


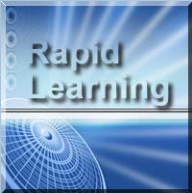
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 **Eukaryotes: Characterization and Classification**

Microbiology Rapid Learning Series

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Learning Objectives

By completing this tutorial, you will learn about:

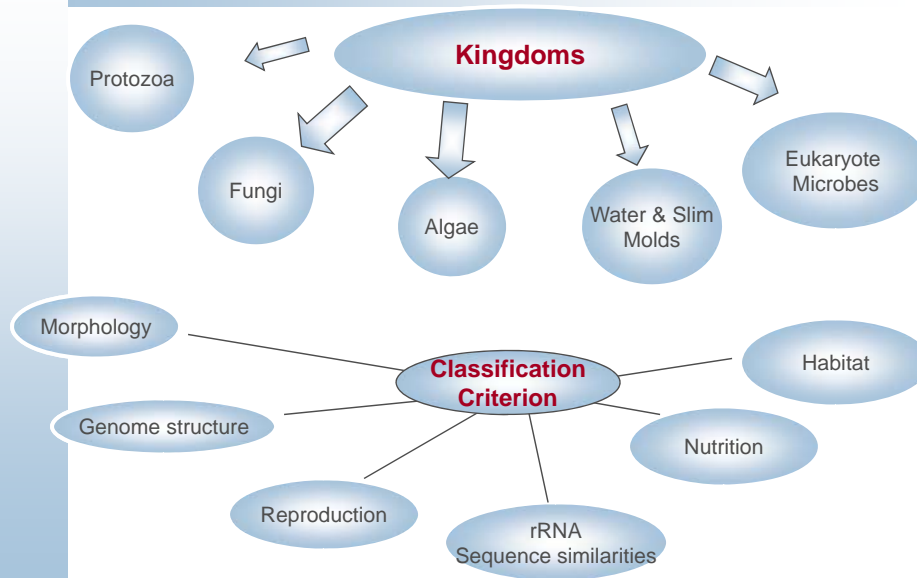


- Classification of eukaryotes.
- Some of the differences between 21st and 20th Century classification.
- Review of Eukaryote reproduction.
- Characteristics of:
 - Protozoa
 - Fungi
 - Algae
 - Water & Slime Molds

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Concept Map



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Reproduction Eukaryotes

- Most of the DNA in eukaryotes is complexed with histone proteins as chromosomes, in the form of chromatin, which are located in nuclei.
- Some eukaryotic DNA can be found in chloroplasts and mitochondria. These organelles reproduce by binary fission.
- Eukaryote asexual reproduction: binary fission, budding, fragmentation, spore formation and schizogony.
- Sexual reproduction involves the formation of gametes, fusions of gametes and formation of a zygote.
- Algae, fungi and some protozoa reproduce both sexually and asexually.

