CHAPTER 7

CHAPTER

7

KINGDOM PROTISTA (PROTOCTISTA)

LONG QUESTIONS

Q.1: Discuss important features of protists. Why are protists so difficult to classify?

→ What are major characteristics of kingdom protista?

→ What are the reasons for grouping simple eukaryotic organisms into a separate kingdom protista.

Ans. PROTISTA (PROTOCTISTA)

Introduction

This system is defined by exclusion i.e. all members have characteristics that exclude them from the other four kingdoms.

This kingdom consists of organisms whose diverse body forms, types of reproduction, modes of nutrition and lifestyles make them difficult to characterize.

Characteristics

(i) Most of the organisms present in this phylum are **aquatic**.

(ii) They posses eukaryotic organization.

(iii) All protists are **eukaryotes** and have evolved from prokaryotes.

(iv) These are **unicellular, colonial or simple multicellular organisms**.

(v) Eukaryotic cell, the unifying feature of protista, is common to complex multi-cellular oganisms belonging to three eukaryotic kingdoms (Fungi, Plantae, Animalia) but clearly differentiate protista from members of prokaryotic kingdom (Monera).

(vi) Unlike plants and animals they do not develop from a blastula or an embryo.

Reason of Creation of Kingdom Protista

There was a difficulty in placing certain eukaryotic organisms in the appropriate kingdom. This difficulty is from the point that all other eukaryotic organisms i.e. plants, fungi and animals have their evolutionary origin from kingdom Protista.

Division of Kingdom Protista

The kingdom protista consists of **four groups** of eukaryotic organisms, which are

(i) Single celled protozoans(animal like protists)

(ii) Algae (unicellular and multicellular, plant like protists)

(iii) Slime molds (fungus like protists)

(iv) Oomycotes

Q.2: Give historical perspective of kingdom protista.

Ans. Work of some scientists related to origin of kingdom Protoctista is given below.

(i) **John Hogg:**
In 1861, John Hogg proposed the kingdom protista for microscopic organisms.

(ii) **Earnest Haeckel:**
In 1866, Earnst Hacckel suggested creating the Kingdom Protista to include bacteria and other microorganisms (such as *Euglena*) that did not fit into plant or animal kingdom.
He separated blue green algae and bacteria (prokaryotes) from nucleated protists and placed them in a separate group called Monera, within Kingdom Protista.

(iii) **Herbert Copeland**
In 1938, Herbert Copeland elevated the prokaryotes to kingdom status, thus separating them from Protista. Recently colonial and simple multicellular eukaryotes have also been included in kingdom Protista.

(iv) **Robert Whittaker**
In 1969, Robert Whittaker placed only unicellular eukaryotes in Kingdom Protista according to five kingdom classification system.

(v) **Margulis and Schwartz**
In 1988, Margulis and Schwartz modified five-kingdom system. Protista or Protoctista is one of the five kingdoms.

DIVERSITY AMONG PROTISTS

Q.3: Write a note on diversity among Protists.

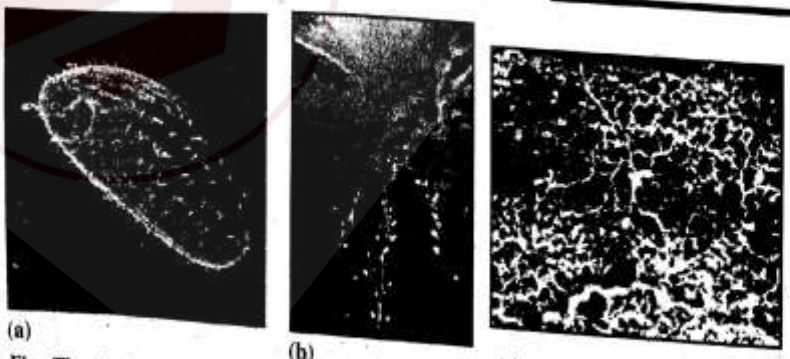
Ans. During the course of evolutionary history, organisms in the Kingdom Protista have evolved diversity in different features e.g. in

- ★ Size
- ★ Structure
- ★ Means of locomotion
- ★ Ways of obtaining nutrients
- ★ Interaction with other organisms
- ★ Habitat
- ★ Modes of reproduction

Q. Write two reasons for creating seprate Kingdom protist. (SGD-G1)-16

Diversity is exhibited by all of the major protist groups. Based on diversity, most biologists regard Kingdom Protista as **polyphyletic group** of organisms. Protists do not share a single common ancestor. Margulis and Schwartz have listed **27 phyla** to accommodate this diverse assembling of organisms.

Q. Why Kingdom protista considered as polyphyletic group. (SWL-G1)-14



(a) (b) (c)

Fig. The kingdom protista includes such diverse species as (a) single celled ciliated protozoan, (b) giant brown algae (kelps) and (c) slime molds.

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Q.4: Discuss major groups of protista.

