BT201 – ECOLOGY, BIODIVERSITY & EVOLUTION II

MID TERM MOST IMPORTANT QUESTIONS

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GROUP LINK: https://chat.whatsapp.com/BjC6W0jZx8o9yaC2ISh1Gu

1. Explain notochord.

The notochord is a flexible, rod-like structure found in the embryos of all chordates, serving as a key feature that distinguishes this group of animals. Positioned along the dorsal side of the embryo, it provides essential structural support and helps guide the development of surrounding tissues, including the formation of the neural tube, which later becomes the spinal cord. In vertebrates, the notochord is eventually replaced by the vertebral column, though remnants of it persist as part of the intervertebral discs. This structure plays a critical role in organizing the body plan during early development and is fundamental to the classification of animals within the phylum Chordata.

2. Write a short note on Echinodermata.

Echinodermata is a phylum of marine animals that includes starfish, sea urchins, sea cucumbers, and brittle stars. They are characterized by radial symmetry in adults (usually five-point), a water vascular system used for movement and feeding, and a calcareous endoskeleton made of ossicles. Echinoderms have no head or centralized brain, but they possess a nerve ring and are capable of regeneration. They are exclusively marine and play important roles in ocean ecosystems. Unique among invertebrates, echinoderms share developmental features with chordates, making them evolutionarily significant.

3. Explain subphylum Chelicerate.

The subphylum Chelicerata is a group of arthropods that includes animals such as spiders, scorpions, ticks, mites, horseshoe crabs, and sea spiders. Members of this group are characterized by having chelicerae, which are specialized mouthparts used for feeding. Unlike other arthropods, chelicerates do not have antennae. Their bodies are typically divided into two main parts: the cephalothorax (prosoma) and the abdomen (opisthosoma). Most chelicerates have four pairs of walking legs, and many are adapted for predation or parasitism. This subphylum is part of the larger phylum Arthropoda and includes both terrestrial and aquatic species, with significant ecological and medical importance.

4. Write short note on Appendix.

The appendix is a small, tube-like structure attached to the cecum, which is part of the large intestine in the human digestive system. It is located in the lower right side of the abdomen. For a long time, the appendix was considered a vestigial organ with no significant function. However, recent studies suggest it may play a role in the immune system, particularly in maintaining gut flora by serving as a reservoir for beneficial bacteria. Despite this, the appendix can become inflamed, leading to a condition known as appendicitis, which often requires surgical removal.

5. Name the organism belonging to each of the following group: Shapeless Protozoa, Ciliate, Flagellate, Sporozoa.

Here are examples of organisms belonging to each specified group:

1. ***Asymmetrical*** – *Amoeba*
2. ***Shapeless Protozoa*** – *Amoeba*
3. ***Ciliate*** – *Paramecium*
4. ***Flagellate*** – *Euglena*
5. ***Sporozoa*** – *Plasmodium*

6. What techniques are being developed by comparative genomics?

Comparative genomics is the study of the similarities and differences in the genomes of different organisms. Several advanced techniques are being developed and refined in this field to better understand gene function, evolution, and disease. These include:

1. ***Genome Sequencing and Assembly*** – High-throughput sequencing technologies are used to rapidly decode entire genomes, followed by computational assembly to reconstruct them accurately.
2. ***Genome Alignment Tools*** – Techniques like whole-genome alignment allow researchers to compare DNA sequences across species to identify conserved and divergent regions.
3. ***Phylogenomic Analysis*** – Combines genomic data with evolutionary biology to construct detailed phylogenetic trees and understand evolutionary relationships.
4. ***Gene Annotation and Prediction*** – Algorithms are being developed to identify genes, regulatory elements, and non-coding regions across species by comparison.
5. ***Ortholog and Paralog Identification*** – Tools are used to identify genes in different species that originated from a common ancestor, helping to trace gene function and duplication events.
6. ***Synteny Mapping*** – This technique maps the order of genes on chromosomes across species to study genome rearrangements and conservation.
7. ***Functional Genomics Integration*** – Combines comparative data with transcriptomics and proteomics to infer gene function and regulatory networks.
8. ***Comparative Epigenomics*** – Studies differences and similarities in epigenetic markers (like DNA methylation) between species to understand gene regulation.

7. What is convergent evolution?

Convergent evolution is the process by which unrelated or distantly related organisms independently evolve similar traits or features as a result of adapting to similar environments or ecological niches. This occurs not because of shared ancestry, but due to similar selective pressures.

Example:

- Wings in birds**,** bats, and insects evolved independently, yet all serve the function of flight.
- The streamlined bodies of dolphins (mammals) and sharks (fish) are another example, evolved separately for efficient swimming.

8. What is the evolutionary significance of sequencing whole genome in ecological studies?

Sequencing whole genomes in ecological studies has significant evolutionary importance because it provides comprehensive insights into the genetic makeup of organisms, allowing researchers to understand how species adapt, evolve, and interact with their environments. By comparing whole genomes across populations and species, scientists can identify genetic variations linked to traits important for survival and reproduction in specific ecological contexts. This helps reveal patterns of natural selection, gene flow, and genetic drift that shape biodiversity. Additionally, whole-genome data enable the study of evolutionary relationships and the detection of cryptic species, contributing to better conservation strategies. Overall, whole-genome sequencing deepens our understanding of the molecular basis of adaptation and evolution within ecosystems.

9. How life on earth depends on Oxidation and Reduction reaction?

Life on Earth fundamentally depends on oxidation-reduction (redox) reactions because these chemical processes drive the flow of energy needed for biological functions. In redox reactions, one molecule loses electrons (oxidation) while another gains electrons (reduction). This transfer of electrons is crucial for energy production in cells.

