VIRUSES

- The word virus is derived from the Latin language and means a poisonous liquid or poison.
- Viruses have been variously defined by scientists and can be regarded as living or non-living.
- They are the smallest and possibly the most primitive living organisms yet known to science.
- Bowden (1964)defined viruses as submicroscopic infective entities that multiply only intracellularly and are potentially pathogenic.
- Virology is an aspect of microbiology that specializes in the study of viruses.

- Viruses are responsible for many common human diseases, such as colds, flu, diarrhea, chicken pox, measles, and mumps.
- Some viral diseases such as rabies, hemorrhagic fevers, encephalitis, polio, yellow fever, and acquired immunodeficiency syndrome (AIDS) can result in death.
- German measles and cytomegalovirus can cause serious abnormalities or death in unborn infants.
- Of the estimated 1000 to 1500 types of viruses, approximately 250 cause disease in humans.

Viruses are living because;

- They show growth
- They show mutation
- They react to heat, chemicals and radiation
- They have genetic materials ie. RNA or DNA
- They show irritability
- They have ability to infect
- They are able to multiply in number in the same genetic type.

The non-living characteristics of viruses include;

- They can be crystallized
- They are inert outside the host
- A cell wall or cell membrane of any type is absent
- They do not show functional anatomy
- They do not respire or excrete
- They are dependent on living organisms
- They lack any energy producing enzyme system.

Unique Characteristics of Viruses

- Presence of only one type of nucleic acid either RNA or DNA.
- Capacity to reproduce from their sole nucleic acid.
- They do not undergo binary fission.
- They make use of the ribosomes of their host cell.

LIFE CYCLE OR REPLICATION OF BACTERIOPHAGE

Two types of life cycle are exhibited by bacteriophage;

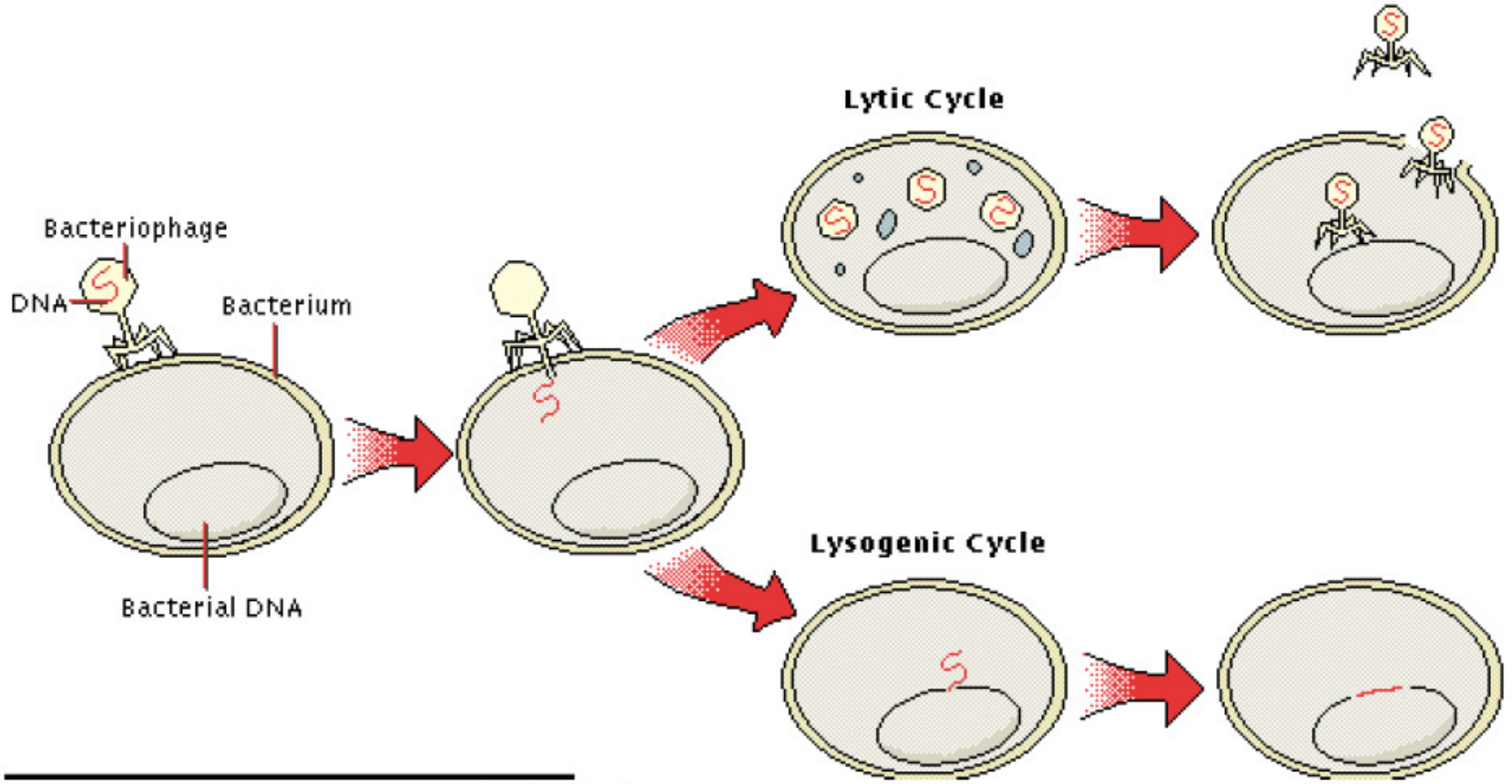
a) Virulent or lytic

b) Temperate or lysogenic.

In virulent life cycle, the intracellular phage multiplication leads to the disintegration and release of virions while in temperate life cycle no harm is done to the cell of the host bacterium.

The major events involved in the lytic cycle of T-even phages are;

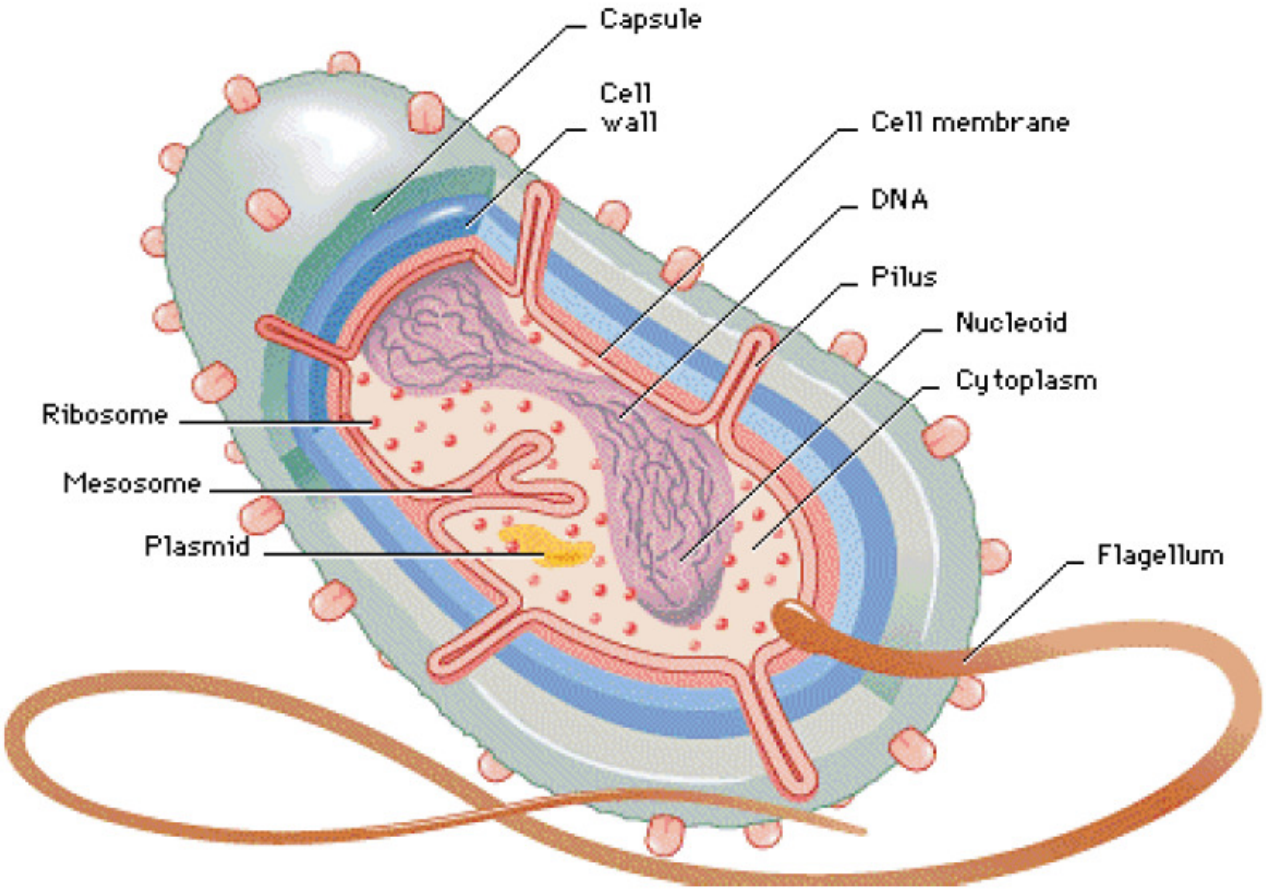
- i) attachment of phage particle to the host
- ii) penetration into the host
- iii) replication of viral nucleic acid
- iv) protein synthesis
- v) assembly of new virions
- vi) release of mature viruses