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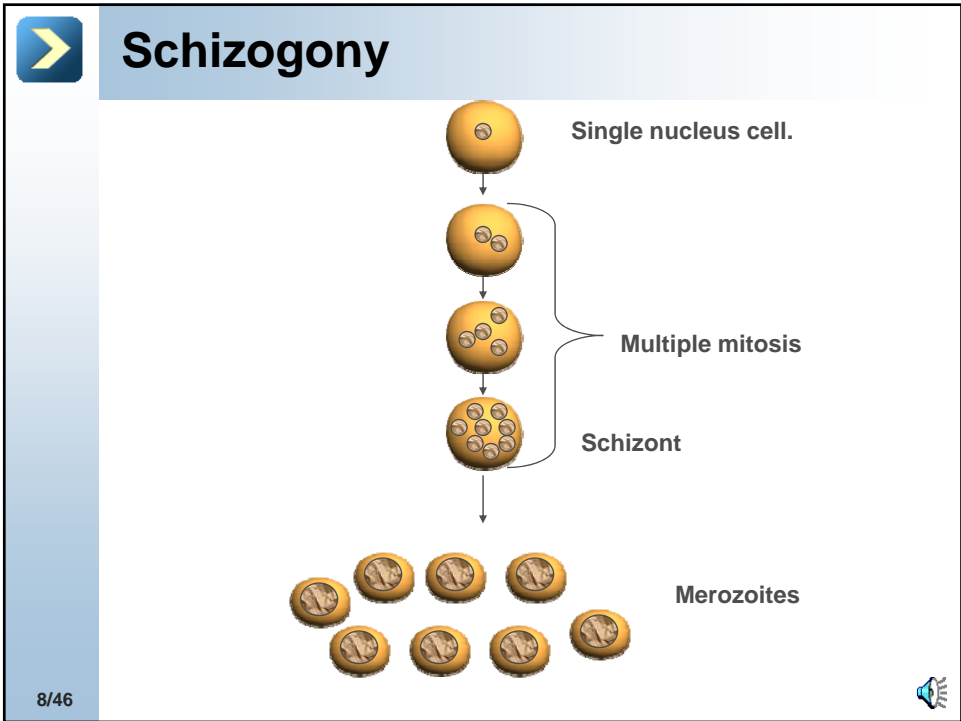
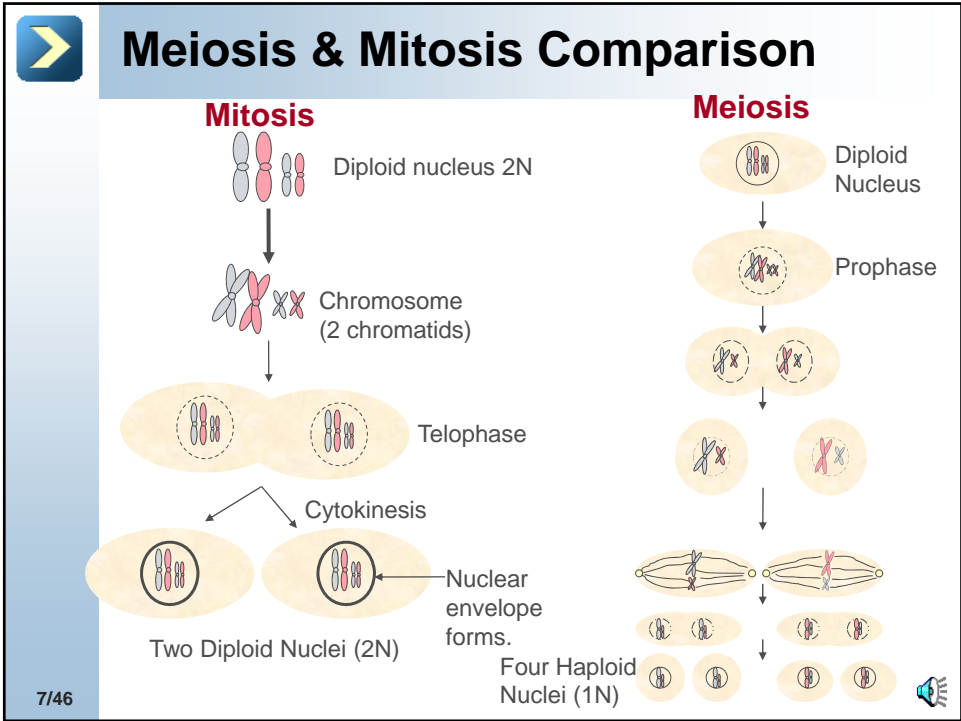


