Chapter 19

Diversity of Protists and Fungi
Protists

- ‘Misfit” or “Junk-drawer” Kingdom
- Very diverse:
  - Most unicellular BUT
    Some multicellular
  - Some heterotrophic BUT
    some autotrophic
  - Some reproduce sexually
    but Some reproduce asexually
What Unites Protists?

- All eukaryotes
- Do not form embryos
- No complex reproductive structures
Kingdom Protista
Reproduction in Protists

- Many reproduce asexually
- Some use asexual reproduction
  - Most of the time
- Some use sexual reproduction
  - During environmental stress
Sexual Reproduction

- **Gametes**
  - Sex cells
    - Produced by meiosis
    - Haploid
      - Half set of chromosomes
    - Fuse to form diploid zygote
Asexual Reproduction

- No gametes (sex cells)
- Cells just divide by:
  - Mitosis
    - Binary fission
- Diploid cells
- Exact copy of original cell
General Classification

- Informal grouping
- Autotrophic protists
  - Algae
- Heterotrophic protists
  - Protozoa
Protist Groups

- Amoebas & forams
  - Unicellular heterotrophs
  - Use ameboid movement
    - Ooze and flow
Amoebas

- Phylum Rhizopoda
- Extremely flexible
  - No cell wall
- Pseudopodia
  - “False” “Feet”
  - Cytoplasmic extensions
  - Used in locomotion
  - Used in feeding
    - Engulfs microorganisms
Amoeba Structure

- Live in:
  - aquatic environments
  - Moist soil
- Contractile vacuole
  - “Sub-pump”
  - Pumps out excess water
  - Water moves in by osmosis
Amoeba Feeding

- Some parasitic
  - *Entamoeba histolytica*
    - Causes amebic dysentery

- Most free-living
  - Feed on microorganisms
  - Engulf food
  - Form food vacuoles
  - Digest prey with lysosomes
  - Food vacuole moves throughout cytoplasm
Forams

- **Phylum Foraminifera**
  - Marine protists
    - Live in the sand or on rocks
  - Porous shells = **tests**
    - Spiral shaped
    - Resemble tiny snail
    - Made of calcium carbonate
      \( \text{(CaCO}_3\text{)} \)
Forams

- Have pores in tests
  - Cytoplasmic extensions go through pores
    - Used for feeding and locomotion
Forams

- Dead forams
  - Tests accumulate on ocean floor
  - Forms limestone
  - Important components of landforms
Algae

- All photosynthetic
- Unicellular or multicellular
- Classified by pigments and cell or body type
  - 1) Green
  - 2) Red
  - 3) Brown
1) Green Algae

- Phylum Chlorophyta
- Most in freshwater
- Most unicellular
- Contain chlorophyll
- Most have sexual and asexual stages
Green Algae

- Some marine
- Some multicellular
- Part of marine plankton
2) Red Algae

- **Phylum**
  - Rhodophyta
  - “Red” “Plant”
  - Most multicellular
  - Red pigments
    - Absorb light in deep water
  - Most marine
    - Warm ocean waters
3) Brown Algae

- Phylum Phaeophyta
  - Multicellular
  - Mostly marine
  - Larger brown algae are called *kelp*
    - Among the largest organisms on Earth
Diatoms

- **Phylum Bacillariophyta**
  - Photosynthetic
  - Unicellular
  - Double glass shells
    - Made of silica
    - Pill box shape
    - Unique markings/designs
Diatoms

- Float in water
- Move by gliding
  - Secrete chemicals
- Body shape (symmetry)
  - Radial
  - Bilateral
Diatoms

- Autotrophs
- Key producers!
- Part of plankton
  - Beginning of aquatic food chains

Archaea, Bacteria, Protists 12 min
Diatoms

- Empty shells
  - Accumulate over time
  - Mined

- Diatomaceous earth
  - Abrasive
  - Gives sparkle to paint
  - Natural control of:
    - Slugs
    - Fleas
Diatom Reproduction

- Asexual
  - 1) Shells separate
  - 2) Halves regenerate
  - 3) Eventually get smaller and have to slip out of shell
    - Grow to full size
    - Regenerate new shell
Colonial Algae