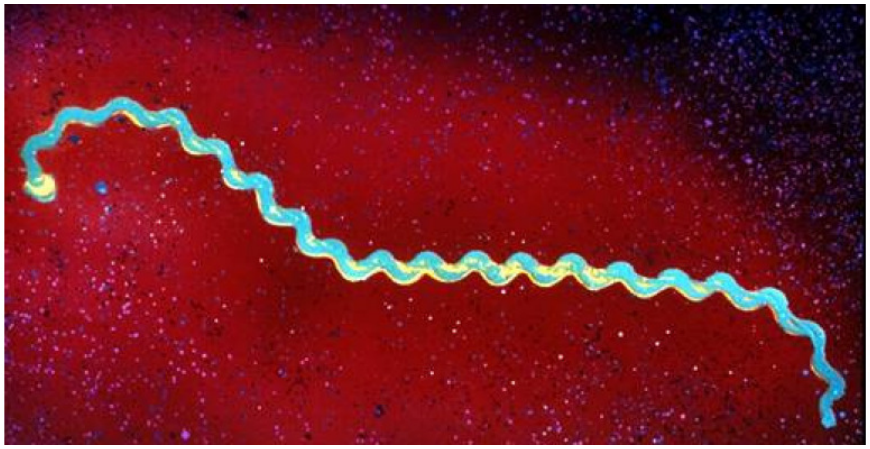


Lytic and Lysogenic Cycles of a Bacteriophage

All bacteriophages (viruses that parasitize bacteria) have a *lytic* or infectious cycle, in which the virus, incapable of replicating itself, injects its genetic material into a bacterium. By pirating its host's enzymes and protein-building capacities, the virus can reproduce and repackage, making about 100 new copies before it bursts from and destroys the bacteria. Some bacteriophages, however, behave differently when they infect a bacterium. The injected genetic material instead integrates itself into its host DNA, passively replicating with it to be inherited by bacterial daughter cells. In about 1 in 100,000 of these *lysogenic* cells, the viral DNA spontaneously activates and starts a new lytic cycle.

BACTERIA


Capsule
Cell wall
Cell membrane
DNA
Pilus
Nucleoid
Cytoplasm
Ribosome
Mesosome
Plasmid
Flagellum



ALGAE

- Algae are autotrophic, non-vascular aquatic or semi aquatic plants
- They range from unicellular microscopic forms to multi cellular macroscopic plants many meters in length
- They are found in oceans, freshwater, ponds, reservoirs, temporary water bodies, soil and moist surfaces

Classification of Algae

CRITERIA FOR ALGAL CLASSIFICATION

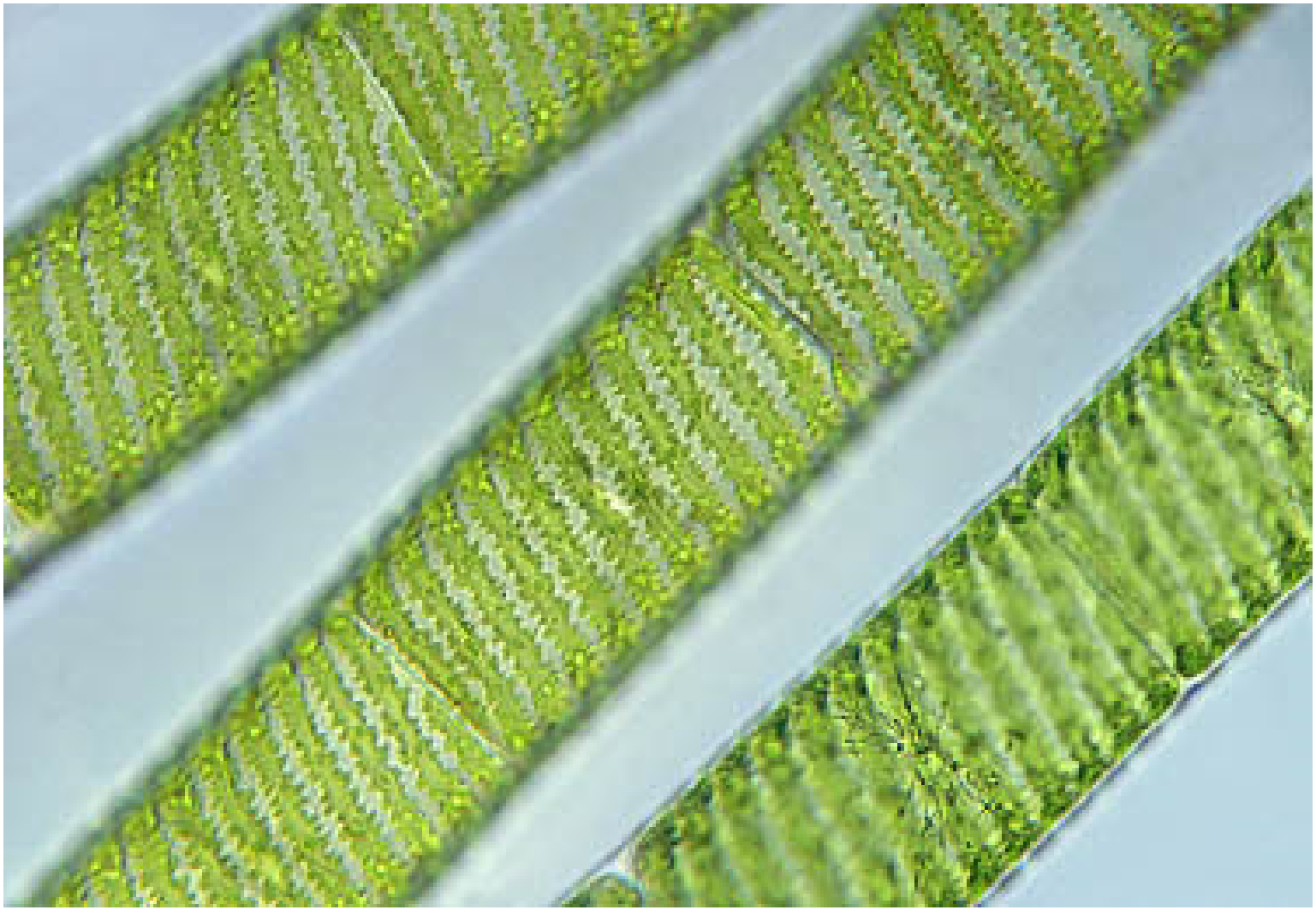
- Pigmentation
- Habitat
- Cell wall components
- Stored food reserve
- flagellation

