CHAPTER 1

Diversity in Living Organisms

- **Biodiversity** refers number and types of wide variety of plants and animals present on earth.
- In 1773, Swedish botanist **Carolus Linnaeus** formulated the system of Binomial Nomenclature in his book '*Species plantarum*'. In binomial system, each name is expressed in two parts *i.e.*, **generic** name and **specific** name.
- **Taxonomy** is the branch of biology that deals with the framing of laws and principles for classifying the organisms on the basis of their characteristics and evolutionary relationships.
- The hierarchial system of classification was introduced by **Linnaeus**.

  Kingdom → Phylum or Division → Class → Order → Family → Genus → Species
- **Species** is defined as "the smallest real basic unit of taxonomy which is reproductively isolated from other group of individuals".
- **Genus** is a group of closely related species that are alike in broad features of their organisation.
- **Family** is a group of related genera having several common characters.
- Generally, **Order** and other higher taxonomic categories are identified based on the aggregates of characters.
- A **Class** is made of one or more related orders.
- The term **Phylum** is used for animals while **Division** is commonly employed for plants.
- **Kingdom** is the highest taxonomic category. All plants are included in Kingdom Plantae. All animals are included in Kingdom Animalia.
- **Herbarium** is a collection of pressed and dried plant specimens that are preserved on paper sheets.
- In **Botanical garden**, various plants groups are grown for scientific study, conservation, public education, aesthetics, and recreation. The famous botanical gardens are at **Kew (England), Indian Botanical Garden, Howrah (India)** and **National Botanical Research Institute, Lucknow (India).**
- **Museum** is a building used for the preservation, storage and exhibition of inanimate objects.
- **Zoological park** or zoological garden or zoo is a place where wild animals are kept in protected environment under human care. These animals are kept for public exhibition.

History of Classification

- **Biological classification** was first proposed by **Aristotle** who used simple morphological characters to classify plants and animals.
- **Linnaeus** initially separated plants and animals in **two Kingdoms** *i.e.*, Kingdom Plantae and Kingdom Animalia.
- Most accepted System of classification is **Five system classification** which was given by **Whittaker**.

Basic Features of Whittaker's Five Kingdoms

	Kingdom	Cellular Organisation	Movement	Nutrition	Reproduction
1.	**Monera** (All Prokaryotes)	Unicellular, without nucleus or membranous organelle.	By flagella (tubulin-dynein system)	Absorptive or photosynthetic	Asexual
2.	**Protista** (Protozoans, unicellular algae)	Unicellular, eukaryote with nucleus and membranous organelles.	By flagella, cillia, pseudopodia and mucilage propulsion	Absorptive, photosynthetic & holozoic	Both sexual and asexual
3.	**Fungi** (Multicellular decomposers)	Multicellular eukaryote coenocytic, no plastids, cells wall of cellulose, chitin.	Non-motile	Heterotrophic (saprophytic/ parasitic)	Asexual and sexual both
4.	**Plantae** (All plants)	Multicellular, higher organisation eukaryotes, cellulosic cell wall, plastids present.	Non-motile	Autotrophic or photosynthetic	Asexual and sexual both
5.	**Animalia** (All animals)	Multicellular, higher organization, eukaryotes without cell wall and chlorophyll.	Highly motile with all type of motile machinery	Heterotrophic (holozoic or saprozoic)	Both sexual and asexual but in higher forms only sexual

Types of Classification

- **Artificial classification system :** It was used by **Linneaus**. The artificial classification system was based on vegetative characters or on the androecium structure.
- **Natural classification system :** It was based on natural affinities among organisms. Both external and internal features were taken into account. It was used by **George Bentham** and **Joseph Dalton Hooker**.
- **Phylogenetic classification system :** This system of classification is based upon evolutionary relationship and uses morphological characters, origin and evolution of the different organisms. It was proposed by **Hutchinson**.

Viruses

- The term 'virus' has been derived from latin, which means poison or venom or viscous fluid. They are obligate parasites, *i.e*., can live inside living host only. They have either RNA or DNA. They have character of both living and non-living.