- Made of many cells
- Ex: Volvox
  - Hollow ball or sphere
  - Made of biflagellated cells
  - Colony glides and rolls through the water
Flagellates

- Flagella
  - Long hair-like structure
  - Moves back and forth
  - Locomotion
Flagellates

- Three major phyla
  - Dinoflagellates
  - Euglenoids
  - Kinetoplasts
Dinoflagellates

- Phylum Dinoflagellata
  - Unicellular
  - Most have two flagella
    - Beat in two grooves
      - One is belt-like
      - Other is perpendicular
    - Spin like a top
Dinoflagellates

- Protective coat
  - Cellulose
  - Silica
- Unusual shapes
- Part of plankton
- Most are marine
Dinoflagellates

- Reproduce asexually
- Feeding
  - Autotrophic
  - Heterotrophic
  - Both
Dinoflagellates

- Some produce powerful toxins:
- “Red Tides”
  - Occur in coastal areas
  - Population explosions
  - Deadly to organisms that feed on them
Euglenoids

- Phylum Euglenophyta
  - Freshwater protists
  - Two flagella
Euglenoids

- **Reproduction**
  - Mitosis
  - Asexual

- **Feeding**
  - Some autotrophic
  - Some heterotrophic
Euglena Structure

- **Flagella**
- **Eyespot = stigma**
  - Light sensitive organ
  - Move toward light
- **Pellicle**
  - Stiff protein inside cell membrane
  - Flexible; allows shape changes
Euglena Structure
Euglenophyta

- YouTube - Euglenoids from a ditch
Kinetoplasts

- Sometimes included with Euglenoids
- Phylum Kinetoplastida
  - Unicellular
  - Heterotrophs
  - Flagella
Kinetoplasts

- **Reproduction**
  - Most asexual
  - Some sexual

- **Ex:**
  - *Trichonympha* – in termite gut
    - Help digest wood
    - [YouTube - HOW TERMITES DIGEST WOOD](https://www.youtube.com)
    - [YouTube - Protozoa in termite gut with AxioCam HS](https://www.youtube.com)
  - *Trypanosomes* – cause sleeping sickness
Ciliates

- YouTube - Protists | Biology (an overview 4 min)
- Phylum Ciliophora
- Cilia
  - Multiple
  - Short
  - Hair-like
  - Used for locomotion
Ciliates

- Complex
- Unicellular
- Heterotrophs
Ciliates

- Many ciliates have two types of nuclei
  - Macronucleus
    - “Macro” = big
    - Small pieces of DNA
  - Micronucleus
    - “Micro” = small
    - Normal chromosomes
    - Mitosis
Ciliates

- Body “wall”
  - Called *pellicle*
  - Tough
  - Flexible

- Can move around obstacles
Asexual Reproduction

- Reproduction usually by mitosis
  - Body splits in half
  - Binary fission
  - Clones result
  - 700 generations max
  - Will die if sexual reproduction does not occur
Sexual Reproduction

- Most ciliates
- Conjugation
  - Two cells unite and exchange genetic material
    - Shuffles genes
    - Adds variation
    - Advantageous
Ciliates

- Conjugation
  - Type of sexual reproduction
  - Exchanging genetic material
Paramecium

- Many different species
- **Ex: Paramecium caudatum**
  - Unicellular
  - Heterotrophic
  - Ciliated
  - Lives in freshwater
  - Feeds on microorganisms
Paramecium Structure
Paramecium Structure
Stentor
Blepharisma
Protistan Molds

- Heterotrophs
- Some mobility
- Similar appearance and reproductive structures to Fungi
  - Different cell wall material
Protistan Molds

- 3 phyla
  - Phylum Acrasiomycota
    - Cellular slime molds
  - Phylum Myxomycota
    - Plasmodial slime molds
  - Phylum Oomycota
    - Water molds
    - White rusts
    - Downy mildews
Cellular Slime Molds

- Phylum Acrasiomycota
  - Look like amoebas
  - Haploid blobs
  - Ingest bacteria
  - Move through soil
  - Ingest decaying material
Cellular Slime Molds