Classification of Algae

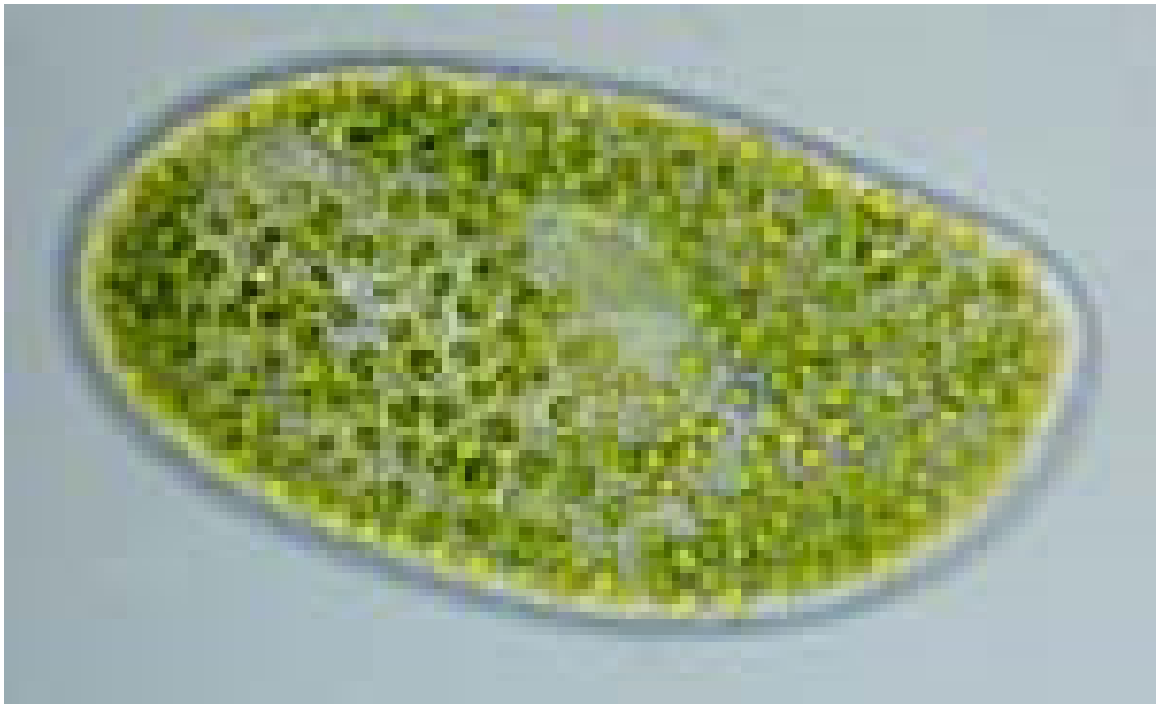
- Chlorophyta (green algae)
- Phaeophyta (brown algae)
- Rhodophyta (red algae)
- Chrysophyta (diatoms, yellow-green and golden-brown algae)
- Euglenophyta (euglenoids)
- Pyrrhophyta (dinoflagellates)

Chlorophyta (green algae)

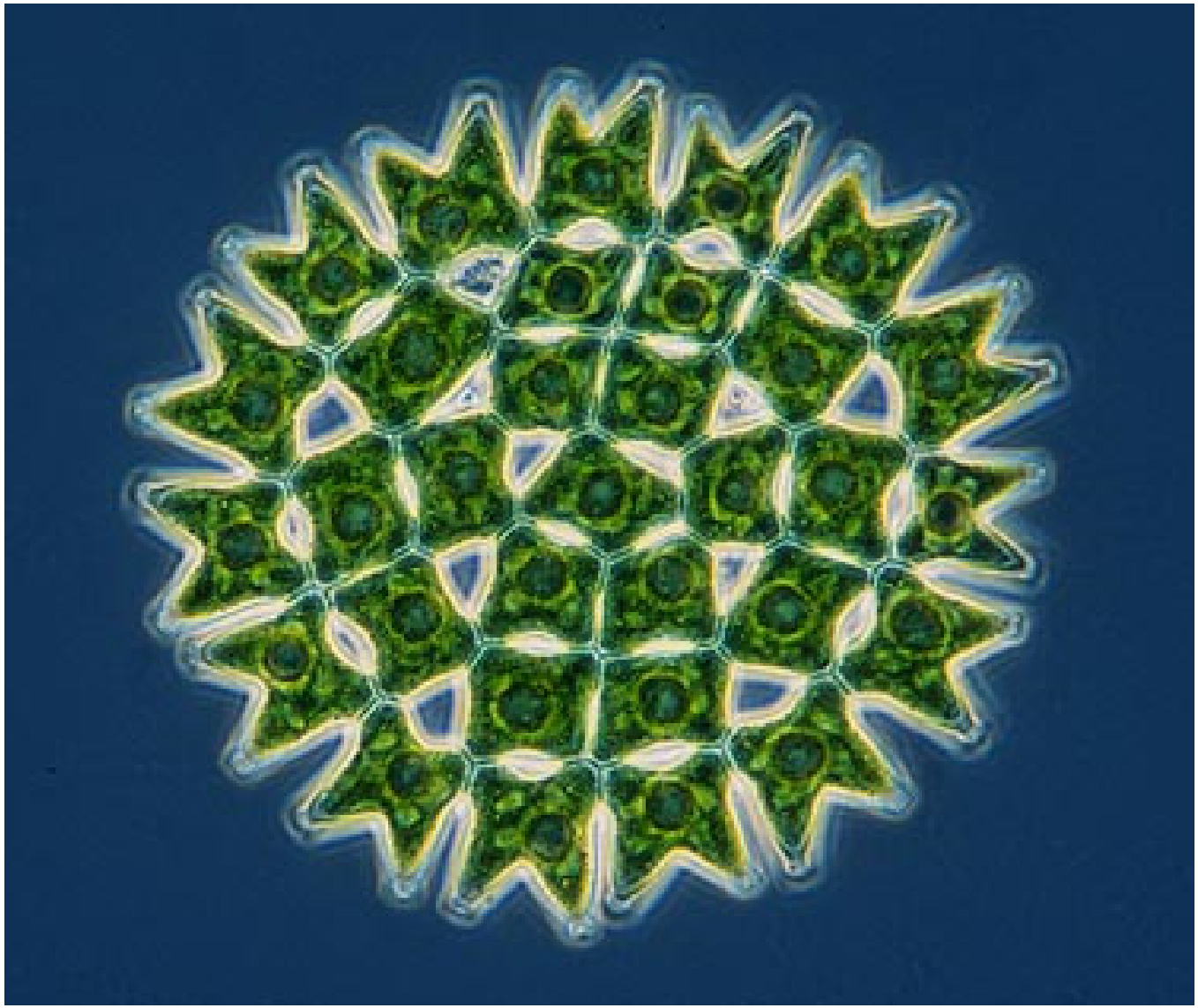
- chlorophyll a and b and carotenoids
- Present in both aquatic, semi-aquatic and terrestrial environments
- Cell wall components are polysaccharides, including cellulose
- Food reserve in the form of starch
- They may be colonial or filamentous, although unicellular forms with 1 – 8 whiplash flagella abound.



