General Biology 1
BIO1201 RM 1021
Syllabus & Textbook:
https://openlab.citytech.cuny.edu/oer-biology/lecture-schedule/

Lecturer: Michael Gotesman, PhD
Email: mgotesman@citytech.cuny.edu

Grade Breakdown:

Lecture (60%)
Exams (4): 22.5% Each
Pop Quizzes (?): 10% Average

Lab (40%) – Lab Instructor

Letter Grade	Numerical Ranges
A	93-100
A-	90-92.9
B+	87-89.9
B	83-86.9
B-	80-82.9
C+	77-79.9
C	70-76.9
D	60-69.9
F	59.9 and below

Reading List:

Week 1: Evolution 479-502 & Phylogeny 523-545

Week 2: Virus 547-573 & Prokaryotes 575-610

Week 3: Protists 611-642

Week 4: Fungi 643-673

Week 5: Seedless Plants 675-701

Week 6: Seeded Plants 643-673

Week 7: Animal Kingdom 703-730

Week 8: Animal Organization 731-754

Week 9: Circulation 1175-1199

Week 10: Immunity 1225-1258

Week 11: Digestion 967-995

Week 12: Respiration 1147-1173

Week 13: Body Fluid 1201-1223

Week 14: Nervous System 997-1037

Week 15: Reproduction 1259-1293

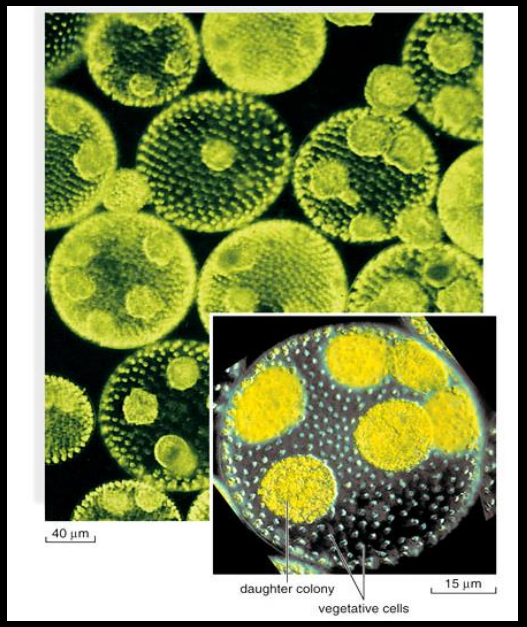
https://openlab.citytech.cuny.edu/oer-biology/textbook/

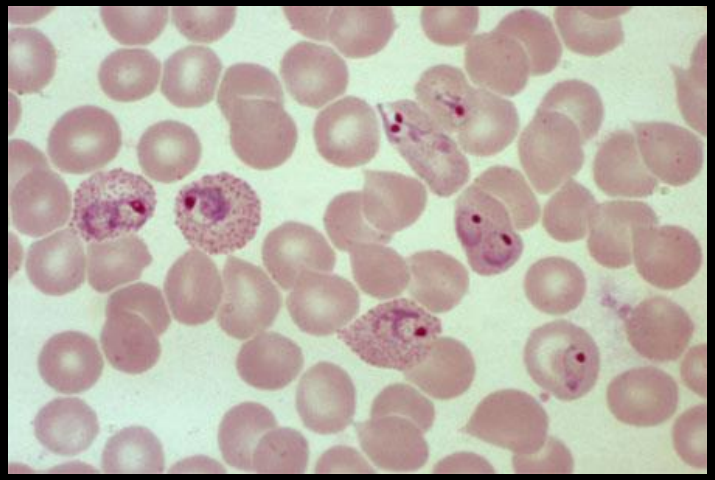
https://bbhosted.cuny.edu/

Quiz Time

https://openlab.citytech.cuny.edu/oer-biology/lecture-schedule/

The Protists:
Evolution and Diversity



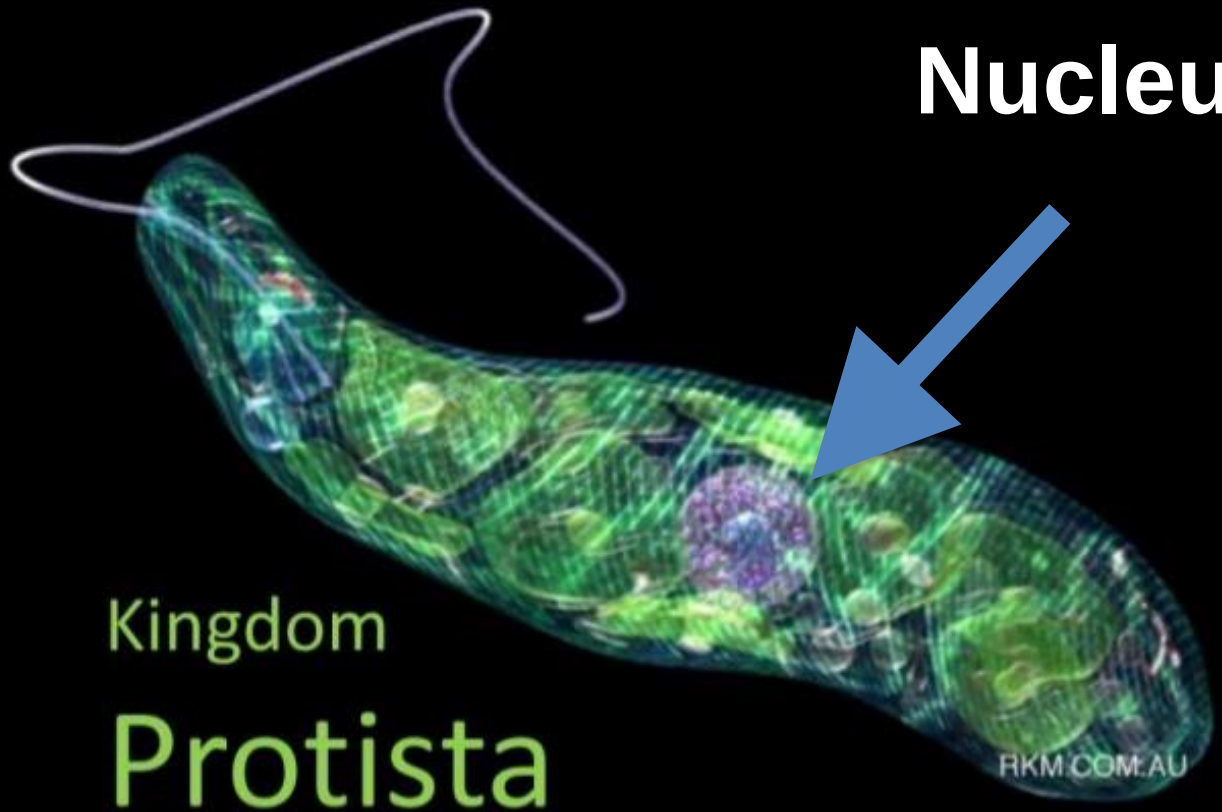


Outline

- **The Eukaryotic Cell**
  - Origins of eukaryotic cells – the Endosymbiont Theory
  - Eukaryotes vs Prokaryotes
- **General Biology of Protists**
  - Protistology
  - Ecology
  - Classification
- **Diversity of Protists:**
  - The plant-like: the Algae
  - The animal-like: the Protozoa
  - The fungi-like: the Slime and Water Molds

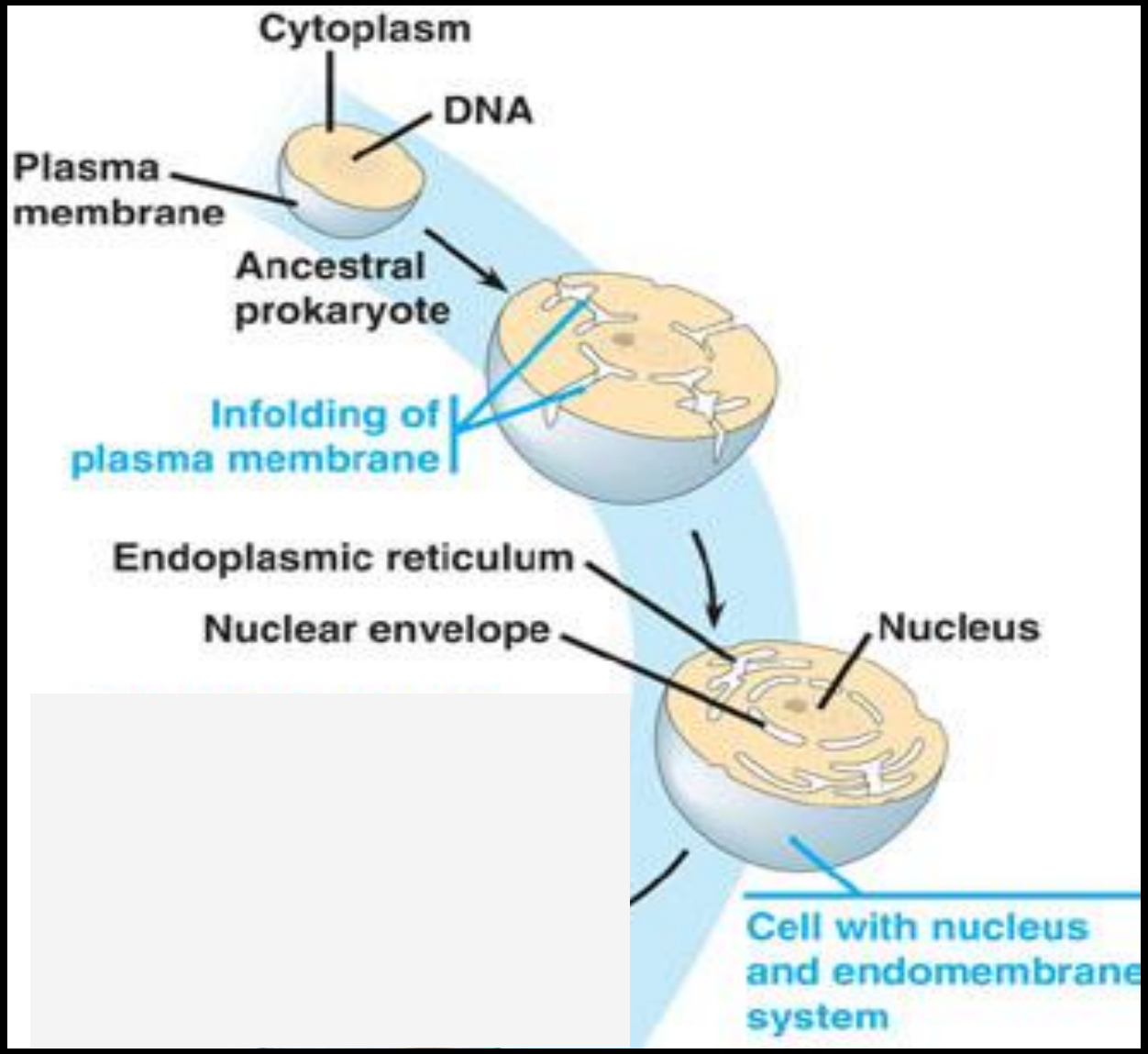
What does a protist look like?
Do we eat protists? Can we have them as pets?
What are they good for/at?

Protista are not prokaryotes



Where did the Nucleus come from?