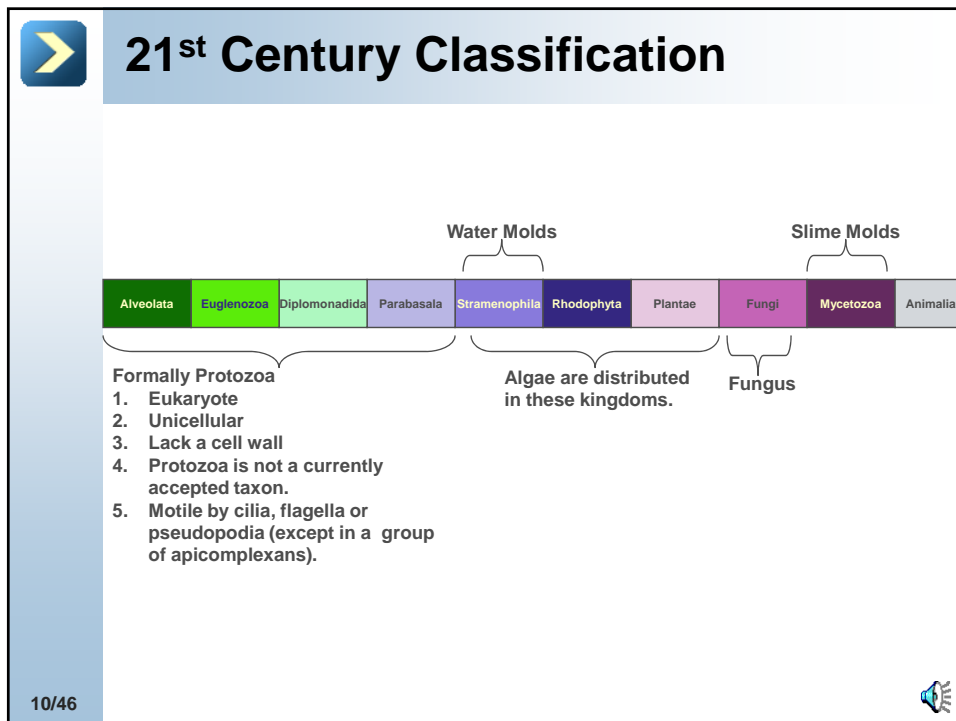
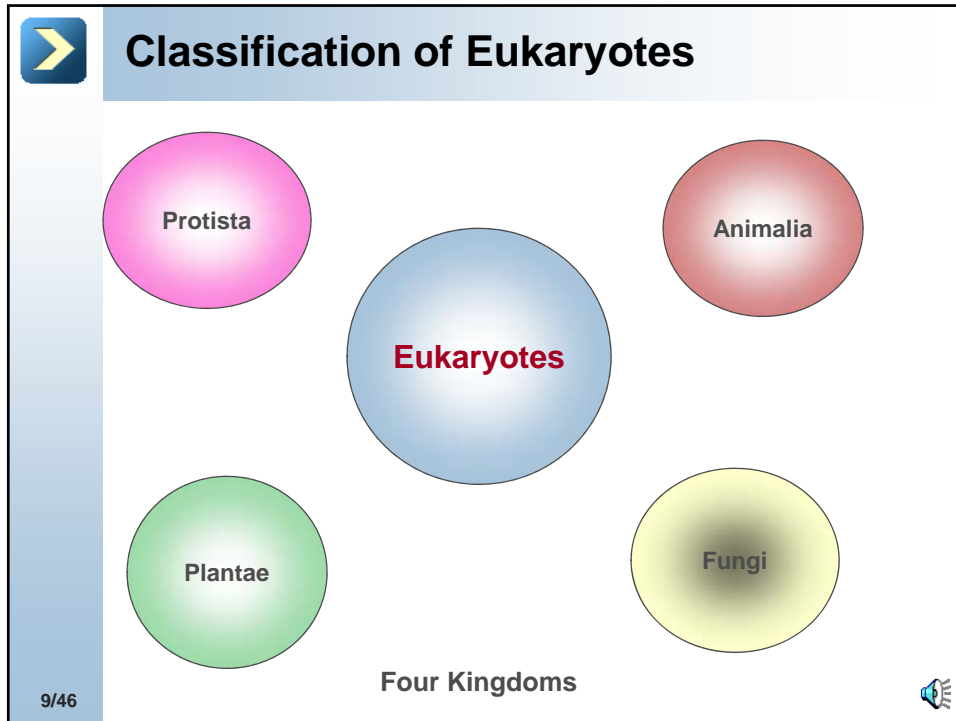
Nuclear Division

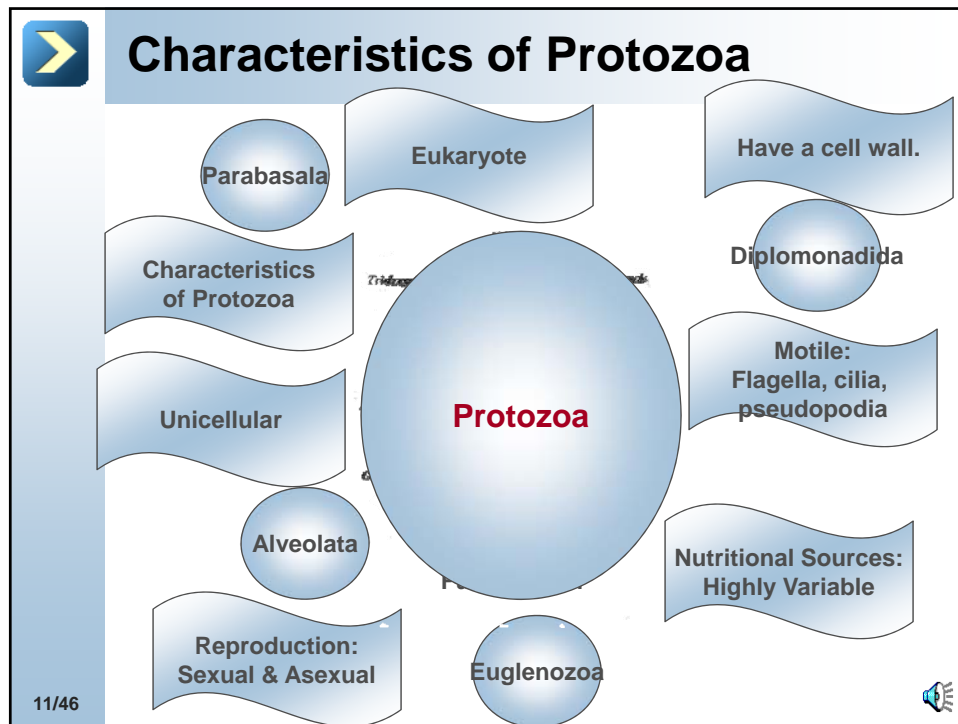
- The eukaryotic nucleus has either one or two complete copies of a cell's genome.
- A nucleus with one copy of each chromosomes is called haploid or 1N.
- A nucleus that has two sets of chromosomes is diploid or 2N.
- The cells of most fungi, many algae and some protozoa are haploid.
- Cells of most plants, animals and some fungi, algae and protozoa are diploid.

