DAY ONE

The Living World

Learning & Revision for the Day

- Characteristics of Living Beings
- General Classification of Living Beings
- Classification and its Needs
- Taxonomy and Systematics
- Tools for Study of Taxonomy
- Classification of Living World
- Kingdom–Monera
- Kingdom–Protista
- Kingdom–Fungi
- Lichens
- Viruses

Biology is the science, which deals with the study of living organism and their life processes. Life is a characteristic quality that differentiates non-living objects from the living forms. Classification is the method of arrangement of these living organisms in groups, according to their similarities and dissimilarities and finally placing them within the taxonomic hierarchy, such as species, genus, family, etc. The most widely accepted method of classification is five kingdom classification given by **RH Whittaker** (1969).

Characteristics of Living Beings

Some important characteristic features of living beings, which differentiate living organisms from non-living organisms are given below

(i) **Growth** is the characteristic of all living organisms. Increase in biomass and increase in size of individuals are twin characteristics of growth.
A multicellular organism grows by cell division. In plants, growth occurs by cell division continuously throughout their lifespan.

(ii) **Reproduction** is a basic characteristic feature of living organisms. Reproduction means the production of offsprings possessing features more or less similar to that of parents.

(iii) **Consciusness** is the ability of living beings to sense their surroundings or environment and respond to these environmental stimuli, which could be physical, chemical or biological.

(iv) **Cellular organisation** is the defining feature of living forms, as cells are basic building blocks of the living organisms.

(v) **Biological organisation** starts with submicroscopic molecular level, where four types of molecule, i.e. carbohydrates, proteins, lipids and nucleic acids are organised into cells and cells into organelles of cell.

The cells are organised into tissues. Tissues inturn are organised into organs and organs are organised into organ systems.

The organism is made up of organ systems. It lives in populations, which form communities, which are part of ecosystems and ecosystems are part of the biosphere.

(vi) **Respiration** is the process of generation of energy by breaking of the C—C bonds of complex compound through oxidation leading to release of energy which is stored in the form of ATP.
All cells require energy and in every kind of organism, ATP is used as a source of energy that is why ATP is called as universal energy carrier.

(vii) **Evolution** refers to changes which occur from time to time. Infact biology is the study of evolution of living organisms on earth.

(viii) **Homeostasis** is the process of maintenance of constant internal environment. Living things actively maintain their complex structure and their constant internal structure through this process.

The term 'Homeostasis' was coined by American physiologist **Walter Bradford Cannon** in 1929.

(ix) **Metabolism** is the sum total of all the chemical reactions occurring in our body.

Metabolism has two phases, i.e. anabolism and catabolism.

Metabolism = Anabolism + Catabolism

General Classification of Living Beings

All living beings have been categorised into different groups on the basis of various common features shared by them. These are as follows

(i) On the basis of **body temperature**, living beings can be divided into two groups

- **Ectothermic** Animals whose body temperature fluctuates considerably with environment is called poikilothermic or cold-blooded or ectothermic, e.g. amphibians, reptiles, insects, etc.
- **Endothermic** Some organisms, which are capable of maintaining a stable body temperature independent of the environmental temperature are called **homeothermic** or **warm-blooded** or **endothermic**, e.g. birds, mammals.

NOTE
- **Hibernation** Winter sleep or dormancy during winter is called hibernation.
- **Aestivation** Dormancy during summer or dry weather is called aestivation.

(ii) On the basis of **osmoregulation**, animals are divided into two groups

- **Osmoconformers** Animals, whose body is iso-osmotic with outer environment are called osmoconformers, e.g. hag fishes (jawless members of the class–Agnatha), elasmobranchs, coelocanths (*Latimeria*) and most of the marine invertebrates.
- **Osmoregulators** Animals, whose body fluids are not isotonic with the outside environment are called osmoregulators. They must either discharge excess water when they live in a hypotonic environment or continuously intake of water is required when they live in a hypertonic environment, e.g. all freshwater and many marine animals along with humans and other terrestrial animals.

(iii) On the basis of **aquatic habitat**, animals can be divided into two groups

- **Anadromous** fishes live and mature in marine water and migrate to freshwater for breeding, e.g. *Salmon.*
- **Catadromous** fishes live and mature in fresh water and migrate to ocean for breeding, e.g. American eels and *Anguilla*.

(iv) On the basis of **salinity**, animals can be divided into two groups

- **Stenohaline** are fishes which can tolerate only a narrow range of salinities.
- **Euryhaline** are fishes which can tolerate wide range of salinities.

Biodiversity

Planet earth exhibits a large variety of living organisms, like plants, animals, fungi, etc. These all constitute our 'Biodiversity'. In it each and every different kind of organism represents a species. The number of species that are known and described is in the range between 1.7-1.8 million. These organisms inhabit distinct geographical locations. Thus, every distinct geographical location has its own flora (plants) and fauna (animals).

Classification and its Need

- It is nearly impossible to study all the living organisms, so it is necessary to devise some means to make this possible. This process is called **classification.** It is the process by which anything is grouped into convenient categories based on some easily observable characters.
- Classification is the systematic arrangement of organisms into groups on the basis of their affinities or relationships.
- Classification is necessary for organisms due to the following reasons
  (i) Convenience of study
  (ii) Knowledge of adaptations
  (iii) Knowledge of sequence of evolution
  (iv) Knowledge of phylogenetic relationships
  (v) Discovery of new organisms
- The modern system of classification began in 1758, when **Carolus Linnaeus** (1707-1778), a Swedish botanist published the tenth edition of his book '*Systema Naturae.*'

There are three main systems of classification

(i) **Artificial classification** is based on arbitrary, easily observable, single or a few morphological characters such as habit, colour, number, form or similar features, e.g. Linnaeus system of classification.

(ii) **Natural classification** is based on overall similarities or affinities derived from morphology, anatomy, embryology, phytochemistry, ultrastructure and all other fields of study, e.g. Bentham and Hooker's system.

(iii) **Phylogenetic classification** is based on the evolutionary descent of a group of organisms. The relationship is depicted through a phylogram, phylogenetic tree or a cladogram, e.g. Engler and Prantl's system and Takhtajan classification.

Some Important Books and their Authors

Books	Authors
Philosophica Botanica	Carolus Linnaeus
Species Plantarum	Carolus Linnaeus
Systema Naturae	Carolus Linnaeus
Genera Plantarum	Bentham and Hooker
Families of Flowering Plants	John Hutchinson

Nomenclature

It is a science of providing distinct and proper names to organism, so that they can easily be recognised and differentiated from others. It is done by using rules and recommendations of the code, prescribed by different scientific bodies as mentioned below

Various Codes

ICBN International Code of Botanical Nomenclature

ICZN International Code of Zoological Nomenclature

ICNB International Code of Nomenclature of Bacteria

ICNCP International Code of Nomenclature for Cultivated Plant

ICTV International Committee for the Taxonomy of Viruses

The ICBN recognises several kinds or types depending on the way in which a type of specimen is selected.

Types of Specimen

Holotype	Nomenclature type.
Isotype	Duplicate of holotype.
Paratype	Any other specimen described along with holotype.
Syntype	Any one of the two or more specimens cited by author, when there is no holotype.
Lectotype	Specimen selected from original material to serve as nomenclature type, where there is no holotype.
Neotype	New nomenclatural type, when the original material is missing.
Topotype	A specimen collected from the same locality from which the holotype was originally collected.

There are two types of names which can be given during nomenclature

- **Vernacular names** are the names given to the organisms in the local language of that region. These names are invalid as they are not recognised universally.
- **Scientific names** are given to the organisms by biologists based on agreed principles and criteria for their acceptability all over the world. These are

(i) **Polynomial Nomenclature** Before 1750, this system was used, in which, organism's name consisted of series of Latin descriptive words. Such names were lengthy and difficult to learn. e.g. *Caryophyllum saxatilis*, *Folis gramineus*, *Umbellatis corymbis*.

(ii) **Trinomial Nomenclature** This system is used to describe sub-species, e.g. *Homo sapiens sapiens*.

(iii) **Binomial Nomenclature** Swedish naturalist Carolus Linnaeus established binomial nomenclature, though, it was first proposed by Gaspard Bauhin. The nomenclature was used first in his book *Species Plantarum* (1753), in which, names and description of **5900 plant species** were given. Later Linnaeus published *Systema Naturae* (1758), in which **4326 animal species** were described.

According to this system, name of any organism consists of two parts or epithets, i.e. **generic epithet** and **specific epithet**, e.g. the botanical name of mango is *Mangifera indica* L. In which, *Mangifera* is generic epithet, which represents its genus and *indica* is specific epithet, which represents its species. L represents the name of the scientist (Linnaeus), who gave the name of mango.

Some rules for binomial nomenclature are

- Names should be in Greek or Latin language.
- Generic name begins with capital letter (*Mangifera*) and is placed before species name, while species name begins with a small letter (*indica*).
- The scientific name should be either underlined or italicised.
- Name of the authority should be written after specific epithet in an abbreviated form.
- The most important rule of ICBN is rule of priority. In case, where two or more names are given, the oldest, i.e. the name given first is recognised as valid name and all other names are called synonyms whereas, names with same generic and specific names are called tautonyms, e.g. *Rattus rattus*.

Taxonomy and Systematics

- **Taxonomy** is the branch of biology dealing with the identification, nomenclature and classification of living organisms. The term 'Taxonomy' was coined by **AP de Candolle**. **Carolus Linnaeus** is known as Father of Taxonomy and Father of Systematic Botany, whereas **Santapau** is known as Father of Indian Taxonomy.

- **Systematics** is the branch of biology concerned with reconstructing phylogenies and with naming and classifying species.
- The term 'Systematics' was coined by **Linnaeus** and **G Simpson** (1961) distinguished systematics, taxonomy and classification.
- **Julian Huxley** (1940) proposed the term 'New systematics'. It deals with the study of diversity of organisms and all their comparative and evolutionary relationship based on comparative anatomy, ecology, physiology and biochemistry.

Modern Trends in Taxonomy

- **Phenetic classification** is based on the overall similarity of organisms evaluated without any regard to phylogeny.
- A modern method of classification called **cladistics,** it is based on evolutionary history.
- Arranging organisms on the basis of their shared similar or derived characters that differ from ancestral characters will produce a phylogenetic tree called **cladogram**.
- The phylogenetic tree is also known as **genealogical tree** or **dendrogram**.
- **Karyotaxonomy** is based on nucleus and chromosomes.
- **Numerical taxonomy** is based on statistical methods. It is now easily carried out using computers. Each character is given equal importance and at the same time, hundreds of characters can be considered.
- **Experimental taxonomy** is based on experimental determination of genetic inter-relationships.
- **Cytotaxonomy** is based on cytological information like chromosome number, structure and behaviour.
- The **chemotaxonomy** emphasises on the chemical constituents of the organisms to resolve confusions and is used these days to determine evolutionary closeness.

Taxonomic Category or Taxon

- A **taxon** is a taxonomic group of any rank. It is a taxonomic group of real organisms assigned to a category, whereas **taxonomic category** represents rank or level in a hierarchy and does not represents the living organisms. For example, Reptilia is a taxon, but class is a category similarly Poaceae is a taxon but family is a category.
- According to ICBN, the names of different categories must end in the standard endings (suffixes).