The emergence of Eukaryotes – the Endomembranes

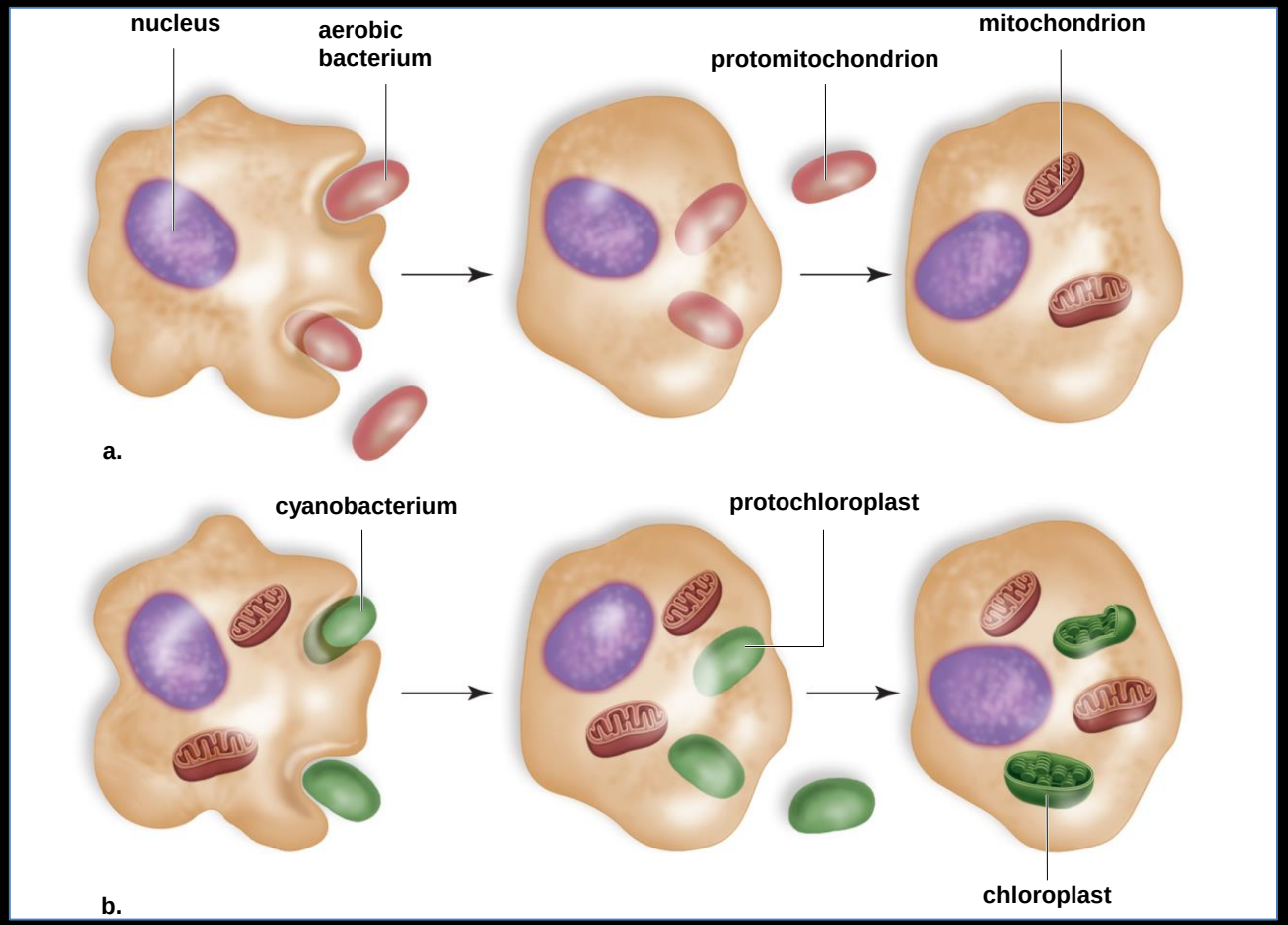


Origin of the Eukaryotic Cell

The endosymbiotic hypothesis

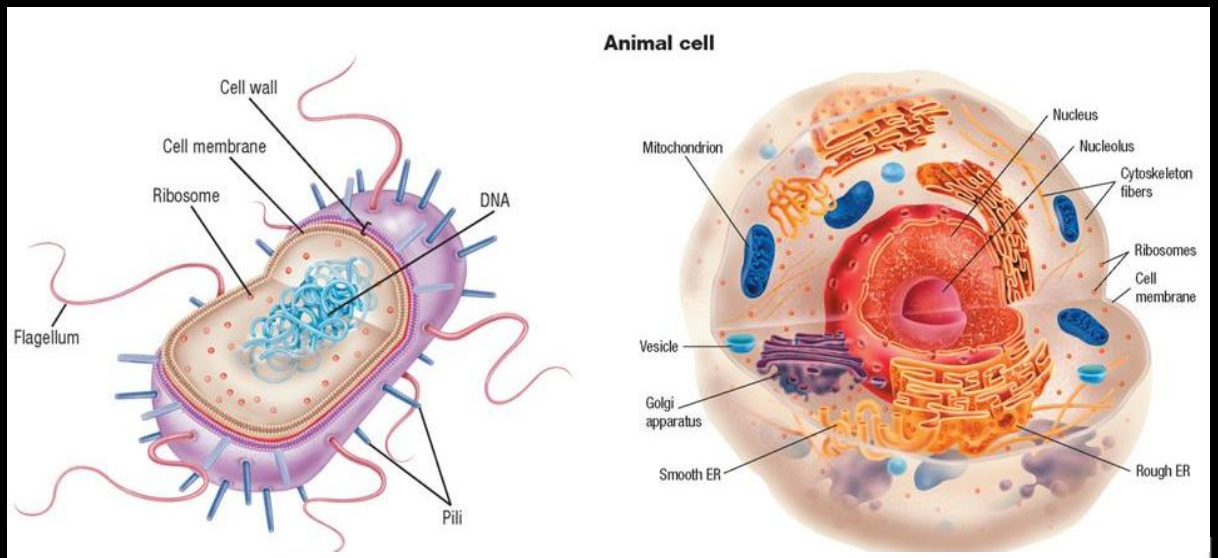
Aerobic bacteria became mitochondria

Cyanobacteria became chloroplasts



Also see: http://www.sumanasinc.com/webcontent/animations/content/organelles.html

Eukaryotes *vs* Prokaryotes



Prokaryotic

- Nucleoid
- Circular DNA that floats freely around cell
- Simpler DNA
- No membrane bound organelles
- Typically much smaller
- Divide by binary fission
- Typically unicellular
- Anaerobic and aerobic

Both

- Chromosomes
- DNA as genetic material
- Ribosomes
- Cytoplasm
- Plasma Membrane
- Sometimes have cell walls
- Vacuoles

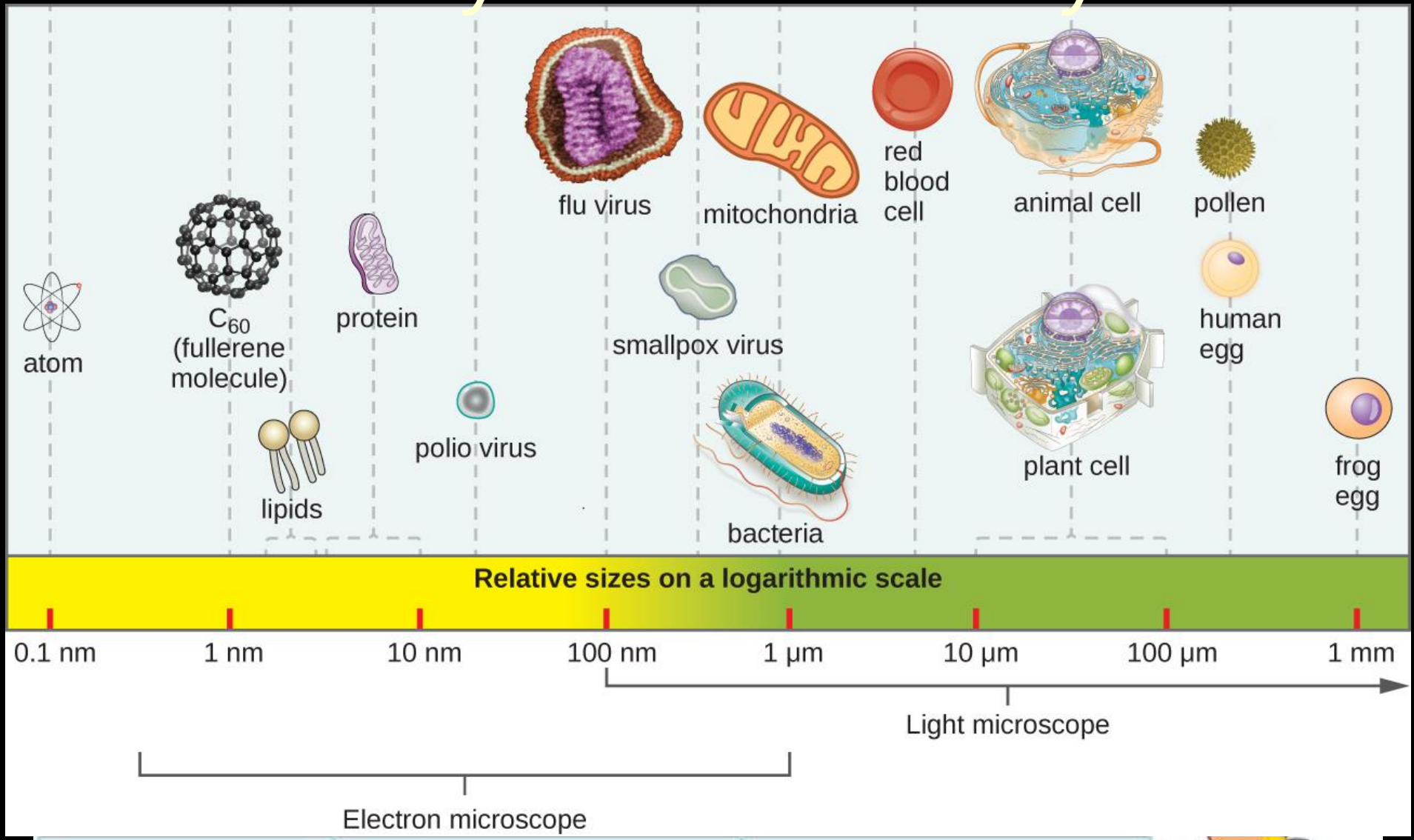
Eukaryotic

- Nucleus
- Linear DNA that is held in the nucleus
- Complex DNA
- Membrane bound organelles
- Typically much larger
- Divide by mitosis and meiosis
- Typically multicellular
- Aerobic

