BT201 – ECOLOGY, BIODIVERSITY & EVOLUTION II

FINAL TERM IMPORTANT QUESTIONS

Prepared by: *Sir Mughal*

Admin: **BS Biological Sciences** (One place to all your solutions)

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1. Make a restoration model by using bryophytes in degraded rocky land.

Degraded rocky land is characterized by lack of soil, low moisture retention, and high erosion. Bryophytes act as pioneer species and can be used effectively for ecological restoration of such areas.

Bryophytes such as *Bryum*, *Funaria*, *Tortula*, and *Polytrichum* are selected because they can grow on bare rocks and tolerate desiccation. The rocky surface is first cleaned and slightly roughened to allow attachment. Small fragments of locally available bryophytes are used as inoculum and spread over the rock surface, often mixed with water to form a slurry.

Once established, bryophytes absorb and retain water, reduce surface runoff, and bind fine particles. They trap dust and organic matter, leading to the gradual formation of a thin soil layer. Bryophytes also facilitate the growth of microorganisms and lichens, which further improve soil conditions.

With time, the improved microenvironment allows colonization by grasses and other higher plants. Thus, bryophytes initiate ecological succession and play a key role in restoring degraded rocky land by stabilizing the surface, enhancing moisture retention, and promoting soil formation.

2. Define cross pollination and its advantages.

Cross-pollination

Cross-pollination is the transfer of pollen grains from the anther of one flower to the stigma of a flower on another plant of the same species.

Advantages of cross-pollination

- Produces genetic variation among offspring
- Increases adaptability to changing environmental conditions
- Results in hybrid vigor (heterosis), leading to healthier and more vigorous plants
- Reduces the expression of harmful recessive traits
- Improves yield and quality of fruits and seeds

3. Justify classification of symbiotic protist as main keystone species.

Symbiotic protists are classified as keystone species because their ecological impact is disproportionately large compared to their abundance.

Many symbiotic protists play an essential role in nutrient cycling. For example, zooxanthellae (dinoflagellate protists) live inside coral tissues and perform photosynthesis, supplying up to 90% of the coral's energy requirements. Without these protists, coral reefs cannot survive.

Symbiotic protists also maintain ecosystem structure. Coral reefs built with the help of symbiotic protists provide habitat, shelter, and breeding grounds for thousands of marine species. Loss of these protists leads to coral bleaching and collapse of entire reef ecosystems.

In terrestrial ecosystems, protists in the guts of termites digest cellulose, enabling termites to decompose wood. This process is crucial for carbon recycling and soil fertility. Removal of these protists would disrupt decomposition and nutrient flow.

Because symbiotic protists regulate energy flow, support primary productivity, and maintain community stability, their removal causes severe ecological imbalance. Hence, symbiotic protists are rightly classified as keystone species.

4. Give a procedure by which we can know commensal bacteria on leaves.

Fresh, healthy leaves are collected aseptically from the plant and placed in sterile polythene bags to avoid external contamination. In the laboratory, the leaves are gently washed with sterile distilled water or phosphate buffer to remove surface dust and loosely attached microbes.

The washed leaves are then shaken vigorously in a known volume of sterile buffer solution. This step dislodges the commensal bacteria present on the leaf surface into the liquid, forming a bacterial suspension.

Serial dilutions of the suspension are prepared, and a measured volume from appropriate dilutions is spread onto nutrient agar plates using aseptic techniques. The plates are incubated at 28–30 °C for 24–48 hours.

After incubation, bacterial colonies appear on the agar surface. Colony count, morphology, and basic staining techniques (such as Gram staining) are used to identify and confirm the presence of commensal bacteria on leaves.

5. What are examples of symbiosis?

Examples of symbiosis

1. **Mutualism** (both partners benefit)
    - *Rhizobium* bacteria in legume root nodules → fix nitrogen for the plant; bacteria get shelter and nutrients
    - Lichens → association of fungi and algae or cyanobacteria
    - Zooxanthellae in corals → provide energy to corals; corals provide protection

2. **Commensalism** (one benefits, other unaffected)
   - Epiphytic orchids on trees → get support; tree is unaffected
   - Barnacles on whales → gain mobility and food; whale is unaffected

3. **Parasitism** (one benefits, other harmed)
   - *Plasmodium* in humans → malaria parasite harms host
   - *Cuscuta* (dodder) on other plants → obtains nutrients at host's expense

4. **Amensalism** (one harmed, other unaffected)
   - Penicillium secreting penicillin → kills bacteria; fungus is unaffected

5. **Neutralism** (both unaffected, rare)
   - Many soil microorganisms coexisting without interaction

6. Write four factors of genetic diversity.

Four factors of genetic diversity

1. ***Mutation*** – Spontaneous changes in DNA create new alleles, introducing genetic variation.
2. ***Gene flow (migration)*** – Movement of individuals or gametes between populations brings new alleles.
3. ***Sexual reproduction*** – Recombination and independent assortment during meiosis shuffle alleles, producing variation.
4. ***Population size and selection*** – Natural selection favors certain alleles, while genetic drift in small populations can change allele frequencies.

7. Explain population growth.

Population growth

Population growth refers to the change in the number of individuals in a population over time. It is determined by the balance between birth rate**,** death rate**,** immigration**,** and emigration. There are two main patterns of population growth:

1. **Exponential growth (J-shaped curve)**
   - Occurs under ideal conditions with unlimited resources.
   - Population increases rapidly because the growth rate is proportional to the current population size.
   - Example: bacterial growth in nutrient-rich medium.
2. **Logistic growth (S-shaped curve)**
   - Occurs when resources are limited.
   - Population grows rapidly at first, then slows as it approaches the carrying capacity (K) of the environment.
   - Example: human population or wildlife in a forest.

8. What is Food Web? Explain it.

Food Web

A food web is a complex network of interconnected food chains in an ecosystem that shows how energy and nutrients flow between different organisms. Unlike a simple food chain, a food web illustrates multiple feeding relationships and the interdependence of species.

Explanation:

- Producers (green plants) capture solar energy and form the base of the web.
- Primary consumers (herbivores) feed on producers.
- Secondary consumers (carnivores) feed on herbivores.
- Tertiary consumers feed on secondary consumers.
- Decomposers (bacteria and fungi) break down dead organisms and recycle nutrients back into the ecosystem.

9. Define mutation and its link to selective pressure.

Mutation

A mutation is a permanent change in the DNA sequence of an organism's genome. Mutations can occur spontaneously or be induced by environmental factors such as radiation, chemicals, or viruses.

Link to selective pressure:

- Mutations create genetic variation, which is the raw material for evolution.
- Selective pressure (e.g., predators, climate, disease, competition) acts on this variation.
- Beneficial mutations that increase survival or reproduction are favored and become more common in the population over generations (natural selection).
- Harmful mutations are usually eliminated, while neutral mutations may persist.

