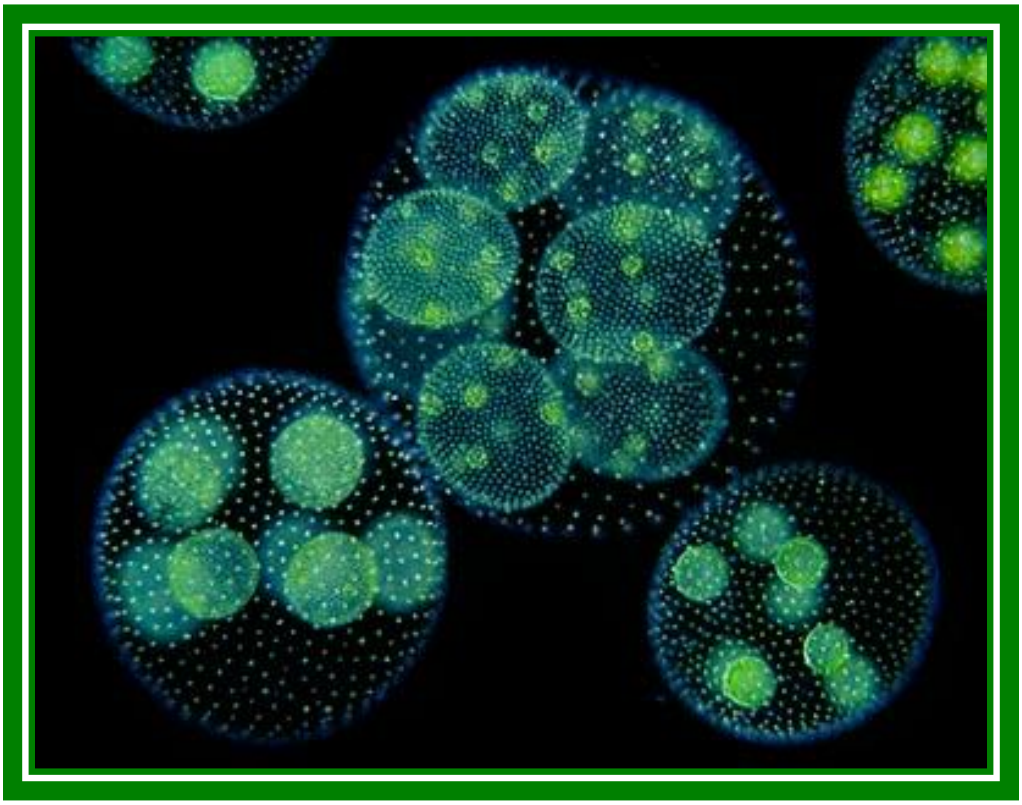
STAB 2124
BOTANI KRIPTOGAM



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KANDUNGAN

- **Kriptogamia** (*kryptos* = tersembunyi; *gamos* (kahwin)
  - Tumbuhan tanpa biji & bunga
    - **Thallophyta** (alga, fungi, bakteria & liken)
    - **Bryophyta** (lumut & lumut hati (liverwort)
    - **Pteridophyta** (paku-pakis)
- **Phanerogamia (**Greek *phaneros*, visible, evident.)
  - Gymnospermae
  - Angiospermae
    - Dicotyledonae
    - Monocotyledonae

PENGELASAN

Two kingdoms

- The classification of living things into animals and plants is an ancient one.
  - Aristotle classified animal species in his work the History of Animals
  - his pupil Theophrastus wrote a parallel work on plants (the History of Plants)
- Carolus Linnaeus distinguished two kingdoms of living things:
  - *Regnum Animale* ('animal kingdom') for animals
  - *Regnum Vegetabile* ('vegetable kingdom') for plants.
    - *Regnum Lapideum*.) for minerals
  - Linnaeus divided each kingdom into classes,
    - later grouped into
      - phyla for animals

- divisions for plants.

Three kingdoms

- In 1674, Antonie van Leeuwenhoek,
  - often called the "father of microscopy",
  - sent the Royal Society of London a copy of his first observations of microscopic single-celled organisms.
  - In 1866, Ernst Haeckel proposed a third kingdom of life.
  - whether organisms were unicellular (**Protista**) or multicellular (animals and plants).

Four kingdoms

- The development of
  - Microscopy, and
  - electron microscope
    - revealed an important distinction between those unicellular organisms whose cells do not have a distinct nucleus, **prokaryotes**,
    - and those unicellular and multicellular organisms whose cells do have a distinct nucleus, **eukaryotes**.
- In 1938, Herbert F. Copeland proposed a four-kingdom classification, moving the two prokaryotic groups, bacteria and "blue-green algae", into a separate Kingdom **Monera**.
- This required the creation, for the first time, of a rank above kingdom, a superkingdom or empire
  - Empire Prokaryota,
  - Empire Eukaryota

Five kingdoms

- The differences between fungi and other organisms regarded as plants had long been recognized.
- Robert Whittaker recognized an additional kingdom for the Fungi. The resulting five-kingdom system, proposed in 1969, has become a popular standard and with some refinement is still used in many works and forms the basis for newer multi-kingdom systems.
- It is based mainly on differences in nutrition;
    - Plantae were mostly multicellular autotrophs,
    - Animalia multicellular heterotrophs,
    - Fungi multicellular saprotrophs.
    - The remaining two kingdoms, Protista and Monera, included unicellular and simple cellular colonies.

Six kingdoms

- From around the mid-1970s onwards,
    - there was an increasing emphasis on molecular level comparisons of genes as the primary factor in classification; genetic similarity was stressed over outward appearances and behavior.
    - Taxonomic ranks, including kingdoms, were to be groups of organisms with a common ancestor,
    - Whether monophyletic (*all* descendants of a common ancestor) or
    - paraphyletic (only some descendants of a common ancestor).
- Based on such RNA studies, Carl Woese divided the prokaryotes (Kingdom Monera) into two groups
    - Eubacteria

- Archaebacteria

In 1990, the name "domain" was proposed for the highest rank.

Domain Bacteria	Kingdom Bacteria
Domain Archaea	Kingdom Archaea
Domain Eukarya	Kingdom Protista
	Kingdom Plantae
	Kingdom Fungi
	Kingdom Animalia

BIODIVERSITI

- "Biological diversity" or "biodiversity" can have many interpretations
- Biologists most often define biodiversity as the "totality of genes, species, and ecosystems of a region".
    - species diversity
    - ecosystem diversity
    - genetic diversity

How many species are known to currently exist in the world.		
Category	**Species**	**Totals**
Vertebrate Animals		
Mammals	5,490	
Birds	9,998	
Reptiles	9,084	
Amphibians	6,433	
Fishes	31,300	
Total Vertebrates		**62,305**
Invertebrate Animals		
Insects	1,000,000	
Spiders and scorpions	102,248	
Molluscs	85,000	
Crustaceans	47,000	
Corals	2,175	
Others	68,827	

Total Invertebrates		**1,305,250**
Plants		
Flowering plants (angiosperms)	282,00	
Conifers (gymnosperms)	1,000	
Ferns and horsetails	12,000	
Mosses	22,000	
Algae	19,000	
Lichens	17,000	
Fungi	50,000	
Bacteria	2,000	
Total Plants		405000
TOTAL SPECIES		**1,772,555**

	Bilangan spesies
Bakteria	2,000
Alga	19,300
Fungi	50,000
Liken	15,500
Bryophyta	22,000
Pteridophyta	11,000
Gymnospermae	700
Angiospermae	220,000
Dicotyledonae	170,000
Monocotyledonae	50,000
Jumlah	340,500

Charles Robert Darwin

- established that all species of life have descended over time from common ancestry, and proposed the scientific theory that this branching pattern of evolution resulted from a process that he called natural selection.
- He published his theory with compelling evidence for evolution in his 1859 book *On the Origin of Species*.
- His five-year voyage on HMS *Beagle*
- Puzzled by the geographical distribution of wildlife and fossils he collected on the voyage, Darwin investigated the transmutation of species and conceived his theory of natural selection in 1838.
- He was writing up his theory in 1858 when Alfred Russel Wallace sent him an essay which described the same idea, prompting immediate joint publication of both of their theories.

