Course: Biology-IV (6454)
Semester: Spring, 2021
ASSIGNMENT No. 1

Q. 1 Give detailed explanation of the mode of nutrition, excretion and reproduction among protists.

Protists are simple eukaryotic organisms that are neither plants nor animals or fungi. Protists are unicellular in nature but can also be found as a colony of cells. Most protists live in water, damp terrestrial environments or even as parasites.

The term 'Protista' is derived from the Greek word "protistos", meaning "the very first". These organisms are usually unicellular and the cell of these organisms contains a nucleus which is bound to the organelles. Some of them even possess structures that aid locomotion like flagella or cilia.

Scientists speculate that protists form a link between plants, animals and fungi as these three kingdoms diverged from a common protist-like ancestor, billions of years ago. Though this "protists-like" ancestor is a hypothetical organism, we can trace some genes found in modern animals and plants to these ancient organisms.

Therefore, these organisms are traditionally considered as the first eukaryotic forms of life and a predecessor to plant, animals and fungi.

Characteristics of Kingdom Protista

The primary feature of all protists is that they are eukaryotic organisms. This means that they have a membrane-enclosed nucleus. Other characteristic features of Kingdom Protista are as follows:

1. These are usually aquatic, present in the soil or in areas with moisture.
2. Most protist species are unicellular organisms, however, there are a few multicellular protists such as kelp. Some species of kelp grow so large that they exceed over 100 feet in height. (Giant Kelp).
3. Just like any other eukaryotes, the cells of these species have a nucleus and membrane-bound organelles.
4. They may be autotrophic or heterotrophic in nature. An autotrophic organism can create their own food and survive. A heterotrophic organism, on the other hand, has to derive nutrition from other organisms such as plants or animals to survive.
5. Symbiosis is observed in the members of this class. For instance, kelp (seaweed) is a multicellular protist that provides otters, protection from predators amidst its thick kelp. In turn, the otters eat sea urchins that tend to feed on kelp.
6. Parasitism is also observed in protists. Species such as Trypanosoma protozoa can cause sleeping sickness in humans.
7. Protists exhibit locomotion through cilia and flagella. A few organisms belonging to kingdom Protista have pseudopodia that help them to move.
8. Protista reproduces by asexual means. The sexual method of reproduction is extremely rare and occurs only during times of stress.

Classification of Protista

Kingdom Protista is classified into the following:

Protozoa

Protozoans are unicellular organisms. Historically, protozoans were called “animal” protists as they are heterotrophic and showed animal-like behaviours.

There are also parasitic protozoans which live in the cells of larger organisms. Most of the members do not have a predefined shape. For instance, an amoeba can change its shape indefinitely but a paramecium has a definite slipper-like shape. The most well-known examples of protozoans are amoeba, paramecium, euglena. Unlike other members of this group, euglena is a free-living protozoan that has chlorophyll, which means it can make its own food.

The protozoans can be divided into four major groups:

1. **Amoeboid protozoans –** Mostly found in water bodies, either fresh or saline. They have pseudopodia (false feet) which help to change their shape and in capturing and engulfing food. E.g. Amoeba
2. **Flagellated protozoans –** As the name suggests, the members of this group have flagella. They can be free-living as well as parasitic. E.g. Euglena
3. **Ciliated protozoans –** They have cilia all over their body which help in locomotion as well as nutrition. They are always aquatic. E.g. Paramecium
4. **Sporozoans –** These organisms are so-called because their life cycle has a spore-like stage. For example, the malarial parasite, Plasmodium.

Slime Moulds

Slime moulds are saprophytic organisms (they feed on the dead and decaying matter). These are tiny organisms that have many nuclei.

Usually, Slime moulds are characterized by the presence of aggregates called plasmodium and are even visible to the naked eye.

Chrysophytes, Dinoflagellates and Euglenoids

These form another category under kingdom Protista. These are generally single-celled or multicellular organisms. These are photosynthetic, found mostly in freshwater sources or marine lakes. They are characterized by a stiff cell wall.

Example of chrysophytes include diatoms and golden algae. They are characterised by the presence of a hard siliceous cell wall. Diatomaceous earth is formed due to the accumulation of cell wall deposits. They are photosynthetic organisms.