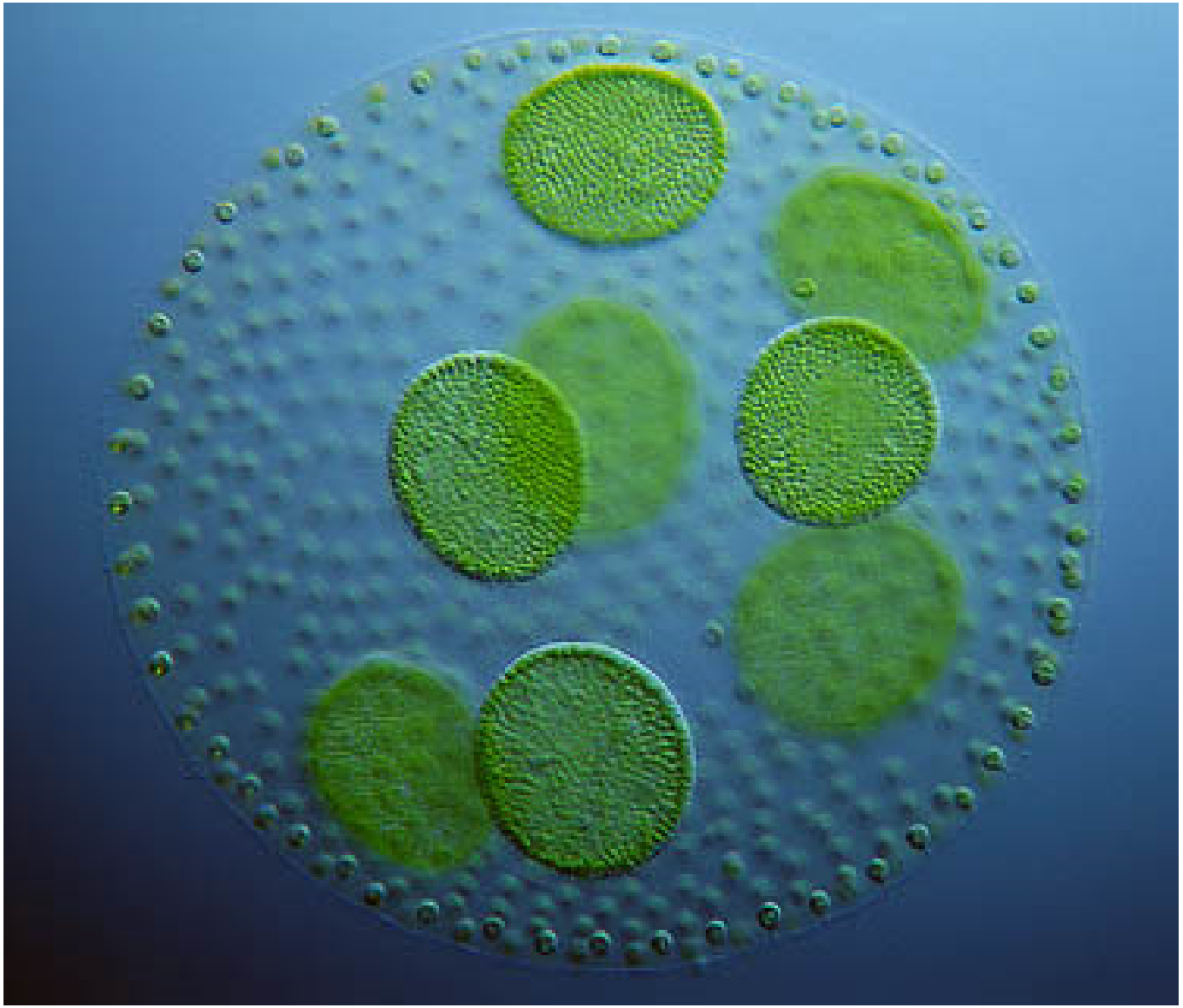
Spirogyra



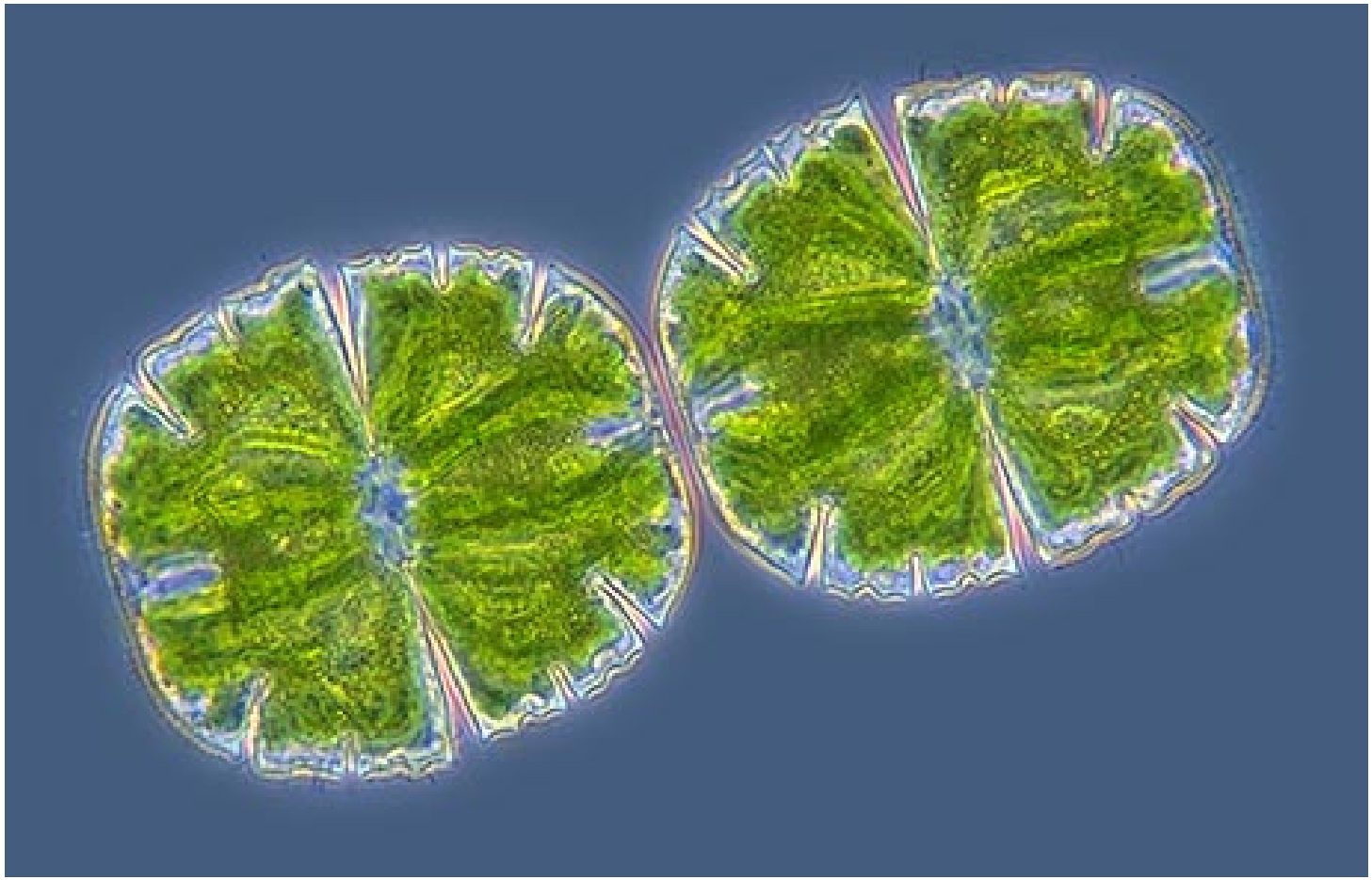
Chlorella



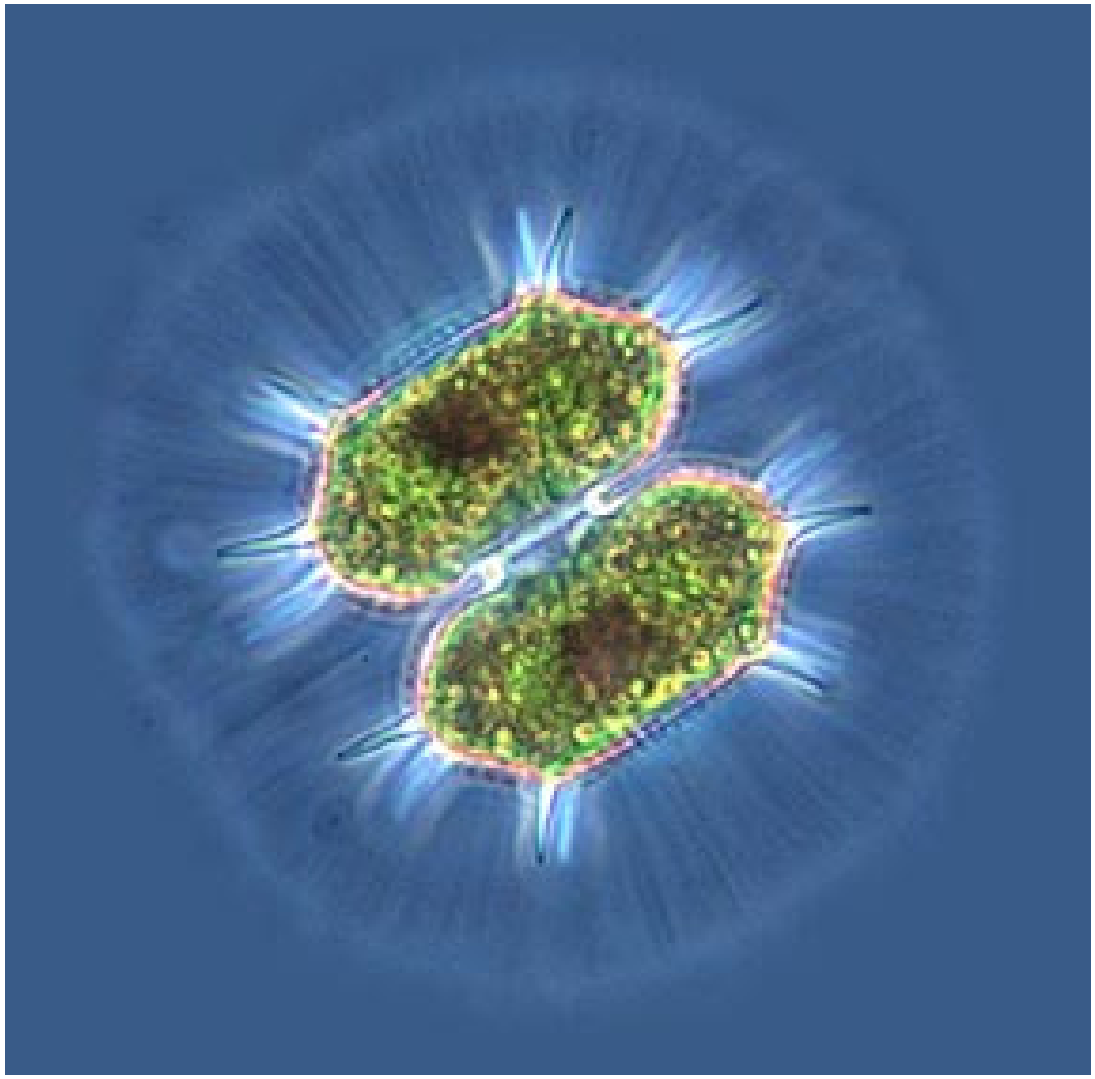
Pediastrum



Volvox



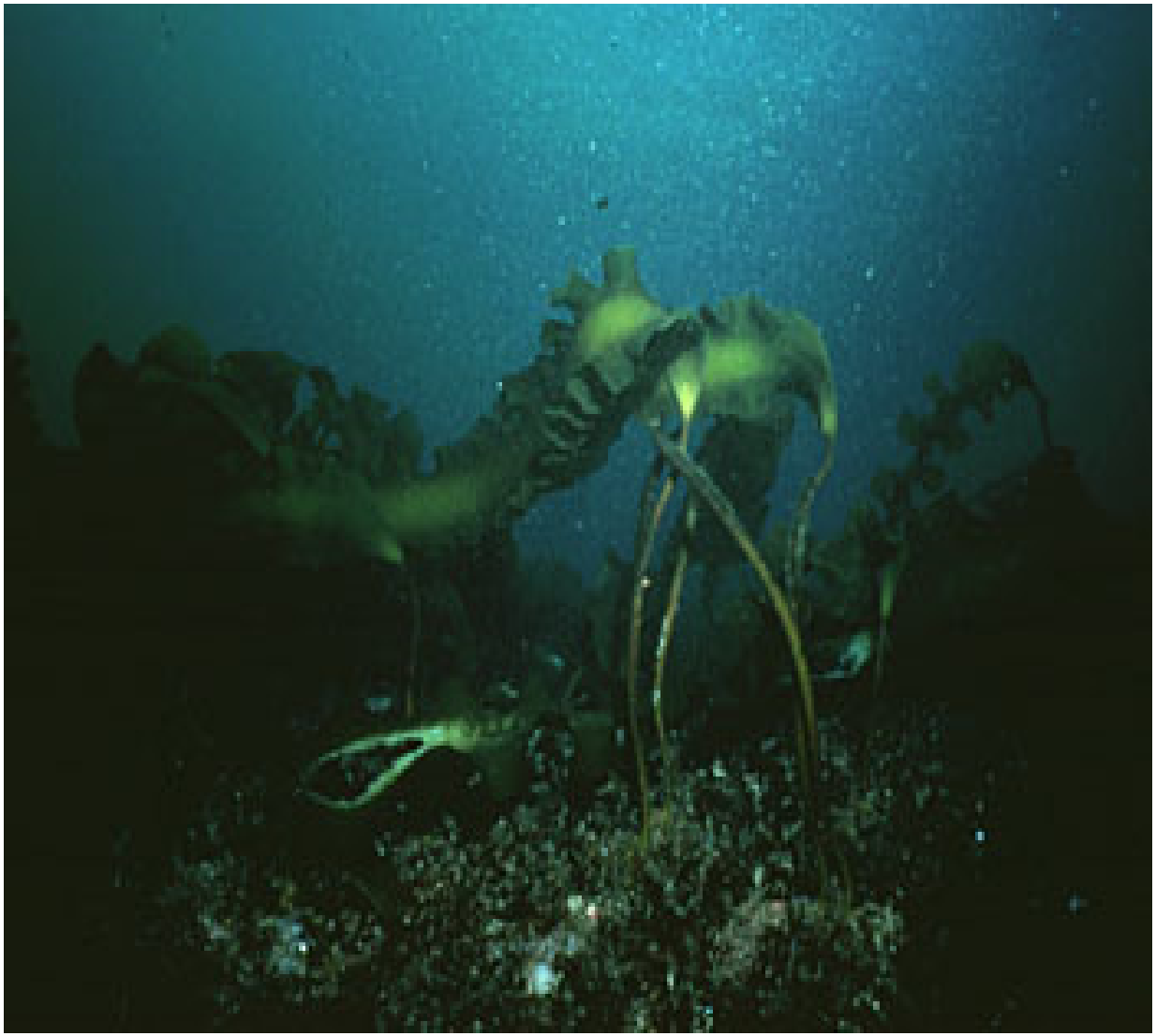
Two *Micrasterias truncata* still attached after cell division



Staurastrum

Phaeophyta (brown algae)

- Photosynthetic pigments are chlorophylls a and c, fucoxanthin and carotenoids
- Almost all marine, although a few freshwater species are present.
- Cell wall components are cellulose, alginic acid and sulfated polysaccharides.
- Food reserve laminarin and mannitol