End Date (millions of years ago	Era	Period	Epoch	Organisma
0.1	**Cenozoic**	Quaternary	Recent	Modern humans appear
			Pleistocene	Woolly mammoth
2.5		Tertiary	Pliocene	Large Carnivores; apes
7			Miocene	Land mammals diversify
25			Oligocene	Primitives apes; horses
38			Eocene	Small horses
53			Paleocene	First carnivores, primates
65	**Mesozoic**	Cretaceous		Dinosaurs die out; flowering plants appear
135		Jurassic		Age of dinosaurs, birds arise
195		Triassic		First dinosaurs, mammals, forest of conifer
225	**Paleozoic**	Permian		First seed plants
280		Carboniferous		First reptiles appear
345		Devonian		First insects and amphibians appear
395		Silurian		Fishes dominant; first modern vascular plants invade land
430		Ordovician		Modern groups of algae and fungi appear
500		Cambrian		First fish, many invertebrates and marine plants
600	**Precambrian**			First eukaryotes; blue-green bacteria and bacteria abound

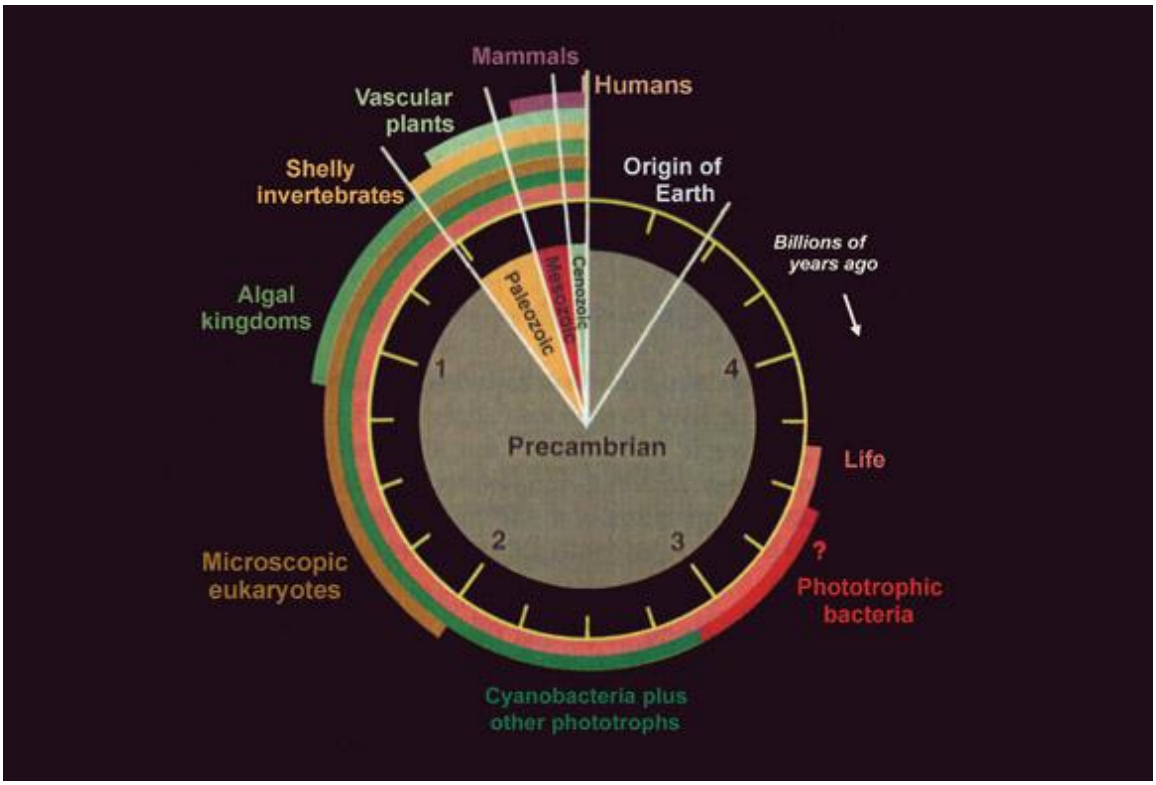

Mammals
Humans
Vascular plants
Shelly invertebrates
Origin of Earth
Billions of years ago
Algal kingdoms
Paleozoic
Mesozoic
Cenozoic
1
2
3
4
Precambrian
Life
?
Phototrophic bacteria
Microscopic eukaryotes
Cyanobacteria plus other phototrophs

Table 25.1 The Geologic Record

Relative Duration of Eons	Era	Period	Epoch	Age (Millions of Years Ago)	Some Important Events in the History of Life
Phanerozoic	Cenozoic	Neogene	Holocene	0.01	Historical time
			Pleistocene	1.8	Ice ages; humans appear
			Pliocene	5.3	Origin of genus *Homo*
			Miocene	23	Continued radiation of mammals and angiosperms; apelike ancestors of humans appear
		Paleogene	Oligocene	33.9	Origins of many primate groups, including apes
			Eocene	55.8	Angiosperm dominance increases; continued radiation of most present-day mammalian orders
			Paleocene	65.5	Major radiation of mammals, birds, and pollinating insects
	Mesozoic	Cretaceous		145.5	Flowering plants (angiosperms) appear and diversify; many groups of organisms, including most dinosaurs, become extinct at end of period
		Jurassic		199.6	Gymnosperms continue as dominant plants; dinosaurs abundant and diverse
		Triassic		251	Cone-bearing plants (gymnosperms) dominate landscape; dinosaurs evolve and radiate; origin of mammals
Proterozoic	Paleozoic	Permian		299	Radiation of reptiles; origin of most present-day groups of insects; extinction of many marine and terrestrial organisms at end of period
		Carboniferous		359.2	Extensive forests of vascular plants form; first seed plants appear; origin of reptiles; amphibians dominant
		Devonian		416	Diversification of bony fishes; first tetrapods and insects appear
		Silurian		443.7	Diversification of early vascular plants
		Ordovician		488.3	Marine algae abundant; colonization of land by diverse fungi, plants, and animals
Archaean		Cambrian		542	Sudden increase in diversity of many animal phyla (Cambrian explosion)
		Ediacaran		635	Diverse algae and soft-bodied invertebrate animals appear
				2,100	Oldest fossils of eukaryotic cells appear
				2,500	
				2,700	Concentration of atmospheric oxygen begins to increase
				3,500	Oldest fossils of cells (prokaryotes) appear
				3,800	Oldest known rocks on Earth's surface
				Approx. 4,600	Origin of Earth

TAKRIFAN ALGA

- Sukar diberi takrifan khusus
  - A group
    of aquatic, photosynthetic, eukaryotic organisms ranging from unicellular to multicellular forms, and generally possess chlorophyll but lack
    true roots, stems and leaves characteristic
    of terrestrial plants.
  - Unicellular or multicellular photosynthetic eukaryotes that generally lack roots, stems, leaves, conducting vessels, and complex sex organ
  - a plant or plantlike organism of any of several phyla, divisions, or classes of chiefly aquatic usually chlorophyll-containing nonvascular organisms of polyphyletic origin that usually include the green, yellow-green, brown, and red algae in the eukaryotes and especially formerly the cyanobacteria in the prokaryotes
  - very simple, usually small plants that grow in or near water and do not have ordinary leaves or roots very simple, usually small plants that grow in or near water and do not have ordinary leaves or roots

    - Tumbuhan peringkat rendah
      - Tiada tisu vaskular (tiada xilem, tiada floem)
      - Tiada akar, batang atau daun sebenar
      - Tiada bunga, buah atau biji
    - **Eukariot**
      - Kecuali Cyanophyta (**Prokariot**)
    - Fotosintesis
    - Tiada struktur pembiakan khusus
      - Hasil **gametangium** (gamet) dan **sporangium** (spora)

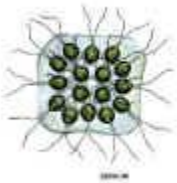
Bidang Pengajian

- **Algologi** (Latin : rumpai laut)
- **Fikologi** (*phykos* (Greek) = alga

- Saiz
    - Sel mikroskopik (*Chlamydomonas*) hingga ke kelpa gergasi (*Macrocystis*) yang melebihi 50 m panjang

- Talus
    - Unisel, Koloni, Soenobium, Filamen (bercabang, tidak bercabang)
    - Tumbuhan bak daun

- A **coenobium** (plural coenobia) is a colony containing a fixed number of cells, with little or no specialization. They occur in several groups of algae. The cells are often embedded in a mucilaginous matrix and may be motile or non-motile.
- Examples : *Volvox*, *Scenedesmus*, *Pediastrum*, and *Hydrodictyon*.

