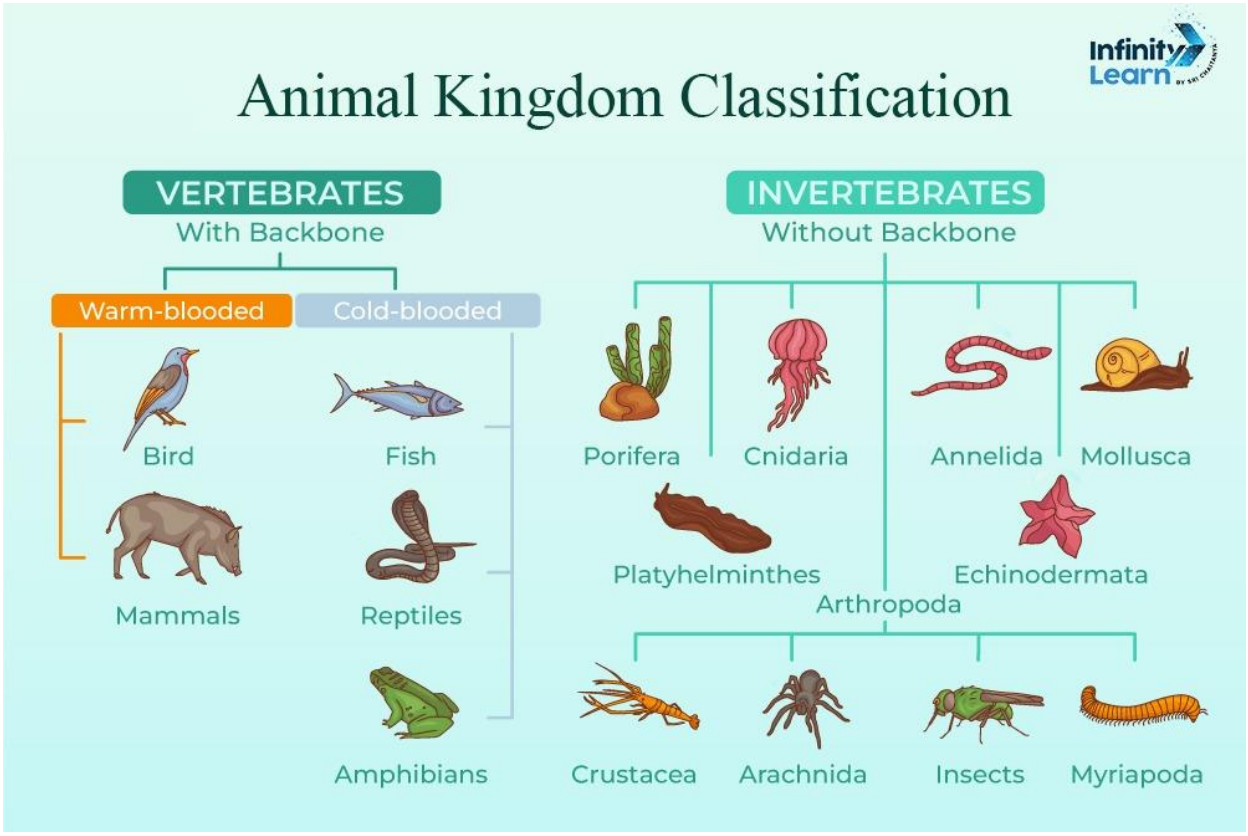
The classification of Kingdom Animalia and chordata

The animal kingdom, **Kingdom Animalia**, includes all animals on Earth. Animals are classified based on characteristics like body structure, presence of a backbone, and complexity of their systems.

Classification of Kingdom Animalia

1. **Porifera (Sponges)**
    - Simple, porous body structure; no tissues or organs.
    - **Examples**: *Sycon*, *Spongilla*.
2. **Cnidaria (Jellyfish and Corals)**
    - Aquatic, have stinging cells called cnidocytes, radial symmetry.
    - **Examples**: *Hydra*, *Jellyfish*.
3. **Platyhelminthes (Flatworms)**
    - Flat, unsegmented bodies; many are parasitic.
    - **Examples**: *Planaria*, *Tapeworm*.
4. **Nematoda (Roundworms)**
    - Round, unsegmented bodies; some are free-living, others are parasitic.
    - **Examples**: *Ascaris*, *Hookworm*.
5. **Annelida (Segmented Worms)**
    - Segmented, cylindrical bodies with a true body cavity.
    - **Examples**: *Earthworm*, *Leech*.
6. **Arthropoda (Insects, Spiders, Crabs)**
    - Jointed legs, segmented body, exoskeleton.
    - **Examples**: *Butterfly*, *Spider*, *Crab*.
7. **Mollusca (Soft-bodied Animals)**
    - Soft body, many have a shell.
    - **Examples**: *Snail*, *Octopus*, *Clam*.
8. **Echinodermata (Sea Stars and Sea Urchins)**
    - Marine animals with spiny skin and radial symmetry.
    - **Examples**: *Starfish*, *Sea Urchin*.
9. **Chordata (Animals with a Notochord)**
    - Have a notochord (a flexible rod that supports the body) at some stage in their life.
    - **Examples**: Humans, fish, frogs (discussed further below).