Plant Kingdom

TABLE : Divisions of Algae and their Main Characteristics

Classes Name	Common	Major Pigments Food	Stored	Cell Wall	Flagellar Number and Position of Insertions	Habitat
Chlorophyceae	Green algae	Chlorophyll *a, b*	Starch	Cellulose	2-8, equal, apical	Fresh water, brackish and salt water.
Phaeophyceae	Brown algae	Chlorophyll *a, c*, fucoxanthin	Mannitol, laminarin	Cellulose and algin	2, unequal, lateral	Fresh water (rare), brackish water, salt water
Rhodophyceae	Red algae	Chlorophyll *a, d*, phycoerythrin	Floridean starch	Cellulose	Absent	Fresh water (some), brackish water, salt water (most)

Bryophytes

- Bryophytes are also called **amphibians of the plant kingdom** because these plants can live in soil but are dependent on water for sexual reproduction. They usually occur in damp, humid and shaded localities.
- Species of *Sphagnum*, a moss, provide peat that have long been used as fuel, and because of their capacity to hold water as packing material for trans-shipment of living material.

Pteridophytes

- Evolutionarily, they are the first terrestrial plants to possess vascular tissues – xylem and phloem.
- The main plant body is a sporophyte which is differentiated into true root, stem and leaves. These organs possess well-differentiated vascular tissues. Examples are *Psilotum*, *Equisetum*, *Dryopteris*, *Marsilea*, etc.

Gymnosperms

- Gymnosperms are plants which bear naked seeds *i.e*., the ovules and the seeds that develop from these ovules after fertilization are not enclosed in fruit wall.
- Roots in some genera have fungal association in the form of **mycorrhiza** (*Pinus*), while in some other (*Cycas*) small specialised roots called **coralloid roots** are associated with N_2– fixing cyanobacteria.

Angiosperms (Flowering Plants)

- Angiosperms are seed bearing, flowering vascular plants in which seeds are enclosed in fruits.
- The flower is the most characteristic structure of the angiosperms. The male sex organ in a flower is the **stamen**. Each stamen consists of a slender **filament** with an **anther** at the tip. The anthers, following meiosis, produce pollen grains.
- The female sex organ in a flower is the **pistil** or the **carpel**. Pistil consists of an ovary enclosing one to many ovules. Within ovules are present highly reduced female gametophytes termed **embryo sacs.**
  Each embryo-sac has a seven-celled **egg apparatus** – one **egg cell** and two **synergids,** three **antipodal** cells and two **polar nuclei**. The polar nuclei eventually fuse to produce a diploid secondary nucleus.
- Pollen grain, after dispersal from the anthers, are carried by wind or various other agencies to the stigma of a pistil. This is termed as **pollination**.
- The pollen tubes enter the embryo-sac where two male gametes are discharged. One of the male gametes fuses with the egg cell to form a zygote (**syngamy**). The other male gamete fuses with the diploid secondary nucleus to produce the **triploid primary endosperm nucleus (PEN)**. Because of the involvement of two fusions, this event is termed as **double fertilisation**, and event unique to angiosperms.

Animal Kingdom

- Animals are the most diverse groups of organisms. Multicellular, heterotrophs characterised by mobility, sensory and nervous systems.

Phylum-Porifera

- Sponges are aquatic, mostly marine, solitary or colonial and sessile.
- Examples of some sponges are : *Sycon* (scypha), *Spongilla* (fresh water sponge) and *Euspongia* (bath sponge).

Phylum-Coelenterata (Cnidaria)

- All are aquatic and are mostly marine (exception-*Hydra* are found in fresh-water), solitary or colonial, sessile, or free-swimming and radially symmetrical animals.
- Example-*Physalia* (Portuguese man of war), *Adamsia* (Sea anemone), *Pennatula* (Sea-pen), *Gorgonia* (Sea-fan) and *Meandrina* (Brain coral).

Phylum-Ctenophora

- These are diploblastic, radial symmetrical animals with tissue level of organization.
- Examples–*Hormiphora* (sea walnut), *Pleurobranchia* (sea gooseberry), *Cestum* (venus girdle), *Beroe*.

Phylum-Platyhelminthes

- These are mostly endoparasites, bilateral symmetrical, triploblastic and acoelomate animals with organ level of organisation.
- Examples– *Taenia* (Tape worm), *Fasciola* (liver fluke).

Phylum-Aschelminthes

- They may be free-living, aquatic and terrestrial or parasitic in plants and animals.
- Examples: *Ascaris* (Round worm), *Wuchereria* (filarial worm), *Ancylostoma* (Hook worm), *Enterobius* (Pin worm).

Phylum-Annelida

- It is characterised by metameric segmentation forming ring like segments.
- Example: *Neries*, *Pheretima* (Earthworm) and *Hirudinaria* (Blood sucking leech).

