The kingdom Protista (in the five kingdom system) contains mostly unicellular eukaryotes. This taxonomic grouping is polyphyletic and based only on cellular structure and life styles not on any molecular evidence. Using molecular biology and detailed comparison of cell structure, scientists are now beginning to see evolutionary history in the protists. The ongoing changes in the protest phylogeny are rapidly changing with each new piece of evidence. The following classification suggests 4 “supergroups” within the original Protista kingdom and the taxonomy is still being worked out. This lab is looking at one current hypothesis shown on the right. Some of the organisms are grouped together because of very strong support and others are controversial. It is important to focus on the characteristics of each clade which explains why they are grouped together. This lab will only look at the groups that were once included in the Protista kingdom and the other groups (higher plants, fungi, and animals) will be examined in future labs.
Protista Classification

Starting with the four “Supergroups”, we will divide the rest into different levels called clades. A Clade is defined as a group of biological taxa (as species) that includes all descendants of one common ancestor. To simplify this process, we have included a cladogram we will be using throughout the course. We will divide or expand parts of the cladogram to emphasize evolutionary relationships. For the protists, we will divide the supergroups into smaller clades assigning them artificial numbers (clade1, clade2, clade3) to establish a grouping at a specific level.

CLASSIFICATION:

Domain: Eukarya

- **Supergroup: Excavata**
  - Clade 2: Diplomonads
  - Clade 2: Parabasalids
  - Clade 2: Euglenozoans
  - Clade 2: Kinetoplastids

- **Supergroup: Archaeplastida**
  - Clade 2: Rhodophyta
  - Clade 2: Charophyta
  - Clade 2: Eustigmatophyta
  - Clade 2: Chlorophyta

- **Supergroup: Unikonta**
  - Clade 3: Euglenids
  - Clade 3: Kinetoplastids

- **Supergroup: Rhizaria**
  - Clade 2: Forams
  - Clade 2: Radiolarians
  - Clade 2: Cercozoans

- **Supergroup: SAR**
  - Clade 1: Alveolates
  - Clade 1: Dinoflagellates
  - Clade 1: Ciliates
  - Clade 1: Apicomplexans
  - Clade 1: Oomycetes

- **Supergroup: Opisthokonts**
  - Clade 3: Entamoebas
  - Clade 3: Land Plants
  - Clade 3: Slime Molds

- **Supergroup: Stramenopila**
  - Clade 2: Bacillariophyta
  - Clade 2: Chrysophyta

- **Supergroup: Alveolates**
  - Clade 2: Dinoflagellates
  - Clade 2: Apicomplexans
  - Clade 2: Ciliates

- **Supergroup: Amoebozoans**
  - Clade 1: Forams
  - Clade 1: Cercozoans
  - Clade 1: Radiolarians

- **Supergroup: Opisthokonts**
  - Clade 3: Entamoebas
  - Clade 3: Nematodes
  - Clade 3: Fungi
  - Clade 3: Chondrozoans

- **Supergroup: Archaeplastida**
  - Clade 2: Chlorophyta
  - Clade 2: Charophyta
  - Clade 2: Eustigmatophyta

- **Supergroup: Unikonta**
  - Clade 3: Euglenids
  - Clade 3: Kinetoplastids

- **Supergroup: Rhizaria**
  - Clade 2: Forams
  - Clade 2: Radiolarians
  - Clade 2: Cercozoans

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  - Clade 1: Ciliates
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  - Clade 1: Oomycetes
Protista Classification

1. General Characteristics and structures – These organisms once were placed in a single kingdom but with new genetic information, it now appears this kingdom is polyphyletic. The individuals included in this new clade are all eukaryotes (with a nucleus and membrane-bound organelles) and most are single-celled.

2. Natural History – The first protist (eukaryotic) organism appears in the fossil record about 2.1 billion years ago during the Precambrian. It is believed the first protist was probably a non-pigmented heterotrophic form. It is believed that mitochondria and plastids were small prokaryotes that lived within other prokaryotes giving rise to new organelles. The serial endosymbiosis hypothesis suggests that mitochondria evolved before plastids through a series of endosymbiotic events.

3. Biogeography – The distribution of protists is worldwide; as a group, these organisms are both cosmopolitan and ubiquitous. Every individual species, however, has preferred niches and microhabitats, and all protists are to some degree sensitive to changes in their surroundings. The availability of sufficient nutrients and water, as well as sunlight for photosynthetic forms, is, however, the only major factors restraining successful and heavy protist colonization of practically any habitat on Earth.
Supergroup: Excavata

1. **General Characteristics and structures** – The members of this supergroup have similar cytoskeletal features and some members have an “excavated” groove on one side of their body.

