Biodiversity & Classification

Unit 1 — Short Questions and SLO,Based Answers

Unit 1: Biodiversity & Classification — Short Questions

Q1. What constitute the three domains of life, and how do they diverge regarding cellular architecture?

Three Domains of Life:

- In 1990, American microbiologist Carl Woese categorized living entities into three domains: **Archaea**, **Bacteria**, and **Eukaryota (Eukarya)**.
- Under this tripartite framework, both Archaea and Bacteria comprise prokaryotic organisms, yet diverge significantly across various biological traits.

Cellular Architecture:

- **Archaea:** Prokaryotic organisms devoid of membrane,bound organelles and a true nucleus. Their plasma membranes feature unique lipids bound via **ether linkages** between glycerol and fatty acid chains.
- **Bacteria:** Also prokaryotic, lacking a true nucleus and membrane,bound organelles. Their plasma membranes contain lipids with **ester linkages** anchoring fatty acids to glycerol.
- **Eukarya:** Eukaryotic cells containing a true nucleus bounded by a nuclear envelope, with membrane,bound organelles such as mitochondria and chloroplasts.

Q2. Elucidate a primary distinguishing characteristic that segregates Archaea from Bacteria.

Answer: A key structural disparity lies in cell envelope composition. Archaeal cell walls entirely **lack cellulose and peptidoglycan**, instead incorporating unique polysaccharides and proteins, with some taxa possessing **pseudopeptidoglycan**. Bacterial cell walls predominantly consist of **peptidoglycan** — a polymer of carbohydrate chains cross,linked by amino acid peptides, providing mechanical integrity.

Q3. Which biological kingdom is characterized by organisms containing chitin within their cell walls and functioning primarily as saprotrophs (decomposers)?

Answer: Kingdom Fungi is characterized by **chitin** within cell walls. Fungi are decomposers due to their **absorptive (osmotrophic) nutrition**, acquiring nutrients without ingesting solid organic material. Examples: mushrooms, rusts, smuts, and molds.

Q4. What mode of speciation transpires when populations undergo geographic isolation?

Answer: Allopatric speciation occurs when populations become geographically segregated by physical barriers, experience different environmental pressures, and undergo independent evolutionary trajectories. Accumulated genetic divergence eventually precludes interbreeding, even if the barrier is later removed. Example: Darwin's finches across the Galápagos Archipelago.

Q5. What is the impact of genetic drift on the mechanism of speciation?

Answer: Genetic drift denotes stochastic (random) fluctuations in allele frequencies within small, isolated populations. It drives genetic divergence and promotes the emergence of novel species lineages.

Q6. What primary methodology is employed to evaluate species distribution across an environmental gradient?

Answer: Transect sampling is the principal quantitative methodology, involving a line or narrow strip across a study site with systematic recording of organism abundance and diversity at intervals. Example: a transect perpendicular to the shoreline from high tide to low tide, recording intertidal zonation.

Q7. Which tier of biodiversity assessment entails evaluating the variety of ecosystems within a geographical region?

Answer: Assessment at the **Ecosystem Level** measures the heterogeneity of ecological communities within a territory — forests, wetlands, deserts — to understand how ecosystem dynamics contribute to overall ecological integrity.

SLO,Based Short Question Answers

Three,Domain System

Q8. Define phylogeny. Define and illustrate a phylogenetic tree.

Answer: Phylogeny is the evolutionary history and relationships among ancestral and extant organisms. A **phylogenetic tree** is a diagrammatic representation of evolutionary lineage relationships, also called an evolutionary tree.

Q9. What motivated Carl Woese to propose the three,domain system, and how does it diverge from Whittaker's five,kingdom classification?

Answer: Woese used **molecular phylogenetic evidence** (ribosomal RNA sequencing) showing prokaryotes are not a single monophyletic group, but split into Archaea and Bacteria. Whittaker's five,kingdom system grouped all prokaryotes into Kingdom Monera; Woese instead split prokaryotes into two domains, with Eukarya as the third.

Q10. What molecular evidence indicates that Archaea share a closer evolutionary affinity to Eukarya than to Bacteria?

Answer: Archaea share genomic sequences and transcription/translation machinery strikingly similar to Eukarya but absent in Bacteria, indicating closer phylogenetic kinship to Eukarya.

Q11. Define Domain. Enumerate the three domains delineated by Carl Woese.

Answer: A **Domain** is the highest taxonomic rank, above Kingdom. Woese (1990) proposed:

1. Domain Archaea
2. Domain Bacteria
3. Domain Eukarya

Q12. Delineate the dimensional range and modes of reproduction characteristic of domain Archaea.

Answer: Size: Solitary archaeal cells range from 0.1 μm to 15 μm in diameter; some form aggregates or filaments up to 200 μm long. **Reproduction:** Exclusively asexual — binary fission, multiple fission, fragmentation, or budding. No true mitosis or meiosis occurs.