Phylum-Arthropoda

- They are bilateral symmetry, triploblastic animals, which have organ-system level of organisation.
- Example: *Apis* (Honey bee), *Bombyx* (Silkworm), *Laccifer* (Lac insect).

Phylum-Mollusca

- They are aquatic (marine or fresh water), or terrestrial having an organ-system level of organisation.
- Ex. *Pila*, *Octopus* (devil fish), *Loligo* (sea squid).

Phylum-Echinodermata

- All existing echinoderms are marine, generally live at sea bottom.
- Ex. *Asterias* (star fish), *Cucumaria* (commonly called as sea cucumber), *Antedon* (water lily or feather star).

Phylum-Hemichordata

- They are bilaterally symmetrical, triploblastic, and entrocoelous animals.
- Ex. *Balanoglossus* (acorn worm or tongue worm), *Saccoglossus*.

Phylum-Chordata

- The fundamental four characters of phylum chordata are presence of notochord, a dorsal hollow nerve cord, paired pharyngeal gill slits and post anal tail either in the embryonic or adult stage.
- Examples: *Herdmania* (sea squirt), *Branchiostoma*.

Subphylum vertebrata is divided into two sections:

Section 1 Agnatha (The jawless vertebrates)

Class : Cyclostomata

- Mouth jawless suctorial and round.
- All living members are ectoparasites on some fishes.
  Ex. *Petromyzon* (lamprey), *Myxine* (hag fish).

Section 2 Gnathostomata (The jawed vertebrates)

Superclass : Pisces (Bear fins)

Class : Chondrichthyes

- They have a cartilagenous skeleton.
- Some of them possess electric organs *e.g.* Torpedo.
- Examples: *Scoliodon* (Dog fish), *Trygon* (Sting ray).

Class : Osteichthyes

- They have a bony skeleton.
- Examples : Marine – *Exocoetus* (Flying fish), *Hippocampus* (Sea horse), *Lophius* (Angler fish), Fresh water fishes – *Labeo* (Rohu), *Catla* (Katla).

Superclass : Tetrapoda (Bear Limbs)

Class : Amphibia

- Adapted for both water and land life.
- They are oviparous and development indirect through distinct larval stage called tadpole. Exambles : *Bufo* (Toad), *Rana* (Frog), *Hyla* (Tree frog), *Salamandra* (Salamander), *Ichthyophis* (Limbless amphibia).

Class: Reptilia

- The class name refers to their creeping or crawling mode of locomotion.
- They are oviparous ; Development direct.
  Examples: *Crocodilus* (Crocodile), *Bangarus* (Krait)

Class: Aves

- Birds are bipedal feathered animals.
- Endoskeleton is fully ossified (bony) and the long bones are hollow with air cavities (pneumatic).
  Examples : *Corvus* (crow), *Pavo* (Peacock).

Class: Mammalia

- These are warm blooded (homiothermous) animals having hair and mammary glands.
- They are viviparous with few exceptions and development is direct.
  Example : Oviparous – *Tachyglossus* = *Echidna* (spiny Anteater). Viviparous – *Pteropus* (Flying fox), *Camelus* (Camel), *Macaca* (Monkey).

Plant Morphology

The Root

- It is the underground system, usually below the soil and originates from the radicle.
- The primary functions of root are fixation of plant firmly on soil, absorption of water and conduction of mineral nutrients.

Modified Tap Roots

- **Fusiform :** *e.g.* radish.
- **Napiform :** *e.g.* sugar beet.
- **Conical :** *e.g.* carrot.
- **Tuberous root :** *e.g.* tapioca.
- **Nodulated :** *e.g. Rhizobium.*

Modified Branched Root

- **Pneumatophores :** Pneumatophores or respiratory roots are short, vertical and negatively geotropic (grow in an upward direction) that occur in certain halophytes, which grow in saline marshes (mangroves). *e.g. Rhizophora*.

Modified for Mechanical Functions

- **Prop root :** *e.g.* banyan.
- **Stilt root :** *e.g.* screwpine.
- **Climbing root :** *e.g.* betel.
- **Clinging root :** *e.g.* orchid.
- **Floating root :** *e.g., Jussiaea*.
- **Contractile root :** *e.g.*, onion.
- **Root thorn :** *e.g.*, coconut.