2. **Natural History** – Each of the clades within the supergroup are monophyletic, but it is difficult to determine if this supergroup is monophyletic because the characteristics they have may have been found in the common ancestor of all eukaryotes.

3. **Biogeography** – The Excavata includes taxa that are photosynthetic, parasitic, symbiotic and heterotrophic. The three clades are the Diplomonads, the Parabasalids and the Euglenozoans.

Diagrammatic representations of the proximal cytoskeletons of Excavata
Supergroup: Excavata

Clade$_2$: Diplomonads

1. General Characteristics and structures – The members of this clade have modified mitochondria called mitosomes. They lack functional electron transport chains and cannot use oxygen to make ATP. They are anaerobic. They also have two equally sized haploid nuclei.

2. Biogeography – Many Diplomonads are parasitic. Our Example is Giardia lamblia which parasitize the intestines of mammals. In California, it can be found in the highest streams in the Sierras.

3. Unique Characteristics - It can infect people when they drink contaminated water. It can cause cramps and severe diarrhea.
1. **General Characteristics and structures** – The members of this clade have reduced mitochondria called hydrogenosomes. They are anaerobic and release hydrogen peroxide as a by-product. They also have a modified flagella with an undulating membrane.

2. **Biogeography** – Many parabasalids are parasitic. Our Example is *Trichomonas vaginalis*.

3. **Unique Characteristics:** It causes *Vaginitis* by infecting the vagina and urethral mucus membranes and can be transmitted by sexual intercourse. Males often have no symptoms when infected.
1. **General Characteristics and structures** – The members of this clade all have a rod with either a spiral or a crystalline structure inside each of their flagella. They also have a disc-shaped cristae.

2. **Biogeography** – The members of this clade are very diverse including predators, heterotrophs, photosynthetic autotrophs and parasites. The two best known groups are in the clades: Kinetoplastids and Euglenids.
Supergroup: Excavata

Clade$_2$: Euglenozoans

Clade$_3$: Kinetoplastids

1. **General Characteristics and structures** – The members of this clade have a single, large mitochondrion that contains a large mass of DNA called a kinetoplast.

2. **Biogeography** – The members of this clade include species that feed on prokaryotes in freshwater, marine and most terrestrial habitats. There are also species that parasitize animals, plants, and other protists.

3. **Unique Characteristics**: Our example is a *Trypanosoma* which is a human pathogen that causes African Sleeping Sickness in Africa spread by the TseTse Fly and Chagas Disease in South America spread by the Kissing Bug.
Supergroup: Excavata

Clade$_2$: Euglenozoans

Clade$_3$: Euglenids

1. **General Characteristics and structures** – The members of this clade have an anterior pocket with one or two flagella emerging from the pocket.

2. **Biogeography** – They are commonly found in freshwater especially when it is rich in organic materials, with a few marine and endosymbiotic members.

3. **Unique Characteristics** - Many members of this clade are called mixotrophs because they are autotrophic in sunlight but when unavailable, they can become heterotrophic.
Supergroup: SAR

1. **General Characteristics and structures** – The members of this supergroup are grouped together based on two pieces of evidence: 1) DNA Sequence Data and 2) the secondary endosymbiotic relationship with a red algae.

2. **Natural History** – Evidence suggests this supergroup evolved over a billion years ago with the incorporation of plastids from a red algae although some lack plastids and it is believed these were lost later in their evolutionary history.

3. **Biogeography** – The SAR include taxa that are very diverse including some of the most important photosynthetic organisms on Earth. It also includes organisms that make up our large kelp forests and some important pathogens. This supergroup can be divided into three clades: the Alveolates, the Stramenopiles, and the Rhizaria.
Supergroup: SAR
Clade$_1$: Alveolates

1. **General Characteristics and structures** – The monophyletic grouping for this clade is well supported by DNA similarities. The members of this clade also include species with membrane-bound sacs (alveoli) just under the plasma membrane.

2. **Biogeography** – The Alveolates include three different clades: 1) the Dinoflagellates, 2) the Apicomplexans, and 3) the Ciliates.
Supergroup: SAR

Clade₁: Alveolates

Clade₂: Dinoflagellates

1. **General Characteristics and structures**
   – This clade is identified by the reinforced cellular plates with two flagella, one apical and one in a groove within the plates.