Q13. Compare the cellular membrane composition of Archaea with that of Bacteria and Eukarya.

Answer: Archaeal membranes use **ether linkages** joining glycerol to hydrophobic side chains, while Bacteria and Eukarya use **ester linkages**. Archaeal fatty acid chains are **branched**; Bacteria/Eukarya chains are predominantly **unbranched**.

Q14. Structural representation of Archaeal vs. Bacterial/Eukaryotic Membrane Lipids.

Answer: (Reference schematic: branched,chain ether linkages in Archaea versus unbranched,chain ester linkages in Bacteria and Eukarya.)

Q15. How do Archaea differ from Eukarya and Bacteria regarding cell wall composition?

- **Archaeal cell wall:** unique polysaccharides and proteins (no cellulose or peptidoglycan).
- **Bacterial cell wall:** peptidoglycan (alternating disaccharides cross,linked by peptide chains).
- **Eukaryotic cell wall:** plants use cellulose; fungi use chitin.
- *Note:* some archaea contain pseudopeptidoglycan, differing from bacterial peptidoglycan in backbone and linkages.

Q16. State the metabolic disparities distinguishing Archaea from Eukarya and Bacteria.

- **Archaea:** unique pathways such as **methanogenesis** (methane production), absent in Bacteria and Eukarya.
- **Bacteria:** photosynthesis (oxygenic/anoxygenic), nitrogen fixation, fermentation.
- **Eukarya:** aerobic cellular respiration, photosynthesis (plants/algae), specialized fermentation.

Q17. Elaborate on the application of diverse Archaea within biotechnology, wastewater treatment, and biomining/bioleaching.

- **Biotechnology:** extremophilic archaea provide thermostable, acid/alkali,tolerant enzymes (e.g., DNA polymerases for PCR that withstand high heat).
- **Sewage treatment:** methanogenic archaea drive anaerobic digestion, converting waste into biogas.
- **Biomining/bioleaching:** acidophilic archaea extract valuable metals (gold, cobalt, copper) from low,grade ores.

Q18. Enumerate the four principal groups of Archaea alongside their respective natural habitats.

1. **Methanogens:** anaerobic environments, produce methane.
2. **Halobacteria:** hyper,saline waters.
3. **Thermococci:** high,temperature hydrothermal environments.
4. **Thaumarchaeota:** widely distributed, active in nitrogen cycling.

Q19. Is there an established association between Humans and Archaeans?

Answer: Yes — **methanogens** reside in the human gut as part of normal microbiota; their metabolic gas production can contribute to flatulence and abdominal discomfort.

Q20. What appendages do bacteria possess, and what are their respective functional roles?

- **Flagella:** whip,like structures for locomotion.
- **Pili:** hair,like structures facilitating conjugation (gene transfer between cells).
- **Fimbriae:** short projections aiding adhesion to surfaces and biofilm formation.

Q21. What are plasmids? Describe their structural characteristics and distinguish them from bacterial chromosomal DNA.

Answer: Plasmids are small, extrachromosomal, double,stranded circular DNA molecules that replicate independently and transfer horizontally between bacteria, aiding traits like antibiotic resistance. The **bacterial chromosome** is a single, larger circular DNA molecule in the nucleoid, encoding essential survival genes.

Q22. Define EXTREMOPHILES and provide illustrative examples of harsh environmental parameters in which specific bacteria proliferate.

Answer: Extremophiles are organisms (bacteria and archaea) thriving in conditions lethal to most life.

1. **Thermophiles:** adapted to extreme heat.
2. **Halophiles:** adapted to hyper,saline habitats.
3. **Acidophiles:** thrive in low,pH environments.

Q23. What structural features are shared between Archaea and Bacteria?

1. Both have prokaryotic organization — no membrane,bound nucleus or organelles.
2. Both have a single circular double,stranded DNA chromosome in an undefined nucleoid region.
3. Both reproduce asexually, via binary fission and fragmentation.

Q24. Describe the morphological diversity of Bacteria and Archaea.

Answer: They exhibit varied shapes: spherical (cocci), rod,shaped (bacilli), spiral (spirilla), lobed, rectangular, or comma,shaped (vibrios).

Q25. Enumerate the major taxonomic groups of bacteria along with representative species.

1. **Proteobacteria:** *E. coli*, *Rhizobium*, *Helicobacter pylori*
2. **Firmicutes:** *Bacillus subtilis*, *Lactobacillus*, *Clostridium botulinum*
3. **Actinobacteria:** *Streptomyces*, *Mycobacterium tuberculosis*
4. **Cyanobacteria:** *Anabaena*, *Spirulina*
5. **Spirochaetes:** *Treponema pallidum*
6. **Acidobacteria:** *Acidobacterium*
7. **Aquificae:** *Aquifex pyrophilus*

Q26. Why is the eukaryotic cell considered a highly organized structure, and what functional advantages do its specialized organelles confer over prokaryotic cells?