– During environmental stress
  • Come together
  • Form multicellular colonies
    – Colony = slug
  • Developes a stalk
  • Produces spores
  • Spores survive harsh conditions
  • Spores become new amoebas
Plasmodial Slime Molds

- Phylum Myxomycota
- Plasmodium
  - Mass of cytoplasm
- Looks like oozing slime
- Engulf bacteria and other organic materials
Plasmodial Slime Molds

- Cells with many nuclei
- No cell walls
- Under stress
  - Divides into small mounds
  - Stalk and capsules form
  - Forms spores
Plasmodial Slime Molds

- Spores resistant to harsh conditions
- Germinate
- Haploid cells are released
  - Flagellated
  - Amoeboid motion
- Fuse to form diploid zygotes
Other Molds

- Phylum Oomycota
- Oomycetes
  - Spores have 2 flagella
  - Water molds
  - Scavengers
    - Grow on dead organisms in water
Other Molds

- Phylum Oomycota
  - Oomycetes
    - Parasites
      - White rusts
      - Downy mildews
      - Plant parasites
      - Plant pathogens
        - Irish potato famine
        - 400,000 people starved to death
Sporozoans

- Phylum Apicomplexa
- Characteristics
  - Nonmotile
  - Unicellular
  - Parasites
  - Complex life cycles
  - Form spores
Sporozoans

- All parasitic
- Cause many serious diseases
  - Malaria
  - Cryptosporidiosis
Beneficial Protists

- Symbiosis (Close relationship)
  - Ex: Commensalism
    - Live in digestive tract
      - Help digest food in cattle
Protists and Humans

- Greatest impact on humans
  - Cause disease
    - Humans
    - Livestock
    - Crops
Malaria

- One of the most deadly diseases
- 2010:
  - ~ 210,000,000 people had
  - ~ 660,000 die each year
    - Mostly children
    - Mostly tropical
    - In Africa, a child dies every 45 seconds from malaria
Malaria

- Means “bad or evil air”
- Originally thought that this disease was caused by foul air
- Particularly by vapors given off by swamps
- It was also called “swamp fever”
- It is one of the most ancient infections known to man
Malaria

- **Symptoms**
  - Severe chills
  - Fever
  - Sweating
  - Confusion
  - Can be fatal
    - Anemia
    - Kidney failure
    - Brain damage
Malaria Protist

- *Plasmodium sp.*
  - Sporozoan
  - Parasite
  - Complex life cycle

- Spread by mosquitoes
  - *Anopheles* sp.
  - Females spread
Plasmodium Life Cycle

- Three stages
  - Sporozoite
  - Merozoite
  - Gametes
Stage 1:
- Infected mosquito bites human
- Injects saliva
  - To prevent clotting so it can eat
  - Also injects about 1000 protists
- Sporozoites
  - Infective stage
    - Infects liver
    - Divide rapidly
Plasmodium Life Cycle

- Stage 2:
  - Merozoites
    - Leave the liver and infect RBCs
    - Divide rapidly
  - ~ 48 hours RBCs rupture
  - Release toxins
Plamodium Life Cycle

- Stage 2 cont’d
  - Released toxins
    cause fever and chills
- Cycle repeats
every 48-72 hours
Plamodium Life Cycle

- Stage 3:
  - Merozoites develop into gametes
  - Gametes ingested by a mosquito
  - Gametes fuse to form a zygote
  - Then form sporozoites
    - Migrate to salivary glands of mosquito
      - Must mature before it can be infective
    - Bites human, cycle repeats
Treating Malaria

- **Quinine**
  - Antimalarial
  - From bark of cinchona tree

- **Derivatives**
  - Chloroquine
  - Primaquine
Preventing Malaria

- Reduce bites
  - Mosquito netting
- Reduce mosquito populations
  - Spray insecticides
  - Reduce breeding grounds
  - Mosquito fish
Largest organism on Earth = fungus growing in Oregon
  ~ 3.5 miles across and extends an average of three feet into ground
  ~ covers an area over 1,500 football fields
  ~ 2400 years old!
- *Armillaria ostoyae*
  - “honey mushroom”
Fungi Environments