Categories and their Suffixes

Category	Suffix
Division	phyta
Sub-division	phytina
Class	phyceae or opsida or ae
Order	ales
Sub-order	incae
Family	aceae
Sub-family	oideae
Tribe	eae

Suffixes used in the animal kingdom are

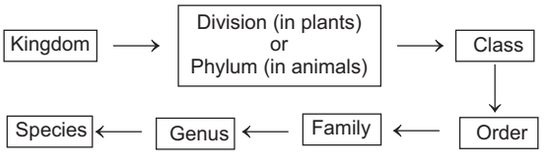
(i) Super-family — oidea (ii) Family — idae

(iii) Sub-family — inae (iv) Tribe — ini

- Tribe is an intermediate category between sub-family and genus.

Taxonomic Hierarchy

- The system of arranging organism in a definite sequence of various taxonomic categories arranged in a proper descending or ascending order is called taxonomic hierarchy.
- It is also called **Linnaeus hierarchy** as it was first proposed by Carolus Linnaeus.
- Linnaeus introduced five categories in the taxonomic hierarchy *viz*, Class, Order, Genus, Species and Variety.
- Later on, three more categories, i.e. Kingdom, Division (in plants) or Phylum (in animals) and Family were added and Variety was discarded to make a hierarchy of seven obligate categories, *viz*.



Taxonomic hierarchy

- The term **subspecies** is used more commonly by zoologists, while **variety** is used commonly by botanists.

Concept of Species

- **Species** is the fundamental or **smallest unit of classification**. The term 'species' was recognised from Genus by **John Ray**.
- **Static concept of species** or morphological concept of species was proposed by Carolus Linnaeus. He considered species as a fixed and immutable entity.
- **Dynamic concept of species** was proposed by Lamarck, who considered species as a mutable and dynamic entity.
- **Biological concept of species** was proposed by **Ernst Mayr**. According to this concept, a species is a group of individuals, who resemble each other in morphological, physiological, biochemical and behavioural characters and are capable of interbreeding.

Few important points related to concept of species are

- **Taxonomic species** are the species having a binomial name.
- **Sibling species** are two distinct species, which do not interbreed but are otherwise difficult to separate on the basis of morphological characters alone.
- **Allopatric species** are species having exclusive areas of geographical distribution.
- **Sympatric species** are species having overlapping areas of geographical distribution.
- **Parapatric species** are species with adjacent geographic ranges meeting in a very narrow zone of overlap.
- **Allochronic species** are species belonging to different time periods.
- **Synchronic species** are species belonging to a same period or time.
- **Linnaean species** are taxonomic species distinguished on the basis of morphological grounds.
- **Keystone** species play a key role or central role in the ecology of a place.

Tools for Study of Taxonomy

Taxonomic studies of plants, animals and other organisms are useful in agriculture, forestry, industry and in knowing our bioresources and their diversity. Biologists have established certain procedures and techniques to store and preserve the information as well as the specimens. These procedures are called as taxonomic tools or aids.

Following are the main tools for study of taxonomy

1. **Herbarium** is a store house of collected plant specimens that are dried, pressed and preserved on sheets.

   The biggest herbarium of the world is **Royal Botanical Garden** at Kew, England, while the biggest herbarium of India is **Indian Botanical Garden** at Kolkata.
2. **Botanical garden** is essentially a collection of living plants maintained for both pure and applied studies. Largest Botanical Garden of Asia is Indian Botanical Garden, Sibpur. First Botanical Garden is Pisa Botanical Garden, Italy.

   The main functions of botanical gardens are
   - To provide records of local flora for monographic work.
   - To provide facilities for collections of living plant materials for biosystematic studies.
   - To supply seeds and materials for botanical investigation.
3. **Museums** have collections of preserved plants and animals for the study and reference.
   - These are prepared for preservation of algae, fungi, mosses, ferns, animals, etc., because they cannot be kept in herbaria.
   - Insects are preserved in insect boxes, after collecting, killing and pinning.
   - Larger animals like birds and mammals are usually stuffed and preserved.
4. **Zoological parks** are the places, where wild animals are kept in protected environments under human care. Largest zoo of the world is situated in Kruger (South Africa).
5. **Taxonomic key** is one of the taxonomical aid used for identification of plants and animals.
   - The keys are based on the contrasting characters generally in pair called couplet and represents the choice made between two opposite options. One is accepted and other is rejected.
   - Two types of keys are always used-**indented** and **bracketed**. Each statement in key is called a lead.

Classification of Living World

The study of all living organisms without placing them at appropriate place is not possible, so scientists placed the organisms into kingdoms. Kingdom is the highest taxonomic category.

1. **Two Kingdoms** Linnaeus divided all organisms into **two kingdoms**, i.e. plant kingdom and animal kingdom. Photosynthetic organisms were included into plant kingdom, while non-photosynthetic organisms in animal kingdom. **Exceptions**
   - ***Euglena*** shows characteristics of both plants and animals.
   - **Bacteria** and **cyanobacteria** (blue-green algae) have cytological differences from plants and animals.
   - **Fungi** which are usually classified in plants, are non-photosynthetic. Fungi are non-motile, multiply like plants and non-photosynthetic like animals.
   - **Tunicate sponges** and **corals** are non-motile and fixed like plants.
   - **Some algae** which are photosynthetic are either motile or produce motile reproductive cells.
2. **Three Kingdoms** E Haeckel (1866), a German biologist, suggested a **third kingdom**–Protista to include unicellular protozoans and algae.
3. **Four Kingdoms** Copeland (1956) developed four **kingdom system** with kingdoms, i.e. Monera, Protista, Plantae and Animalia.
4. **Five Kingdoms** RH Whittaker (1969), an American taxonomist, divided all the organisms into **five kingdoms**, i.e. Monera, Protista, Fungi, Plantae and Animalia.
   - The main criterias or characteristics used by him for classification were cell structure, body organisation, mode of nutrition, reproduction and phylogenetic relationship.

- The major characteristics of all the five kingdoms are tabulated below

Characteristics	Five Kingdom				
	Monera	**Protista**	**Fungi**	**Plantae**	**Animalia**
Cell type	Prokaryotic	Eukaryotic	Eukaryotic	Eukaryotic	Eukaryotic
Cell wall	Non-cellulosic (polysaccharide + amino acid)	Present in some	Present (without cellulose)	Present (cellulose)	Absent
Nuclear membrane	Absent	Present	Present	Present	Present
Body organisation	Unicellular	Unicellular	Multicellular/ Loose tissue	Tissue/Organ	Tissue/ Organ/Organ system
Mode of nutrition	Autotrophic (chemosynthetic or photosynthetic) and heterotrophic (saprophytic/ parasitic)	Autotrophic (photosynthetic) and heterotrophic	Heterotrophic (saprophytic/ parasitic)	Autotrophic (photosynthetic)	Heterotrophic (holozoic/ saprophytic, etc.)

5. **Six Kingdoms** Carl Woese *et.al.* proposed the six kingdom system, in which monerans are divided into Archaebacteria and Eubacteria.

Three Domains of Life

Studies of ribosomal RNA (*r*RNA) show that all living organisms share a common ancestor and there are three major evolutionary lineages. These are as follows

(i) Archaea (ii) Eubacteria (iii) Eukarya

Each of these lineages is called **domain**. The domain supersedes.

Distinguishing Features of Domains

Feature	Three Domains		
	Archaea	**Eubacteria**	**Eukarya**
Membrane bound organelles	Absent	Absent	Present
Membrane lipid structure	Branched	Unbranched	Unbranched
Nuclear envelope	Absent	Absent	Present
Number of different RNA polymerases	Several	One	Several
Peptidoglycan in cell wall	Absent	Present	Absent

Kingdom–Monera

- It includes all prokaryotic organisms, i.e. bacteria, mycoplasma, actinomycetes, spirochaetes, rickettsiae, chlamydiae and cyanobacteria.
- Members of this kingdom are known as **monerans**, which lack true nucleus, nuclear membrane, nucleolus, chromatin, histone proteins and all membrane bound organelles.
- Genetic material is called **nucleoid** or **genophore** or **incipient nucleus** or **prochromosome**, which is composed of naked DNA, RNA and proteins.
- Plasmids are small extrachromosomal rings of DNA discovered by **Hayes** and **Lederberg** (1952). They can replicate independently without nucleoid. If associated with nucleoid they are called **episomes**.
- Ribosomal RNA are of 70S type.
- Cell wall is made up of peptidoglycan (except archaebacteria and mycoplasma).
- Reproduction is usually asexual by means of binary fission.
- Respiratory enzymes are found associated with the plasma membrane.
- Cell division is of amitotic type and lacks spindle formation.

Classification of Kingdom–Monera

In 1977, Carl Woese and George Fox reported two quite distinct groups in this kingdom. These groups are archaebacteria and eubacteria. **Archaebacteria** (Gr. *Archae*–primitive; bacteria) includes methanogens, halophiles and thermoacidophiles. **Eubacteria** (Gr. *Eu* —true; bacteria) are true bacteria that includes cyanobacteria, mycoplasma, actinomycetes, rickettsia and spirochaetes.

1. Archaebacteria

- It is a primitive group of bacteria. These are oldest of the living fossils. They inhabit most extreme environments on earth that is why, they are called **extremophiles**.
- Their cell walls lack peptidoglycan which is an important component of the cell wall of eubacteria.
- The lipids contain phytanyl side chains (branched lipid). Branch chained lipids decrease membrane fluidity and increase tolerance to extremes of heat as well as low pH.
- They possess distinctive ribosomal RNA sequences and introns (i.e. non-coding genes) like that of eukaryotes.
- They are primary producers of deep sea hydrothermal vent ecosystem and have chemosynthetic mode of nutrition.

The three main groups of Archaebacteria are

(a) **Methanogens** are obligate anaerobic (i.e. free oxygen will kill them), Gram negative bacteria, which utilise CO_2 during cellular respiration to produce methane (CH_4) as a waste product.

- These are found in the musk of swamps and marshes, the rumen of cattle (where they live on the hydrogen and CO_2 produced by other microbes living along with them), our colon (large intestine), sewage sludges and the gut of termites.
- These are chemoautotrophs, which use hydrogen as a source of electrons for reducing carbon dioxide to food and giving off methane (marsh gas and CH_4) as a byproduct, e.g. *Methanobacterium, Methanobacillus, Methanosarcina, Methanococcus*

$$4H_2 + CO_2 \longrightarrow CH_4 + 2H_2O$$

(b) **Halophiles** are found in extremely **saline** environments such as great salt lake in the US and Dead sea.

- They maintain osmotic balance with their surroundings by building up the solute concentration within their cells.

(c) **Thermoacidophiles** are found in hot and acidic places such as **acidic sulphur springs** (i.e. in Yellowstone National Park) and **deep-sea-vents** (black smockers).

- Some forms of thermoacidophiles (aerobic bacteria) reduce sulphur to H_2S under anaerobic conditions, e.g. *Sulfolobus*, *Thermoproteus*, etc.

2. Eubacteria

These are typical prokaryotic (i.e. no membrane enclosed nucleus) cells with a single chromosome (i.e. a closed circle of double-stranded DNA, without histone protein) and without mitochondria, chloroplast and any other membrane bound cell organelles.

Bacteria

These are microscopic, relatively simple, unicellular organism, whose genetic material is not enclosed in nuclear membrane.