Classification of Phylum Chordata

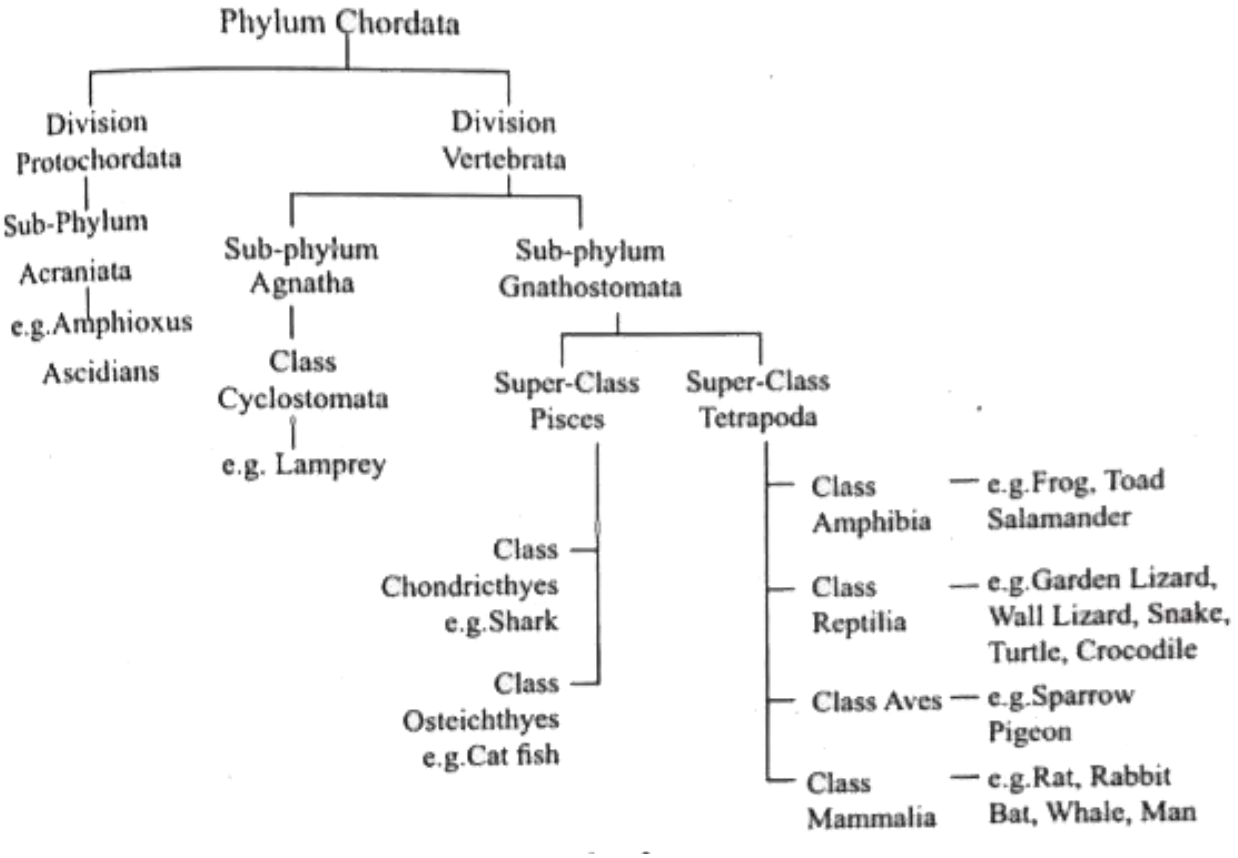
Chordates are animals with a **notochord** (a precursor to the backbone in vertebrates), a dorsal nerve cord, pharyngeal slits, and a post-anal tail at some stage in development.

Major Classes of Chordates:

1. **Pisces (Fishes)**

- Aquatic, have gills, scales, and fins.
- **Examples**: *Shark*, *Goldfish*, *Salmon*.

2. **Amphibia (Amphibians)**
   - Live both in water and on land, breathe through lungs or skin, have moist skin.
   - **Examples**: *Frog*, *Salamander*.
3. **Reptilia (Reptiles)**
   - Dry, scaly skin, lay eggs on land, mostly cold-blooded.
   - **Examples**: *Snake*, *Lizard*, *Crocodile*.
4. **Aves (Birds)**
   - Feathers, beaks, lay eggs, warm-blooded.
   - **Examples**: *Eagle*, *Sparrow*, *Penguin*.
5. **Mammalia (Mammals)**
   - Warm-blooded, have hair or fur, produce milk for young.
   - **Examples**: *Human, Tiger, Whale*.



Summary Table

Group	Characteristics	Examples
Porifera	Simple, porous body	*Sycon*, *Spongilla*
Cnidaria	Stinging cells, radial symmetry	*Hydra*, *Jellyfish*

Group	Characteristics	Examples
Platyhelminthes	Flat bodies, often parasitic	*Planaria*, *Tapeworm*
Nematoda	Round bodies, some parasitic	*Ascaris*, *Hookworm*
Annelida	Segmented worms with body cavity	*Earthworm*, *Leech*
Arthropoda	Jointed legs, exoskeleton	*Butterfly*, *Crab*
Mollusca	Soft bodies, often with a shell	*Snail*, *Octopus*
Echinodermata	Spiny skin, radial symmetry	*Starfish*, *Sea Urchin*
Chordata	Notochord, dorsal nerve cord	Humans, fish, frogs
Pisces	Aquatic, have gills and scales	*Shark*, *Goldfish*
Amphibia	Moist skin, live on land and in water	*Frog*, *Salamander*
Reptilia	Scaly skin, lay eggs on land	*Snake*, *Crocodile*
Aves	Feathers, beaks, warm-blooded	*Eagle*, *Penguin*
Mammalia	Hair/fur, warm-blooded, produce milk	*Human*, *Tiger*

This classification helps us understand the diversity of animals and how they are related based on physical traits and evolutionary history.