Answer: Eukaryotic cells have a true nucleus with a double,membrane envelope and specialized organelles:

- **Mitochondria:** oxidative phosphorylation for energy.
- **Chloroplasts:** photosynthetic carbon fixation.
- **Golgi apparatus, lysosomes, peroxisomes:** processing, sorting, and catabolic centers.
- **Cytoskeleton:** microtubules, microfilaments, and intermediate filaments providing structural support, transport, and motility.

Q27. How does the organization of genetic material in a eukaryotic cell offer evolutionary advantages compared to a prokaryotic cell?

Answer: Eukaryotic DNA is compartmentalized into multiple linear chromosomes within a nucleus, complexed with **histone proteins** forming chromatin — enabling precise compaction, gene regulation, and accurate segregation during cell division.

Q28. How do eukaryotes execute reproductive processes?

- Most reproduce **sexually** via meiosis and gametic fertilization, generating genetic variation.
- Some also reproduce **asexually** via mitosis, producing genetically identical clones.

Q30. Define taxa and taxonomic hierarchy. Enlist the levels of taxonomic hierarchy from highest to lowest rank.

Answer: Taxonomic hierarchy is the framework classifying organisms into nested groups (taxa) based on shared evolutionary and morphological traits.

1. Domain
2. Kingdom
3. Phylum
4. Class
5. Order
6. Family
7. Genus
8. Species

Continued Questions & Answers

Q29. Elucidate the evolutionary origin of the eukaryotic cell and explain how the endosymbiotic theory accounts for this transition.

Answer: Eukaryotes are thought to have arisen through **endosymbiosis**: primitive host cells engulfed ancestral prokaryotic endosymbionts (precursors to mitochondria and chloroplasts), eventually forming a mutually beneficial, obligate symbiotic relationship.

Q31. Delineate the taxonomic distinctions between a Kingdom and a Phylum.

• **Kingdom:** a highly inclusive rank directly below Domain, grouping organisms sharing broad fundamental traits (e.g., Animalia, Plantae, Fungi).

• **Phylum:** the rank beneath Kingdom, encompassing organisms sharing a unified body plan (e.g., Phylum Chordata within Animalia — organisms with a notochord, such as mammals, birds, reptiles, amphibians, and fishes).

Q32. How are organisms categorized within the Class and Order ranks of the taxonomic hierarchy?

• **Class:** subdivides a phylum by specialized shared traits (e.g., Class Mammalia — homeothermy, body hair, mammary glands).

• **Order:** further categorizes organisms within a class (e.g., Order Primates — humans, monkeys, apes; enlarged brain, opposable digits).

Q33. Explain the interrelationship between the Genus and Species ranks.

Answer: Species is the most specific taxonomic unit — organisms capable of interbreeding to produce fertile offspring (e.g., *Homo sapiens*). **Genus** is a broader rank grouping closely related species (e.g., genus *Homo* includes *H. sapiens*, *H. habilis*, *H. erectus*).

Q34. Detail the complete taxonomic hierarchy for Humans (Homo sapiens) and Onions (Allium cepa).

Taxonomic Rank	Human (Homo sapiens)	Onion (Allium cepa)
Domain	*Eukarya*	*Eukarya*

Kingdom	*Animalia*	*Plantae*
Phylum	*Chordata*	*Tracheophyta (Angiosperms)*
Class	*Mammalia*	*Monocotyledonae*
Order	*Primates*	*Asparagales*
Family	*Hominidae*	*Amaryllidaceae*
Genus	*Homo*	*Allium*
Species	*Homo sapiens*	*Allium cepa*

Q35. Detail the complete biological classification for the House Sparrow (Passer domesticus).

Taxonomic Rank	House Sparrow (Passer domesticus)
Domain	*Eukarya*
Kingdom	*Animalia*
Phylum	*Chordata*
Class	*Aves*

(Note: the source material ends mid,entry for the House Sparrow's Order rank.)

Kingdoms, Animal Phyla, Vertebrates, Virology & Ecology

Q35 (continued) through Q105 — Short Question Answers

Q35. Detail the complete biological classification for the House Sparrow (Passer domesticus).

Taxonomic Rank	House Sparrow (Passer domesticus)
Domain	Eukarya
Kingdom	Animalia
Phylum	Chordata
Class	Aves
Order	Passeriformes
Family	Passeridae
Genus	Passer
Species	Passer domesticus

Salient Features of Kingdom Protista & Fungi

Q36. Describe the salient features of Kingdom Protista and enumerate its major functional groupings.

Answer: Kingdom Protista encompasses eukaryotic organisms displaying unicellular, colonial, or simple multicellular coenocytic organization (no specialized multicellular reproductive organs).