Size and Shape of Bacteria

- The size of bacteria ranges from 0.1-1.5 μm in diameter and 2-10 μm in length. *Dialister pneumosintes* (0.15-0.3 μm long) is the smallest bacterium, while *Beggiatoa mirabilis* (16-45 μm diameter and upto several centimeter long) is the largest bacterium.
- On the basis of shape, bacteria can be either **coccus** (i.e. spherical or nearly spherical, small and non-flagellated), **bacillus** (i.e. rod-shaped, e.g. *Escherichia coli* and *Lactobacillus*), **vibrio** (i.e. comma-shaped, e.g. *Vibrio cholerae*), **spiral** (i.e. coiled form of bacteria exhibiting twist with one or more turns, e.g. *Spirillum minus*).
- **Coccus bacteria** can be either *Micrococcus* (occurs singly, e.g. *Micrococcus agilis, Micrococcus roseus*), *Diplococcus* (found in pairs, e.g. *Gonococcus, Meningococcus, Diplococcus pneumoniae*), *Streptococcus* (i.e. cells remain attached to form a chain, e.g. *Streptococcus lactis*), *Staphylococcus (*irregular bunches of cells or grape-like clusters, e.g. *Staphylococcus aureus*) and sarcinae, (cubical packets of 8, 27 or more cells, e.g. *Sarcina*).
- **Bacilli bacteria** arranged in pairs are called **diplobacilli**, e.g. *Bacillus subtilis*, bacilli arranged in chain are called **streptobacilli,** e.g. *Streptobacillus, Azotobacter, Bacillus anthracis*, bacilli arranged side-by-side like matchsticks are called **palisade-like**, e.g. *Corynebacterium diphtheriae,* when the cells of a chain have much larger area of contact with each other, it is called trichomes, e.g. *Beggiatoa*. *Caulobacter* is stalked bacterium, *Rhodomicrobium* is budding bacterium, while *Rhizobium, Corynebacterium, Azotobacter* and *Mycobacterium* are called **pleomorphic bacteria**.

Structure of Bacterial Cell

Structural components of bacteria are as follows

1. **Bacterial flagella** are made up of a single filament of the protein flagellin, instead of 9 + 2 tubulin containing microtubules found in eukaryotes.
   - It consists of basal body, hook and filament.
   - Basal body is the most complex portion of flagellum having 4 rings (L, P, S and M) in Gram negative and 2 rings (S and M) in Gram positive bacteria.

- Hook consists of a single type of protein and functions to connect the filament to motor portion.
- Filament is the longest portion of flagellum, which is 20 nm wide and 1-70 nm long and consists of 8 vertical rows of flagellin.
- Depending upon the arrangement of flagella, bacterial cell can be of following types
  - **Atrichous** Flagella absent, e.g. *Lactobacillus, Pasteurella*.
  - **Monotrichous** Single polar flagellum, e.g. *Vibrio cholerae* and *Thiobacillus*.
  - **Amphitrichous** Single flagellum at each end of the cell, e.g. *Nitrosomonas*.
  - **Cephalotrichous** Bacteria with many flagella attached at one end, e.g. *Pseudomonas fluorescence*.
  - **Lophotrichous** Bacteria with a group of flagella attached at each end, e.g. *Spirillum volutans*.
  - **Peritrichous** Bacteria with flagella all over the body, e.g. *E. coli* and *Clostridium tetani*.

2. **Pili or Fimbriae** are extremely minute hair-like structures found mostly in male bacterial cells.
   - Fimbriae are shorter and thinner (3-10 nm diameter) than flagellum and used for attachment and colonisation.
   - They are composed of protein sub-units called **pilin**.
   - A special type of pili called sex pili present on male bacterium makes conjugation tube during conjugation.
3. **Cell wall** is the outer tough covering around the cell, which provides specific shape and protection to the bacterium. It prevents the cell from swelling and bursting due to the osmotic changes.
   - Glycocalyx is the outer most mucilage layer that gives sticky character to bacterial cell.
   - It is composed of a polysaccharide called **murein** or **peptidoglycan**. It consists of polysaccharide NAG and NAM cross linked with short amino acid chains.
   - Antibiotics such as penicillin, cephalosporin, etc., prevent the cross linking and inhibit the bacterial cell wall formation.
   - **Lysozyme** attacks on the bond between glucosamine and muramic acid and hydrolyses the cell wall. The cell wall of Gram positive bacteria is much thicker and contains less lipids as compared to that of Gram negative bacteria.
   - Lysozyme digests the polysaccharide back bone of murein.

Gram Positive and Gram Negative Bacteria

- Bacteria are classified as Gram positive (+ve) and Gram negative (–ve) based on their reaction with Gram's stain. This technique of Gram staining was introduced by Hans Christian Gram in 1884.
- After staining the bacteria, which retain their original crystal violet stain are called Gram positive bacteria. On the other hand, bacteria that lose stain and decolourise are called Gram negative bacteria.
- The basis of Gram staining is the lipid content of bacteria. Gram negative bacteria have high lipid content due to, which the lipids dissolve in organic solvent taking out the stain along with itself.

Comparison between Gram Positive and Gram Negative Bacteria

Characteristic	Gram Positive	Gram Negative
Gram staining	Retain crystal violet dye and stain dark violet or purple	Can be decolourised to accept counter- stain (safranin) and stain red
Peptidoglycan layer	Thick (multilayered)	Thin (single layered)
Teichoic acids	Present in many	Absent
Outer membrane	Absent	Present
Lipopolysaccharide	Virtually none	High
Flagellar structure	Two rings in basal body	Four rings in basal body
Toxins produced	Primarily exotoxins	Primarily endotoxins
Cell wall disruption by lysozyme	High	Low (requires pretreatment to destabilise the outer membrane)
Susceptibility to anionic detergents	High	Low
Resistance to drying	High	Low
Examples	*Staphylococcus, Streptococcus, Pneumococcus, Bacillus, Clostridium, Mycobacterium* and *Streptomyces*	*Salmonella, Pseudomonas, Vibrio, Helicobacter, Haemophilus* and *Escherichia*

4. **Cytoplasm** is a semi-fluid ground substance enclosed by the plasma membrane which is a phospholipid bilayer but there is no cholesterol or other steroids.
   - Cytoplasm appears granular due to the presence of large number (as many as 20,000) of 70 S type ribosomes, which may occur singly or in clusters called polyribosome.

- Apart from the nucleoid, certain bacterial cells contain extrachromosomal genetic material called **plasmids**.
- The plasmid DNA replicates independently. It contains genes like fertility factor (F-factor), resistance factor (R-factor), nitrogen fixing genes (*Nif*-genes).
- Some plasmids may temporarily become associated with nucleoid DNA and are known as **episomes**.
- **Plasmid** term was coined by **Lederberg** and **Hayes**. Each plasmid is circular, supercoiled, double-stranded and naked DNA.

Nutrition in Bacteria

Bacteria exhibit different modes of nutrition. On this basis, broadly two types of bacteria can be recognised; autotrophic bacteria and heterotrophic bacteria.

1. **Autotrophic bacteria** are able to synthesise their own organic food from inorganic substances. They use carbon dioxide for obtaining carbon and utilise hydrogen sulphide (H_2S) or ammonia (NH_3) or hydrogen (H_2) as the source of hydrogen to reduce carbon. These bacteria can be distinguished further into two types, i.e. photoautotrophic bacteria and chemosynthetic bacteria.

   (i) **Photoautotrophic bacteria** possess photosynthetic pigments in membrane bound lamellae (thylakoids) and utilise solar energy.
   - The bacterial photosynthesis is different from that of green plants since, here water is not used as a hydrogen donor.
   - Hence, oxygen is not released as a byproduct. For this reason, the process is described as anoxygenic photosynthesis.

   $$CO_2 + H_2S \xrightarrow{\text{Light energy}} \text{Sugar} + \text{Sulphur} + \text{Water}$$

   (ii) **Chemosynthetic bacteria** manufacture organic compounds from inorganic raw materials utilising energy, liberated from the oxidation of inorganic substances. The following are the common types of chemosynthetic bacteria

   (a) **Nitrifying bacteria** derive energy by oxidising ammonia into nitrates, e.g. *Nitrosomonas* and *Nitrobacter*.

   $$NH_4^+ + 2O_2 \longrightarrow NO_2 + 2H_2O + \text{energy}$$

   (b) **Sulphur bacteria** derive energy by oxidising hydrogen sulphide to sulphur, e.g. *Thiobacillus* and *Beggiatoa.*

   $$2H_2S + O_2 \longrightarrow 2S + 2H_2O + \text{energy}$$

   (c) **Iron bacteria** derive energy by oxidising ferrous ions into ferric form, e.g. *Ferrobacillus* and *Gallionella.*

   $$4FeCO_3 + 6H_2O + O_2 \rightarrow 4Fe(OH)_3 + 4CO_2 + \text{energy}$$

2. **Heterotrophic bacteria** are unable to manufacture their own organic food and hence, are dependent on external source. These bacteria can be distinguished into saprophytic bacteria, symbiotic bacteria and parasitic bacteria.

   (i) **Saprophytic bacteria** obtain their nutritional requirements from dead organic matter.
   - They breakdown the complex organic matter into simple soluble form by secreting exogenous enzymes.
   - Subsequently, they absorb the simple nutrients and assimilate them, during which they release energy. These bacteria have a significant role in the ecosystem as they function as decomposers.
   - The aerobic breakdown of organic matter is called as decay or decomposition. It is usually complete and not accompanied by the release of foul gases.
   - Anaerobic breakdown of organic matter is called fermentation. It is usually incomplete and is always accompanied by the release of foul gases. Anaerobic breakdown of proteins is called putrifaction.

   (ii) **Symbiotic bacteria** live in a mutually beneficial association with other organisms. Such bacteria derive the essential nutrients from their host organisms and in that process help the host through some of their biological activities.
   - The most familiar example of symbiotic bacteria are the nitrogen fixing bacteria, found in the root nodules of leguminous plants.
   - Bacteria such as *Rhizobium* and *Pseudomonas* reside in the root nodules and reduce atmospheric nitrogen directly to ammonia. This becomes the source of nitrogen for the host plants. The plants in return provide bacteria with nutrients and protection.
   - **Nitrogenase enzyme** system helps in fixation of nitrogen. This system is made up of two components, i.e. nitrogenase and nitrogenase reductase.
   - Blue-green algae (cyanobacteria) fix nitrogen in heterocysts under anaerobic conditions.
   - *Rhizobium* bacteria needs leghaemoglobin for fixation of nitrogen. *Nif* gene is responsible for synthesis of these enzyme. This gene is found in plasmids of prokaryotes.
   - Because plasmids are not found in eukaryotes, they cannot fix atmospheric nitrogen.
   - The bacteria found in the human alimentary canal, *Escherichia coli* are non-pathogenic. These bacteria check the growth of harmful putrefying bacteria. In addition, these bacteria release vitamin-K and B_{12}, which are necessary for blood components.

(iii) **Parasitic bacteria** occur in the body of animals and plants, obtaining their organic food from there.

Most of these bacteria are pathogenic, causing serious diseases in the host organisms either by exploiting them or by releasing poisonous secretion called **toxins** which are of two types, i.e. exotoxins and endotoxins.

Differences between Exotoxin and Endotoxin

Exotoxin	Endotoxin
Excreted by Gram positive bacteria.	Excreted by Gram negative bacteria.
Also known as protein toxins.	Also known as lipopolysaccharide toxins.
Released to outside from a living cell.	Remain in cell wall and released on death of cell.
Strongly antigenic	Poor antigenic
Highly toxic	Less toxic

Respiration in Bacteria

Based on mode of respiration, bacteria may be

(i) **Obligate aerobic bacteria** They can perform only aerobic respiration, e.g. *Bacillus subtilis*.

(ii) **Obligate anaerobic bacteria** They can perform only anaerobic respiration, e.g. *Clostridium botulinum.*

(iii) **Facultative aerobes** These are anaerobic bacteria, but can live in the presence of oxygen, e.g. *Chlorobium* green sulphur bacteria.