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Animal Physiology – Basics of Organ Systems & their functions, Hormones and Disorders

Animal physiology is the study of how animal bodies function, including their organ systems, hormones, and common disorders.

1. Organ Systems and Their Functions

1. **Digestive System**
   - Breaks down food into nutrients and absorbs them into the body.
   - **Main Parts**: Mouth, esophagus, stomach, intestines, liver, pancreas.
   - **Example**: In humans, the stomach produces acids and enzymes to digest food, and nutrients are absorbed in the intestines.
2. **Respiratory System**
   - Supplies oxygen to the body and removes carbon dioxide.
   - **Main Parts**: Nose, trachea, lungs.
   - **Example**: In mammals, lungs take in oxygen when we inhale and release carbon dioxide when we exhale.
3. **Circulatory System**
   - Transports oxygen, nutrients, and waste throughout the body.
   - **Main Parts**: Heart, blood vessels (arteries, veins, capillaries), blood.

- **Example**: The human heart pumps oxygen-rich blood to body cells and carries back waste products.

4. **Excretory System**
   - Removes waste products from the body.
   - **Main Parts**: Kidneys, ureters, bladder, urethra.
   - **Example**: Kidneys filter blood to remove wastes, which are excreted as urine.
5. **Nervous System**
   - Controls and coordinates body activities by transmitting signals.
   - **Main Parts**: Brain, spinal cord, nerves.
   - **Example**: The human brain processes information and sends instructions to muscles for movement.
6. **Endocrine System**
   - Regulates body processes through hormones (chemical messengers).
   - **Main Parts**: Glands like the pituitary, thyroid, adrenal glands, pancreas.
   - **Example**: The pancreas releases insulin to help control blood sugar levels.
7. **Reproductive System**
   - Allows animals to produce offspring.
   - **Main Parts**: Male and female reproductive organs (testes in males, ovaries in females).
   - **Example**: In mammals, females produce eggs and males produce sperm for reproduction.
8. **Skeletal and Muscular Systems**
   - Provides structure, supports the body, and enables movement.
   - **Main Parts**: Bones, muscles, tendons, and ligaments.
   - **Example**: In humans, bones support our body, and muscles attached to bones allow us to move.

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2. Hormones and Their Functions

Hormones are chemical messengers produced by glands and regulate various bodily functions.

1. **Insulin**
   - **Produced by**: Pancreas.
   - Helps regulate blood sugar levels.
   - **Disorder**: Diabetes (when the body doesn't produce enough insulin or use it properly).
2. **Thyroxine**
   - **Produced by**: Thyroid gland.
   - Regulates metabolism (the process of energy use in the body).

- **Disorder**: Hypothyroidism (low thyroid hormone levels, causing fatigue) or Hyperthyroidism (high levels, causing weight loss).

3. **Adrenaline**
   - **Produced by**: Adrenal glands.
   - Prepares the body for "fight or flight" in stressful situations.
   - **Example**: When we're scared, adrenaline increases heart rate and energy levels.
4. **Growth Hormone**
   - **Produced by**: Pituitary gland.
   - Stimulates growth and cell reproduction.
   - **Disorder**: Gigantism (overproduction, leading to excessive growth) or Dwarfism (underproduction, leading to stunted growth).
5. **Estrogen and Testosterone**
   - **Produced by**: Ovaries in females (estrogen), testes in males (testosterone).
   - Regulate development of reproductive organs and secondary sexual characteristics.
   - **Example**: Estrogen helps regulate the menstrual cycle in females; testosterone affects muscle and bone growth in males.

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3. Common Disorders and Conditions

1. **Diabetes**
   - **Cause**: Insufficient insulin production or response, leading to high blood sugar.
   - **Symptoms**: Increased thirst, frequent urination, fatigue.
   - **Example**: Type 1 diabetes requires insulin injections to manage blood sugar levels.
2. **Asthma**
   - **Cause**: Narrowing of airways due to inflammation, often triggered by allergens or exercise.
   - **Symptoms**: Difficulty breathing, wheezing.
   - **Example**: Inhalers are commonly used to open up airways during an asthma attack.
3. **Hypertension (High Blood Pressure)**
   - **Cause**: Often due to lifestyle factors like diet, stress, or genetics.
   - **Symptoms**: Generally no symptoms, but long-term hypertension can lead to heart disease.
   - **Example**: Regular exercise and a balanced diet can help manage blood pressure.
4. **Osteoporosis**
   - **Cause**: Weakening of bones, often due to aging or lack of calcium.
   - **Symptoms**: Increased risk of fractures.

- **Example**: Weight-bearing exercise and calcium intake help strengthen bones.

Summary Table

System/Function	Purpose	Key Example
Digestive System	Breaks down and absorbs nutrients	Stomach and intestines digest food
Respiratory System	Supplies oxygen, removes carbon dioxide	Lungs exchange gases
Circulatory System	Transports oxygen and nutrients	Heart pumps blood
Endocrine System	Regulates via hormones	Insulin from pancreas regulates blood sugar
Nervous System	Controls body actions, responses	Brain processes and sends signals
Hormones (e.g., Insulin)	Chemical messengers regulating functions	Insulin controls blood sugar
Common Disorder (e.g., Diabetes)	Condition due to hormonal imbalance	Requires insulin management

Understanding these basics helps explain how the body works, keeps balanced, and reacts to health conditions.