Eukaryotes *vs* Prokaryotes

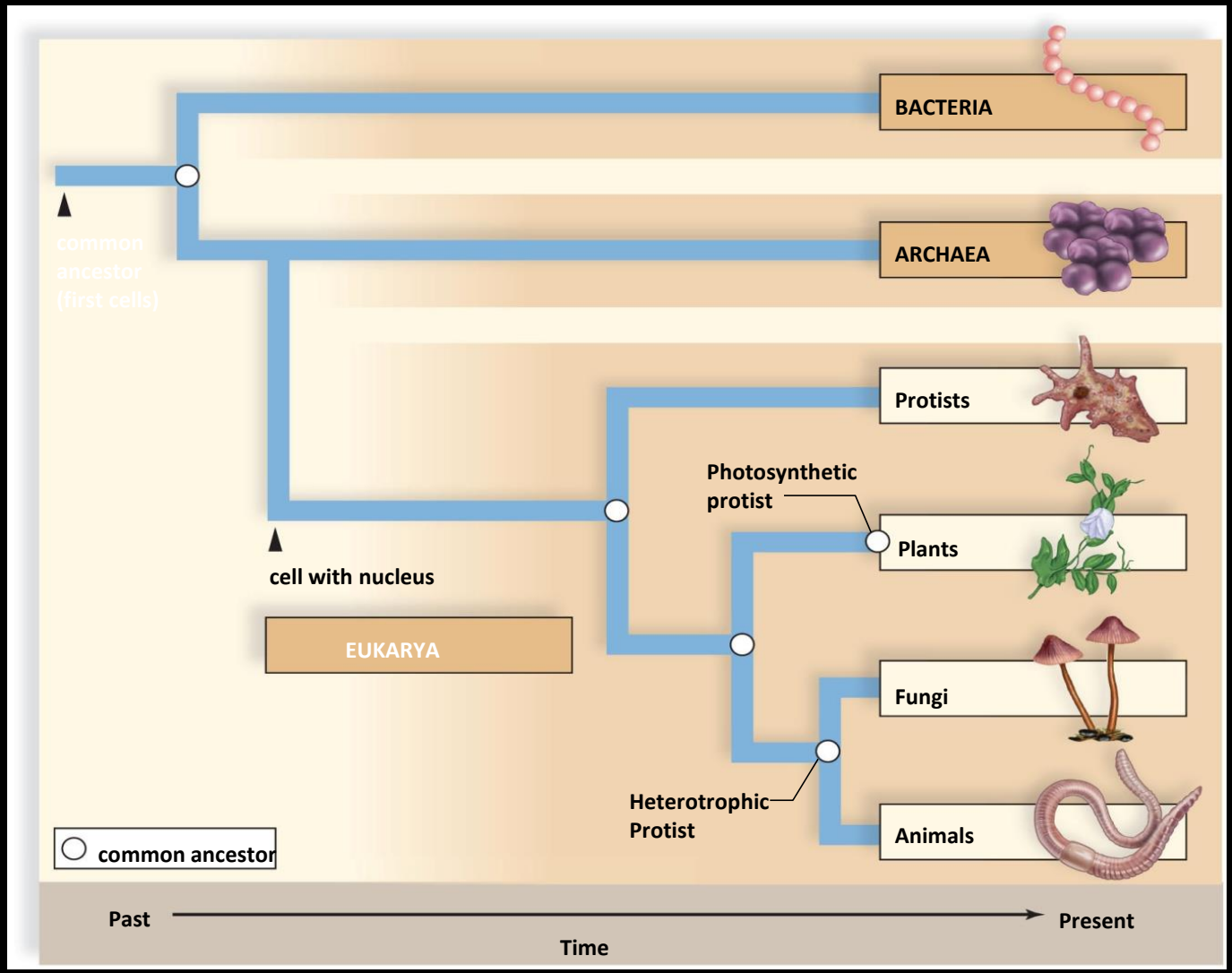
	Prokaryotes	Eukaryotes
DNA	DNA is naked	DNA bound to protein
	DNA is circular	DNA is linear
	Usually no introns	Usually has introns
Organelles	No nucleus	Has a nucleus
	No membrane-bound	Membrane-bound
	70S ribosomes	80S ribosomes
Reproduction	Binary fission	Mitosis and meiosis
	Single chromosome (haploid)	Chromosomes paired (diploid or more)
Average Size	Smaller (~1–5 μm)	Larger (~10–100 μm)

Eukaryotes *vs* Prokaryotes



Average Size	Smaller (~1–5 µm)	Larger (~10–100 µm)

Evolutionary Tree of Life
3 Domains



Protists

- Classified into the Domain **Eukarya & the Kingdom Protista**
- Complexity and diversity of protists makes them difficult to classify
  - –Cannot be classified as plants, animals, or fungi
- Could be split into as many as a dozen kingdoms
- **Morphology**:
  - – Most are unicellular, not all!
  - – Many with amazingly high level of structural and functional complexity
    - Amoeboids and ciliates possess unique organelles, such as contractile vacuoles

Assorted fossilized diatoms

Onychodromus, a giant ciliate ingesting one of its own kind

Plasmodium, a slime mold

Acetabularia, a single-celled green alga

Synura, a colony-forming golden alga

Amoeba proteus, a protozoan

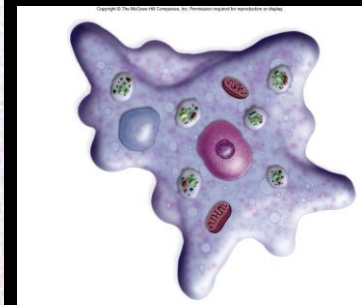
Blepharisma, a ciliate with visible vacuoles

Licmorpha, a stalked diatom

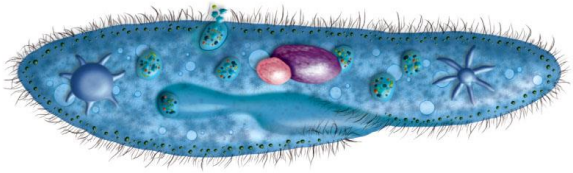
Nonionina, a foraminiferan

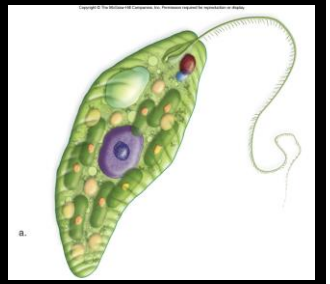
Ceratium, an armored dinoflagellate

Bossiella, a coralline red alga

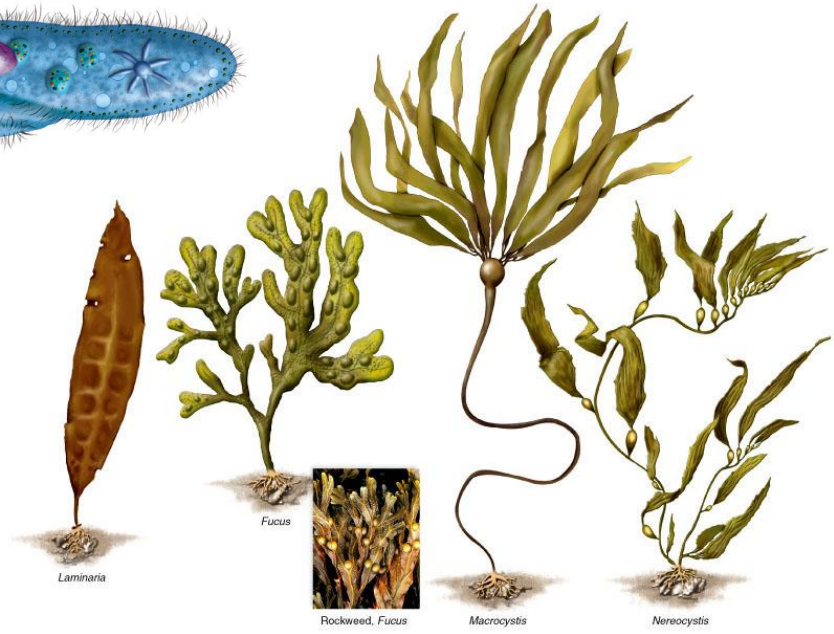


a. Amoeba, *Amoeba proteus*





a.



Laminaria

Fucus

Rockweed, *Fucus*

Macrocystis

Nereocystis

General Biology of the Protists

- Life cycles
  - Most protists are free-living
  - Some are parasitic
  - Asexual reproduction common
  - Sexual reproduction may occur when conditions deteriorate
  - Some life cycles simple, many extremely complex
- Size
  - Vary in size from microscopic algae and protozoans to kelp more than 200 m in length

© International Workshop on Integrated vision of urban and agro-industrial wastewater treatment, monitoring and reclamation: key role played by the Waste Water Treatment Plant. Terni, Italy (2009)

Efficiency of nitrogen removal and protist communities: the potential for introduction of novel biological index

B. PÉREZ-UZ[#], L. ARREGUI[#], P. CALVO*, H. SALVADÓ, N. FERNÁNDEZ°, E. RODRIGUEZ°, A. ZORNOZA°°, AND S. SERRANO***

1 figure both as first author

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** Dept. Biologia Animal, Facultat Biologia. Universitat de Barcelona, Spain

° Grupo de Bioindicación de Sevilla (GBS), Spain

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ARTICLE INFO

Article published in the International Workshop on Integrated vision of urban and agro-industrial wastewater treatment, monitoring and reclamation: key role played by the Waste Water Treatment Plant. 2-3 Julio, 2009. ISRIM / LIFE (CEE n. 1973/92 EU Financial Instrument for the Environment) , Terni, Italy.

ABSTRACT

The study of three WWTPs with different nitrogen removal systems during a year h
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BioRemediation

Ecology of Protists

- Protists are of enormous ecological importance
- Photoautotrophic forms:
  - Produce oxygen
  - Function as producers in both freshwater and saltwater ecosystems
  - Major component of plankton
    - Organisms that are suspended in the water
    - Serve as food for heterotrophic protists and animals
- Many protists are symbionts
  - Ranges from strict parasitism to mutualism
  - Coral reefs greatly aided by symbiotic photoautotrophic protists in tissues of corals (animals)

Unicellular and colonial eukaryotes in a drop of pond water

Evolution of Protists

Complexity and diversity of protists makes them difficult to classify

- Cannot be classified as plants:
  - Gametes and zygotes are not protected from drying out
- Cannot be classified as fungi
  - Do not have chitin in their cell wall
- Cannot be classified as animals
  - Do not undergo embryonic development

COULD BE SPLIT IN A 12 DIFFERENT KINGDOMS

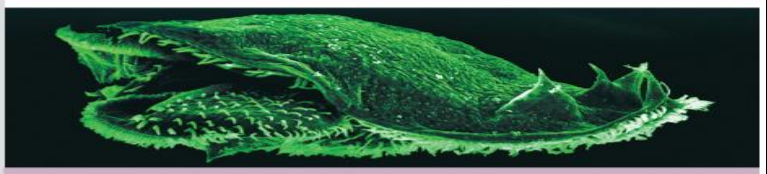
NOW **6 SUPERGROUPS**

DOMAIN: Eukarya
Protists

CHARACTERISTICS
Usually a complex single cell:
Photosynthesize, ingest, or absorb food;
Halpold life cycle

Supergroup	Members	Distinguishing Features
Archaeplastids	Green algae, red algae, land plants, charophytes	Plastids; unicellular, colonial, and multicellular
Chromalveolates	Stramenopiles: brown algae, diatoms, golden brown algae, water molds Alveolates: ciliates, apicomplexans, dinoflagellates	Most with plastids; unicellular and multicellular Alveoli support plasma membrane; unicellular
Excavates	Euglenids, kinetoplastids, parabasalids, diplomonads	Feeding groove; unique flagella; unicellular
Amoebozoans	Amoeboids, plasmodial and cellular slime molds	Pseudopods; unicellular
Rhizarians	Foraminiferans, radiolarians	Thin pseudopods; some with tests; unicellular
Opisthokonts	Choanoflagellates, animals, nucleariids, fungi	Some with flagella; unicellular and colonial