Dinoflagellates are photosynthetic and found in various different colours, according to the pigment present in them. They show bioluminescence and known to cause red tide.

Euglenoids are the link between plants and animals. They lack a cell wall but perform photosynthesis. In the absence of sunlight, they act as a heterotroph and feed on small organisms. The outer body covering is a protein-rich layer known as a pellicle. E.g. Euglena, Trachelomonas, etc.

Economic Importance of Protists

- Protists serve as the foundation of the food chain.
- Protists are symbionts – having a close relationship between two species in which, one is benefited.
- Some protists also produce oxygen and may be used to produce biofuel.
- Protists are the primary sources of food for many animals.
- In some rare cases, Protists are harvested by humans for food and other industrial applications.
- Phytoplankton is one of the sole food sources for whales
- Seaweed is an alga, which is considered a plant-like protist.
- Zooplankton is fed on by various sea creatures including shrimp and larval crabs.

At the cellular level, the metabolic pathways known for protists are essentially no different from those found among cells and tissues of other eukaryotes. Thus, the plastids of algal protists function like the chloroplasts of plants with respect to photosynthesis, and, when present, the mitochondria function as the site where molecules are broken down to release chemical energy, carbon dioxide, and water. The basic difference between the unicellular protists and the tissue- and organ-dependent cells of other eukaryotes lies in the fact that the former are simultaneously cells and complete organisms. Such microorganisms, then, must carry out the life-sustaining functions that are generally served by organ systems within the complex multicellular or multitissued bodies of the other eukaryotes. Many such functions in the protists are dependent on relatively elaborate architectural adaptations in the cell. Phagotrophic feeding, for example, requires more complicated processes at the protist's cellular level, where no combination of tissues and cells is available to carry out the ingestion, digestion, and egestion of particulate food matter. On the other hand, obtaining oxygen in the case of free-living, free-swimming protozoan protists is simpler than for multicellular eukaryotes because the process requires only the direct diffusion of oxygen from the surrounding medium. Although most protists require oxygen (obligate aerobes), there are some that may or must rely on anaerobic metabolism—for example, parasitic forms inhabiting sites without free oxygen and some bottom-dwelling (benthic) ciliates that live in the sulfide zone of certain marine and freshwater sediments. Mitochondria typically are not found in the cytoplasm of these anaerobes; rather, microbodies called hydrogenosomes or specialized symbiotic bacteria act as respiratory organelles. The major modes of nutrition among protists are autotrophy (involving plastids, photosynthesis, and the organism's manufacture of its own nutrients from the milieu) and heterotrophy (the taking in of nutrients). Obligate autotrophy, which requires only a few inorganic materials and light energy for survival and growth, is characteristic of algal protists (e.g., Chlamydomonas). Heterotrophy may occur as one of at least two types: phagotrophy, which is essentially the engulfment of particulate food, and osmotrophy, the taking in of dissolved nutrients from the medium, often by the method of pinocytosis. Phagotrophic heterotrophy is seen in many ciliates that seem to require live prey as organic sources of energy, carbon, nitrogen, vitamins, and growth factors. The food of free-living phagotrophic protists ranges from other protists to bacteria to plant and animal material, living or dead. Scavengers are numerous, especially among the ciliated protozoans; indeed, species of some groups prefer moribund prey. Organisms that can utilize either or both autotrophy and heterotrophy are said to exhibit mixotrophy. Many dinoflagellates, for example, exhibit mixotrophy.

Q. 2 Write important characteristics of phylum Gastroticha.

Characteristic Features of Phylum Gastrotricha:

1. Phylum Gastrotricha is microscopic, un-segmented, worm-like animals.
2. Body length ranges 50-1000 μm.
3. Cephalic region slightly swollen and caudal region forked with glands.
4. Dorsal and lateral surfaces of Phylum Gastrotricha is covered with spines, scales and warts.
5. Ventral surface with abundant cilia, hence called Gastrotricha.
6. Head with a number of sensory bristles.
7. Locomotion by cilia and muscular action. They glide over the bottom on ventral cilia.
8. Phylum Gastrotricha has multi-layered cuticle.
9. Epidermis with monociliated cells with gland cells and glandular adhesive tubes in some species as are gnathostomulids.
10. Circular and longitudinal muscles are present in the body wall of Phylum Gastrotricha.
11. The space between the body wall and gut is filled with loose organs and mesenchyme that indicate the acoelomate condition. Blastocoel forms during development but does not persist in the adult stage.
12. Digestive tract complete; mouth surrounded by bristles; pharynx triradiate and muscular.
13. Circulatory and respiratory systems are absent in Phylum Gastrotricha.
14. Nervous system consists of two cerebral ganglionic masses at the anterior of the pharynx with two lateral nerve cords.
15. Excretory organs of Phylum Gastrotricha are protonephridia with ciliated flame cells.
16. Phylum Gastrotricha are eutelic animals.
17. Hermaphrodite or parthenogenetic with simple gonads. Marine species are mostly hermaphroditic and freshwater species are parthenogenetic.
18. Fertilization is internal in Phylum Gastrotricha.
19. Development with determinate cleavage as in rotifers and other aschelminthes.
20. Blastopore forms both mouth and anus.
21. No larval stage occurs in the life cycle of Phylum Gastrotricha.

Habitat of Phylum Gastrotricha:

They are found in marine and freshwater habitats and the marine species inhabit the interstitial spaces of benthic sediments.

Q. 3 What are common characteristics of Arthropods and nematodes? Write internal characteristics of nematodes.

The phylum Nematoda, or roundworms, includes more than 28,000 species with an estimated 16,000 parasitic species. The name Nematoda is derived from the Greek word "nemos," which means "thread." Nematodes are present in all habitats and are extremely common, although they are usually not visible.

The nematode body is encased in a cuticle, a flexible but tough exoskeleton, or external skeleton, which offers protection and support. The cuticle contains a carbohydrate-protein polymer called chitin. The cuticle also lines the pharynx and rectum. Although the exoskeleton provides protection, it restricts growth, and therefore must be continually shed and replaced as the animal increases in size.

A nematode's mouth opens at the anterior end with three or six lips and, in some species, teeth in the form of cuticular extensions. There may also be a sharp stylet that can protrude from the mouth to stab prey or pierce plant or animal cells. The mouth leads to a muscular pharynx and intestine, leading to the rectum and anal opening at the posterior end.

In nematodes, the excretory system is not specialized. Nitrogenous wastes are removed by diffusion. In marine nematodes, regulation of water and salt is achieved by specialized glands that remove unwanted ions while maintaining internal body fluid concentrations.

Most nematodes have four nerve cords that run along the length of the body on the top, bottom, and sides. The nerve cords fuse in a ring around the pharynx, to form a head ganglion or "brain" of the worm, as well as at the posterior end to form the tail ganglion. Beneath the epidermis lies a layer of longitudinal muscles that permits only side-to-side, wave-like undulation of the body.

Nematodes employ a diversity of sexual reproductive strategies depending on the species; they may be monoecious, dioecious (separate sexes), or may reproduce asexually by parthenogenesis. Caenorhabditis elegans is nearly unique among animals in having both self-fertilizing hermaphrodites and a male sex that can mate with the hermaphrodite.

The name "arthropoda" means "jointed legs," which aptly describes each of the enormous number of species belonging to this phylum. Arthropoda dominate the animal kingdom with an estimated 85 percent of known species, with many still undiscovered or undescribed. The principal characteristics of all the animals in this phylum are functional segmentation of the body and the presence of jointed appendages. As members of Ecdysozoa, arthropods also have an exoskeleton made principally of chitin. Arthropoda is the largest phylum in the animal world in terms of numbers of species, and insects form the single largest group within this phylum. Arthropods are true coelomate animals and exhibit prostostomic development.