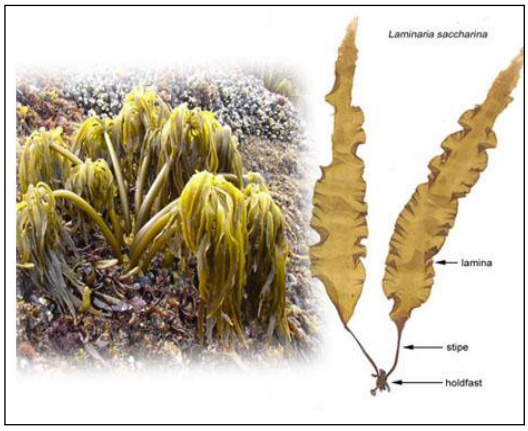
 ACTINASTRUM	 BOTRYOCOCCUS	 COELASTRUM		
 CLOSTRIUM	 CLOSTRIUM			
		 MOUGEOTIA		 OOCYSTIS
 OEDOGONIUM	 PINNULARIA	 SCENEDESMUS	 SPHAEROCYSTIS	
	 ZYGNEMA			

Macrocystis

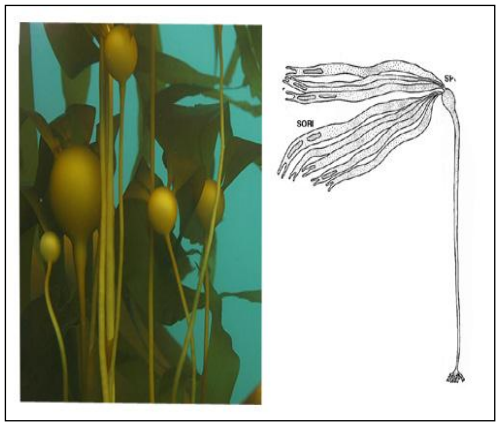
Sargassum

Warna

- Alga biru hijau (**Cyanophyta**)
- Alga hijau (**Chlorophyta**)
- Alga merah (**Rhodophyta**)
- Alga perang (**Phaeophyta**)
- Alga perang keemasan (**Chrysophyta**)
- Alga hijau kekuningan (**Xanthophyta**)



Postelsia & *Laminaria*



Nereocystis

- **Kelp** are large seaweeds (algae)
  - belonging to the brown algae
- classified in the order Laminariales.
- Despite their appearance they are not grouped with the normal aquatic or land plants (kingdom Plantae),
  - but instead are included in either kingdom Protista or Chromista.
- 30 different genera.
- Kelp grows in underwater forests (kelp forests) in clear, shallow, oceans,
  - requiring nutrient rich water below about 20 °C,
  - it offers a protection to some sea creatures, or food for others.
- It is known for its high growth rate
  - the genus *Macrocystis* grows up to 30 cm per day, to a total length of over 60 meters.

Morphology

- In most Kelp
- the thallus (or body), consists of flat or leaf-like structures known as blades.
- Blades originate from elongated stem-like structures, the stipes.
- The holdfast, a root-like structure anchors the Kelp to the substrate of the ocean.
- Gas-filled bladders (pneumatocysts) form at the base of most blades and keep the Kelp blades close to the surface.

Prominent species

- Bull-head Kelp (*Nereocystis luetkeana*), a northwestern American species. Used by coastal indigenous peoples to create fishing nets.
- Giant Kelp (*Macrocystis pyrifera*), the largest seaweed. Found in the Pacific coast of North America and South America.
- Kombu (*Laminaria japonica*), an edible species of kelp found in Japan.

Diversiti & taburan divisi

Divisi	Bilangan spesies	Air tawar (%)	Laut (%)
Chlorophyta	6,750	86.7	13.3
Euglenophyta	450	96.7	3.3
Phaeophyta	1,000	2.3	**97.7**
Chrysophyta	6,000	50	50
Pyrrophyta	1,000	10	**90**
Cryptophyta (+ Bacillariophyta)	100	50	50
Rhodophyta	2,500	2	**98**
Cyanophyta	1,500	90	10
Jumlah	19,300		

- Habitat

  (A **habitat** is an ecological or environmental area that is inhabited by a particular species)

a) Air

- Lautan & Air Tawar
  - Sungai, tasik, lombong

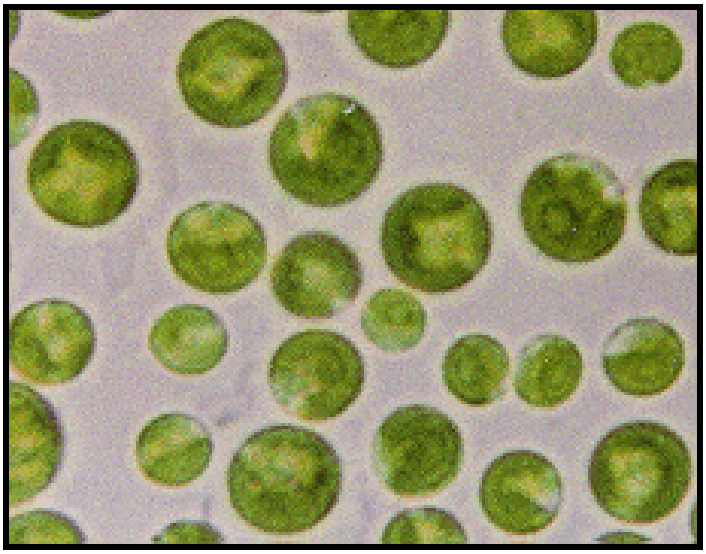
<u>Peranan Ekologi</u>

- Penghasil utama
  - Hutan dalam air
- Sumbang oksigen dunia

- Hidup terapung (plankton)
  - **Fitoplankton**
    - **Diatom**
    - **Dinoflagelat**
      - **Ombak merah (red tide)**

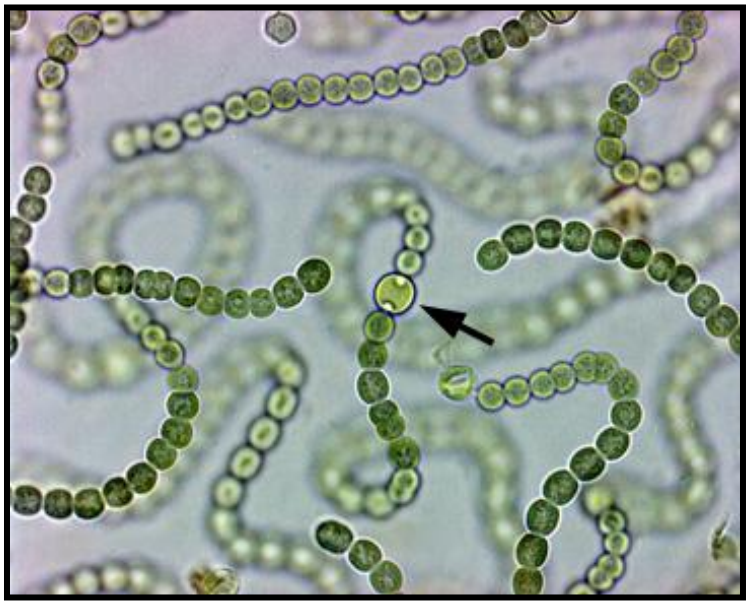
- Bentik (terikat pada substrat)
    - **Epilitik** (atas batu), **Epifitik** (atas tumbuhan)
    - **Epizoik** (atas haiwan) – *Basicladia* pada penyu
    - **Epipelik** (atas lumpur), **Epipsamonik** (atas pasir)

- **Endosimbion**
    - **Endozoik**
        - *Chlorella* dalam span & *Hydra*
        - Alga biru-hijau dalam usus mamalia



Chlorella

- **Endofitik**
  - *Anabaena* dalam sikad (cycad)



Anabaena

b) Terestrial (daratan)

- Kawasan lembap
    - **Epidafik** (atas tanah), **Epilitik** (atas batu)
- **Kortikolous** (atas kulit kayu)
- **Krioplankton** atau **kriobiota** (atas salji)
    - Tompokan merah di salji oleh C*hlamydomonas nivalis*
        - Hijau tetapi berpigmen merah(**Haematokrom**)

Alga yang hidup di kulit kayu (**Kortikolous)**

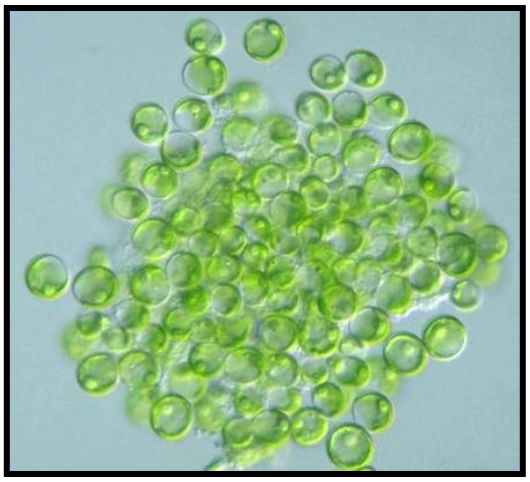
C*hlamydomonas nivalis*

c) Air Panas

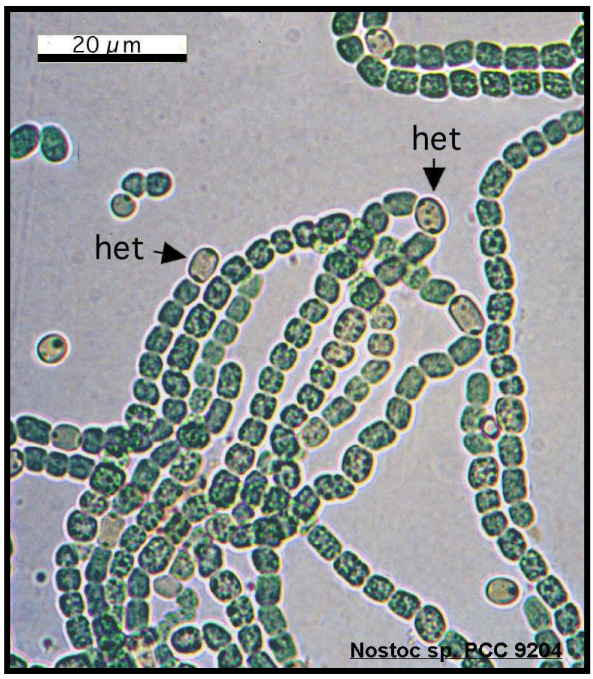
- Alga biru-hijau
- Suhu melebihi 85 C

d) Simbion

- **Liken**
- Kulat (Mikobion) dengan alga (**Fikobion**)
- Contoh fikobion (*Trebouxia, Nostoc*)