- **Protozoa (animal,like):** unicellular heterotrophs (e.g., Paramecium, Amoeba, Plasmodium, Trypanosoma).
- **Algae (plant,like):** photosynthetic autotrophs with cellulose,based walls and chlorophyll (e.g., Euglena, diatoms, chlorophytes, phaeophytes).
- **Fungus,like protists:** heterotrophic saprotrophs — Myxomycota (slime molds) and Oomycota (water molds).

Q37. Provide a concise overview of the principal groups within Kingdom Protista.

- **Protozoa:** heterotrophic, unicellular, diverse motility (Paramecium, Amoeba, Plasmodium, Trypanosoma).
- **Algae:** autotrophic, photosynthetic, cellulose walls, chlorophyll (Euglena, diatoms, macroalgae).
- **Myxomycota & Oomycota:** fungus,like, coenocytic hyphae,like filaments, saprotrophic decomposers (Physarum polycephalum, Phytophthora infestans).

Q38. State the key diagnostic features characterizing Kingdom Fungi.

- Eukaryotic, non,photosynthetic, absorptive heterotrophs (osmotrophs).
- Unicellular or multicellular filamentous forms.

- Cell walls composed primarily of chitin.
- Nutrients acquired via extracellular enzyme secretion then absorption.
- Examples: mushrooms, rusts, smuts, molds, yeasts.

Q39. Summarize the major phyla comprising Kingdom Fungi.

- **Zygomycota** (conjugating fungi): non,septate/coenocytic hyphae (Rhizopus, Spirobolus).
- **Ascomycota** (sac fungi): largest phylum, septate hyphae, sexual spores in asci (morels, truffles, Neurospora, yeasts).
- **Basidiomycota** (club fungi): extensively septate hyphae, spores on club,shaped basidia (mushrooms, toadstools, puffballs, bracket fungi, rusts, smuts).

Kingdom Plantae & Animalia (Invertebrates)

Q40. Outline the general characteristics and principal divisions of Kingdom Plantae.

Answer: Multicellular eukaryotic autotrophs with cellulose cell walls, using chlorophyll for photosynthesis, developing from embryonic structures.

- **Bryophytes:** non,vascular plants, lacking conducting tissue.
- **Tracheophytes:** vascular plants with xylem and phloem.

Q41. Differentiate between Non,Vascular and Vascular Plants.

Parameter	Non,Vascular (Bryophytes)	Vascular (Tracheophytes)
Common Term	Bryophytes	Tracheophytes
Vascular Tissues	Lacks xylem and phloem	Possesses xylem and phloem
Taxa / Examples	Liverworts, hornworts, mosses	Ferns; gymnosperms and angiosperms

Q42. Describe the aquiferous (water flow) system of sponges (Phylum Porifera).

- **Ostia:** incurrent pores where water enters.
- **Spongocoel:** central cavity lined with flagellated cells.
- **Osculum:** large excurrent opening where water exits.

Q43. Describe the histological layers constituting the body wall of sponges.

- **Pinacoderm** (outer): flattened pinacocytes.
- **Mesohyl** (middle): gelatinous matrix with amoebocytes and spicules.
- **Choanoderm** (inner): flagellated choanocytes (collar cells) driving water currents and capturing food.

Q44. Elucidate reproductive mechanisms in sponges, specifically detailing responses to adverse environmental conditions.

Answer: Sponges reproduce sexually and asexually (budding/fragmentation). Under stress, many freshwater and marine sponges form resistant internal **gemmules**; when conditions improve, totipotent amoeboid cells emerge to regenerate a full sponge.

Q45. Detail the processing method for commercial sponges and state their practical applications and representative taxa.

Answer: Preparation: drying, beating, and maceration remove cellular material, leaving the spongin skeleton. **Applications:** hygiene, surgical fluid absorption, acoustic insulation. **Taxa:** Leucosolenia, Spongilla (freshwater), Euplectella (Venus' flower basket).

Q46. Enumerate the defining diagnostic characteristics of Phylum Cnidaria.

- Radial symmetry, diploblastic (ectoderm and endoderm).
- Cnidocytes bearing nematocysts for defense/prey capture.
- Gastrovascular cavity with a single opening serving as mouth and anus.

Q47. Compare the digestive architecture of Cnidarians and Platyhelminthes, highlighting the evolutionary advantage exhibited by flatworms.

Answer: Cnidarians have a simple sac,like gastrovascular cavity with one opening. Platyhelminthes also have an incomplete sac,like gut, but it is extensively branched, increasing surface area for direct nutrient diffusion without needing a circulatory system.

Q48. Delineate the structural body plan of Cnidarians.

- **Epidermis:** outer layer, from ectoderm.
- **Gastrodermis:** inner digestive lining, from endoderm.
- **Mesoglea:** jelly,like middle layer with amoeboid cells.