(iv) **Facultative anaerobes** These are aerobic bacteria, but can live in the absence of oxygen also, e.g. *Pseudomonas*.

NOTE Anaerobic bacteria do not evolve oxygen during photosynthesis and they use H_2S as a source of reducing power rather than water. This type of photosynthesis is called anoxygenic photosynthesis.

Reproduction in Bacteria

Reproduction in bacteria take place by following three types

1. **Vegetative reproduction** It takes place by binary fission, in which the bacterial DNA undergoes replication and under favourable conditions the bacterial cell expands and cytoplasm divides into two parts.
2. **Asexual reproduction** It takes place by endospore formation.
   - Bacterial population is counted by 2^n(n = number of generation). For example, a bacterial cell after 5 generations of fission will result into $2^5 = 2 \times 2 \times 2 \times 2 \times 2 = 32$ bacterial cells.
3. **Sexual reproduction** It takes place by genetic recombination. There are three methods of genetic recombination in bacteria.

   (i) **Transformation** Here, DNA released from one bacterial cell is taken up by another without any contact between donor and recipient bacterium.
   - It was discovered by **Griffith** in 1928, when he was working with the bacterium *Diplococcus pneumoniae* or *Pneumococcus pneumoniae*, which causes pneumonia.
   - In 1944, **Avery, MacLeod** and **McCarty** succeeded in isolating and identifying the transforming factor and found that it was DNA.
   - This was the first direct evidence that DNA is the genetic material.

   (ii) **Conjugation** In it, transfer of DNA involves direct cell to cell contact and a conjugative plasmid in donor cell. Conjugation was discovered by **Lederberg** and **Tatum** (1946) in *E. coli.*
   - Conjugation occurs between donor cell (F^+) and recipient cell (F^-). Donor cell is having sex pili and F-factor, whereas recipient cell is lacking both.
   - It may involve either only the replication and transfer of the F-plasmid (fertility factor or F-factor) from donor (F^+) to the recipient (F^-), thus making the later also a donor or integration of F-plasmid with the chromosome of donor to form episome.
   - Term 'episome' is applied to extra-nuclear genetic material, which may remain integrated or free state, e.g. F-factor, temperate phage, etc.
   - All plasmids are episomes but all episomes are not plasmids.
   - When F-factor is integrated with main genome or nuclear DNA, the frequency of recombination increases by 1000 times. That is why, the donor cell is called Hfr-donor (High frequency donor) or high frequency male.

   (iii) **Transduction** Transfer of genetic material between bacteria is mediated by viruses, e.g. bacteriophage. It was first of all reported in *Salmonella typhimurium* by **Zinder** and **Lederberg** (1952). Transduction is of three types

   (a) **Generalised transduction**, i.e. transducing bacteriophage can transfer any gene of the donor bacterium, e.g. T_4-bacteriophage.

   (b) **Restricted** (specialised) **transduction**, i.e. transducing bacteriophage can carry only a specific region of the bacterial DNA to a recipient, e.g. λ-bacteriophage.

   (c) **Abortive transduction**, i.e. DNA fragment from donor bacterium is not integrated in the genome of recipient bacterium and is lost after one or few generations.

Some Popular Bacteria

Some popular bacteria are as follows

1. ***Rickettsias*** are obligate intracellular parasites. This means that they can only grow and reproduce, within the living cells of their host including certain arthropods (ticks, mites, lice and fleas) and mammals.
   - *Rickettsia prowazekii* causes typhus fever, when it is transmitted to humans by lice. **Rocky mountain spotted fever** is a rickettsial disease transmitted by ticks.
2. ***Nitrosomonas*** is a chemoautotroph, which oxidises NH_3 (produced from proteins by decay bacteria) to nitrites (NO_2).
   - This provides the energy to drive their anabolic reactions.
   - The nitrites are then converted (by other nitrifying bacteria) into nitrates (NO_3^-), which supply the nitrogen needs of plants.
3. ***Neisseria meningitis*** causes meningococcal meningitis, an extremely serious infection of the meninges that occasionally occurs in very young children and in military camps.
   - *Neisseria gonorrhoeae* causes gonorrhoea, one of the most common Sexually Transmitted Diseases (STDs).
4. ***Escherichia coli*** is most thoroughly-studied of all creatures (possibly excepting ourselves).
5. ***Salmonella enterica*** includes two major human pathogens, they are as follows
   - ***Salmonella enterica var. typhi*** causes typhoid fever, a serious systemic infection occurring only in humans.
   - ***Salmonella enterica var. typhimurium*** confined to the intestine, it is a frequent cause of human gastrointestinal upsets but is also found in many other animals (that are often of the source of the human infection). Also known as *Salmonella typhimurium.*
6. ***Vibrio cholerae*** causes cholera, one of the most devastating intestinal diseases.
   - The bacteria liberate a toxin that causes massive diarrhoea (10-15 L/day) and loss of salts.
7. ***Yersinia pestis*** is a *Bacillus* that causes bubonic plague.
   - It is usually transmitted to human by the bite of an infected flea.
   - As it spreads into the lymph nodes, it causes them to become greatly swollen, hence the name 'bubonic' (bubo–swelling of a lymph node) plague.
   - Once in the lungs, however, the bacteria can spread through the air causing the rapidly lethal (2-3 days) 'pneumonic' plague.
8. **Purple sulphur bacteria** are photosynthetic, that use energy of sunlight to reduce carbon dioxide to carbohydrate.

   Unlike plants however, they do not use water as a source of electrons. Instead, they use hydrogen sulphide to supply the electrons needed to synthesise NADPH and ATP.

   $$2H_2S + CO_2 \longrightarrow (CH_2O) + H_2O + 2S$$

   - In this process, they produce elemental sulphur (e.g. *Chromatium*).
   - Photosynthetic bacteria contain special types of chlorophylls called **bacterio chlorophylls** incorporated into membranes.
   - With this machinery, they can run photosystem-I but not photosystem-II (which explains their inability to use water as a source of electrons).
   - Most photosynthetic bacteria are obligate anaerobes. They cannot tolerate free oxygen. Thus, they are restricted to such habitats as the surface of sediments, at the bottom of shallow ponds and estuaries.
9. ***Bacillus* sp.** organisms differ mainly in the plasmids that they contain.
   - *B. anthracis* that causes anthrax possess two plasmids that contain the genes needed to synthesise capsule, which (like those of *Pneumococci*) makes it resistant to phagocytosis and three components of the toxin, that cause the disease symptoms.
   - *B. thuringiensis* toxins and the gene (also plasmid-encoded) for the toxin are used as biocontrol agents against a variety of insect pests.
10. ***Clostridium tetani*** are spore-forming obligate anaerobes. The spores of *C. tetani* are widespread in the soil and often get into the body through the wounds.
    - Puncture wounds (e.g. by splinters or nails) are particularly dangerous because they provide the anaerobic conditions needed for the germination of spores and growth of bacteria.
    - This interferes with the reciprocal inhibition of antagonistic pairs of skeletal muscles. So, the victim suffers from violent muscle spasms.
11. ***Clostridium botulinum*** Its toxin if eaten with an uncooked bean or mushroom, can be fatal.
    - The toxin is a protein and is quickly (10 min) denatured at 100°C, so boiling home-canned products make them safe to eat.
12. ***Mycobacterium tuberculosis*** is the agent of Tuberculosis (TB).
13. ***Mycobacterium leprae*** causes leprosy.
    - *M. leprae* is an obligate intracellular parasite; it has never been cultured *in vitro.*

14. ***Corynebacterium diphtheriae*** causes diphtheria.
    - As in tetanus, it is not the growth of the organism (in the throat), that is dangerous but the toxin it liberates.
    - The toxin is the product of a latent bacteriophage in the bacterium.
    - The toxin has no such effect on the translation machinery of bacteria (or of chloroplasts and mitochondria).
    - Treatment of the toxin with formaldehyde converts it into a harmless toxoid.
15. **Spirochaetes** are thin, corkscrew-shaped, flexible organisms that range in length from a few to as many as 500 μm. Two notorious examples are
    - *Treponema pallidum*, the cause of syphilis, one of the most dangerous of the Sexually Transmitted Diseases (STDs).
    - *Borrelia burgdorferi* is transmitted to humans through the bit of a deer tick causing lyme disease.
16. **Chlamydiae** are also obligate intracellular parasites (they cannot make their own ATP).
    - *Chlamydia trachomatis* infection is usually spread by sexual intercourse making it the most common Sexually Transmitted Disease (STD).
    - The eye infection is caused by a strain of *C. trachomatis* (and is responsible for its name).
    - ***Chlamydia psittaci*** infects birds, but can also infect their human contacts causing psittacosis (ornithosis).
17. **Cyanobacteria** (blue-green algae) have many characters similar to bacteria.
    - They use water as the source of electrons to reduce CO_2 to carbohydrate (because they have photosystem-II as well as photosystem-I).
      $$CO_2 + 2H_2O \longrightarrow CH_2O + H_2O + O_2$$
    - Cyanobacteria also contain two antenna pigments, i.e. blue phycocyanin (making them 'blue-green') and red phycoerythrin (the red sea gets its name from the periodic blooms of red-coloured cyanobacteria).
    - These two pigments also occur in red algae.

Common Differences between Bacteria and Cyanobacteria (Blue-green Algae)

Features	Bacteria	Cyanobacteria
Size	Comparatively smaller	Comparatively larger
Flagella	May be present	Always absent
Nutrition	Autotrophic or heterotrophic	Usually autotrophic
Photosynthetic pigments	Bacteriochlorophyll and chlorobium chlorophyll.	Chlorophyll-*a*
Accessory pigment	Absent	Phycocyanin and phycoerythrin are present in dominating form.
Hydrogen donor	During photosynthesis, hydrogen donor is not water, as a result oxygen is not evolved. This photosynthesis is anoxygenic.	Hydrogen donor is water, oxygen is evolved. The process is oxygenic.
Reserve food	Glycogen	Cyanophycean starch.
Spore formation	Endogenous	Spore formation is not endogenous.

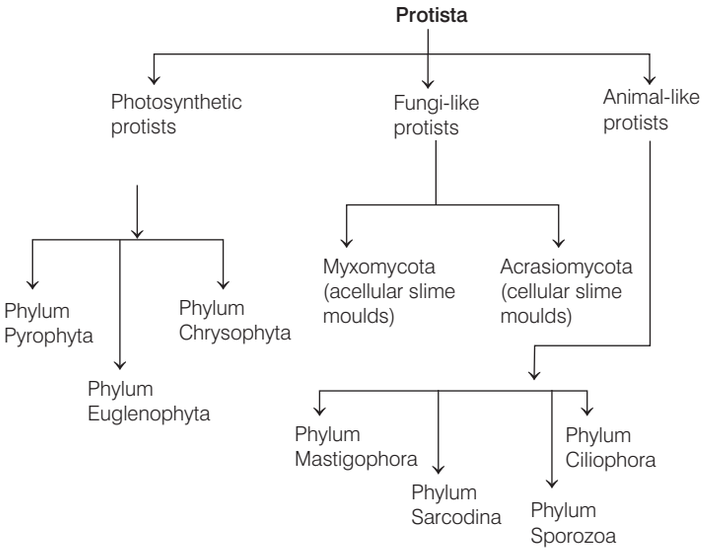
18. **Mycoplasma** are known as the smallest living organisms. They are so small (0.1 μm) that they can be seen only under the electron microscope. Mycoplasmas are obligate parasites.
    - They can live within the cells of other organisms.
    - Mycoplasma Like Organisms (MLOs) or Pleuropneumonia Like Organisms (PPLOs) were discovered by **Nocard** and **Roux** (1898) in pleural fluid of cattle having bovine pleuropneumonia.
    - These are unicellular, prokaryotic, non-motile, highly polymorphic and filterable through bacterial filters.
    - It is resistant to those antibiotics, which act on cell walls like penicillin, due to the lack of cell wall.
    - Mycoplasmas are inhibited by those antibiotics, which act on metabolic pathways such as **tetracycline.**
    - Mycoplasmas do not stain Gram positive because they lack cell walls. These are phylogenetically related to low GC Gram positive bacteria.
    - Mycoplasma resemble protoplasts in that they lack cell wall, but they are more resistant to osmotic lysis and are able to survive conditions, under which protoplast lyse due to the presence of sterols. Some mycoplasma require sterols in their growth media.
    - DNA is linear but coiled. Mesosomes are absent. Reproduction occurs by fission, elementary bodies are reproductive units.
    - The cells of mycoplasma divide unevenly into very minute bodies (elementary bodies) of 330-450 nm in size.
    - *Mycoplasma* causes little leaf disease in brinjal, yellow aster, greening stubborn and witches broom in plants.