Trebouxia



Nostoc

PERBEZAAN ALGA DENGAN FUNGI	
Alga	**Fungi**
Fotosintesis	Tiada **klorofil**
Autotrof	**Heterotrof** (parasit atau saprofit)
Tisu parenkima	**Hifa**
Dinding selulos benar	Dinding **kitin** dengan selulos
Hidup di atas substratum lembap	Parasit atau saprofit
Makanan simpanan : **kanji**	Makanan simpanan : **glikogen**

A **hypha** (plural **hyphae**) is a long, branching filamentous structure of a fungus, and also of unrelated Actinobacteria. In most fungi, hyphae are the main mode of vegetative growth, and are collectively called a mycelium; yeasts are unicellular fungi that do not grow as hyphae.

A hypha consists of one or more cells surrounded by a tubular cell wall. In most fungi, hyphae are divided into cells by internal cross-walls called "septa" (singular septum). Septa are usually perforated by pores large enough
for ribosomes, mitochondria and sometimes nuclei to flow between cells.

The major structural polymer in fungal cell walls is
typically chitin, in contrast to plants that have cellulosic cell walls. Some fungi have aseptate hyphae, meaning their hyphae are not partitioned by septa.

Pengelasan

	Takson
Divisi	Chlorophyta
Kelas	Chlorophyceae
Order	Ulvales
Famili	Ulvaceae
Genus	Ulva
Spesies	*Ulva lactuca*

Kriteria Pengelasan

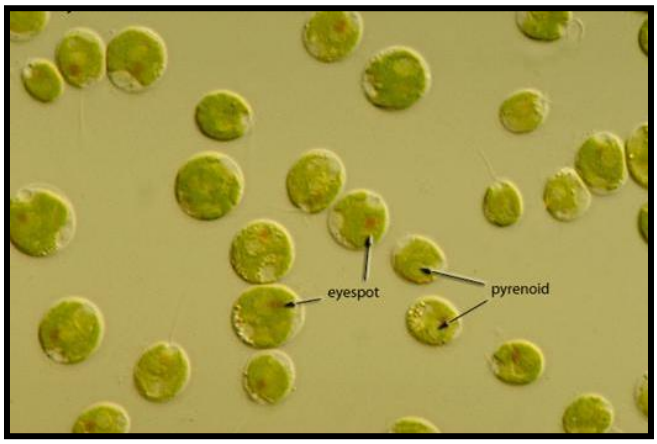
- Pigmen, Makanan simpanan, Komposisi dinding
- Sitologi (prokariot atau eukariot), Bentuk & susunan kloroplas
- Morfologi – unisel, multisel, filamen, soenobium
- Pembiakan & kitar hidup

MORFOLOGI

- Unisel
    - Kesemua divisi **kecuali Phaeophyta**
        - Tidak bergerak (**kokoid**)
        - Bergerak
            - Ameboid, flagelum

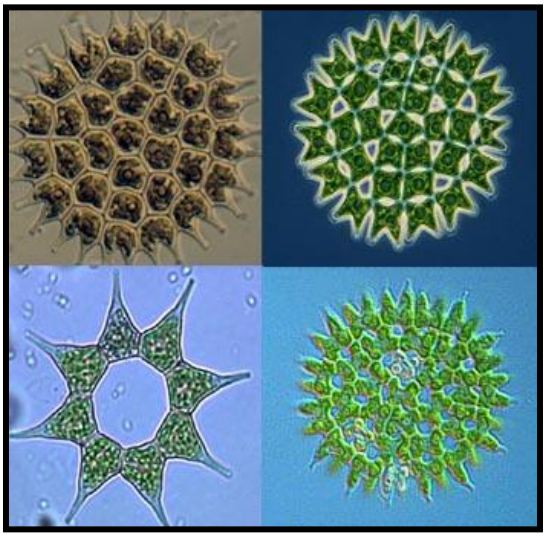
Euglena

- Rhodophyta & Cyanophyta – **tiada jasad bergerak**



Chlamydomonas

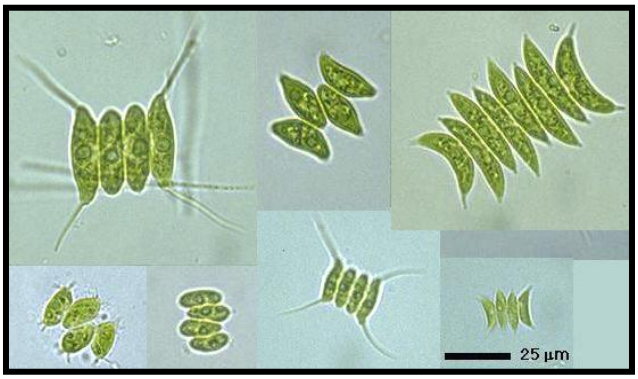
Eudorina



Pediastrum

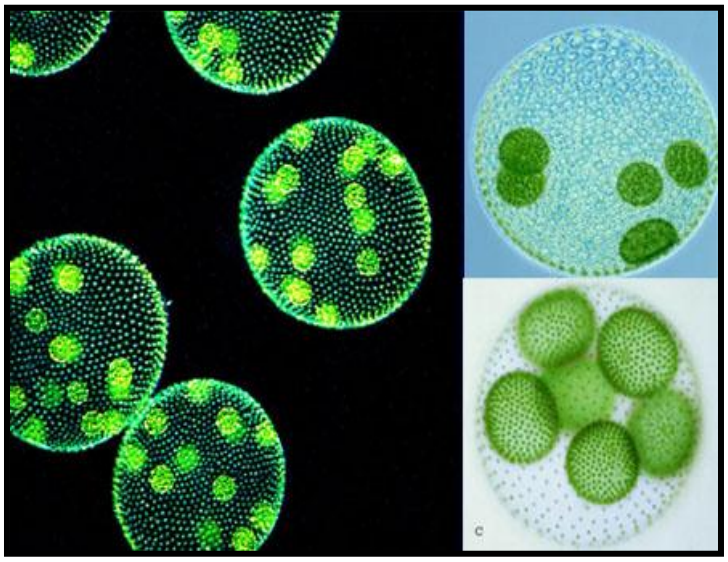
Cosmarium

Closterium

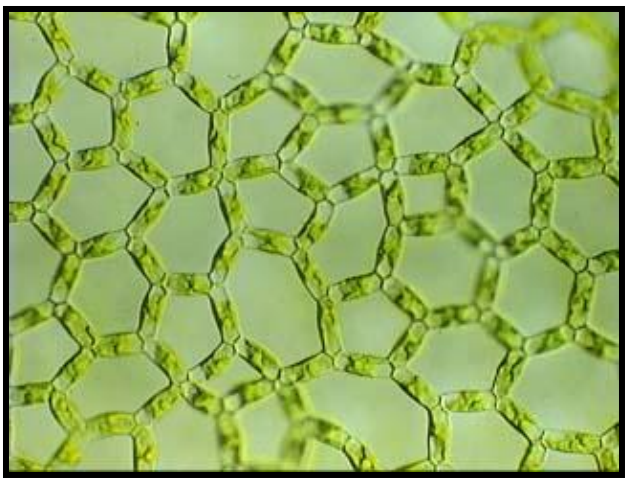


Scenedesmus

- Multisel
    - Koloni dalam **matriks**
    - **Soenobium**
        - Bilangan sel tetap secara genetik
            - Tidak bertambah semasa membesar
        - Bentuk khusus
            - Tidak bergerak (*Pediastrum, Hydrodictyon*)
            - Bergerak dengan flagelum (*Volvox*)