Example:

A mutation in a bacterial gene that confers antibiotic resistance allows those bacteria to survive when exposed to the drug. The antibiotic acts as a selective pressure, increasing the frequency of the resistant mutation in the population.

10. Why Zoos are considered as dead livings?

Zoos are often called "dead livings" because, although they house live animals, the natural behaviors, freedom, and ecological interactions of these animals are highly restricted.

- Animals in zoos live in artificial enclosures, which limit movement, hunting, foraging, and social interactions.
- They are dependent on humans for food, water, and protection, unlike in the wild where they must survive naturally.
- The ecosystem dynamics, predator-prey relationships, and natural selection pressures are absent.
- Essentially, while the animals are alive, their natural life processes and ecological roles are largely suspended, making the environment "artificially alive" rather than truly wild.

11. Define disturbance and nutrients depletion factors.

Disturbance

A disturbance is any event that disrupts the structure, composition, or functioning of an ecosystem. Disturbances can be natural or human-induced.

- ***Examples:*** fires, floods, storms, deforestation, mining, overgrazing
- ***Effect:*** Alters species composition, reduces biomass, and changes resource availability.

Nutrient depletion factors

Nutrient depletion factors are processes or activities that reduce the availability of essential nutrients in the soil or ecosystem.

- **Examples:** Continuous cropping without fertilization, Soil erosion, Overgrazing, Leaching due to excessive rainfall, Deforestation.
- **Effect:** Limits plant growth, reduces soil fertility, and can lead to ecosystem degradation.

12. Define cause of Dysentery, Sleeping Sickness and Malaria.

Causes of the diseases:

1. ***Dysentery*** – Caused by *Shigella* bacteria (bacillary dysentery) or *Entamoeba histolytica* (amoebic dysentery). It leads to inflammation of the intestine and severe diarrhea with blood and mucus.
2. ***Sleeping sickness*** – Caused by the protozoan *Trypanosoma* species, mainly *Trypanosoma brucei*, transmitted by the tsetse fly. It affects the central nervous system, causing sleep disturbances and neurological symptoms.
3. ***Malaria*** – Caused by protozoan parasites of the genus *Plasmodium* (*P. falciparum, P. vivax, P. malariae, P. ovale*) and transmitted by the bite of infected female Anopheles mosquitoes. It leads to fever, chills, anemia, and other systemic symptoms.

13. Which factors effect environmental decomposition?

Factors affecting environmental decomposition

Decomposition of organic matter in the environment is influenced by biotic and abiotic factors:

1. ***Temperature*** – Higher temperatures generally increase microbial activity, speeding up decomposition; very low temperatures slow it down.
2. ***Moisture*** – Adequate water is required for microbial growth; too little or too much water slows decomposition.
3. ***Oxygen availability*** – Aerobic decomposition is faster; anaerobic conditions slow the process and produce different by-products (e.g., methane).
4. ***pH of the environment*** – Most decomposers prefer neutral to slightly acidic conditions; extreme pH inhibits microbial activity.
5. ***Type of organic matter*** – Easily degradable materials (sugars, proteins) decompose faster than resistant compounds (lignin, cellulose).
6. ***Microbial community*** – The presence and diversity of decomposer organisms (bacteria, fungi, and protozoa) directly affect decomposition rate.
7. ***Chemical composition and nutrient content*** – Nitrogen-rich materials decompose faster than carbon-rich, nutrient-poor substances.

14. What are effects of Habitat destruction and climate warming?

Effects of Habitat Destruction

- ***Loss of biodiversity:*** Many species lose their homes and may become endangered or extinct.
- ***Disruption of ecological balance:*** Food chains and interactions between species are disturbed.
- ***Fragmentation:*** Remaining habitats become isolated, limiting gene flow and reproduction.
- ***Soil erosion and degradation:*** Removal of vegetation exposes soil to erosion and nutrient loss.
- ***Altered water cycles:*** Deforestation and land clearing affect rainfall patterns and water retention.

Effects of Climate Warming

- ***Melting of ice caps and glaciers:*** Leads to sea-level rise and loss of polar habitats.
- ***Changes in species distribution:*** Some species migrate to cooler areas; others may not survive.
- ***Extreme weather events:*** Increased frequency of storms, droughts, and floods.
- ***Ecosystem stress:*** Coral bleaching, forest dieback, and reduced agricultural productivity.
- ***Disruption of phenology:*** Timing of flowering, breeding, and migration may change, affecting survival.

15. What are different modes of gene transfer in bacteria?

Different modes of gene transfer in bacteria

Bacteria can exchange genetic material through horizontal gene transfer, which increases genetic diversity. The main modes are:

- ***Transformation:*** Uptake of free DNA fragments from the environment by a bacterial cell. ***Example***: *Streptococcus pneumoniae* can acquire genes for capsule formation.
- ***Transduction:*** Transfer of bacterial DNA from one cell to another via a bacteriophage (virus)**.** ***Example***: *Salmonella* genes transferred by phages.
- ***Conjugation:*** Direct transfer of DNA (usually a plasmid) from a donor to a recipient bacterium through a sex pilus.***Example***: F-plasmid transfer in *E. coli*.
- ***Gene transfer agents (GTAs) and other mechanisms*** (less common): Some bacteria produce virus-like particles that package random DNA fragments for transfer.

16. What are proto primates and true primates?

Proto-primates

Proto-primates are considered the earliest or primitive primates that lived during the late Paleocene to early Eocene, around 60–55 million years ago. They were small, arboreal mammals that showed the first adaptations for life in trees. Their body structure included grasping hands and feet with nails instead of claws, which allowed them to hold onto branches efficiently. They also had relatively large eyes, suggesting they were adapted for nocturnal activity, and their brains were small compared to later primates. Their teeth were simple and unspecialized, reflecting a generalized diet.

Examples of proto-primates include *Plesiadapis* and *Carpolestes*. These animals were not fully specialized for arboreal life but showed features that provided an evolutionary link to modern primates. They represent a transitional stage between primitive mammals and true primates, giving insight into how traits like grasping limbs, enhanced vision, and tree-dwelling behavior began to develop. Proto-primates laid the foundation for the evolution of more advanced primates.

True primates

True primates evolved from proto-primates during the Eocene, around 55–34 million years ago, and were fully adapted for life in trees. They had highly developed brains, allowing better coordination, problem-solving, and social behaviors. Their vision became stereoscopic and forward-facing, improving depth perception for arboreal navigation. True primates had opposable thumbs and, in many cases, opposable toes, giving them the ability to grasp branches and manipulate objects with precision. They also had flexible shoulder and hip joints, reduced snouts, and enhanced tactile sensitivity.

Examples of true primates include lemurs, tarsiers, and monkeys. Unlike proto-primates, they were more specialized for arboreal life and showed complex behaviors such as grooming, social hierarchy, and tool use in some species. True primates demonstrate the evolutionary advances in sensory perception, motor skills, and brain development that allowed them to exploit a wide variety of ecological niches. They are the direct ancestors of modern primates, including humans.