For example, during cellular respiration, glucose is oxidized, and oxygen is reduced, releasing energy stored in chemical bonds. This energy is then captured in the form of ATP, which powers various cellular activities essential for life. Similarly, photosynthesis involves redox reactions where water is oxidized and carbon dioxide is reduced to produce glucose and oxygen. These redox processes sustain the energy cycles that support growth, reproduction, and maintenance of living organisms, making them vital for life on Earth.

10. What are the methods of prey capturing among spiders?

Spiders use a variety of methods to capture their prey, adapted to their species and environment. The main methods include:

1. ***Web-building:*** Many spiders spin intricate webs made of silk to trap flying or crawling insects. When prey gets stuck, the spider senses the vibrations and quickly immobilizes it. Examples include orb-weaver spiders.
2. ***Active hunting:*** Some spiders, like jumping spiders and wolf spiders, do not use webs but actively stalk and pounce on their prey using speed and agility.

3. ***Trapdoor spiders:*** These spiders build silk-lined burrows with camouflaged trapdoors and wait for prey to pass by, then swiftly grab it.
4. ***Bolus throwing:*** Some spiders fling sticky silk balls at their prey to immobilize them before capture.
5. ***Bolas spiders:*** These spiders use a single line of sticky silk with a droplet at the end, swinging it to catch moths attracted by chemical mimicry.

11. How can gene be identified?

A gene can be identified using several molecular and computational techniques that locate specific DNA sequences associated with inherited traits or biological functions. Here are the main methods:

1. ***DNA Sequencing:*** Modern sequencing technologies (like Next-Generation Sequencing) read the entire genome, allowing scientists to identify gene regions based on known patterns such as start/stop codons and regulatory elements.
2. ***Gene Annotation:*** Computational tools scan DNA sequences for characteristic features like open reading frames (ORFs), promoters, and splice sites to predict gene locations and functions.
3. ***Comparative Genomics:*** Genes can be identified by comparing the DNA sequence of an unknown genome with that of a well-studied organism, looking for conserved gene sequences.
4. ***Expression Analysis:*** Techniques like RT-PCR, microarrays, or RNA sequencing detect actively transcribed genes by analyzing mRNA, confirming which parts of the genome are functional genes.
5. ***Mutational Analysis:*** Observing phenotypic changes caused by mutations helps identify genes responsible for specific traits or diseases.
6. ***Gene Probes and Hybridization:*** Short, labeled DNA or RNA sequences (probes) can bind to complementary gene sequences in a sample, helping locate genes of interest.

12. How evolution's history of organisms are documented into a genome?

The evolutionary history of organisms is documented in their genomes through changes that accumulate in DNA over time. These changes serve as a biological record of evolution. Here's how:

1. ***Mutations:*** Random mutations in DNA—such as substitutions, insertions, or deletions—accumulate over generations. Some of these changes become fixed in populations and can be traced to understand evolutionary timelines.
2. ***Conserved Sequences:*** Genes or DNA regions that remain similar across different species indicate shared ancestry. Highly conserved genes suggest essential biological functions and point to common evolutionary origins.
3. ***Gene Duplication and Loss:*** The presence or absence of certain genes, or multiple copies of a gene, can show how organisms adapted to different environments or evolved new traits.
4. ***Endogenous Retroviruses and Mobile Elements:*** Genomes often carry viral DNA or repetitive elements that were inserted millions of years ago. Their presence and patterns can be used as evolutionary markers.
5. ***Comparative Genomics:*** By comparing genomes of different species, scientists can reconstruct evolutionary relationships, track divergence events, and estimate how long ago species split from common ancestors.

6. ***Molecular Clocks:*** The rate at which mutations accumulate can be used as a "clock" to estimate evolutionary time and date lineage splits.

13. Explain feeding behavior of Annelids.

The feeding behavior of annelids (segmented worms) varies widely depending on the species and habitat, but they generally exhibit specialized strategies suited to their ecological roles. Here are the main feeding behaviors:

1. ***Deposit Feeding:*** Many annelids, like earthworms (*Lumbricus*), ingest soil or sediment to extract organic matter and decomposing plant material. They process the material through their digestive system, absorbing nutrients and excreting the rest.
2. ***Filter Feeding:*** Some aquatic annelids, such as certain polychaetes, filter microscopic organisms or organic particles from the water using specialized appendages or cilia-lined structures.
3. ***Predatory Feeding:*** Carnivorous annelids, like the *Nereis* species (ragworms), actively hunt small invertebrates. They may have strong jaws or eversible pharynges (a kind of extendable throat) to grasp and consume prey.
4. ***Parasitic Feeding:*** A few annelids, such as leeches (*Hirudinea*), are ectoparasites that feed on the blood of vertebrates. They use suckers and secrete anticoagulants to draw blood efficiently.

14. Explain reproduction in Annelids.

Reproduction in annelids varies across different groups but includes both asexual and sexual methods, with many species capable of regeneration.

1. Asexual Reproduction:

- Some annelids, especially in the class Polychaeta and a few Oligochaetes, reproduce asexually by budding or fragmentation, where parts of the body break off and regenerate into a new individual.
- This is common in environments where rapid population growth is advantageous.

2. Sexual Reproduction:

- Most annelids reproduce sexually, and their reproductive strategies differ by class:

a. Oligochaetes (e.g., Earthworms):

- They are hermaphrodites, meaning each individual has both male and female reproductive organs.
- During mating, two earthworms exchange sperm. Fertilization occurs externally in a mucus ring secreted by the clitellum, which later slips off the body and forms a cocoon where embryos develop.

b. Polychaetes (Marine worms):

- Most have separate sexes (dioecious), and fertilization is usually external.
- They release sperm and eggs into the water, often synchronously, during breeding seasons.
- Some species produce reproductive individuals called epitokes, which break off and release gametes.

c. Hirudinea (Leeches):

- Like earthworms, leeches are also hermaphroditic and engage in internal fertilization.
- Fertilized eggs are deposited in a cocoon, where development occurs.