Q49. Explain the structure and physiological role of nematocysts.

Answer: Nematocysts are stinging organelles within cnidocytes that discharge toxic harpoon,like threads upon stimulation, paralyzing prey and deterring predators without need for complex musculature.

Q50. Describe the dimorphic body forms observed across Phylum Cnidaria.

- **Polyp:** sessile, cylindrical, reproduces asexually by budding (e.g., Hydra).
- **Medusa:** motile, umbrella,shaped, reproduces sexually (e.g., jellyfish).

Q51. Explain how flame cells mediate nitrogenous excretion and osmoregulation in flatworms.

Answer: Flatworms use protonephridia with ciliated **flame cells** that generate fluid pressure, drawing interstitial fluid into excretory tubules; waste and excess water are filtered and discharged via ventral nephridiopores.

Q52. Describe the body wall architecture and symmetry of Platyhelminthes.

Answer: Bilateral symmetry (anterior,posterior, dorsal,ventral, lateral axes), triploblastic acoelomate organization from ectoderm, endoderm, and mesoderm. The mesoderm forms parenchyma filling the space between the body wall and organs.

Q53. Enumerate representative taxa belonging to Phylum Platyhelminthes.

- Planaria (free,living turbellarian)
- Fasciola hepatica (liver fluke)
- Taenia species (tapeworm)

Q54. Describe the excretory anatomy characteristic of parasitic roundworms (Nematoda).

Answer: Parasitic nematodes have protonephridial structures with paired longitudinal excretory canals along the lateral body wall, coalescing anteriorly to discharge wastes through a single ventral nephridiopore.

Q55. Name representative species of roundworms (Phylum Nematoda).

- Caenorhabditis elegans (free,living model organism)
- Ascaris lumbricoides (intestinal parasite)
- Hookworms (Ancylostoma)
- Pinworms (Enterobius)
- Whipworms (Trichuris)

Mollusca, Annelida, Arthropoda & Echinodermata

Q56. Elaborate on the primary anatomical regions constituting the body structure of mollusks.

- **Head:** anterior region with sensory structures and neural ganglia.
- **Visceral mass:** houses metabolic, digestive, excretory, reproductive organs.
- **Muscular foot:** ventral organ for locomotion or burrowing.

Q57. Define the Mantle and Radula in Phylum Mollusca.

- **Mantle:** epithelial fold enclosing the visceral mass, forms mantle cavity, secretes the shell in most species.
- **Radula:** chitinous rasping organ used for scraping/ingesting food (absent in bivalves).

Q58. Describe the cardiovascular organization of Phylum Mollusca.

Answer: Except in cephalopods, mollusks have an open circulatory system: hemolymph is pumped by a heart (one ventricle, two auricles) through short vessels into open sinuses (hemocoel), bathing organs directly before returning to the heart.

Q59. Why do some mollusks possess an open circulatory system while others possess a closed circulatory system?

- **Open system:** hemolymph directly bathes cells in interstitial sinuses/hemocoel.
- **Closed system:** blood stays within vessels, no direct contact with tissue.

Answer: Cephalopods (octopus, cuttlefish, squid) are active predators needing high metabolic rates and continuous oxygenation via a high,pressure closed system. Less active mollusks (gastropods, bivalves) manage with a low,pressure open system.

Q60. Classify Phylum Mollusca with representative examples.

- **Gastropoda:** snails, slugs (e.g., Helix aspersa).
- **Bivalvia:** two,valved shell (mussels, oysters, clams).
- **Cephalopoda:** highly encephalized, modified tentacled foot (squid, cuttlefish, octopus).

Q62. Define metameric segmentation in Annelids and explain its physiological significance.

Answer: The annelid body is divided into repeating segments (metameres), separated externally by constrictions and internally by mesodermal septa. Each metamere has independent coelomic chambers, nerve ganglia, excretory organs, and vascular elements, enabling localized muscular contraction and locomotion.

Q63. Enlist representative taxa of Phylum Annelida alongside their characteristic habitats.

- Nereis (clam worm): marine benthic environment.

- Hirudo medicinalis (leech): freshwater/semi,aquatic habitats.
- Lumbricus terrestris (earthworm): damp, organic,rich soil.

Q64. Describe the nervous system and sensory receptors of Annelids.

Answer: Nervous system: bilobed cerebral ganglion (brain) linked via connectives to a double ventral nerve cord with segmental ganglia. **Sensory receptors:** tactile receptors, chemoreceptors, statocysts, and photoreceptors.

Q65. Why must Arthropods undergo ecdysis (molting)?

Answer: Arthropods have a rigid chitinous cuticle that cannot expand, restricting growth. Periodic shedding (ecdysis/molting) allows body expansion before the new exoskeleton hardens.