****

Developmental Biology – Basic process of development (Gametogenesis, Fertilization, Cleavage and Organogenesis).

Developmental biology studies how living organisms grow and develop from a single cell to a fully formed organism. Here's an overview of the basic steps in development in simple terms:

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1. Gametogenesis

- The process by which organisms produce specialized cells called **gametes** (sperm and egg cells) used in reproduction.
- Process

    - **In males**: Gametogenesis is called **spermatogenesis**, where sperm cells are produced in the testes.
    - **In females**: Gametogenesis is called **oogenesis**, where egg cells (ova) are produced in the ovaries.
- **Example**: In humans, spermatogenesis produces millions of sperm cells daily, while oogenesis releases one egg cell per menstrual cycle.

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2. Fertilization

- The process where a sperm cell fuses with an egg cell to form a **zygote** (fertilized egg), which marks the beginning of a new organism.
- Process:
    - **Sperm meets egg**: When sperm reaches the egg, it penetrates the egg membrane and fuses with the egg's nucleus.
    - **Formation of zygote**: The fusion combines genetic material from both parents, forming a single cell with a complete set of DNA.
- **Example**: In frogs, fertilization occurs externally in water when the male releases sperm over eggs laid by the female.

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3. Cleavage

- The early cell divisions of the fertilized egg (zygote) that increase the cell number without increasing the size of the embryo.
- Process:
    - **Rapid division**: The zygote divides rapidly into smaller cells called **blastomeres**.
    - **Formation of a ball of cells**: These divisions continue until a cluster of cells, known as a **morula**, forms. Eventually, it becomes a hollow structure called a **blastula**.
- **Example**: In sea urchins, cleavage divides the zygote quickly to form a ball of cells, which will later develop into an embryo.

---

4. Organogenesis

- The process by which cells in the developing embryo differentiate (specialize) to form organs and tissues.
- Process:

- **Formation of germ layers**: Cells organize into three main layers—**ectoderm**, **mesoderm**, and **endoderm**—each giving rise to different organs.
- **Differentiation**: These layers develop into specific organs. For example:
  - **Ectoderm** forms the skin and nervous system.
  - **Mesoderm** forms muscles, bones, and the circulatory system.
  - **Endoderm** forms the digestive and respiratory systems.

- **Example**: In chicks, organogenesis includes forming the heart, limbs, and brain as the embryo grows within the egg.

Summary Table

Process	Purpose	Key Example
Gametogenesis	Formation of sperm and egg cells	Spermatogenesis in human males
Fertilization	Fusion of sperm and egg to form a zygote	Frog fertilization in water
Cleavage	Rapid cell division of the zygote	Sea urchin cleavage to blastula
Organogenesis	Formation of organs and tissues	Heart formation in chick embryo

These processes explain how a single cell (zygote) gradually becomes a complex organism with specialized cells, tissues, and organs. Each step is essential for the development of life.

****

Economic Zoology – Sericulture, Apiculture, Aquaculture

Economic Zoology is the branch of zoology that studies animals which are beneficial to humans. It focuses on the management and cultivation of these animals for economic purposes, such as producing food, materials, and other products.

1. Sericulture (Silk Farming)

Sericulture is the practice of breeding and raising silkworms to produce silk.

- **Silkworms:** The main insect used is the **Bombyx mori**.
- **Process:**
  1. **Eggs:** Silkworm eggs are hatched into larvae.
  2. **Feeding:** Larvae feed on mulberry leaves.
  3. **Cocoon Formation:** After several molts, silkworms spin cocoons made of silk threads.
  4. **Harvesting Silk:** Cocoons are boiled to unravel the silk fibers.

Examples:

- **Silk Fabric:** Used to make luxurious clothing like Silk sarees, scarves and dresses.
- **Silk Products:** Includes silk ties, bed linens, and upholstery.

Benefits:

- Provides high-quality natural fiber.
- Supports livelihoods in regions like India and China.

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2. Apiculture (Beekeeping)

Apiculture is the management and cultivation of honeybees to produce honey and other bee products.

- **Bees:** The main species used is the **Apis mellifera** (Western honeybee).
- **Process:**
    1. **Hive Setup:** Beekeepers provide hives for bees to live in.
    2. **Care:** Regular maintenance includes checking for diseases and ensuring bees have enough food.
    3. **Honey Harvesting:** Bees collect nectar, convert it to honey, and store it in the hive. Beekeepers extract the honey.

Examples:

- **Honey:** Used as a natural sweetener in food and beverages.
- **Beeswax:** Used in candles, cosmetics, and as a sealing agent.
- **Propolis:** Used in health supplements and natural remedies.
- **Pollination Services:** Bees help pollinate crops, increasing agricultural yields.

Benefits:

- Produces valuable products like honey and beeswax.
- Enhances crop production through pollination.

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3. Aquaculture (Fish Farming)

Aquaculture is the breeding, raising, and harvesting of fish, shellfish, and other aquatic organisms in controlled environments.

- **Environments:** Can be practiced in freshwater, saltwater, ponds, tanks, or ocean cages.
- **Process:**
    1. **Breeding:** Selecting and breeding fish species suitable for farming.
    2. **Raising:** Providing optimal conditions for growth, including water quality and feeding.
    3. **Harvesting:** Collecting mature fish for sale or consumption.

Examples:

- **Fish:** Salmon, tilapia, and catfish are commonly farmed.