15. Define the terms: Biosphere, Biome, Ecosystem, Community, Population.

1. Biosphere

The biosphere is the global sum of all ecosystems. It includes all life on Earth and the physical environments in which they live—land, water, and atmosphere. It's the broadest level of ecological study. Example: The entire Earth, including forests, oceans, deserts, and the atmosphere where life exists.

2. Biome

A biome is a large geographic region characterized by a specific climate, vegetation, and wildlife. Biomes contain many ecosystems with similar climate and organisms. Example: The tundra, rainforest, desert, and grassland are all examples of biomes.

3. Ecosystem

An ecosystem consists of all the living organisms (biotic factors) in a particular area, along with the non-living components (abiotic factors) such as sunlight, water, and soil, interacting as a system. Example: A coral reef, a pond, or a forest ecosystem.

4. Community

A community includes all the different populations of species that live and interact in the same area. Example: In a forest, the community includes trees, birds, insects, fungi, and other organisms living together.

5. Population

A population refers to a group of individuals of the same species living in a specific geographic area at the same time. Example: A population of deer in a woodland area.

16. How can a protein be used to characterize into gene?

How a Protein Can Be Used to Identify a Gene

1. Isolate the protein from cells.
2. Determine its amino acid sequence using mass spectrometry.
3. Infer the possible DNA sequence (gene) that could code for the protein.
4. Design DNA probes or primers based on the protein sequence.
5. Use these to find the gene in a DNA or cDNA library via PCR or hybridization.
6. Confirm the gene by checking if it produces the same protein.

17. Write history of Biodiversity.

History of Biodiversity

The concept of biodiversity—the variety of life on Earth—has a long history rooted in biology, ecology, and conservation science. Here's a brief overview:

1. Ancient Observations

- Early humans noticed the diversity of plants and animals for survival (e.g., hunting, farming, and medicine).
- Ancient texts from Greece, India, and China mention different species and their uses.

2. Scientific Foundations (18th–19th Century)

- ***Carl Linnaeus** (1707–1778):* Developed a system to classify organisms (taxonomy), which helped organize knowledge of species.
- ***Charles Darwin** (1809–1882):* His theory of evolution by natural selection explained how species diversify over time.
- Naturalists began documenting global species during exploration and colonization.

3. Modern Ecology and Conservation (20th Century)

- The field of ecology emerged, studying how organisms interact with each other and the environment.
- Scientists realized that human activities (e.g., deforestation, pollution) were reducing species diversity.
- The term **"**biological diversity**"** began to appear in scientific literature.

4. The Term "Biodiversity" (1980s)

- The word "biodiversity" was popularized during the 1986 National Forum on Biodiversity in the U.S., organized by biologist E.O. Wilson.
- It became a key term in environmental science and policy.

5. Global Action (1990s–Today)

- ***1992 Earth Summit** (Rio de Janeiro):* Led to the **Convention on Biological Diversity (CBD)**, a global treaty to protect biodiversity.
- Ongoing international efforts aim to conserve species, protect ecosystems, and promote sustainable use of natural resources.

18. What do you know about plant breeding?

Plant breeding is the science-driven art of improving plants for human benefit. It involves selecting plants with desirable traits and using various methods to develop improved varieties that perform better in terms of yield, quality, resistance to pests and diseases, climate adaptability, and other agronomic or horticultural traits.

Key Concepts in Plant Breeding:

1. ***Selection***
   - Choosing plants with favorable traits from a population to be parents of the next generation.
   - Types include mass selection**,** pure line selection, and clonal selection.

2. ***Hybridization***
   - Crossing genetically different plants to produce offspring (hybrids) that combine traits from both parents.
   - This includes intraspecific (same species) and interspecific (different species) crosses.

3. ***Genetic Variation***
   - The foundation of plant breeding. Variation can be natural or induced through mutation breeding or polyploidy.

4. ***Mendelian Genetics***
   - Understanding inheritance patterns is essential to predict and manipulate the transmission of traits.

5. ***Quantitative Genetics***
   - Many traits (like yield or drought tolerance) are controlled by multiple genes, requiring statistical tools to evaluate.

6. ***Backcrossing***
   - A breeding method used to introduce a specific trait from one variety into the genetic background of another.

7. ***Marker-Assisted Selection (MAS)***
   - Using DNA markers to select plants with desirable genes, speeding up the breeding process and improving accuracy.

8. ***Genomic Selection***
   - Uses whole-genome data to predict the breeding value of plants, improving efficiency in complex trait selection.

9. ***Genetic Engineering / Biotechnology***
   - Transferring genes from other organisms into plants (e.g., Bt cotton, Golden Rice). It's controversial but powerful.

10. ***CRISPR and Gene Editing***
    - New tools allow precise edits to the plant genome, offering more targeted and faster breeding solutions.

11. ***Participatory Breeding***
    - Involves farmers directly in selecting and developing new varieties, especially in developing countries.

Types of Plant Breeding:

- ***Conventional Breeding:*** Based on crossing and selection, guided by field performance.
- ***Modern/Genetic Breeding:*** Utilizes molecular tools and genetic engineering.
- ***Organic Breeding:*** Focuses on developing varieties adapted to organic farming systems.