Q66. Define tagmata and contrast tagmatization with ancestral annelid segmentation.

Answer: Tagmata are specialized body regions (head, thorax, abdomen) formed by evolutionary fusion (tagmatization) of ancestral metameres. Unlike the uniform, independently functioning segments of annelids, tagmatization groups segments into units specialized for specific functions.

Q67. Outline the respiratory, excretory, and nervous systems of Arthropods.

- **Respiratory:** tracheal systems with spiracles (or book lungs) in terrestrial forms; gills in aquatic species.
- **Excretory:** Malpighian tubules at the midgut,hindgut junction, precipitating wastes as uric acid.
- **Nervous:** centralized brain (three fused ganglia pairs) with a double ventral nerve cord and segmental ganglia.

Q68. Classify Phylum Arthropoda into major subphyla/classes with examples.

- **Crustacea:** aquatic, bi,ramous appendages (crayfish, crabs, lobsters, prawns).
- **Insecta:** tri,segmented body, three pairs of legs (wasps, grasshoppers, butterflies, dragonflies).
- **Arachnida:** chelicerate mouthparts, four pairs of legs (mites, spiders, scorpions, ticks).
- **Myriapoda:** elongated, multi,segmented (centipedes, millipedes).

Q69. Describe the body symmetry exhibited by Echinoderms across life cycles.

- **Larval stage:** bilaterally symmetrical, free,swimming.
- **Adult stage:** pentaradiate (five,part) radial symmetry around an oral,aboral axis.

Q70. Detail the structure and mechanics of the Echinoderm water,vascular system.

Answer: Water enters through the **madreporite**, down a stone canal into a ring canal around the esophagus. **Radial canals** extend along ambulacral grooves, with lateral canals connecting to muscular ampullae and tube feet (podia). Hydraulic pressure shifts extend the tube feet, enabling adhesion, locomotion, gas exchange, and prey capture.

Q71. List representative Echinoderms categorized by body morphology.

- Sand dollar: biscuit,shaped/flattened disk.
- Sea urchin: globular test with movable spines.
- Sea cucumber: soft,bodied, elongated.
- Starfish: central disk with short radiating arms.
- Brittle star: central disk with long, slender, flexible arms.

Chordata & Vertebrate Adaptations

Q72. Enumerate the four definitive synapomorphies (diagnostic traits) of Phylum Chordata.

- Notochord: axial supporting rod.
- Dorsal hollow nerve cord.
- Pharyngeal slits.
- Post,anal tail.

Q73. Define the Notochord and explain its occurrence across Chordate lineages.

Answer: The notochord is a flexible rod of vacuolated cells in a fibrous sheath, dorsal to the gut and ventral to the nerve cord. In protochordates (e.g., Amphioxus) it persists for life; in vertebrates it appears in the embryo and is replaced by a cartilaginous or bony vertebral column.

Q74. Explain the evolutionary fates and transformations of pharyngeal slits.

- **Invertebrate chordates & fishes:** functional gill slits for respiration/feeding.
- **Amphibians:** functional larval gills, lost at metamorphosis.
- **Amniotes:** modified into structures like the Eustachian tube, middle ear cavity, and palatine tonsils.

Q75. Differentiate between Subphylum Urochordata and Subphylum Cephalochordata.

Feature	Urochordata (Tunicata)	Cephalochordata
Notochord Persistence	Only in larval tail; lost in sessile adults	Persists throughout life
Enclosure	Tunic made of tunicin	Naked, segmented myotomes
Representative Taxa	Sea squirts (Ascidia), Molgula	Amphioxus (Branchiostoma)

Q76. Define Vertebrates and outline their primary sub,divisional grouping.

Answer: Vertebrates are chordates with a distinct cranium protecting a tripartite brain and a segmented vertebral column replacing the embryonic notochord.

- **Pisces:** limbless aquatic vertebrates — Cyclostomata, Chondrichthyes, Osteichthyes.
- **Tetrapoda:** four,limbed vertebrates — Amphibia, Reptilia, Aves, Mammalia.

Q77. Compare the key anatomical features of Class Chondrichthyes and Class Osteichthyes.

Parameter	Chondrichthyes (Cartilaginous)	Osteichthyes (Bony)
Endoskeleton	Entirely cartilaginous	Calcified bony matrix
Integument	Placoid (tooth,like) scales	Bony scales (ctenoid/ganoid/cycloid)
Fins	Paired pectoral/pelvic; two dorsal fins	Median and paired fins
Reproduction	Typically internal fertilization	Predominantly external fertilization

Q78. If a frog and a lizard both lay eggs in an arid desert, which species' offspring will survive? Justify.