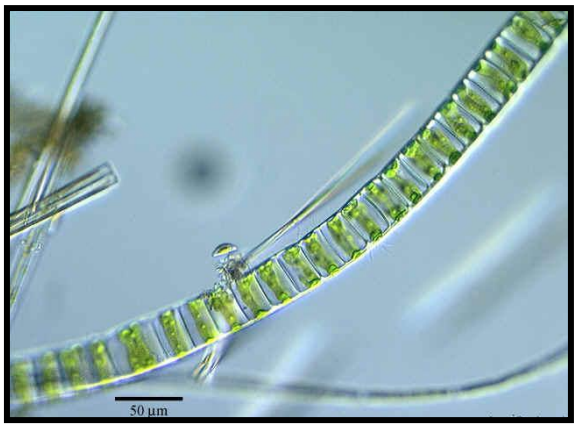


Volvox



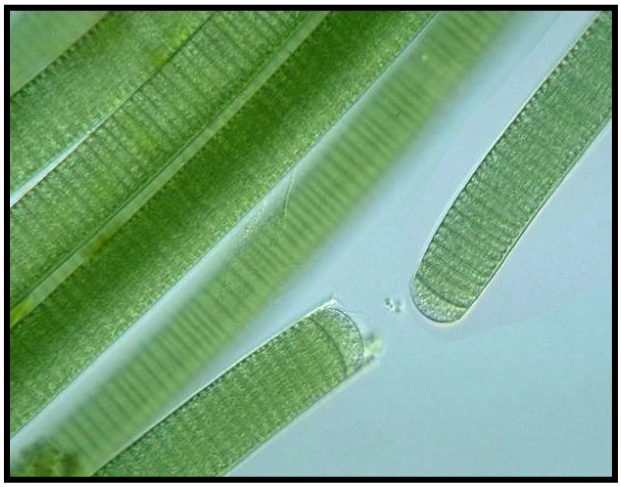
Hydrodictyon

- Filamen
  - Sel di atur hujung ke hujung dengan dinding rentas
  - Sambungan sitoplasma melalui plasmodesmata
    - **Uniseriat**
    - **Multiseriat**
      - **Trikom** – filamen diselaputi oleh selaput (sheath)
- Tiada bercabang

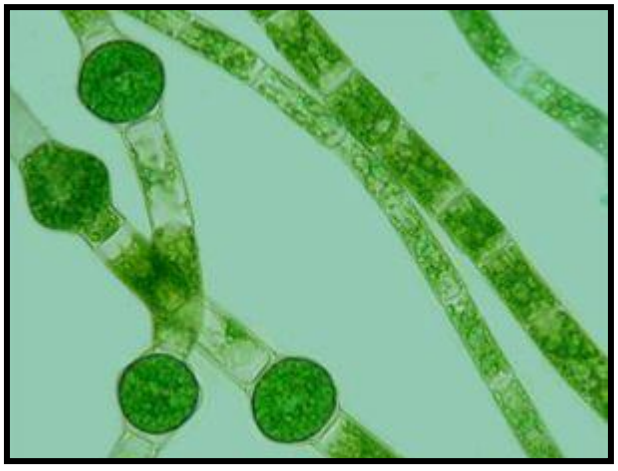


Ulothrix

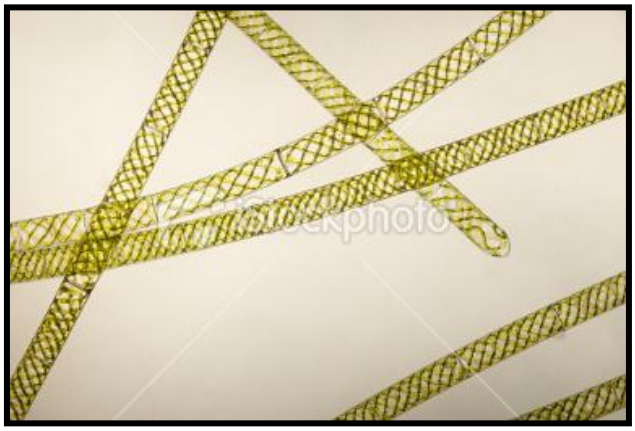
Anabaena



Oscillatoria



Oedogonium



Spirogyra

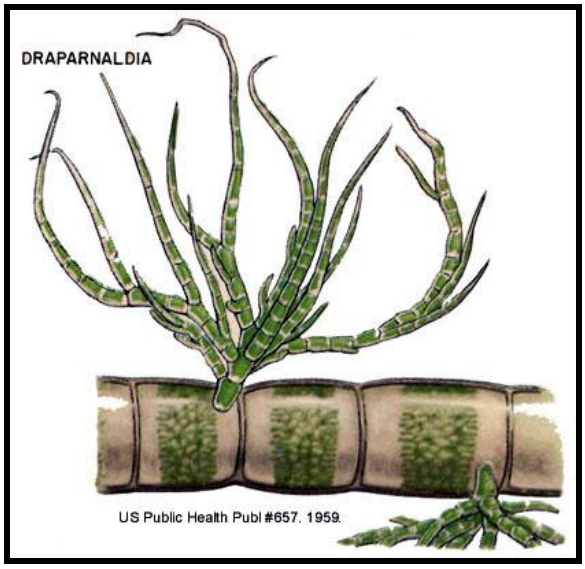
- Bercabang
  - **Pseudocabang** (cabang palsu)
    - *Tolypothrix*

Tolypothrix

- Cabang tulen
    - Bercabang mudah (*Cladophora*)
    - Heterotrik (heterotrichous)
        - A body that is divided into both prostrate and erect parts.

Cladophora

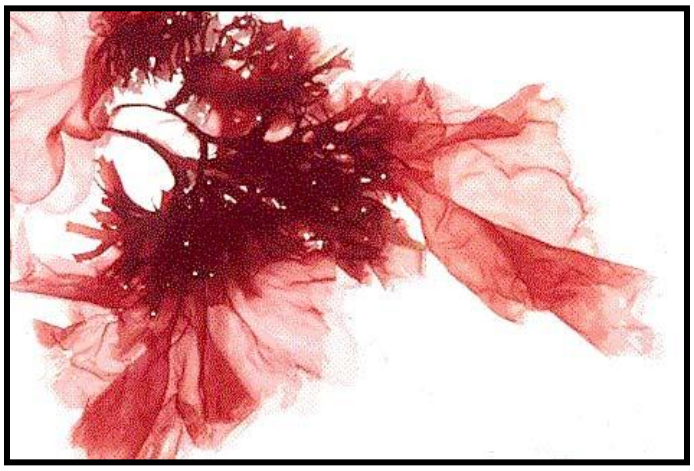
- Bentuk maju (*Draparnaldia*)
    - Filamen bercabang yang menjalar
        - Pelekap
    - Filamen bercabang yang tegak



Draparnaldia

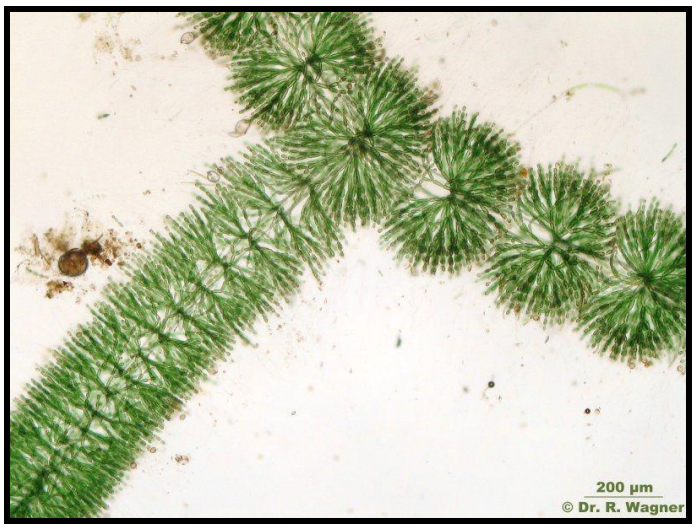
- Parenkima
  - Pembahagian berkali-kali
    - Hasil struktur leper, silinder bercabang atau tiub berongga
      - *Ulva & Porphyra*

Ulva



Porphyra

- Pseudoparenkima
  - Filamen bercabang yang disusun rapat
    - Bak parenkima
      - *Batrachospermum* (Rhodophyta)



Batrachospermum

- Sifon

describes a type of thallus composed of large multinucleate coenocytic cells wherein cross-walls are rarely formed