19. Correlate mRNA and protein.

The relationship between mRNA and protein levels is complex and not always linear. While mRNA serves as the template for protein synthesis, the amount of mRNA in a cell does not directly determine the amount of protein produced. Several factors influence this correlation, including the stability of the mRNA, how efficiently it is translated, and how quickly the resulting protein is degraded. Additionally, post-transcriptional mechanisms, such as regulation by microRNAs or RNA-binding proteins, can suppress or enhance translation independently of mRNA abundance. Post-translational modifications and differences in protein half-lives also

contribute to discrepancies between mRNA and protein levels. As a result, while there is often a general trend or moderate correlation—especially for housekeeping genes—many genes show weak or inconsistent correspondence between their mRNA and protein levels due to these regulatory complexities.

20. What is Species Tree and Gene Tree?

A **species tree** is a diagram that represents the evolutionary relationships among different species, showing how they have diverged from common ancestors through speciation over time. It reflects the "true" evolutionary history of organisms at the species level and is typically constructed using data from multiple genes or entire genomes to ensure accuracy. Species trees are used to understand how different species are related and to trace the lineage of groups of organisms across evolutionary time. They are fundamental in evolutionary biology, systematics, and comparative genomics, providing a framework for studying biodiversity and the history of life.

A **gene tree**, on the other hand, traces the evolutionary history of a specific gene or gene family across different species or individuals. Unlike species trees, gene trees focus on the genetic level and can be influenced by events such as gene duplication, gene loss, horizontal gene transfer, or incomplete lineage sorting. As a result, the branching pattern of a gene tree may not always match the corresponding species tree. Gene trees are important for understanding the molecular evolution of genes, functional divergence, and the mechanisms of genetic inheritance, and they can offer insights into evolutionary events that are not apparent in species-level analyses.

21. Write role of Bioinformatics in health and human food.

Bioinformatics plays a vital role in improving health and food by using computational tools to analyze biological data. In healthcare, it helps identify disease-causing genes, supports personalized medicine, aids in drug and vaccine development, and enables early disease detection. It also helps track infectious diseases and understand their genetic makeup. In the food sector, bioinformatics improves crop yield, quality, and resistance by analyzing plant genomes. It supports the development of genetically improved crops, ensures food safety by detecting pathogens, and promotes personalized nutrition through nutritional genomics. Overall, it enhances both human health and food security.

22. Define homology and its types.

Homology refers to the similarity between biological structures, genes, or proteins due to shared ancestry. When two sequences or structures are homologous, it means they evolved from a common ancestor. Homology is a key concept in evolutionary biology and bioinformatics, used to infer evolutionary relationships and functional similarities.

Types of Homology:

1. ***Orthologs:*** Genes in different species that evolved from a common ancestral gene through speciation. They usually retain the same function. Example: The hemoglobin gene in humans and mice.

2. ***Paralogs:*** Genes related by duplication within the same genome. They may evolve new functions. Example: Human hemoglobin and myoglobin genes.

3. ***Xenologs:*** Genes that are related through horizontal gene transfer between species, rather than vertical inheritance. Example: Antibiotic resistance genes transferred between bacteria.

23. Define Sarcodina, its types and its characteristics.

Sarcodina is a subphylum of protozoa (unicellular eukaryotic organisms) characterized by their ability to move and feed using temporary projections of their cytoplasm called pseudopodia. These organisms are mostly found in aquatic or moist environments and play important roles in ecological food chains and nutrient cycling.

Characteristics of Sarcodina:

- ***Locomotion:*** Move using pseudopodia (false feet), which are also used to engulf food by phagocytosis.
- ***Nutrition:*** Mostly heterotrophic; they ingest food particles like bacteria or other protozoa.
- ***Body Structure:*** Unicellular and often without a fixed shape due to their flexible cell membrane.
- ***Reproduction:*** Mainly asexual, through binary fission.
- ***Habitat:*** Aquatic environments, moist soil, or as parasites in animals.
- ***Examples:*** *Amoeba proteus*, *Entamoeba histolytica* (a human parasite).

Types of Sarcodina (based on structure and lifestyle):

- ***Lobosea:*** Have broad, lobe-shaped pseudopodia. Example: *Amoeba proteus*.
- ***Filosea:*** Possess slender, thread-like pseudopodia. Often found in freshwater or marine environments.
- ***Radiolaria:*** Marine forms with intricate silica skeletons and radial symmetry. Have stiff, radiating pseudopodia.
- ***Foraminifera:*** Marine organisms with calcareous shells and long, branching pseudopodia. Important in fossil records and geological studies.
- ***Heliozoa:*** Spherical cells with axopodia (thin, stiff pseudopodia) radiating from the surface. Mostly freshwater organisms.

24. Write features of flightless birds.

Flightless birds are a group of birds that have lost the ability to fly through evolution. Despite this, they have adapted well to their environments and exhibit unique features that distinguish them from flying birds.

Features of Flightless Birds:

1. ***Reduced or Vestigial Wings:*** Their wings are usually small and not suitable for flight, though they may be used for balance, display, or swimming (e.g., penguins).
2. ***Strong Legs:*** They have powerful, well-developed legs adapted for running, walking, or swimming, depending on the species.
3. ***Heavy Bodies:*** Many flightless birds have larger and heavier bodies, making flight physically impractical.
4. ***Flat or Reduced Keel:*** The breastbone (keel), which in flying birds anchors strong flight muscles, is reduced or absent.
5. ***Feather Adaptations:*** Their feathers are often softer or more hair-like, especially in birds like ostriches or kiwis, since they don't need aerodynamic feathers for flying.

6. ***Ground-Dwelling:*** Most flightless birds live and nest on the ground, relying on speed, camouflage, or group defense for protection.
7. ***Evolutionary Isolation:*** Many evolved on islands with few predators, where flight became unnecessary (e.g., New Zealand's kiwi, Madagascar's extinct elephant birds).
8. ***Examples:*** Ostrich, emu, kiwi, cassowary, penguin, and the extinct dodo.