Kingdom–Protista

- It includes all the unicellular eukaryotic organisms, e.g. flagellates, diatoms, dinoflagellates, slime moulds, sarcodins, etc.
- The protists are regarded as ancestors of all multicellular eukaryotic organisms.
- Phylogenetically, the kingdom–Protista acts as a connecting link between the prokaryotic kingdom–Monera on one hand and the complex multicellular kingdoms of fungi, plants and animals on the other hand.

Classification of Protists

They are broadly divided into following three groups



1. Photosynthetic Protists

These are phytoplanktons and their common habitats are lakes and oceans. These protists can be further classified into the following phyla

(i) **Phylum–Pyrophyta** (Dinoflagellates) These are unicellular, golden-brown photosynthetic protists that are found in both marine and freshwater habitat.

- Their cell wall is composed of plates made up of cellulose and pectin. It is called theca or lorica and it possess a transverse and a longitudinal groove.
- They possess two flagella (heterokontae condition).
- Reserve food is starch in freshwater forms and oil in marine forms.
- They possess eye spot or stigma and trichocyst and exhibit the phenomenon of **bioluminescence**.
- They are responsible for red tides, e.g. *Gonyaulax*.

(ii) **Phylum–Chrysophyta** This phyla includes diatoms and golden algae.

(a) **Diatoms** are the chief producers in the oceans.

- Their cell wall is called frustule or shell which contain silica and hence, it is indestructible.
- Their reserve food material is leucosin and oils.
- They grow in size and form auxospores that develop into diploid diatom.

(b) **Golden Algae** (Desmids) These are unicellular green algae. Their cell walls have distinct halves. Sexual reproduction occurs by 'conjugation' (similar to *Spirogyra*). They are usually found in freshwater and acts as an indicators of polluted water.

(iii) **Phylum–Euglenophyta** Euglenoids live in fresh aquatic habitats and damp soils.

- They are unicellular flagellate protists.
- Euglenoids have two flagella, usually one long and one short.
- They perform creeping movements by expansion and contraction of their body. This phenomenon is called **metaboly**.
- Reserve food is carbohydrate in the form of **paramylon** or **paramylum** bodies.
- Euglenoids reproduce by longitudinal binary fission under favourable conditions. The **palmella stage** is found during unfavourable conditions. e.g. *Euglena, Perenema, Eutreptia, Phacus,* etc.

2. Fungi-like Protists

These are unicellular, saprophytic organisms.

- They lack cell wall and chlorophyll.
- They move through pseudopodia and exhibit amoeboid movements.
- The somatic structure of **Myxomycota** are free-living, diploid, multinucleate, mobile mass of protoplasm and their thalloid body is called *Plasmodium*, e.g. *Physarum*.
- The somatic structure of **Acrasiomycota** is haploid, uninucleate cell covered by plasma membrane. They do not possess flagellum, e.g. *Polysphondylium.*

3. Animal-like Protists or Protozoans

- These are unicellular or acellular eukaryotic animals that exhibit heterotropic mode of nutrition.
- On the basis of locomotory organelles and nuclear apparatus, protozoans are divided into following phyla

(i) **Phylum–Mastigophora** includes animal-like flagellated protists, i.e. zoomastigophores or zooflagellates, e.g. *Leishmania.*

(ii) **Phylum–Sarcodina** (or Rhizopoda) includes amoeboid organisms without definite pellicle. Mostly free-living, possess contractile vacuole, locomotion by pseudopodia, e.g. *Amoeba, Entamoeba* (parasitic).

(iii) **Phylum–Sporozoa** includes organisms that lack locomotory organs and contractile vacuole as they are endoparasites. Body is surrounded by thick pellicle, reproduce by multiple fission or schizogony (asexually) or spore formation (sexually), e.g. *Plasmodium.*

(iv) **Phylum–Ciliophora** These are aquatic, actively moving organisms because of the presence of thousands of cilia, e.g. *Paramecium*, *Opalina*.

NOTE Ciliates differ from all other protozoans in having two types of nuclei, i.e. meganucleus and micronucleus.

Kingdom–Fungi

- It is a group of eukaryotic, achlorophyllous, non-photosynthetic, heterotrophic and thalloid organisms.
- The study of fungi is called Mycology. **PA Micheli** is known as **Father of Mycology**, whereas **EJ Butler** is known as Father of Indian Mycology.
- **KC Mehta,** an Indian scientist is famous for studying rust disease in wheat.
- **Fungal cell wall** consists of fungal cellulose or chitin, a polymer of N-acetyl glucosamine (except Oomycetes, where cellulose occurs as the main component of cell wall).
- When the septa show a pore in the middle of the cross wall, it is known as simple pore (observed in Ascomycetes). They look like a large jar (the rim is swollen barrel-shaped guarded by cap-like covers).
- In dolipore septum (observed in Basidiomycetes) the cap is like a round bracket or parenthesome. The septal pore cap is called **parenthesome.**
- Reserve food materials found in fungi are glycogen and oil.
- When a single nucleus is present in a cell, the fungal cell is known as **monokaryon**. When two nuclei are present in a cell the fungal cell is known as **dikaryon**.
- Most fungi grow as tubular filaments called **hyphae**. An interwoven mass of hyphae is called **mycelium**.
- When cross walls or septa are formed in the mycelium dividing it into segments, it is known as septate mycelium.
- **Pseudomycelium** is a structure observed in yeast, where during budding process, buds are adhered with one another and form a chain-like structure.

Types of Mycelium

Type	Definition	Example
Coenocytic mycelium	Aseptate, multinucleate mycelium	Oomycetes and Zygomycetes
Primary mycelium	Septate and uninucleate	Ascomycetes
Secondary mycelium	Dikaryotic mycelium	Basidiomycetes

Reproduction in Fungi

- At the reproductive stage, the entire cell protoplast (in unicellular lower fungi) is involved in zoospore formation. The coenocytic thallus is known as **holocarpic**, e.g. *Synchytrium.*
- When the mycelium is differentiated into distinct sterile and fertile portion the thallus is **eucarpic**, e.g. *Phytophthora*.
- When two types of strain (+ and –) are required for performing sexual reproduction, the phenomenon is known as **heterothallism**.
- Blakeslee observed heterothallism in mucorales.
- Reproduction in fungi takes place by following methods

(i) **Asexual reproduction** occurs with the help of various reproductive structures.

- **Zoospores** are thin-walled, motile spores formed in a sporangium. Zoospores may be uniflagellates or biflagellates. The flagella are always heterokont type.
- **Conidia** or **Conidiophores** are spores borne on tips of hyphal structures called conidiophores.
- **Chlamydospores** are usually formed during unfavourable conditions and are thick walled, single celled spores, which are highly resistant in adverse conditions, e.g. *Ustilago, Saprolegnia.*
- **Oidia** are formed in some mycelial fungi.
- The thallus breaks into its component cells and each cell then round up into a structure called **oidium** (pl. oidia).

(ii) **Sexual reproduction** in fungi involves plasmogamy, karyogamy and meiosis. As a result of sexual reproduction, following types of sexual spores are produced

- **Ascospores** are usually single celled, produce haploid spores in a sac called an **ascus**, e.g. Ascomycetes.
- **Basidiospores**, i.e. haploid spores borne on special structures called **basidia.**
- **Zygospores**, i.e. thick-walled diploid spores produced by the fusion of entire gametangia.
- The site of meiosis in Oomycetes, Zygomycetes is zygospore/zygote/oospore, whereas ascus in Ascomycetes and basidium in Basidiomycetes.

The Major Divisions of Fungi

Common Name (Division)	Reproductive Structure	Cellular Characteristics	Economic and Health Impact	Representative Genera	App. No. of Living sp.
Zygote fungi (Zygomycota)	Produce sexual diploid zygospores.	Cell walls contain chitin; septa are absent.	Cause soft fruit rot and black bread mould.	*Rhizopus* (causes black bread mould); *Pilobolus* (dung fungus).	1050
Sac fungi (Ascomycota)	Sexual spores formed in sac-like ascus.	Cell walls contain chitin; septa are present.	Cause moulds on fruit; can damage textiles; cause Dutch elm disease and chestnut blight; include yeasts and morels.	*Saccharomyces* (yeast) : *Ophiostoma* (causes Dutch elm disease). *Neurospora*	32,000
Club fungi (Basidiomycota)	Sexual reproduction involves production of haploid basidiospores on club-shaped basidia.	Cell walls contain chitin; septa are present.	Cause smuts and rusts on crop; include some edible mushrooms.	*Amanita* (poisonous mushroom); *Polyporus* (shelf fungus). *Agaricus*	22,000
Imperfect fungi (Deuteromycota)	Not observed engaging in sexual reproduction.	Cell walls contain chitin; septa are present.	Cause athlete's foot, ringworm, histoplasmosis; source of penicillin.	*Penicillium* (produces penicillin); *Arthrobotrys* (nematode predator), *Alternaria*	17,000

Economic Importance of Fungi

(i) **Yeast** (*Saccharomyces cerevisiae*) is one of the budding yeasts, which ferments sugar to ethanol and carbon dioxide and thus used in

- Making alcoholic beverages like beer and wine.
- **Baker's yeast** is used in baking and commercial production of some vitamins and in the production of some human therapeutic proteins by using recombinant DNA technology.
- Yeast is also used as Single Cell Protein (SCP).
- *Ashbya gossypii,* a filamentous yeast is used in the production of vitamin riboflavin.

(ii) ***Neurospora*** is a fungus which belongs to class–Ascomycetes. It is an excellent research material for the researchers in genetics, that is why, it is known as *Drosophila* of plant kingdom.

(iii) **Penicillin** is obtained from *Penicillium notatum* and *Penicillium chrysogenum.*

(iv) ***Mucor arrhizus*** is used for waste water treatment because it removes heavy metal contamination of water.