2. **Biogeography**
   – The dinoflagellates are abundant in both marine and freshwater plankton.

3. **Unique Characteristics**
   – In California, these organisms are responsible for Red Tides. These organisms release a neurotoxin that can be magnified in filter feeding shellfish and can cause respiratory distress or even death. Many of the species are mixotrophs.
1. **General Characteristics and structures** – This clade is identified by the apical structure of the sporozoite. This apical complex is used to penetrate their host.

2. **Biogeography** – The Apicomplexans are all internal parasites of animals. The pathogenic species are now mainly confined to Africa, Asia and Latin America in tropical and subtropical areas where the Anopheles mosquito can breed.

3. **Unique Characteristics** – One of the best know species is *Plasmodium sp.* which causes Malaria. The host species of this disease is the *Anopheles* mosquito. It attacks a human’s red blood cells.
Supergroup: SAR
Clade 1: Alveolates
Clade 2: Ciliates

1. **General Characteristics and structures** – This clade is identified by cilia which is used for movement or feeding. They also have two distinct nuclei, a macro and a micronuclei.

2. **Biogeography** – The Ciliates are a diverse group that is common almost everywhere there is water — in lakes, ponds, oceans, rivers, and soils. Ciliates have many ectosymbiotic and endosymbiotic members, as well as some obligate and opportunistic parasites.

3. **Unique Characteristics** – The macronuclei control the functions of the cell and the micronuclei are exchanged during conjugation (sexual reproduction) where the organisms are side by side. They reproduce asexually through transverse binary fission (end to end).
Supergroup: SAR
Clade₁: Stramenopiles

1. **General Characteristics and Structures** - Members of this group include members that have flagellum with numerous fine, hair like projections.

2. **Biogeography** – This is the clade that includes some of the most important photosynthetic organisms on the planet. It also includes several clades of heterotrophs. The Stramenopiles include four different clades: 1) the Diatoms, 2) the Golden Algae, 3) the Brown Algae and 4) the Oomycetes (Water Molds).
Supergroup: SAR

Clade₁: Stramenopiles

Clade₂: Diatoms

1. **General Characteristics and structures** – This clade is identified by cell walls made up of overlapping silica tests called a frustule.

2. **Biogeography** – The diatoms are unicellular algae that are a large component of phytoplankton in oceans and lakes.

3. **Unique Characteristics** – Fossilized diatoms accumulate in sediments known as diatomaceous earth. These sediments are mined to use as a filtering medium and can be found in products like paints and toothpastes. After a bloom, many diatoms die and are left un-decomposed on the ocean floor which removes their carbon from the carbon cycle. This acts as a carbon sink, a natural way of reducing carbon dioxide emissions that contribute to global climate change.
Supergroup: SAR

Clade₁: Stramenopiles

Clade₂: Golden Algae

1. **General Characteristics and structures** – This clade is identified by their color due to yellow and brown carotenoids (xanthophyll). The cells of these organisms are typically bi-flagellated, with both flagella near one end of the cell.

2. **Biogeography** – The Golden Algae are components of fresh water and marine plankton.

3. **Unique Characteristics** – While most species are photosynthetic, some species are mixotrophic. Most species are unicellular but the one in lab is colonial. They can form protective cysts under extreme conditions and can survive for decades.
Supergroup: SAR
Clade₁: Stramenopiles
Clade₂: Brown Algae

1. **General Characteristics and structures** – This clade is the largest and most complex multicellular algae. They get their color from the brown or olive color (pigments: carotene, fucoxanthin) in their plastids. The intertidal species are subject to desiccation and wave action and have evolved a cell-wall with cellulose and a gel-like substance called algin (a polysaccarhide) to reduce drying and help cushion them from waves.

2. **Biogeography** – The Brown Algae are mostly marine found along temperate coasts where the water is cool.