Answer: Lizard eggs will survive. Lizards produce **amniotic eggs** with extra,embryonic membranes (amnion, allantois, chorion, yolk sac): the amnion buffers against shock/desiccation, the chorion handles gas exchange, and the allantois stores uric acid waste. A leathery, calcareous shell reduces water loss while allowing gas exchange. Frog (anamniotic) eggs lack these protections and desiccate in dry air.

Q80. Enlist representative taxa of Class Reptilia.

- Turtles / Tortoises (Testudines)
- Cobras / Snakes (Squamata)
- Tuatara (Sphenodon)
- Crocodiles / Alligators (Crocodilia)

Q81. Differentiate between Poikilotherms (Ectotherms) and Homeotherms (Endotherms).

Parameter	Poikilotherms (Ectotherms)	Homeotherms (Endotherms)
Thermoregulation	Body temp fluctuates with environment	Maintains constant core temperature
Heat Source	External (solar/conduction)	Internal metabolic heat
Representative Taxa	Fishes, amphibians, reptiles	Birds, mammals

Avian & Mammalian Physiology

Q82. Explain the anatomical functions of the Crop and Gizzard in birds.

- **Crop:** esophageal sac for rapid food storage, allowing foraging in risky open areas and later digestion under shelter.
- **Gizzard:** muscular stomach region with a keratinous lining that grinds food and grit, compensating for lack of teeth.

Q83. Describe the anatomical perspective of the avian respiratory system.

Answer: Air flows from external nares through the pharynx, trachea, and primary bronchi into thin,walled air sacs, which act as bellows driving air through non,collapsible lungs with parabronchi, enabling continuous unidirectional airflow. Sound is produced at the tracheal bifurcation via the **syrinx**.

Q84. Why do birds exhibit diverse bill and tongue structures? Name representative taxa.

Answer: Bills and tongues have evolved to specialize for different dietary niches and foraging behaviors. Examples: Emu, Kiwi, Pigeon, Sparrow, Falcon, Hummingbird.

Q85. Differentiate between flighted and flightless (ratite) birds with examples.

- **Flighted (Carinatae):** keeled sternum for flight muscle attachment (pigeons, falcons, eagles, robins).
- **Flightless (Ratites):** flat sternum lacking a keel (ostrich, kiwi, rhea, emu, cassowary, penguins).

Q86. Why are mammals named as such? List the defining diagnostic characteristics of Class Mammalia.

Answer: Named for **mammary glands**, which secrete milk to nourish offspring.

- Presence of hair/fur.
- Sebaceous and sudoriferous (sweat) skin glands.

- Heterodont, diphyodont, thecodont dentition.
- External ear pinnae.
- Middle ear with three ossicles (malleus, incus, stapes).
- Muscular diaphragm separating thoracic and abdominal cavities.

Q87. Distinguish between Oviparous, Viviparous, and Ovoviviparous animals with examples.

- **Oviparous:** eggs laid externally, development outside the body (most fishes, amphibians, reptiles, birds, monotremes like the platypus).
- **Viviparous:** embryos develop internally with placental nourishment, live birth (placental mammals).
- **Ovoviviparous:** embryos develop in eggs retained internally without placental nourishment (some sharks, vipers, echidna, platypus).

Q88. Why do marsupial mammals possess an abdominal pouch (marsupium)?

Answer: Marsupials have a short,lived, rudimentary placenta, so young are born extremely altricial and must crawl into the pouch to attach to a teat and complete development (e.g., kangaroos, opossums, Tasmanian devils).

Q89. Why are Placental Mammals considered the most evolutionarily advanced clade? Justify.

Answer: Placental mammals evolved a complex allantoic placenta enabling prolonged intrauterine gestation with intimate maternal,fetal exchange for nutrients, gas, waste removal, and immune protection — producing precocial, well,developed offspring (e.g., dolphins, primates, elephants).

Acellular Entities: Prions, Viroids & Virology

Q90. What do you know about prions and viroids?

- **Prions:** infectious misfolded proteins with no nucleic acid, causing neurodegenerative encephalopathies.
- **Viroids:** short, circular, unencapsulated single,stranded RNA infecting plants.

Answer: Examples: potato spindle tuber disease, chrysanthemum stunt disease.

Q91. Why are viruses not considered living organisms? Write their chemical composition.

Answer: Viruses lack cellular organization, independent metabolism, and ATP generation; they are obligate intracellular parasites dependent on host machinery, falling outside the three,domain system. A virion consists of a nucleic acid core (DNA or RNA) surrounded by a protein **capsid** made of capsomeres; enveloped viruses also have an outer phospholipid membrane from the host.

Q92. On what basis are viruses classified? Name the governing body establishing these guidelines.

Answer: Viruses are classified by genome type, strand architecture, capsid symmetry, replication strategy, envelope presence, and host range. The **International Committee on Taxonomy of Viruses (ICTV)** sets these standards.

Q93. Classify viruses on the basis of host range and provide representative examples.

