LIFE-CYCLES
and
The Green Algae

Life-Cycle of the Sea Lettuce (*Ulva*)

Green Alga (*Ulothrix*)
Some Basic Biological Processes

Life Cycle

Reproduction and Biological Reproduction

Sex

Sexual Reproduction

Asexual Reproduction
What Is a Life Cycle?

**Life Cycle** = Sequence of stages in the growth and development of an organism.
What Is Reproduction?

Reproduction = Process by which something makes copies of itself.

What Is Biological Reproduction?

Biological Reproduction = Process of reproduction in organisms; biological copies, i.e., offspring, may be genetically identical to parent or they may be genetically different due to mutation and genetic recombination.
What Is Sex?

Sex = Introduction of some of the genes from one organism into another (prokaryotes) or the combining of all of the genes from two different parts (gametes) of the life cycle of an organism (eukaryotes).
What Is Sexual Reproduction?

Sexual Reproduction = Biological reproduction in which sex is combined with the process of reproduction (most eukaryotes).
What Is Asexual Reproduction?

**Asexual Reproduction** = Biological reproduction in which sex is not part of the process of reproduction (all prokaryotes and some eukaryotes).
Life Cycle, Reproduction, and Sex

**Life Cycle** = Sequence of stages in the growth and development of an organism.

**Reproduction** = Process by which something makes copies of itself; in biological reproduction the copies, i.e., offspring, may be genetically identical to the parent or they may be genetically different due to mutation and genetic recombination.

**Sex** = Introduction of some of the genes from one organism into another (prokaryotes) or the combining of all of the genes from two different parts (gametes) of the life cycle of an organism (eukaryotes).

**Sexual Reproduction** = Biological reproduction in which sex is combined with the process of reproduction (most eukaryotes).

**Asexual Reproduction** = Biological reproduction in which sex is not part of the process of reproduction (all prokaryotes and some eukaryotes).
Prokaryotes
Sex Not Linked with Reproduction

Eukaryotes
Sex and Reproduction Linked

Types of Sex

Prokaryotic Sex
- Donor Cell (1N) → Recipient Cell (1N)
- **Conjugation**

Eukaryotic Sex
- Unicell (1N)
- Gametes (1N)
- **Fertilization**
- Zygote (2N)
- Diplophase (2N)
- Haplophase (1N)
- **Meiosis**
- Spores (1N)
BASIC EUKARYOTIC SEXUAL LIFE-CYCLE

Haplophase (1n) → Haplophase (1n) → UNICELL (1N) → GAMETES (1N) → **FERTILIZATION** → ZYGOTE (2N) → Diplophase (2n) → **MEIOSIS** → (SPORES (1N)) → Haplophase (1n)

* Some Algae & All Plants
IMPORTANT FEATURES of EUKARYOTIC SEX

(1) FERTILIZATION & MEIOSIS

(2) GAMETES (and sometimes SPORES) 1n; ZYGOTE 2n

(3) HAPLOIDY & DIPLOIDY

(4) ALTERNATION OF GENERATIONS: HAPLOPHASE & DIPLOPHASE
THE THREE TYPES of MEIOSIS in EUKARYOTES

**Gametic Meiosis** - Gametes Produced by Meiosis and are the Only Haploid Part of the Life-Cycle (many Protozoa and all Animals)

**Zygotic Meiosis** - Zygote undergoes Meiosis and is the Only Diploid Part of the Life-Cycle (many Algae)

**Sporic Meiosis** - Spores Produced by Meiosis and Develop into a Multicellular Haploid “Gametophyte” (some Algae and all Plants)
EUKARYOTIC SEXUAL LIFE-CYCLES

**HAPLOBIONTIC-Diploid** = with one Biont* that is Diploid & Gametic Meiosis (many Protozoa and all Animals)

**HAPLOBIONTIC-Haploid** = with one Biont* that is Haploid & Zygotic Meiosis (many Algae)

**DIPLOBIONTIC** = with two Bionts* (a Haploid Gametophyte & a Diploid Sporophyte) & Sporic Meiosis (some Algae and all Plants)

**Diplobiontic-Isomorph** = with Bionts* morphologically identical (some Algae)

**Diplobiontic-Heteromorph** = with Bionts* morphologically different (a few algae and all Plants)

*An actual organism, not merely stages in a life-cycle, such as gametes or spores.*
HAPLOBIONTIC-Diploid Life-Cycle (with Gametic Meiosis)
Many Protozoa & All Animals

Haplophase (1n)

Diplophase (2n)
HAPLOBIONTIC-Haploid Life-Cycle (with Zygotic Meiosis)
Many Algae

Diplophase (2n)

Haplophase (1n)

* Gametophyte if Multicellular

Biont in Box
DIPLOBIONTIC-Isomorphic Life-Cycle
(Sporic Meiosis)

Ulva life cycle

Diplophase (2n)
- Sporophyte 2n
- Germinating zygote
- Zygote 2n
- Fertilization

Haplophase (1n)
- Spore (1n)
- Gametophyte (1n)
- Gamete
- Fertilization

Bionts (2) in Boxes
GREEN ALGAE
Ancestors of the Plant Kingdom
Plant-Like Characters of the Green Algae

1. Chlorophyll A & B

2. Starch as the Food Reserve

3. Cell Walls with Cellulose

4. Motile Cells with Two Anterior, Whiplash Flagella (most Green Algae)

5. Cell Division by Cell Plate Formation Rather than Furrowing (some Green Algae)
Chlamydomonas
Archetypical Basal Green Alga

Zygote
Volvolcine Green Algae Evolution

- **Chlamydomonas** (1)*
- **Gonium** (4-16-32)*
- **Pandorina** (16-32)*
- **Eudorina** (16-32)*
- **Pleodorina** (32-64-128)*
- **Volvox** (1,000-50,000)*

* Number of Cells
Pandorina morum

Cells in Colony Similar
Pleodorina

Cells in Colony Differentiated

- Non-Reproductive Cells
- Reproductive Cells
Volvox with Daughter Colonies
Volvox Cells
Showing Eyespot and Flagella
Ulothricine Green Algae

*Freshwater Filamentous Green Algae*

I. Unbranched Filaments

*Ulothrix*

*Oedogonoum*

II. Branched Filaments

*Stigeoclonium*

*Fritschiella*
Ulothrix
Oedogonium
(with Zygote)
ULVOPHYTES

Marine Coenocytic or Membranous Green Algae

I. Siphonaceous (Coenocytic, i.e., Multinucleate)
   
   *Bryopsis*, *Caulerpa*

   *Acetabularia*

II. Membranous - *Ulva*
Bryopsis
Caulerpa paspaloides
Acetabularia
(Mermaid’s Wine Glass)
Ulva (Sea Lettuce)
Ulva (Sea Lettuce)
CHAROPHYTES

Group That Gave Rise to the Plant Kingdom

I. Filamentous to Secondarily Unicellular
   A. Filamentous (Unbranched) - Spirogyra
   B. Secondarily Unicellular - Desmids

II. Parenchymatous - Coleochoaete

III. Stoneworts - Chara, Nitella
Green Alga *Spirogyra* (lower):
Note Grass Green Color

Cyanobacterium *Anabaena* (upper):
Note Blue-Green Color
Spirogyra Conjugation
Desmids
Coleochaete
One of the Green Algae Most Closely Related to Plants
Stoneworts
(Chara)

Habit: Note Stoneworts Are Coenocytic (Multinucleate)

Male Gametangia (with sperm)
Female Gametangium (with egg)
Chara Sex Organs
Male (left), Female (right)