- **What are three major groups of protists?**
- **Describe structure and reproduction of slime molds.**
- **Discuss general characteristics of algae.**
- **What features distinguish Oomycotes from fungi.**
- **Green algae are considered ancestral organisms of green land plants. Discuss.**

Ans. MAJOR GROUPS OF PROTISTA

Q. Name any four phylum of protista. (MTN-G1)-16

The kingdom protista consists of four groups of eukaryotic organisms, which are

(i) Single celled protozoans

(ii) Algae (unicellular and multicellular, plant like protists)

(iii) Slime molds (fungus like protists)

(iv) Oomyocotes

(1) PROTOZOA: ANIMAL – LIKE PROTISTS

★ All protozoans are **unicellular**.

★ Most **ingest** their food by endocytosis.

★ A summary of protozoan diversity is given below:

Common Name	Form	Locomotion	Examples
Zooflagellates	Unicellular, some colonial	One or more flagella	*Trypanosoma, Euglena*
Amoebas	Unicellular, no definite shape	Pseudopods	*Amoeba, Entamoeba*
Actinopods	Unicellular	Pseudopods	Radiolarians
Foraminifera	Unicellular	Pseudopods	Forams
Apicomplexans	Unicellular	None	*Plasmodium*
Ciliates	Unicellular	Cilia	*Paramecium, Vorticella, Stentor*

(A) AMOEBAS

Introduction

This group includes all free living freshwater, marine and soil amoebas, as well as those that are parasite of animals.

Characteristics

(i) Amoebas **lack flagella**.

(ii) They move by forming specialized cytoplasmic projections called **pseudopodia** (false feet).

Example

The intestinal parasite, *Entamoeba histolytica*, causes amoebic dysentery in humans.

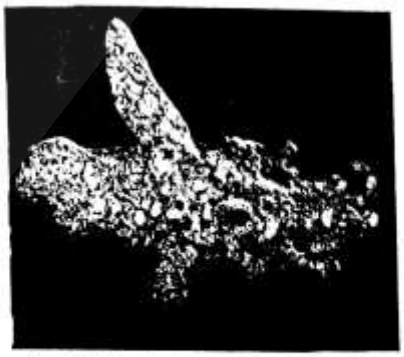

Fig. The flowing pseudopods of *Amoeba* constantly change shape as the organism moves and feeds.

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The Giant Amoeba

The giant amoeba *Pelomyxa Palustris* may be the most primitive of all eukaryotic life forms.

- ★ They have multiple bound nuclei but no other organelles found in all other eukaryotes.
- ★ They inhabit mud at the bottom of freshwater ponds, where they contribute to the degradation of organic molecules.
- ★ They obtain energy from methanogenic bacteria, which reside inside them.

Fig. *Pelomyxa palustris*

(B) ZOOFLAGELLATES

Introduction

Flagellates are those organisms, which have one to many, long, whip-like **flagella**. Flagellates may be;

(i) These are mostly unicellular (few colonial organisms with spherical or elongated bodies and a single central nucleus.

(ii) They move rapidly, pulling themselves forward by lashing flexible flagella that are usually located at the anterior end.

(iii) They obtain their food either by ingesting living or dead organisms or by absorbing nutrients from dead or decomposing organic matter.

(iv) They may be free living, symbionts or parasites.

Q. Write the characteristics of gaint Amoeba.
(DGK-G2)-15, (LHR-G1,2)-17
Q. From where do giant Amboebas get energy.
(SWL-G1)-16, (SGD-G1)-17

Q. Write a note on Ciliates.
(MTN-G1)12
Q. Write two characteristics of Zooflagellates.
(LHR-G1)-16 (MTN-G2)-17

Examples

- ★ *Trichonymphas* are complex, specialized flagellates with many flagella, which live assymbionts in the gut of termites and help in the digestion of dry wood.
- ★ *Parasitic* flagellates cause diseases. For example *Trypanosoma* is a human parasite causing African sleeping sickness. It is transmitted by the bite of infected tsetse fly.