- Produce pear-shaped spores with 2 laterally inserted tinsel and whiplash flagella



Laminaria longicarpa

Nereocystis luetkeana

Fucus serratus

Nereocystis luetkeana

Sargassum

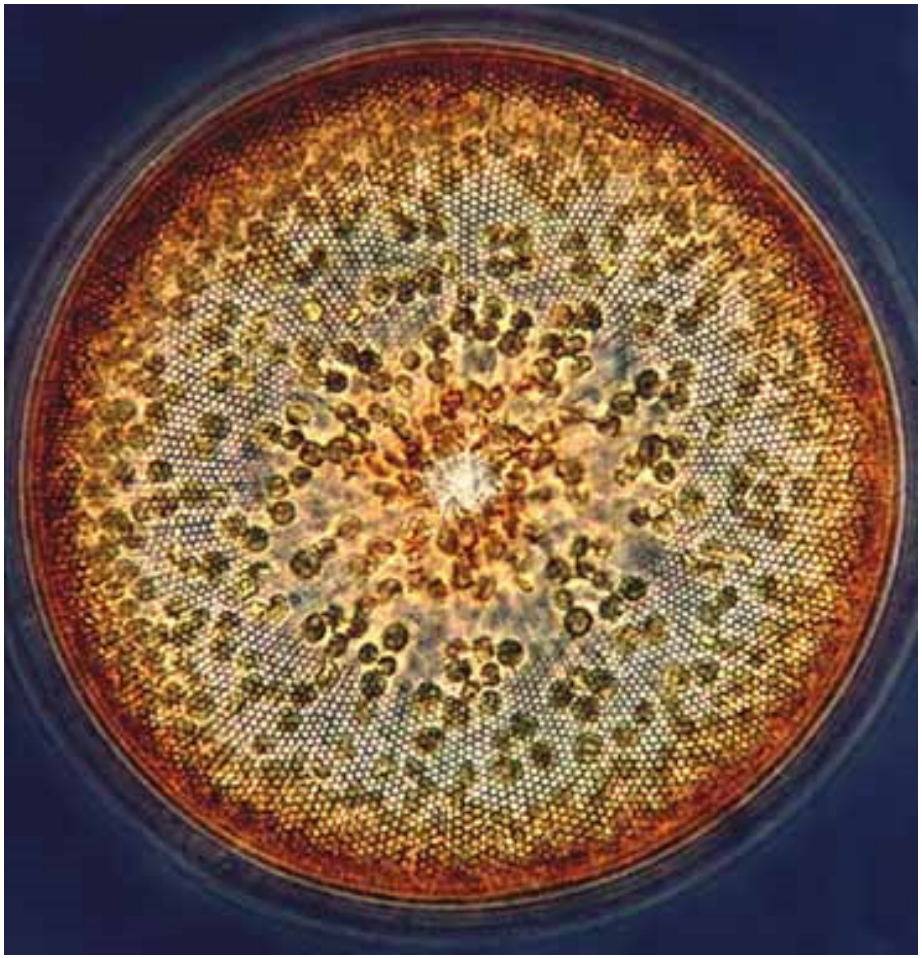
Division Rhodophyta (red algae)

- Photosynthetic pigments are chlorophyll a, carotenoids and phycobilins.
- Present in marine &freshwaters microscopic filament or macroscopic leafy branches. Major components of coral reefs
- Stored food is floridean starch
- Their cell wall components are cellulose, pectin and calcium salts
- Flagellated cells absent

