Introduction to Biology& the nature of life

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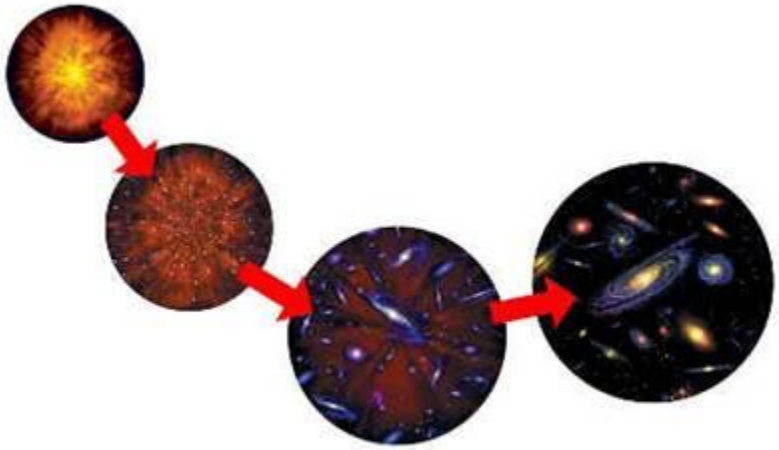
Biology – The Study of Life

- Life arose more than 3.5 billion years ago
- First organisms (living things) were single celled
- Only life on Earth for millions of years
- Organisms changed over time (evolved)



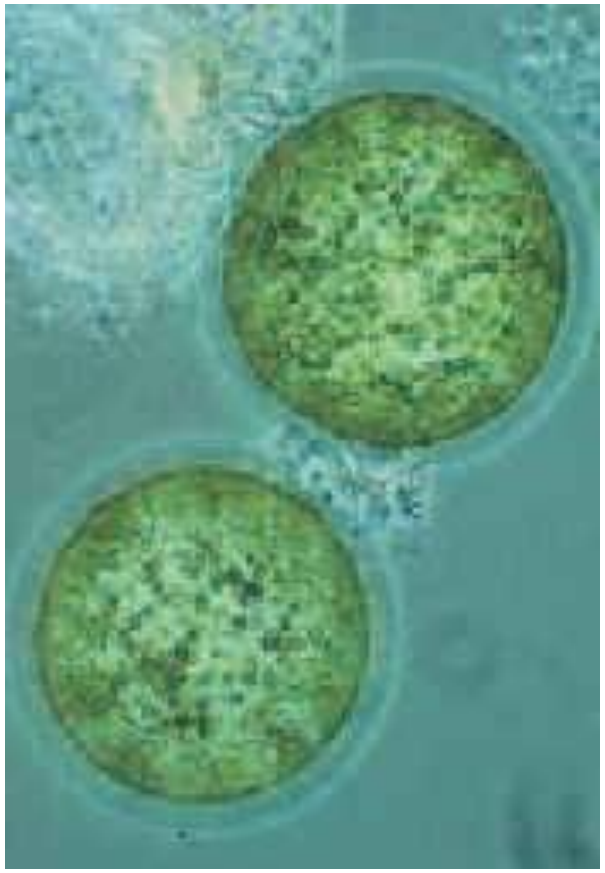
Big Bang Theory

Themes of Biology

- Cell structure and function
- Stability and homeostasis
- Reproduction and inheritance
- Evolution
- Interdependence of organisms
- Matter, energy, and organization

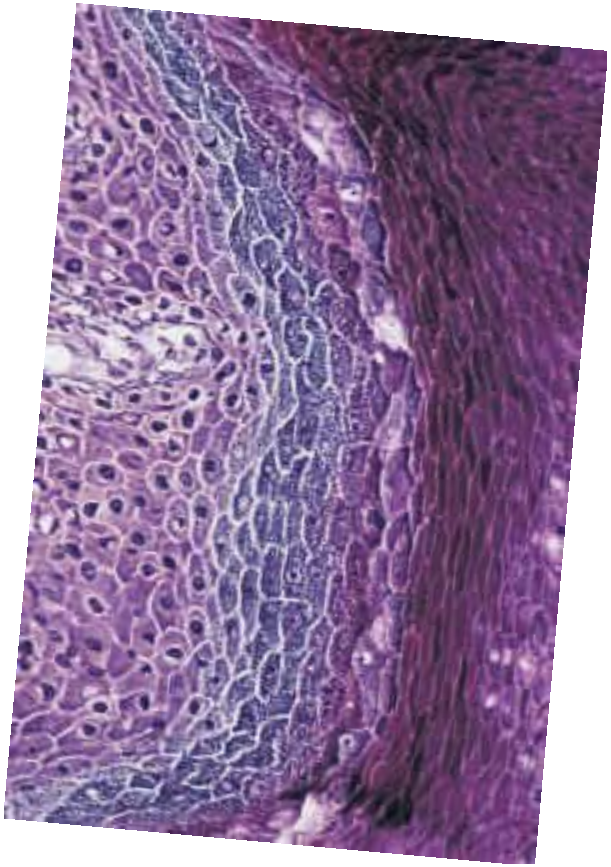
Cell Structure and Function

- **Cell** basic unit of life
- All organisms are **made of and develop from cells**
- Some composed of only a single cell **(unicellular)** which is usually **identical to parent**

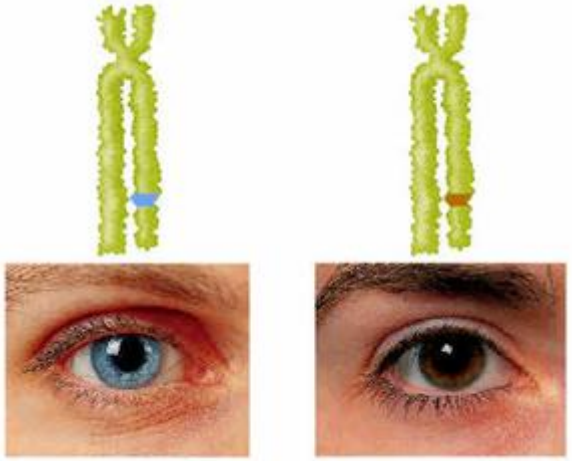


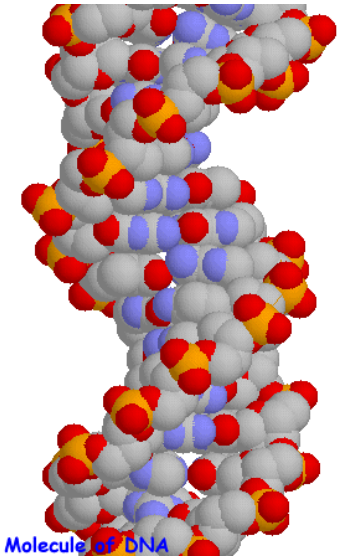
Cells

- Most organisms are composed of many cells **(multicellular)**
  - Cells are **different** (undergo differentiation)
- Cells are **small**
- Cells are **highly organized**



- Cells contain specialized structures (organelles) that carry out the cell's life processes
- Many different kinds of cells exist
- All cells surrounded by a plasma membrane
- Contain a set of instructions called DNA (genetic information)



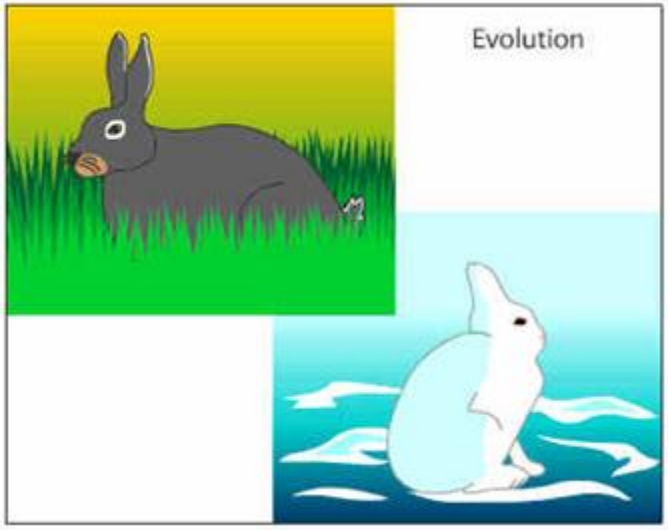


Asexual Reproduction

- Hereditary information from one, usually unicellular, organism that divides
- Resulting cells contain identical hereditary information
- Genetic information from single parent

Evolution

- Populations of organisms change (evolve) over generations (time)
- Explains how many different kinds of organisms came into existence SPECIES
- Explains how modern organisms are related to past organisms



- Explains why **organisms look and behave** the way they do
- Provides a basis for exploring the **relationships among** different groups of organisms

Natural Selection

- Natural selection is the **driving force in evolution**
- Organisms that have certain **favorable traits** are better able to **successfully reproduce** than organisms that lack these traits

Natural Selection

- Survival of organisms with favorable traits cause a gradual change in populations over many generations
- Also Called "Survival of the Fittest"

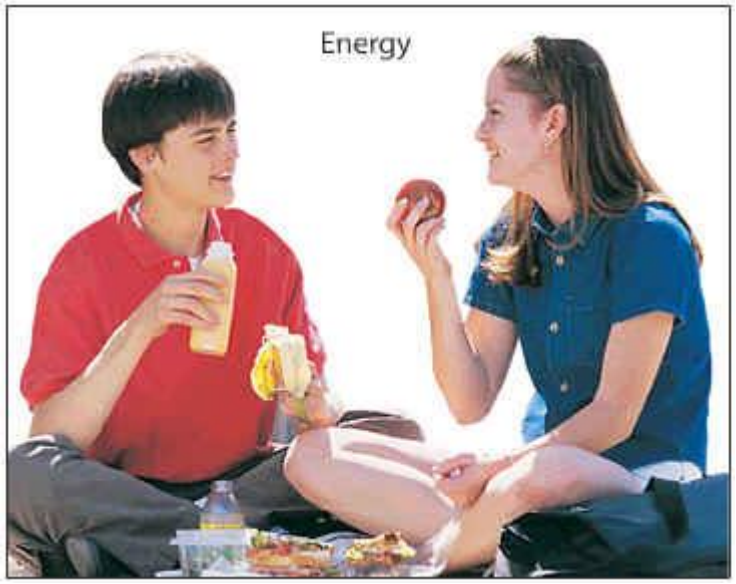
Interdependence of Organisms

- Interaction of organisms with one another and with their environment ECOLOGY
- Insects depend and flowers DEPEND on each other for food & pollination COEVOLUTION

- All organisms need substances such as **nutrients, water, and gases** from the environment
- The **stability of the environment** depends on the healthy functioning of organisms in that environment