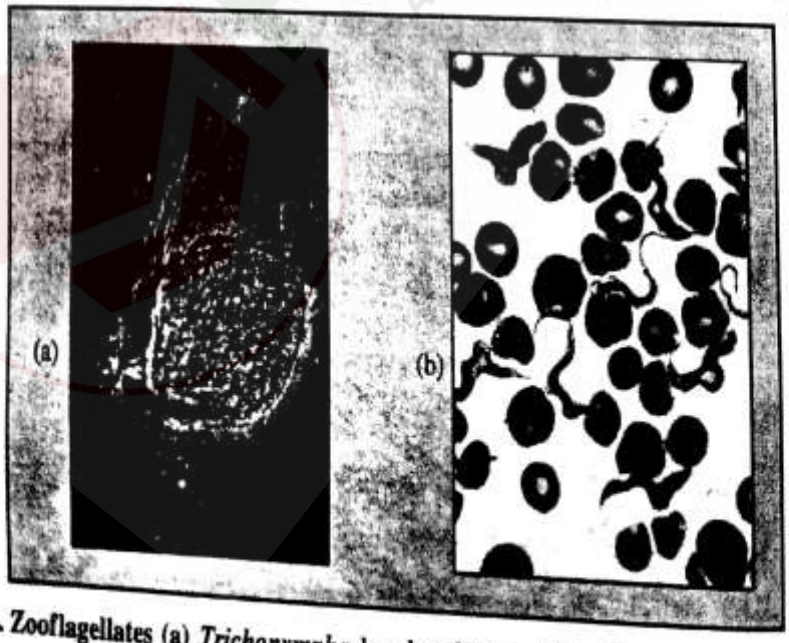

Fig. Zooflagellates (a) *Trichonympha* has hundreds of flagella (b) *Trypanosoma* causes sleeping sic

Choanoflagellates

These are sessile, marine or freshwater flagellates, which are attached by a stalk and their single flagellum is surrounded by a delicate collar. They are of special interest due to their resemblance with collar cells in sponges.

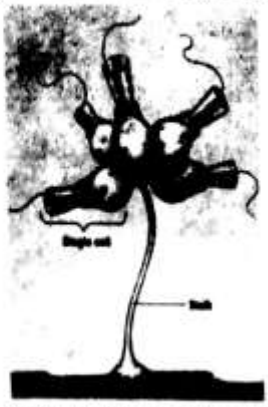

Fig: A colonial choanoflagellate

Q. What are cynoflagellates.
(FBD-G1)-14, (LHR-G2)-15
(FBD-G1)(SWL-G1)-16, (LHR-G1)-17

(C) CILIATES

These are organisms with cilia as locomotary organs. The cilia beat in such a precisely coordinated fashion that organisms not only go forward but can also move back and turn around.

Characteristics

(i) These are unicellular organisms with definite but changeable shape.

(ii) They have flexible outer covering called a pellicle.

(iii) There surface covered with short, hair-like and large number of structures called cilia.

(iv) Some are **sessile** and remain attached to a rock or other surface. Their cilia set up water currents that draw food towards them.

(v) Most ciliates **ingest** bacteria or other tiny protists.

(vi) **Water regulation** in freshwater ciliates is controlled by special organelles called **contractile vacuoles.**

(vii) They differ from other protozoans in having two kinds of nuclei i.e. small (micronucleus) and large (macronucleus).

- ★ ***Micronuclei,*** which are small one or more in number and function in sexual process.
- ★ ***Macronucleus,*** which is single, large, polyploid nucleus that controls cell metabolism and growth.

(viii) Most ciliates are capable of sexual process called *conjugation*. During conjugation, two individuals come together and exchange genetic material.

Q. Write two characteristics of ciliates.
Q. Write fiction of Pellicle.
(DGK-G2)-16

Q. How ciliates differ from protozoa. (RWP-G1)-16
(LHR-G1)-17

Example

Paramecium, Vorticella and Stentor are common examples.

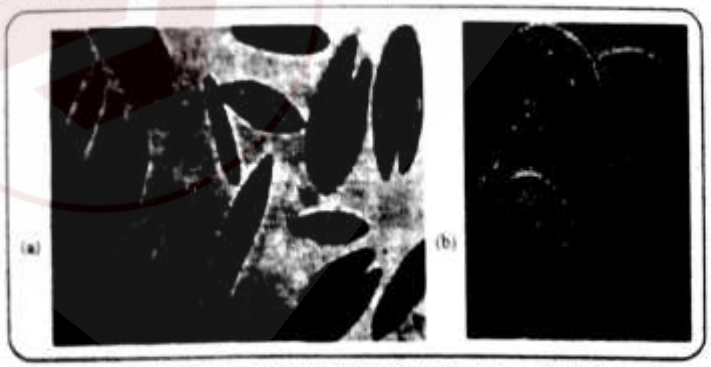

Fig. (a) *Paramecium*, conjugating individuals (b) *Stentor*, a sessile ciliate.

(D) FORAMINIFERANS AND ACTINOPODS

Introduction

These organisms have shell, so also called as shelled organisms.

Characteristics

(i) These are **mostly marine**, which produce shells (also called as tests).

(ii) **Shells (Tests)** of foraminifera are made of calcium whereas those of actinopods **are made of silica.**

(iii) The shells contain pores through which cytoplasmic projections can be extended. **These cytoplasmic projections** form a sticky, interconnected net that entangles prey.

(iv) **Dead foraminiferans** sink to the bottom of the ocean where their shells form **a grey mud that is** gradually transformed into chalk. Foraminiferans of the past have created vast limestone deposits.