Assorted fossilized diatoms



Onychodromus, a giant ciliate ingesting one of its own kind

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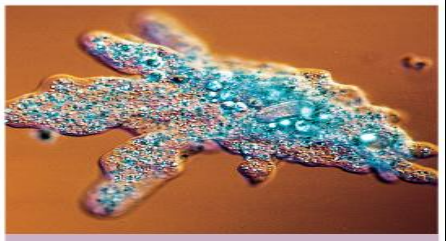
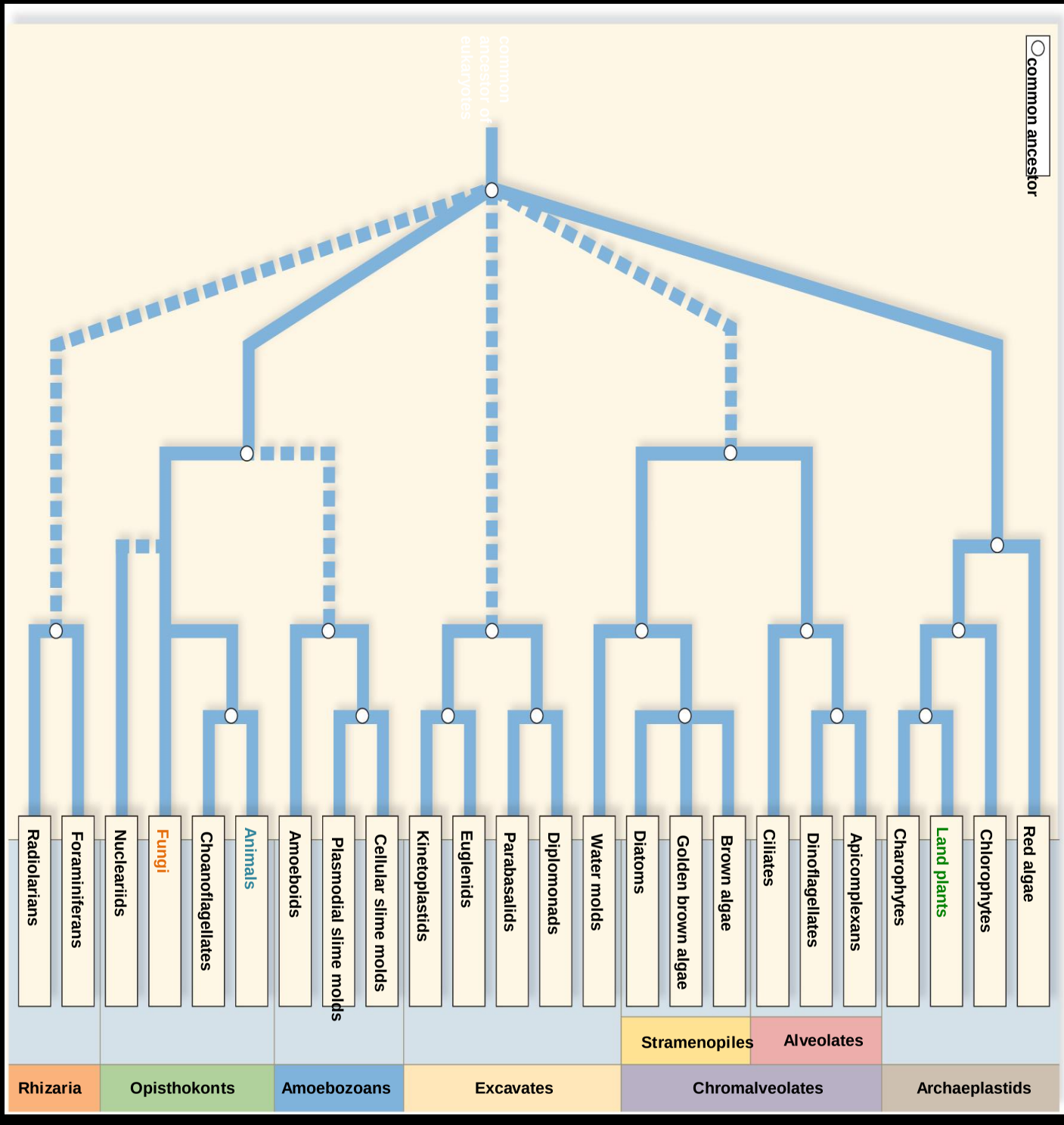


Amoeba proteus, a protozoan

Evolutionary Relationships



- The scheme chosen for this discussion is based on **modes of nutrition:**

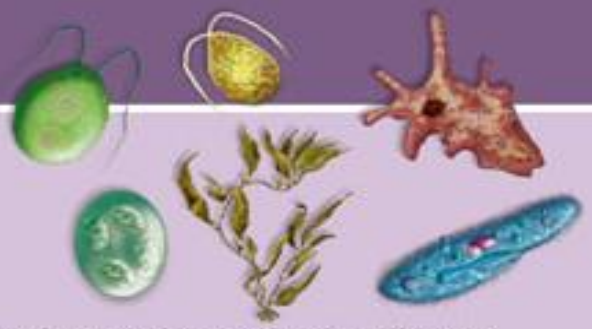
- Plant-like: photoautotrophs

- Animal-like: heterotrophs by ingestion or parasites

- Fungus- like: heterotrophs by absorption
- Some are **mixotrophic**
    - Combine autotrophic and heterotrophic nutritional modes

CLASSIFICATION

DOMAIN: Eukarya
KINGDOM: Protista



CHARACTERISTICS

- Eukaryotes
- Primarily unicellular
- Metabolically diverse
- Structurally complex
- Asexual reproduction usual: sexual reproduction diverse

Photoautotrophs*	
PHYLUM: Chlorophyta	green algae
PHYLUM: Rhodophyta	red algae
PHYLUM: Phaeophyta	brown algae
PHYLUM: Chrysophyta	diatoms, golden-brown algae
PHYLUM: Pyrrophyta	dinoflagellates
PHYLUM: Euglenophyta	euglenoids
Heterotrophs by ingestion or parasitic*	
PHYLUM: Zoomastigophora	zooflagellates
PHYLUM: Rhizopoda	amoeboids
PHYLUM: Foraminifera	foraminiferans
PHYLUM: Actinopoda	radiolarians
PHYLUM: Ciliophora	ciliates
PHYLUM: Apicomplexa	sporozoans
PHYLUM: Myxomycota	plasmodial slime molds
PHYLUM: Acrasiomycota	cellular slime molds
Heterotrophs by absorption (saprotrophs) or parasitic*	
PHYLUM: Oomycota	water molds

* Not in the classification of organisms but added here for clarity

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Email: mgotesman@citytech.cuny.edu
Office Hours: Wednesday 11:30 - 12:30 PM
Room: A 302

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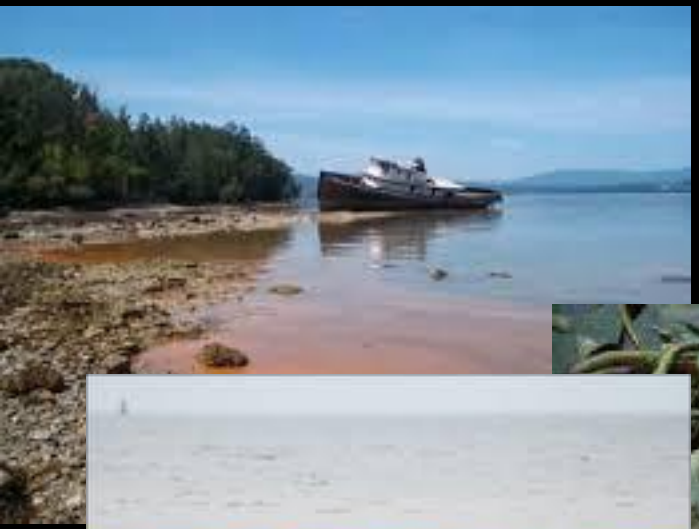
F	59.9 and below

Reviewing this first part…

1. List and discuss ways that protists are varied.
2. What do they have in common?
3. Describe how the nucleus, the chloroplast and the mitochondrion may have become a part of the eukaryotic cell. How is this theory called?
4. Where would you find protists? Give some important roles of protists.
5. How can we very simply organize protists (according to the previous slides)

The Plant-like:
The Algae



Diversity of Protists:
Green Algae – The Chlorophyta

- **Algae** refers to many phyla of protists that carry out **photosynthesis**
  - Phylum Chlorophyta contains green algae
  - Approximately 7,500 species
  - Inhabit a variety of environments including oceans, freshwater, snowbanks, tree bark, and turtles backs
  - Many are symbionts with fungi, plants, or animals
  - Morphology varies
- Majority unicellular, but many are filamentous or colonial
- Some are **multicellular** and resemble leaves of lettuce

Diversity of Protists:
Green Algae – The Chlorophyta

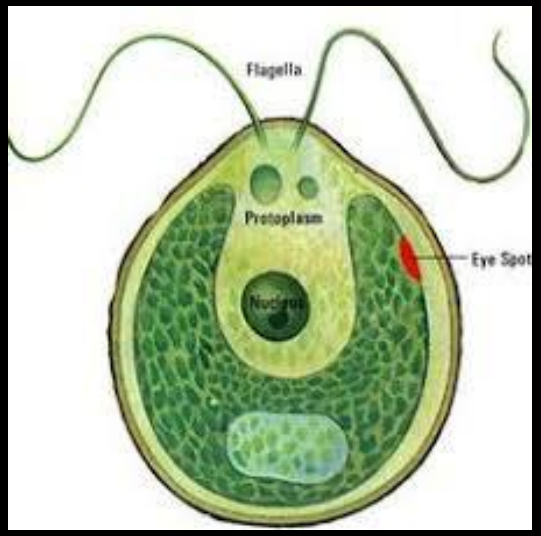
Plants thought to be derived from Chlorophyta because both groups:

- Have a cell wall that contains cellulose
- Possess chlorophylls a and b, and
- Store excess food as starch

Charophyta – the plant ancestor…

Green Algae: *Chlamydomonas*

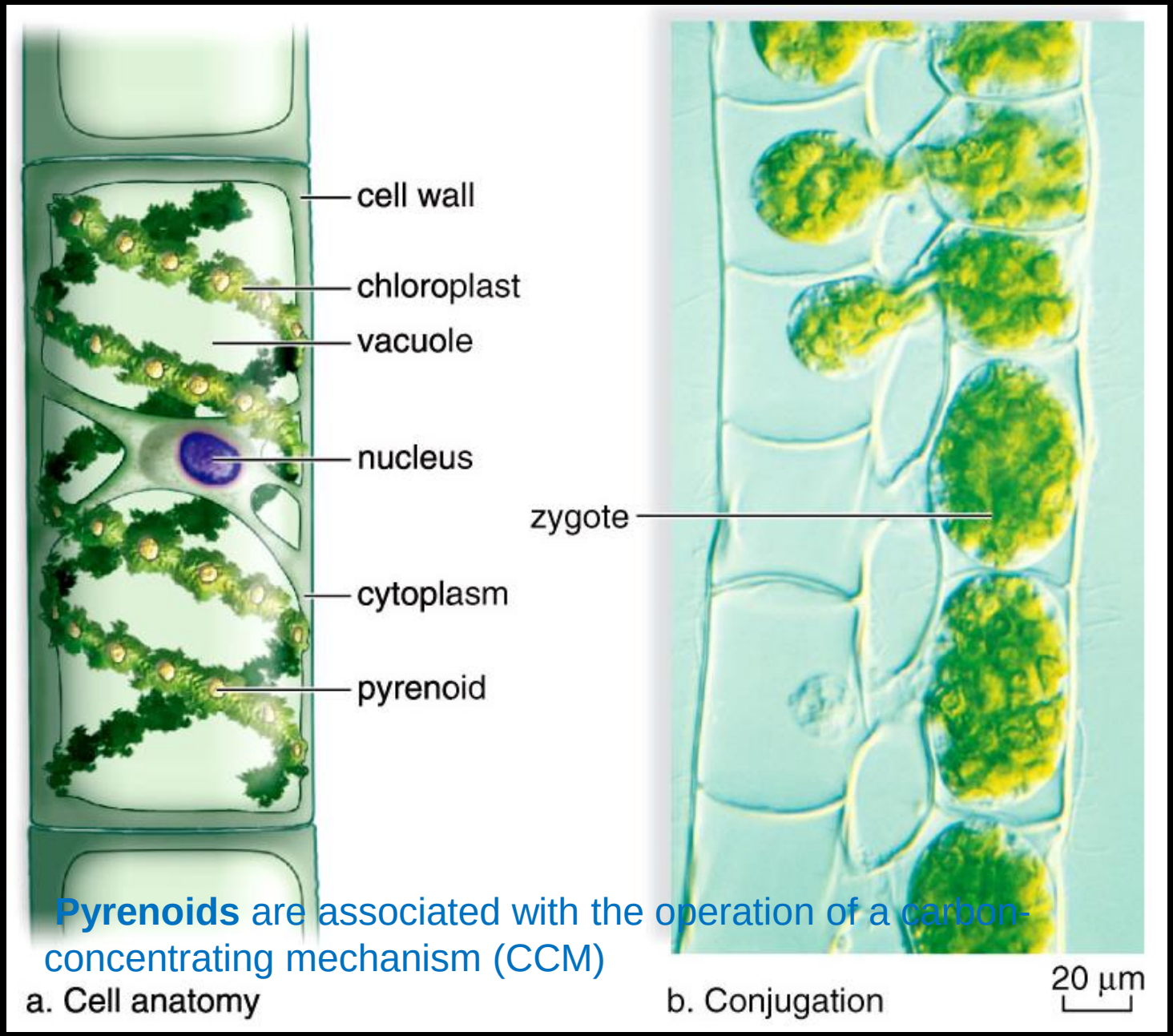
- A minute (<25 *μ*m), actively moving flagellate
- Inhabits still, freshwater pools
- Fossil ancestors date back over a billion years
- Most often reproduces asexually
- Occasionally reproduces sexually