25. Explain exoskeleton in Arthropods.

The **exoskeleton** in arthropods is a hard, external covering that provides support, protection, and structure to their bodies. Made primarily of chitin, a tough, flexible polysaccharide, and often reinforced with proteins and minerals like calcium carbonate, the exoskeleton acts like a suit of armor. It protects arthropods from physical damage, dehydration, and predators, while also serving as a point of attachment for muscles, enabling movement. Since the exoskeleton is rigid and does not grow with the animal, arthropods periodically shed it through a process called molting or ecdysis to allow for growth. The exoskeleton also plays a role in preventing water loss, which is crucial for arthropods living in terrestrial environments. Overall, the exoskeleton is a key adaptation that has contributed to the success and diversity of arthropods.

26. Why zoos are considered land in living dead?

The phrase **"zoos are considered land in living dead"** seems a bit unclear or possibly mistranslated, but if you're referring to why **zoos** are sometimes called places where animals are like the "living dead," it relates to the idea that animals in zoos often live in unnatural, confined environments that restrict their natural behaviors and instincts.

Animals in zoos might appear alive but not truly living as they would in the wild—limited in movement, unable to hunt or roam freely, and sometimes stressed or bored. Their survival depends entirely on humans, and while they are physically alive, their natural way of life is greatly diminished, leading to this metaphorical idea of being "living dead."

27. Define consequences of deforestation.

Deforestation is the large-scale removal of trees from forests, and it has several serious consequences for the environment and human life. It leads to loss of biodiversity because many plants and animals lose their natural habitats, causing some species to become endangered or extinct. Deforestation also contributes to climate change by reducing the number of trees that absorb carbon dioxide, a major greenhouse gas, thus increasing global warming. It causes soil erosion, as tree roots that hold soil in place are removed, leading to loss of fertile land and increased risk of floods and landslides. Additionally, deforestation disrupts the water cycle, affecting rainfall patterns and reducing water availability. It can also impact local communities that depend on forests for their livelihood, fuel, and food, leading to social and economic problems. Overall, deforestation threatens ecosystem stability, climate balance, and human well-being.

28. Write uses of phylogenetic.

Phylogenetics, the study of evolutionary relationships among organisms, has several important applications. It helps scientists understand the evolutionary history and relatedness of species, tracing how they have diverged from common ancestors. Phylogenetic analysis is used in classification and taxonomy to group organisms based on evolutionary lineage rather than just physical similarities. It aids in identifying new species and

understanding biodiversity. In medicine, phylogenetics tracks the evolution and spread of pathogens, such as viruses and bacteria, helping to manage outbreaks and develop vaccines. It also supports comparative genomics, allowing researchers to predict gene functions by studying related species. Additionally, phylogenetics informs conservation efforts by identifying genetically important populations and evolutionary distinct species that need protection. Overall, it is a powerful tool for research across biology, ecology, and health sciences.

29. What is the difference between free floating and Zooprotozoans?

Free-floating protozoans are mostly aquatic, single-celled organisms that drift or float freely in water bodies like ponds, lakes, and oceans. They are often planktonic and rely on water currents for movement. Many free-floating protozoans are autotrophic (able to perform photosynthesis) or mixotrophic, combining photosynthesis and heterotrophy.

Zooprotozoans, on the other hand, are protozoans that are primarily heterotrophic and animal-like. They actively move using structures like cilia, flagella, or pseudopodia and obtain nutrients by ingesting other organisms or organic matter. Zooprotozoans are often free-living but can also be parasitic.

30. Which bacteria as a genomic is valuable because of degradation of pollution?

Pseudomonas species are among the most valuable bacteria gnomically for their ability to degrade pollution. These bacteria have versatile metabolic pathways that allow them to break down a wide range of environmental pollutants, including hydrocarbons, pesticides, and industrial chemicals. Because of this, *Pseudomonas* plays a key role in bioremediation, the process of using microorganisms to clean up contaminated soils, water, and air. Their genomes often contain genes encoding enzymes that can degrade toxic compounds, making them especially important for environmental cleanup efforts.

31. What is the feeding behavior of leeches?

Leeches are mostly hematophagous, meaning they feed on the blood of other animals. They attach to their hosts using suckers and use sharp, specialized jaws or a proboscis to pierce the skin and suck blood. Some leeches secrete an anticoagulant called hirudin to prevent the host's blood from clotting, allowing them to feed more easily. While many leeches feed on blood, some are predatory and consume small invertebrates instead. Overall, their feeding behavior is adapted to either parasitic blood-feeding or predation, depending on the species.

32. What is Industrial Ecology?

Industrial Ecology is a field of study that examines the flow of materials and energy through industrial systems with the goal of creating sustainable and environmentally friendly production processes. It views industrial systems like natural ecosystems, where waste from one process can become the input for another, promoting recycling, resource efficiency, and waste reduction. By optimizing these flows, industrial ecology aims to minimize environmental impact, reduce pollution, conserve resources, and support sustainable development. It combines principles from engineering, environmental science, economics, and social sciences to design systems that mimic natural cycles and improve the overall sustainability of industrial activities.

33. Why freshwater is life threatened nowadays?

Freshwater is increasingly becoming life-threatening due to several critical issues. Rapid pollution from industrial waste, agricultural runoff, and untreated sewage contaminates freshwater sources, making the water unsafe for drinking and harming aquatic life. Over-extraction of freshwater for agriculture, industry, and human consumption leads to depletion of rivers, lakes, and underground aquifers. Climate change is causing droughts and altering rainfall patterns, reducing freshwater availability in many regions. Habitat destruction and loss of wetlands further diminish natural water purification and storage systems. These factors together threaten not only human health but also the survival of countless plants and animals that depend on freshwater ecosystems, making freshwater scarcity a pressing global concern.