(v) Some of them have **glassy beautiful look.**

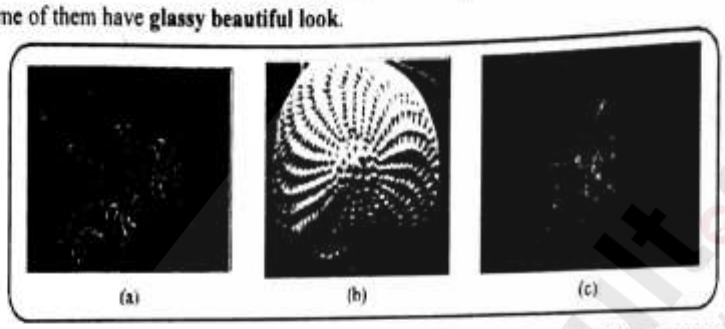

Fig: (a) Foraminiferan tests have (a) beautiful geometric patterns and (b) pores through which cytoplasmic projections are extended (c) Radiolorians are actinopods with glassy shells.

Example

Forams (Foraminiferans) and *Radiolarians* (actinopods) are common examples.

(E) APICOMPLEXANS

Introduction

Apicomplexans are a large group of parasitic protozoa, some of which cause serious diseases such as malaria in humans.

Characteristics

(i) They lack specific structures for locomotion but **move by flexing.**

(ii) At some stage in their lives, they develop a **spore** (a small infective agent) transmitted to the next host.

(iii) Many of them spent part of their life in one **host** and part in a different host species.

Q. Write two character of Apicomplexans. (GUJ-G2)
(SGD-G1)-14, (GUJ-G2) (SGD-G1)-14, (GUJ-G2) (LHR-G2)-15, (MTN-G1)-16, (LHR-G1)-17

Example

Plasmodium is common example.

Life Cycle of Plasmodium

Plasmodium, the apicomplexan, causes malaria. Different steps involved in its life cycle are;

(i) It enters human blood through the bite of an infected female *Anopheles*mosquito.

(ii) Plasmodium first enters liver cells and multiplies there.

(iii) After liver, it attacks on red blood cells, where it multiplies. When each infected red blood cell bursts, many new parasites are released. The released parasites infect new red blood cells and the process is repeated. The simultaneous bursting of millions of red cells causes the symptoms of malaria; a chill, followed by high fever caused by toxic substances that are released and affect other organs of the body.

(iv) Some of these cells convert into gametocytes, which are taken by bite of mosquito.

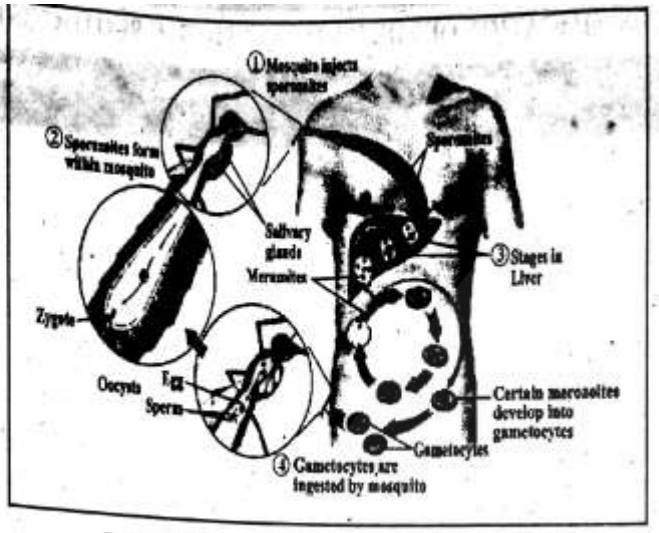

Fig: The life cycle of the malarial parasite (Plasmodium).

(2) THE ALGAE: PLANT LIKE PROTISTS

Introduction

Algae (singular alga) are photosynthetic protists, carrying out probably 50-60% of all the photosynthesis on earth (plants account for most of the rest).

Characteristics

(i) Difference from Plants

Algae differ from plants in their **sex organs** which are unicellular and the zygote is not protected by the parent body. A plant zygote, on the other hand, grows into a multicellular embryo that is protected by parental tissue.

(ii) Habitat

Almost all are **aquatic**. When actively growing, algae are restricted to damp or wet environments, such as the ocean, freshwater ponds, lakes and streams, hot springs, polar ice, moist soil, trees and rocks.

(iii) Mode of Life

Algae exhibit a remarkable range of growth forms. Some are **unicellular**, others are **filamentous**. Filaments are composed either of distinct cells or coenocytes (multinucleate structures that lack cross-walls). Still others (e.g. seaweeds) are **multicellular** and intricately branched or arranged in leaf-like extensions.

A body, which is not differentiated into true roots, stems and leaves and lacks xylem and phloem is called a **thallus**.

Q. Define thallus. (RWP-G1)-17

(iv) Photosynthetic Pigments

Green algae possess chlorophyll *a*, yellow and orange carotenoids (photosynthetic pigments) are found in all algae, other algal phyla possess a variety of other pigments (such as xanthophyllus and phycoerythrin) that are also important in photosynthesis. Classification of algae into phyla is largely based on their pigment composition.