17. Explain Endosymbiotic theory of Eukaryotic evolution.

Endosymbiotic Theory of Eukaryotic Evolution

The endosymbiotic theory explains the origin of eukaryotic cells from prokaryotic ancestors. It was first proposed by Lynn Margulis in the 1960s. According to this theory, certain organelles in eukaryotic cells, such as mitochondria and chloroplasts, originated as free-living prokaryotes that were engulfed by a larger ancestral host cell. Instead of being digested, these prokaryotes formed a mutually beneficial symbiotic relationship with the host, eventually evolving into permanent organelles.

Evidence supporting this theory includes the fact that mitochondria and chloroplasts have their own circular DNA**,** double membranes, and prokaryote-like ribosomes**,** and they replicate independently by binary fission**,** similar to bacteria. Mitochondria are believed to have originated from aerobic bacteria, providing the host cell with efficient energy production, while chloroplasts originated from photosynthetic cyanobacteria, enabling photosynthesis. This theory explains how complex eukaryotic cells evolved from simpler prokaryotic ancestors through symbiosis, leading to the diversity of eukaryotic life we see today.

18. Write benefits of pollen dispersal.

Benefits of Pollen Dispersal

1. ***Genetic diversity*** – Pollen dispersal allows cross-pollination between different plants, mixing genes and producing genetically varied offspring. This increases the adaptability and survival of the species.
2. ***Colonization of new areas*** – Pollen can travel long distances via wind, water, or animals, enabling plants to reproduce in new locations and expand their range.
3. ***Reduced competition*** – By spreading pollen over a wide area, plants reduce the likelihood of self-pollination and competition among seedlings for resources in the same location.
4. ***Enhanced survival*** – Cross-pollination reduces the chances of inbreeding and expression of harmful recessive traits, producing healthier and more vigorous plants.
5. ***Support for ecosystems*** – Dispersed pollen provides food for insects and other pollinators, supporting biodiversity and ecological interactions.

19. What Hardy-Weinberg equilibrium?

Hardy-Weinberg Equilibrium

The Hardy-Weinberg equilibrium is a principle in population genetics that describes a state in which allele and genotype frequencies in a population remain constant from generation to generation, provided certain conditions are met. It serves as a mathematical model to predict genetic variation in an idealized population.

The equilibrium assumes no mutation, no migration, no natural selection, random mating, and an infinitely large population. Under these conditions, the frequencies of alleles (p and q) and genotypes (p^2, 2pq, q^2) remain stable. It provides a baseline to detect evolutionary changes, because deviations from the equilibrium indicate that one or more evolutionary forces—such as selection, gene flow, or genetic drift—are acting on the population.

Equation:

- Allele frequency: ($p + q = 1$)
- Genotype frequency: ($p^2 + 2pq + q^2 = 1$)

Where:

- p = frequency of dominant allele
- q = frequency of recessive allele

20. Explain dependency of plant and animals.

Plants and animals are highly interdependent, forming the basis of ecosystem functioning. Plants depend on animals for processes like pollination and seed dispersal. Many flowering plants rely on insects, birds, or mammals to transfer pollen from one flower to another, ensuring reproduction. Animals also help in spreading seeds to new locations, increasing the plants' chances of survival and colonization.

Conversely, animals depend on plants for food, oxygen, and habitat. Herbivores feed directly on plants, while carnivores indirectly depend on plants through the food chain. Plants produce oxygen through photosynthesis, which is essential for animal respiration. Many animals also use plants for shelter, nesting, or protection. This mutual dependency maintains ecological balance, supports biodiversity, and ensures the flow of energy and nutrients within ecosystems.

21. Write a note on parasites.

Parasites

Parasites are organisms that live on or inside another organism (the host) and derive nutrients at the host's expense, often causing harm. They can be obligate, requiring a host to complete their life cycle, or facultative, able to survive independently but sometimes living on a host. Parasites are found in all major groups of organisms, including protozoa, helminths (worms), arthropods, and even some plants.

Types of parasites:

- ***Ectoparasites:*** Live on the body surface of the host (e.g., lice, ticks, fleas)
- ***Endoparasites:*** Live inside the host's body (e.g., *Plasmodium, Ascaris, Taenia*)
- ***Social parasites:*** Exploit other species' social systems (e.g., cuckoo birds laying eggs in other birds' nests)

22. Write a brief note on Flatworms.

Flatworms (Phylum: Platyhelminthes)

Flatworms are soft-bodied, bilaterally symmetrical, and dorsoventrally flattened invertebrates. They are acoelomates, meaning they lack a true body cavity between the gut and body wall. Flatworms exhibit cephalization, with a distinct head region containing sensory organs, and are triploblastic, having ectoderm, mesoderm, and endoderm.

They can be free-living (e.g., *Planaria*) or parasitic (e.g., *Taenia*, *Fasciola*). Free-living flatworms are mostly aquatic and feed on small invertebrates, while parasitic flatworms live inside hosts and obtain nutrients from them. Flatworms have a simple digestive system (incomplete or absent in parasites), excretory system with flame cells, and a nervous system with longitudinal nerve cords and a brain-like cerebral ganglion. They reproduce both sexually and asexually, and some show remarkable regeneration ability**.**

23. What are vascular plants?

Vascular Plants

Vascular plants, also called tracheophytes, are plants that have a well-developed system of conducting tissues—xylem and phloem—for the transport of water, minerals, and food throughout the plant. Xylem transports water and dissolved minerals from roots to other parts, while phloem distributes organic nutrients, mainly sugars, from leaves to growing tissues and storage organs.

Vascular plants are usually larger, more complex, and capable of growing in a variety of terrestrial habitats compared to non-vascular plants like mosses. They have true roots, stems, and leaves, which help in support, nutrient absorption, and photosynthesis. Examples include ferns, gymnosperms (conifers), and angiosperms (flowering plants)**.** The evolution of vascular tissue allowed plants to colonize land more effectively, grow taller, and form diverse ecosystems.

24. Differentiate between Monocots and Dicots.

Monocots and dicots are two major groups of angiosperms that differ in several structural features. Monocots have one cotyledon, while dicots have two cotyledons in their seeds. The leaves of monocots show parallel venation, whereas dicot leaves have reticulate (net-like) venation. Monocots typically develop a fibrous root system, while dicots usually have a taproot system. The flower parts of monocots are generally in multiples of three, whereas dicot flowers are in multiples of four or five. In the stem, vascular bundles are scattered in monocots but arranged in a ring in dicots. Secondary growth is rare in monocots but common in dicots, especially in woody plants. Examples of monocots include rice, maize, and wheat, while dicots include sunflower, rose, and mango.