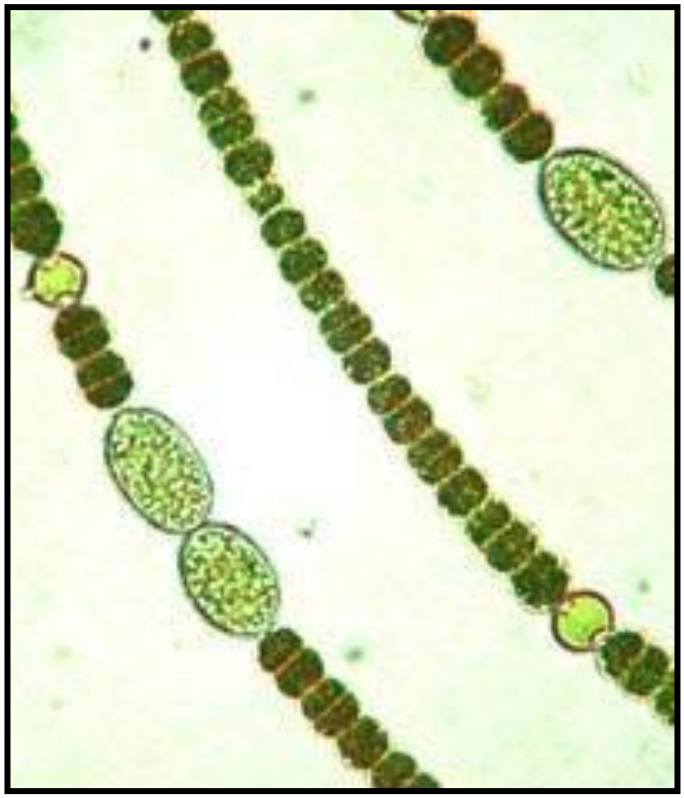
  - Multinukleus
    - Tiada **septum**
      - *Protosiphon, Botrydium, Vaucheria & Enteromorpha*

Enteromorpha

PEMBIAKAN

- Aseksual
    - Tiada pencantuman gamet
        - Pembahagian sel (belahan)
        - Fragmentasi
        - **Hormogonium**
            - **Hanya untuk alga biru-hijau berfilamen**
                - Pembentuk **nekridium** (sel mati)
        - Sel vegetatif khusus
            - **Akinet**
                - Sel vegetatif menjadi besar
                    - **Dinding tebal**
                    - **Banyak makanan simpanan**
                - Persekitaran buruk, sel vegetatif mati
                    - Akinet tahan

- Keadaan baik, akinet bercambah
    - Hasil filamen vegetatif

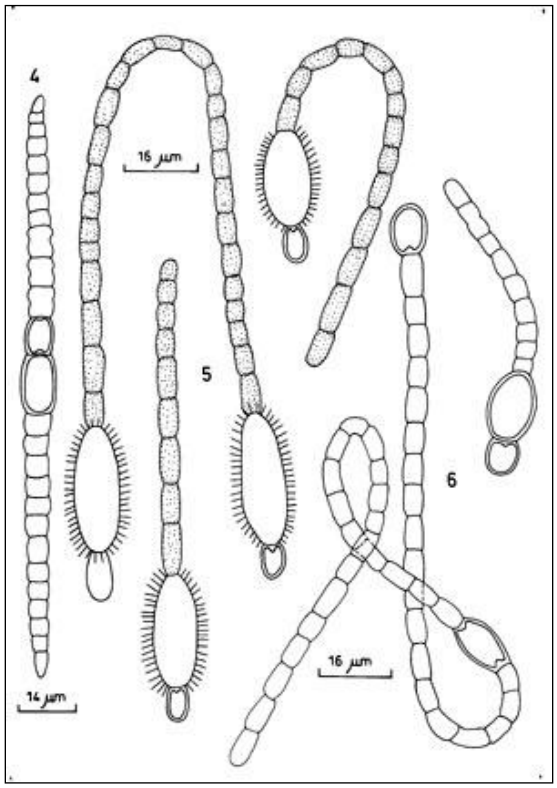


`

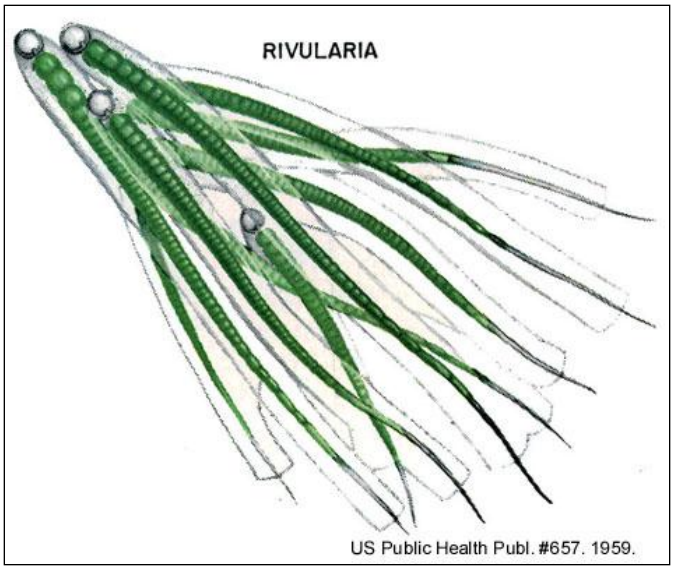
        - Kedudukan
            - Sebelah **heterosista**
            - Terasing daripada heterosista
            - Dalam rantai
                - *Anabaena, Gloeotrichia*

- Heterosista
    - Sel jernih dengan dinding lutsinar
        - **Nodul Polar** (satu atau dua)
    - Bercambah membentuk filamen
        - **Hanya untuk alga biru-hijau**

- Kedudukan
  - Terminal (apikal), **Interkalari**
- **Penetapan nitrogen**
  - *Gloeotrichia, Rivularia*

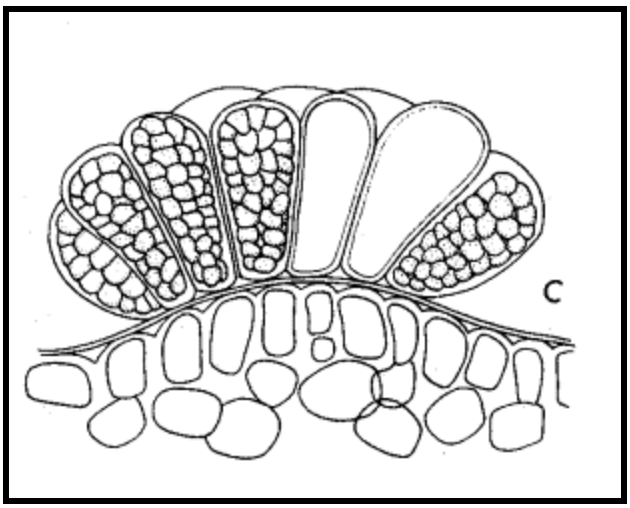


Gloeotrichia



Rivularia

- Spora
    - Sel yang mampu membawa kepada satu peringkat lain dalam kitar hidup
- Endospora atau **Baeosista**
    - Protoplasma menjadi spora
        - Dibebaskan apabila dinding induk pecah
        - **Hanya untuk alga biru-hijau**
            - Contoh *Dermocarpa*



- Eksospora
    - Dinding sel pecah di apeks
    - **Hanya untuk alga biru-hijau**

- Zoospora atau planospora
    - Sel berflagelum tiada dinding
        - Biflagelum (*Chlamydomonas*), Kuadriflagelum (*Ulothrix*)
        - Multiflagelum (*Oedogonium*)
- Aplanospora
    - Tidak bergerak
        - Mempunyai dinding sel

Nota 3 (tangguh)

PEMBIAKAN SEKSUAL

- Percantuman gamet
    - Tukar bahan genetik dan bentuk kombinasi baru
        - Gamet mungkin serupa secara morfologi dengan sel vegetatif (*Chlamydomonas*)
- **Gametangium**
    - **Oogonium** – betina
    - Hasil telur atau ovum
        - **Karpogonium** (alga merah)
            - Oogonium ada **trikogin**
            - Fungsi = terima gamet jantan yang tidak bergerak

- **Anteridium** – jantan
            - Hasil **anterozoid** (**spermatozoid**) yang bergerak
                - Alga merah, hasil spermatium
                    - Gamet jantan tidak bergerak

Proses

- **Singami**
    - Cantum gamet & hasil zigot
- **Plasmogami**
    - Cantum sitoplasma
- **Kariogami**
    - Cantum nukleus

JENIS SINGAMI

- Isogami
    - Pencantuman 2 gamet **identikal** dari segi saiz dan pergerakan
        - Serupa jantan betina
- Anisogami
    - Pencantuman 2 gamet yang berbeza dari segi saiz **ATAU** pergerakan
        - Satu jantan, satu betina
- Oogami
    - Pencantuman gamet yang berbeza dari segi saiz **DAN** pergerakan
        - Melibatkan ovum dan sperma
            - Alga merah, tiada sperma bergerak

    - **Monoesius** – organ sex jantan dan betina di individu yang sama
    - **Dioesius** – organ sex jantan dan betina di individu yang berbeza