3. **Unique Characteristics** – The algin is used to thicken processed foods such as ice cream, pudding, salad dressing and other products like paint.
Supergroup: SAR
Clade₁: Stramenopiles
Clade₂: Brown Algae

External Structures – A representative of the brown algae is the common seaweed, *Fucus*, often called kelp or rockweed. It occurs in the rocks along seashores. Seaweeds are multicellular and made up of differential tissues and organs that resemble those we find in plants. They lack true roots, stems and leaves and are called a thallus. A thallus consists of a holdfast (used for attachment), a stem-like stipe, and leaf-like blades. On the blades are air bladders that are used to help the blades float and on the ends are receptacles that are swollen areas at the ends of the blades that contain the reproductive components for the algae. The small pores that enter the receptacles are called ostioles.
Supergroup: SAR
Clade₁: Stramenopiles
Clade₂: Brown Algae

**Internal Structures** – The *ostioles* in the *Fucus* receptacles lead into chambers called *conceptacles*. Observe both the male and female conceptacles, which are available on prepared slides. In the male, find the branched *antheridia* and the *sperm*. Surrounding the antheridia, there are sterile hairs called *paraphyses*, which are used for protection (top picture). In the female, observe the *oogonia* and its *eggs* along with the *paraphyses* (bottom picture).
Supergroup: SAR
Clade$ _1$: Stramenopiles
Clade$ _2$: Brown Algae

**Alternation of Generation** – The brown algae life cycle consists of a cycle with multicellular haploid and diploid forms. This term refers to the fact that both forms are multicellular. This pattern will also be seen in higher plants. The structure most people identify as “algae” is a sporophyte structure that is diploid.
Supergroup: SAR
Clade$_1$: Stramenopiles
Clade$_2$: Oomycetes

1. **General Characteristics and structures** – They have hyphae like a fungus (and at one point they were thought to be a fungus) but their cell walls are made of cellulose (fungus cell walls are made of chitin). This clade includes the water molds, the white rusts, and the downy mildews.

2. **Biogeography** – The Oomycetes have lost their plastids and are therefore either decomposers or parasites. Water molds are usually parasites on dead algae and animals in fresh water and the white rusts and downy mildews are usually plant parasites.

3. **Unique Characteristics** – The Oomycetes are responsible in the 19th century for the French Wine Crisis and for the Potato Famine in Ireland causing the Irish to migrate to North America and Russia.
Supergroup: SAR
Clade₁: Rhizaria

1. General Characteristics and structures – The members of this clade have similar DNA sequences even though they vary greatly in morphology. Many of the former amoebas were included with this clade but we now know they are distinctly different and belong in this clade and are characterized by thin like pseudopodia.

2. Natural History – Each of the clades within the larger clade are monophyletic. The three clades are the Cercozoans, the Forams and the Radiolarians.

3. Biogeography – The Rhizaria are found in marine, freshwater or soil ecosystems.
Supergroup: SAR
Clade$_1$: Rhizaria
Clade$_2$: Cercozoans

1. **General Characteristics and structures** – This clade includes most of the amoeboid-shaped Protista with thin pseudopodia.

2. **Biogeography** – The Cercozoans are predators, and parasites found in freshwater, marine, and soil ecosystems.

3. **Unique Characteristics** – They have evolved a sausage-shaped internal structure through endosymbiosis of a cyanobacteria for photosynthesis (a chromoatophore) which is different from the cyanobacteria that produced plastids in other organisms.
Supergroup: SAR
Clade1: Rhizaria
Clade2: Forams

1. **General Characteristics and structures** – This clade includes the amoebas with thin pseudopodia and a calcium carbonate test. (Foramen is Latin for little hole).

2. **Biogeography** – The Forams are found in both ocean and freshwater habitats attached to sand, rocks or algae. Others are found in plankton.

3. **Unique Characteristics** – Most Forams are known from fossils and make up sedimentary rock. They also are symbiotic with photosynthetic algae that can live in their calcium carbonate test and provide them with nourishment.
Supergroup: SAR
Clade1: Rhizaria
Clade2: Cercozoans

1. **General Characteristics and structures** – This clade includes the amoebas with thin pseudopodia and a delicate silica skeleton.

2. **Biogeography** – The Radiolarians are common as marine plankton.

3. **Unique Characteristics** – Most Radiolarians are planktonic and when they die, their skeletons sink to the bottom and form a radiolarian ooze covering much of the sea floor.
Supergroup: Archaeplastida

1. **General Characteristics and structures** – The members of this supergroup have similar DNA sequences and cell structure (The plastids are endosymbiotic cyanobacteria).

2. **Natural History** – Evidence suggests this supergroup evolved over a billion years ago with the incorporation of plastids from a cyanobacteria.

3. **Biogeography** – The Archaeplastida contain the red algae, green algae, and the higher plants.

![Biological classification diagram showing the relationships between red algae, chlorophytes, charophyceans, and plants.](image)
1. **General Characteristics and structures** – This clade includes 6000 known species that are reddish in color (pigment: phycoerythrin) which hides the green chlorophyll color. The red pigment allows them to absorb green and blue wavelengths of light that penetrate relatively far into the water. Their life cycle lacks a flagellated stage.

