18.4: Phylum Chlorophyta and Phylum Streptophyta

The nature of the evolutionary relationships between the green algae are still up for debate. As of 2019, genetic data supports splitting the green algae into two major lineages: chlorophytes and streptophytes. The streptophytes include several lineages of green algae and all land plants. Streptophytes and chlorophytes represent a monophyletic group called Viridiplantae (literally “green plants”).

Organisms that are classified as green algae share the following characteristics:

- **Morphology**: Unicellular to multicellular; two whiplash flagella on motile cells
- **Cell wall composition**: Cellulose
- **Chloroplasts**: 2 membranes, pigments are chlorophyll a, chlorophyll b, and carotenoids
- **Storage carbohydrate**: Starch
- **Life cycle**: Varies, but primarily haplontic. Some marine species have alternation of generations.
- **Ecology**: Freshwater, marine, and terrestrial species

**Selection Pressures and Drivers**

1. **Sun Damage**. Green algae represent a diverse group of organisms with diverse life history traits, many of which are shared with land plants. The development of **carotenoids**—yellow, orange, and red pigments that act in both light harvesting and sun protection—offers this group increased access to sunlight while simultaneously protecting against UV damage. UV rays do not penetrate very far into the water column, so organisms moving into shallower waters or terrestrial environments would need to deal with this new challenge. Many terrestrial species of green algae appear orange, rather than green, due to the production of large amounts of carotenoids.
Observing the Life Cycle of Green Algae

Though green algae display a diversity of life cycles, many have a haplontic life cycle. A model organism for the green algae is *Spirogyra*. *Spirogyra* is a unicellular green algae that grows in long, filamentous colonies, making it appear to be a multicellular organism. Even though it is technically unicellular, its colonial nature allows us to classify its life cycle as haplontic. In the haploid vegetative cells of the colony, the chloroplasts are arranged in spirals, containing darkened regions called **pyrenoids** where carbon fixation happens. Each haploid cell in the filament is an individual, which makes sexual reproduction between colonies an interesting process. Note the nucleus suspended in the center of each cell in the colony on the right.

![Spirogyra vegetative colony](https://bio.libretexts.org/Bookshelves/Botany/Book%3A_Botany_Lab_Manual_(Morrow)/18%3A_Red_and_Green_Algae/18.4…

When two colonies of *Spirogyra* meet that are of a complementary mating type (+/-), sexual reproduction occurs.

The two colonies align, each cell across from a complementary cell on the other filament. A **conjugation tube** extends from each cell in one colony, inducing formation of a tube on the cells in the other colony. The conjugation tubes from each colony fuse together.
The contents of one cell will move through the conjugation tube and fuse with the contents of the complementary cell, resulting in a diploid \textit{zygote}.
The zygote appears as a large, egg-like structure contained within the complementary cell. It has a thick wall that provides resistance to desiccation and cold, allowing colonies of *Spirogyra* to overwinter, when needed. The other colony is now a filament of empty cells that will be broken down by some decomposer.

When conditions are right, the zygote undergoes meiosis to produce another vegetative colony of haploid cells.

In the life cycle diagram below, indicate where meiosis and fertilization occur. Label a **vegetative cell**, **chloroplast**, **pyrenoid**, **nucleus**, **conjugation tube**, and **zygote**. Choose a color for the zygote to indicate that this structure is diploid.
What type of life cycle is this?

**Contributors and Attributions**

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