References (Textbook - pages 373-392, Lab Manual - pages 95-115)

Major Characteristics

Algae

1. Characteristics
2. Classification
3. Division Chlorophyta
4. Division Chrysophyta
5. Division Phaeophyta
6. Division Rhodophyta

Protozoans

1. Characteristics
2. Classification
3. Class Flagellata
4. Class Sarcodina
5. Class Ciliata
6. Class Sporozoan
Major Characteristics

1. Protists possess eukaryotic cells with well defined nuclei and organelles
2. Most are unicellular, however there are multi-cellular forms
3. They are diverse in their structure
4. They vary in size from microscope algae to kelp that can be over 100 feet in length
5. They are diverse (like bacteria) in the way they meet their nutritional needs
   A. Some are photosynthetic like land plants - are autotrophic
   B. Some ingest their food like animals - heterotrophic by ingestion
   C. Some absorb their food like bacteria and fungi - heterotrophic by absorption
   D. One species – Euglena – is mixotrophic meaning that it is capable of both autotrophic and heterotrophic life styles.
6. Reproduction in Protists
   A. is usually asexual by mitosis
   B. sexual reproduction involves meiosis and spore formation and usually occurs only when environmental conditions are hostile
   C. spores are resistant and can withstand adverse conditions
7. Some protozoans form cysts – a type of resting stage
8. Photosynthetic protists (mostly algae) are part of plankton. Plankton are those organisms suspended in fresh and marine waters that serve as food for heterotrophic animals and other protists
9. There are diverse opinions on how to classify members of the Kingdom Protista.

10. However, members of the Kingdom Protista can be divided into 2 major groups
    A. Algae
    B. Protozoans

Algae

1. Characteristics
   A. Algae are chlorophyll bearing organisms with undifferentiated tissue that never forms true roots, true stems, or true leaves
   B. The algal body is called a thallus
   C. Algae are mainly aquatic, but some may be found growing on soil, rocks, or other damp, shaded surfaces
   D. Algae colors vary from green, blue-green, yellow-green, to red, yellow, and brown
   E. Their shapes may be in the form of sheets, filaments, balls, or ribbons
   F. Many are microscopic in size while others may grow over 100 feet like the giant kelps of the Pacific Ocean
   G. Algae are at the very foundation of the food chain and are directly responsible for about 80% of the earth's oxygen.

2. Classification
   A. We will study 4 Divisions of Algae
      1) Chlorophyta
      2) Chrysophyta
      3) Phaeophyta
      4) Rhodophyta
   B. Again, some biologists choose to include these 4 Divisions in the Kingdom Plantae
3. **Division Chlorophyta** (Green algae)

A. Of all the protists, *green algae* are the *most like plants* in terms of their biochemistry and structure.

B. Some evolutionists believe *green algae* were the *group* from which *plants* evolved.

C. *Like plants, green algae*

   1) Possess *chlorophylls a* and *b*

   2) Possess *cell walls* composed of *cellulose, pectins,* and other *polysaccharides*

   3) *Store carbohydrates* as *starch* in their *chloroplasts*

D. There are over *7,000 known species*

E. **Spirogyra** - an *example* of a *green algae*

   (See Handout of Figure 9.3, page 98 of Lab Manual, Williams, 4th Ed.)

   and

   (See Handout of Figure 9.4, page 100 of Lab Manual, Williams, 4th Ed.)

   1) **Spirogyra** is sometimes called *pond scum*

   2) It is the *green, slimy growth* of most *farm ponds* and slow moving *streams*

   3) **Structure**

      a) *Cylindrical shaped cells* are attached in *long filaments*

      b) Possesses a *cell wall* and *dividing cell wall* between cells of a *filament*

      c) *Chloroplasts* are *spiral shaped*

      d) Possesses *pyrenoids* that are *intracellular particles* associated with *chloroplasts*, around which *starch forms*

      e) *Nucleus* is *well defined*

      f) *Cytoplasm* may occur in *strands*
4) Asexual Reproduction
   a) Mitosis
   b) Fragmentation of a filament

5) Sexual Reproduction
   a) Sexual reproduction is by a process called conjugation
   b) The cylindrical cells of the filament are haploid (N)
   c) At the beginning of conjugation 2 filaments will align cell to cell
   d) Outgrowths of cells appear and eventually form conjugation tubes between adjacent cells of 2 filaments
   e) The protoplasm (gamete) of one cell will move through the conjugation tube into an adjoining cell and merge with the protoplasm (gamete) of the adjoining cell
   f) This fusion of 2 haploid protoplasts (gametes) forms a zygote that is diploid (2N)
   g) Original filaments dry up and break up and the zygote sinks to the bottom of stream or pond
   h) Zygote becomes a zygospore by forming a protective outer wall and may overwinter on stream bottom
   i) The following spring the zygospore undergoes meiosis to form a new haploid (N) filament
   j) Sexual reproduction where gametes are alike is called isogamy.
k) The life cycle of Spirogyra can be represented by the following simple diagram.