(v) Life Cycle

Algal life cycles show extreme variations, but all algae except members of the phylum Rhodophyta (red algae) have forms with flagellated motile cells in at least one stage of their life cycle.

Four Similarities between algae and plant

(i) Both have same photosynthetic pigments i.e. Chlorophyll"a", Chlorophyll, "b".

(ii) Both have same energy source

(iii) Both are Eukaryotic organisms

(iv) Both have same RNA sequence.

Q. Why green algae concides as ancestor of plants. (AJK-G1)-15 (GUJ-G2)-16, (SGD-G2)-16, (MTN-G2)-17

CLASSIFICATION OF THE PHOTOSYNTHETIC PROTOCTISTS

Phylum	Common Name	Form	Locomotion	Pigments	Examples
Euglenophyta	Euglenoids	Unicellular	Two flagella one long one short	Chl.*a*, Chl.*b*, Carotenoids	*Euglena*
Pyrrophyta	Dinoflagellates	Unicellular	Two flagella	Chl.*a*, Chl.*c*, Carotenes including Fucoxanthin	*Gonyaulax Ceratium*
Chrysophyta	Diatoms	Usually multicellular	Usually none	Chl.*a*, Chl.*c*, Carotenes including Fucoxanthin	*Diatoma, Frequilaria Pimnularia*
Phaeophyta	Brown algae	Multicellular	Two flagella on reproductive cells	Chl.*a*, Chl.*c*, Carotenes including Fucoxanthin	*Fucus, Macrocystis*
Rhodophyta	Red algae	Multicellular or unicellular	None	Chl.*a*, Carotenes, Phycoerythrin	*Chondrus, polysiphonia*
Chlorophyta	Green algae	Unicellular, colonial, multicellular	Most have flagella	Chl.a, Ch.*b*, carotenes	*Chlorella, Ulva, Acetabularia, Spirogyra*

(A) THE EUGLENOIDS (EUGLENOPHTA)

Q. Write a note on Euglenoids.
(DGK-G1)-15, (SGD-G2)-17

Euglenoids have been classified in various groups with time. They have been placed in

- Plant kingdom (with algae) because they have pigments for process of photosynthesis.
- Animal kingdom (in protozoans) based on molecular data, euglenoid are thought to be closely related to zooflagellates. Some photosynthetic euglenoids lose their chlorophyll when grown in dark and obtain their nutrients heterotrophically by ingesting organic matter. Other species of euglenoids are always colourless and heterotrophic.

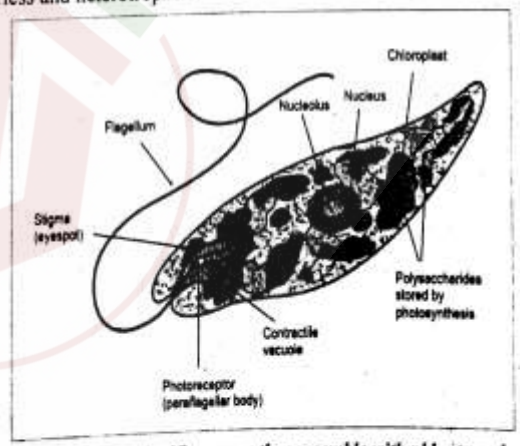

Fig: Euglenoids have sppecial evolutionary significance as they resemble with pklants and gren algae in having similar pigments and on other hand, are also related to zooflagellates.

(B) DINOFLAGELLATES (PYROPHYTA)

Q. Write two character of pinoflagellates.
(AJK-G1)-15, (SGD-G1)-16, (LHR-G2)-17

Introduction

It is a one of the most unusual phylum of protists.

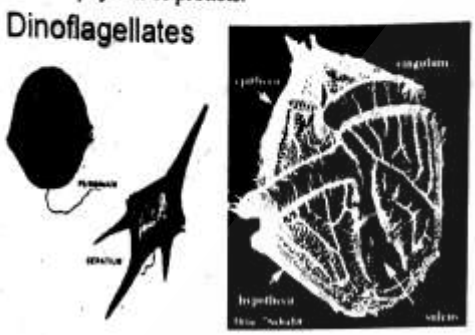

Fig: A dinoflagellate showing cellulose plates in the shell and flagella located in the grooves

Characteristics

(i) Most dinoflagellates are **unicellular**.

(ii) Their cells are often covered with shells of **interlocking cellulose plates** impregnated with silicates.

(iii) Ecologically, dinoflagellates are one of the most important groups of **producers** (second only to diatoms) in marine ecosystem.

Q. What are red tides. (GUJ-G1)-16

(iv) Dinoflagellates are known to have occasional population explosions or blooms. These blooms frequently colour the water orange, red or brown and are known as **red tides**.

(C) DIATOMS (CHRYSOPHYTA)

Introduction

They are called diatoms because the cell wall of each diatom consists of two shells that overlap where they fit together much like a petri dish.