Matter, Energy and Organization

- Living things are **highly organized**
- Require a **constant supply of energy** to maintain their orderly state



Energy

- ALL energy comes from the **SUN** (directly or indirectly)
- **Photosynthesis** is the process by which some organisms capture the energy from the **sun (solar)** and transform it into **energy (chemical)** that can be used by living things

Autotrophs

- Organisms that make their own food are called **autotrophs**
- **Phototrophs** – use solar energy (photosynthesis) to get energy
- Convert **H_2O and CO_2** into **sugar and O2**
- **Chemotrophs** – use different chemical processes to get energy

Heterotrophs

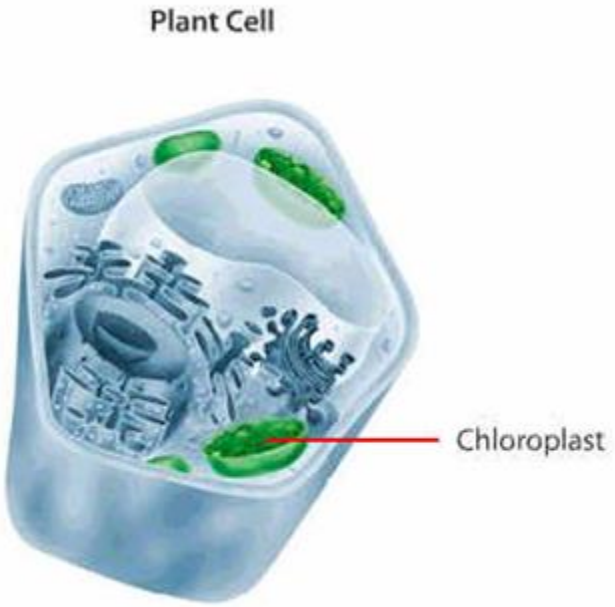
- Organisms that must take in food to meet their energy needs are called **heterotrophs** Consume autotrophs **(herbivores),** other heterotrophs **(carnivores)** or both **(omnivores)** for their energy needs

- Complex chemicals are broken down and **reassembled into chemicals** and structures needed by organisms

Characteristics of Life

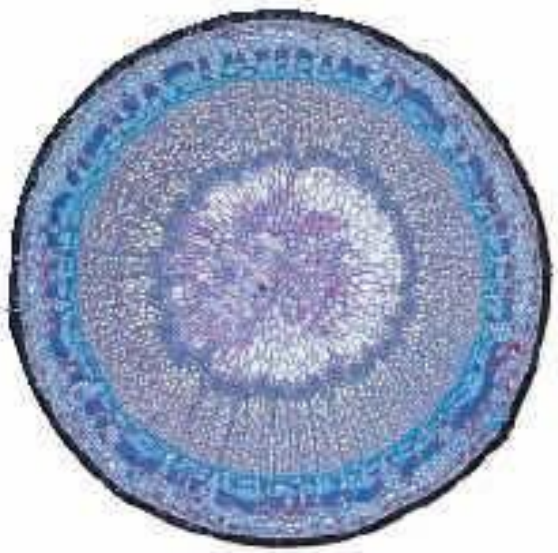
Cells

- All living things are composed of **cells**
- In multicellular organisms, many are **specialized** to perform specific functions
- Cells are always very **small**
- The size of multi-celled organisms depends on **the number of cells NOT their size**

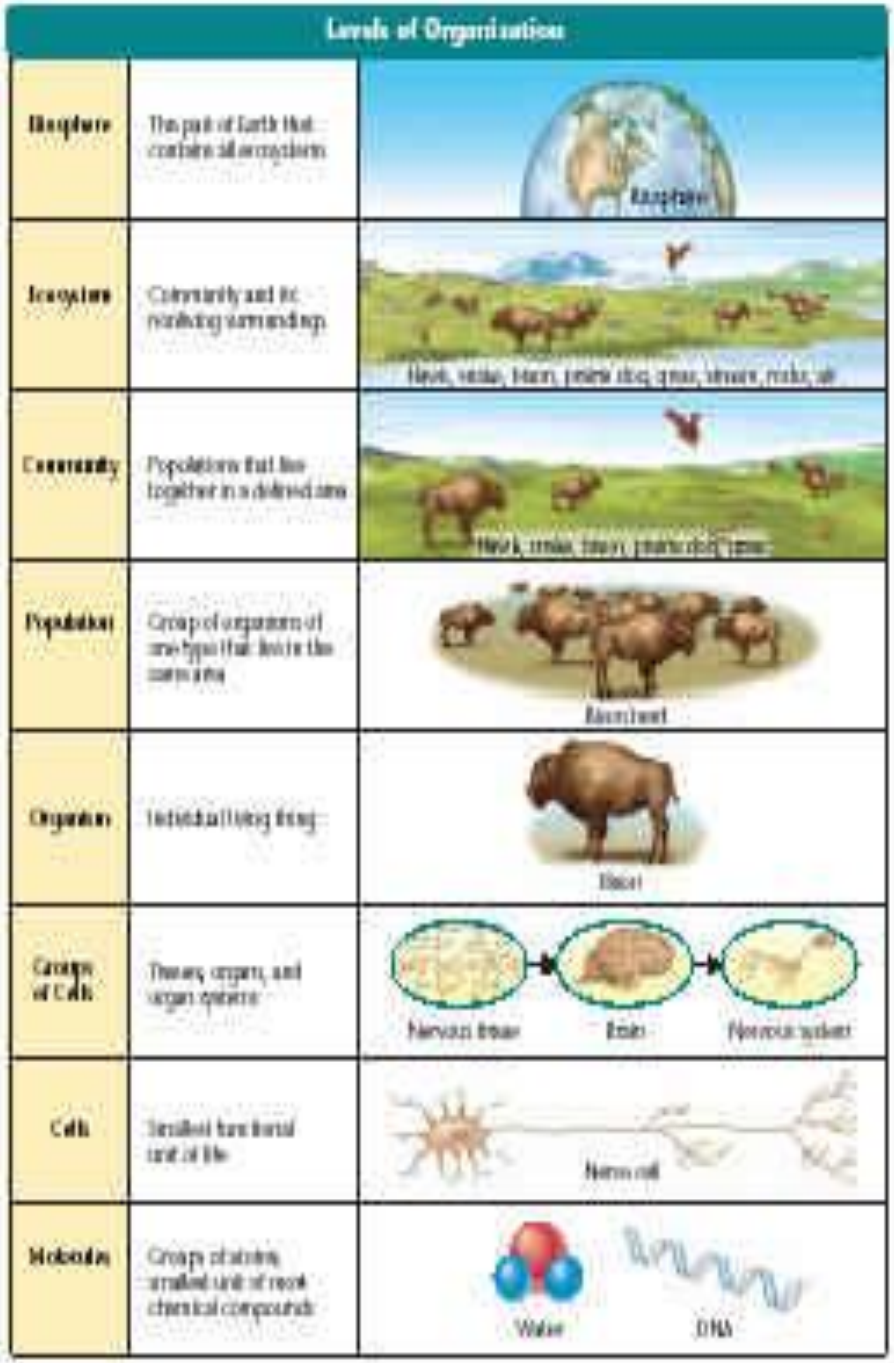


Organization

- Organized at both the **molecular and cellular levels**
- Take in substances from the environment and organize them in complex ways
- Specific cell structures **(organelles)** carry out particular functions

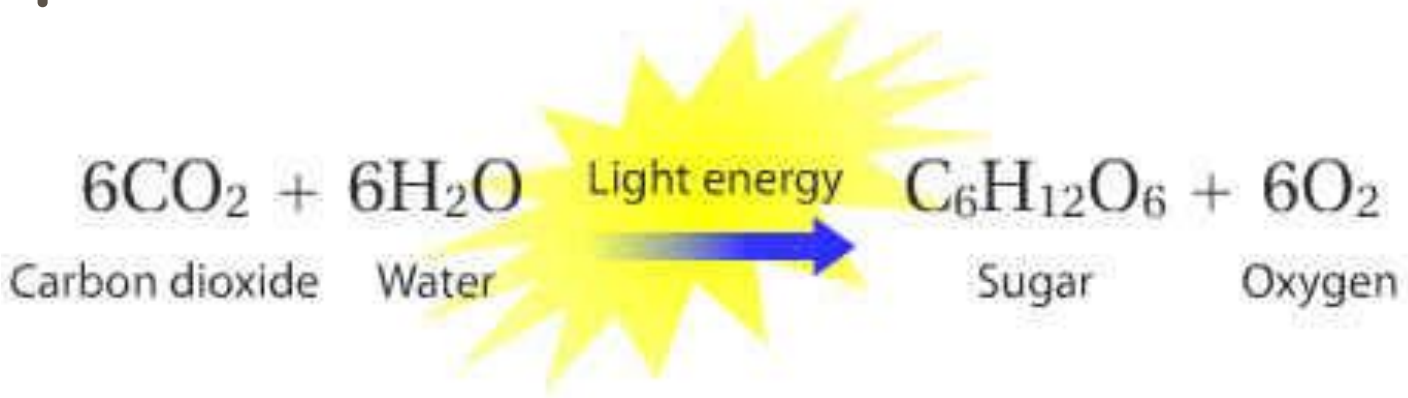


- In **multicellular organisms,** cells and groups of cells (tissues) are organized by their function
  - **Cells** → tissues
  - **Tissues** → organs
  - **Organs** → systems
  - **Systems** →
  - **ORGANISM**



Energy Use

- Use energy in a process called **metabolism**
  - ***Sum of all chemical processes***
- Require energy to maintain their molecular and cellular organization, grow and reproduce

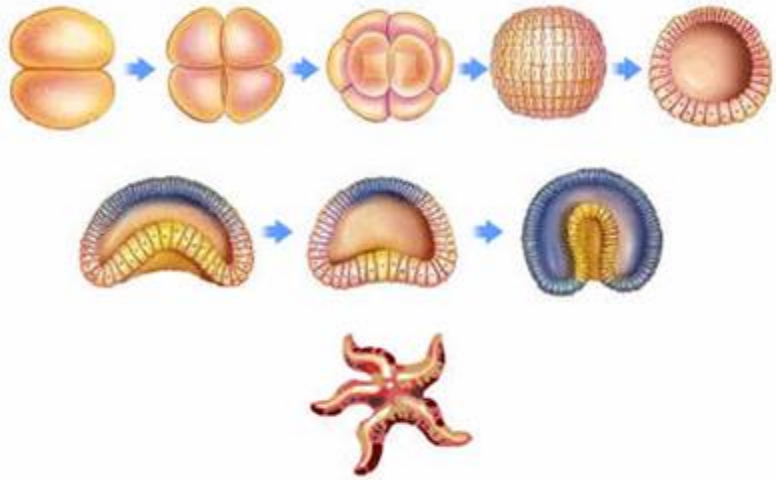


Growth

- Grow occurs as the result of **cell division and cell enlargement**
- **Cell division** is the formation of two cells from a **preexisting cell**
- New cells enlarge as they mature
- When a cell grows to a size where its **surface area isn't big enough for its volume**, the cell divides

Development

- The process by which an adult organism arise is called **development**
  - Repeated cell divisions and **cell differentiation**



Evolve

- Ability to adapt to their environment through the process of **evolution**
- **Favorable characteristics** are selected for and passed on to offspring
- Called **adaptations**
- Driven by **natural selection** or **"survival of the fittest"**

What are Plants?