- **Shellfish:** Shrimp, oysters, and mussels.
- **Aquatic Plants:** Such as algae for food supplements.

Benefits:

- Provides a steady supply of seafood, reducing pressure on wild fish populations.
- Supports the economy through job creation and export opportunities.

Simple Summary

- **Sericulture:** Raising silkworms to produce silk for fabrics and products.
  Example: Making silk scarves.
- **Apiculture:** Managing honeybees to produce honey, beeswax, and pollinate crops.
  Example: Harvesting honey and using bees for pollinating fruit trees.
- **Aquaculture:** Farming fish and other aquatic organisms for food and products.
  Example: Raising salmon in fish farms for grocery stores.

UNIT-4

1.Compare the Ultrastructure of Prokaryotic and Eukaryotic Cells

Prokaryotic Cells:

Prokaryotic cells are simple, single-celled organisms that lack a true nucleus and membrane-bound organelles. The DNA in prokaryotes is free-floating inthe cytoplasm in a region called the nucleoid.

Key Features:

- Lack a true nucleus
- No membrane-bound organelles
- Single, circular DNA molecule
- Reproduce by binary fission

Examples:

- **Bacteria** (e.g., *Escherichia coli* or *Staphylococcus aureus*)
- **Archaea** (e.g., *Halophiles* and *Thermophiles*)

Eukaryotic Cells:

Eukaryotic cells are complex cells that have a true nucleus enclosed by a nuclear membrane, along with membrane-bound organelles such as mitochondria, endoplasmic reticulum, and Golgi apparatus. Eukaryotic cells canbe single-celled or multicellular.

Key Features:

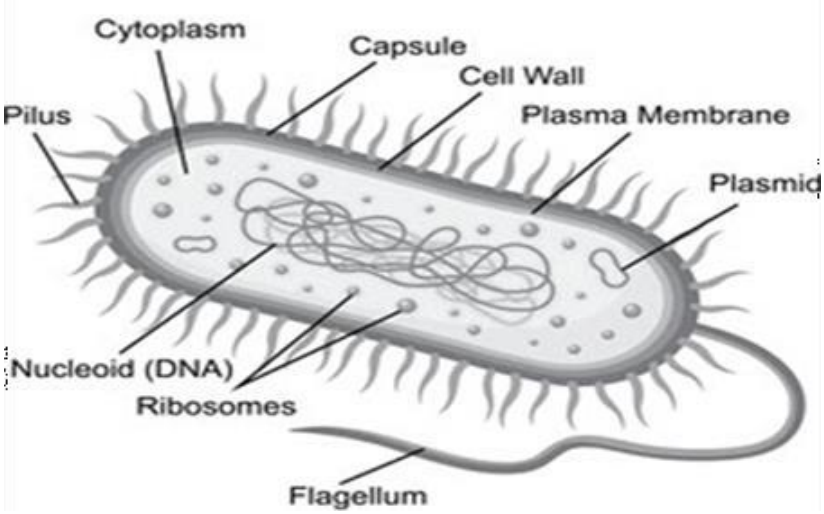
- True nucleus containing DNA
- Membrane-bound organelles
- Larger and more complex than prokaryotes
- Reproduce by mitosis (asexual) and meiosis (sexual)

Examples:

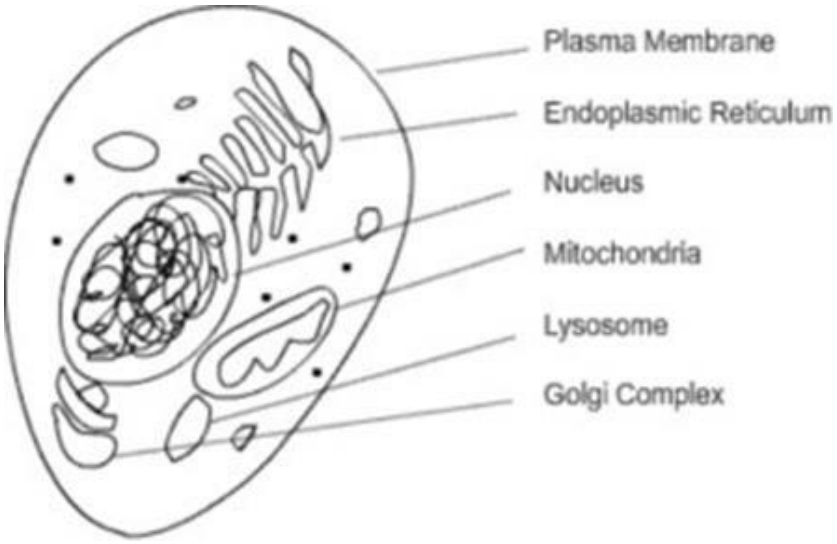
- **Animal cells** (e.g., human cells, nerve cells)
- **Plant cells** (e.g., leaf cells of *Spinach*)
- **Fungi** (e.g., *Saccharomyces cerevisiae* - yeast)
- **Protists** (e.g., *Amoeba*, *Paramecium*)

Differences between Prokaryotic Cells and Eukaryotic Cells:

Feature	Prokaryotic Cells	Eukaryotic Cells
Nucleus	No true nucleus; nucleoid region	True nucleus with nuclear membrane
Size	Smaller (1-10 µm)	Larger (10-100 µm)
Cell Structure	Simple structure	Complex structure
Organelles	No membrane-bound organelles	Membrane-bound organelles (e.g., mitochondria, ER)
DNA	Circular DNA, no histones	Linear DNA with histones
Reproduction	Asexual (binary fission)	Both asexual (mitosis) and sexual (meiosis)
Ribosomes	70S ribosomes	80S ribosomes (except in mitochondria and chloroplasts)
Cell Wall	Present in most, made of peptidoglycan	In plants (cellulose) and fungi (chitin); absent in animal cells
Examples	Bacteria and Archaea	Animals, plants, fungi, protists



