III. Protists (Chapter 27)

A. Characteristics
1. Protists are all the eukaryotes that are not fungi, plants, or animals.

Picture Slide #1: The ciliate *Tetrahymena* undergoing sexual reproduction

Picture Slide #2: Fig 27.1 Protists on the Tree of Life

2. Protists are a paraphyletic group.
   a. Members share characteristics
   b. All members of the group do not share a common ancestor
   c. Not a meaningful evolutionary group

3. Protists exhibit wide variation in morphology, size, and nutritional strategies.
4. All protists live in water, or moist soil, or moist interiors of other organisms.

Picture Slide #3: Fig. 27.2 Diverse morphologies and life-styles are found among protists

B. Timeline of Early Eukaryotic Evolution
1. Fossils of the earliest eukaryotes are controversial because the defining features of eukaryotes, the nucleus and cytoskeleton, do not fossilize.

Picture Slide #4: Fig. 27.3 The Fossil Record of Protists

3. Eukaryotes appear to have evolved close to, or soon after, the time that O<sub>2</sub> became abundant in the atmosphere and oceans.

C. The tree of life groups protists based on molecular data.
1. The molecular data for protists supports much of the historical groupings of protists based on their morphology.
4. Most protists within each group on the tree share the same distinctive cell features.

Picture Slide #5 The majority of eukaryotes (except amebas) can be assigned to 1 of 8 major groups (This slide not in text.)

D. Increasing Diversity Is a Theme in the Evolution of Protists
1. The earliest eukaryotes solved the problem of increasing cell size.
   a. Larger cells make possible the evolution of diverse structures and functions.
   b. Compartmentalization into organelles increased the available surface area in the interior of cells, facilitating food and waste transport in and out of the cell.

Picture Slide #6: Fig 27.6 Protists have specialized intracellular structures.

2. Innovations in cell structure facilitate the development of diversity in nutritional strategies.
   a. Ingestive heterotrophs engulf bacteria and other food materials in pseudopods.

Picture Slides #7 & 8: Fig 27.6a *Pseudopodia* and *cilia* capture food
   b. Parasites developed the ability to penetrate a host and absorb its nutrients.

Picture Slide #9 Fig. 27.6b Parasitic red alga species gets its nutrition from host cell

Picture Slides #10 (trypanosomes), #11, #12 (amebic dysentery), & #13 (Far Side) are not from text.

   c. Photosynthetic Autotrophs
(1). Vary in the types of photosynthetic pigments.
   (a) Different groups of plants and algae utilize different wavelengths of light
   (b) Water absorbs some wavelengths of light faster than others
   (c) Different alga groups are more efficient than others at absorbing light at different depths (See this week’s hall display.)

Picture Slides #14, 15, & 16: Fig. 27.6d

(2) May engage in mutualistic relationships with heterotrophic protists
Picture Slide #17: Fig 27.6c Symbiosis in common in protists

   d. Nutritional strategies may vary widely within any one phylogenetic group i.e. some are free-living, while others are parasites, etc.

3. Methods of Locomotion, Support, and Protection
   a. Protists utilize pseudopodia, cilia and/or flagella for movement.
   Picture Slides #18, 19, 20 & 21: Fig 27.7a,b,c, & d

   b. Support and protection are provided by hard external tests or shells, or by rigid internal structures.
   Picture Slides #22, 23, & 24: Fig. 27.8a Foraminifera covered with shell of calcium carbonate, b Diatoms covered with test of silica oxides, & c Dinoflagellates covered with plates of cellulose

   a. Meiosis makes eukaryotic sexual reproduction possible.
      (1). Meiosis reduces the diploid chromosome number to haploid and introduces genetic variability through crossover and independent assortment.
      (2). Fusion of haploid gametes from two parents creates genetically different offspring, some of which may be more resistant to environmental changes and pathogens than the parents.
   c. Diversity in the timing of meiosis and sexual reproduction has led to a wide variety of life cycles in the protists.
   Picture Slides #25, 26 & 27: Fig 27.11a Chlamydomonas; b Ulva (Green alga); c Laminaria (Brown alga)
   Remember: 1. Multi-celled organisms can be haploid
               2. Mitosis can occur in haploid organisms

E. The Origin of Mitochondria and Chloroplasts
   1. The Endosymbiotic Theory
      a. Larger anaerobic eukaryotes engulfed aerobic prokaryotes, which became endosymbionts that enabled the host cell to become aerobic.
   Picture Slide #28: Fig. 12 Proposed Initial Steps in the Evolution of Mitochondrion by Endosymbiosis
      b. Evidence Supporting the Theory of Endosymbiosis
         (1). Physical similarities exist between mitochondria, chloroplasts, and prokaryotes.
(2). Molecular data indicates mitochondria and chloroplasts are prokaryotic in origin.

2. Lateral gene transfer has occurred between mitochondria and the host cell nucleus.

F. Protists and Human Health and Welfare

1. Many protists are responsible for human diseases, such as sleeping sickness & malaria.
Picture Slides # 29 (Trypanosomes Cause Sleeping Sickness), #30 (Map of sleeping sickness), #31 (Far Side), #32 (Middle Passage), #33 (John Wayne), & #34 (Battle of the Little Big Horn), #35 (malaria) are not from text.
Picture Slide #36: Fig. 27.14 Secondary endosymbiosis
Picture Slides #37, #38, & #39 (The dinoflagellate *Pfiesteria* may kill fish. Figures not in text.)
Picture Slides #40 & #41 (Dinoflagellates known as *zooxanthellae* are symbiotic in corals, sea anemones & some mollusks. Figures not in text.)

2. Protists are the leading primary producers in oceans and are the basis for marine and freshwater food chains.
Picture Slide #42: Fig 27. 15: Protists and the Global Carbon Budget
Picture Slide #43: Fig. 27.16: Protists and Marine Ecosystems