Green Algae: *Spirogyra*

- Filamentous green algae
- Found in green masses on the surfaces of ponds and streams
- Has ribbon-like, spiraled chloroplasts
- Sexual reproduction by **conjugation**:
  - A temporary union during which the cells exchange genetic material
  - Two filaments line up parallel to each other
    - Cell contents of one filament move into the cells of the other filament
    - Forms diploid zygospores
    - In spring, undergo meiosis to produce new haploid filaments

Spirogyra



Pyrenoids are associated with the operation of a carbon-concentrating mechanism (CCM)

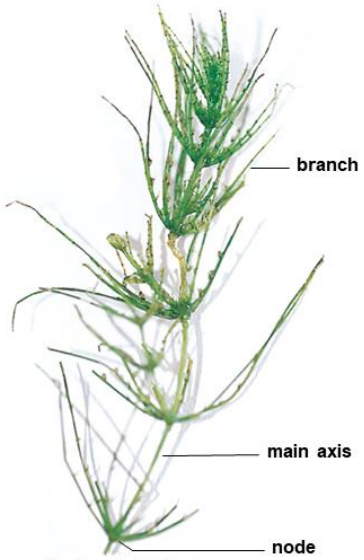
Green Algae: **Multicellular Forms**

- ***Ulva***
  - Multicellular green algae
  - Commonly called sea lettuce
  - Thallus (body) is two cells thick
  - Can be as much as a meter long
  - Sexual cycle involves alternation of generations (What's that?)
  - Similar to higher plants, except
    - Both generations look exactly alike, and the gametes all look the same

a. Ulva, several individuals

b. One individual

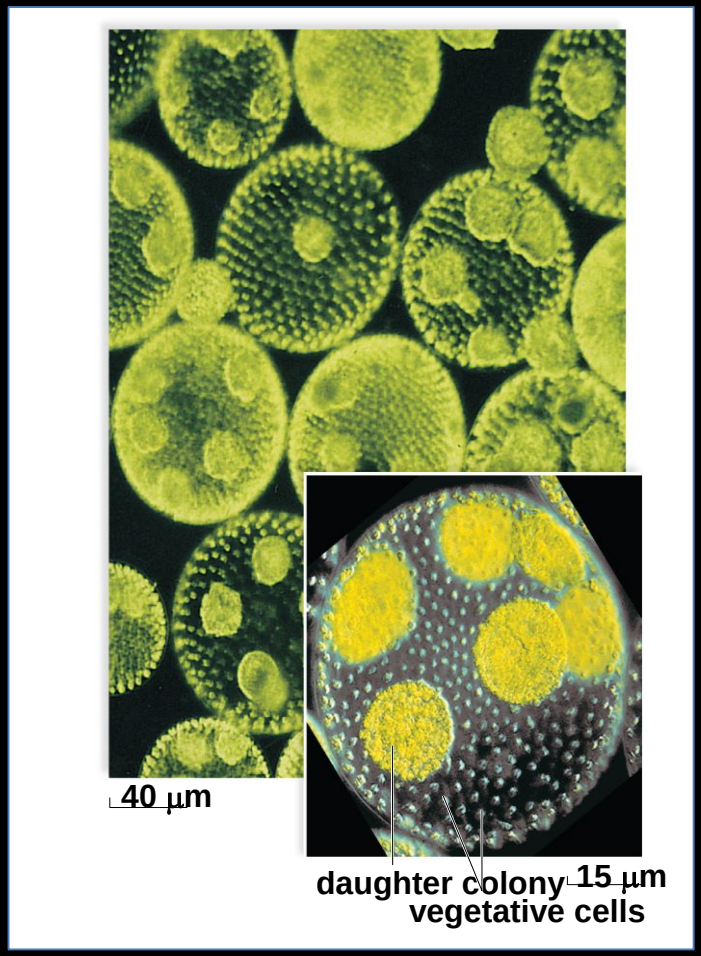
a. Chara, several individuals



b. One individual

Green Algae: **Colonial Forms**

- ***Volvox***
- A colony is a loose association of independent cells
- A Volvox colony:
  - A hollow sphere
  - Thousands of cells arranged in a single layer surrounding a watery interior
  - Each cell of colony resembles a Chlamydomonas cell
  - Flagella beat in a coordinated fashion
  - Some cells are specialized for reproduction



Diversity of Protists:
Red Algae – The Rhodophyta

- Multicellular
- About 5,000 species
- Live mostly in warmer seawater, some as deep as 200 m
- Economic Importance
  - Agar - capsules; dental impressions; cosmetics; culture medium; electrophoresis; food prep.
  - Carrageen - an emulsifying agent used in chocolate, low-fat foods, & cosmetics
  - The reddish-black wrappings around sushi rolls consist of processed Porphyra blades

Red Algae

Nutrition F

Serving Size 1 Bottle

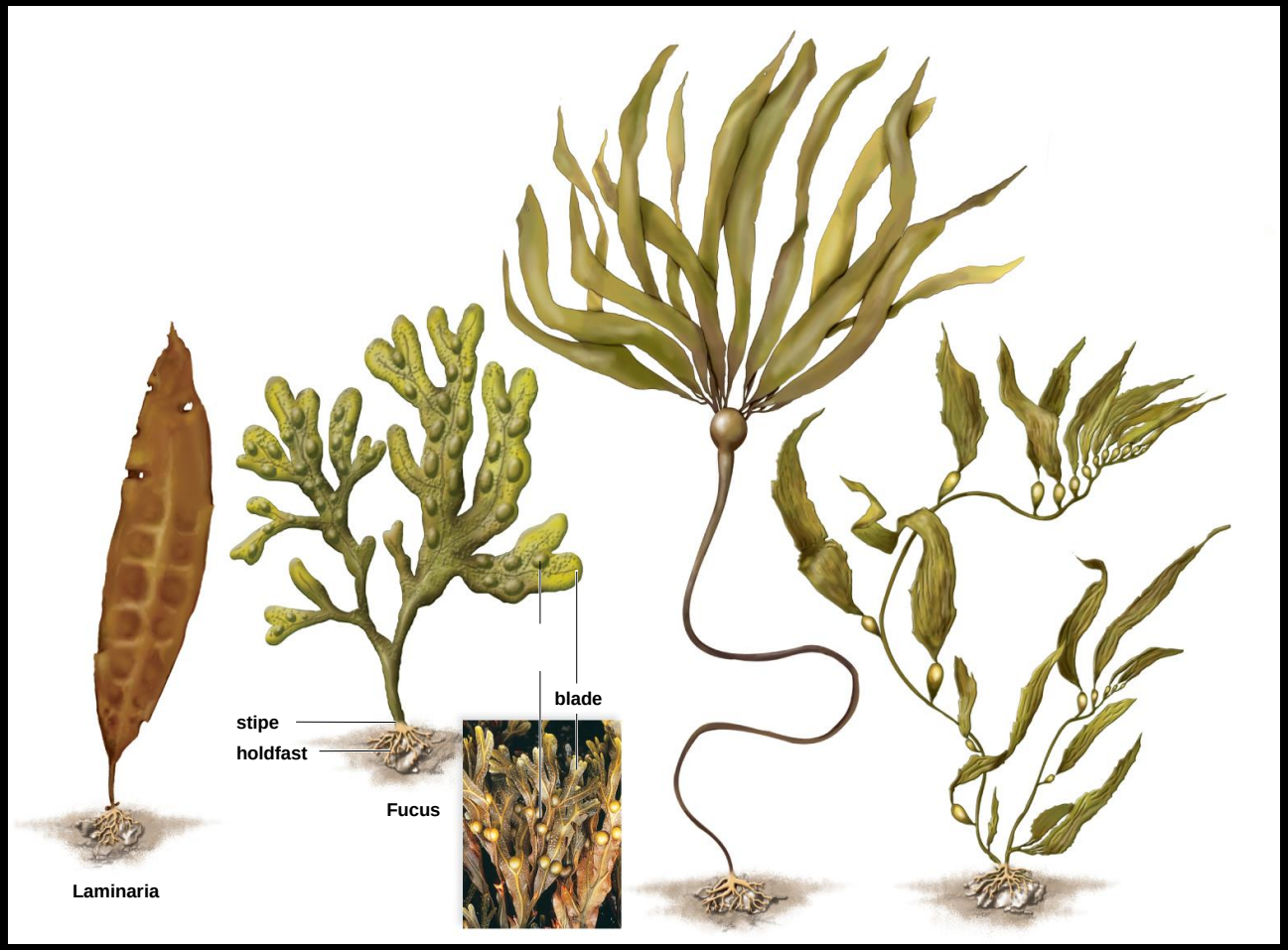
Amount Per Serving	
Calories 180	Calories fr
	% D
Total Fat 5g	
Saturated Fat 0.5g	
Trans Fat 0g	
Cholesterol 15mg	
Sodium 230mg	
Potassium 520mg	
Total Carbohydrate 29g	
Dietary Fiber 5g	
Sugars 18g	
Protein 10g	**20%**
Vitamin A 35% • Vitamin C	100%
Calcium	
Vitamin D	
Vitamin K	
Riboflavin	
Vitamin B_6	
Vitamin B_{12}	
Pantothenic Acid	
Iodine	
Zinc	
Manganese	
Molybdenum	

GELLAN GUM, CELLULOSE GUM, SOY LECITHIN, MONO- AND DIGLYCERIDES, ASCORBIC ACID (VITAMIN C), SALT, POTASSIUM PHOSPHATE, CARRAGEENAN, CORN SYRUP SOLIDS, SUCRA-

Diversity of Protists:
Brown Algae – The Phaeophyta

- About 1,500 species
- Most live in colder ocean waters along rocky coasts
- No unicellular or colonial brown forms
- Morphology:
  - Some small forms with simple filaments
  - Others large multicellular forms that may exceed 200 m in length
- **Pigments:**
  - Chlorophylls a and c
  - Fucoxanthin (a type of carotinoid pigment) gives them their color
- **Excess food stored as a carbohydrate called laminarin**

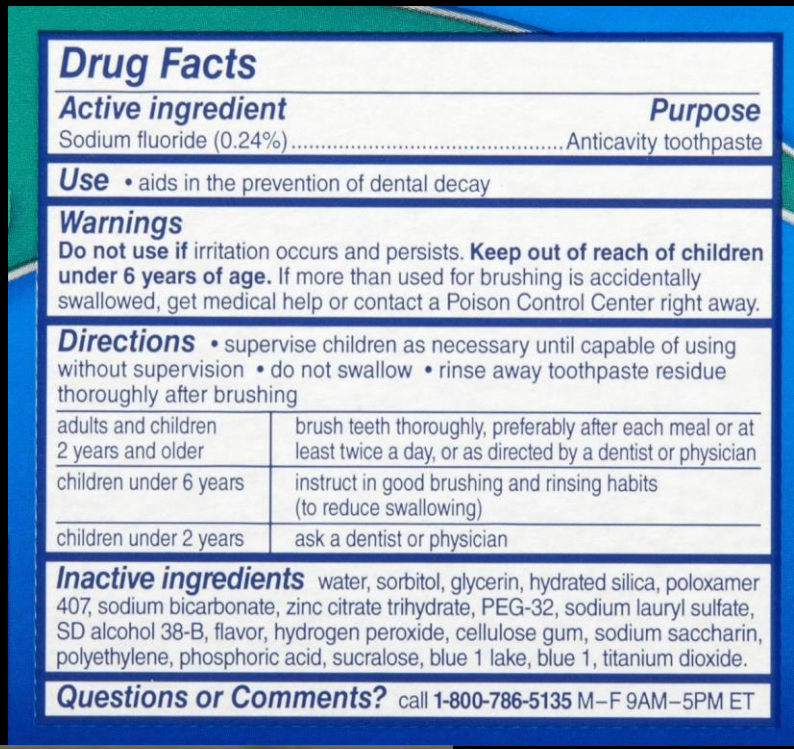
Brown Algae



Diversity of Protists:

Yellow-green Algae – The Chrysophyta

- **Diatoms** (formerly Bacillariophyta) are the most numerous unicellular algae in the oceans
- Significant portion of **phytoplankton**
- Cell wall
  - Two valves, with the larger valve acting as a lid (like a mint tin)
  - Contains silica
- Diatomaceous earth used as
  - Filtering agents
  - Sound-proofing materials
  - Polishing abrasives



Drug Facts

Active ingredient	Purpose
Sodium fluoride (0.24%)	Anticavity toothpaste

Use • aids in the prevention of dental decay

Warnings

Do not use if irritation occurs and persists. **Keep out of reach of children under 6 years of age.** If more than used for brushing is accidentally swallowed, get medical help or contact a Poison Control Center right away.