KITAR HIDUP

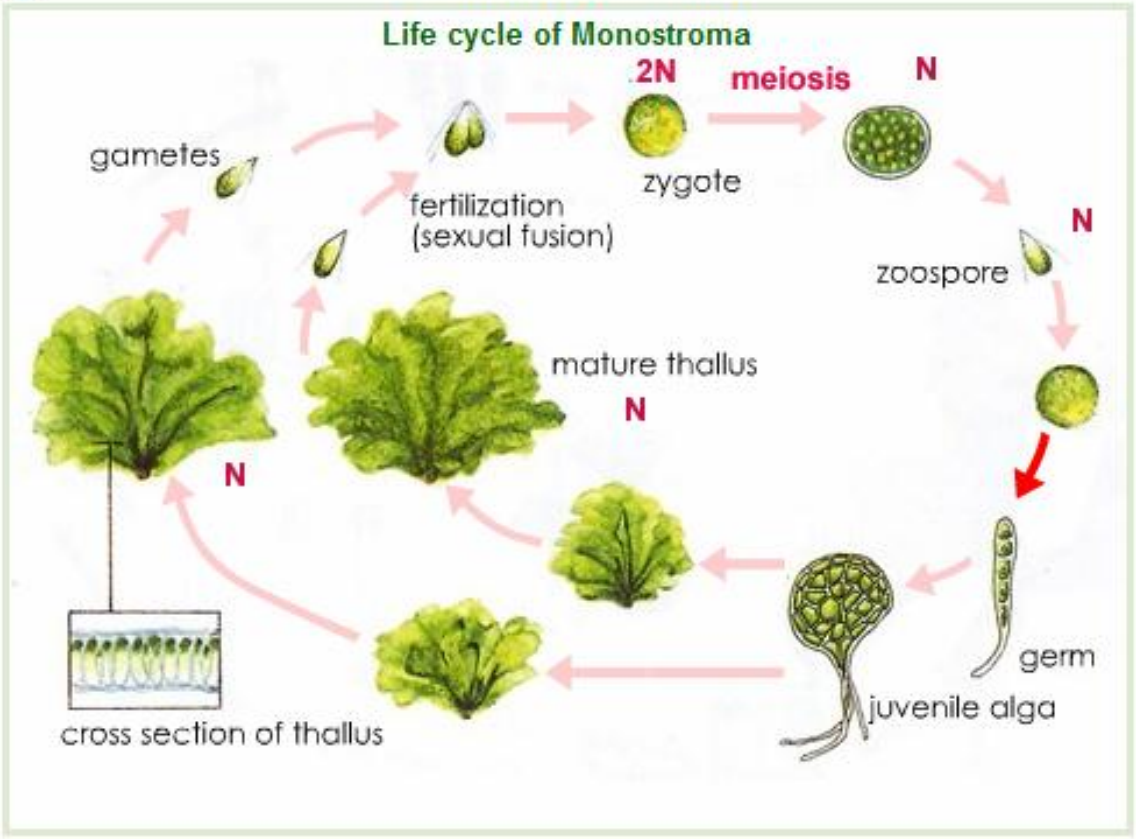
- 2 peristiwa utama
    - Persenyawaan dan meiosis

JENIS KITAR HIDUP

- **Haplobiontik-haploid (h, h)**

Haplobiontic haploid

In the life cycle of Hh type of algae, the free living thallus is haploid (1N) and only one form. The algae can mutiply by fragmentation or cell divisions, or by producing spores for asexual reproduction. They can also perform sexual reproduction by producing gametes. After fertilization, the zygote undergoes meiosis to generate four spores. Each spore will then geminate into a haploid thallus. Examples include *Bangia atropurpurea* and *Monostroma nitidum*.

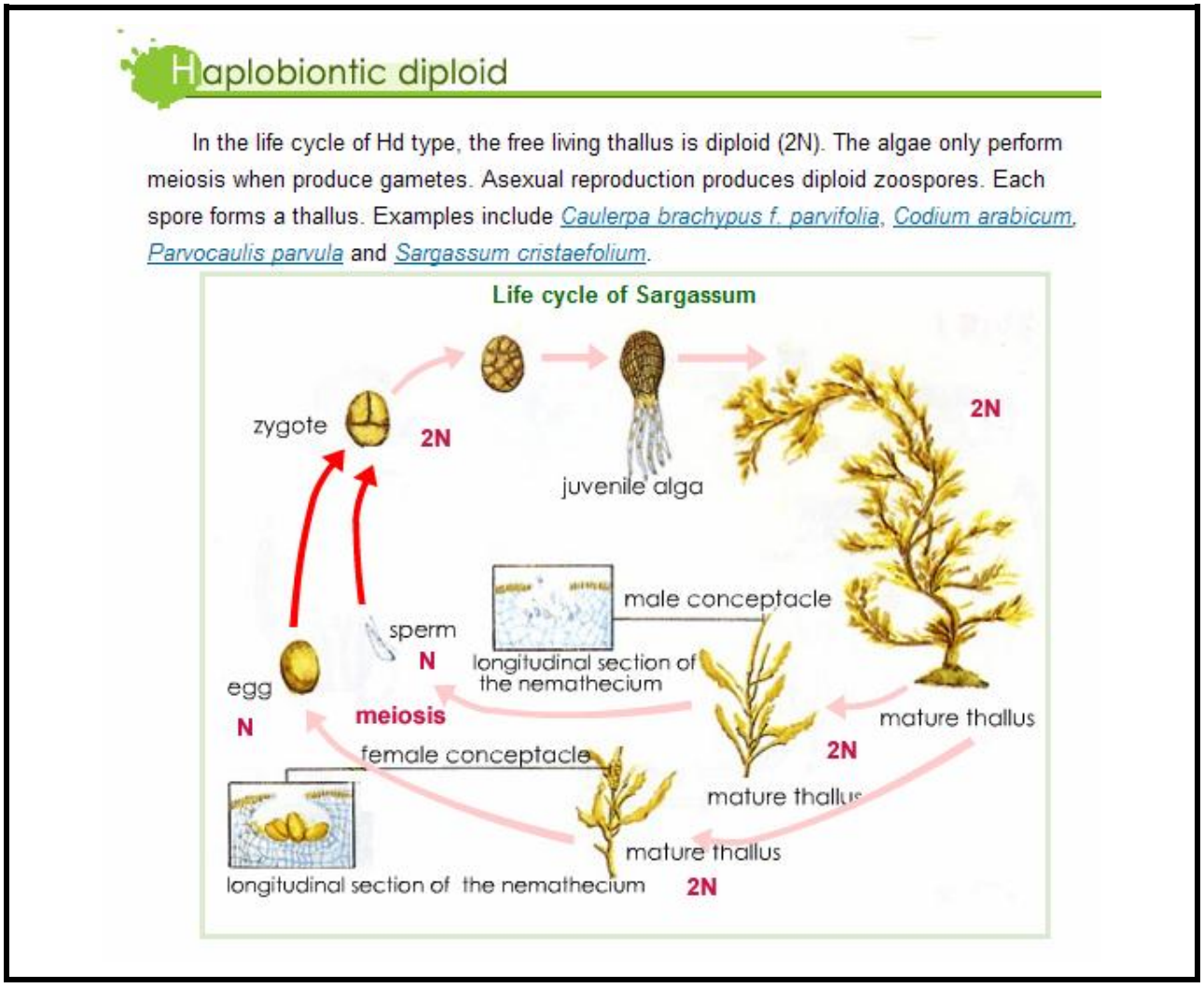


- Fasa dominan – haploid
    - Meiosis berlaku dalam zigot

- **Haplobiotik** – satu individu bebas

    - Kebanyakan alga hijau
    - Gamet bercantum hasil zigot (2n)
        - Peringkat dorman
        - Monoesius atau dioesius
    - Meiosis
        - Hasil zoospora, aplanospora atau tumbuhan juvenil (n)
            - **Meiosis zigot** (zygotic meiosis)