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Distribution of Protozoa

- Protozoa require damp environments because they do not have cell walls.
- They inhabit lakes, streams, oceans, rivers and most bodies of water around the world.
- As plankton, they are free-living and drift and, as such, are part of the aquatic food chain.
- Some protozoa live in damp environments, such as beach sand.
- Very few are human pathogens.

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➤ Morphology of Protozoa

Great diversity in morphology Membrane-bound organelles.

No cell wall

Trophozoite: Free living aquatic motile feeding stage


Unicellular

Movement: flagella, cilia, pseudopodia.

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➤ Nutrition of Protozoa

- Most protozoa are chemoheterotrophic.
- Nutrients are obtained by phagocytizing bacteria, decay of organic matter, other protozoa or tissues of a host.
- The dinoflagellate and euglenoids are photoautotrophic.



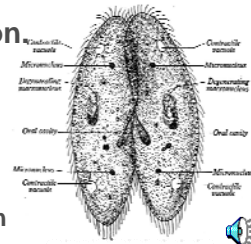
Dinoflagellates are probably best known as the cause of marine bioluminescence, "red tides" and paralytic shellfish poisoning.

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Reproduction in Protozoa

- Dominant form of reproduction is asexual or binary fission.
- A few protozoa reproduce sexually, involving the exchange of genetic material between two individual organisms.
- In sexual reproduction, the protozoa become a gametocyte and fuse to form a diploid zygote.
- Paramecium reproduce via conjugation.

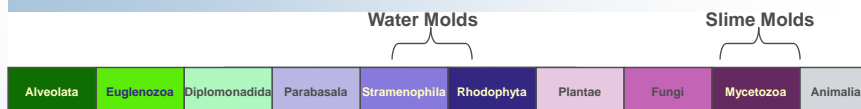


Paramecium conjugation

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Classification of Protozoa



Alveolata

Protozoa with small membrane-bound cavities called alveoli.

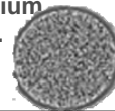
Ciliate



Have cilia to move water past their cell surfaces. Have two nuclei (micro and macro). Include: Vorticella, Balantidium (pathogen), Didinium (carnivor on other protozoa) and Paramecium.

Apicomplexans

Animal pathogens. At the apice, there is a complex of special intracellular organelles, which include Plasmodium and Toxoplasma.



Dinoflagellate

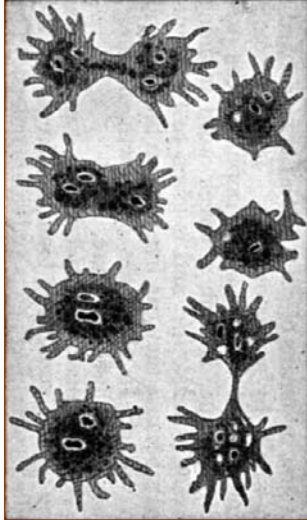


Have photosynthetic pigments. Classed: protozoa based on 18S rRNA and alveoli. Freshwater & marine plankton.

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> Amoebae

- Unclear where, in the group of protozoa, amoebae belong.
- Some amoebae share traits (sRNA homology, disc-shape and mitochondrial cristae) with euglenoids.
- Two dominant characteristics of protozoa: move by pseudopodia, lack mitochondria (some exceptions).
- Reproduce by binary fission.
- Most are not human pathogens. Exceptions to this are: Naegleria and Acanthamoeba, which cause brain diseases and Entamoeba dysentery (can be fatal).