Plants

- Multicellular
- Eukaryotes
- Autotrophs
- Oxygenic photosynthesis
- Adapted to life on land

Life on Land: Advantages

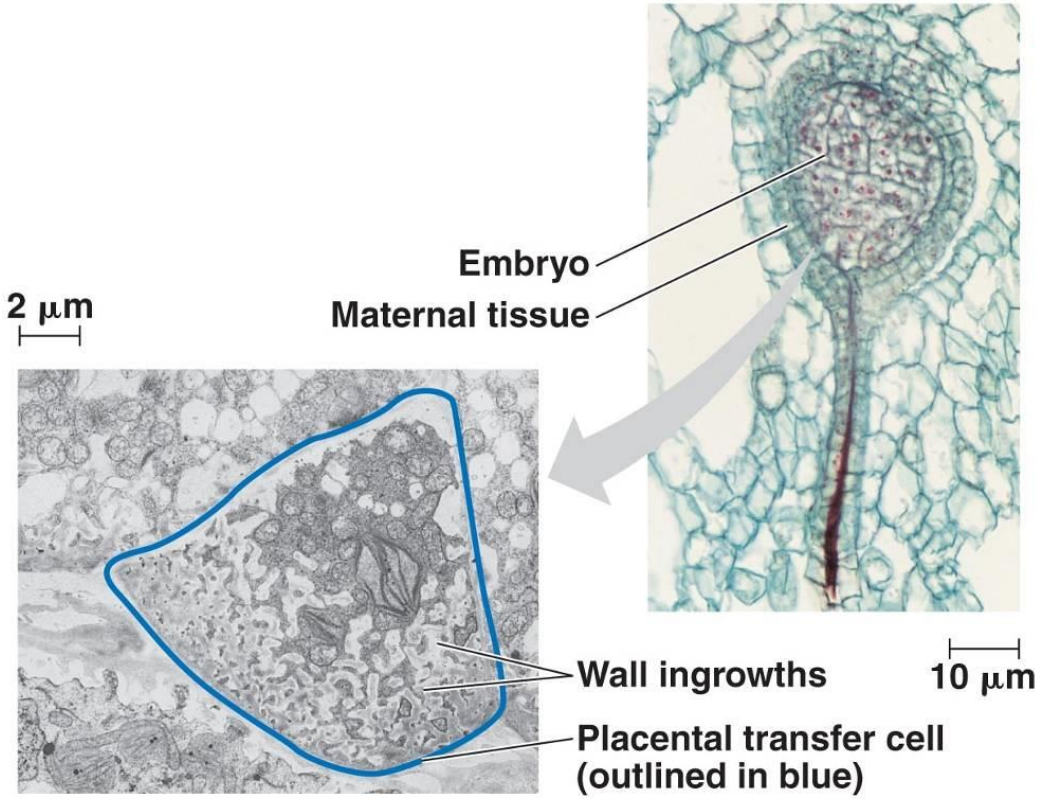
- Plenty of light
- Plenty of CO_2
- Space (at first)
- No predators (at first)

Life on Land: Challenges

- Water availability
- Dehydration
- Support
- Location of nutrients
  - Soil
  - Atmosphere
- Light
- High UV levels

Plant Adaptations

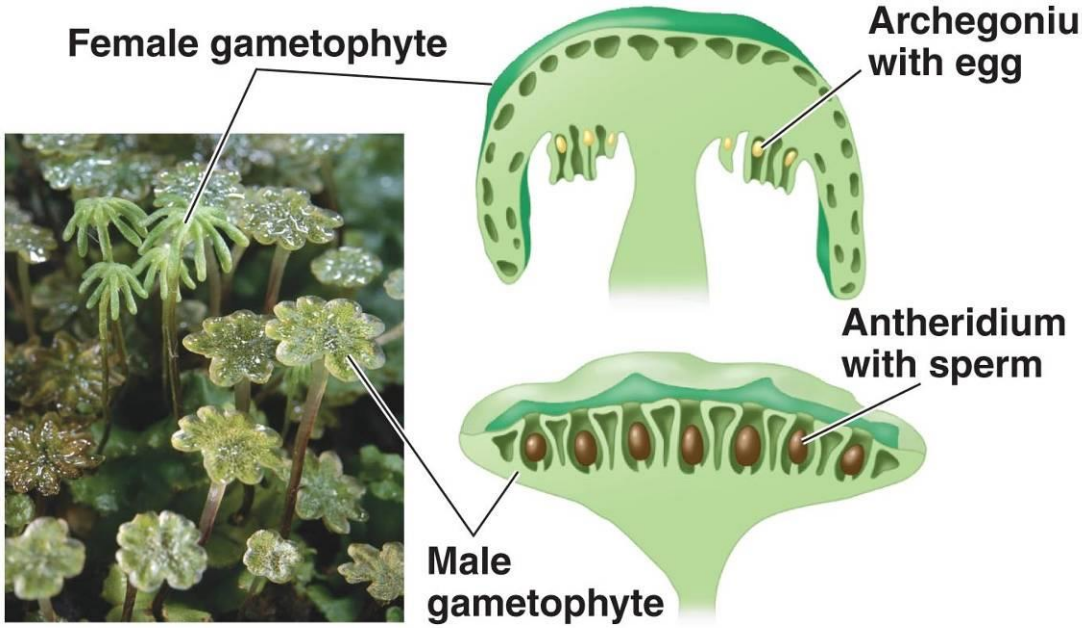
- Embryophytes
  - Protect embryos on parent body
  - Surrounded by protective tissue
  - Nourish embryos



Embryo (LM) and placental transfer cell (TEM) of *Marchantia* (a liverwort)

Plant Adaptations

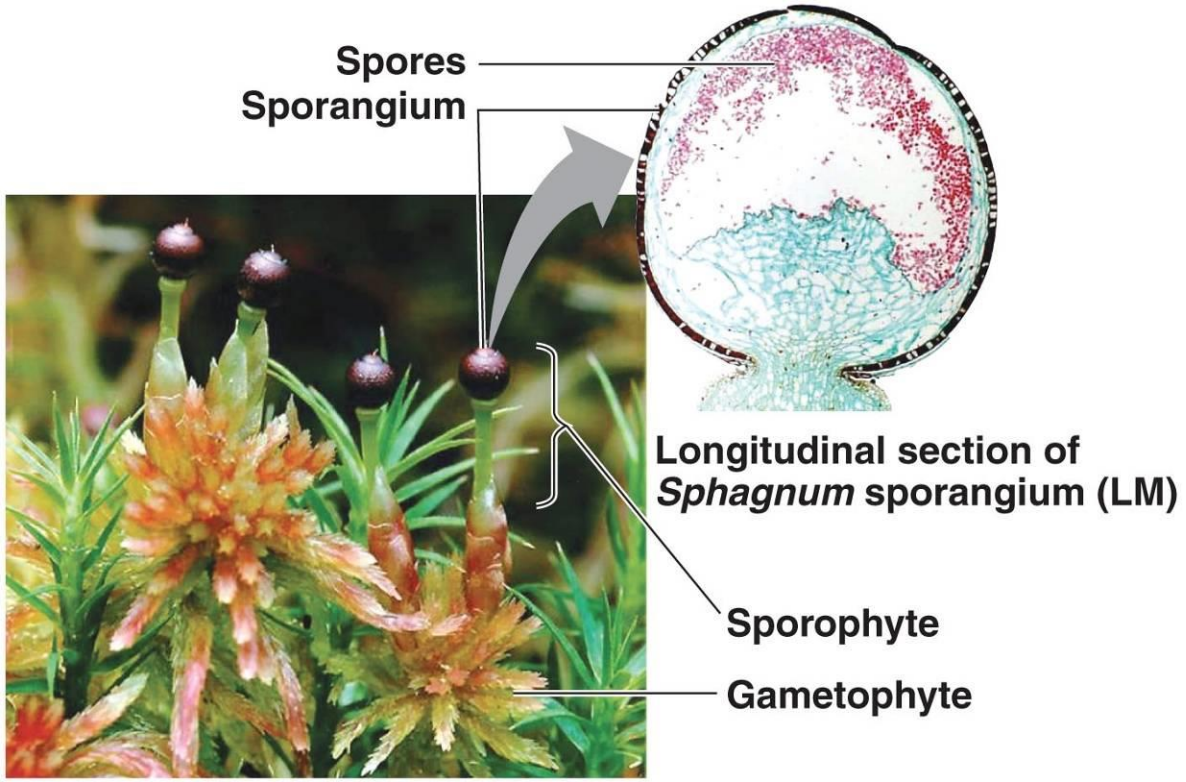
- Gametangia
  - Multicellular organs
  - Produce gametes
  - Two types:
    - Archegonia → eggs
    - Antheridia → sperm



Archegonia and antheridia of *Marchantia* (a liverwort)