25. What adaptations prokaryotes have made to live in diverse habitat?

Adaptations of Prokaryotes to Diverse Habitats

Prokaryotes, including bacteria and archaea, have evolved a variety of adaptations that allow them to survive in almost every habitat on Earth. Many have cell walls with peptidoglycan (in bacteria) or unique lipids (in archaea) that provide structural support and protect against extreme conditions. Some form endospores, highly resistant dormant structures, to survive heat, desiccation, radiation, and lack of nutrients.

Metabolically, prokaryotes are extremely versatile. They can be aerobic or anaerobic**,** photosynthetic or chemosynthetic, and can use a wide range of organic and inorganic compounds for energy. Motility via flagella allows them to move toward favorable environments, while biofilm formation helps them adhere to surfaces and resist environmental stresses. These adaptations enable prokaryotes to thrive in soil, water, extreme temperatures, acidic or alkaline environments, high salt areas, and even radioactive sites**,** making them some of the most ecologically successful organisms on the planet.

26. What are root characteristics of Cambrian explosion?

The Cambrian Explosion, which occurred around 541 million years ago, marks a period of rapid diversification of multicellular animal life in the fossil record. During this time, most major animal phyla appeared over a relatively short geological period. Organisms developed hard parts like shells and exoskeletons, which greatly improved their chances of fossilization. There was also a dramatic increase in body size, complexity, and morphological diversity, including specialized tissues, appendages, and sensory organs.

Other notable characteristics include the emergence of predation, which led to evolutionary arms races and the development of defensive adaptations like spines and armor. Complex ecological interactions—such as predator-prey relationships, burrowing, and competition for resources—became widespread. The Cambrian Explosion also saw the establishment of complex ecosystems in marine environments, with organisms occupying different ecological niches, which laid the foundation for modern animal diversity.

27. Define predation and intelligence in Cephalopods.

Predation:

Cephalopods, such as octopuses, squids, and cuttlefish, are active predators in marine ecosystems. They capture prey using tentacles equipped with suckers, immobilize it with a beak, and often inject venom to subdue it. Many cephalopods use camouflage, stealth, and rapid color changes to ambush prey or avoid detection. They feed on fish, crustaceans, and other invertebrates, playing an important role in regulating marine food webs.

Intelligence:

Cephalopods are considered highly intelligent among invertebrates. They have large, well-developed brains and complex nervous systems, allowing them to learn, remember, and solve problems. They exhibit behaviors such as tool use, mimicry, social interactions, and escape tactics. Their ability to change skin color and texture not only aids predation but also demonstrates cognitive control over sophisticated motor and sensory systems, reflecting advanced learning and adaptability in their environment.

28. What is the role of vascular tissues in gymnosperm adaptation?

Vascular tissues play a central role in the adaptation and ecological success of gymnosperms by enabling efficient transport and strong structural support. The xylem, composed mainly of tracheids, conducts water and dissolved minerals from roots to aerial parts while also providing mechanical strength, allowing gymnosperms to grow tall and dominate forest canopies. The presence of lignified xylem reduces water loss and prevents collapse under tension, an important adaptation for survival in dry, cold, or windy environments. Phloem tissue distributes photosynthates from leaves to non-photosynthetic regions, ensuring sustained growth and reproduction even in large, woody bodies. Together, well-developed vascular tissues permit gymnosperms to inhabit terrestrial habitats far from water sources, support long life spans, and maintain efficient physiological functioning under harsh environmental conditions.

29. What consideration and ethics are kept in mind for GM crops?

The development and use of genetically modified (GM) crops require careful consideration of ethical, environmental, and social issues to ensure safety and sustainability. Ethical considerations include thorough assessment of potential risks to human health, such as allergenicity or toxicity, before approval for consumption. Environmental ethics focus on preventing unintended effects on ecosystems, including gene flow to wild relatives, development of resistant pests, and loss of biodiversity. Social and economic considerations involve fair access to GM technology, protection of farmers' rights, avoidance of monopolistic control by seed companies, and respect for traditional farming practices. Transparency, proper labeling of GM foods, informed public consent, and compliance with national and international biosafety regulations are also essential ethical principles guiding the responsible use of GM crops.

30. Why multicellularity is considered in evolution innovation?

Multicellularity is considered an evolutionary innovation because it allowed organisms to increase structural and functional complexity far beyond what unicellular life could achieve. By having many cells, organisms could develop division of labour, where different cells specialize for specific functions such as protection, movement, digestion, and reproduction. This specialization improved efficiency, survival, and adaptability in changing environments.

Multicellular organisms also gained advantages in size and organization, which helped reduce predation and allowed exploitation of new ecological niches. Cell–cell communication, tissue formation, and coordinated growth enabled the development of complex organs and body plans. These features led to greater evolutionary potential and diversification, making multicellularity a major innovation that shaped the evolution of plants, animals, and fungi.

31. How angiosperms fertilize? Also define the process.

Angiosperms fertilize by a unique process called double fertilization, which is a characteristic feature of flowering plants. Fertilization occurs after pollination, when pollen grains are transferred from the anther to the stigma of a flower. On a compatible stigma, the pollen grain germinates and forms a pollen tube that grows through the style toward the ovule, carrying two male gametes. When the pollen tube reaches the embryo sac, it releases the two male gametes. One male gamete fuses with the egg cell to form a diploid zygote (syngamy), which develops into the embryo. The second male gamete fuses with the two polar nuclei to form a triploid endosperm (triple fusion), which provides nourishment to the developing embryo.

32. Differentiate between bacterial cell and archaeal cell.

Bacterial cells and archaeal cells are both prokaryotic, but they differ in several structural, biochemical, and genetic features. Bacterial cell walls are typically composed of peptidoglycan, whereas archaeal cell walls lack peptidoglycan and may be made of pseudopeptidoglycan, proteins, or polysaccharides. The cell membrane of bacteria contains ester-linked fatty acids, while archaeal membranes have ether-linked lipids, which provide greater stability in extreme environments.

Genetically and biochemically, archaea are more similar to eukaryotes than bacteria. Archaeal RNA polymerase and transcription machinery resemble those of eukaryotes, whereas bacterial systems are simpler. Many archaea inhabit extreme environments such as high temperature, salinity, or acidity, although they are also found in normal habitats. Bacteria are widespread in all environments and include many pathogenic species, while no confirmed archaeal pathogens are known.

33. How upright posture involved in human evolution?

Upright posture, or bipedalism, played a crucial role in human evolution by bringing major anatomical and functional changes. Walking on two legs freed the forelimbs from locomotion, allowing early humans to use their hands for tool making, carrying food, and caring for offspring. It also improved field of vision, helping early humans detect predators and resources over long distances in open environments.

Bipedal posture also made movement more energy-efficient for long-distance walking and running, which was important for hunting and migration. Anatomical changes such as the S-shaped vertebral column, broad pelvis, longer lower limbs, and arched feet supported upright walking. These adaptations contributed to improved survival, cognitive development, and the cultural evolution that distinguishes humans from other primates.