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> Protozoa Euglenozoa

Alveolata	Euglenozoa	Diplomonadida	Parabasala	Stramenophila	Rhodophyta	Plantae	Fungi	Mycetozoa	Animalia
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Euglenoids

Kinetoplastids

1. Photoautotrophic.
2. Unicellular microbes with chloroplasts.
3. Food storage paramylon (unique polysaccharide).
4. Lack cell walls.
5. Use flagella to move.
6. Chemoheterotrophic phagocytes (in the dark).
7. Includes some free-living amoeba.



1. Single, large mitochondria having DNA with a unique coding region.
2. Live inside animals.
3. Some are pathogenic: Trypanosoma (African sleeping sickness).



<http://www.glerl.noaa.gov/seagrant/GLWL/Algae/Euglena/Images/OUeuglena.JPG>
🔊


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▶ Diplomonadida Protozoa

Alveolata	Euglenozoa	Diplomonadida	Parabasala	Stramenophila	Rhodophyta	Plantae	Fungi	Mycetozoa	Animalia
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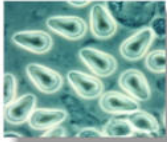
Diplomonads


1. Two equal-sized nuclei.
2. Multiple flagella.
3. Forms resistant cysts.
4. Giardia, human pathogen causing diarrhea.



Microsporidia

1. Small protozoa with polar filaments.
2. Obligatory intracellular parasites.
3. Spread via small resistant cysts called “spores”.
4. Some human pathogens.
5. Nosema parasitic on insects like honeybees and silkworms.



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▶ Protozoa Parabasala

Alveolata	Euglenozoa	Diplomonadida	Parabasala	Stramenophila	Rhodophyta	Plantae	Fungi	Mycetozoa	Animalia
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1. Lack mitochondria.
2. Each microbe has a single nucleus.
3. Each microbe has a parabasal body, which is a Golgi-like structure.

Trypanosoma lives in the gut of termites and helps digest wood.

Trichomonas lives in the human vagina and can cause severe inflammation.

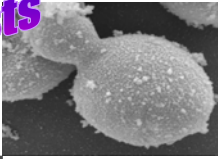

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Fungi

Alveolata	Euglenozoa	Diplomonadida	Parabasala	Stramenophila	Rhodophyta	Plantae	Fungi	Mycetozoa	Animalia
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Molds **Mushrooms** **Yeasts**


- Chemoheterotrophic
- Have cell walls (which is unlike protozoa).
- Cell walls are made of a strong, flexible, nitrogenous polysaccharide called chitin.
- Lack chlorophyll and do not photosynthesize.
- Differ from animals by having cell walls.
- Mycology is the study of fungi.

21/46 http://exploration.nasa.gov/programs/station/yeast/GAP_lite.html

Significance of Fungi

- In nature, they help decompose dead organisms and recycle/breakdown products.
- Used for food and medicine, e.g. antibiotics such as penicillin and cephalosporin.
- About 30% of fungi produce fungal diseases, e.g. Dutch Elm disease.
- About 90% of plants form mycorrhizae. This is a relationship, between fungi and plants, that helps plants absorb water and minerals.
- Mycoses: fungal disease of plants, animals and humans.



Fungus on soybean leaf

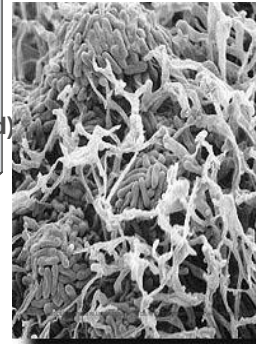
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Morphology of Fungi

- **Thallus:** vegetative body of a fungus.
- **Yeasts:** small, globular, composed of a single cell.
- **Mold thalli:** large, long, branched tubes like filaments (hyphae).

- **Hyphae:** long branched tube like filaments.
- **Septate:** hyphae divided by crosswalls.
- **Aseptate:** not divided by walls and are coenocytic (multinucleate).
- **Mycelia:** a web of hyphae (usually underground)



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Nutrition of Fungi

Most fungi are *saprobies*, which means they absorb nutrients from nonliving or decaying organisms.

Secrete enzymes and break down large organic molecules.

Some fungi trap and kill nematodes (worms).

Haustoria are modified hyphae, the tip of a parasitic fungus.

Haustoria are used to penetrate tissue of the host (plants or animals) to acquire nutrients.

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Reproduction of Fungi

- Haploid cells form a + and – thallus fuse, forming a dikaryon designated (n+n).
- Nuclei within the dikaryon fuse forming a diploid.
- Meiosis restores the haploid condition.
- Haploid nuclei are partitioned into a + and – spores.

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Reproduction in Fungi

Budding & Asexual Spore Formation

Following mitosis, one daughter nucleus is sequestered in the cytoplasm by the formation of a new wall.