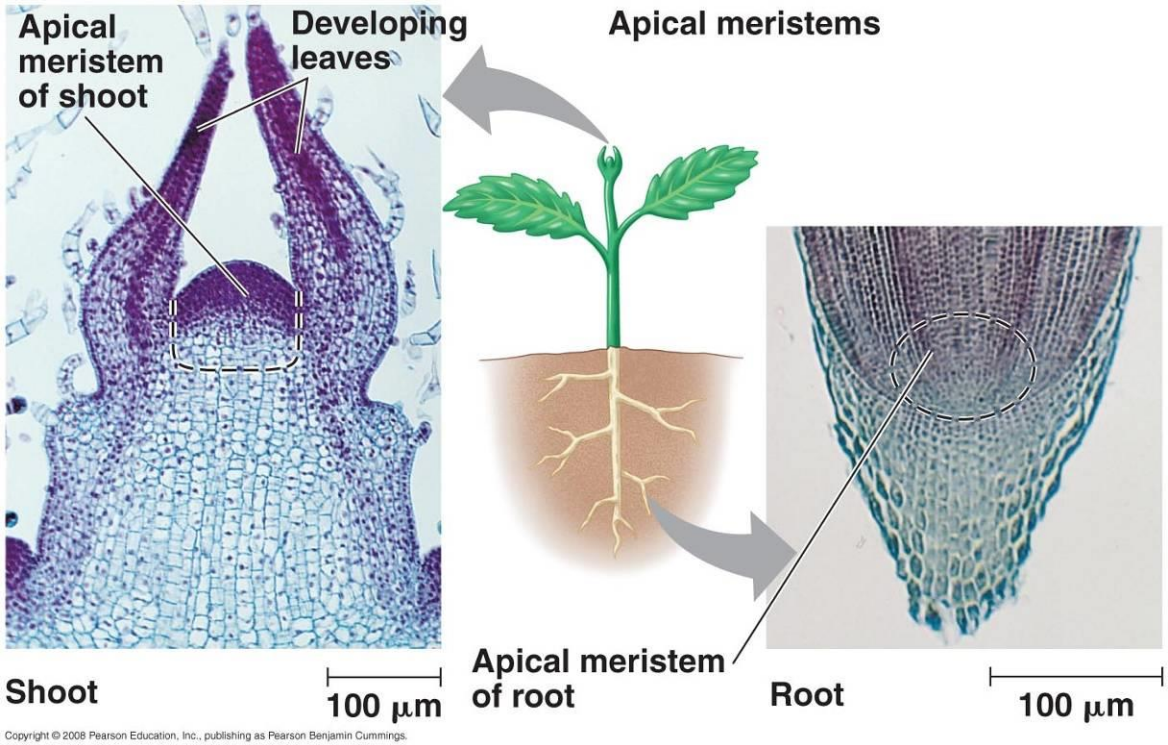
Plant Adaptations

- Sporangia
  - Multicellular organs
  - Produce spores



Sporophytes and sporangia of *Sphagnum* (a moss)

Plant Adaptations



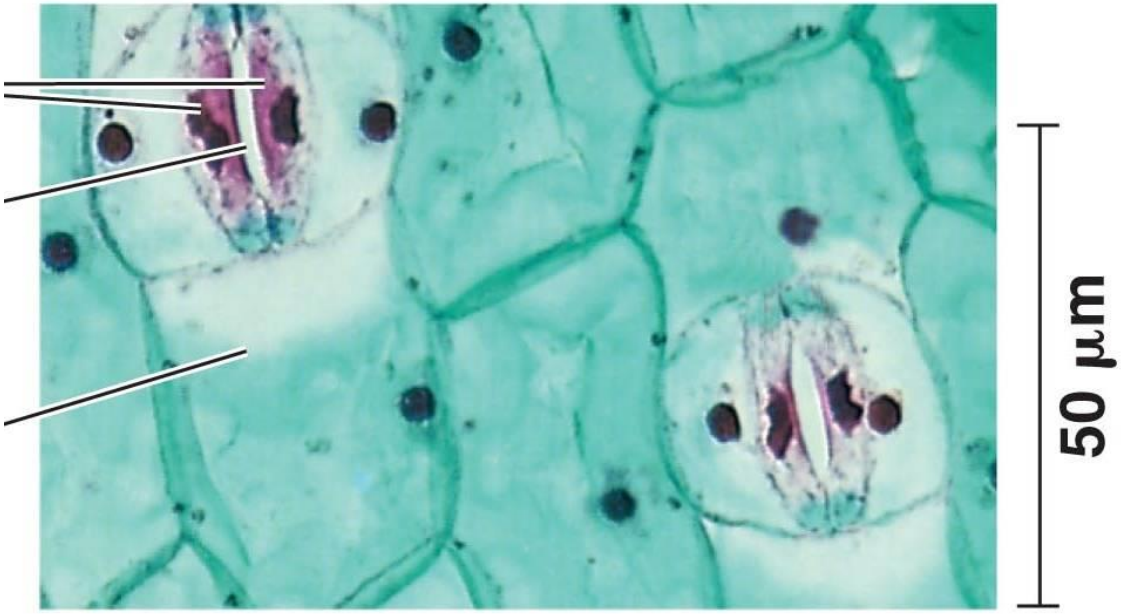
- Apical Meristems
  - Growing points
  - Located at tips of plant structures

Plant Adaptations

- Cuticles
  - Waxy Coat
  - Plant surfaces above ground

Plant Adaptations

- Stomata
  - Pores in leaves and other photosynthetic organs
  - Gas exchange

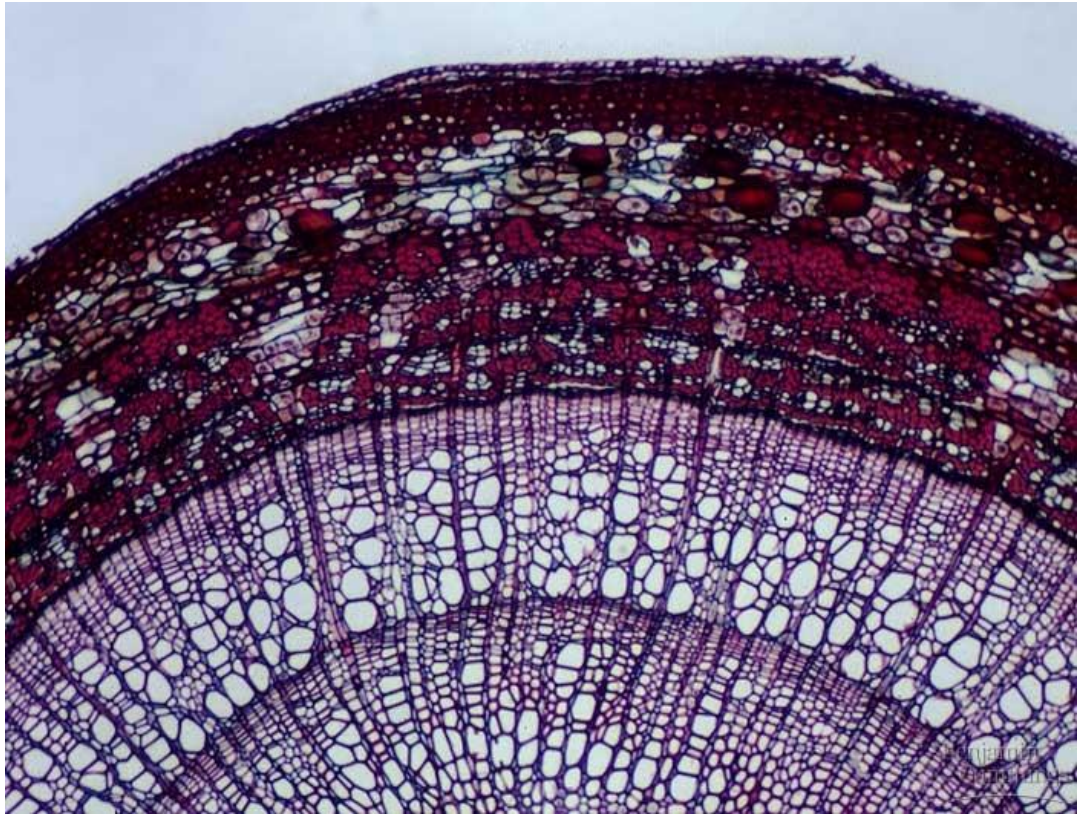


(b) Surface view of a spiderwort (*Tradescantia*) leaf (LM)

Cummings.

Plant Adaptations

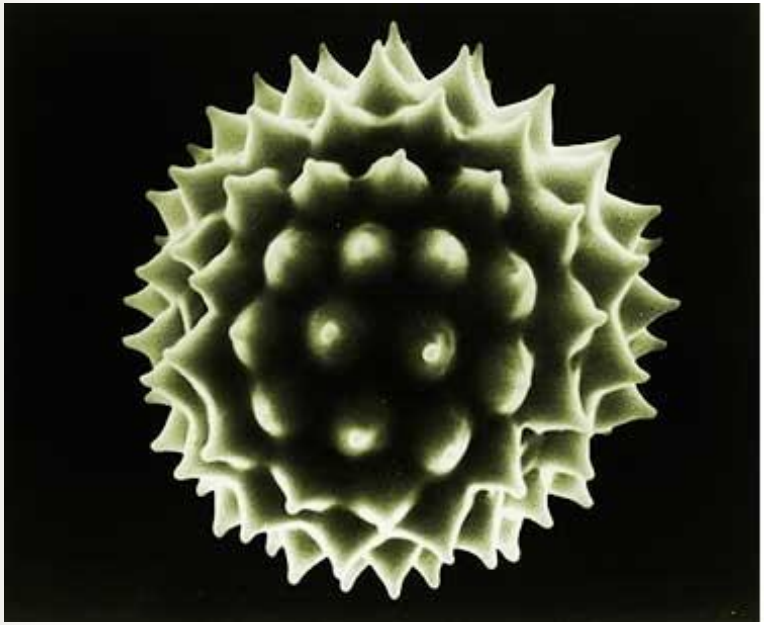
- Vascular Tissue
  - Support
  - Transport
  - Two Types:
    - Xylem
    - Phloem