Prokaryotic cell



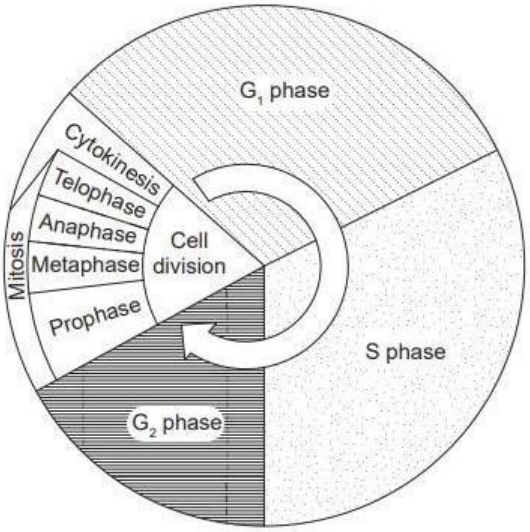
Eukaryotic Cell

Outline the key stages of the cell cycle. Add a note on the differences betweenmitosis and meiosis

Cell Cycle

The **cell cycle** is a series of phases that a cell goes through to grow and divide. Itconsists of the following main stages:

1. **Interphase**: The longest phase, where the cell prepares for division. It isdivided into three sub-phases:
    - **G1 Phase (Gap 1)**: The cell grows and synthesizes proteins, organelles, and other cellular components.
    - **S Phase (Synthesis)**: DNA is replicated, resulting in two identical sets of chromosomes.
    - **G2 Phase (Gap 2)**: The cell continues to grow and prepares for mitosis.
2. **M Phase (Mitosis)**: The phase where the cell divides its copied DNA and cytoplasm to form two new daughter cells. Mitosis is further divided into four stages:
    - **Prophase**: Chromosomes condense and become visible, the nuclear envelope begins to break down, and spindle fibers form.
    - **Metaphase**: Chromosomes line up at the cell's equator, and spindlefibers attach to the centromeres.
    - **Anaphase**: Sister chromatids are pulled apart to opposite poles ofthe cell.
    - **Telophase**: Chromatids reach the poles, the nuclear envelope re-forms around each set of chromosomes, and chromosomes begin tode-condense.
3. **Cytokinesis**: The final stage where the cytoplasm divides, resulting in two separate daughter cells, each with its own nucleus and organelles.



Differences Between Mitosis and Meiosis

Feature	Mitosis	Meiosis
Purpose	Cell division for growth and repair	Formation of gametes (sperm and eggs)
Number of Divisions	One division (PMAT)	Two divisions (Meiosis I and Meiosis II)
Chromosome Number	Maintains the same chromosome number (diploid to diploid)	Reduces chromosome number by half (diploid to haploid)
Genetic Variation	Produces genetically identical daughter cells	Produces genetically diverse gametes due to crossing over and independent assortment
Outcome	Two identical daughter cells	Four non-identical gametes
Cell Types	Somatic (body) cells	Germ (reproductive) cells

3. Write notes on the central dogma of molecular biology.

Central Dogma of Molecular Biology

The **Central Dogma of Molecular Biology** describes the flow of genetic information within a biological system. It outlines the process by which theinformation encoded in DNA is transferred to RNA and then translated intoproteins. The key processes involved are **replication**, **transcription**, and **translation**.

Key Components

1. **DNA (Deoxyribonucleic Acid)**:
    - The genetic material that carries the instructions for the development, functioning, growth, and reproduction of all knownorganisms.
    - DNA is structured as a double helix, composed of nucleotides(adenine, thymine, cytosine, and guanine).
2. **RNA (Ribonucleic Acid)**:
    - A single-stranded molecule that plays important roles in theexpression of genes.
    - There are different types of RNA involved in the central dogma:
        - **mRNA (messenger RNA)**: Carries the genetic informationfrom DNA to the ribosome.
        - **tRNA (transfer RNA)**: Transfers specific amino acids to theribosome during protein synthesis.
        - **rRNA (ribosomal RNA)**: A structural component ofribosomes, aiding in protein synthesis.
3. **Proteins**:
    - They are made up of amino acids. They play important role invarious cellular functions.

Key Processes

1. **Replication**:

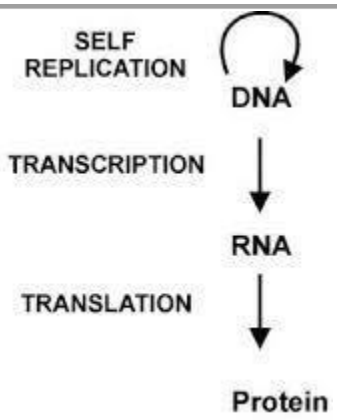
- The process by which DNA makes a copy of itself before celldivision.
- Ensures that each daughter cell receives an identical copy of thegenetic material.

2. **Transcription**:
   - The process of synthesizing RNA from a DNA template.
   - Occurs in the nucleus (in eukaryotes) and involves the enzyme RNA polymerase, which unwinds the DNA and assembles the complementary RNA strand.
   - The resulting mRNA carries the genetic code from the DNA to theribosome.
3. **Translation**:
   - The process of synthesizing proteins based on the sequence of themRNA.
   - Takes place in the cytoplasm at the ribosome.