- **Fermented foods** are prepared from rice and soybean with the help of *Rhizopus* and *Mucor.*
- **Citric acid** is obtained from molasses with the help of *Mucor.*
- **Fumaric acid** is obtained from *Rhizopus stolonifer.*
- **Cortisone** is obtained from *Rhizopus stolonifer.*
- **Lactic acid** is obtained from *Rhizopus stolonifer* and *Rhizopus nodosus.*
- **Alcohol** is obtained from *Rhizopus oryzae* and *Mucor javanicus.*

(v) **Mushrooms** are used as food for their flavour, protein and vitamin contents. Edible part of mushrooms is basidiocarp, which has a fleshy stalk or stipe and umbrella cap or pileus. Some edible mushrooms are

- *Agaricus campestris* (common)
- *Agaricus bisporus* (cultivated)
- **Toadstool** is a poisonous mushroom, e.g. *Amanita muscaria* (fly mushroom).
- **Puff-balls** are edible in young state, e.g. *Lycoperdon, Clavatia.*
- **Stinkhorn** produce stinking odour due to the spore mass, which is attractive for flies, e.g. *Phallus impudicus* (dead man's finger).

Lichens

- These are composite organisms, which are formed by a fungus **mycobiont** and an algal partner called **photobiont** or **phycobiont.**
- This relation is called **symbiosis** or **mutualism.**
- They may grow on rocks, bark, wood, soil, marine or freshwater.
- The various types of lichens are: crustose, foliose, fruticose, leprose and filamentous.
- Algal part prepares food for fungi and fungi provide shelter and absorb mineral nutrients and water for its partner.
- Lichens can multiply by fragmentation, isidia and soredia. Sexual reproduction and asexual spores are formed only by the mycobiont.
- They are sensitive to sulphur dioxide and are hence, the indicator of air pollution. They do not grow in polluted areas.

- Mycorrhiza is a mutualistic association between a fungus and the root of a higher plant, e.g. pine birch. Mycorrhizal roots occur in superficial layers of soil.
- Mycorrhiza is of two types, i.e. ectomycorrhiza and endomycorrhiza.
- Mycorrhiza is an example of symbiosis or mutualism. The fungus obtains shelter and food from root.
- It helps the root in absorption of water, dissolution and absorption of inorganic nutrients locked in organic matter (especially nitrogen and phosphorus) and protection from other fungi.

Viruses

- They did not find a place in classification, since they are not truely 'living'.
- They are non-cellular organisms that have inert crystalline structure outside the living cell.
- Once they infect a cell, they take over the machinery of the host cell to replicate themselves, killing the host.
- The name virus was given by **DJ Ivanowsky** (1892). He recognised certain microbes as causal organism of the mosaic disease of tobacco.
- **WM Stanley** (1935) showed that viruses could be crystallised.
- Viruses are ultramicroscopic, obligatory and intracellular parasites. Structure of a virus consists of core, capsid and envelope.
- **Capsid** is the outer most protective covering made up of units called **capsomeres**.
- Some highly specialised viruses show an outer covering called envelope.
- **Virion** is a complete virus particle composed of nucleic acid and surrounded by protein coat. It contains either DNA or RNA as nucleic acid.
- The nucleic acid is present in the central core.
- A group of viruses with RNA genome that carry the enzyme reverse transcriptase and form a DNA copy of their genome is called **retrovirus.**
- **Phycophages** are viruses parasite on algae, whereas **mycophages** are parasites on fungi.
- Once enter into host genome, the virus's genetic material is copied along with host genetic material.
- When viral DNA is incorporated into the host chromosome as a latent form, this is called **provirus** in plant and animal virus but **prophage** in bacterial virus.
- **Interferon** is a glycoprotein having non-specific antiviral activity produced by host cells after stimulation of pathogenic viruses.
- The multiplication of bacteriophages may be of lytic type (in virulent phage) or lysogenic type (in temperate phages).
- Virus that infect plants have single-stranded RNA and viruses that infect animals have either single or double-stranded RNA or double-stranded DNA.
- Bacteriophages are usually double-stranded DNA viruses.
- Viruses cause disease like mumps, smallpox, herpes, influenza, AIDS, etc., in human.
- In plants, it causes mosaic formation, leaf rolling and curling, yellowing and vein clearing, dwarfing and stunted growth.

Differences Between Lytic and Lysogenic Phases of Viruses

Character	Lytic Phase	Lysogenic Phase
Integration of DNA	Viral genome does not integrate with host DNA.	Viral genome gets integrated with host DNA to form prophage or provirus.
Hydrolysis of host DNA	Occurs	Does not occur.
Replication	Prophage replicates once along with replication of host genome to transfer a single particle to daughter cell.	Viral genome replicates many times to form many copies in same host cell.

Viroids

- These are new infectious agents discovered by **TO Diener** (1971). They are smaller than viruses and causes potato spindle tuber disease. They are formed of be free RNA, these lack protein coat that is found in viruses, hence name as viroid.
- **Virusoids** discovered by **JW Randels** and associates are small circular RNA, always associated with larger viral RNA and may form part of viral genome.

Prions

Prions discovered by **Stanley B Prusiner** are infectious proteinaceous particles without having nucleic acids. These are formed due to the misfolding of protein particles. They cause a number of diseases like-scrapie in sheep, bovine spongiform encephalopathy (or mad cow disease), Creutzfeldt-Jacob disease in man, etc.

DAY PRACTICE SESSION 1

FOUNDATION QUESTIONS EXERCISE

1 In general, growth involves
(a) cell proliferation
(b) cell enlargement and secretion of extracellular matrix
(c) Both (a) and (b)
(d) None of the above

2 Growth in living things occur due to synthesis of
(a) protoplasmic substances (b) cytoplasmic substances
(c) apoplasmic substances (d) Both (a) and (c)

3 Biological organisation starts with
(a) submicroscopic molecular level
(b) cellular level
(c) organismic level
(d) atomic level

4 Homeostatic mechanisms operate at which level of hierarchy?
(a) Cell level (b) Population level
(c) Ecosystem level (d) All of these

5 Read the statements with respect to homeostasis and choose the incorrect statement.
(a) It is the process of maintenance of a constant internal environment
(b) The term 'Homeostasis' was coined by Cannon for the first time
(c) Organisms adapt to changes in temperature, salinity, etc.
(d) Most fishes, amphibians, reptiles, plants are homeotherms

6 Metabolic reactions can be demonstrated outside the body in cell free systems. An isolated metabolic reaction outside the body of an organism, performed in a test tube is
(a) living thing
(b) non-living thing
(c) Neither living nor non-living thing but a living reaction
(d) None of the above

7 Reason for diversity in living being is
(a) varying environmental conditions
(b) long term evolutionary changes
(c) short term evolutionary changes
(d) gradual internal changes

8 Who proposed phylogenetic system of classification?
(a) George Bentham (b) JD Hooker
(c) Engler and Prantl (d) Carolus Linnaeus

9 System of classification used by Linnaeus was
(a) natural system (b) artificial system
(c) phylogenetic system (d) asexual system

10 What is the name of the book written by Aristotle?
(a) *Systema Naturae* (b) *Historia Naturae*
(c) *Historia Animalium* (d) *Philosophie Zoologique*

11 *Species Plantarum* was written by
(a) Julian Huxley (b) John Ray
(c) Carolus Linnaeus (d) Charles Darwin

12 Phenetic classification of organisms is based on
(a) observable characteristics of existing organisms
(b) the ancestral lineage of existing organism
(c) dendrogram based on DNA characteristics
(d) sexual characteristics

13 Type of specimen described along with holotype is
(a) isotype (b) paratype
(c) topotype (d) syntype

14 Nomenclature is governed by certain universal rules. Which one of the following is contrary to the rules of nomenclature? ➜ NEET-I 2016
(a) The first word in a biological name represents the genus name and the second is a specific epithet
(b) The names are written in Latin and are Italicised
(c) When written by hand, the names are to be underlined
(d) Biological names can be written in any language

15 The term 'Neo systematics' was introduced by
(a) Linnaeus (b) John Ray
(c) Julian Huxley (d) Georges Cuvier

16 Taxonomy based on number of shared characteristics of various organisms is called
(a) chemotaxonomy (b) numerical taxonomy
(c) biochemical taxonomy (d) experimental taxonomy

17 As we go from species to kingdom in a taxonomic hierarchy, the number of common characteristics
(a) will decrease
(b) will increase
(c) remain same
(d) may increase or decrease

18 The term 'Systematics' refers to
(a) identification and classification of plants and animals
(b) nomenclature and identification of plants and animals
(c) diversity of kinds of organisms and their relationship
(d) different kinds or organisms and their classification

19 Genus represents
(a) an individual plant or animal
(b) a collection of plants or animals
(c) a group of closely related species of plants or animals
(d) None of the above

20 Which of the following 'Suffixes' used for units of classification in plants indicates a taxonomic category of 'family'?

(a) Ales (b) Onae
(c) Aceae (d) Ae

21 The taxonomic unit 'Phylum' in the classification of animals is equivalent to which hierarchical level in classification of plants?

(a) Class (b) Order
(c) Division (d) Family

22 The correct sequence of taxa is

(a) Class—Order—Family—Tribe—Genus— Species
(b) Class—Order—Tribe—Family—Genus— Species
(c) Phylum—Order—Class—Tribe—Genus— Species
(d) Phylum—Tribe—Class—Order—Genus— Species

23 A species inhabiting different geographical areas is known as

(a) allopatric
(b) sympatric
(c) biospecies
(d) sibling species

24 Two plants can be conclusively said to belong to the same species if they

(a) can reproduce freely with each other and form seeds
(b) have more than 90% similar genes
(c) look similar and possess identical secondary metabolites
(d) have same number of chromosomes

25 What is a keystone species?

(a) A species, which makes up for only a small proportion of the total biomass of a community, yet has a huge impact on the community's organisation and survival
(b) A common species that has plenty of biomass, yet has a fairly low impact on the community's organisation
(c) A rare species that has minimal impact on the biomass and on other species in the community
(d) A dominant species that constitutes a large proportion of the biomass and which affect many other species

26 The label of a herbarium sheet does not carry an information on ➝ NEET-II 2016

(a) date of collection (b) name of collector
(c) local names (d) height of the plant

27 The largest collection of herbarium in India is

(a) Central National Herbarium, Kolkata
(b) Southern Circle Herbarium, Coimbatore
(c) Central Circle Herbarium, Allahabad
(d) Blatter Herbarium, Mumbai

28 Botanical gardens and zoological parks have

(a) collection of endemic living species only
(b) collection of exotic living species only
(c) collection of endemic and exotic living species
(d) collection of only local plants and animals

29 Taxonomic key is one of the taxonomic tools in the identification and classification of plants and animals. It is used in the preparation of

(a) Monographs (b) Flora
(c) Both (a) and (b) (d) None of these

30 Manuals contain information for

(a) habitat and distribution of animals of a given area
(b) habitat and distribution of all the plants on earth
(c) identification of names of species found in an area
(d) habitat and distribution of some useful animals of a given area

31 All monerans

(a) contain DNA and RNA
(b) demonstrate a long circular strand of DNA, not found enclosed in a nuclear membrane
(c) are bacteria
(d) All of the above

32 Which of the followings are found in extreme saline conditions? ➝ NEET 2017

(a) Archaebacteria (b) Eubacteria
(c) Cyanobacteria (d) Mycobacteria

33 *Thermococcus*, *Methanococcus* and *Methanobacterium* exemplify

(a) archaebacteria that contain protein homologous to eukaryotic core histones
(b) archaebacteria that lack any histones resembling those found in eukaryotes, but whose DNA is negatively supercoiled
(c) bacteria whose DNA is relaxed or positively supercoiled but which have a cytoskeleton as well as mitochondria
(d) bacteria that contain a cytoskeleton and ribosomes