4. Division Chrysophyta (Golden algae and diatoms)

A. There are about

1) 500 species of golden algae
2) 600 species of yellow-green algae
3) And 5,600 species of diatoms

B. Most are free living and photosynthetic

C. From time-to-time – some species undergo a stupendous increase in population size - this event is called an algal bloom

D. Diatoms have sculptured cell walls composed of silica and occur in a variety of shapes

E. The remains of diatoms have accumulated in the bottom of many lakes and there are large areas of their remains in underground deposits.

F. These deposits are called diatomaceous earth and are mined for use in insulation, abrasives, and filters

G. Near Lompoc, California, more than 270,000 metric tons are mined each year.
5. **Division Phaeophyta** (Brown algae)

A. There are about 1,500 species of brown algae

B. Nearly all live in cool or temperate sea water

C. These are commonly called brown sea-weed

D. **Masses of a floating brown algae** called Sargassum are the basis of the great floating ecosystem called the Sargasso Sea in the Atlantic Ocean

E. **Brown algae** range from microscopic species to giants that form underwater forests in the sea

F. In the Far East, people harvest kelp as a source for food and mineral salts, and as a fertilizer for crops

6. **Division Rhodophyta** (Red algae)

A. The red algae are characterized by a distinctive red color

B. They are often called the most beautiful of the algae

C. There are 4,100 species and most all are marine

D. Most are branched and feathery in body form and are seldom over 2 or 3 feet long

E. Extracts from red algae are used

   1) As a moisture preserving agent in baked goods and cosmetics

   2) A setting agent in jellies

   3) Soft capsules for drugs and vitamins

   4) A stabilizer in paints and dairy products

F. One species of red algae is used as nori in sushi bars as wrapping for rice and fish
Protozoans

1. Characteristics

A. We will call this *Phylum Protozoa*

B. *Some* biologists include *Phylum Protozoa* in the *Kingdom Animalia*

C. There are approximately *65,000* named *species* of protists that can be called protozoans

D. Protozoans possess *eukaryotic cells*

E. They are *mostly heterotrophic* (*recall that algae were mostly autotrophic and photosynthetic*)

F. Protozoans *ingest food* by forming *food vacuoles*

G. Reproduction

1) *Mostly asexual* by a type of *mitosis* called *binary fission*

   a) A *process* where the *body divides* into *two*

   b) *Division plane* is *random* in amoebas

   c) *Division plane* is *longitudinal* for flagellates

   d) *Division plane* is *transverse* for ciliates

   e) *Budding* from *parent organism* can also occur

2) *Sexual* exchange *sometimes occurs* in some *species*

3) *Species alternate* between *sexual* and *asexual* modes based on *environmental conditions*

H. Many *parasitic protozoans* may form a *cyst* by making their own *resistant body covering*. (*a strategy that helps individuals survive during harsh environmental conditions*)

I. *Free-living protozoans* live in *damp soil, freshwater habitats, and marine habitats*

J. *Parasitic protozoans* live *inside* or on the *moist tissues* of a *host organism*
K. Like bacteria, some protozoans are major pathogens.

2. Classification

A. Protozoans can be classified according to their type of locomotion.

B. We will study the following 4 classes:

1) Class Flagellata
   a) Organ of locomotion – flagella
   b) Example – Euglena

2) Class Sarcodina
   a) Organ of locomotion – pseudopodia
   b) Example – Amoeba

3) Class Ciliata
   a) Organ of locomotion – cilia
   b) Example – Paramecium

4) Class Sporozoa
   a) Organ of locomotion – none
   b) Example – Plasmodium

3. Class Flagellata

(See Handout of Figure 9.11 C, page 112 of Lab Manual, Williams, 4th Ed.)

A. Mode of locomotion is by flagella

B. We will study Euglena as an example of this Class

C. There are approximately 1,000 known species of Euglena.
D. They are a common inhabitant of freshwater ditches and ponds.

E. They are mixotrophic

1) Can make their own food by photosynthesis – autotrophic

2) Ingest food from their surroundings (organic compounds dissolved in water) – heterotrophic

F. Structures of Euglena

1) Chloroplasts
   a) Contain chlorophyll a and b like chlorophyll found in Division Chlorophyta (green algae)
   b) Their chloroplasts are also similar to those found in green algae
   c) Site of photosynthesis

2) Pellicle – a flexible protein covering

3) Stigma – a light-sensitive eyespot

4) Contractile vacuole – a vacuole used for riding the cell of excess water

G. Reproduction in Euglena

1) Asexual reproduction by longitudinal cell division

2) Sexual reproduction is not known to occur in Euglena

4. Class Sarcodina

   (See Handout of Figure 9.11 A, page 112 of Lab Manual, Williams, 4th Ed.)