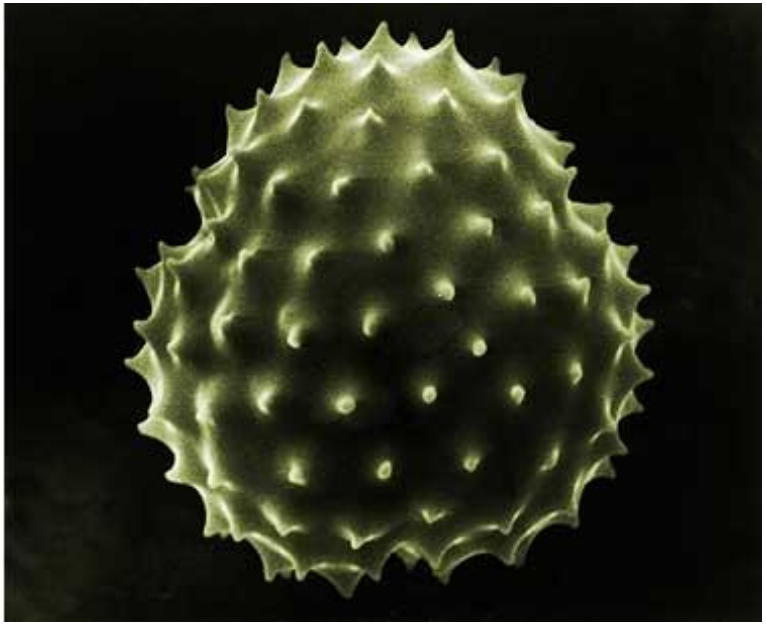


Plant Adaptations

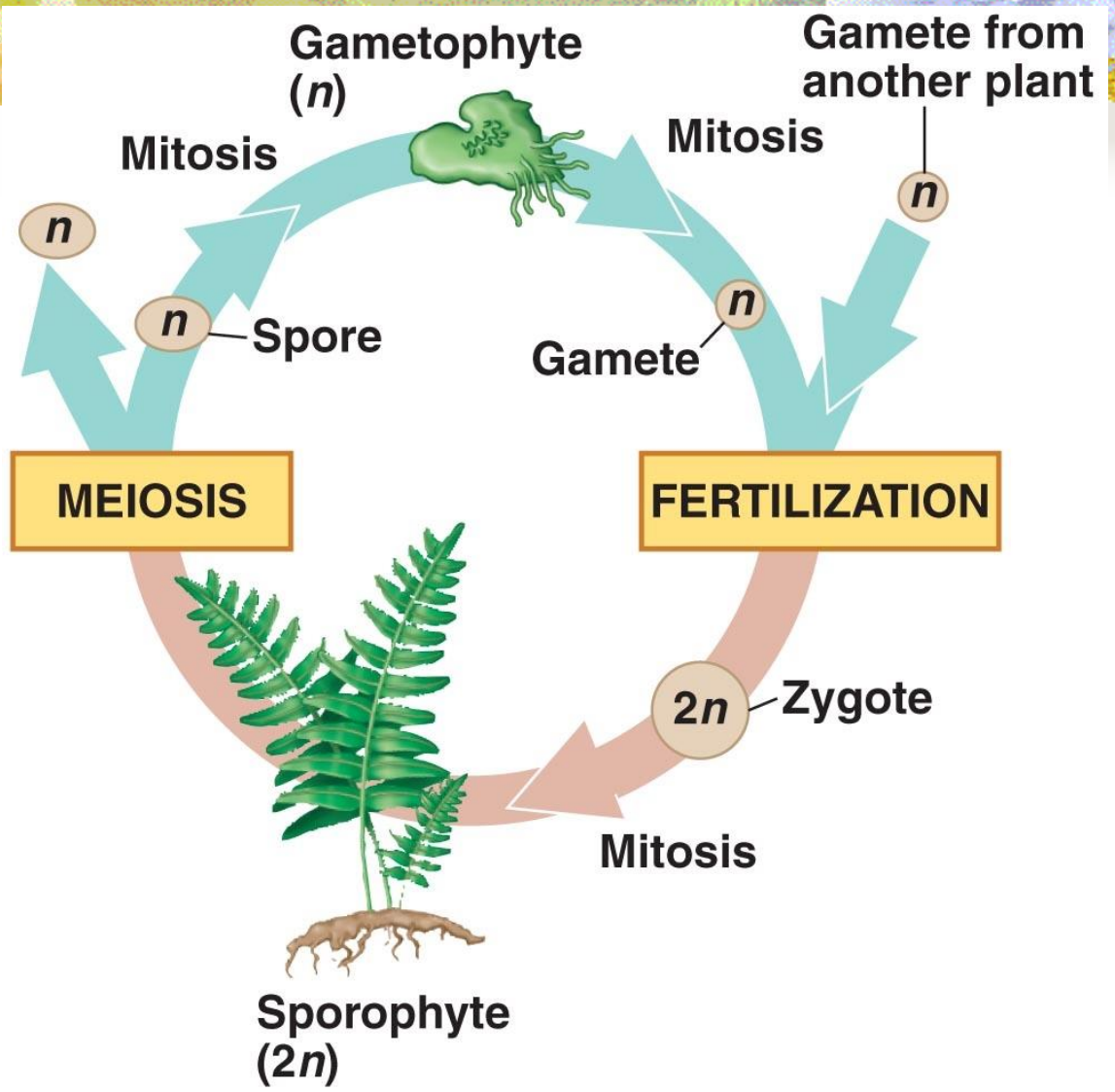
- Secondary Compounds
  - Defense
    - Toxins: Digitalis
    - Antifeedants: Tannins
  - Support
    - Lignin
  - UV Protection
    - Flavonoids