A unique feature of arthropods is the presence of a segmented body with fusion of certain sets of segments to give rise to functional segments. Fused segments may form a head, thorax, and abdomen, or a cephalothorax and abdomen, or a head and trunk. The coelom takes the form of a hemocoel (or blood cavity). The open circulatory system, in which blood bathes the internal organs rather than circulating in vessels, is regulated by a two-chambered heart. Respiratory systems vary, depending on the group of arthropod: Insects and myriapods use a series of tubes (tracheae) that branch throughout the body, open to the outside through openings called spiracles, and perform gas exchange directly between the cells and air in the tracheae. Aquatic crustaceans use gills, arachnids employ "book lungs," and aquatic chelicerates use "book gills." The book lungs of arachnids are internal stacks of alternating air pockets and hemocoel tissue shaped like the pages of a book. The book gills of crustaceans are external structures similar to book lungs with stacks of leaf-like structures that exchange gases with the surrounding water.

Phylum Arthropoda includes animals that have been successful in colonizing terrestrial, aquatic, and aerial habitats. The phylum is further classified into five subphyla: Trilobitomorpha (trilobites), Hexapoda (insects and relatives), Myriapoda (millipedes, centipedes, and relatives), Crustacea (crabs, lobsters, crayfish, isopods, barnacles, and some zooplankton), and Chelicerata (horseshoe crabs, arachnids, scorpions, and daddy longlegs). Trilobites are an extinct group of arthropods found from the Cambrian period (540–490 million years ago) until they became extinct in the Permian (300–251 million years ago) that are probably most closely related to the Chelicerata. The 17,000 described species have been identified from fossils.

The Hexapoda have six legs (three pairs) as their name suggests. Hexapod segments are fused into a head, thorax, and abdomen. The thorax bears the wings and three pairs of legs. The insects we encounter on a daily basis—such as ants, cockroaches, butterflies, and bees—are examples of Hexapoda.

Subphylum Myriapoda includes arthropods with legs that may vary in number from 10 to 750. This subphylum includes 13,000 species; the most commonly found examples are millipedes and centipedes. All myriapods are terrestrial animals and prefer a humid environment.

Q. 4 Write general characteristics of class Polyplacophora.

1. **Habitat:** The Class Polyplacophora contains the Chitons. Chitons live on hard substrates in shallow marine water. Early Native Americans ate Chitons. Chitons have a fishy flavor. But they are touch to chew and difficult to collect.
2. **Body Parts:** Chitons have a reduced head, a flattened foot, and a shell. Shell divides extends beyond the margins of the shell and foot. The mantle cavity Islamabad restricted to the space between the margin of the mantle and the foot.
3. **Locomotion**: Chitons crawl over their substrate like gastropods. Their body attaches to a substrate with the help of muscular foot. It allowed chitons to withstand strong waves and tidal currents. Sometimes, chitons are disturbed. In this case, the edges of the mantle rightly grip the substrate. The foot muscles contract and raise the middle of the foot. This action creates a vacuum that holds the chiton in place. There are articulations in the shell. Chitons roll into a ball due to this articulation when dislodged from the substrate.

4. **Gills and mantle Cavity:** A linear series of gills are present in the mantle cavity on each side of the foot. Cilia are present on thi gills. These cilia create water currents. Water enters below the anterior mantle margins and exit posteriorly. The digestive, excretory, and reproductive tracts open near the exhalant area of the mantle cavity. Exhalant water carries products of these systems away.
5. **Nutrition:** Most chitons feed on attached algae. A subradular organ extends from the mouth. It Islamabad a chemoreceptor and dectects food. The radula rasps this food the mouth. It Islamabad a chemoreceptor and detects food. The radula rasps this food from the substrate. Mucus traps food. Food then enters the esophagus by ciliary action. Extracellular digestion and absorption occur in the stomach. The wastes move in to the intestine and pass out fan LIS.
6. **Nervous system and sense organs:** The nervous system is ladder like. It is composed tour anteroposterior nerve cords and many transverse nerves. A nerve ring encircles the esophagus. Sensory structures are osphradia. tactile receptors. chemoreceptors and statocysts. Tactile receptors are present on the mantle margin. Chemoreceptors are present near the mouth. **Statocysts** are present in the foot. **Photoreceptors** are present on the surface of the shell in some chitons.
7. **Reproduction:** Sexes are separate in chitons. External fertilization takes place The zygote develops to ⁻form a swimming **trochophore.** This larva settles and metamorphoses into an adult. Veliger stage is absent in them.