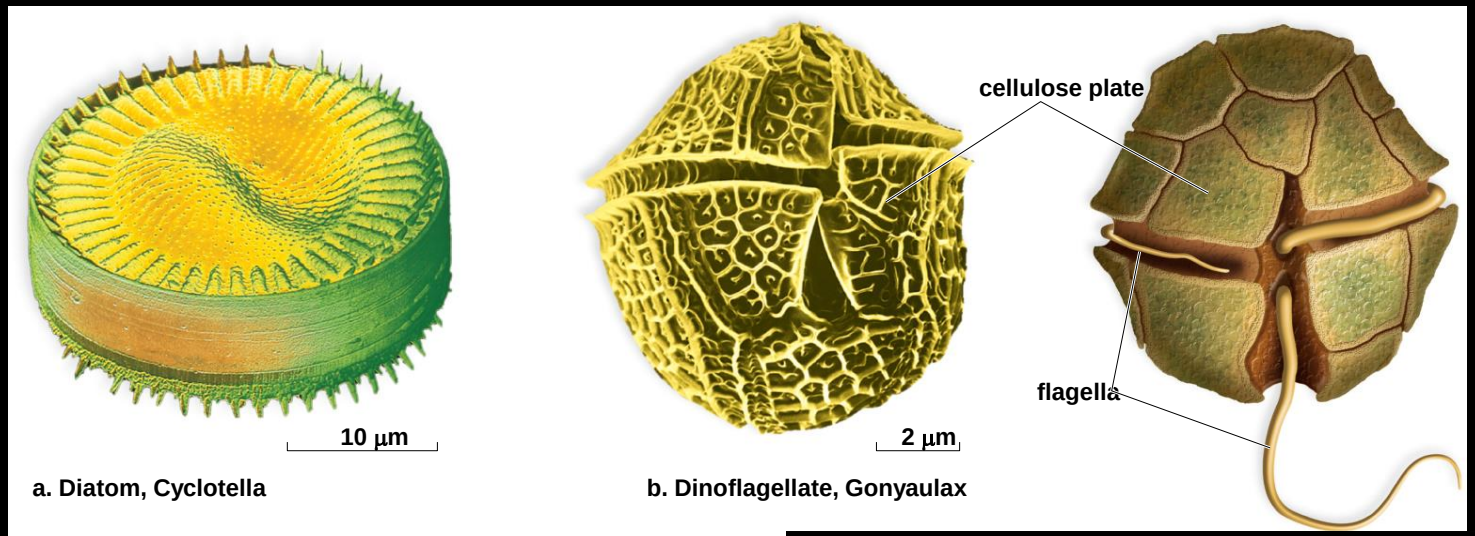
Directions • supervise children as necessary until capable of using without supervision • do not swallow • rinse away toothpaste residue thoroughly after brushing

adults and children 2 years and older	brush teeth thoroughly, preferably after each meal or at least twice a day, or as directed by a dentist or physician
children under 6 years	instruct in good brushing and rinsing habits (to reduce swallowing)
children under 2 years	ask a dentist or physician

Inactive ingredients water, sorbitol, glycerin, hydrated silica, poloxamer 407, sodium bicarbonate, zinc citrate trihydrate, PEG-32, sodium lauryl sulfate, SD alcohol 38-B, flavor, hydrogen peroxide, cellulose gum, sodium saccharin, polyethylene, phosphoric acid, sucralose, blue 1 lake, blue 1, titanium dioxide.

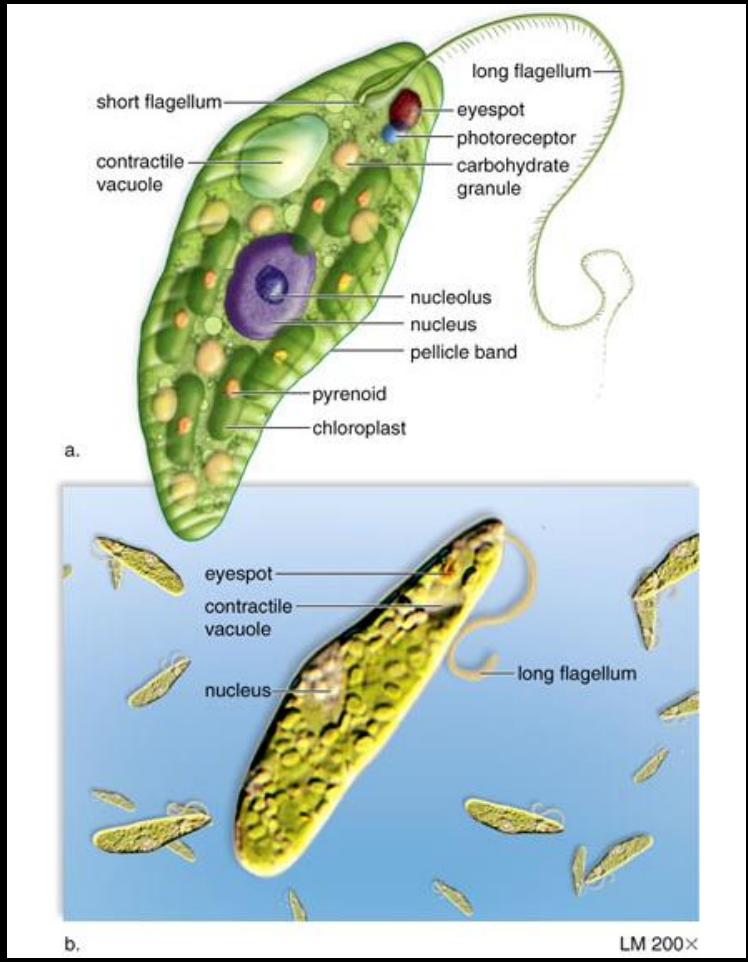
Questions or Comments? call **1-800-786-5135** M–F 9AM–5PM ET

Diatoms and Dinoflagellates

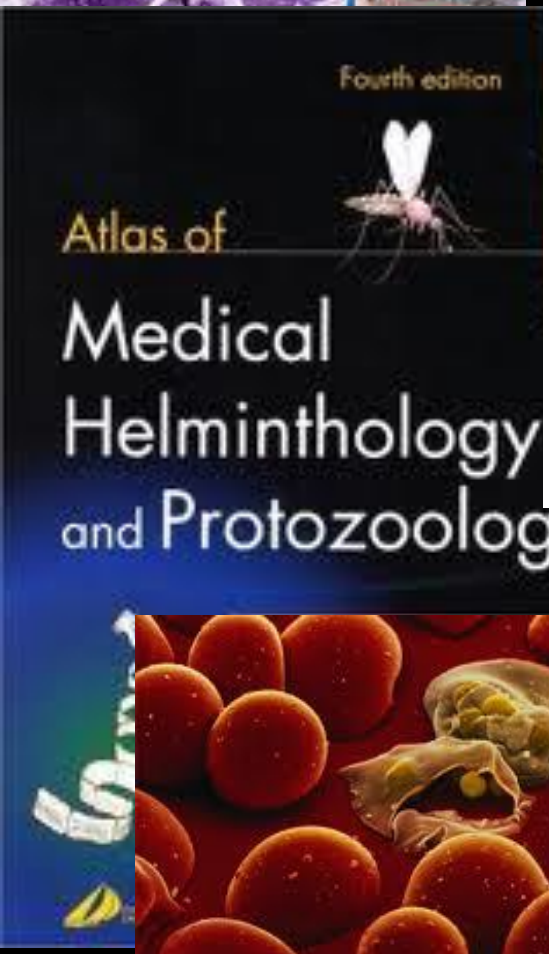


Diversity of Protists:
The Euglenoids – Phylum Euglenophyta

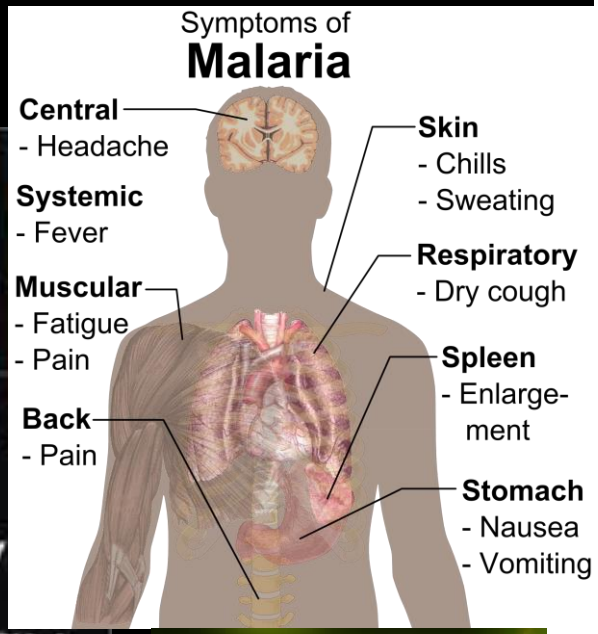
- Small freshwater unicellular organisms
- Difficult to classify: **mixotroph**
- Have two flagella and an eyespot (photoreceptor)
- Chloroplasts:
  - Surrounded by three rather than two membranes
  - With a **pyrenoid** which produces an unusual type of carbohydrate called paramylon