- **Animal viruses:** influenza, rabies, HIV, herpesviruses.
- **Plant viruses:** Tobacco Mosaic Virus (TMV), Potato virus X.
- **Bacteriophages:** T4 phage, Lambda phage.
- **Archaeal viruses:** Sulfolobus spindle,shaped virus.

Q94. How are viruses classified on the basis of structural morphology? Give examples.

- **Helical:** rod/filament with helical cavity (TMV, rabies virus).
- **Icosahedral:** 20 triangular faces, 12 vertices (adenoviruses, herpesviruses).
- **Complex:** icosahedral head with helical tail (T,even bacteriophages).
- **Enveloped:** lipid bilayer with glycoproteins (influenza, HIV).
- **Non,enveloped (naked):** no lipid envelope (poliovirus, adenovirus).

Q95. Classify viruses on the basis of genetic material and associated pathologies.

- **dsDNA:** adenoviruses (respiratory infections), herpesviruses (herpes simplex, chickenpox).
- **ssDNA:** parvoviruses (gastroenteritis, erythema infectiosum).
- **ssRNA:** coronaviruses (COVID,19), influenza viruses.
- **dsRNA:** rotaviruses (pediatric gastroenteritis).

Q96. Classify viruses on the basis of replication strategy and provide examples.

- **+ssRNA:** genome acts directly as mRNA (poliovirus, Hepatitis C).
- –**ssRNA:** genome must be transcribed to mRNA by RdRp first (rabies, Ebola).
- **RNA reverse,transcribing:** RNA to cDNA integration (retroviruses, HIV).
- **DNA reverse,transcribing:** dsDNA to RNA intermediate, then back to DNA (hepadnaviruses, Hepatitis B).

Ecosystem Dynamics & Biodiversity

Q97. Differentiate between an ecosystem and an ecological niche.

Feature	Ecosystem	Ecological Niche
Definition	A dynamic community of interacting biotic or	The specific biotic and abiotic resource use of a species in its
Scope	Broad spatial scales, energy flow, nutrient cy	Habitat boundaries, trophic interactions, physiological toleranc

Q98. Define biodiversity and list the hierarchical levels of its assessment.

Answer: Biodiversity refers to the structural and functional variability among living organisms across terrestrial, marine, and limnetic ecosystems.

- **Genetic diversity:** variation of genes/alleles within populations.
- **Species diversity:** variety and richness of species within a region.
- **Ecosystem diversity:** variety of habitats, communities, and ecological processes.

Q99. Contrast biodiversity assessment at the species level versus the genetic level.

- **Species level:** species richness (count) and evenness (relative abundance).
- **Genetic level:** nucleotide/allelic/genomic variability within a species; higher diversity increases adaptive potential against stressors and pathogens.

Q100. Why is random sampling essential for assessing environmental biodiversity?

- **Eliminates selection bias:** every spatial unit has equal inclusion probability.
- **Statistical validity:** supports unbiased parametric inference.

- **Resource efficiency:** representative estimates without exhaustive census.
- **Comparability:** enables reliable comparisons and longitudinal monitoring.

Ecological Methodology & Speciation

Q101. Enlist standard field methods used to assess the spatial distribution of biodiversity.

- **Quadrat sampling:** frame,based analysis for sessile/immobile organisms.
- **Transect line/belt sampling:** linear environmental gradient analysis.
- **Remote sensing & aerial surveys:** landscape,level mapping.

Q102. Compare quadrat sampling and transect sampling methods, including their respective utility.

Answer: Quadrat sampling: grid frames placed randomly to count individuals/percentage cover — ideal for measuring density and frequency of plants or immobile organisms. **Transect sampling:** a continuous or interval line across a gradient (elevation, intertidal zones) — effective for evaluating zonation and distribution trends.

Q103. Name standard quantitative methods used to assess species abundance.

- Point count methods (stationary counting over fixed intervals).
- Mark,release,recapture (Lincoln,Petersen Index) for mobile animals.
- Quadrat density counts.
- Removal sampling / capture methods.
- Biomass & remote spectral sensing.

Q104. Define the terms "species" and "speciation."

- **Species** (Biological Species Concept): interbreeding natural populations producing fertile, viable offspring, reproductively isolated from other groups.
- **Speciation:** the process by which ancestral lineages diverge into reproductively isolated daughter species through genetic variation and isolation.

Q105. Differentiate between Allopatric and Peripatric speciation.

Parameter	Allopatric Speciation	Peripatric Speciation
Geographic Mechanism	Large population split by a major barrier (r	oSumnatalinfosu, nidversp)opulation isolated at the ec ge of the range
Evolutionary Driver	Divergent selection and drift over broad re	iAoconse/lemraetsecladersit and founder effect in a sn all pool
Classic Example	Darwin's finches across Galápagos island	Speciation in small island-founding popula ions