34. How fungi play role in grazing animals in digestion of cellulose?

Fungi play an important role in the digestion of cellulose in grazing animals such as cows, sheep, and goats. These animals lack the enzyme cellulase, which is required to break down cellulose present in plant cell walls. Symbiotic fungi live in the rumen of these herbivores and produce cellulase enzymes that degrade cellulose into simpler sugars.

The sugars released are further fermented by rumen microorganisms into volatile fatty acids, which serve as a major energy source for the animal. Fungi also physically penetrate plant tissues, increasing the surface area for bacterial action and improving digestion efficiency. Thus, fungi enable grazing animals to utilize plant cellulose effectively and obtain energy from fibrous plant material.

35. Write ecological importance of fungi.

Ecological importance of fungi

- ***Decomposers:*** Break down dead plants and animals, recycling nutrients like carbon, nitrogen, and phosphorus into the soil.
- ***Soil fertility:*** Decomposition by fungi enriches soil, supporting plant growth.
- ***Symbiosis (Mycorrhizae):*** Fungi associate with plant roots to enhance water and mineral absorption; plants provide carbohydrates.
- ***Lichens:*** Fungal-algal symbiosis helps in soil formation and colonization of bare surfaces.
- ***Population regulation:*** Some fungi act as parasites, controlling populations of other organisms.
- ***Food source:*** Serve as nutrition for many animals in ecosystems.

36. Define self and cross pollination.

Self-pollination

Self-pollination is the transfer of pollen grains from the anther to the stigma of the same flower or another flower on the same plant. It does not involve another plant and usually occurs in flowers that have both male and female reproductive organs.

Cross-pollination

Cross-pollination is the transfer of pollen grains from the anther of one flower to the stigma of a flower on a different plant of the same species. It requires an external agent like insects, wind, or water and promotes genetic variation in offspring.

37. Write importance of sponges in marine.

Importance of Sponges in Marine Ecosystems

- ***Water filtration:*** Sponges filter large volumes of water, removing bacteria and organic particles, which helps maintain water clarity and quality.
- ***Habitat formation:*** Their porous bodies provide shelter and surfaces for small marine organisms like crustaceans, worms, and algae.
- ***Nutrient cycling:*** Sponges recycle nutrients by breaking down organic matter and releasing nutrients back into the ecosystem.
- ***Symbiotic relationships:*** Many sponges host photosynthetic bacteria or algae, contributing to primary productivity in marine environments.
- ***Indicator species:*** Sponges are sensitive to environmental changes and can indicate the health of marine ecosystems.

38. Write three types of symbiotic relationships with prokaryotes.

1. ***Mutualism*** – Both partners benefit.
   - ***Example***: *Rhizobium* bacteria in legume root nodules fix nitrogen for the plant, while the plant provides carbohydrates to the bacteria.
2. ***Commensalism*** – One benefits, the other is unaffected.
   - ***Example***: *Nitrosomonas* bacteria in soil gain nutrients from organic matter, while plants are not affected.
3. ***Parasitism*** – One benefits, the other is harmed.
   - ***Example***: *Mycobacterium tuberculosis* in humans causes tuberculosis, benefiting the bacteria while harming the host.

39. Why placenta is evolutionary advantage in mammals?

The placenta is an evolutionary advantage because it allows direct nutrient, gas, and waste exchange between the mother and developing embryo. This provides the embryo with a stable and protected environment, supporting longer gestation and development of more complex organs before birth.

Placental nourishment also reduces dependence on external food sources for the young immediately after birth, increasing survival rates. Additionally, the placenta enables mammals to give birth to relatively well-developed and mobile offspring, enhancing their ability to survive in diverse and sometimes challenging environments. This adaptation has contributed to the success and diversity of placental mammals.

40. What is Intrinsic and Acquired antibiotic resistance?

Intrinsic resistance

This is the natural, built-in ability of a bacterial species to resist certain antibiotics. It is present in all strains of that species due to inherent structural or functional features, such as lack of the antibiotic target, low membrane permeability, or efflux pumps. For example, *Pseudomonas aeruginosa* is intrinsically resistant to many penicillins. It does not require prior exposure to the antibiotic.

Acquired resistance

This occurs when bacteria that were originally sensitive to an antibiotic gain resistance through genetic changes, such as mutations or horizontal gene transfer (plasmids, transposons). For example, *Escherichia coli* can acquire beta-lactamase genes that break down penicillin. Acquired resistance allows bacteria to adapt to antibiotic pressure and survive in treated environments.

41. Design an experiment on activity of halophilic archaea in varying salt concentrations?

Objective:

To investigate how different salt concentrations affect the growth and metabolic activity of halophilic archaea.

Materials:

- Pure culture of halophilic archaea (e.g., *Halobacterium* species)
- Sterile saline solutions of varying concentrations (e.g., 5%, 10%, 15%, 20%, 25% NaCl)
- Nutrient agar or broth suitable for halophiles
- Test tubes or flasks
- Incubator set at optimal temperature for halophiles
- Spectrophotometer (for measuring growth) or colony counting materials

Procedure:

1. Prepare sterile growth media with different salt concentrations (5%, 10%, 15%, 20%, 25% NaCl).
2. Inoculate equal amounts of halophilic archaea culture into each medium.
3. Incubate all cultures at the optimal temperature for halophiles (usually 37–40°C) for 48–72 hours.
4. Monitor growth byMeasuring turbidity using a spectrophotometer at regular intervals or counting colony-forming units (CFUs) on agar plates if using solid medium.
5. Record observations, noting which salt concentrations support maximum growth and which inhibit it.

Observations and Analysis:

- Plot growth (OD or CFU) vs. salt concentration.
- Determine the optimal salt concentration for halophilic archaea activity.
- Discuss how extreme salinity affects cellular processes such as osmotic balance and enzyme function.

Conclusion:

This experiment demonstrates that halophilic archaea require high salt concentrations for growth, with activity varying according to salinity, reflecting their adaptation to hypersaline environments.

42. How position of sedimentary rock layers are used in fossil dating?

The position of sedimentary rock layers is used in relative fossil dating based on the principle of superposition. According to this principle, in an undisturbed sequence of sedimentary rocks, the oldest layers are at the bottom, and the youngest layers are at the top. Fossils found within these layers can be dated relative to each other: fossils in lower layers are older than those in higher layers.

This method allows scientists to reconstruct the chronological sequence of life on Earth. By studying the stratigraphy (arrangement of layers) and correlating fossils across different locations, paleontologists can identify index fossils, which are species that existed for a short geological period but had wide distribution. These fossils help in estimating the relative age of rock layers and the organisms preserved within them, providing insight into evolutionary history.

43. Write a note on Myriapods.

Myriapods are arthropods belonging to the subphylum Myriapoda, which includes organisms with many legs. They are bilaterally symmetrical, segmented, and terrestrial, with a body divided into a head and trunk. Each trunk segment typically bears one or two pairs of legs, depending on the class. Myriapods have jointed appendages, a chitinous exoskeleton, and a simple nervous system.