Flow of Information

The central dogma can be summarized as follows:

- **DNA → RNA → Protein**
- The flow of genetic information from DNA to RNA (throughtranscription) and from RNA to protein (through translation).



Central Dogma of molecular biology

UNIT-5

DEFINITION AND SCOPE OF CHEMISTRY

Chemistry is the branch of science that studies the composition, structure, properties, and changes of matter. It explores how substances interact and transform into new substances.

Scope of Chemistry:
Chemistry impacts almost every aspect of life and science, including:

1. **Medicine:** Designing drugs and treatments.
2. **Food Science:** Preservatives and nutrition analysis.
3. **Energy:** Fuels, batteries, and renewable energy sources.
4. **Environment:** Pollution control and recycling.
5. **Industry:** Manufacturing plastics, textiles, and fertilizers.
6. **Space Science:** Understanding the composition of planets and stars.

Applications of Chemistry in Daily Life

Chemistry plays a vital role in our everyday activities. Here are some examples:

1. Food and Cooking

- Chemistry helps understand how ingredients interact during cooking.
- **Example:**
  - Baking: Baking soda releases carbon dioxide to make cakes fluffy.
  - Preservation: Salt and vinegar prevent food spoilage.

2. Cleaning Products

- Detergents, soaps, and disinfectants are products of chemistry.
- **Example:**
  - Soap breaks down grease on dishes.
  - Bleach kills bacteria in bathrooms.

3. Medicine and Healthcare

- Chemistry is used to develop drugs and medical treatments.
- **Example:**
  - Pain relievers like paracetamol.
  - Antibiotics to treat infections.

4. Clothing and Fabrics

- Chemistry helps create synthetic materials like polyester and nylon.
- **Example:**
    - Waterproof jackets made from chemically treated fabrics.

5. Energy and Fuel

- Fuels like petrol, diesel, and cooking gas are chemical products.
- **Example:**
    - LPG (liquefied petroleum gas) used in home cooking.
    - Batteries in mobile phones and vehicles.

6. Cosmetics and Personal Care

- Chemistry formulates lotions, shampoos, and makeup.
- **Example:**
    - Sunscreen protects skin from harmful UV rays.
    - Toothpaste contains fluoride to strengthen teeth.

7. Agriculture

- Fertilizers, pesticides, and herbicides are chemical products that boost crop yield.
- **Example:**
    - Urea is used as a fertilizer to enrich soil with nitrogen.

8. Environmental Protection

- Chemistry helps in water purification and waste management.
- **Example:**
    - Chlorine purifies drinking water.
    - Recycling plastic involves chemical processes.

Summary:

- **Definition:** Chemistry studies matter, its properties, and transformations.
- **Scope:** Chemistry is essential in medicine, food, environment, industry, and more.
- **Daily Applications:**
    - **Food:** Baking and preservation.
    - **Cleaning:** Soaps and detergents.
    - **Medicine:** Drugs and healthcare.
    - **Energy:** Fuels and batteries.
    - **Cosmetics:** Lotions and toothpaste.
    - **Agriculture:** Fertilizers and pesticides.

BRANCHES OF CHEMISTRY

Chemistry is divided into various branches, each focusing on specific areas of study.

1. Organic Chemistry

- It studies Compounds containing carbon and hydrogen (and sometimes other elements like oxygen or nitrogen).
- **Examples:**
    - Studying the structure of glucose (a sugar).
    - Making plastics like polyethylene.

2. Inorganic Chemistry

Branches of Chemistry

Chemistry is divided into various branches, each focusing on specific areas of study. Here's an overview with easy examples:

1. Organic Chemistry

- It studies Compounds containing carbon and hydrogen (and sometimes other elements like oxygen or nitrogen).
- **Examples:**
    - Studying the structure of glucose (a sugar).
    - Making plastics like polyethylene.

2. Inorganic Chemistry

- It studies Compounds that do not primarily contain carbon-hydrogen bonds.
- **Examples:**
    - Analyzing salts like sodium chloride (table salt).
    - Making fertilizers like ammonium nitrate.

3. Physical Chemistry

- It studies the physical properties and energy changes of matter.
- **Examples:**
    - Studying how temperature affects reaction rates.
    - Understanding how batteries produce electricity.

4. Analytical Chemistry

- It studies the Techniques to identify and measure substances in a sample.
- **Examples:**
  - Testing water for pollutants.
  - Measuring sugar levels in blood.

5. Biochemistry

- It studies the Chemical processes in living organisms.
- **Examples:**
  - Understanding how enzymes break down food.
  - Studying DNA and genetic material.

6. Environmental Chemistry

- It studies Chemical processes occurring in the environment and their effects.
- **Examples:**
  - Analyzing air pollution levels.
  - Studying the effect of pesticides on soil.

7. Industrial Chemistry

- It studies Chemical processes used in manufacturing industries.
- **Examples:**
  - Producing cement and glass.
  - Manufacturing detergents and soaps.

8. Theoretical Chemistry

- It studies using mathematics and computer models to understand chemical behavior.
- **Examples:**
  - Simulating molecular structures using software.
  - Predicting how new drugs will interact with the body.