34 Archaebacteria differ from eubacteria in ➝ CBSE AIPMT 2014

(a) cell membrane structure (b) mode of nutrition
(c) cell shape (d) mode of reproduction

35 The primitive prokaryotes responsible for the production of biogas from the dung of ruminant animals, include the ➝ NEET-I 2016

(a) thermoacidophiles (b) methanogens
(c) eubacteria (d) halophiles

36 Some hyperthermophilic organisms that grow in highly acidic habitats belong to the two groups called

(a) eubacteria and archaea
(b) cyanobacteria and diatoms
(c) protists and mosses
(d) liverworts and yeasts

37 Which one of the following statements is incorrect? ➝ NEET-I 2016

(a) Golden algae are also called desmids
(b) Eubacteria are also called false bacteria
(c) Phycomycetes are also called algal fungi
(d) Cyanobacteria are also called blue-green algae

38 In eubacteria, a cellular component that resembles eukaryotic cells is ➜ CBSE AIPMT 2011

(a) nucleus (b) ribosomes
(c) cell wall (d) plasma membrane

39 The structures that help some bacteria to attach to rocks and/or host tissues are ➜ CBSE AIPMT 2015

(a) rhizoids (b) fimbriae
(c) mesosomes (d) holdfast

40 Bacteria are (were) considered more as plants than animals because of the presence of

(a) small nucleus (b) plasma membrane
(c) cell wall (d) spore formation

41 Bacterial flagella do not show ATPase activity and 9 + 2 organisation. These are chemically

(a) flagellin (b) pilin
(c) tubulin (d) bacterin

42 Which one of the following statements regarding cilia is not correct?

(a) The organised beating of cilia is controlled by fluxes of Ca^{2+} across the membrane
(b) Cilia are hair-like cellular appendages
(c) Microtubules of cilia are composed of tubulin
(d) Cilia contain an outer ring of nine doublet microtubules surrounding two single microtubules

43 When a bacteriophage in its lytic phase, carries some of the bacterium's partially digested chromosome with it to another host cell, the process is called

(a) transformation (b) general transduction
(c) restricted transduction (d) conjugation

44 The cyanobacteria are also referred to as ➜ CBSE AIPMT 2012

(a) protists (b) golden algae
(c) slime moulds (d) blue-green algae

45 Oxygen is not produced during photosynthesis by ➜ NEET 2018

(a) *Cycas* (b) *Nostoc*
(c) Green-sulphur bacteria (d) *Chara*

46 The fertility or F^+ factor that plays a role in conjugation is a

(a) retrovirus (b) plasmid
(c) viroid (d) lysogenic phage

47 Which statement is correct for the bacterial transduction?

(a) transfer of some genes from one bacteria to another bacteria through virus
(b) transfer of genes from one bacteria to another bacteria by conjugation
(c) bacteria obtained its DNA directly
(d) bacteria obtained DNA from other external source

48 The cells of cyanobacteria and bacteria exhibit similarity in having

(a) plastids (b) nuclei
(c) centrosome (d) naked DNA

49 In mycoplasma (PPLO), the plasmalemma is rich in

(a) cholesterol (b) glycogen
(c) cellulose (d) myosin

50 *Mycoplasma* differ from viruses in that they are sensitive to

(a) penicillin (b) tetracyclines
(c) sugars (d) amino acids

51 Outer limiting layer of mycoplasma is

(a) slime layer (b) mucilage layer
(c) cell wall (d) cell membrane

52 Which one of the following statements about mycoplasma is incorrect?

(a) They are also called PPLO
(b) They are pleomorphic
(c) They are sensitive to penicillin
(d) They cause disease in plants

53 Pigment-containing membranous extensions in some cyanobacteria are ➜ CBSE AIPMT 2012

(a) heterocysts (b) basal bodies
(c) pneumatophores (d) chromatophores

54 Which among the following are the smallest living cells, known without a definite cell wall, pathogenic to plants as well as animals and can survive without oxygen? ➜ NEET 2017

(a) *Bacillus* (b) *Pseudomonas*
(c) *Mycoplasma* (d) *Nostoc*

55 Chrysophytes, euglenoids, dinoflagellates and slime moulds are included in the kingdom ➜ NEET-I 2016

(a) Protista (b) Fungi
(c) Animalia (d) Monera

56 In which group of organisms the cell walls form two thin overlapping shells which fit together? ➜ CBSE AIPMT 2015

(a) Chrysophytes (b) Euglenoids
(c) Dinoflagellates (d) Slime moulds

57 Slime moulds in the division–Myxomycota (true slime moulds) have

(a) pseudoplasmodia
(b) spores that develop into free-living amoeboid cells
(c) spores that develop into flagellated gametes
(d) feeding stages consisting of solitary individual cells

58 What is common about *Trypanosoma, Noctiluca, Monocystis* and *Giardia*?

(a) These are all unicellular protists
(b) They have flagella
(c) They produce spores
(d) These are all parasites

59 Which of the following organisms are known as chief producers in the oceans?

(a) Cyanobacteria
(b) Diatoms
(c) Dinoflagellates
(d) Euglenoids

60 Which of the following unicellular organisms has a macronucleus for trophic function and one or more mirconuclei for reproduction?
(a) *Euglena* (b) *Amoeba*
(c) *Paramecium* (d) *Trypanosoma*

61 Which of the following is a dinoflagellate responsible for red tides?
(a) *Anabaena* (b) *Gonyaulax*
(c) *Mycoplasma* (d) Archaebacteria

62 Ciliates differ from all other protozoans in
(a) using pseudopodia for capturing prey
(b) having contractile vacuole for removing excess water
(c) using flagella for locomotion
(d) having two types of nuclei

63 Which of the following is not correctly matched?
(a) Amoeboid protozoan — *Amoeba*
(b) Flagellated protozoan — *Trypanosoma*
(c) Sporozoan — *Anopheles*
(d) Ciliated protozoan — *Paramecium*

64 Select the incorrect statement.
(a) Pseudopodia are locomotory and feeding structures in sporozoans
(b) Mushrooms belong to Basidiomycetes
(c) Cell wall is present in members of Fungi and Plantae
(d) Mitochondria are the powerhouse of the cell in all kingdoms except Monera

65 The slime moulds and multicellular algae are presently included in the Kingdom–Protista because
(a) they appear to be more closely related to unicellular eukaryotes
(b) they lack important characteristics of the fungi and plants
(c) kingdom–Protista includes eukaryotic organisms that do not clearly belong in the other three kingdoms
(d) All of the above

66 The highest number of species in the world is represented by ➜ CBSE-AIPMT 2012
(a) fungi (b) mosses
(c) algae (d) lichens

67 The imperfect fungi which are decomposers of litter and help in mineral cycling belong to ➜ CBSE-AIPMT 2015
(a) Deuteromycetes (b) Basidiomycetes
(c) Phycomycetes (d) Ascomycetes

68 In most of the fungi, the food material is stored in the form of
(a) starch (b) glucose
(c) sucrose (d) glycogen

69 One of the major components of cell wall of most fungi is ➜ NEET-I 2016
(a) peptidoglycan (b) cellulose
(c) hemicellulose (d) chitin

70 Which of the following would appear as the pioneer organisms on bare rocks? ➜ NEET-II 2016
(a) Liverworts (b) Mosses
(c) Green algae (d) Lichens

71 After karyogamy followed by meiosis, spores are produced exogenously in ➜ NEET 2018
(a) *Agaricus* (b) *Alternaria*
(c) *Neurospora* (d) *Saccharomyces*

72 Choose the incorrect statement. ➜ CBSE-AIPMT 2015
(a) *Penicillium* is multicellular and produces antibiotics
(b) *Neurospora* is used in the study of biochemical genetics
(c) Morels and truffles are poisonous mushrooms
(d) Yeast is unicellular and useful in fermentation

73 Which one of the following is incorrect for fungi? ➜ NEET-II 2016
(a) They are eukaryotic
(b) All fungi possess a purely cellulosic cell wall
(c) They are heterotrophic
(d) They are both unicellular and multicellular

74 Virus envelope is known as ➜ CBSE-AIPMT 2010
(a) capsid (b) virion
(c) nucleoprotein (d) core

75 Viruses that infect bacteria multiply and cause their lysis, are called
(a) lysozymes (b) lipolytic
(c) lytic (d) lysogenic

76 A naked RNA particle causing the symptoms like that of a viral disease is known as
(a) viroid (b) virion
(c) viral (d) None of these

77 Which one of the following statements is incorrect for viroids? ➜ NEET-I 2016
(a) They are smaller than viruses
(b) They cause infections
(c) Their RNA is of high molecular weight
(d) They lack a protein coat

78 Viroids differ from viruses in having ➜ NEET 2017
(a) DNA molecules with protein coat
(b) DNA molecules without protein coat
(c) RNA molecules with protein coat
(d) RNA molecules without protein coat

79 Which statement is incorrect for viruses? ➜ CBSE-AIPMT 2012
(a) All are parasites
(b) All of them have helical symmetry
(c) They have ability to synthesise nucleic acids and proteins
(d) Antibiotics have no effect on them

80 Which of the following is not correct about viruses?
(a) In addition to proteins, viruses also contain genetic material that could be either DNA or RNA
(b) No virus contains both RNA and DNA
(c) A virus is a nucleoprotein and genetic material is infectious
(d) The protein coat called capsid is made up of small subunits called viroids

81 The correct statement is

(a) generally viruses that infect plants have single-stranded RNA

(b) generally viruses that infect animals have either single or double-stranded RNA or double-stranded DNA

(c) bacteriophages are double-stranded DNA viruses

(d) All of the above

82 Select incorrect statement. ➜ CBSE-AIPMT 2015

(a) The viroids were discovered by DJ Ivanowski

(b) WM Stanley showed that viruses could be crystallised

(c) The term *'Contagium vivum fluidum'* was coined by MW Beijerinck

(d) Mosaic disease in tobacco and AIDS in human being are caused by viruses

83 Study the four statements (I-IV) given below and select the two correct ones out of them ➜ NEET-II 2016

I. Definition of biological species was given by Ernst Mayr.

II. Photoperiod does not affect reproduction in plants.

III. Binomial nomenclature system was given by RH Whittaker.

IV. In unicellular organisms, reproduction is synonymous with growth.

The two correct statements are

(a) II and III (b) III and IV (c) I and IV (d) I and II

84 Match the items given in column I with those in column II and select the correct option given below. ➜ NEET 2018

	Column I		Column II
A.	Herbarium	1.	It is a place having a collection of preserved plants and animals.
B.	Key	2.	A list that enumerates methodically all the species founds in an area with brief discription aiding identification.
C.	Museum	3.	It is a place where dried and pressed plant specimens mounted on sheets are kept.
D.	Catalogue	4.	A booklet containing a list of characters and their alternates which are helpful in identification of various taxa.

	A	B	C	D
(a)	2	5	4	1
(b)	3	2	1	4
(c)	1	4	3	2
(d)	3	4	1	2

85 Match the following columns.

	Column I		Column II
A.	Dinoflagellate	1.	*Dictyostelium*
B.	*Plasmodium*	2.	*Noctiluca*
C.	Myxomycota	3.	Slime mould
D.	Acrasiomycota	4.	*Fuligo*

Codes

	A	B	C	D
(a)	3	2	1	4
(b)	1	4	3	2
(c)	2	3	4	1
(d)	4	3	1	2

Directions (Q. Nos. 86 and 88) *In each of the following questions a statement of Assertion is given followed by the corresponding statements of Reason. Of the statements, mark the correct answer as*

(a) If both Assertion and Reason are true and Reason is the correct explanation of Assertion

(b) If both Assertion and Reason are true, but Reason is not the correct explanation of Assertion

(c) If Assertion is true, but Reason is false

(d) If both Assertion and Reason are false

86 **Assertion** Carolus Linnaeus was a Swedish naturalist.