Plant Adaptations

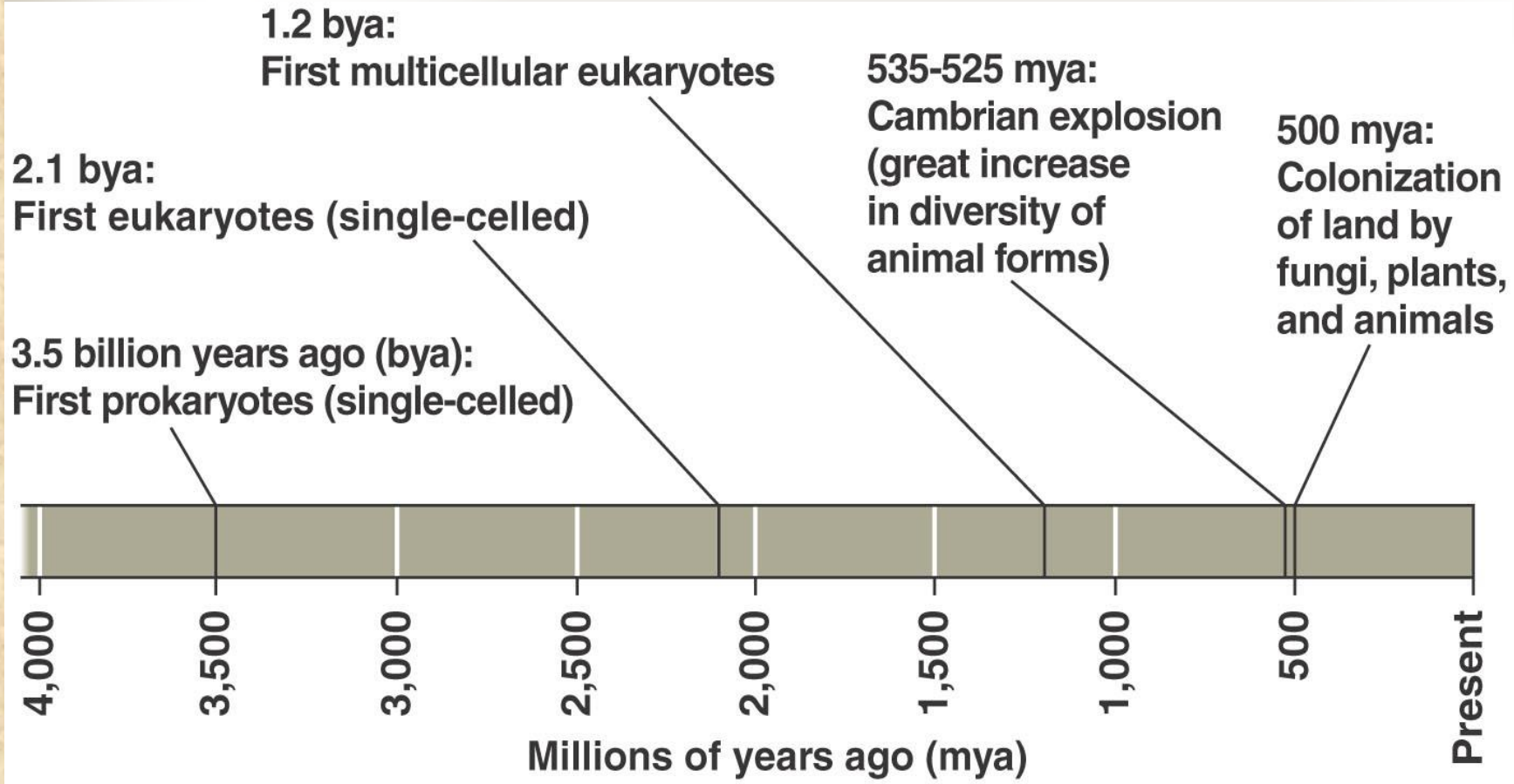




- Secondary Compounds
  - Sporopollenin
    - Spore coat
    - Pollen coat

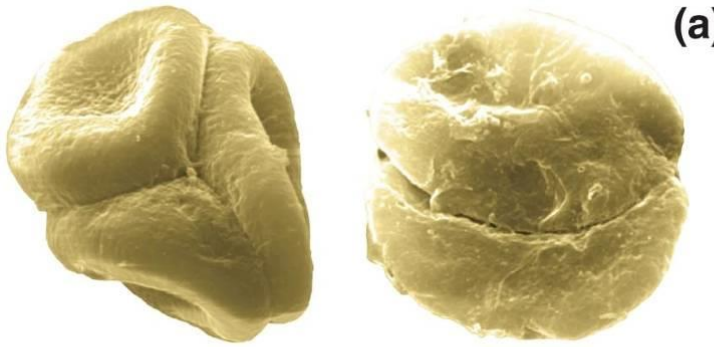


Alternation of generations

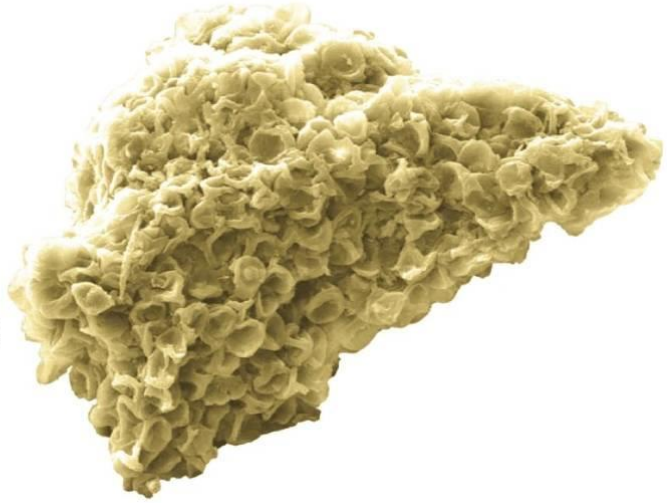


Plant Evolution

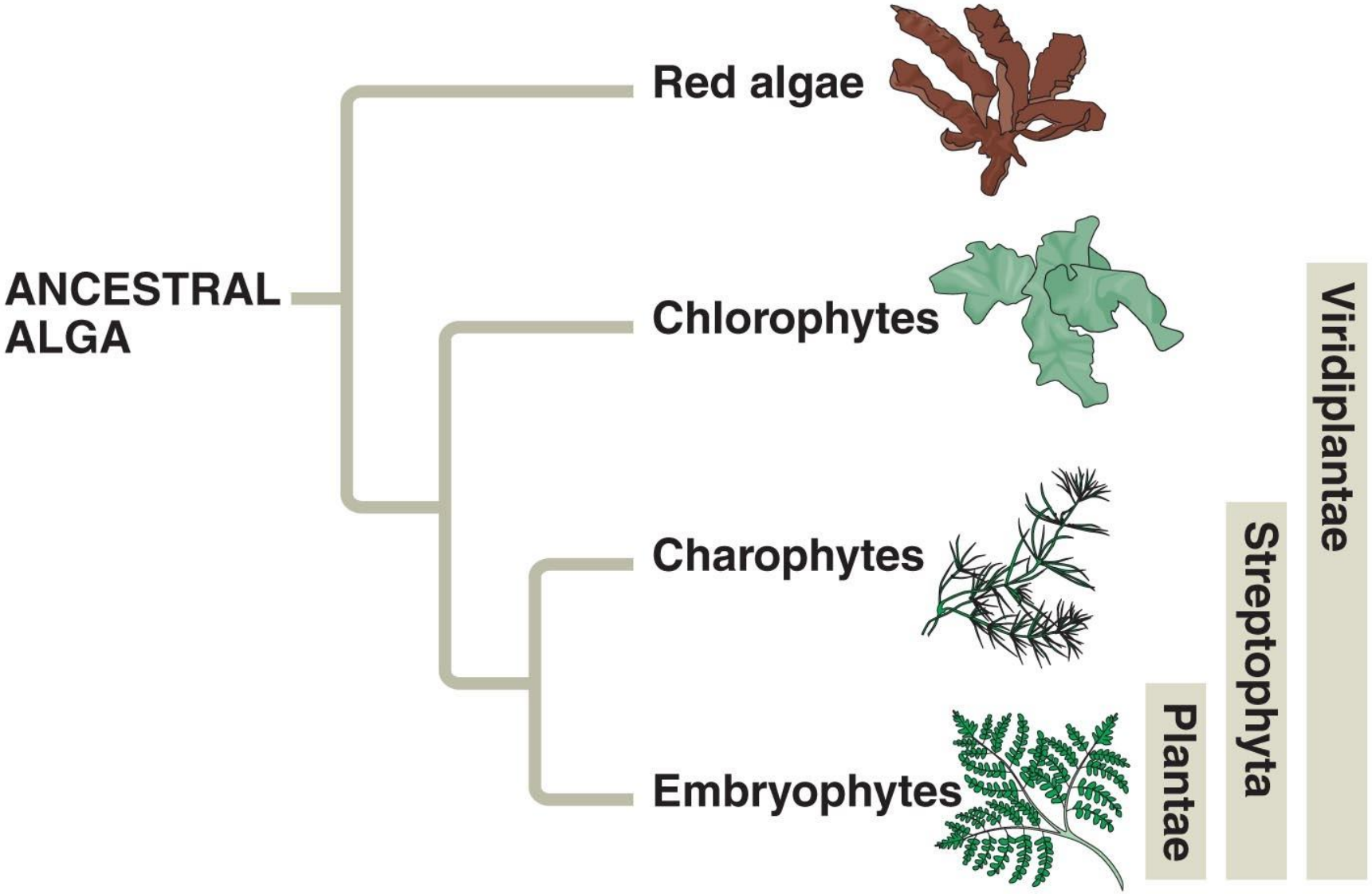
- Earliest body fossils of plants
  - 475 mya
  - Plant spores in plant sporophyte tissues