Q. Write two characters of diatoms.
(LHR-G2)(DGK-G2)-15,(BWP-G2)
(GUJ-G2)-16

Fig:Diatoms have silica shells with extremely beautiful symmetrical patterns

Characteristics

(i) Their **shell** is made of silica, which gives glassy appearance in an intricate pattern.

(ii) They are extremely **large in number**.

(iii) Due to large number, they are **major producers** in the aquatic system (marine and fresh water ecosystems.

(iv) They are very **important in aquatic food chains**.

(D) BROWN ALGAE (PHAEOPHYTA)

Introduction

Brown algae include the giants of the protist kingdom.

Fig: Laminaria,a brown alga showing blades,stipes and holdfast

Characteristics

(i) All brown algae are **multicellular**.

(ii) They **range** from a few centimeters to approximately 75 meters in length.

(iii) They are common in ***cooler marine water***, especially along rocky coastlines in the intertidal zone.

Example

The largest brown algae, called the **kelps,** are tough and leathery in appearance. They possess;

- ★ Leaf-like Blades
- ★ Stem-like Stipes
- ★ Root-like Anchoring Holdfast.

Q. What are kelps. (DGK-G2)-15
(LHR-G1)-16, (GUJ-G1)-17

(E) RED ALGAE (RHODOPHYTA)

Characteristics

(i) Body is commonly composed of complex **interwoven filaments** that are delicate and feathery.

(ii) A few red algae are **flattened sheets** of cells

(iii) Most **multicellular** are **attached to rocks** or other substances by a basal holdfast.

(iv) Some red algae incorporate calcium carbonate in their cell walls from the ocean and **take part in building coral reefs** alongwith coral animals.

Example

Polysiphonia is representative red algae with worldwide distribution.

Fig. *Polysiphonia* is a representative red alga with world wide distribution

(F) GREEN ALGAE (CHLOROPHYTA)

Introduction

Green algae are considered to be the ancestors of plants.

Q. Write down the phylum form pigment of red Algae. (BWP-G1)-14
(SGK-G1)-15

Q. Also write two characteristic of fed algae. (SGD-G2)-15

Charaeteristics

(i) Green algae have **pigments**, energy reserve products and cell walls that are identical to those of plants.

(ii) They are photosynthetic with **cholorophyll 'a' and chlorophyll 'b'** and **carotenoids** present in the chloroplasts.

(iii) Their main energy reserves are stored as **starch**.

(iv) Most green algae possess cell walls with **cellulose**.

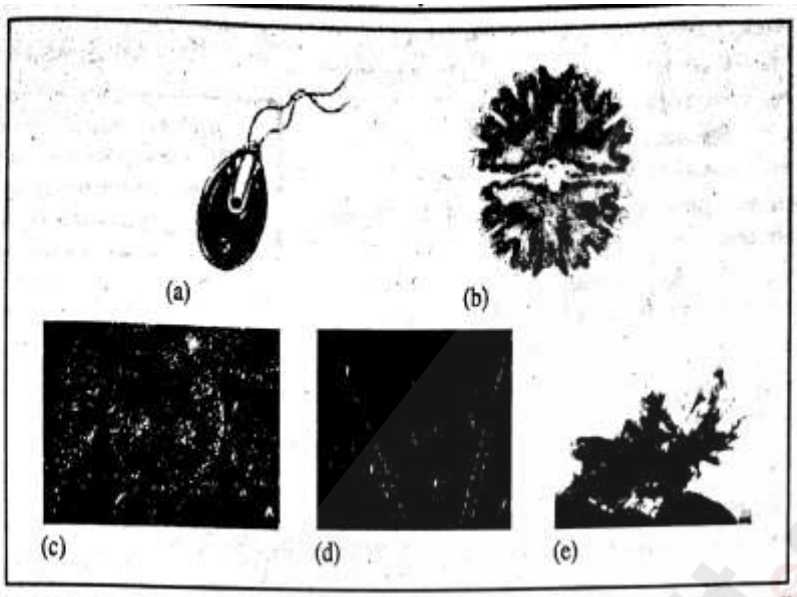

Fig. Green algae exhibit diverse forms. (a) Unicellular *Chlamydomonas* (b) *Desmids* **have cells with two halves.** (c) **Colonial** *Volvox* (d) **Filamentous** *Spirogyra* (e) *Ulva*, **having sheet like body.**

Relation with Plants

Green algae and plants are evolutionary related. Green algae are considered to be the ancestors of plants due to various similarities. Some of the similarities between them are;

- ★ They have **chlorophyll** 'a' and 'b' and carotenoids.
- ★ Their **cell wall** is made up cellulose.
- ★ **RNA sequencing** also indicates that green algae and the plants form a monophyletic lineage.

Example

Chalamydomanas and *Chlorella* (unicellular), *Desmids* (cells with two halves), *Volvox* (colonial), *Spirogyra* (filamentous) and *Ulva* (sheet-like body) are some examples.