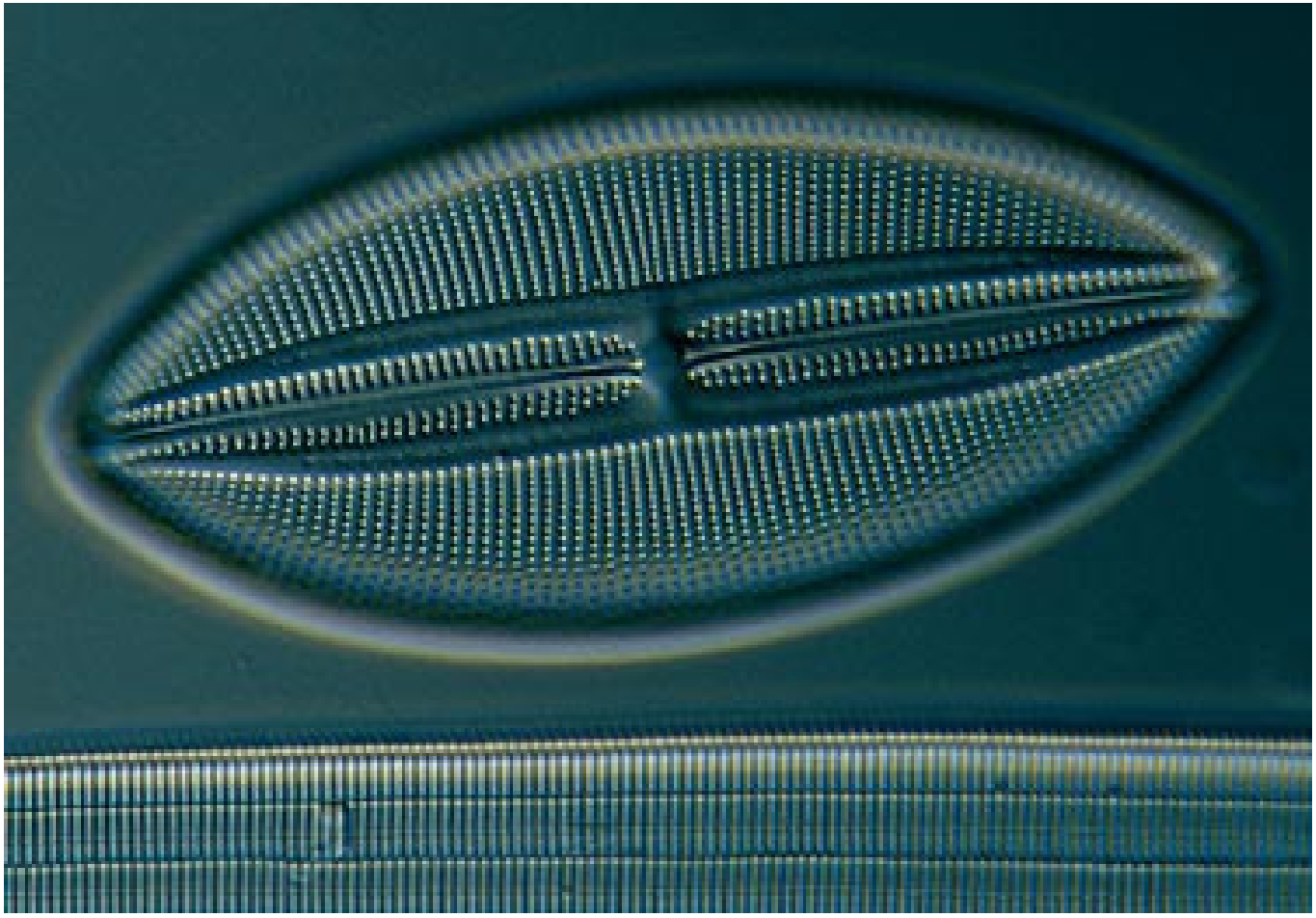
Porphyra

Gracillaria

Chrysophyta (yellow-green, golden-brown algae and diatoms)



Coscinodiscus



Navicular

BRYOPHYTES

- The bryophytes are small, seedless, non vascular plants consisting of liverworts, hornworts and mosses.
- They evolved from aquatic to terrestrial ecosystems.
- Bryophytes live in almost all places that plants can grow and in many places where vascular plants cannot grow.
- They are often the first plants to invade an area after a fire, grow at elevations from sea level to 5,500 meters. There are no marine bryophytes.

- Their life cycle is dominated by free living, photosynthetic haploid gamete-producing plant – the gametophyte; which regularly alternates with a diploid, spore-bearing plant – the sporophyte.
- Bryophytes require free water to carry out sexual reproduction.
- Members reproduce asexually by fragmentation of gametophyte or by special bodies known as gemmae (singular, gemma).
- Gametangia – antheridia and archegonia) are surrounded with sterile cells.

CLASSIFICATION OF BRYOPHYTES

- There are three major Divisions of bryophytes, namely;
  - Division Hepaticophyta (liverworts)
  - Division Anthocerophyta (hornworts)
  - Division Bryophyta (mosses)

CLASS HEPATICAE (Liverworts)

- These are the most primitive bryophytes and consist of simple, flat, ribbon-like, green thallus
- There are about 8,500 species of liverworts and they range in size from 0.5mm in diameter to thallus more than 20 cm wide.
- All liverworts have a prominent gametophyte which sometimes has a waxy cuticle.

- They have the following distinguishing features;
- unicellular rhizoids
- The entire thallus is photosynthetic, and the lower side modified for storage in a few species.
- A dominant haploid gametophyte has two shapes; leafy and thallose (a plant body undifferentiated into root, stem and leaves).
- Leafy gametophytes are often lobed and bilaterally symmetrical. They lack mid rib.

The diploid sporophyte of liverworts lack stomata.

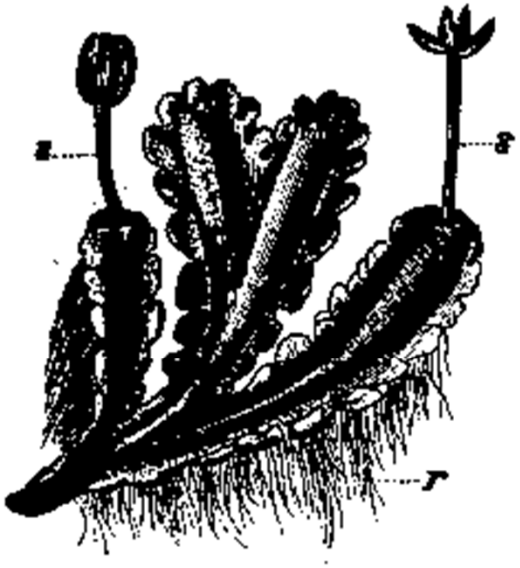
- Their sporangia are often unstalked.
- They shed spores from sporangia for a relatively short time.
- Liverworts reproduce asexually by death of old parts of the plant or by fragmentation.
- They also bear ovoid, star-shaped or lens-shaped pieces of haploid tissues called gemmae.

Leafy Liverworts

Bazzania

Lophocolea

- Kny's Wall Chart Showing Male Gametophyte of *Marchantia* a thallose liverwort



Thallose liverwort -
bilaterally symmetrical
rhizoids unicellular

Leafy liverwort -
bilaterally symmetrical
rhizoids unicellular
leaves without a midrib