- In soil, water, air
- In or on plants and animals
- 70,000 named species
Plants vs. Fungi

Plants
- Chlorophyll
- Photosynthesize
- True roots, leaves, and stems
- Cell wall of cellulose

Fungi
- No chlorophyll
- Absorb food from environment
- No roots, leaves, stems
- Cell wall of chitin
Fungi Anatomy

- All multicellular *EXCEPT* yeasts
- **Hyphae** – long strands
  - may be chains of cells or one long cell
  - Not in yeasts
Fungi Anatomy

- **Mycelium** (mycelia = plural) – long tangled masses of hyphae
  - Underground network
- **Fruiting body** – reproductive structure
Absorbing Nutrients

- Ex: tree bark, cheese, bread, you!
- Hyphae extend into food
  - Release enzymes
    - Break down nutrients so it can go thru cell wall
    - Allows very rapid growth!
4 Main Fungi Groups

- 1) Phylum Chytridiomycota – primitive
- 2) Phylum Asomycota – sac
- 3) Phylum Zygomycota – bread molds
- 4) Phylum Basidiomycota - club
1) Primitive Fungi

- “Chytrids”
- Smallest
- Simplist
- Mostly aquatic
- Only fungi with flagellated spores
- Decomposers or parasitic
- Ex: killing amphibians
2) Sac Fungi

- All form a sac (ascus) for reproduction

- Ex:
  - Yeasts
  - *Penicillium*
    - Deep green, fuzzy
    - Grows on fruit
  - Morels and truffles
    - Tastey!
2) Sac Fungi

- *Aspergillus flavus*
  - Mold that makes aflatoxin
  - Poisonous
  - Contaminates cereals, nuts, milk
  - May cause liver cancer and eventually death
3) Bread Molds

- Often on spoiled foods
- Mycorrhizae (my kuh RY zuh)
  - Help plants fix nitrogen
4) Club Fungi

- Mushrooms, puffballs, bracket (shelf) fungi
- Rusts and smuts – cause plant disease
Reproduction

- Asexual
  - Budding
  - Fission (mitosis)

- Sexual
  - Thru meiosis
  - Produce spores
    - Everywhere
    - Can cause allergies
19.6 Fungi Ecology

- Decompose dead and decaying matter
  - Important to ecosystems
- Return nutrients to soil
  - Ex: C, N, and minerals
- Can damage trees and wooden houses
Fungi as Pathogens

- **Obligate** – always cause disease
- **Opportunistic** – only cause disease when homeostasis is disrupted
Fungi and Humans

- *Candida* – yeast that occupies skin and mouth normally
  - Can cause disease if immune system is damaged

- Others cause:
  - Ringworm
  - Athletes foot
  - Lung infections
  - Death
Fungi and Plant Diseases

- **Dutch Elm Disease**
  - Transmitted by beetle
    - carry spores from one tree to next
- **Peach scab**
- **Gray mold**
  - Strawberries
Treatments

- Fungicides
- Genetically engineered crops
- Antifungal medications
- Difficult to treat without hurting our own cells because both are eukaryotic
Mutualism

- Symbiotic relationship in which both organisms benefit
- Ex: Lichen – fungus and algae or photosynthetic bacteria
  - Algae provide food
  - Fungus provide habitat
Lichens

- Grow on solid surface
- Like cool, dry environments
- Withstand severe temps
Lichens

- Sensitive to air pollution
  - Air quality indicators
- Recycle nutrients
  - Decomposer and producer
- Used in dyes
- Antibiotic properties
Mycorrhizae

- Mutualistic relationship bw plant roots and soil fungi
  - 80% of plants in world have
  - Plant gets larger root surface area
  - Fungus gets sugars
- Boost growth
- Reduce need for fertilizer
- Produce chemicals with antibiotic properties
Leafcutters

- Use and grow fungi
- Build nest of leaves
  - Add fungi
    - Fungi break down leaves, ants eat fungi
- Farmer ants video 9 min
Important Uses

- Eat em’!
- Make bread rise
- Citric acid in soft drinks
- Antibiotics