34. What is sequencing?

Sequencing is the process of determining the exact order of nucleotides (adenine, thymine, cytosine, and guanine) in a DNA or RNA molecule. It reveals the precise genetic information encoded in a gene or genome. Sequencing is fundamental in genetics and molecular biology because it helps scientists understand the structure, function, and evolution of genes. Modern sequencing technologies, like Next-Generation Sequencing (NGS)**,** allow rapid and large-scale analysis of entire genomes, enabling advances in research, medicine, and biotechnology.

35. Explain backward draw of protein gene characterization.

Reverse Genetics (Backward Approach):

In reverse genetics, researchers start with a known gene sequence and work backward to understand its function and the protein it encodes. This contrasts with forward genetics, which starts from a phenotype (observable trait) and searches for the responsible gene. The process usually involves:

- Identifying a gene sequence of interest.
- Manipulating the gene through techniques like gene knockout, knockdown, or mutation.
- Observing changes in the protein product or the organism's phenotype.
- Characterizing how the gene influences protein structure, function, and biological role.

36. Why breeding of new crops is important?

Breeding new crops is important because it helps develop varieties that are more productive, nutritious, and resilient to environmental stresses. New crop varieties can have higher yields to meet the growing food demand of an increasing global population. They can also be bred for resistance to pests, diseases, drought, and extreme temperatures, reducing crop losses and the need for chemical inputs. Improved crops may have better nutritional qualities, enhancing food security and public health. Additionally, breeding supports sustainable agriculture by creating plants that use resources more efficiently and adapt to changing climates. Overall, crop breeding is vital for ensuring stable food supplies, protecting the environment, and supporting farmers' livelihoods.

37. What is importance of Biodiversity?

Biodiversity is critically important because it ensures ecosystem stability, resilience, and productivity. A rich variety of plants, animals, and microorganisms supports essential ecosystem services like pollination, nutrient cycling, water purification, and soil fertility, all of which are vital for human survival. Biodiversity also provides

genetic resources necessary for agriculture, medicine, and biotechnology, enabling the development of new crops and treatments. Moreover, diverse ecosystems help regulate the climate and protect against natural disasters. Beyond practical benefits, biodiversity has cultural, aesthetic, and recreational value, enriching human life. Protecting biodiversity is essential to maintain the health of the planet and ensure sustainable development for future generations.

38. What were the conditions on early earth?

The conditions on early Earth, about 4.5 billion years ago, were very harsh and vastly different from today. The planet's surface was extremely hot, with frequent volcanic eruptions and intense volcanic activity releasing gases like water vapor, carbon dioxide, methane, ammonia, and nitrogen into the atmosphere. There was little to no free oxygen. The atmosphere was thick and mostly made up of these volcanic gases, creating a reducing environment. Early Earth was also bombarded by meteorites and exposed to strong ultraviolet radiation from the sun due to the lack of a protective ozone layer. Oceans formed as the planet cooled, creating environments where life could potentially begin. These extreme conditions set the stage for the chemical reactions that eventually led to the origin of life.

39. What are advantages of In Situ Conservation?

In situ conservation refers to the preservation of species in their natural habitats. Its advantages include maintaining the natural ecosystem and evolutionary processes, allowing species to continue adapting to environmental changes. It helps conserve not only individual species but also the complex interactions between them and their environment, which is essential for ecosystem stability. In situ conservation is often more cost-effective than ex situ methods and supports local communities by preserving resources they depend on. It also protects a wide range of genetic diversity within species, which is important for their long-term survival and potential use in agriculture, medicine, and research. Overall, it ensures the conservation of biodiversity in a natural and sustainable way.

40. Write names of some extinct birds. Write reason for extinction of any one bird.

Here are some names of extinct birds:

1. **Dodo** (*Raphus cucullatus*)
2. **Great Auk** (*Pinguinus impennis*)
3. **Passenger Pigeon** (*Ectopistes migratorius*)
4. **Labrador Duck** (*Camptorhynchus labradorius*)
5. **Carolina Parakeet** (*Conuropsis carolinensis*)

Reason for Extinction of the Dodo:

The dodo became extinct primarily due to human activities after it was discovered on the island of Mauritius. Hunting by sailors and the introduction of invasive species like rats, pigs, and monkeys destroyed dodo nests and competed for food. Since the dodo was flightless and had no natural predators before humans arrived, it was vulnerable and unable to adapt quickly to these new threats, leading to its extinction in the late 1600s.

41. What role bacteria play in oxidation and reduction?

In **oxidation**, certain bacteria (called chemoautotrophs) obtain energy by oxidizing inorganic substances like ammonia, nitrites, or sulfur compounds, converting them into forms that other organisms can use. For example, nitrifying bacteria oxidize ammonia (NH_3) to nitrites (NO_2^-) and then to nitrates (NO_3^-) in the nitrogen cycle.

In **reduction**, other bacteria perform the opposite reaction by using compounds like nitrates, sulfates, or carbon dioxide as electron acceptors in the absence of oxygen. For instance, denitrifying bacteria reduce nitrates back to nitrogen gas (N_2), completing the nitrogen cycle. Similarly, sulfate-reducing bacteria reduce sulfate to hydrogen sulfide. Through these oxidation-reduction reactions, bacteria help recycle nutrients, maintain ecosystem balance, and drive energy flow in various environments.