Modified Adventitious Root

Modified for Physiological Functions

- **Parasitic root :** *e.g., Cuscuta*.
- **Epiphytic root :** *e.g.*, Orchids.
- **Tuberous root :** *e.g.*, sweet potato.

Shoot System

- It is negatively geotropic and positively phototropic.
- Stem facilitates conduction of water, mineral and food material. It also produces and supports leaves and reproductive structure.

Modified Stems

Underground

- **Tuber:** *e.g.* potato.
- **Bulb :** *e.g.* onion.
- **Rhizome :** *e.g.* ginger.
- **Corm :***e.g. Amorphophallus.*

Sub-aerial

- **Runner :** *e.g. Oxalis*.
- **Offset :** *e.g. Pistia*.
- **Stolon :** *e.g. Mentha*.
- **Sucker :** *e.g. Chrysanthemum*.

Aerial or Metamorphosed

- **Thorn :** *e.g. Duranta*.
- **Stem-tendril :** *e.g.* grape.
- **Phylloclade :** *e.g. Opuntia*.

Leaf

The leaf is a specialised organ of photosynthesis, transpiration and gaseous exchange.

Venation

Venation is the arrangement of the veins and the veinlets in a leaf.

- **Reticulate Venation:** The veins are arranged in a net like manner, *e.g.*, dicots.
- **Parallel Venation:** Here the veins are arranged parallel to each other, *e.g.*, monocots.

Modifications of Leaves

- **Leaf tendrils** *e.g. Pisum sativum, Gloriosa*
- **Leaf spines** *e.g. Opuntia, Barberry*
- **Scale leaves** *e.g. Asparagus*
- **Phyllode** *e.g. Australian acacia*
- **Pitcher** *e.g. Nepenthes*
- **Bladder** *e.g. Utricularia*

Phyllotaxy (Arrangement of Leaves)

- **Alternate :** Only one leaf is borne at each node in alternate manner *e.g.* Mustard, Sunflower
- **Opposite :** two leaves occur at each node.
- **Whorled :** When more than two leaves occur at a node, *e.g. Nerium, Hydrilla*.

Inflorescence

- An inflorescence is the mode of arrangement of flowers on peduncle or mother axis.

Types of Inflorescence

- **I. Racemose (Indefinite)** (Main axis grows indefinitely bearing flowers in Acropetal order)
- **II. Cymose (Definite)** (Main axis terminates into flower & flowers arise in Basipetal order)

Fruit = Ripened Ovary

FRUIT

Flesh Simple Fruit
(Pericarp fleshy)

- **Berry :** *e.g.* tomato, guava.
- **Hesperidium :** *e.g.* lemon, orange
- **Pepo :** Epicarp makes a hard rind, *e.g.* cucumber, watermelon
- **Pome :** *e.g.* apple, pear.

Dry Simple Fruit
(Pericarp dry)

Indehiscent

- **Achene :** *e.g.*, Hogweed (*Boerhaavia*), *Mirabilis jalapa*
- **Caryopsis :** *e.g.*, rice, wheat, maize
- **Cypsela :** *e.g.*, sunflower, marigold
- **Nut :** *e.g.*, water chestnut, oak, cashew-nut, litchi

Dehiscent

- **Follicle :** *e.g.*, *Caloptropis*.
- **Legume or Pod :** *e.g.*, *pea*.
- **Siliqua :** *e.g.* mustard to expose replum with attached seeds (*Brassica*)
- **Capsule :** *e.g.*, lady finger.

Schizocarpic

Dehiscing into one seeded parts :

- **Lomentum :** *e.g.*, *Acacia*, *Mimosa*.
- **Cremocarp :** *e.g. Coriander*, Fennel.
- **Regma :** *e.g. Castor*, *Geranium*
- **Double samra :** *e.g. Acer* (Maple)