Chlorella

- ★ It is a **unicellular** non-motile green alga.
- ★ Its habitat is **fresh water**, ponds and ditches.
- ★ It is easily cultured and has been used as an experimental organism in research on photosynthesis and investigated as an alternate source of food.

Q. What is chlorella? (SGD-G1) (GUJ-G1)(RWP-G1)-15, (GUJ-G1) (LHR-G2)-17

Q. Give two example of unicellular algae. (FBD-G1)(SGD-G2)-17

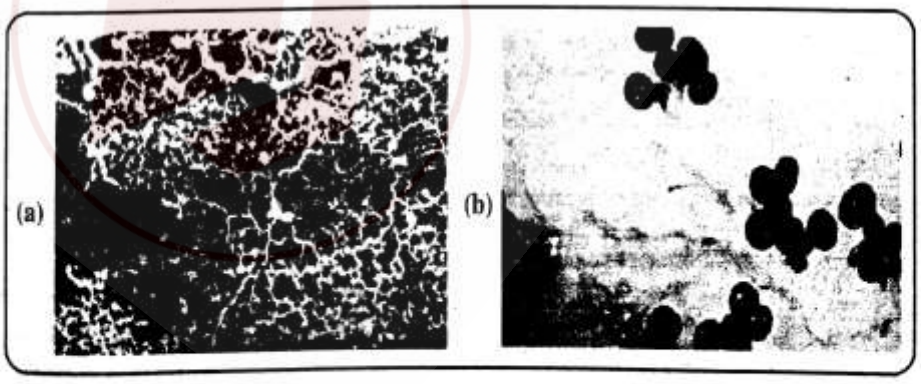

Fig. Slime mold *Physarum* **(a) The plasmodium is a naked mass of cytoplasm having many nuclei. (b) Reproductive structures are stalked sporangia.**

Importance of Algae

Algae have great economic and environmental importance for us.

(i) Some algae such as **kelps** are **edible** and may be used to overcome shortage of food in the world.

(ii) Marine algae are also **source of many useful substances** like algin, agar, carrageenan and antiseptics.

(iii) Algae are major producers of the aquatic ecosystem, thus they play a basic **role in food chains,** providing food and oxygen to other organisms.

Q. Write four useful substances from Marine algae. (SGD-G1)-16

Q. Write importance of algal. (DGK-G1)(AJK-G1)-15, (GUJ-G1)-16

(3) FUNGUS – LIKE PROTISTS

Some protists superficially resemble fungi in some way and differ in other way.

Similarities

Some of their similarities are;

(i) They are **not photosynthetic**.

(ii) They have bodies formed of thread-like structures called **hyphae**.

Differences

Some of their differences are;

(i) Many of these protists have **centrioles**, which are absent in fungi.

(ii) Many of them have **cellulose** in cell wall, while cell wall in fungi is made of chitin.

Q. Write a difference on fungus like Protists and fungi (AJK-G1)-16 (GUJ-G1)-17

Q. Write detailed note on Slime Molds. (MTN-GI-2011)

Q. Describe structure and reproduction of slime molds. (MTN-GII-2010)

Types

Two major groups of fungus-like protists are;

(A) Slime molds (myxomycotes)

(B) Water molds (oomycotes)

(A) SLIME MOLDS OR MYXOMYCOTA

They pass through two important stages.

(i) Feeding Stage

The feeding stage of a slime mold is a **plasmodium**. Different features of plasmodium are;

- ★ It is a multinucleate mass of cytoplasm that can grow to **30 cm** (1ft) in diameter.
- ★ It is slimy in appearance, streams over damp, decaying logs and leaf litter.
- ★ It often forms a network of channels that cover a large surface area.
- ★ It creeps along and ingests bacteria, yeasts, spores and decaying organic matter.

Q. Discuss the adaptation of slim molds. (SGD-G2)-15, (BWP-G1)-14

Q. What is feeding stage of spimemald. (AJK-G1)-16

(ii) Reproductive Stage

- ★ During unfavourable condition, slime mold forms resistant haploid spore by meiosis within stalked structures called sporangia.
- ★ When conditions become favourable, spores germinate into biflagellated or amoeboid reproductive or **swarm cells**, which unite to form diploid zygote. Zygote produces multinucleate plasmodium, each nucleus being diploid.

Importance

The plasmodial slime mold *Physarum polycephalum* is a model organism that has been used to study many fundamental biological processes, such as growth and differentiation, cytoplasmic streaming and function of cytoskeleton.

Q. What is physarumpolycephalum. (MTN-G1)-16, (GUJ-G2)-16

(B) WATER MOLDS OR OOMYCOTES

Q. Write structure of OOMYCOTES. (GUJ-G1)-14, (SGD-G2)-15, (MTN-G2)-17

Introduction

Oomycotes show close relations with the fungi and have a similar structure but are now regarded as more ancient group.

Characteristics

(i) Their **cell walls** contain cellulose, not chitin.

(ii) Their **hyphae** are aseptate (without cross walls).

