**Lecture -5-**

**Division**: **Chlorophyta**

**Class**: **Chlorophyceae (Green algae)**

1. The division members occur 90% in freshwater.
2. The cells are eukaryotic.
3. The cell wall is made of two layers, the inner layer mainly consisting of cellulose and the outer layer consisting of pectic substances.
4. The chloroplasts are well-organized, the main pigments are chlorophyll-a, chlorophyll-b, and the other pigments are carotenes and xanthophylls.
5. The shape of the chloroplast is variable. It may be cup-shaped (e.g., *Chlamydomonas*), girdle-shaped (e.g., *Ulothrix*), reticulate (e.g., *Cladophora*), stellate (e.g., *Zygnema*), spiral (e.g., *Spirogyra*), or discoid (e.g., *Chara*).
6. The reserve food is in the form of starch.
7. The motile reproductive structures, i.e., zoospores and gametes, have 2 or 4 flagella that are apical, equal in size, and acronematic (whiplash) type.
8. The sexual reproduction is isogamous, anisogamous, conjugation, or oogamous type.

**Phototaxis and Eyespots:**

There are two types of phototactic movement in the Chlorophyta: movement by flagella and movement by the secretion of mucilage. Most of the flagellated cells that show phototactic movement have an eyespot. In the Chlorophyta, the eyespot or stigma is always in the chloroplast. The phototactic response varies with light intensity; *Bendix (1960)* observed that organisms with positive phototaxis at moderate light intensities exhibited negative phototaxis at very high light intensities.

**Classification of Chlorophyceae:**

The Chlorophyceae are divided into the following important orders:

* **Order 1 - Volvocales**: Vegetative cells flagellated, coenobium colony, and motile.
* **Order 2 - Tetrasporales**: Non-filamentous colonies with immobile vegetative cells capable of cell division.
* **Order 3 - Prasiolales**: Marine, freshwater, or terrestrial algae composed of unicells, short filaments.
* **Order 4 - Chlorellales**: Unicellular; vegetative cells are non-motile.
* **Order 6 - Sphaeropleales**: Unbranched filaments.
* **Order 7 - Cladophorales**: Branched or unbranched filaments with reticulate or granular chloroplasts.
* **Order 8 - Oedogoniales**: Uninucleate filamentous freshwater algae with intercalary cell division; motile spores and gametes with a ring of flagella at one pole.

**Order: Volvocales**

The algae can be unicellular motile or multicellular. If they are multicellular, then the number of cells in the vegetative colony forms a motile coenobium colony. Almost all of these organisms are freshwater.

* **Family 1 - Chlamydomonadaceae**: Motile unicellular algae.
* **Family 2 - Volvocaceae**: Motile colonial algae formed into coenobia, colonies with a definite number of cells arranged in a specific manner.

**Family: Volvocaceae**

**Genus: *Volvox***

Volvox is a freshwater planktonic alga which is usually found in stagnant water like pools and ponds during spring and rainy seasons. On the water surface, its colony appears as small pinhead-like structures that are visible to the naked eye.

**Structure of the coenobium Colony:**

The colony of *Volvox* is composed of many small vegetative cells that form the coenobia. A definite number of cells form the globular structure, which is held together by a highly viscous gelatinous sheath. The coenobia of different species may consist of 500-50,000 cells, including reproductive cells or gonidia, which are embedded in the gelatinous sheath. The individual cells in their general morphology resemble the cell of *Chlamydomonas*. Each cell is ovate in shape, having a broad posterior and narrow apical end with two apically inserted flagella that are equal in size. Eye spots and two or more contractile vacuoles are present in the anterior region near the base of the flagella. The chloroplast is cup-shaped with a pyrenoid. Cells are uninucleate. In most species, individual cells are held together by prominent cytoplasmic strands. In the coenobium, the cells of the posterior region are usually larger than those at the anterior end.