Reason Linnaeus is called Father of Taxonomy.

87 **Assertion** Cytotaxonomy involves the cytological information for classification purpose.

Reason Chemotaxonomy is based on the chemical constituents of plants.

88 **Assertion** Macronucleus in *Paramecium* is polyploid.

Reason Micronucleus in *Paramecium* is diploid.

DAY PRACTICE SESSION 2

PROGRESSIVE QUESTIONS EXERCISE

1 Binomial nomenclature is described in the book
(a) *Genera Plantarum* (b) *Historia Plantarum*
(c) *Systema Naturae* (d) *Flora Japonica*

2 Tribe is an independent category between sub-family and
(a) family (b) genus (c) class (d) subclass

3 Clinical death is characterised by stoppage of
(a) breathing (b) pulse
(c) heartbeat (d) All of these

4 In the five-kingdom classification *Chlamydomonas* and *Chlorella* have been included in
(a) Protista (b) Algae
(c) Plantae (d) Monera

5 Taxon is the
(a) taxonomic group of any rank
(b) procedure to assign a scientific name
(c) process of classification
(d) process by which any thing is grouped into convenient categories based on characteristics

6 Binomial nomenclature means
(a) one name given by two scientists
(b) two names, one scientific, other local
(c) two names, one Latinised, other of a person
(d) one scientific name consisting of a generic and a specific epithet

7 Most abundant organic compound on earth is
(a) protein (b) cellulose
(c) lipids (d) steroids

8 How many organisms in the list given below are autotrophs?
Lactobacillus, *Nostoc*, *Chara*, *Nitrosomonas*, *Nitrobacter*, *Streptomyces*, *Saccharomyces*, *Trypanosoma*, *Porphyra*, *Wolffia*
(a) Four (b) Five
(c) Six (d) Three

9 Which of the following is a slime mould?
(a) *Rhizopus* (b) *Physarum*
(c) *Thiobacillus* (d) *Anabaena*

10 The thalloid body of a slime mould (Myxomycetes) is known as
(a) *Plasmodium* (b) fruiting body
(c) mycelium (d) protonema

11 Which of the following is not the locomotory organ of Protozoa?
(a) Cilia (b) Flagella
(c) Parapodia (d) Pseudopodia

12 Golden brown protists belong to
(a) Chrysophytes (b) Euglenoids
(c) Dinoflagellates (d) Diatoms

13 In *Mangifera indica* L., generic epithet is
(a) *indica* (b) *Mangifera*
(c) Linnaeus (d) None of these

14 ICBN stands for
(a) Indian Congress of Biological Names
(b) International Code of Botanical Nomenclature
(c) International Congress of Biological Names
(d) Indian Code of Botanical Nomenclature

15 The type of spores found in *Ustilago* are
(a) oidia (b) conidia
(c) zoospores (d) chlamydospores

16 The site of respiration in bacteria is
(a) episome (b) mesosome (c) ribosome (d) microsome

17 Protists obtain food as
(a) photosynthesisers, symbionts and holotrophs
(b) photosynthesisers
(c) chemosynthesisers
(d) holotrophs

18 Genophore bacterial genome or nucleoid is made up of
(a) histones and non-histones
(b) RNA and histones
(c) a double-stranded DNA
(d) a single-stranded DNA

19 Protists having transverse and longitudinal groove in their theca are
(a) foraminiferans (b) radiolarians
(c) diatoms (d) dinoflagellates

20 The word species was coined by
(a) Aristotle (b) Linnaeus
(c) John Ray (d) Engler

21 Chromosomes in a bacterial cell can be 1-3 in number
(a) can be circular as well as linear within the same cell
(b) are always circular
(c) are always linear
(d) can be either circular, but never both within the same cell

22 Which of the following viral structures are not completely coded by the virus' own nucleic acids?
(a) Capsid
(b) Glycoprotein gp 120 of HIV
(c) Viral envelope
(d) Tail sheath of T_4 bacteriophage

23 Auxospores and hormocysts are formed, respectively by
(a) several diatoms and a few cyanobacteria
(b) several cyanobacteria and several diatoms
(c) some diatoms and several cyanobacteria
(d) some cyanobacteria and many diatoms

24 Five kingdom system of classification suggested by RH Whittaker is not based on
(a) presence or absence of a well- defined nucleus
(b) mode of reproduction
(c) mode of nutrition
(d) complexity of body organisation

25 Which of the following is not the main criteria for five kingdom system of classification?
(a) Cell structure and thallus organisation
(b) Mode of nutrition and reproduction
(c) Phylogenetic relationship
(d) Gram staining

26 Which of the following is not true for a species?
(a) Members of a species can interbreed
(b) Variations occur among members of a species
(c) Each species is reproductively isolated from every other species
(d) Gene flow does not occur between the populations of a species

27 Most of the lichens consist of
(a) blue-green algae and Basidiomycetes
(b) blue-green algae and Ascomycetes
(c) red algae and Ascomycetes
(d) brown algae and Phycomycetes

28 Macro and micronucleus are the characteristic features of
(a) *Paramecium* and *Vorticella*
(b) *Opalina* and *Nyctotherus*
(c) *Hydra* and *Ballantidium*
(d) *Vorticella* and *Nyctotherus*

29 Protistan genome has
(a) membrane bound nucleoproteins embedded in cytoplasm
(b) free nucleic acid aggregates
(c) gene containing nucleoproteins condensed together in loose mass
(d) nucleoprotein in direct contact with cell substance

30 A gene transfer occurred between two strains of bacteria. It was observed that cell-cell contact is not required and a filter that removes viruses eliminates transfer. This would mean that the transfer occurred by
(a) conjugation (b) transformation
(c) transposition (d) transduction

31 Which one of the following is not true about lichens?
(a) Their body is composed of both algal and fungal cells
(b) Some form food for reindeers in Arctic regions
(c) Some species can be used as pollution indicators
(d) These grow very fast at the rate of about 2 cm per year

32 About 98% of the mass of every living organism is composed of just six elements including carbon, hydrogen, nitrogen, oxygen,
(a) phosphorus and sulphur
(b) sulphur and magnesium
(c) magnesium and sodium
(d) calcium and phosphorus

33 Which one of the following statements is not a correct statement?
(a) Herbarium houses dried, pressed and preserved plant specimens
(b) Botanical gardens have collection of living plants for reference
(c) A museum has gardens collection of photographs of plants and animals
(d) Key is a taxonomic aid for identification of specimens

34 Neo sytematics aims at
(a) the classification of organism based on broad morphological characters
(b) delimiting various taxa of organisms and establishing their relationship
(c) the classification of organisms based on their evolutionary history and establishing their phylogeny on the totality of various parameters from all fields of studies
(d) Identification and arrangement of organisms on the basis of their cytological characteristics

35 Which one of the following statements about bacteria is true?
(a) Bacteria possess 80S ribosomes, introns and RNA processing
(b) Bacteria possess 70S ribosomes, introns and no RNA processing
(c) Bacteria possess 70S ribosomes, no introns and no RNA processing
(d) Bacteria possess 80S ribosomes, RNA processing and no introns

36 Match the following columns.

	Column I		Column II
A.	Numerical taxonomy	1.	Nuclear and chromosomal studies
B.	Classical taxonomy	2.	Number of shared characters
C.	Practical taxonomy	3.	Utility of organism
D.	Karyotaxonomy	4.	α- taxonomy

Codes

	A	B	C	D
(a)	2	4	3	1
(b)	1	3	2	4
(c)	4	2	3	1
(d)	1	2	4	3

37 Match the following columns.

	Column I		Column II
A.	*Philosophie Zoologique*	1.	Carolus Linnaeus
B.	*Historia Plantarum*	2.	Lamarck
C.	*Systema Naturae*	3.	Theophrastus
D.	*Genera Plantarum*	4.	Bentham and Hooker

Codes

	A	B	C	D
(a)	3	2	4	1
(b)	2	3	1	4
(c)	1	2	3	4
(d)	4	3	2	1

38 Match the following columns.

	Column I		Column II
A.	Protozoan	1.	*Gonyaulax*
B.	Bacillariophyceae	2.	Diatoms
C.	Euglenoid	3.	*Paramecium*
D.	Dinoflagellates	4.	*Euglena*

Codes

	A	B	C	D
(a)	2	3	4	1
(b)	4	2	3	1
(c)	1	3	2	4
(d)	3	2	4	1

Directions (Q. Nos. 39-40) *In each of the following questions a statement of Assertion is given followed by a corresponding statement of Reason just below it. Of the statements, mark the correct answer as*

(a) If both Assertion and Reason are true and Reason is the correct explanation of Assertion
(b) If both Assertion and Reason are true, but Reason is not the correct explanation of Assertion
(c) If Assertion is true, but Reason is false
(d) If both Assertion and Reason are false

39. **Assertion** Bentham and Hooker's system of classification is based on more number of characters and natural affinities.
Reason Bentham and Hooker's system of classification is a phylogenetic system.

40. **Assertion** Scientific names are printed in *Italics*.
Reason The name of author is written in abbreviated form after the specific epithet and is printed in Roman.

ANSWERS

SESSION 1

1 (c)	**2** (d)	**3** (a)	**4** (d)	**5** (d)	**6** (c)	**7** (b)	**8** (c)	**9** (b)	**10** (c)
11 (c)	**12** (a)	**13** (b)	**14** (d)	**15** (c)	**16** (b)	**17** (a)	**18** (c)	**19** (c)	**20** (c)
21 (c)	**22** (a)	**23** (a)	**24** (a)	**25** (a)	**26** (d)	**27** (a)	**28** (c)	**29** (c)	**30** (c)
31 (d)	**32** (a)	**33** (a)	**34** (a)	**35** (b)	**36** (a)	**37** (b)	**38** (d)	**39** (b)	**40** (c)
41 (a)	**42** (a)	**43** (b)	**44** (d)	**45** (c)	**46** (b)	**47** (a)	**48** (d)	**49** (a)	**50** (b)
51 (d)	**52** (c)	**53** (d)	**54** (c)	**55** (a)	**56** (a)	**57** (c)	**58** (a)	**59** (b)	**60** (c)
61 (b)	**62** (d)	**63** (c)	**64** (a)	**65** (d)	**66** (a)	**67** (a)	**68** (d)	**69** (d)	**70** (d)
71 (a)	**72** (c)	**73** (b)	**74** (a)	**75** (c)	**76** (a)	**77** (c)	**78** (d)	**79** (b)	**80** (d)
81 (d)	**82** (a)	**83** (c)	**84** (d)	**85** (c)	**86** (b)	**87** (b)	**88** (b)		

SESSION 2

1 (c)	**2** (b)	**3** (d)	**4** (c)	**5** (a)	**6** (d)	**7** (b)	**8** (c)	**9** (b)	**10** (a)
11 (c)	**12** (c)	**13** (b)	**14** (b)	**15** (d)	**16** (b)	**17** (a)	**18** (c)	**19** (d)	**20** (c)
21 (b)	**22** (c)	**23** (a)	**24** (c)	**25** (d)	**26** (d)	**27** (b)	**28** (a)	**29** (a)	**30** (d)
31 (d)	**32** (a)	**33** (c)	**34** (c)	**35** (c)	**36** (a)	**37** (b)	**38** (d)	**39** (c)	**40** (b)