They are detritivores or herbivores, feeding mainly on decaying plant material or living plants. Examples of myriapods include centipedes (Class Chilopoda), which are carnivorous with one pair of legs per segment, and millipedes (Class Diplopoda), which are herbivorous or detritivorous with two pairs of legs per segment. Myriapods play an important ecological role by decomposing organic matter and recycling nutrients in terrestrial ecosystems.

44. How Zircon crystals are used in study of early earth life?

Zircon crystals are valuable minerals used to study the early history of the Earth because they can preserve chemical and isotopic information for billions of years. These crystals contain trace amounts of uranium, which decays into lead at a known rate. By measuring the uranium-to-lead ratio, scientists can determine the absolute age of the crystal using radiometric dating.

In addition to dating, zircons can contain inclusions and isotopic signatures that provide clues about the conditions of early Earth, such as the presence of water, crust formation, and possible microbial activity. For example, certain carbon isotope ratios trapped in ancient zircon crystals suggest that life-related processes may have existed over 4 billion years ago. Thus, zircons are crucial for reconstructing Earth's early environment and the origins of life.

45. What is stromatolites and its evidence?

Stromatolites are layered, sedimentary structures formed by the growth and metabolic activity of cyanobacteria (blue-green algae) and other microbial communities. As these microorganisms trap and bind sediment particles, they create laminated, dome-shaped structures that accumulate over time in shallow water environments. Stromatolites are considered some of the earliest evidence of life on Earth.

Evidence of stromatolites:

- Fossilized stromatolites have been found in rocks over 3.5 billion years old, showing that microbial life existed very early in Earth's history.
- The layered morphology of stromatolites, combined with microscopic fossils of microbial cells within the layers, provides direct evidence of ancient microbial activity.
- Chemical signatures, such as isotopic ratios of carbon, preserved in stromatolite fossils indicate biological processes, supporting their role as early biosignatures.

46. Write adaptions for survival made by mollusks.

Adaptations for Survival in Mollusks

Mollusks have evolved various adaptations that help them survive in diverse habitats:

- ***Protective shells:*** Most mollusks, like snails and clams, have hard calcareous shells that protect against predators and environmental stresses.
- ***Muscular foot:*** The foot allows locomotion, burrowing, and attachment to surfaces, helping them escape predators or search for food.
- ***Radula:*** A rasping organ called the radula helps mollusks scrape or cut food efficiently.
- ***Camouflage and color change:*** Some mollusks, like octopuses and cuttlefish, can change color or texture to blend with their surroundings and avoid predators.
- ***Respiration and excretion adaptations:*** Gills (ctenidia) enable efficient gas exchange in water, while nephridia remove metabolic wastes.
- ***Reproductive adaptations:*** Many mollusks produce large numbers of eggs, sometimes with protective capsules, ensuring survival of offspring in harsh conditions.

47. How flagellates are used in fertilization?

Flagellates, particularly sperm cells, play a crucial role in fertilization due to their motility. The flagellum is a whip-like structure that allows the sperm to swim through the female reproductive tract to reach the egg. This movement is essential for sexual reproduction in many plants and animals, where sperm must travel through fluids or tissues to deliver the male gamete.

In addition to locomotion, the energy for flagellar movement is supplied by mitochondria concentrated in the sperm midpiece, ensuring that sperm have enough power to reach the egg. This active transport mechanism increases the chances of successful fertilization, enabling the fusion of male and female gametes and the formation of a zygote. Flagellates are therefore vital for the dispersal of male gametes in both aquatic and terrestrial environments.

48. Write two causes of microevolution and macroevolution.

Causes of Microevolution and Macroevolution

***Microevolution*:** (small-scale changes within a population over a short time)

1. ***Mutation:*** Random changes in DNA create new alleles that alter allele frequencies.
2. ***Natural selection:*** Environmental pressures favor certain traits, changing gene frequencies within a population.

***Macroevolution*:** (large-scale changes leading to the formation of new species or higher taxa over long periods)

1. ***Speciation:*** Accumulation of genetic changes over time results in reproductive isolation and the emergence of new species.
2. ***Plate tectonics and environmental changes:*** Geographic isolation and habitat shifts drive large-scale evolutionary changes and diversification.

49. Propose a conservation plan to increase biodiversity in urban areas.

Conservation Plan to Increase Biodiversity in Urban Areas

1. ***Urban Green Spaces:*** Establish parks, gardens, and green corridors to provide habitats for birds, insects, and small mammals. Connect these green areas to allow species movement and reduce habitat fragmentation.
2. ***Native Plant Landscaping:*** Encourage planting of native trees, shrubs, and flowering plants, which support local pollinators, birds, and other wildlife, rather than exotic ornamental species.
3. ***Pollinator Support:*** Install bee hotels, butterfly gardens, and flowering strips to sustain pollinator populations essential for urban ecosystem health.
4. ***Water Management:*** Create ponds, wetlands, and rain gardens to support aquatic species and amphibians while improving stormwater management.
5. ***Reduce Pollution and Pesticide Use:*** Minimize chemical pesticides, herbicides, and plastic pollution to protect soil, water, and urban wildlife.
6. ***Public Awareness and Participation:*** Promote community engagement programs for tree planting, citizen science monitoring, and wildlife protection initiatives.
7. ***Wildlife-Friendly Structures:*** Design buildings and roads with bird-safe glass, wildlife crossings, and nesting spaces to reduce human-wildlife conflicts.

50. Write three stages of sexual reproduction in Fungi.

Three Stages of Sexual Reproduction in Fungi

1. ***Plasmogamy (Fusion of Cytoplasm):***
    - In this stage, the cytoplasm of two compatible fungal hyphae or gametes fuses.
    - The nuclei remain separate initially, forming a dikaryotic (n + n) stage in many fungi.

2. ***Karyogamy (Fusion of Nuclei):***
    - The nuclei from the fused cells combine to form a diploid (2n) zygote nucleus.
    - This stage completes the formation of a true zygote.

3. ***Meiosis (Reduction Division):***
    - The diploid nucleus undergoes meiosis, producing haploid spores.
    - These spores can disperse, germinate, and grow into new fungal mycelia, completing the sexual life cycle.

51. How natural selection would not give a perfect organism left?

Natural selection improves an organism's adaptation to its environment, but it does not create perfection. This is because the environment is constantly changing, so traits that are advantageous today may become less useful tomorrow. Organisms are also limited by their ancestral structures; evolution can only modify existing traits, not design entirely new ones from scratch.

Additionally, natural selection often involves trade-offs. A trait that improves one aspect of survival or reproduction may reduce efficiency in another. For example, a bird with brighter feathers may attract mates but also predators. Mutations occur randomly, so beneficial changes are not guaranteed, and selection can only work with available variation. Therefore, evolution favors "good enough" adaptations rather than perfect organisms.