A. Protozoans that move by pseudopods (false feet)

B. We will study the Amoeba as an example

C. Usually live in aquatic environments like oceans, freshwater lakes, and ponds
D. Are often part of plankton

E. Are heterotrophic
   1) Pseudopods surround and phagocytize prey
   2) Prey includes algae, bacteria, and other protists

F. Structure of Amoeba
   1) Pseudopods - a cytoplasmic extension that is used for locomotion and engulfing food
   2) Food vacuole – site of food digestion
   3) Contractile vacuole – used to rid cell of excess water

G. Reproduction – asexual by cell division along random cellular planes

5. Class Ciliata
   (See Handout of Figure 9.11 B, page 112 of Lab Manual, Williams, 4th Ed.)

A. Protozoans that move by action of cilia
B. Ciliates are the most structurally complex and specialized of all Protozoa
C. Their cilia beat in a coordinated rhythmic manner
D. They use cilia to swim in freshwater and marine habitats to prey on bacteria, tiny algae, and each other
E. They are heterotrophic and ingest their food items
F. Most are free-living, but a few are parasitic
G. There are about 8,000 known species
H. We will study Paramecium as an example
I. Structure of Paramecium

1) Cilia – tiny, hair-like structures that project through tiny holes in pellicle

2) Pellicle – is a semi-rigid outer covering of cell

3) Trichocysts – are barbed threads that can be discharged for defense or capturing prey

4) Pathway of food entering Paramecium

oral groove → cytostome (mouth) → cytopharynx (gullet) → food vacuole

Food is swept down the oral groove, through the cytostome (mouth) through the cytopharynx (gullet) below gullet a food vacuole is formed

5) Food vacuole – site of food digestion

6) Cytopyge (anal pore) – site where digested food wastes are released

7) Contractile vacuole – rids cell of excess water

J. Reproduction in Paramecium

1) Asexual by transverse binary fission

2) Sexual reproduction is by conjugation

   a) During conjugation, 2 Paramecium first unite at the oral areas

   b) In each individual, the macronucleus disintegrates and the micronucleus undergoes meiosis

   c) 2 individual Paramecia exchange haploid micronuclei

   d) New daughter cells arise that have a combination of the genetic material of the original individuals
6. Class Sporozoza

A. Sporozoans have no specialized method of locomotion

B. There are about 3,900 species of non-motile, parasitic, spore-forming protozoans

C. They form sporozoites - a type of motile infective stage

D. Some have encysted stages

E. Most cause serious human diseases

F. We will study *Plasmodium* as an example

G. *Plasmodium* causes malaria

H. There are approximately 350 – 500 million cases of malaria reported around the world each year

I. Life Cycle of *Plasmodium*

(See Handout of Figure 21.17, page 385 of Textbook, Mader 10th Ed)

*Life cycle alternates between sexual phase in mosquito and asexual phase in humans*

1) In **gut of female mosquito** – gametes fuse to form a zygote that undergoes mitosis to form many sporozoites. Sporozoites migrate to mosquito’s salivary gland

2) **Mosquito bites human** and injects sporozoites into human blood stream where they **migrate** to the **human liver**

3) In human **liver cells**, asexual spores called merozoites are **produced** and re-enter human blood stream and **enter** the **red blood cells**

4) **Red blood cells rupture** and merozoites invade and reproduce asexually in new red blood cells

5) Merozoites and their **toxins** are dumped into the blood stream when **red blood cells rupture**. These toxins cause the **chills** and **fevers** associated with **malaria**

6) **Some merozoites** become gametocytes that enter the human blood stream. If **taken up** by the **bite** of a mosquito they become gametes in the **gut** of the mosquito
Label the following drawing of a vegetative filament of *Spirogyra*.

Figure 9.3

A. CHLOROPLAST
B. PYRENODIS
C. CELL WALL
D. NUCLEUS
E. CYTOL PLASM
F. CROSS WALL
Study the drawing of *Spirogyra* conjugation and label all parts.
Figure 9.11

PHYLUM PROTOZOA

1. Amoeba
2. Contractile vacuole
3. Ectoplasm
4. Pseudopodium
5. Nucleus
6. Food vacuole
7. Phagosome
8. Cytopharynx
9. Stigma
10. Contractile vacuole
11. Oral groove
12. Pellicle

C. C. elegans

PHYLUM PROTOZOA
2. When the mosquito bites a human, the sporozoites pass from the mosquito salivary glands into the bloodstream and then the liver of the host.

3. Asexual spores (merozoites) produced in liver cells enter the bloodstream and then the red blood cells, where they feed as trophozoites.

4. When the red blood cells rupture, merozoites invade and reproduce asexually inside new red blood cells.

5. Merozoites and toxins pour into the bloodstream when the red blood cells rupture.

6. Some merozoites become gametocytes, which enter the bloodstream. If taken up by a mosquito, they become gametes.

FIGURE 21.17 Life cycle of Plasmodium vivax, a species that causes malaria.

Asexual reproduction occurs in humans, while sexual reproduction takes place within the Anopheles mosquito.