42. What is sustainability?

Sustainability is the ability to meet present needs without compromising the ability of future generations to meet their own needs. It involves managing resources—such as natural, economic, and social—in a way that balances environmental health, economic growth, and social well-being over the long term. Sustainability aims to create systems that are environmentally friendly, economically viable, and socially equitable, ensuring that ecosystems and human communities can thrive now and in the future. It's a guiding principle for responsible development and conservation efforts worldwide.

43. Define systematics.

Systematics is the scientific study of the diversity of organisms and their evolutionary relationships. It involves identifying, naming, and classifying species based on their genetic, morphological, and ecological characteristics, as well as reconstructing their evolutionary history through phylogenetic analysis. Systematics helps organize biological diversity into a framework that reflects how species are related to each other, providing insights into their origins, adaptations, and classification.

44. Why all members of species are not selected for studies?

All members of a species are not selected for studies because it is often impractical, time-consuming, and costly to study every individual. Instead, scientists use a representative sample that reflects the genetic diversity and characteristics of the whole population. Sampling allows researchers to make reliable conclusions while managing resources efficiently. Studying all members might also be impossible due to the species' large population size, wide distribution, or ethical concerns, especially when dealing with endangered species or humans. Proper sampling ensures manageable, accurate, and meaningful scientific analysis.

45. Write characteristics of crustaceans.

Characteristics of Crustaceans:

1. ***Body Structure:*** Crustaceans have a segmented body divided into three parts—head, thorax, and abdomen. Often, the head and thorax are fused into a cephalothorax.
2. ***Exoskeleton:*** They possess a hard, chitinous exoskeleton that provides protection and support. This exoskeleton is often hardened by calcium carbonate.
3. ***Antennae:*** Crustaceans have two pairs of antennae, which are sensory organs used for touch and taste.

4. ***Limbs:*** They have jointed appendages, including legs and claws (chelae), adapted for walking, swimming, feeding, and defense.
5. ***Respiration:*** Most crustaceans breathe through gills.
6. ***Circulatory System:*** They have an open circulatory system with a heart that pumps hemolymph through the body.
7. ***Reproduction:*** Crustaceans usually reproduce sexually, with separate sexes, though some can reproduce parthenogenetically.
8. ***Nervous System:*** They have a well-developed nervous system with a brain and paired ventral nerve cords.
9. ***Habitat:*** Mostly aquatic, living in marine or freshwater environments, though some species are terrestrial.
10. Examples include crabs, lobsters, shrimps, and barnacles.

46. What kind of areas are suitable for conservation of forests and wildlife?

Areas suitable for the conservation of forests and wildlife are typically those that have rich biodiversity, intact ecosystems, and minimal human disturbance. These include:

1. ***Protected Areas:*** National parks, wildlife sanctuaries, and biosphere reserves where human activities are regulated or restricted to protect habitats and species.
2. ***Forest Reserves:*** Regions with dense and healthy forest cover that serve as natural habitats for various flora and fauna.
3. ***Ecologically Sensitive Zones:*** Areas with endangered species, unique ecosystems, or important ecological functions like watersheds and wetlands.
4. ***Corridors and Buffer Zones:*** Regions that connect fragmented habitats, allowing animal movement and genetic exchange.
5. ***Remote and Undisturbed Regions:*** Places less affected by urbanization, agriculture, or industrial development.
6. ***Community-Conserved Areas:*** Regions managed by local communities who depend on and protect their natural resources sustainably.

47. Describe the traits that breeders have tried to incorporate into crop plants?

Breeders have aimed to incorporate several important traits into crop plants to improve their productivity, resilience, and quality. These traits include:

1. ***High Yield:*** To increase the amount of produce per plant or per hectare.
2. ***Disease Resistance:*** To protect crops from fungal, bacterial, viral, and pest attacks, reducing losses and the need for chemical pesticides.
3. ***Drought and Stress Tolerance:*** To enable crops to survive and produce under water scarcity, extreme temperatures, or poor soil conditions.
4. ***Early Maturity:*** To shorten the growing season, allowing multiple crops per year or avoiding adverse weather.
5. ***Improved Nutritional Quality:*** Enhancing protein content, vitamins, and minerals to improve human nutrition.
6. ***Better Taste and Appearance:*** To meet consumer preferences and increase market value.

7. ***Herbicide and Pest Resistance:*** To facilitate easier weed control and reduce crop damage.
8. ***Storage and Shelf-life:*** To improve post-harvest durability and reduce spoilage.

48. What are orthologous and paralogous genes?

Orthologous genes are genes in different species that originated from a common ancestral gene through speciation. They usually retain the same function across species. For example, the gene for hemoglobin in humans and mice are orthologs.

Paralogous genes are genes related by gene duplication within the same genome. They may evolve new or specialized functions over time. For example, the human hemoglobin and myoglobin genes are paralogs.

49. What are molds and mildews? How are they economically important?

Molds and mildews are types of fungi that grow as multicellular filaments called hyphae.

- Molds usually appear as fuzzy or woolly growths on food, soil, or decaying organic matter and come in various colors like green, black, or white.
- Mildews are a specific type of mold that grows flat and often looks powdery or downy, typically found on plants or damp surfaces.

Economic Importance:

- ***Beneficial Uses:***
  - Molds are essential in the production of antibiotics (e.g., *Penicillium* species produce penicillin).
  - They are used in food industries for cheese making (e.g., *Penicillium roqueforti* in blue cheese).
  - Some molds help in fermentation and biodegradation processes.
- ***Harmful Effects:***
  - Molds and mildews can spoil food, leading to significant economic losses.
  - They cause plant diseases that reduce crop yields and quality.
  - Some produce mycotoxins harmful to humans and animals.