2. **Biogeography** – The red algae are the most abundant large algae in the warm coastal waters of tropical oceans.

3. **Unique Characteristics** – They are eaten as “nori”, the wrap around sushi. In the red algae life cycle, the structure most people identify as “algae” is either a structure that is haploid (n) or tetraploid (4n).
Supergroup: Archaeplastida
Clade $2$: Chlorophytes

1. **General Characteristics and structures** – This clade includes species that are similar to higher plants in color (pigment: Chlorophyll A and B and carotenoids). They are so similar to plants that some want to include them in a kingdom with plants called Virdiplantae.

2. **Biogeography** – The Chlorophytes are found in marine, freshwater and terrestrial ecosystems and are even found in snow.

3. **Unique Characteristics** – They are one of two groups (along with the Charophytes) that are commonly called green algae.

![Image](image.png)

- (a) *Ulva*, or sea lettuce
- (b) *Caulerpa*, an intertidal chlorophyte
Supergroup: Archaeplastida
Clade$_2$: Chlorophytes
Ex. *Desmids*

1. **General Characteristics** - A group of chlorophytes, that are usually **unicellular** with an **isthmus** between its two halves.

2. **Unique Characteristics** – Within the isthmus, you will find the **nucleus**. In the two halves, you will find the **chloroplasts**.

3. **Habitat** - They are a very common alga found **floating in fresh water**.
1. **General Characteristics** - A group of chlorophytes that are a *colonial species* which consists of hundreds to thousands of *vegetative cells* arranged in a single, spherical layer held together by a gelatinous secretion and joined together by *protoplasmic strands*.

2. **Unique Characteristics** – Reproduction may occur by binary fission where *daughter colonies* are formed.

3. **Habitat** - *Volvox* is a *freshwater alga* and is found in ponds and ditches, even in shallow puddles.
1. **General Characteristics** - A group of chlorophytes that are either unicellular are found in small colonies.

2. **Unique Characteristics** – One of the terrestrial alga that is often confused with mosses.

3. **Habitat** - It is found as a thin, green covering on the moist, shaded side of trees, rocks, and soil.
Supergroup: Archaeplastida
Clade₂: Chlorophytes

Ex. *Spirogyra*

1. **General Characteristics** - A group of chlorophytes that occur in multicellular filaments. The Chloroplasts are found in ribbon-like strands, which spiral through the cells. The nucleus is usually found near the center of the cell.

2. **Unique Characteristics** – *Spirogyra* can reproduce asexually or sexually. Asexually, they reproduce by fragmentation usually due to high winds. Sexually, they can reproduce through the process of conjugation. Two haploid filaments under certain conditions will form. The male and female gametes are identical in size and are called isogametes. The male gamete can be recognized because it travels across the conjugation tube to combine with the female gamete and form a diploid zygospore. New filaments are made when the zygospore goes through meiosis and produces new filaments.

3. **Habitat** - It is found in freshwater ponds.
Supergroup: Archaeplastida
Clade₂: Chlorophytes  
**Ex. Ulothrix**

1. **General Characteristics** - A group of chlorophytes that occur in multicellular filaments. They have a single bracelet-like chloroplast in each cell. The structure that most people identify as alga (the filaments) are haploid.

2. **Unique Characteristics** – *Ulothrix* is of interest because it has developed a holdfast, which is a clear example of specialization. The holdfast is often hard to find on prepared slides.

3. **Habitat** – *Ulothrix* is found in fresh water and marine environments and thrive in spring and winter in cool temperatures.
Supergroup: Archeplastida

Clade$_2$: Charophytes

1. **General Characteristics and structures** – This clade includes species that are similar to higher plants in color (pigment: Chlorophyll A and B and carotenoids). They are the closest relatives of land plants.

2. **Biogeography** – The Charophytes are found in ponds and lakes with the ancestors of higher plants living on the edge and were subject to occasional drying.

3. **Unique Characteristics** – They are one of two groups (along with the Chlorophytes) that are commonly called green algae. They have four distinctive traits that are shared with higher plants:
   1. Rings of cellulose-synthesizing proteins
   2. Peroxisome enzymes
   3. Structure of flagellated sperm
   4. Formation of a phragmoplast
Supergroup: Unikonta

1. General Characteristics and structures – The members of this supergroup either include a single flagella (in those species that have one) and the fusion of three genes or have lobed or tube-shaped pseudopodia.