Asexual spores are classes based on the mode of formation:

- **Sporangiospores:** formed inside a sac (sporangium), often on a stalk at either the tips or sides of the hyphae.
- **Chlamydo spores:** inside the hyphae, a thick wall forms.
- **Conidiospores:** formed at the tips or sides of the hyphae, not in a sac.

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Fungi Divisions

Alveolata	Euglenozoa	Diplomonadida	Parabasala	Stramenophila	Rhodophyta	Plantae	Fungi	Mycetozoa	Animalia
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Division Zygomycota	}	Produces the same type of sexual spore.
Division Ascomycota		
Division Basidiomycota		
Division Deuteromycota		No sexual spore has been observed.

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Fungi Division Zygomycota

Alveolata	Euglenozoa	Diplomonadida	Parabasala	Stramenophila	Rhodophyta	Plantae	Fungi	Mycetozoa	Animalia
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Division Zygomycota

1. Coenocytic molds.
2. Most are saprobes.
3. Nonsaprobes are obligate parasites of insects or fungi.
4. Sexual structures include the formation of zygosporangia.
5. Example: Black bread mold *Rhizopus*.

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Fungi - Division Ascomycota

Alveolata	Euglenozoa	Diplomonadida	Parabasala	Stramenophila	Rhodophyta	Plantae	Fungi	Mycetozoa	Animalia
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Division Ascomycota

- Make haploid ascospores within sacs, called asci.
- Asci occur in ascocarps, which have various shapes.
- Ascomycetes can reproduce asexually by conidiospores.
- Fungi that spoil food are ascomycetes; they also include plant pathogens.
- The beneficial aspects include the making of penicillin. *Saccharomyces* ferments sugar to make alcohol and carbon dioxide, which is used in baking.

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Fungi Division-Basidiomycota

Alveolata	Euglenozoa	Diplomonadida	Parabasala	Stramenophila	Rhodophyta	Plantae	Fungi	Mycetozoa	Animalia
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Division Basidiomycota

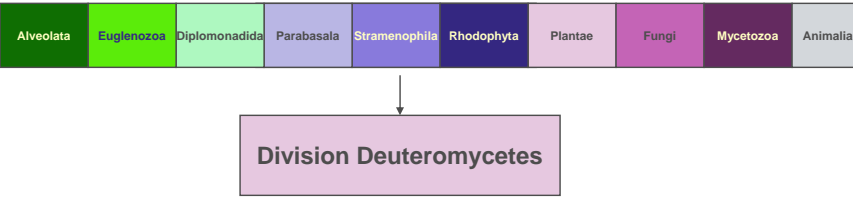


- Basidiocarp are fruiting bodies of basidiomycetes.
- Basidia: the often club-shaped fruiting body is called basidia, the ends of which produce sexual basidiospores.
- Basidiomycetes decompose and digest chemicals like cellulose, lignin and other organic matter.


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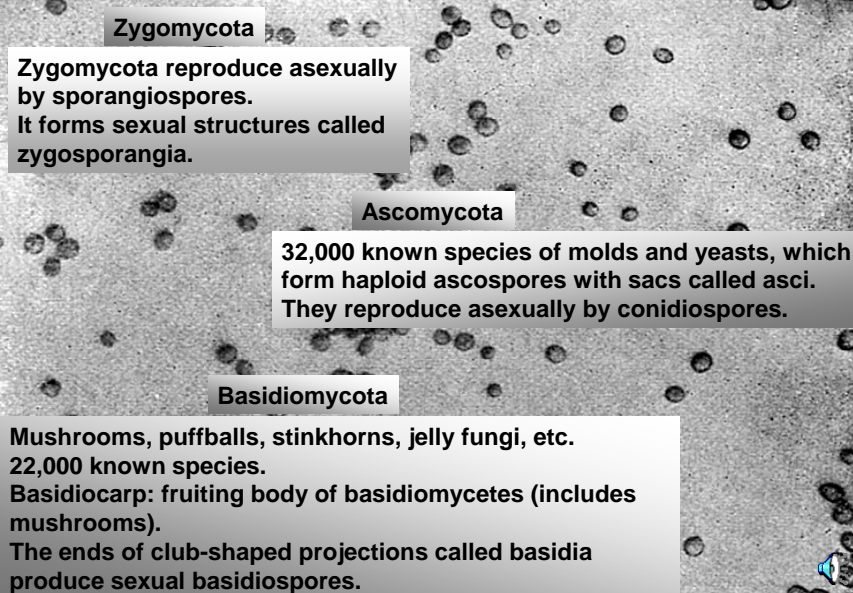
Fungi Deuteromycetes Divisions



- No sexual stages have been observed in Deuteromycota.
- The rRNA sequences have shown that most deuteromycetes belong to the division of Ascomycota. Because of this, modern taxonomists have abandoned Ascomycota as a formal taxon.
- Most deuteromycetes are either terrestrial saprobes or plant pathogens. Trichophyton causes ringworm in humans and so it is a human pathogen.