Major Attributes:

1. Possess eight calcareous plates that overlap to form a linear chain.
2. Surrounding mantle developed into thick girdle, often bearing spines, scales or bristles.
3. Poorly developed head.
4. Lack eyes and sensory tentacles.
5. Large radula with many teeth.
6. Open circulatory system.
7. Protostomate.

Q. 5 How feeding and digestion take place in Cephalopods?

Cephalopods are marine animals and it can be found in oceans all around the world. Some of this species live in caves or rocky areas. Smaller individuals dig dens in sand-shell substrates. All cephalopods have internal shells that have chambers connected by siphuncle. They also have a large brain formed by nerve ganglia and protected by cartilaginous cranium. All cephalopods have flexible tentacles. Cuttlefish and squids generally have two long tentacles. Octopus have eight and nautilus can have up to 90 tentacles! These organisms can range in size from a few centimeters up to more than 20 meters long. They are also known as head-foot because a cephalopod's head is connected with its foot. Some examples of exphalopods are octopus, squids, cuttlefish, and nautiluses.

Feeding :

All cephalopods are carnivores. They are predators with incredible senses to help them detect food. Octopus uses their acute vision to seek a prey. They grab on to the prey with their suckers, engulf the organism with its tentacles and draw the food into them. Some octopus and cuttlefish bite their food into smaller bite-size pieces before digesting it. They would inject their prey with saliva that paralyzes. Diet of bottom-dwelling octopus includes mollusks, crustaceans, and polychaete worms. Diet of open-ocean octopus and squid are fish, prawns, and cephalopods. Furthermore, squid catches its prey by shooting out its tentacles towards their prey and draw the prey inside. Cuttlefish and squids have long, sticky tentacles with suckers that aid them in capturing prey. Others would dangle their long arms down onto a school of fish or prawns and catches the food that goes through the arms. In addition, squid that lacks tentacles have suckers with hooks to lunge at their prey. Feeding patterns of cephalopods vary across different species. Like snails and clams, cephalopods also have a radula used for feeding purposes.

Like a typical aquatic animal, Cephalopods uses gills to breath and to filter food. Cephalopods use hemocyanin rather than hemoglobin to transport oxygen throughout its body. Because these animals use hemocyanin, their blood is colorless when deoxygenated and changes blue when it gets in contact with air.

Digestion:

Digestion in cephalopods is rapid. It starts with a strong beak which contains the radula. The radula is covered with teeth for digging and scraping food. There are two salivary glands (one of them is poisonous) that secrete alpha and beta cephalotoxins that aids them in digestion. Food enters the esophagus and goes through the crop where food can be stored until ready for digestion. The food then goes inside the stomach where food is mashed by digestive substances from the salivary glands, liver, and pancreas. Food is absorbed in the liver, pancreas and cecum. The intestine supplies the stomach and path to the anus with mucous.

Circulation/Internal Transport :

Cephalopods are the only mollusks with a closed circulatory system with three hearts. This is because open circulatory system is not efficient enough for octopi and squids to move quickly. Their coelom is like a bag that surrounds their hearts. The first two hearts, gill hearts (branchial hearts) moves blood through the gill's capillaries whereas, the reminding heart, systemic heart, provides the rest of the body with oxygenated blood.

Excretion :

Wastes are excreted through nephridia. They excrete in the form of urine which contains ammonium and feces.

Reproduction:

Cephalopods are gonochoric which means their sexes are separate. Female possess a single oviduct, whereas, the male produces spermatophore. These are passed from male to the female's genital pore by using specialized arms which is the male's gonoduct. In some species, this specialized arm may tip off into the female's mantle cavity. The arm is called hectocoylus arm. However, in other species that doesn’t have hectocotylus, the male's reproductive organ (penis) is long and strong enough to transfer their spermatophores directly into the female.

The eggs are then fertilized in the female as they leave the oviduct. As a result they lay a batch of fertilized eggs and are released into open water. Most cephalopod are semelparous, they die after they lay their eggs. This is different in Nautiloidea, this class produces a few large eggs in a batch and live afterwards. Cephalopods may mate by their color changes, body movements or both. They are spiral cleavage and protostomes.