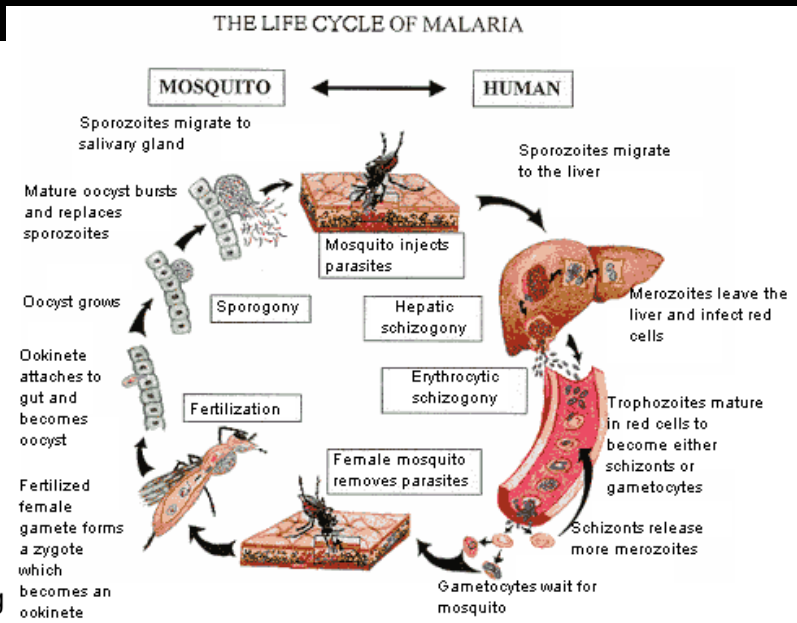


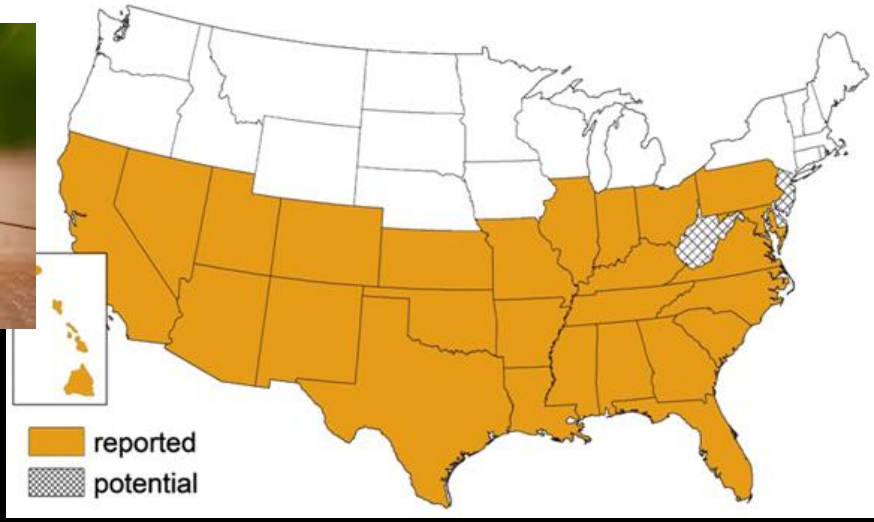
The Animal-like:**The Protozoa**



Plasmodium falciparum







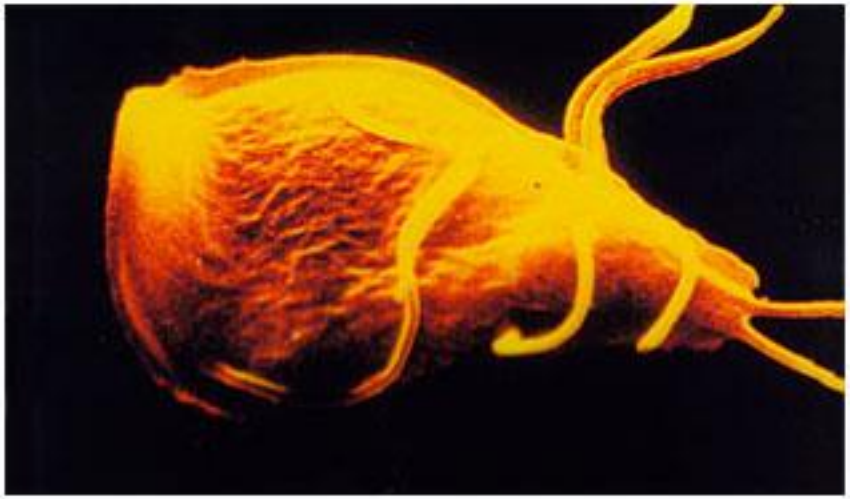
Diversity of Protists:
Zooflagellates – Phylum Zoomastigophora

- Colorless heterotrophs
- Most symbiotic and many parasitic
- Well known for **causing various diseases** in humans
  - *Trypanosoma*
    - African sleeping sickness - Tsetse fly
    - Chagas disease – Kissing bug
  - *Giardia lamblia*
    - Most common flagellate in human digestive tract
    - Causes severe diarrhea
    - Cysts are transmitted in contaminated water
    - Beavers are important reservoir hosts
  - *Trichomonas vaginalis*
    - Sexually transmitted protist,
    - Infects urogenital organs; a common cause of vaginitis

Diversity of Protists:

Zooflagellates – Phylum Zoomastigophora

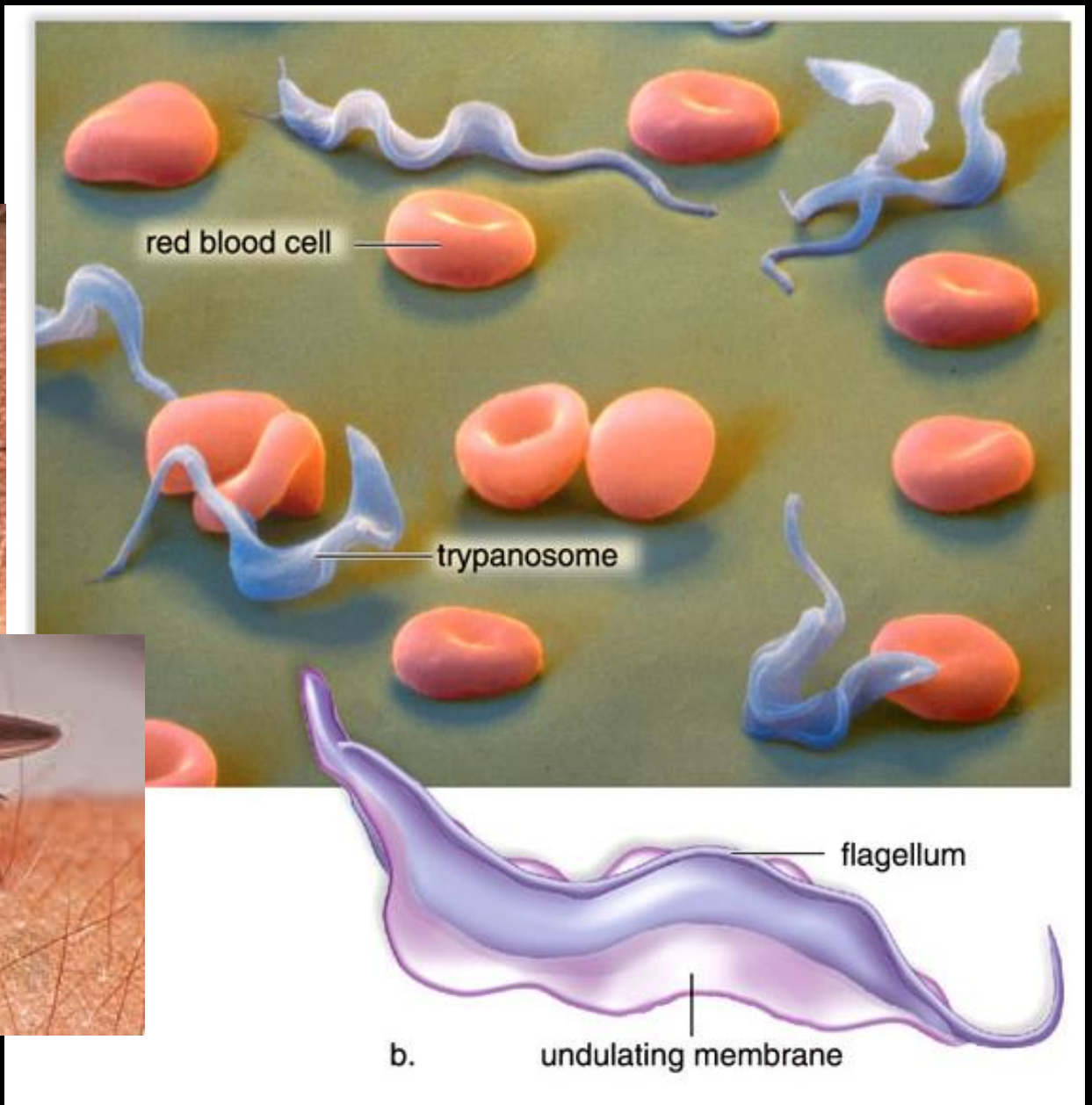
Trypanosoma brucei



Giardia lamblia

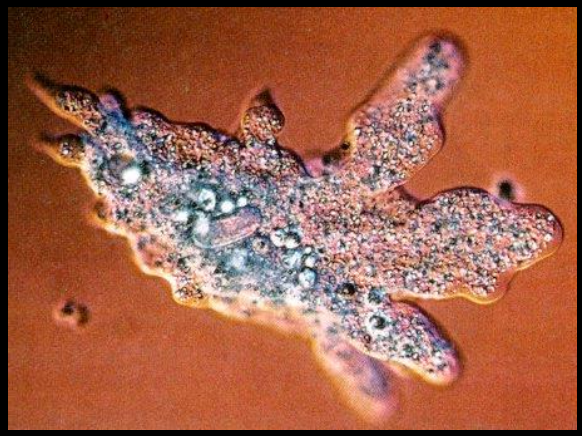
Trichomonas vaginalis

Zooflagellates

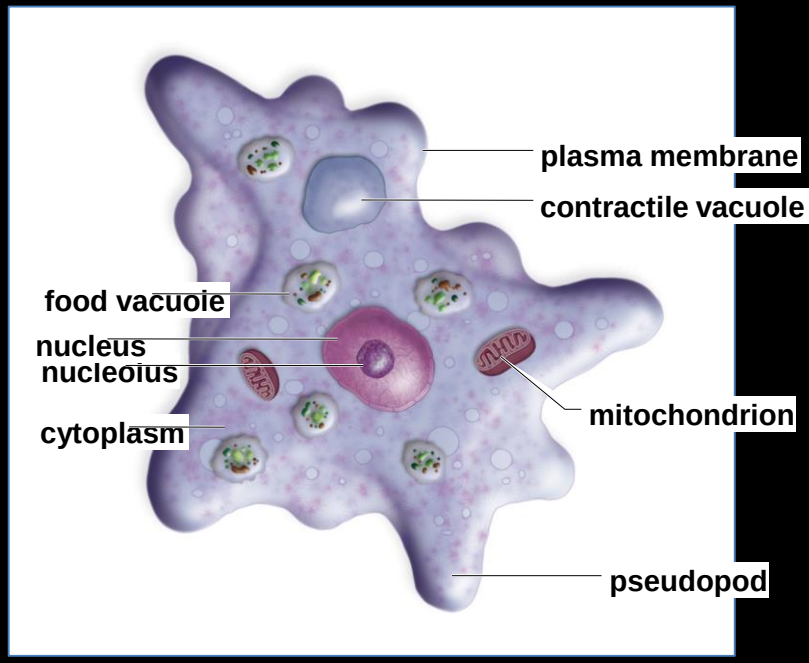


Diversity of Protists:
The Amoeboids- Phylum Rhizopoda

- **Amoeboids** are protists that move and ingest their food with **pseudopods**

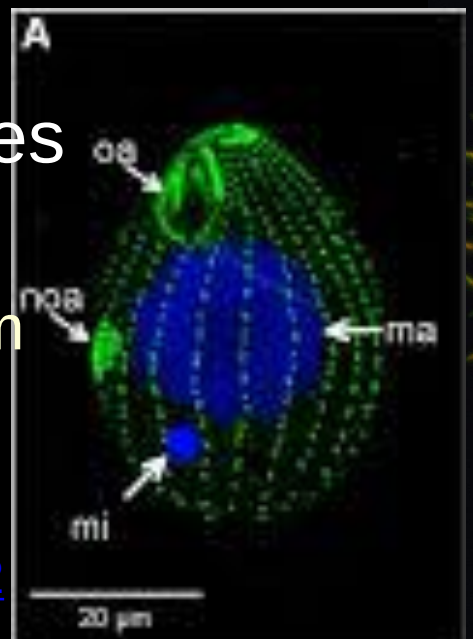


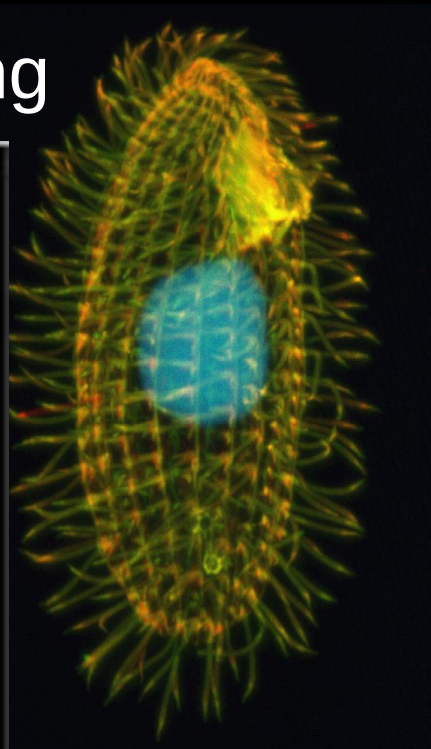
- They use **phagolysosomes** to digest food
  - Phagocytize food
  - *Entamoeba histolytica* - a parasite of the human colon;
    - Causes amoebic dysentery
    - Can be fatal