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Classification of Fungi



Zygomycota
Zygomycota reproduce asexually by sporangiospores. It forms sexual structures called zygosporangia.

Ascomycota
32,000 known species of molds and yeasts, which form haploid ascospores with sacs called asci. They reproduce asexually by conidiospores.

Basidiomycota
Mushrooms, puffballs, stinkhorns, jelly fungi, etc. 22,000 known species. Basidiocarp: fruiting body of basidiomycetes (includes mushrooms). The ends of club-shaped projections called basidia produce sexual basidiospores.

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Lichens

- Lichens are a partnership between fungi and photosynthetic microbes.
- Algae is either green algae or cyanobacteria.
- The hyphae of fungi surround the photosynthetic cells.
- Fungi provide nutrients, water and protection.
- Alga or cyanobacterium provides the fungi with carbohydrates and oxygen.
- The partnership is not always mutually beneficial. Some lichens kill the photosynthetic member.
- Fungi of lichen reproduce by spores, which germinate and develop hyphae.
- About 14,000 species of lichens.



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Classification of Algae

Alveolata	Euglenozoa	Diplomonadida	Parabasala	Stramenophila	Rhodophyta	Plantae	Fungi	Mycetozoa	Animalia
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Algae is spread across these three kingdoms.

Simple eukaryotic, phototrophic organisms.

Can carry out photosynthesis using chlorophyll a.

Have sexual reproductive structures; every cell become a gamete.

Phycology is the study of algae.

Most algae are aquatic and live in the photic zone (penetrated by sunlight).

Algae that grow deeper underwater have phycoerythrin (red pigment) that absorbs light that penetrates lower.

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Algae Overview

Morphology


1. Unicellular, colonial or simple multicellular organisms called thalli.
2. Thalli are large marine algae called seaweeds.

Reproduction

1. Unicellular algae asexually involves mitosis, followed by cytokinesis.
2. Unicellular algae sexually involves the cell acting as a gamete and it fuses with another such gamete.
3. Multicellular algae reproduce asexually by fragmentation.
4. Multicellular algae sexual reproduction: every cell is a reproductive structure and becomes a gamete.


Distribution

1. Diverse habitats: soil, ice, and as lichens, on plants.
2. Most algae are aquatic.


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Classification of Algae

Alveolata	Euglenozoa	Diplomonadida	Parabasala	Stramenophila	Rhodophyta	Plantae	Fungi	Mycetozoa	Animalia
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- Share many characteristics with plants.
- Have chlorophylls a and b.
- Use sugar and starch as food reserves.
- Many have cell walls. Most are unicellular or filamentous.
- Habitat: primarily freshwater ponds, lakes and pools.
- Form green to yellow scum on water.
- 18S rRNA sequences are similar to plants and so are considered progenitors of plants.
- Examples: Spirogyra, Prototheca

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Red Algae

Alveolata	Euglenozoa	Diplomonadida	Parabasala	Stramenophila	Rhodophyta	Plantae	Fungi	Mycetozoa	Animalia
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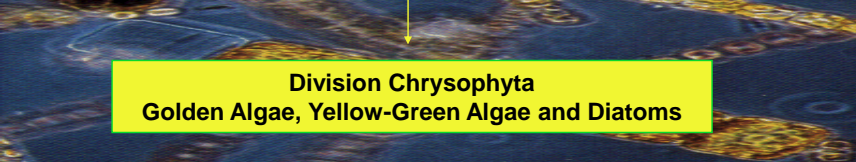


- Have the red accessory pigment, phycoerythrin.
- Also contain chlorophyll a.
- Used glycogen for storage.
- Cell walls are made of agar or carrageenan.
- Nonmotile male gametes, called spermatia.
- Phycoerythrin enables the red algae to absorb short wavelength so they are able to grow at depths greater than 100 m.
- Red algae range in color from green to black in the intertidal zone and red in deeper water.