EXERCISE

1. Study of form and structure of organisms is
   (a) Ecology (b) Taxonomy
   (c) Anatomy (d) Morphology
2. Group of organisms that closely resemble each other and freely interbreed in nature, constitute a
   (a) species (b) genus
   (c) family (d) taxon
3. Herbarium is
   (a) a garden where medicinal plants are grown
   (b) garden where herbaceous plants are grown
   (c) dry garden
   (d) chemical to kill plants
4. Organisms which display properties of both living and non-living are
   (a) Viruses (b) Diatoms
   (c) Lichens (d) Bacteria
5. The taxonomic unit 'Phylum' in the classification of animals is equivalent to which hierachial level in classification of plants
   (a) Class (b) Order
   (c) Division (d) Family
6. Whittaker is famous for
   (a) Two kingdom classification
   (b) Four kingdom classification
   (c) Five kingdom classification
   (d) Distinguishing in Bacteria & Blue green algae
7. Which bacteria is utilized in gober gas plant?
   (a) Methanogens
   (b) Nitrifying bacteria
   (c) Ammonifying bacteria
   (d) Denitrifying bacteria
8. Which one of the following statements about viruses is correct?
   (a) Viruses possess their own metabolic system.
   (b) Viruses contain either DNA or RNA.
   (c) Viruses are facultative parasites.
   (d) Viruses are readily killed by antibiotics.
9. Which one of the following organisms is not an example of eukaryotic cells ?
   (a) *Paramoecium caudatum*
   (b) *Escherichia coli*
   (c) *Euglena viridis*
   (d) *Amoeba proteus*
10. Which of the following does not contain chlorophyll?
    (a) Fungi (b) Algae
    (c) Bryophyta (d) Pteridophyta
11. Which of the following is called amphibians of plant kingdom?
    (a) Bryophytes (b) Pteridophytes
    (c) Gymnosperms (d) Algae
12. The plant group that produces spores and embryo but lacks vascular tissues and seeds is
    (a) Pteridophyta (b) Rhodophyta
    (c) Bryophyta (d) Phaeophyta

13. A plant having seeds but lacking flowers and fruits belongs to
(a) Pteridophytes (b) Mosses
(c) Ferns (d) Gymnosperms

14. Agar is commercially obtained from
(a) red algae (b) green algae
(c) brown algae (d) blue-green algae

15. An alga very rich in protein is
(a) *Spirogyra* (b) *Ulothrix*
(c) *Oscillatoria* (d) *Chlorella*

16. The largest flower found is known as
(a) *Rafflesia* (b) *Tecoma*
(c) *Musa* (d) *Cauliflower*

17. A common characteristic of all vertebrates is
(a) presence of skull
(b) division of body into head, neck, trunk and tail
(c) presence of two pairs of functional appendages
(d) body is covered with an exoskeleton

18. The long bones are hollow and connected by air passages these are characteristics of
(a) Mammals (b) Reptiles
(c) Birds (d) All land vertebrates

19. In which one of the following sets of animals do all the four give birth to young ones?
(a) Platypus, Penguin, Bat, Hippopotamus
(b) Shrew, Bat, Cat, Kiwi
(c) Kangaroo, Hedgehog, Dolphin, , Loris
(d) Lion, Bat, Whale, Ostrich

20. Which of the following animal is not a insect ?
(a) Ticks (b) Honey bee
(c) Beetle (d) Wasp

21. Which of the following group of animals maintains high and constant body temperature such as mammals ?
(a) Reptiles (b) Amphibians
(c) Birds (d) Fishes

22. Insects have
(a) 2 pairs of legs (b) 3 pairs of legs
(c) 4 pairs of legs (d) 1 pair of legs

23. Cymose is
(a) thalamus (b) fruit
(c) inflorescence (d) ovary

24. Which is not a stem modification ?
(a) Rhizome of ginger (b) Corm of *Colocasia*
(c) Pitcher of *Nepenthes* (d) Tuber of potato

25. A modification of leaf is
(a) Tendrils (b) Phylloclade
(c) Cladode (d) Corm

26. Artificial system of classification was first used by
(a) Linnaeus (b) De Candolle
(c) Pliny the Edler (d) Bentham and Hooker

27. Binomial Nomenclature was given by
(a) Lamarck (b) Ernst Mayr
(c) Carolus Linneaus (d) Cuvier

28. Which of the following is not a pteridophyte?
(a) *Ginkgo* (b) *Selaginella*
(c) *Polypodium* (d) *Azolla*

29. The famous botanical garden 'Kew' is located in
(a) England (b) Lucknow
(c) Berlin (d) Australia

30. Which of the following groups of plants play an important role in plant succession on bare rocks/soil?
(a) Algae (b) Bryophytes
(c) Pteridophytes (d) Gymnosperms

31. Which of the following groups of plants are propagated through underground root?
(a) *Bryophyllum* and *Kalanchoe*
(b) Ginger, Potato, Onion and Zamikand
(c) *Pistia*, *Chrysanthemum* and Pineapple
(d) Sweet potato, *Asparagus*, Tapioca and Dahlia

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

33. Leaves of dicotyledonous plants possess _____ venation, while _____ venation is the characteristic of most monocotyledons.
(a) reticulate and parallel respectively
(b) parallel and reticulate respectively
(c) reticulate and perpendicular respectively
(d) obliquely and parallel respectively.