(a) Fossilized spores

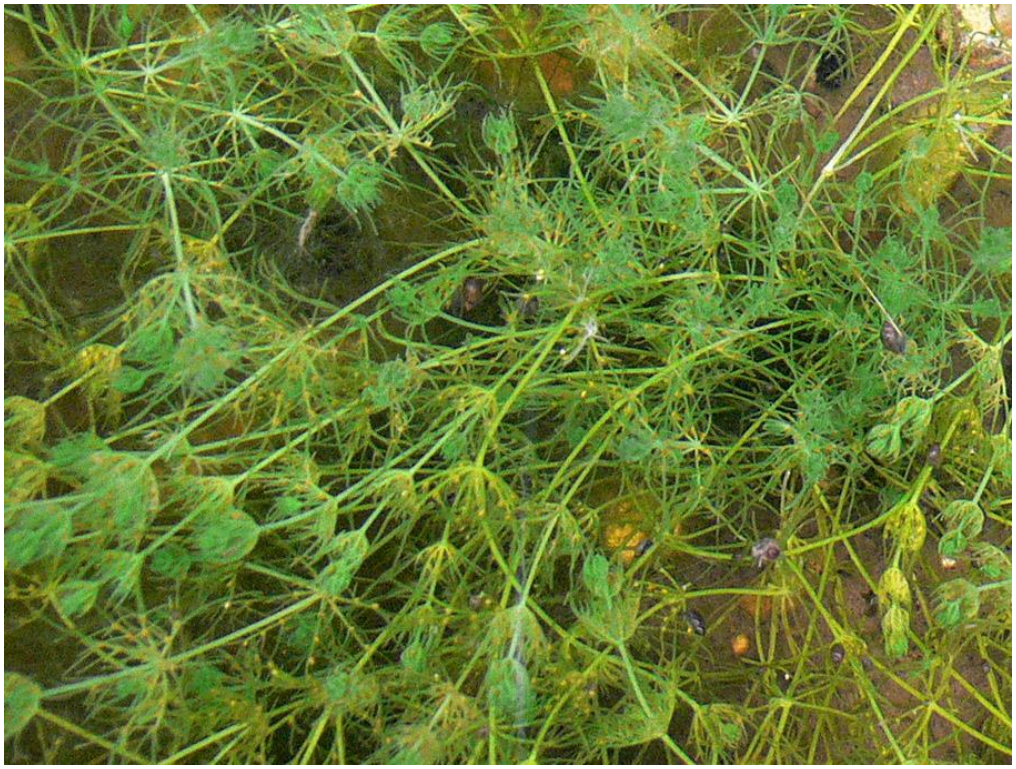


(b) Fossilized sporophyte tissue



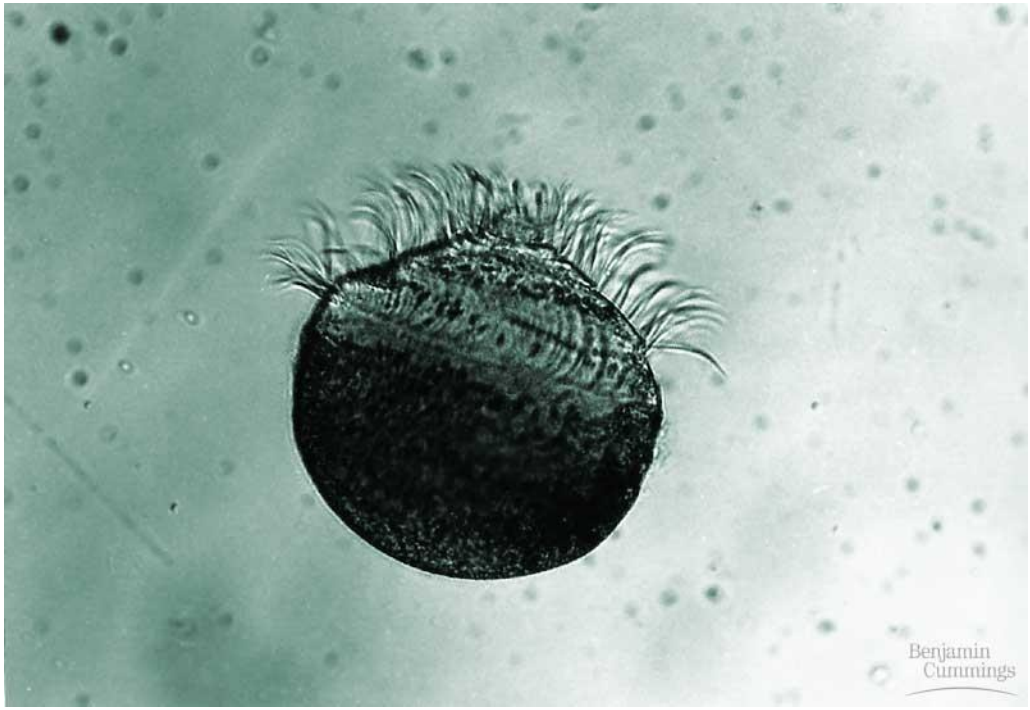
Charophyceans

- Sister taxon
- Molecular evidence
  - Nuclear DNA
  - Chloroplast DNA

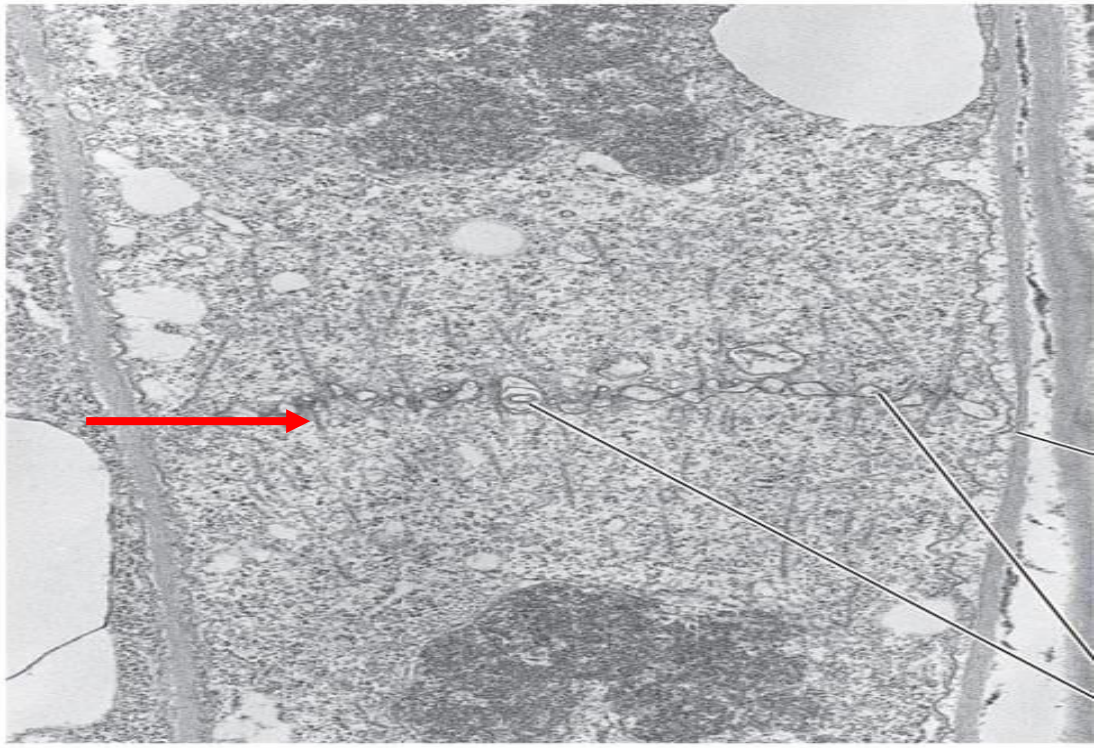


Charophyceans

- Shared Traits
  - Peroxisome enzymes
  - Flagellated sperm



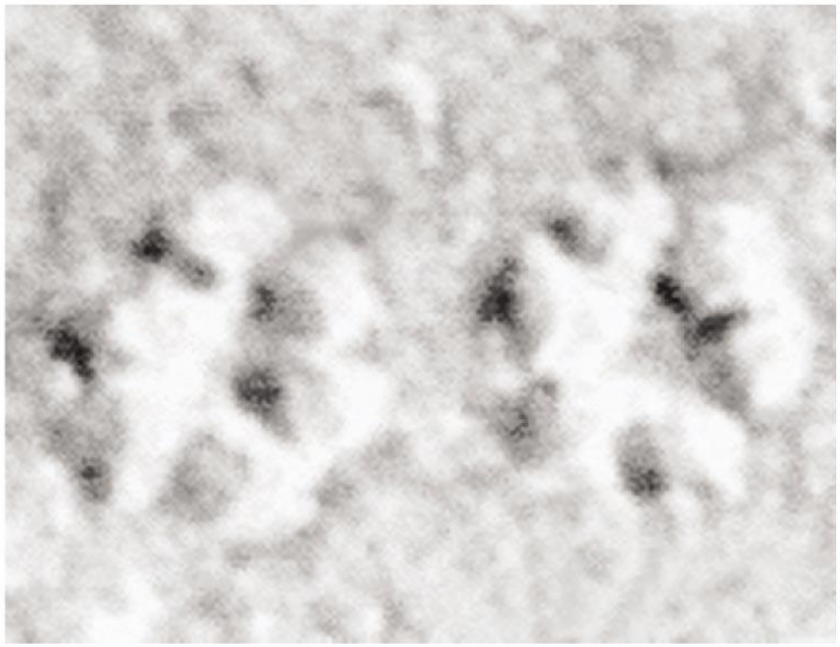
Charophyceans



- Shared Traits
  - Phragmoplasts

Charophyceans

- Shared Traits
  - Rosette-shaped cellulose synthesizing complexes

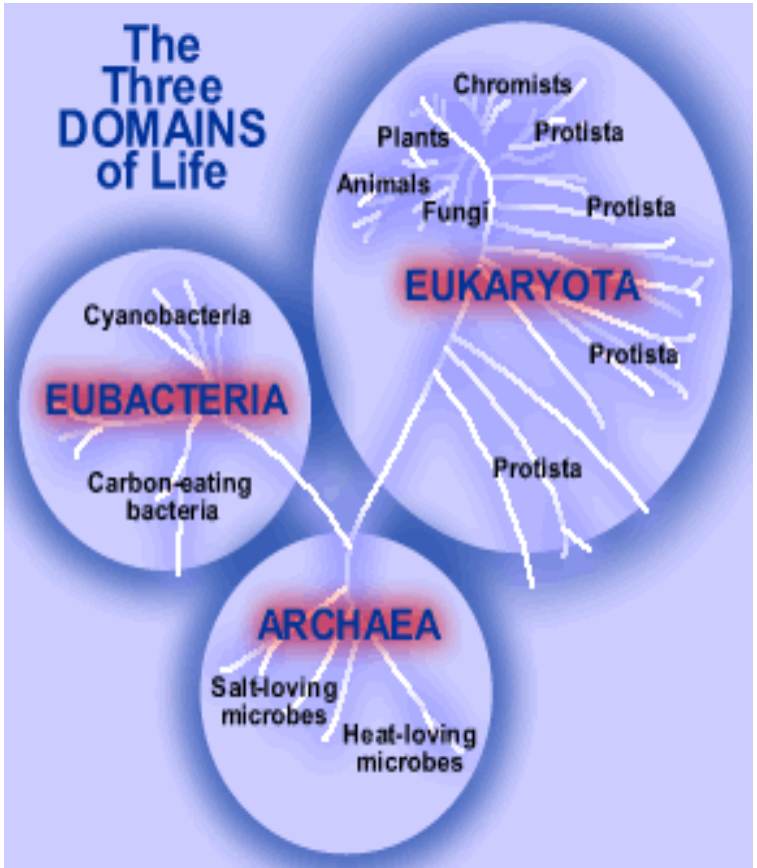


The Three Domains

All organisms belong to one of three domains, depending on their **characteristics.** A domain is the most inclusive (broadest) taxonomic category. A single domain can contain one or more kingdoms.

I. Archaea

II. Eubacteria

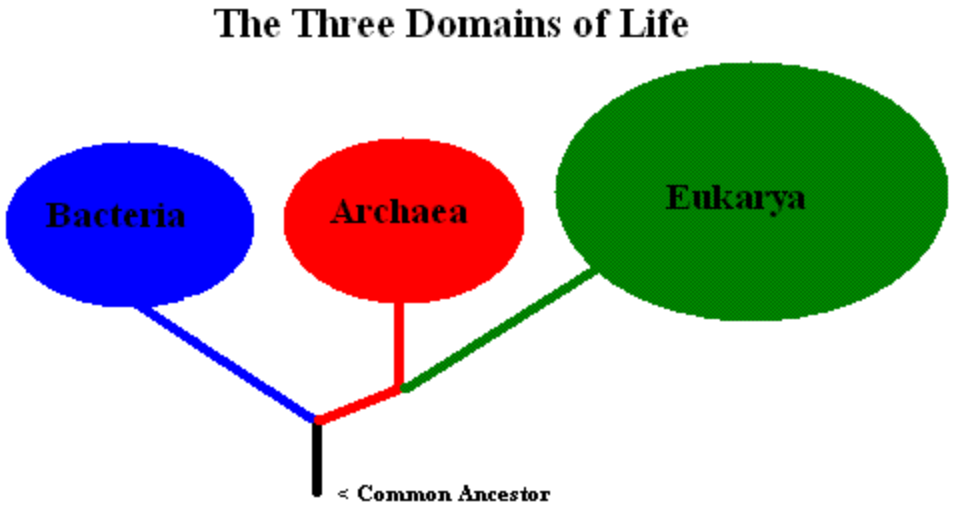


The Three Domains

I. Archeae: very **primitive** forms of bacteria

II. Eubacteria : more advanced forms of

III. eu



with

The Three Domains of Life

Organisms are placed into domains and kingdoms based on their **cell** type, their ability to make **food**, and the number of cells in their bodies.

Ability to make food

Heterotrophic or Autotrophic

Cell Type

Prokaryotic or Eukaryotic

Number of cells in their body

Unicellular or Multicellular

The Three Domains of Life

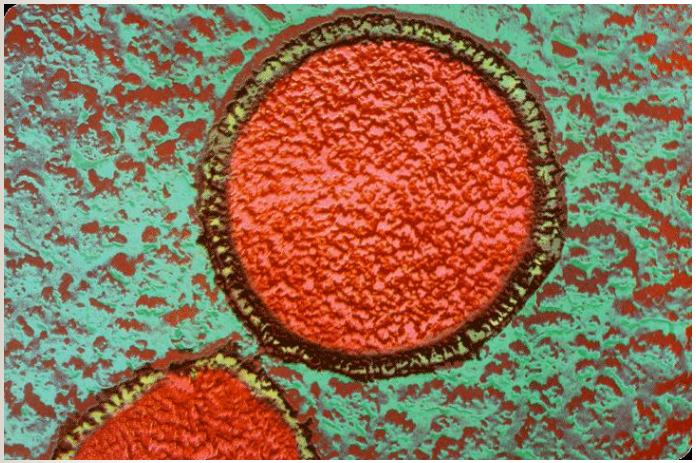
Organisms can be:

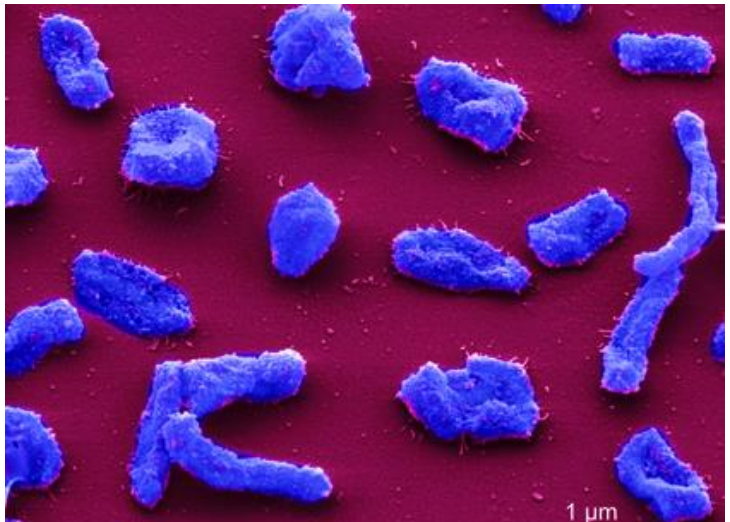
- **Prokaryotic** – cells that lack a nucleus
- **Eukaryotic** – cells that contain a nucleus

- **Unicellular** – single-celled; made up of one cell
- **Multicellular** – made up of many cells

- **Autotrophic** – can make their own food
- **Heterotrophic** – can not make their own food

Domain Archaea

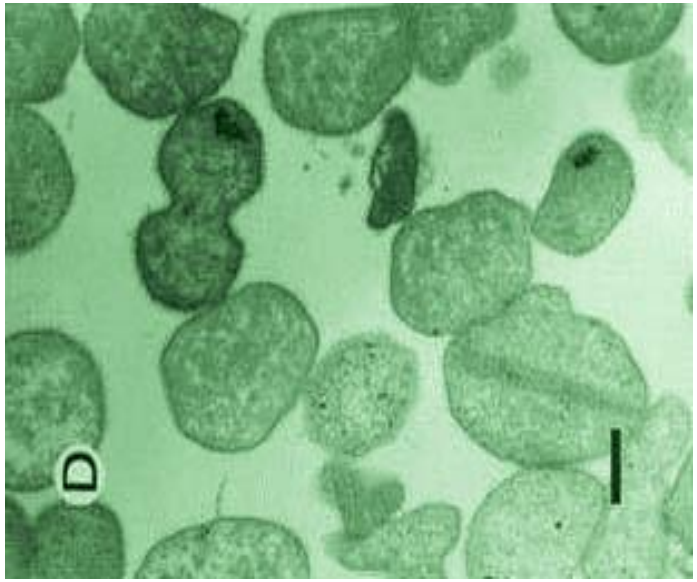




The Six Kingdoms of Life

I. Domain Archaea

1. Kingdom Archaebacteria



- they are unicellular, prokaryotic and some are autotrophic and others heterotrophic