**Reproduction:**

* **Asexual reproduction**:

During asexual reproduction, some cells of the posterior region withdraw their flagella, enlarge, and differentiate into asexual reproductive cells called gonidia. In a coenobium, 2-50 gonidia may be produced. The gonidium divides mitotically several times, mostly longitudinally. The group of 8 daughter cells forms a curved plate-like structure called the Plakea stage. After the 16-celled stage, the cells are arranged at the periphery of a hollow sphere with an opening called the phialopore. When cell division stops, the cells of the sphere turn inside out, passing through the phialopore by the inversion process. The individual cells then develop flagella and become part of a new colony. This new colony may or may not escape from the parent colony.

* **Sexual reproduction (Oogamous)**:

Sexual reproduction occurs during unfavorable seasons. Gametes develop primarily from the posterior half of the coenobia. The potential egg cell loses its flagella and enlarges during development. It is distinct from the gonidia, being flask-shaped, denser, and darker than the latter. The cells forming male gametangium or antheridium divide successively, forming many (16-512) spindle-shaped biflagellate antherozoids. During fertilization, the mass of antherozoids is liberated from the colony and reaches the egg cell of another coenobium. Individual antherozoids are set free, and one fuses with the egg cell to form a zygote, called an oospore. The oospore subsequently secretes a three-layered wall, which may be smooth or spiny depending on the species. The oospore is released by the rupture of the colony and acts as the perennating body of *Volvox*. After a period of rest, the oospore divides meiotically to form four nuclei, three of which degenerate, while the remaining one divides and re-divides mitotically to form the new coenobium.

**Order: Oedogoniales**

**Family: Oedogoniaceae**

**Genus: *Oedogonium***

*Oedogonium* is a common freshwater, filamentous, unbranched alga found attached to various substrates like stones, wood, and leaves of aquatic plants. Some species are terrestrial. The growth in this family is unique (intercalary growth). The terminal cell of the filaments is generally rounded, and intercalary cells show apical-basal polarity. Most distal-end cells possess annular striations at the apical end, known as cap cells. The cells of the filament are cylindrical, uninucleate, and contain parietal reticulate chloroplasts with several pyrenoids. Mature cells contain a central vacuole.

Each cell division results in the formation of a new cap cell. During cell division, the nucleus migrates from the middle to the distal end, where it divides mitotically. In the early stages of mitosis, just below the apical end of the cell, the number of caps on the cell indicates the number of cell divisions that have taken place.

**Reproduction:**

* **Vegetative reproduction**:

Occurs through fragmentation, but under unfavorable conditions, *Oedogonium* may produce akinetes.

* **Asexual reproduction**:

Takes place by forming multiflagellate zoospores. Zoospore formation usually occurs in cap cells. The entire cell content metamorphoses into a single pear-shaped zoospore with a hyaline area at the apex. A ring of flagella develops around the hyaline area, forming stephanokont zoospores. The zoospore is liberated, enveloped in a hyaline sheath, from the parent cell through a hole in the cell wall. After a period of free swimming, the zoospore attaches to a substrate by its anterior end. The flagella are then withdrawn, and the zoospore elongates, developing into a new filament.

* **Sexual reproduction (Oogamous)**:  
  Sexual reproduction is oogamous in type. Some species are monoecious, while others are dioecious. In dioecious species, two different categories are found:
  + **Macrandrous type**: Antheridia are produced on normal filaments.
  + **Nannandrous type**: Antheridia are produced on dwarf male filaments, i.e., nannandrium.

In monoecious species, antheridia are formed in a series by vegetative cells. Each antheridium forms two multiflagellate antherozoids. Oogonia are formed by dividing the oogonial mother cell into a lower supporting cell or suffultory cell and an upper oogonium. The oogonium enlarges and forms a ball-like structure with a small colorless area on one side for the entry of antherozoids. After fertilization, the zygote develops into an oospore with a thick wall. It undergoes a period of rest and later divides mitotically into four haploid zoospores. **In dioecious macrandrous** **types**, two of the zoospores form male filaments and two form female filaments. **In monoecious nannandrous types**, dwarf male filaments are produced from special zoospores called **androspores**. Androspores are produced in the androsporangium. After liberation, androspores attach to the oogonial wall and germinate into dwarf male filaments, which bear the antheridia.