Example

Oomycotes include a number of pathogenic organisms, including powdery mildew *phytophthora infestans*, which have played infamous role in human history.

Phytophthora infestan

Q. Why phytophthora is famous in human history. (LHR-G1)-15 (FBD-G1)-16, (SWL-G1)-16, (LHR-G2)-16

It was the cause of Irish potato famine of the 19th century. It causes a disease commonly known as **late blight of potatoes.** Because of several rainy, cool summers in Ireland in the 1840's, the water mold multiplied unchecked, causing potato tubers to rot in the fields. Since potatoes were the staple of Irish peasants' diet, many people (250,000 to more than 1 million) starved to death. The famine prompted a mass migration out of Ireland to such countries as the United States.

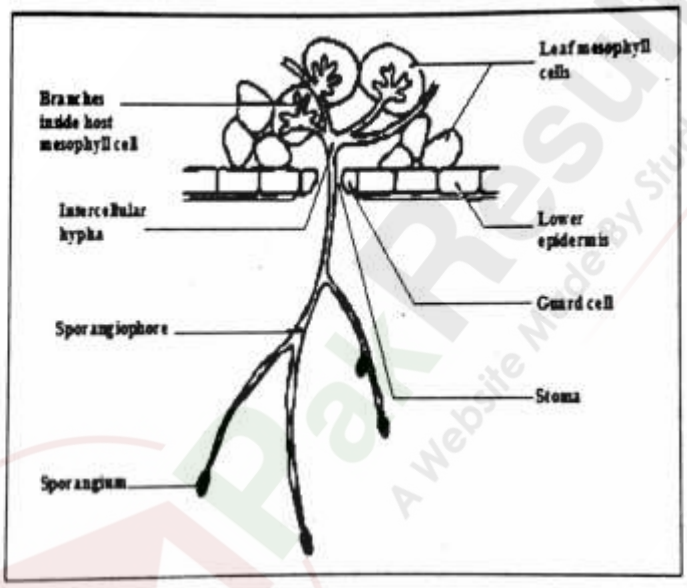

Fig: phytophthora infestans growing in a diseased potato leaf, with sporangiophores emerging from the underside of the leaf.

Q.8: How are protists important to humans? What is their ecological importance?

Ans. IMPORTANCE OF PROTISTS

1. **Disease**

- The intestinal parasite, *Entamoeba Histolytica* that causes amoebic dysentery, germinates from resistant cysts with the digestive tracts of their mammalian hosts including humans.

Q. What is Trypansoma? (LHR-G1)-16

- *Trypansoma* is a human parasite causing African sleeping sickness. It is transmitted by the bite of infected tsetse fly.
- Some Apicomplexans such as *Plasmodium* cause serious diseases such as malaria in humans.

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- *PhytophthoraInfestans* have played infamous roles in human history as they were the cause of Irish potato famine of the 19th century. It causes a disease commonly known as late blight of potatoes. Because of several rainy, cool summers in Ireland in the 1840's, the water mold multiplied unchecked, causing potato tubers to rot in the fields. Since potatoes were the staple of Irish peasant's diet, many people (250,000 to more than 1 million) starved to death. The famine prompted a mass migration out of Ireland to such countries as the United States.

2. Chalk Formation

- Dead foraminiferans sink to the bottom of the oceans where their shells form a grey mud that is gradually transformed into chalk. Foraminiferans of the past have created vast limestone deposits.

3. As Food

- Some algae such as kelps are edible and may be used to overcome shortage of food in the world.
- Larvae of some aquatic insects feed on aquatic protozoans. While these larvae are taken as food by clam, prawn and young fishes which are the ultimate source of food of man.

Q. Write about shell of Foraminiferous. (DGK-G2)-15, (LHR-G1)-16

Q. How are foraminiferous source of lime stone? (DGK-G2)(RWP-G1)-16

4. Useful Substances

- Marine algae are also source of many useful substance like algin, agar, carrageenan and antiseptics.

5. Produces

- Algae are major producers of the aquatic ecosystem, thus they play a basic role in food chains, providing food and oxygen to other organisms.
- Ecologically, diatoms and dinoflagellates are the most important groups of producers in marine ecosystem.

6. Symbiotic Organism

- Trichonymophas are complex, specialized flagellates with many flagella which lives as symbionts in the guts of termites and help in the digestion of dry wood.

7. Helpful in the Study of Biological Processes

- The plasmodial slime mod Physarum Polycephalum is a model organisms that has been used to study many fundamental biological processes, such as growth and differentiation, cytoplasmic streaming, and the function of cytoskeleton.

8. Helpful in Sanitation

- Some protozoans play an important role in the sanitary betterment and improvement of the modern civilization in keeping water safe for drinking purpose. The protozoans living in polluted water feed upon waste organic substances and thus purify it. Some bacteria feed on the bacteria and purify the water indirectly.

9. Building Coral Reefs

- Some red algae incorporate calcium carbonate in their cell walls from the ocean and take part in building coral reefs along with coral animals.