52. Explain locomotion in Prokaryotes.

Prokaryotes, such as bacteria and archaea, exhibit various modes of locomotion that allow them to move toward favorable environments or away from harmful conditions. The most common method is flagellar movement. Prokaryotic flagella are helical filaments anchored in the cell membrane, rotating like a propeller to propel the cell forward or backward. This movement is often guided by chemotaxis, where cells move toward nutrients or away from toxins.

Other forms of locomotion in prokaryotes include gliding and twitching. Gliding occurs in some filamentous bacteria, allowing smooth movement over surfaces without flagella, often aided by slime secretion. Twitching involves the extension and retraction of type IV pili, which pull the cell forward in a jerky motion. These locomotion mechanisms help prokaryotes colonize new habitats, form biofilms, and respond to environmental stimuli, enhancing survival and ecological success.

53. What is allopatric speciation?

Allopatric speciation is the formation of new species when a population is geographically separated into two or more isolated groups. Physical barriers such as mountains, rivers, or oceans prevent gene flow between the populations. Over time, genetic differences accumulate due to mutation, natural selection, and genetic drift, eventually leading to reproductive isolation.

Once the populations can no longer interbreed even if the barrier is removed, they are considered distinct species. An example is the Darwin's finches on the Galápagos Islands, where geographic isolation on different islands led to the evolution of species with different beak shapes adapted to various food sources. Allopatric speciation is one of the most common mechanisms driving the diversity of life on Earth.

54. What were landscapes during Prehistoric times?

During prehistoric times, landscapes were vastly different from what we see today and changed over geological periods. In the Paleozoic Era, much of the land was covered by shallow seas, swamps, and dense forests of primitive plants like mosses, ferns, and horsetails. Large coal-forming forests dominated, and the first terrestrial animals began colonizing land.

In the Mesozoic Era, landscapes included coniferous forests, ferns, and cycads, with widespread inland seas and volcanic activity shaping continents. Dinosaurs roamed these varied habitats. By the Cenozoic Era, flowering plants expanded, grasslands appeared, and modern ecosystems started forming, supporting mammals, birds, and early humans. Prehistoric landscapes were dynamic, shaped by tectonic movements, climate changes, and evolving life forms.

55. Define pathway of transgene movement.

Pathway of Transgene Movement

The pathway of transgene movement refers to the process by which a foreign gene (transgene) is introduced, expressed, and inherited in an organism. The main steps include:

1. ***Gene Isolation and Construction:*** The desired gene is identified, isolated, and inserted into a suitable vector (like a plasmid or viral vector). Regulatory sequences such as promoters and terminators are added to ensure proper expression.
2. ***Gene Delivery:*** The transgene is introduced into the target organism's cells using methods like Agrobacterium-mediated transformation**,** gene gun (biolistics)**, or** microinjection**.**
3. ***Integration and Expression:*** The transgene integrates into the host genome and is transcribed and translated, producing the desired protein or trait.
4. ***Inheritance:*** If the transgene is incorporated into germline cells, it can be passed to the next generation, ensuring stable inheritance of the introduced trait.

56. Write importance of engraving and wall painting during prehistoric times.

Importance of Engraving and Wall Painting in Prehistoric Times

- ***Communication and storytelling:*** Engravings and wall paintings were used by prehistoric humans to convey ideas, experiences, and events, including hunting scenes, daily life, and social activities, serving as an early form of communication.
- ***Cultural expression:*** They reflect the beliefs, rituals, and values of early societies, showing religious or symbolic practices such as fertility rites and animal worship.
- ***Educational purposes:*** These artworks likely taught younger generations about hunting techniques, survival skills, and environmental knowledge.
- ***Historical evidence:*** Wall paintings and engravings provide insights into prehistoric life, including the animals, tools, and habitats that existed, helping scientists reconstruct early human history.
- ***Artistic development:*** They represent the earliest human creativity, demonstrating the evolution of artistic skills and cognitive abilities in humans.

57. Write role of micro propagation in plants.

Role of Micropropagation in Plants

- ***Rapid multiplication:*** Micropropagation allows the production of a large number of genetically identical plants in a short time from a small amount of plant tissue.
- ***Disease-free plants:*** It produces pathogen-free or virus-free plants, improving crop quality and yield.
- ***Conservation of rare species:*** Endangered or rare plant species can be conserved and propagated efficiently using tissue culture techniques.
- ***Production of uniform crops:*** Micropropagation ensures genetic uniformity, which is important for commercial horticulture and agriculture.
- ***Year-round production:*** Plants can be propagated independent of season, allowing continuous supply of planting material.
- ***Genetic improvement:*** It supports clonal propagation of genetically modified or superior varieties for research and agriculture.

58. Explain usage of cyanobacteria on management of environment.

Usage of Cyanobacteria in Environmental Management

Cyanobacteria play an important role in environmental management due to their unique metabolic capabilities:

- ***Nitrogen fixation:*** Cyanobacteria, such as *Anabaena* and *Nostoc*, fix atmospheric nitrogen into forms usable by plants, improving soil fertility in agriculture, especially in rice paddies.
- ***Bioremediation:*** Some cyanobacteria can absorb heavy metals, pesticides, and pollutants from water and soil, helping to clean contaminated environments.
- ***Oxygen production:*** Through photosynthesis, cyanobacteria release oxygen, maintaining aquatic ecosystem balance and supporting life.
- ***Biofertilizers:*** Cyanobacteria are used as biofertilizers to reduce chemical fertilizer use, promoting sustainable farming.
- ***Carbon sequestration:*** They capture carbon dioxide during photosynthesis, helping reduce greenhouse gases and mitigate climate change.

59. Write two methods of finding chromosomal mutation.

Two Methods of Finding Chromosomal Mutations

1. **Karyotyping:**
   - Karyotyping involves visualizing the complete set of chromosomes under a microscope during metaphase of cell division.
   - It helps detect changes in chromosome number (aneuploidy, polyploidy) and large structural abnormalities such as deletions, duplications, inversions, or translocations.
2. **Molecular Cytogenetic Techniques (e.g., FISH – Fluorescence In Situ Hybridization):**
   - FISH uses fluorescent probes that bind to specific DNA sequences on chromosomes.
   - It allows detection of small or subtle chromosomal mutations, including microdeletions, duplications, and rearrangements, with higher precision than traditional karyotyping.

60. Differentiate between Angiosperms and Gymnosperms with example.

Difference between Angiosperms and Gymnosperms

Angiosperms and gymnosperms are both seed-producing plants, but they differ in several key features.

- ***Seed enclosure:*** Angiosperms produce seeds enclosed in a fruit, whereas gymnosperms produce naked seeds exposed on cones or scales.
- ***Reproductive structures:*** Angiosperms have flowers as reproductive organs, while gymnosperms have cones (strobili).
- ***Pollination:*** Angiosperms often rely on insects, birds, or wind for pollination, whereas gymnosperms are mostly wind-pollinated.
- ***Vascular tissues:*** Angiosperms usually have vessels in xylem, while gymnosperms mainly have tracheids.
- ***Life cycle:*** Angiosperms exhibit double fertilization forming a zygote and endosperm, whereas gymnosperms lack double fertilization.