Summary Table

Branch of Chemistry	Definition	Examples
Organic Chemistry	Study of carbon-containing compounds	Alkanes, alcohols, amino acids
Inorganic	Study of inorganic compounds	Salts, metals, coordination

Branch of Chemistry	Definition	Examples
Chemistry		compounds
Physical Chemistry	Study of physical properties and behavior of chemicals	Thermodynamics, kinetics, quantum chemistry
Analytical Chemistry	Techniques to identify and quantify substances	Chromatography, mass spectrometry
Biochemistry	Study of chemical processes in living organisms	Enzymes, nucleic acids, metabolism

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Chemical Bonds

Chemical bonds are forces that hold atoms together to form molecules or compounds. They can be strong (ionic and covalent) or weak (noncovalent bonds).

1. Ionic Bonds

- Formed when one atom transfers electrons to another. This creates charged ions (positive and negative) that attract each other.
- **Strength:** Strong but weaker in water.
- **Example:**
  - Sodium chloride (*NaCl*): Sodium donates an electron to chlorine to form table salt.

2. Covalent Bonds

- Formed when two atoms share electrons. This bond is very strong.
- **Types:**
  - **Polar Covalent:** Unequal sharing of electrons (e.g., water).
  - **Nonpolar Covalent:** Equal sharing of electrons (e.g., oxygen gas).
- **Example:**
  - Water (*H_2O*): Oxygen shares electrons with hydrogen atoms.

3. Noncovalent Bonds

Weaker bonds that do not involve sharing or transferring electrons. They help in temporary interactions.

a. Hydrogen Bonds

- Weak attraction between a hydrogen atom (positive) and an electronegative atom like oxygen or nitrogen (negative).
- **Example:**
  - Between water molecules (H_2O): Hydrogen bonds hold water molecules together.

b. Van der Waals Forces

- Weak forces that occur due to temporary charges on atoms as they come close to each other.
- **Example:**
  - Gecko feet sticking to walls due to van der Waals forces.

c. Hydrophobic Interactions

- Nonpolar molecules group together in water to avoid interaction with it.
- **Example:**
  - Oil droplets clumping in water.

Comparison of Bond Strength:

1. Covalent Bonds > Ionic Bonds > Hydrogen Bonds > Van der Waals Forces > Hydrophobic Interactions

Summary Table

Type of Bond	Definition	Examples
Ionic Bond	Formed by the transfer of electrons between atoms	Sodium chloride (NaCl)
Covalent Bond	Formed by the sharing of electrons between atoms	Water (H_2O), Oxygen (O_2)
Van der Waals Forces	Weak attractions due to transient dipoles	Gecko feet climbing on surfaces
Hydrophobic Interactions	Interactions between nonpolar substances in water	Oil droplets in water
Hydrogen Bonds	Attraction between a hydrogen atom and an electronegative atom	Water molecules, DNA base pairing

GREEN CHEMISTRY

Green chemistry is the field of chemistry focused on creating products and processes that minimize harmful effects on the environment and human health. The goal is to design safer chemicals and reduce waste, pollution, and energy use.

Key Principles of Green Chemistry

1. **Prevent Waste**: Avoid generating waste rather than dealing with it afterward.
    - *Example*: Designing reactions that don't produce harmful by-products.
2. **Use Safe Materials**: Select chemicals that are less toxic and hazardous.
    - *Example*: Using water as a solvent instead of harmful organic solvents.
3. **Energy Efficiency**: Perform reactions at room temperature and pressure to save energy.
    - *Example*: Reactions that work with sunlight instead of requiring heating.
4. **Renewable Resources**: Use materials that can be replenished, like plants, rather than non-renewable ones like fossil fuels.
    - *Example*: Making bio-based plastics from cornstarch instead of petroleum.
5. **Biodegradable Products**: Design chemicals that break down safely in the environment after use.
    - *Example*: Biodegradable plastic bags that decompose naturally.

Examples of Green Chemistry in Action

Green Chemistry focuses on designing chemical processes and products that reduce or eliminate harmful effects on the environment and human health.

1. Biodegradable Plastics

- Plastics made from natural materials like corn starch or sugarcane.
- Reduce pollution from non-biodegradable plastics.
- **Example:** Polylactic acid (PLA) used in packaging and disposable cutlery.

2. Water-Based Paints

- Paints that use water as a solvent instead of harmful organic solvents.
- Reduces toxic fumes and air pollution.
- **Example:** Latex-based paints used for homes and offices.

3. CO_2 as a Solvent

- Using carbon dioxide as a safe alternative to harmful solvents in industrial processes.
- Reduces the use of toxic chemicals.
- **Example:** CO_2 used in dry cleaning instead of perchloroethylene.

4. Renewable Energy Production

- Using catalysts to create biofuels from plants.
- Provides an eco-friendly alternative to fossil fuels.
- **Example:** Biodiesel made from vegetable oil or animal fat.

5. Less Toxic Pesticides

- Designing pesticides that are effective but break down quickly into harmless substances.
- Reduces harm to the environment and humans.
- **Example:** Neem oil-based pesticides for farming.

6. Atom Economy

- Designing reactions that use all the starting materials efficiently, leaving no waste.
- Minimizes chemical waste.
- **Example:** Pharmaceutical synthesis of ibuprofen with high atom efficiency.

7. Supercritical Fluids

- Using fluids like supercritical CO_2 to extract compounds without harmful solvents.
- Reduces waste and toxicity.
- **Example:** Decaffeinating coffee using supercritical CO_2.

Summary

Green chemistry aims to make chemistry safer and more sustainable, with benefits like reduced pollution, conservation of resources, and safer products for everyday life.

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