- They are different from bacteria in the structure and **chemical** makeup of their cells.
- Cell walls of different compositions

The Six Kingdoms of Life

I Domain Archaea

1. Kingdom Archaebacteria

- known as "ancient bacteria"; they are the most primitive type of organisms
- they thrive in the most **extreme** environments on Earth; they are often referred to as "extremophiles"
- found in thermal vents, hot springs, very salty water, swamps, and the intestines of cows

The Three Domains of Life

II. Domain Eubacteria

2. Kingdom Eubacteria

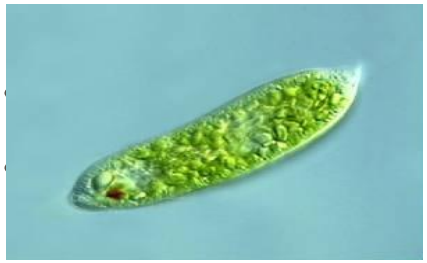
- They are found **everywhere** on Earth except extreme environments.
- They are unicellular, prokaryotic, some are autotrophic and others are heterotrophic.
- Cell wall made of **peptidoglycan**

The Six Kingdoms of Life

III. Domain Eukarya (Eukaryota)

Kingdoms:

- Protista (Protists)



- Fungi
- Plants (Plantae)

- Animals (Animalia)

The Six Kingdoms of Life

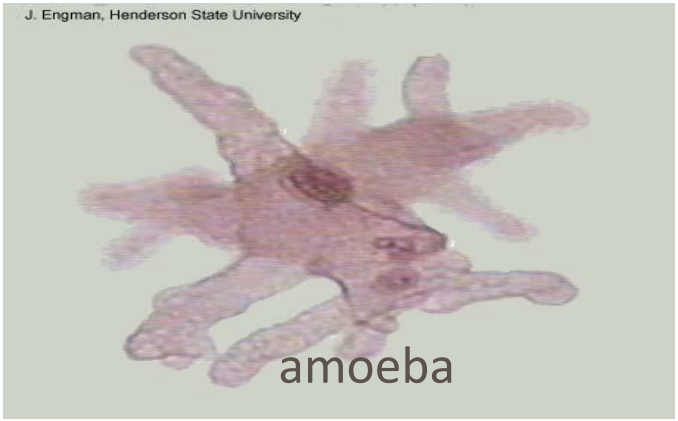
3. Kingdom Protista (Protists)

- the "odds and ends" kingdom
- includes any organism that can not be classified as a animal, plant, or fungus
- eukaryotic
- most are unicellular, others are multicellular
- some are autotrophs, others are heterotrophs
- Some have a cell wall

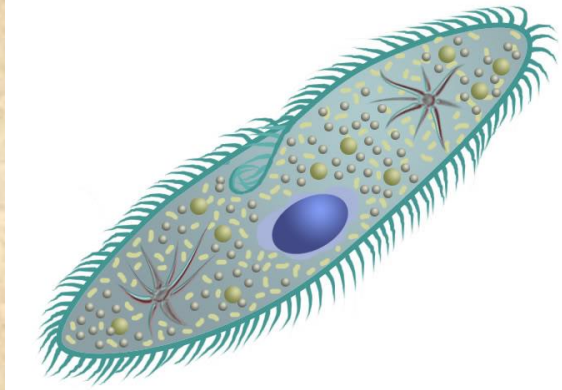
The Six Kingdoms of Life

Protists

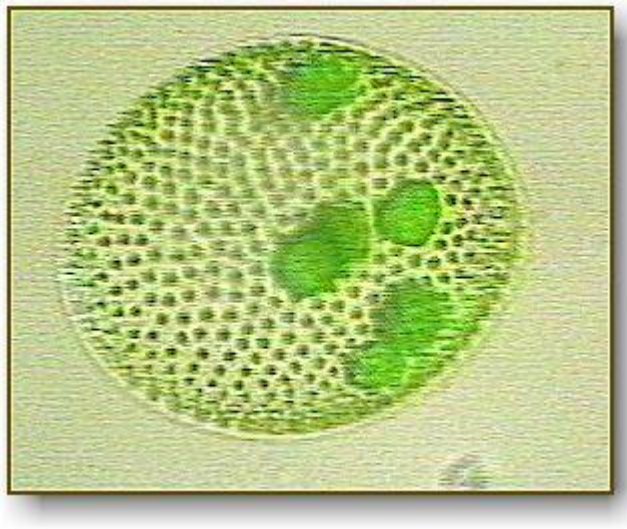
euglena



amoeba



paramecium

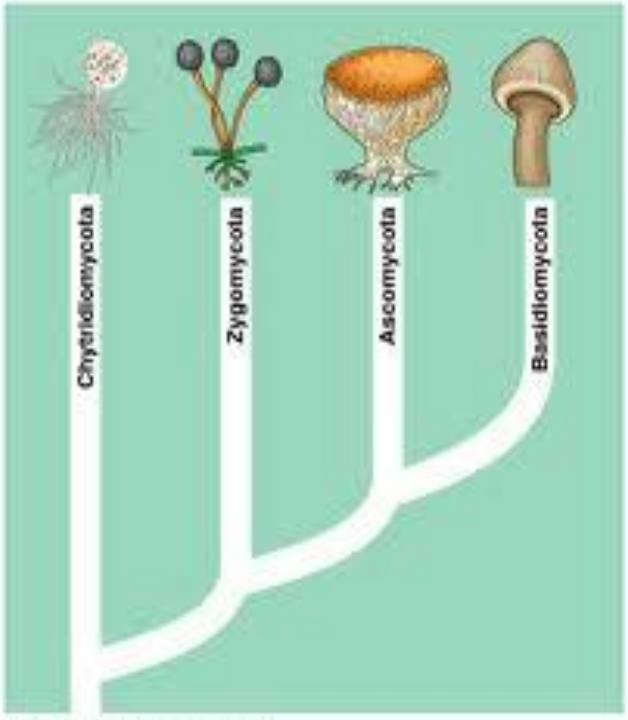


volvox

The Six Kingdoms of Life

4. Fungi

- eukaryotic
- most are multicellular (yeast-unicellular)
- heterotrophic
- include yeast (unicellular), molds, mildews, and mushrooms
- Cell wall made of chitin



The Six Kingdoms of Life

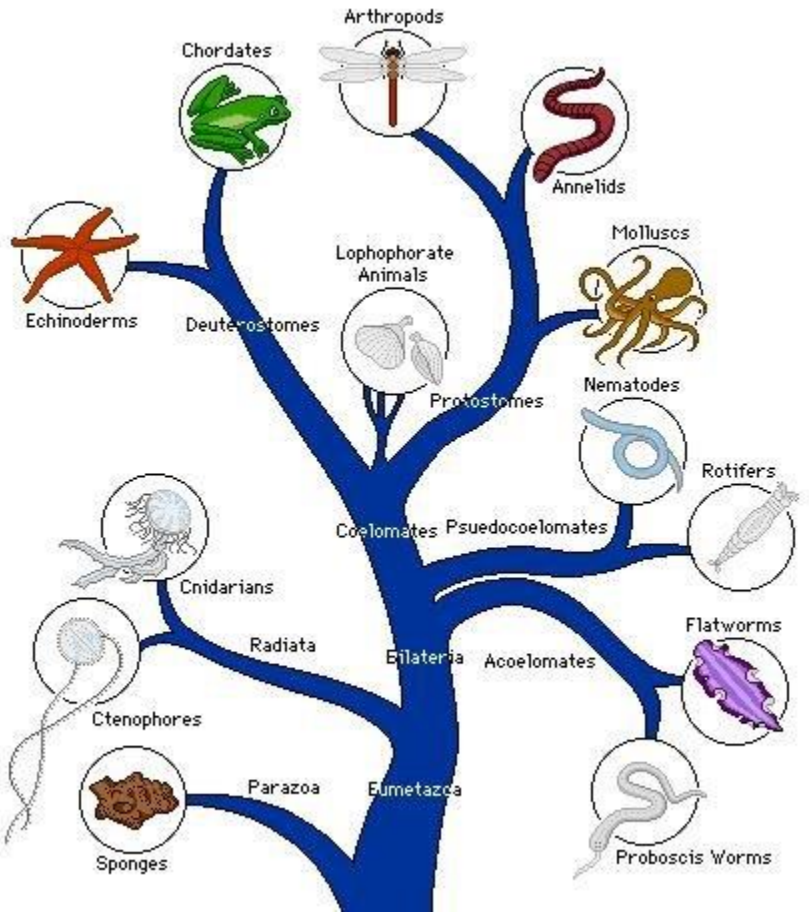
5. Plants

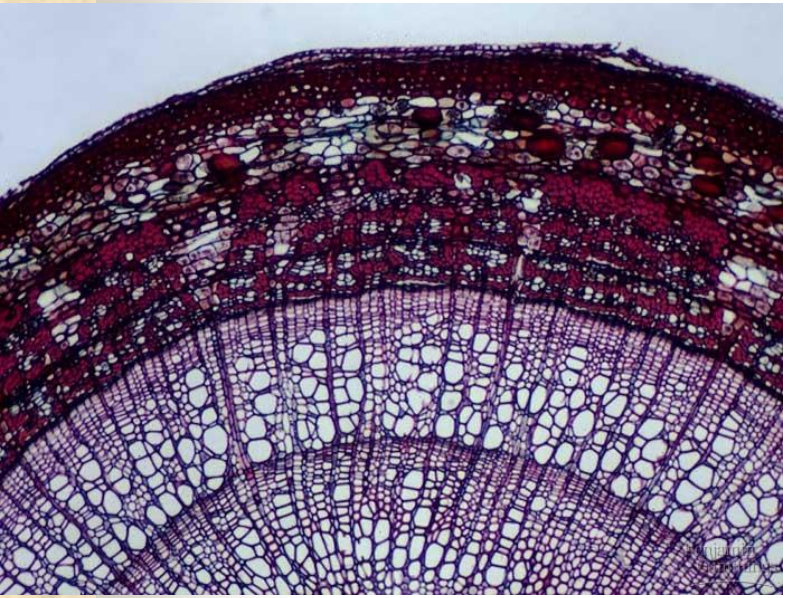
- multicellular
- eukaryotic
- autotrophic
- most live on land
- Cell wall of cellulose

The Six Kingdoms of Life

6. Animals

- multicellular
- eukaryotic
- heterotrophic
- live in diverse environments





Bloody well ask some questions, already!

Thank You