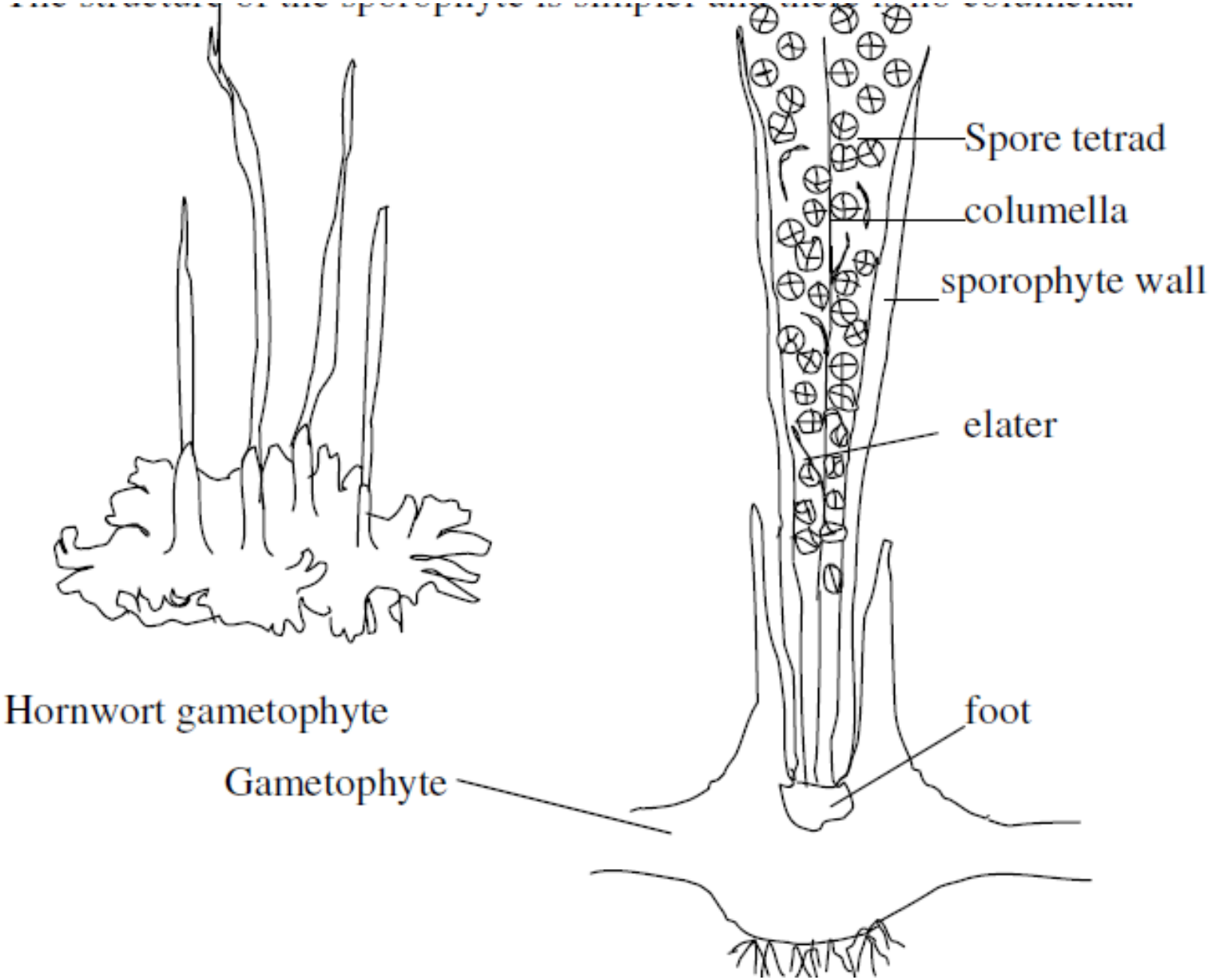
CLASS ANTHOCEROTAE (Hornworts)

- Members of this class have the simplest gametophyte of bryophytes. They are about 100 species in six genera; the most familiar of which is *Anthoceros*, a temperate genus.
- Hornworts have several features that distinguish them from other bryophytes:

➢ The sporophyte is shaped like a tapering horn, hence the common name hornwort.

➢ Each photosynthetic cell contains one to only a few chloroplasts; and each chloroplast is associated with a starch-storing body called pyrenoid as in the cells of green algae and vascular plants.

- Archegonia and antheridia are enclosed snugly in the sporophyte thallus and are in contact with the surrounding vegetative (non reproductive) cells of the thallus.
- The flat dark green gametophytes are structurally simpler than those of the other bryophytes. They are flattened and may superficially resemble those of thallose liverworts. Hornwort gametophytes are either annual or perennial and are anchored to the substratum by rhizoids.
- Sex organs form on the upper surface of thallus. One or more antheridia resembling those of liverworts form in roofed chambers in the upper portion of the thallus and the archegonia form in rows beneath the surface.
- Asexual reproduction is by fragmentation.
- The diploid sporophyte of hornworts differs remarkably from those of other bryophytes. They are long, green spindles (1-4cm long), with tapering tips. They are semi independent, photosynthetic and can live for several months on the gametophyte while spores are released over time.


Spore tetrad
columella
sporophyte wall
elater
foot
Hornwort gametophyte
Gametophyte

Class Musci (Mosses)

- Mosses are remarkably successful land plants that thrive alongside more successful conspicuous vascular plants.
- They are the largest and most familiar group of bryophytes (approx. 12,000 species)
- Moss morphology is diverse and the gametophytes of nearly all species have two growth stages.

  (a) Creeping, filamentous stage – the protonema

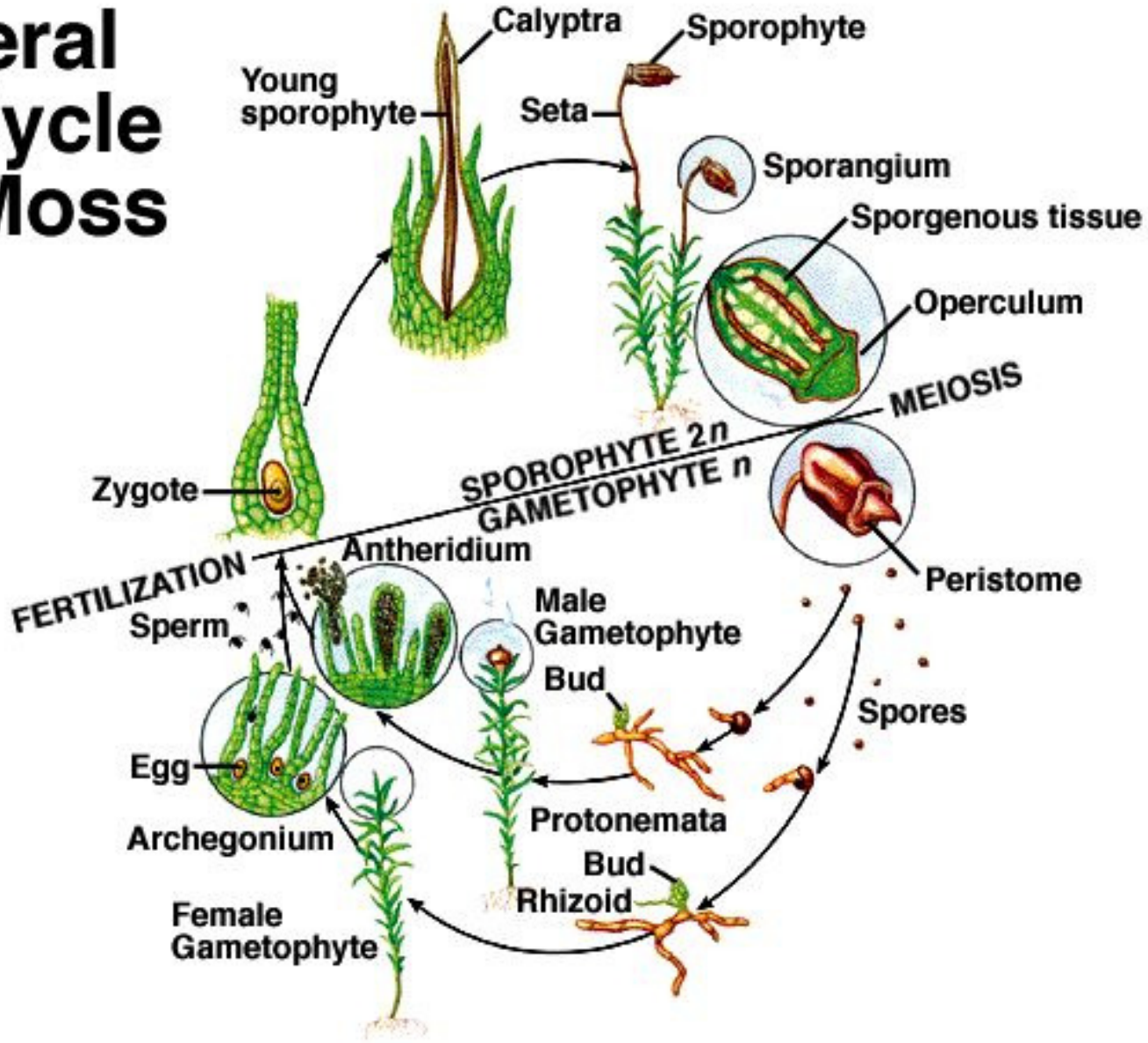
(b) The moss plant with an upright or horizontal stem bearing small, spirally arranged green leaves.

- The gametophytes also bear rhizoids at the base of the stem
- The mature sporophyte is brown, yellowish or reddish and has three parts; a foot, a seta (stalk) and a capsule covered by a calyptra.
- The foot grows into the gametophyte, absorbs water, minerals and nutrients from it.
- The wiry seta elongates and raises the capsule as much as 15 cm above the gametophyte.

