**Lecture 2 (23/9/2024)**

**Cell Ultrastructure**

**Algal Cell Types**

Algal cells can be broadly classified into two types: Prokaryotic and Eukaryotic.

* **Prokaryotic Algal Cells**: These cells lack membrane-bound organelles such as plastids, mitochondria, nuclei, Golgi bodies, and flagella. Prokaryotic algal cells are found in cyanobacteria (commonly known as blue-green algae).
* **Eukaryotic Algal Cells**: The majority of algae are eukaryotic and contain membrane-bound organelles. Their cells are often surrounded by a cell wall composed of polysaccharides.

**Ultrastructure of Prokaryotic Algal Cells**

The structure of a prokaryotic algal cell, such as those found in cyanobacteria, can be divided into two main parts: the outer cellular covering and the cytoplasm.

**A. Outer Cellular Covering**

1. **Mucilaginous Sheath**:
   * Common in cyanobacteria.
   * Functions to retain water, thereby protecting the cell from desiccation.
2. **Cell Wall**:
   * Rigid and composed of mucopeptide.
   * Contains a mucopolymer made up of alanine, glucosamine, and peptidoglycan.
3. **Plasma Membrane**:
   * Lies beneath the cell wall.
   * Composed of a lipid bilayer.

**B. Cytoplasm**

1. **Chromoplasm**:
   * The outer, pigmented region of the cytoplasm.
   * Contains photosynthetic lamellae or thylakoids, which include chlorophyll a, carotenoids, and phycobilins (C-phycocyanin, C-phycoerythrin, and allophycocyanin).
   * Phycobilins are housed in phycobilisomes, located between the photosynthetic lamellae.
   * Unlike eukaryotic cells, prokaryotic cells lack membrane-bound organelles like mitochondria and chloroplasts.
   * Contains gas vacuoles that provide buoyancy to the cell.
2. **Centroplasm**:
   * The central, colorless region of the cytoplasm.
   * Contains the DNA material, which is not bound with histone proteins, leading to the absence of a true nucleus.

**Ultrastructure of Eukaryotic Algal Cells**

Eukaryotic algal cells, found in all algae except cyanobacteria, exhibit a more complex structure with distinct organelles.

**A. Cell Wall**

* Composed of cellulose.
* In some brown algae, the cell wall contains alginic acid, while in red algae, it may include xylan, agar, or carrageenin.
* Diatoms possess a silicified cell wall.

**B. Plasma Membrane**

* Located just beneath the cell wall.
* Made up of a protein-lipid bilayer.

**C. Cytoplasm**

* Contains dense cytoplasm with membrane-bound organelles such as mitochondria, chloroplasts, Golgi bodies, and endoplasmic reticulum.
* Chloroplasts are typically present in most algal cells and can vary in shape (e.g., cup-shaped, parietal, discoid, lobed, star-shaped, spiral, or girdle-shaped).

**D. Nucleus**

* Most eukaryotic algae have a single nucleus, although multinucleate forms exist.
* The nucleus has a nuclear membrane with pores and DNA associated with histone proteins.

**E. Flagella**

* Found in motile algal cells, originating from basal granules.
* Exhibit a 9+2 arrangement of microtubules (nine doublet peripheral fibrils surrounding two central singlet fibrils).
* **Types of Flagella**:
  + **Whiplash (acronematic)**: Smooth surface.
  + **Tinsel (pleuromematic)**: Surface covered with fine hair-like structures called mastigonemes, which can be arranged in different patterns (pantonematic, pantocronematic, or stichonematic).
* **Flagellar Types**:
  + **Isoknot**: Flagella of equal length.
  + **Heteroknot**: Flagella of unequal length, characteristic of certain algal classes.

**F. Vacuoles**

* Bounded by a membrane called the tonoplast.
* **Types**:
  + **Simple or Contractile Vacuoles**: Involved in excreting waste products and secreting substances.
  + **Complex Vacuoles**: Composed of a tube-like structure, a large reservoir, and various-sized vacuoles; play a role in osmoregulation.

**G. Reserve Food Material**

* Stored food varies by algal class:
  + **Green Algae (Chlorophyceae)**: Starch.
  + **Cyanobacteria**: Cyanophycean starch.
  + **Red Algae (Rhodophyceae)**: Floridean starch.
  + **Brown Algae (Phaeophyceae)**: Mannitol and laminarian starch.

**H. Pigmentation in Algae**

* Algal color is due to specific pigments, each imparting a unique hue.
* **Pigment Types**:
  1. **Chlorophylls**: Found in all algae; include chlorophyll a (universal), b (in Chlorophyta, Euglenophyta, Charophyta), c (in Bacillariophyta, Pyrrophyta, Phaeophyta), d (in Rhodophyta), and e (in Xanthophyta).
  2. **Carotenoids**: Include carotenes and xanthophylls, which absorb blue and green light.
     + **Carotenes**: Orange-yellow pigments (C40H56).
     + **Xanthophylls**: Yellow or brown pigments (C40H56O2), e.g., zeaxanthin, astaxanthin, diatoxanthin, fucoxanthin.
  3. **Phycobilins**: Water-soluble pigments found in red and blue-green algae (e.g., phycocyanin, phycoerythrin).

**Growth in Algae**

Growth patterns in algae include:

1. **Diffuse or Generalized Growth**:
   * Occurs when all cells divide, leading to an increase in overall size (e.g., *Ulva*).
2. **Localized Growth**:
   * Occurs in specific regions of the algal body and can be categorized into:
     + **Apical Growth**: Growth at the apex (e.g., *Chara*, *Cladophora*).
     + **Basal Growth**: Growth at the base (rare, e.g., *Bulbochaete*).
     + **Intercalary Growth**: Growth by division of interstitial cells (e.g., *Oedogonium*, *Laminaria*).
3. **Trichothallic Growth**:
   * Observed in some genera of brown algae (Phaeophyta), such as *Ectocarpus*.