Examples:

- ***Angiosperms:*** *Rose, Mango, Sunflower*
- ***Gymnosperms:*** *Pinus, Cycas, Ginkgo*

61. What ocean do Asteroidea inhibit?

Asteroidea, commonly known as starfish, inhabit all the world's oceans, from tropical coral reefs to cold deep-sea environments. They are primarily found in marine benthic zones, living on the seafloor rather than in open water. Starfish prefer rocky substrates, coral reefs, sandy bottoms, and tidal pools, where they can move and hunt for prey like mollusks and other invertebrates.

62. Write characteristics of phylum Porifera.

Characteristics of Phylum Porifera

- ***Body structure:*** Poriferans, or sponges, have a simple, asymmetrical or radial body with pores (ostia) and canals allowing water flow.
- ***Cellular organization:*** They are multicellular but lack true tissues and organs; cells are specialized but loosely organized.
- ***Skeleton:*** The body is supported by a skeleton of spicules (calcium carbonate or silica) or spongin fibers.
- ***Feeding:*** They are filter feeders, drawing water through pores to trap food particles like bacteria and plankton.
- ***Reproduction:*** Poriferans reproduce sexually (hermaphroditic with internal fertilization) and asexually (budding or fragmentation).
- ***Habitat:*** Mostly marine, some freshwater species, attached to submerged surfaces.
- ***Symmetry:*** Mostly asymmetrical, some are radially symmetrical.
- ***Water canal system:*** They possess a system of choanocytes (collar cells) that generate water currents for feeding and respiration.

63. Define heterospory.

Heterospory

Heterospory is the production of two distinct types of spores by a plant species:

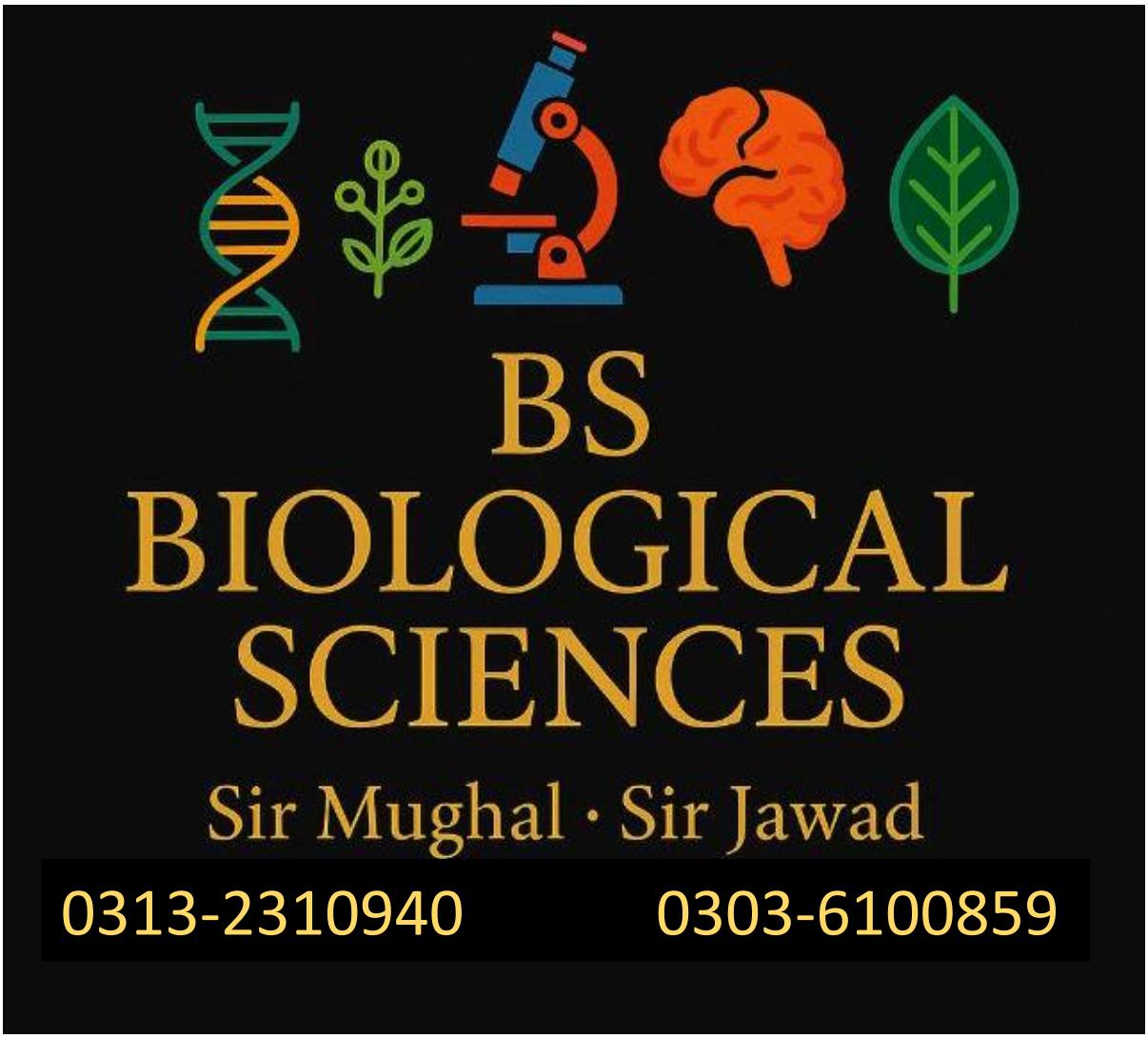
1. ***Microspores*** – Small spores that develop into male gametophytes (producing sperm).
2. ***Megaspores*** – Larger spores that develop into female gametophytes (producing eggs).

Heterospory is an important evolutionary adaptation because it leads to the development of seeds in seed plants and promotes sexual differentiation, specialization, and more efficient reproduction. It is seen in plants like Selaginella, Salvinia, and many gymnosperms.

64. Explain dual nature of Amphibians.

Amphibians are described as having a dual nature because they exhibit adaptations for both aquatic and terrestrial life. Most amphibians, like frogs, toads, and salamanders, lay their eggs in water**,** and their larvae (tadpoles) are fully aquatic, possessing gills for underwater respiration and tails for swimming. This aquatic phase allows them to grow and develop in water before moving to land.

As adults, amphibians typically live on land, breathing primarily through lungs and skin (cutaneous respiration)**.** Their limbs and skeletal structure are adapted for locomotion on land**,** but they remain dependent on moist environments to prevent desiccation. This amphibious lifestyle—living both in water during early stages and on land as adults—represents the dual nature of amphibians and highlights their role as a transitional group in vertebrate evolution.



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