- Specialized sporangium cells (sporogeneous tissues) of the capsule undergo meiosis forming as many as 50 million haploid spores per capsule.
- Spores that land on suitable environment germinate, forming protonemata and thus complete the life cycle.
- Mosses include, *Sphagnum, Funaria, Polytrichium, Bryum, Mnium, Dicranoweisia* etc

Moss -
radially symmetrical
rhizoids multicellular
leaves with or without a midrib

General Life Cycle of a Moss




CAPSULE
SETA

ECONOMIC IMPORTANCE OF BRYOPHYTES

- They are generally not edible.
- They are used as furniture stuffing, soil conditioners, for fuel.
- They serve as absorbent in oil spills and for cushioning.
- Florists use peat moss as a damp cushion when shipping plants.
- *Sphagnum* serves as disinfectant for some Aboriginal people and for wound dressing.

- North American Indians used *Mnium* and *Bryum* to treat burns.
- *Dicranoweisia* has been used to water proof roofs in Europe.
- Bryophyes reduce erosion, condition soil and are often among the first organisms to invade disturbed areas.
- Many of them grow on specific habitats and are sensitive to pollution.

Ecological Role of Bryophytes

- Many are pioneer plants, growing on bare rock and contributing to soil development.
- In bogs and mountain forests they form a thick carpet, reducing erosion.
- In forest ecosystems they act like a sponge retaining and slowly releasing water
- They provide habitat for other plants and small animals as well as microorganisms like N_2-fixing blue-green bacteria
- Lacking a cuticle and transport tissue they readily absorb whatever is around them and can serve as bioindicators of pollution and environmental degradation

PTERIDOPHYTES
(Seedless vascular plants)

The seedless vascular plants are primarily ferns, but they also include

- DIVISION PSILOTOPHYTA - whisk ferns (which are not true ferns),
- LYCOPODIOPHYTA – club and spike mosses
- DIVISION EQUISETOPHYTA – horsetails
- DIVISION POLYPODIOPHYTA - ferns

Features of the seedless vascular plants that enable them to thrive on land include;

- a resistant cuticle
- complex stomata
- vascular tissues
- absorptive root hairs
- desiccation - resistant spores.

DIVISION PSILOTOPHYTA

- This is the most primitive of all vascular plants.
- This is because they have no leaves and root. Instead of root hairs they have rhizomes with absorptive rhizoids.
- There are two genera in the division; *Psilotum* and *Tmesipteris*.
- Majority of whisk ferns abound in fossil are extinct and their remains preserved in fossil form

Psilotum

DIVISION LYCOPODIOPHYTA

- They are also known as Lycopods and most of the species are included in 2 genera, club mosses (*Lycopodium*, about 400 species) and the spike mosses (*Selaginella*, about 700 species), both of which get their common names from their club or spike shaped strobilli.
- Most species are terrestrial, but many are epiphytic (growing on other plants).

- The sporophytes of club mosses are differentiated into leaves (called microphyll), stem and roots.
- The roots branch from perennial rhizomes that sometimes grow outwards from a central point to form ‘fairy rings’.
- The Lycopodiophyta also include the quillworts (*Isoetes*) so named because of their narrow quill-like leaves.

DIVISION EQUISETOPHYTA

- These are also known as horsetails and represented by one living genus *Equisetum*, with about 15 species.
- *Equisetum* species are also called scouring rushes because their epidermal tissues contain abrasive particles of silica.
- They have true leaves and the stems are the dominant photosynthetic organs of the plant body. The most conspicuous feature of the stem is the presence of small leaves arranged in whorls.
- The branching pattern of *Equisetum* stem is unique among vascular plants. Their lateral branches sprout from between the leaf bases instead of growing from the leaf axils.

DIVISION POLYPODIOPHYTA

- Fern include approximately 12,000 living species, making them the largest seedless vascular plants.
- Ferns are primarily tropical plants, but species inhabit temperate regions and even deserts.
- The most conspicuous parts of the fern are the compound leaves called fronds. A pinna is the leaflet of a frond.
- New leaves grow from a fleshy rhizome.
- The leaves exhibit what is called circinate venation as they grow faster at their lower surface than the upper surface giving them initial curled shape.
- The curled young leaves are known as fiddleheads.

ECONOMIC IMPORTANCE OF PTERIDOPHYTES

- The seedless vascular plants have their greatest economic impact in fossil fuel deposits. Their spores are easy to identify and are associated with oil deposits.
- Many ferns are often found in greenhouses or are grown as houseplants and ground covers.
- *Azolla* is substituted as a rotated crop in rice paddies.
- As an aquatic plant, it harbors a cyanobacterium *Anabaena azollae* that fixes nitrogen from air thereby acting as a fertilizer to replenish nitrate in the soil.

- Native Americans treated wounds and nose bleeds with spores from *Lycopodium clavatum* a club moss. It has blood coagulant and antibiotic properties.
- Resins from the rhizome of *Dryopteris marginalis* was once used to get rid of intestinal tapeworms.
- Many species of Lycopodium synthesize several alkaloids that are potent animal poisons. The dried and powdered leaves containing these chemicals are used as pesticides in parts of Eastern Europe.

GYMNOSPERMS

- The term gymnosperm is derived from the Greek word *Gymnos* meaning "naked" and *sperma* meaning seed.
- Gymnosperms are plants whose pollens are carried by wind directly to ovules (unfertilized seeds) instead of to the stigma (as in flowering plants) and whose seeds are naked (not enclosed in fruits).
- By definition, gymnosperms are all seed plants without fruits.

- All are trees and shrubs with varying forms.
- Many have needle or scale leaves and most of these forms are evergreen.
- Some have broad leaves, and in others the leaves are palm like. A number of gymnosperms are extinct
- Their fossils consisting of beautifully preserved stems, roots, leaves and even pollen grains, have been found encased in coal and rock mines.
- Their naked seeds are borne on specialized structures called cones or strobili

There are considerably fewer species of gymnosperms than there are angiosperms.

Most classifications of gymnosperms include about 65 genera, 720 species in 4 divisions namely;

- Cycadophyta (cycads)
- Pinophyta (conifers)
- Ginkgophyta (maiden hair tree)
- Gnetophyta (Gnetum)

DIVISION CYCADOPHYTA

- There are about 10 genera and 100 species of cycads, distributed in the tropical and subtropical regions of the world.
- Cycads have palm like leaves that bear no resemblance to the leaves of other living gymnosperms. Under favorable conditions, cycads usually produce one crown of leaves each year.
- All cycads are dioecious.

Cycad

DIVISION PINOPHYTA

- The common name of this group, conifers, signifies plants that bear cones; even though other divisions of gymnosperms also include cone-bearing species.
- They include pines, firs, junipers, spruces and yew.
- Pines have short shoots, long shoots and two kinds of leaves. The more obvious type is the pine needle, which occur in groups called fascicles of 2 – 5 needles.

Part of a coniferous forest

Pine leaves or fascicles

Pine cone/strobilus

DIVISION GINKGOPHYTA

- Only one living representative, the maiden hair tree (*Ginkgo biloba*), remains in this very ancient division of plants.
- The trees are dioecious, having individual 'male' trees that produce pollen but no ovules and other 'female' trees that produce ovules and seeds.
- . Mature seeds have the size and appearances of small plums, but these are not fruits because *Ginkgo* has no ovary surrounded its ovules.

DIVISION GNETOPHYTA

- The gnetophyta are the most unusual of all gymnosperms and include some of the most distinctive of all seed plants.
- They are tropical plants mostly occurring in Asia, Africa and South America.
- There are 3 clearly defined genera and 71 species. These genera are;

  Ephedra (40 species)

  Gnetum (30 species) and

  Welwitschia (1 species). These genera also vary in their morphology and the division appears intermediate between gymnosperms and angiosperms.

Gnetum

Welwitschia mirabilis

ECONOMIC IMPORTANCE OF GYMNOSPERMS

- The gymnosperms are second only to the angiosperms in their daily impact on human activities and welfare. Their greatest economic impact comes from our use of their wood for making paper and lumber. Other important gymnosperms include;
- White spruce (*Picea glauca*) is the chief source of pulp wood for newsprint in temperate region.
- Conifers produce 75% f the world's timber and much of the pulp used to make paper.
- Douglas fir is the most desired timber tree and is heavily used in plywood and for large beams in construction.

- Wood from the red spruce (*Picea rubens*) is specially used for musical instruments like violin and box guitars.
- Some products from the bark of the gymnosperm pacific yew (*Taxus brevifolia*) have been found to shrink tumor caused by ovarian cancer. The drug Taxol, obtained from this plant has anticancer properties.
- Wood products from conifers like turpentine and rosin (the liquid and waxy component of resin) have been used in many processes including varnishes, deodorants, lotions, drugs, water proofing, etc.
- Gymnosperms are also important as part of national forests, parks and other recreational areas as well as symbols – Christmas tree and the tallest living plants are giant sequoias found in California in U.S.A are gymnosperms.