37/46 http://www.oceanexplorer.noaa.gov/explorations/03mex/background/seaweeds/media/fig1_dive1763_600.jpg

Yellow-Green Algae & Diatoms

Alveolata	Euglenozoa	Diplomonadida	Parabasala	Stramenophila	Rhodophyta	Plantae	Fungi	Mycetozoa	Animalia
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- Diverse composition of cell wall and pigments.
- All cell walls have the polysaccharide chrysolaminarin stored.
- Similar nucleotide sequences with brown algae.
- Diatoms have a unique cell wall that is composed of two halves, called frustules; they make "*diatomaceous earth*" used in gardens.
- Chrysophytes are unicellular or colonial.
- All have the orange pigment carotene and chlorophyll.
- Diatoms are phytoplankton-free-floating photosynthetic microbe.
- Diatoms are a major source of the world's oxygen and basis of ocean food chain.


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➤ Brown Algae

Alveolata	Euglenozoa	Diplomonadida	Parabasala	Stramenophila	Rhodophyta	Plantae	Fungi	Mycetozoa	Animalia
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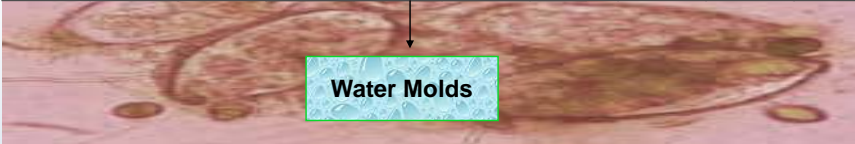


- Have chlorophylls a and c, carotene, brown pigments (called xanthophylls).
- Brown algae may appear dark brown to green.
- Brown algae is typically a marine organism and include some of the giant kelps (*Macrocystis*).
- Produce motile gametes and spores, which move by two flagella, one whip-like and the other tinsel-like.
- Alginic acid (alginate) used as food reserve in cell walls.


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➤ Water Molds

Alveolata	Euglenozoa	Diplomonadida	Parabasala	Stramenophila	Rhodophyta	Plantae	Fungi	Mycetozoa	Animalia
-----------	------------	---------------	------------	---------------	------------	---------	-------	-----------	----------




- Water molds differ from fungi in the following ways:
 - Have tubular cristae in their mitochondria.
 - Cell walls of cellulose, not chitin.
 - Spores have two flagella, one whip-like and the other like tinsel.
 - True diploid thalli, not haploid or dikaryon thalli.
- Example: *Phytophthora*, which caused the great Irish potato famine of 1845.

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<http://www.ncbi.nlm.nih.gov/Science-Articles/Archive/assets/images/2003/Mar-05-2003-Archived/Phytophthora.jpg>

▶ Slime Molds

Alveolata
Euglenozoa
Diplomonadida
Parabasala
Stramenophila
Rhodophyta
Plantae
Fungi
Mycetozoa
Animalia



- Plasmodial slime molds, also known as acellular slime molds.
- Are streaming, coenocytic, colorful filaments of cytoplasm that creep like amoebae.
- Live in forest litter and feed on phagocytizing organic material and bacteria.
- The thallus may contain millions of diploid nuclei.
- Compatible myxamoebae of opposite mating types can fuse to make a diploid zygote.

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? Review Questions - 1

What is a eukaryotic, unicellular microbe that lacks a cell wall? (Most are chemoheterotrophs.)

Protozoa

Mycologists study ____?

Fungi

Algae were previously grouped primarily by ____?

Which photo pigments they contained.

Nuclear division, without cytoplasmic division, results in cells called ____?

coenocytes

Haploid genomes have ____ set(s) of chromosomes.

one

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? Review Questions - 2

Eukaryotic, unicellular organisms lacking a cell wall are called?

Protozoa

The distinction of the Alveolates is _____.

Small membrane-bound cavities called alveoli.

Protozoa nutrition is mostly _____.

Chemoheterotrophic.

Branched, tubular filaments with crosswalls found in fungi are _____.

Septate hyphae.

Asexual fungal spore that buds from a vegetative hyphae is called _____?

conidiospore

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📌 Learning Summary

Eukaryotic nucleus can be haploid or diploid and can undergo meiosis or mitosis.

Taxonomy has been revolutionized due to DNA, RNA and protein sequencing.

There is tremendous reproductive variability in eukaryotes.

Algae are essential in the food chain and in oxygen production.


Fungi reproduction is complex and responsive to environmental pressures.



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Congratulations
You have successfully completed
the core tutorial

**Eukaryotes:
Characterization and
Classification**

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What's Next ...

Step 1: Concepts – Core Tutorial (Just Completed)
→ Step 2: Practice – Interactive Problem Drill
Step 3: Recap – Super Review Cheat Sheet

Go for it!

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<http://www.RapidLearningCenter.com>