Diversity of Protists:
The Ciliates – Phylum Ciliophora

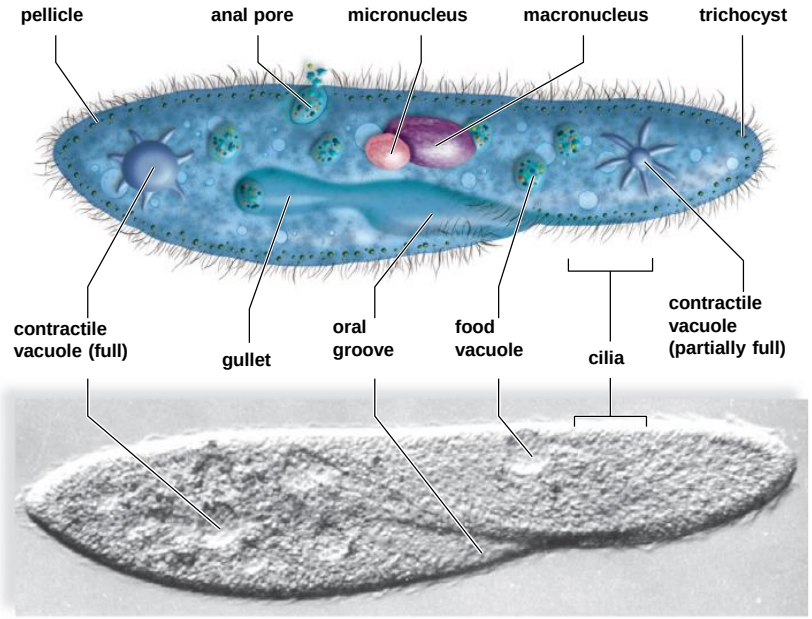
- Ciliates (Phylum Ciliophora) are among the most complex of the protozoans
  - Hundreds of cilia beat in coordinated rhythm
  - Most are holozoic, swallowing food whole
  - Divide by transverse binary fission during asexual reproduction
  - Two nuclei of differing types
    - Micronucleus – Heredity
    - Macronucleus – Metabolism





https://www.ncbi.nlm.nih.gov/pubmed/21387572

Ciliates



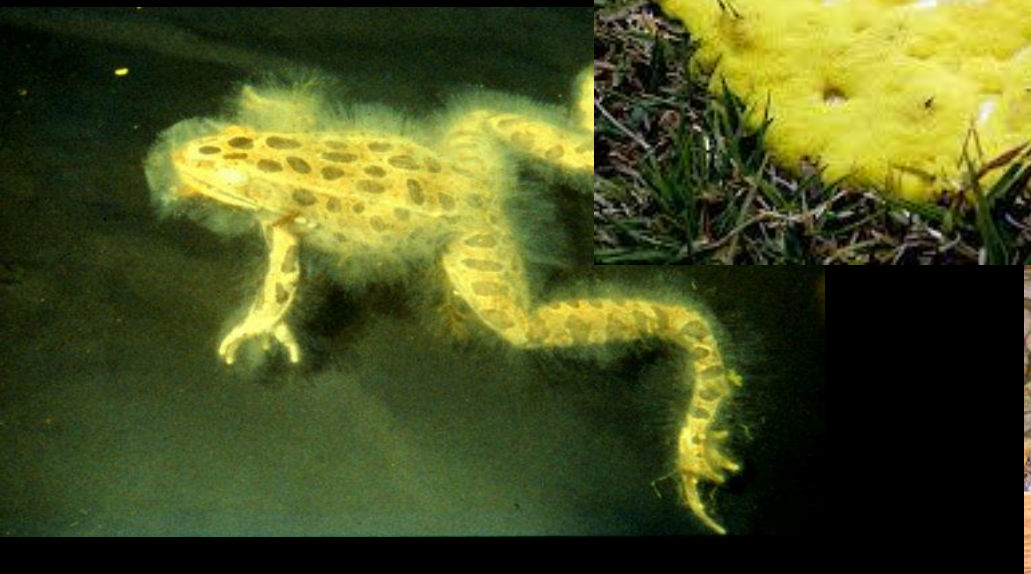
a. Paramecium

b. During conjugation two paramecia first unite at oral areas

200 µm

c. Stentor

The Fungus-like:
The Slime and Water Molds



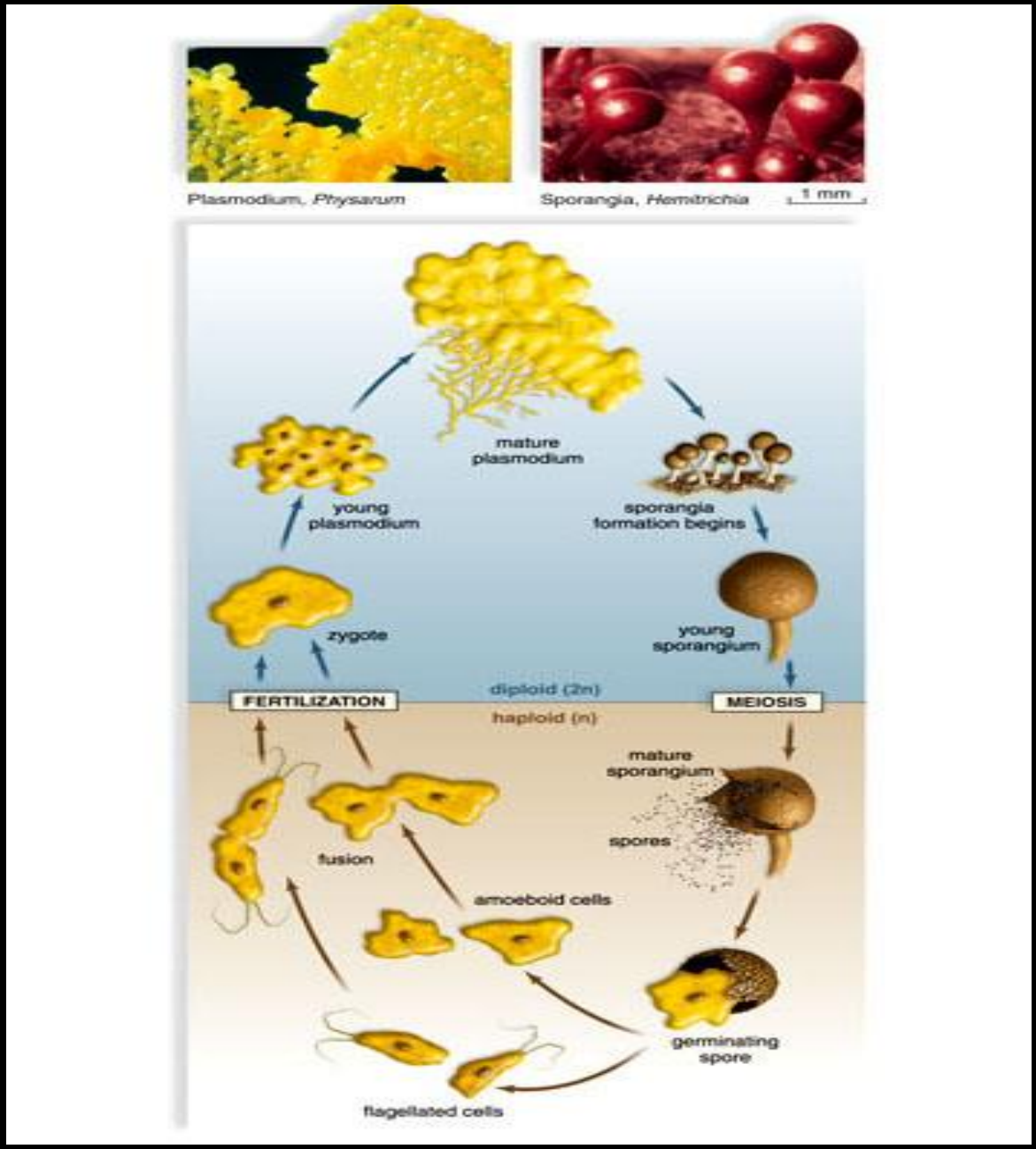
Diversity of Protists:

Slime Molds

Feed like fungi and make spores but no cell wall and they have flagellated cells

- **Plasmodial Slime Molds - Phylum Myxomycota**
  - Body in the form of a plasmodium
    - Diploid, multinucleated, cytoplasmic mass
    - Enveloped by a slimy sheath
  - Eventually produces sporangium which in turn produces spores
- **Cellular Slime Mold - Phylum Acrasiomycota**
  - Body in the form of individual amoeboid cells
  - Later aggregate into pseudoplasmodium which then forms sporangium & spores

Plasmodial Slime Molds

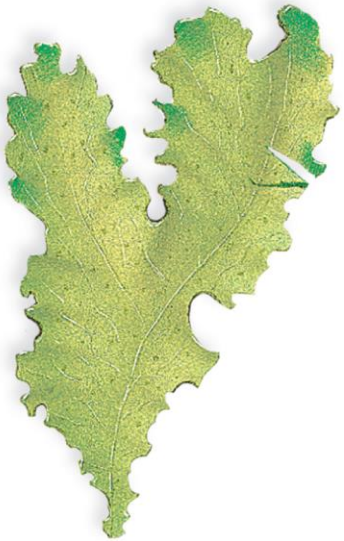


That was a lot but can you …

1. Give an overview of the different types of algae? How they reproduce and explain their ecological and economic importance?
2. Explain what is so special about Euglenoids?
3. List different types of protozoa? Give example of diseases caused by some protozoa
4. Explain what flagella, cilia and pseudopods are and give example of organisms displaying them?
5. How are slime and water mold similar to fungi? What make them different from fungi?

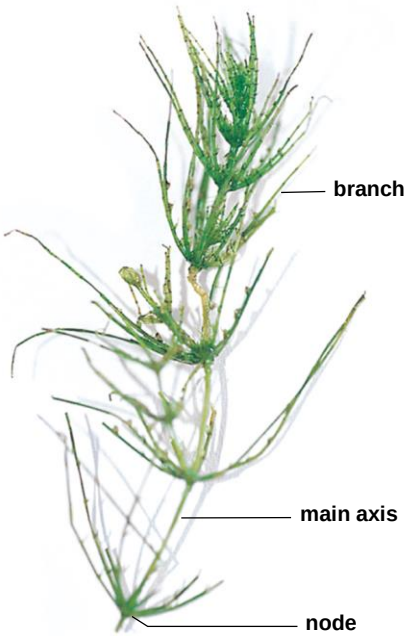
Multicellular Green Algae

a. Ulva, several individuals



b. One individual

a. Chara, several individuals



b. One individual