2. Natural History – Evidence suggests this supergroup might have been the first group of eukaryotes to evolve from other eukaryotes.

3. Biogeography – The Unikonta include two distinct clades: 1) The Amoebozoans and 2) the Opisthokonts
Supergroup: Unikonts

Clade₁: Amoebozoans

1. General Characteristics and structures – This clade is well supported by DNA evidence. These clades have lobe or tube-shaped pseudopodia.

2. Biogeography – The Amoebozoans include three different clades: 1) the Slime molds, 2) the Gymnamoebas, and 3) the Entamoebas.
1. **General Characteristics and structures** – This clade includes species that were once thought to be fungi because they possess hyphae and their fruiting bodies. Molecular evidence suggests that they are Amoebozoans.

2. **Biogeography** – The Slime molds include more than 900 species and occur all over the world and feed on microorganisms that live in any type of dead plant material. They contribute to the decomposition of dead vegetation, and feed on bacteria, yeasts, and fungi. For this reason, these organisms are usually found in soil, lawns, and on the forest floor, commonly on decomposing logs.

3. **Unique Characteristics** – They are divided into two groups distinguished by their unique life cycles: the Plasmodial Slime Molds and the Cellular Slime Molds.
Supergroup: Unikonta
Clade\(_1\): Amoebozoans
Clade\(_2\): Slime Molds
Clade\(_3\): Plasmodial Slime Molds

1. **General Characteristics and structures** – They are brightly colored (yellow or orange) and have hyphae that are multinucleated (Coenocytic)

2. **Biogeography** – These organisms are usually found in soil, lawns, and on the forest floor, commonly on decomposing logs.

3. **Unique Characteristics** - They form a plasmodium for feeding and reproduction.
Supergroup: Unikonta
Clade ₁: Amoebozoans
Clade ₂: Slime Molds
Clade ₃: Cellular Slime Molds

1. **General Characteristics and structures** – They are usually clear and have hyphae that are mono-nucleated (Septate).

2. **Biogeography** – These organisms are usually crawl through dung, soil, rotting mushrooms, decaying leaves and other organic material.

3. **Unique Characteristics** - They form a plasmodium during stress and reproduction.
Supergroup: Unikonta

Clade$_1$: Amoebozoans

Clade$_2$: Gymnamamoebas

1. **General Characteristics and structures** – This clade includes species that have broad pseudopods and usually lack a test.

2. **Biogeography** – The Gymnamamoebas are found in soil, fresh water, and marine environments.

3. **Unique Characteristics** – The majority of amoeba are free living heterotrophs but some feed on detritus (non-living organic material).
Supergroup: Unikonta
Clade₁: Amoebozoans
Clade₂: Entamoebas

1. **General Characteristics and structures** – This clade includes amoeba species that are parasitic.

2. **Biogeography** – The Entamoebas infect all classes of vertebrate animals along with some invertebrates.

3. **Unique Characteristics** – There are six different species that infect humans. The only species that is known to be pathogenic is *Entamoeba histolytica*. Infection causes amebic dysentery and is spread from contaminated food and water. It is responsible for up to 100,000 deaths every year.
Supergroup: Unikonta

Clade₁: Opisthokonts

1. General Characteristics and structures – This clade is a very diverse group. One common characteristic of Opisthokonts is the flagellate cells, such as most animal sperm and chytrid spores, propel themselves with a single posterior flagellum.

2. Biogeography – The Opisthokonts include four different clades: 1) Nucleariids, 2) the Fungi, 3) the Choanoflagellates and the 4) the Animals.
Supergroup: Unikonta
Clade₁: Opisthokonts
Clade₂: Nucleariids

1. **General Characteristics and structures** – This clade lacks distinctive characters but it does include amoeboid species that contain a posterior flagella.
2. **Biogeography** – The Nucleariids are known from soil and freshwater.
3. **Unique Characteristics** – They form temporary pseudopods for feeding and locomotion.
Supergroup: Unikonta

Clade$_1$: Opisthokonts

Clade$_2$: Choanoflagellates

1. **General Characteristics and structures** – This clade consists of organisms that are free-living unicellular and colonial flagellated eukaryotes. There make up is very similar to the collar cells (choanocytes) seen in sponges.

2. **Biogeography** – There are over 125 extant species of choanoflagellates distributed globally in marine, brackish and freshwater environments from the Arctic to the tropics, occupying both pelagic and benthic zones.

3. **Unique Characteristics** – DNA evidence has confirmed that this clade is the sister group to the animal kingdom.