50. What is Binomial Nomenclature?

Binomial nomenclature is the system of naming living organisms using two Latinized names: the genus name followed by the species name. This method, developed by Carl Linnaeus, provides a standardized and universally accepted way to identify species. For example, *Homo sapiens* is the scientific name for humans, where *Homo* is the genus and *sapiens* is the species. The genus name is always capitalized, while the species name is lowercase, and both are italicized or underlined. This system helps avoid confusion caused by common names and allows scientists worldwide to communicate clearly about specific organisms.

51. Why inbreeding is disadvantageous for the genetic diversity?

Inbreeding is disadvantageous for genetic diversity because it involves the mating of closely related individuals, which reduces the genetic variation within a population. This leads to several negative effects:

1. ***Loss of Genetic Diversity:*** With fewer unique alleles being passed on, the gene pool becomes limited, reducing the population's ability to adapt to environmental changes or resist diseases.

2. ***Increased Homozygosity:*** Inbreeding increases the chances that offspring will inherit identical copies of genes from both parents, including harmful recessive alleles.
3. ***Inbreeding Depression:*** This refers to reduced biological fitness in a population due to the expression of deleterious recessive traits, leading to lower survival and reproduction rates.
4. ***Reduced Evolutionary Potential:*** Populations with low genetic diversity are less likely to evolve in response to natural selection, making them more vulnerable to extinction.

52. What is the purpose of transcriptome analysis?

The purpose of transcriptome analysis is to study the complete set of RNA transcripts produced by the genome under specific circumstances or in a specific cell, tissue, or organism. This type of analysis provides a snapshot of gene expression and is crucial for understanding how genes are regulated and how they function in various biological processes.

Key Purposes of Transcriptome Analysis:

1. ***Gene Expression Profiling:***
   - Determines which genes are active (expressed) and to what extent in a given sample.
   - Helps compare expression patterns between different conditions (e.g., healthy vs. diseased tissue).
2. ***Functional Annotation of the Genome:***
   - Helps identify new genes, exons, and alternative splicing events.
   - Refines gene models and improves genome annotation.
3. ***Understanding Regulatory Mechanisms:***
   - Reveals how gene expression is regulated in response to internal or external signals (e.g., stress, drugs, and developmental cues).
4. ***Disease Research:***
   - Identifies gene expression changes associated with diseases such as cancer, neurological disorders, or infectious diseases.
   - Can lead to biomarker discovery and insights into disease mechanisms.
5. ***Developmental and Comparative Studies:***
   - Analyzes how gene expression changes during development or between different species.
   - Aids in evolutionary biology studies by comparing transcriptomes across species.
6. ***Drug Discovery and Toxicology:***
   - Assesses how drugs or toxins affect gene expression.
   - Can identify pathways or targets affected by a treatment.

53. Arthropods are successful in the genetic diversity. Give reasons.

Arthropods are considered one of the most genetically and biologically successful groups of animals on Earth. Their genetic diversity and adaptability have enabled them to colonize nearly every habitat. Here are key reasons for their success in terms of genetic diversity:

1. ***Large Species Diversity:*** Arthropods represent over 80% of all known animal species**,** including insects, arachnids, crustaceans, and myriapods. This incredible species richness reflects a vast genetic pool and variation.

2. ***High Reproductive Rates:*** Many arthropods reproduce rapidly and in large numbers. This leads to faster generation turnover**,** increasing the chances of beneficial genetic mutations and natural selection.

3. ***Metamorphosis:*** Many insects undergo complete metamorphosis (egg → larva → pupa → adult), allowing different life stages to occupy different ecological niches. This reduces competition within the species and encourages specialization, supporting adaptive genetic divergence**.**

4. ***Adaptability to Diverse Environments:*** Arthropods have adapted to live in virtually all environments — from deep oceans to deserts to Arctic regions. Their genetic makeup supports physiological and behavioral adaptability**,** allowing them to thrive under diverse environmental pressures.

5. ***Exoskeleton and Segmentation:*** The exoskeleton provides protection and structural support, while jointed limbs and segmented bodies enable versatility in movement and function. Variations in these traits across groups reflect evolutionary adaptation and genetic variation**.**

6. ***Complex Sensory and Nervous Systems:*** Arthropods possess highly developed sensory organs (e.g., compound eyes, antennae) and nervous systems, helping them respond effectively to environmental changes. Genes associated with sensory input and neural development are diverse and finely tuned**,** enabling complex behaviors.

7. ***Horizontal Gene Transfer and Symbiosis:*** Some arthropods engage in symbiotic relationships (e.g., with gut microbes) or horizontal gene transfer**,** which can enhance genetic capabilities (e.g., digestion, immunity).

8. ***Evolutionary History:*** Arthropods have existed for over 500 million years**,** giving them ample evolutionary time to diversify genetically and morphologically.

54. Differentiate between homology and analogy.

Homologous structures are those that are similar because they were inherited from a common ancestor. These structures may serve different functions in different organisms but share a similar underlying anatomy and developmental origin. For example, the forelimbs of humans, whales, bats, and cats are structurally similar, even though they are used for different purposes such as grasping, swimming, flying, or walking. This indicates a shared evolutionary origin.

Analogous structures arise through convergent evolution, where unrelated organisms independently evolve similar traits as a result of adapting to similar environments or ecological niches. These structures serve similar functions but do not have a common ancestral origin and often differ in internal structure. A classic example is the wings of birds and insects. Both are used for flying, but their structural makeup and embryonic development are entirely different. Thus, while homology reflects evolutionary relationships, analogy reflects functional similarity without shared ancestry.

Disclaimer:

For best results, it is advised NOT to rely on this file only. Go through video lectures, handouts and other sources as well.

Regards,
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