34. In class of Amphibia, respiration occurs through
(a) gills (b) lungs
(c) skin (d) All of these

35. Which of the following class of algae mostly found in salt water?
(a) Phaeophyceae (b) Rhodophyceae
(c) Chlorophyceae (d) Both (a) and (b)

36. Which of the following are correctly matched with respect to their taxonomic classification?
(a) Centipede, Millipede, Spider, Scorpion-Insecta
(b) House fly, Butterfly, Tse tse fly, Silverfish-Insecta
(c) Spiny Anteater, Sea urchin, Sea cucumber-Echinodermata
(d) Flying fish, Cuttlefish, Silverfish-Pisces

37. During the post-fertilisation period the ovules develop into _____ and the ovary matures into a _____.
(a) A – seeds; B – fruit
(b) A – fruit; B – seeds
(c) A – flower; B – seed
(d) A – seeds; B – flower

38. One of the following is a very unique feature of the mammalian body
(a) Presence of diaphragm
(b) Four chambered heart
(c) Rib cage
(d) Homeothermy

39. Which one of the following groups of animals is correctly matched with its one characteristic feature without even a single exception ?
(a) Reptilia : possess 3 - chambered heart with one incompletely divided ventricle
(b) Chordata : possess a mouth provided with an upper and lower jaw
(c) Chondrichthyes : possess cartilagious endoskeleton
(d) Mammalia : give birth to young one.

40. Which of the following plants is growing in swampy areas, where many roots come out of the ground and grow vertically upwards?
(a) Potato (b) *Opuntia*
(c) *Rhizophora* (d) Grass

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

HINTS AND SOLUTIONS

3. (c) Herbarium is dry garden.
7. (a) *Methanobacillus* (methanogen) occurs in marshes and also in dung. It produces CH_4 gas under anaerobic condition and is utilized in gobar gas plant.
8. (b) Viruses have either DNA or RNA as the genetic material. Viruses having RNA as the genetic material are known as Retroviruses.
9. (b) *E. coli* is a prokaryotic celled gram negative bacterium.
12. (c) Bryophytes are the plants which produces spores and embryo but no vascular tissues are present, although primitive type of conducting tissues are present in the form of hadrome and leptome.
13. (d) Gymnosperms are vascular land plants having naked ovules *i.e.*, ovules are not enclosed in a ovary hence, flower is absent. Ovules after fertilization produces naked seeds. Pteridophytes (ferns) and mosses do not produce seeds.
14. (a) The Agar is obtained from several members of red algae such as *Gracilaria*, *Gelidium*, *Chondrus* etc. Agar gels are extensively used for growing micro-organisms.
15. (d) *Chlorella* can be grown to provide human food rich in proteins, lipids, carbohydrates, vitamins and minerals.
16. (a) *Rafflesia* or Corpse flower is a total root parasite. It obtains the total nourishment from the roots of the host plant.
17. (a) Vertebrates are also known as Craniata due to presence of skull in all its members.
18. (c) Hollow bones are characteristic adaptive features of birds. It reduces their body weight and is a major flight adaptation.
19. (c) Penguin, kiwi & ostrich all belong to class Aves of chordata (*i.e.* birds) and they do not give birth to their young ones, they are oviparous while kangaroo, hedgehog, dolphin, loris all belong to class mammalia and are viviparous.
21. (c) Animals which maintain high and constant body temperature are called warm blooded animals. They are also called homeothermic animals. Birds are the first vertebrate to have warm blood. They are homeothermous.
22. (b) Class insecta has 3 pairs of legs located on the thoracic segments. It is the characteristic feature of class Insecta.
26. (c) Pliny the Edler introduced first artificial system of classification in his book *Historia Naturalis*.
28. (a) *Ginkgo* is a gymnosperm.
32. (a) ICBN (International Code of Botanical Nomenclature) - It is one of the code of nomenclature which is independent of zoological and bacteriological nomenclature. The code applies equally to names of taxonomic groups treated as plants whether or not these groups were originally so treated.
39. (c) Chondrichthyes are the cartilaginous fish with a flexible skeleton made of cartilage rather than bone.