- **Haplobiotik-diploid (h, d)**

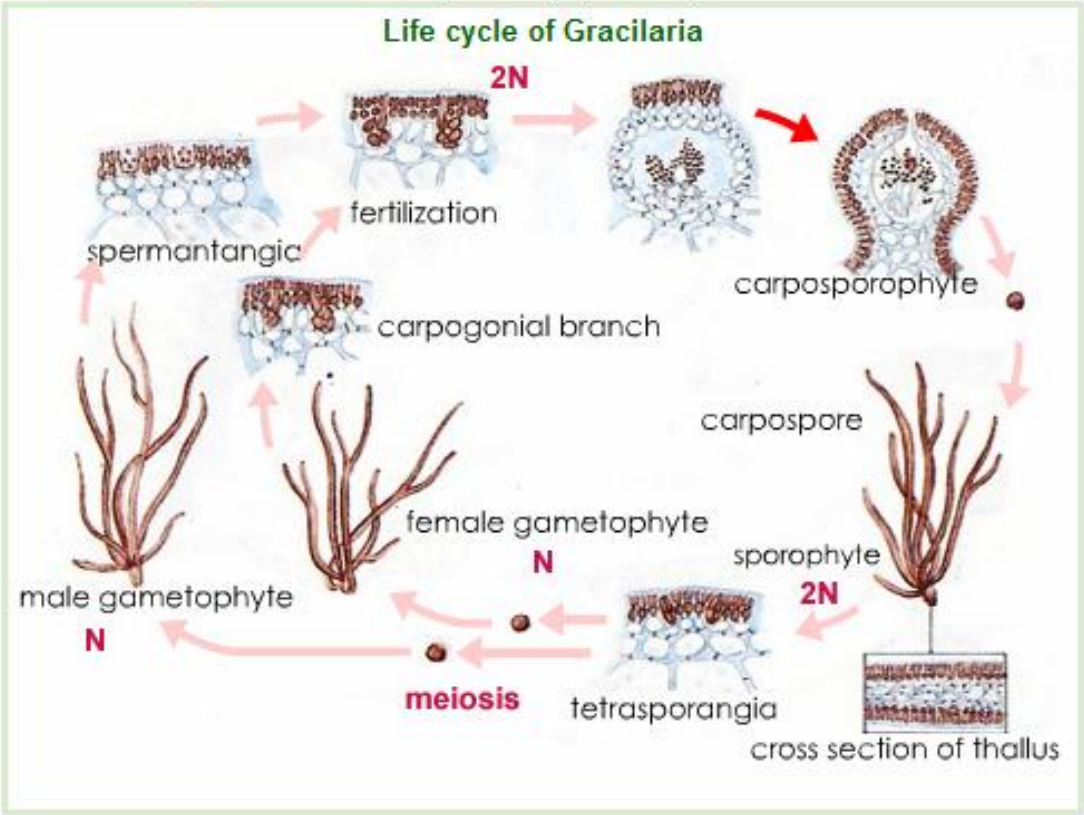


  - Organisma hidup bebas – diploid
  - Meiosis semasa **gametogenesis** (pembentukan gamet)
    - Sama seperti haiwan
      - **Meiosis gamet** (gametic meiosis)
        - Peringkat haploid hanya pada gamet
  - Kitar hidup alga hijau bersifon, Fucales dan diatom

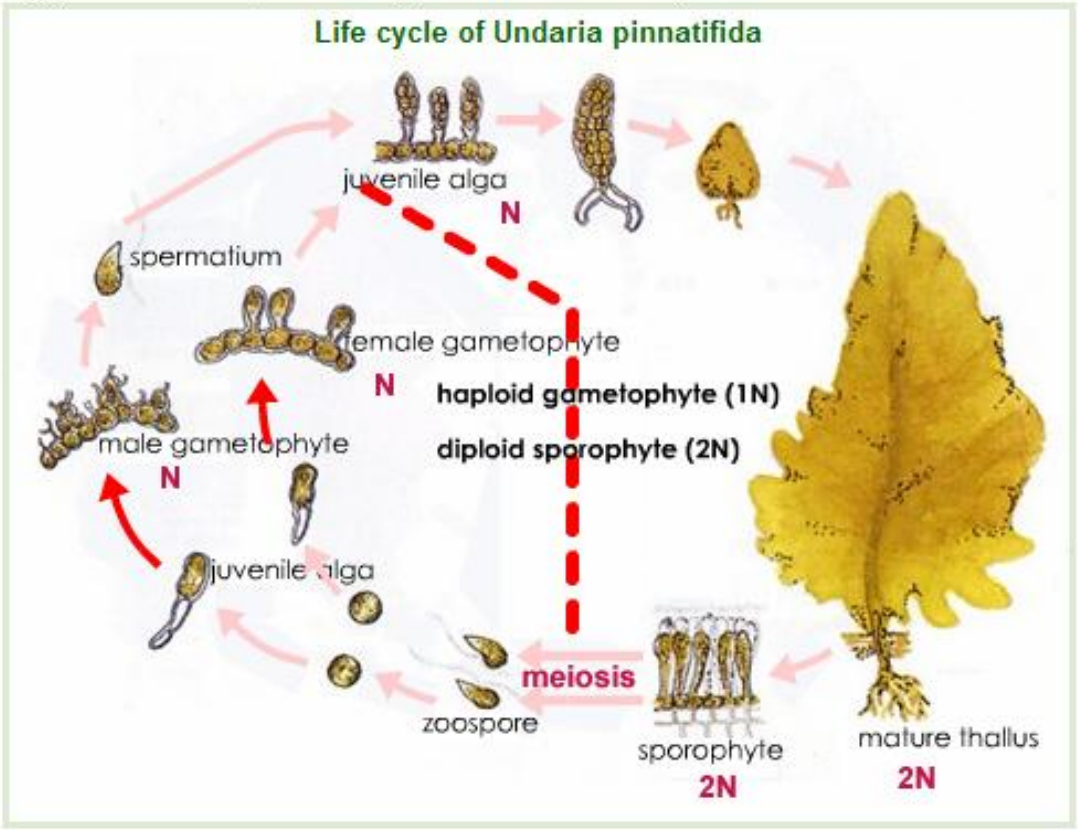
- **Diplobiotik (d, h + d)**

Diplobiontic, haploid + diploid type

In the life cycle of D, h+d type, the life history of the alternation of the generations contains both diploid (2N) and hapiod (1N) stages. They have a diploid sporophyte and a haploid gametophyte. The cells of the sporophyte undergo meiosis to produce spores. When the sporophyte and the gametophyte have the same external morphology, we call it the isomorphic alternation of generations. Examples include *Cladophora catenata*, *Ulva lactuca*, *Hincksia mitchellae*, *Gracilaria arcuata* and *Polysiphonia sp.*



If the sporophyte and the gametophyte differ in size and shape, we call that the life cycle is "heteromorphic alternation of generations". Examples include *Porphyra crispata*, *Asparagopsis taxiformis*, *Laminaria japonica and Undaria pinnatifida*.



- Alga hijau, perang dan merah
- Dua jenis bebas
  - Gametofit haploid, sporofit diploid
- Gamet bercantum bentuk zigot
  - Hasil sporofit diploid
- Meiosis semasa **sporogenesis** (penghasilan spora)
  - **Meiosis spora** (sporic meiosis)
- Spora menjadi gametofit

PERSILANGAN GENERASI

- Isomorfik
    - Sporofit & gametofit serupa secara morfologi (*Ulva & Ectocarpus)*
- Heteromorfik
    - Sporofit & gametofit tidak serupa (*Laminaria)*

SITOLOGI

- **Prokariot** (Cyanophyta)
    - Tiada
        - Nukleus teratur, kloroplas, mitokondria, jasad golgi
        - Endoplasmik retikulum
- **Eukariot**
    - Mempunyai
        - Nukleus teratur & organel

PIGMEN FOTOSINTESIS

- **Klorofil (hijau)**
    - Klorofil a, b, c, d, e
- **Karotenoid**
    - **Xantofil** (berwarna perang)
    - **Karotin** (berwarna kuning)
        - Terdapat lebih 60 karotenoid
            - Beta karotin (Kebanyakan alga)
            - Fukoxantin (Alga perang)
            - Peridin (Pyrrophyta)
- **Fikobilin** – Cyanophyta, Rhodophyta, Cryptophyta
    - **Fikoeritrin** (berwarna merah)
    - **Fikosianin** (berwarna biru)
        - Gabung dengan protein bentuk fikobiliprotein

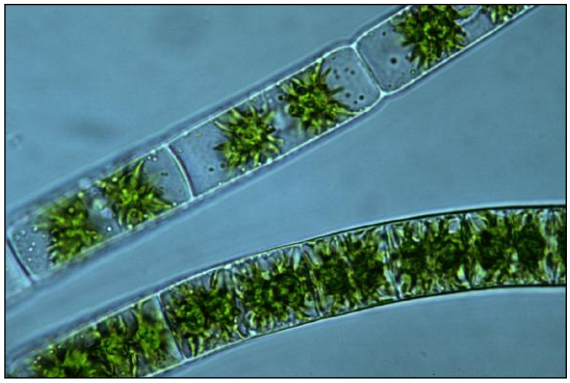
	CY	CH	XA	CHR	BA	PY	CRY	EUG	PHA	RHO
Klorofil A	+	+	+	+	+	+	+	+	+	+
Klorofil B		+						+		
Klorofil C			+		+	+	+		+	
Klorofil D										+
Klorofil E			+							
Alpha Karotin		+					+			+
Beta Karotin	+	+	+	+	+	+	+	+	+	+
Fukoxantin (xantofil)				+	+	+				
Peridin (Xntofil)						+				
Fikosianin	+						+			+
Fikoeritrin	+						+			+

KLOROPLAS

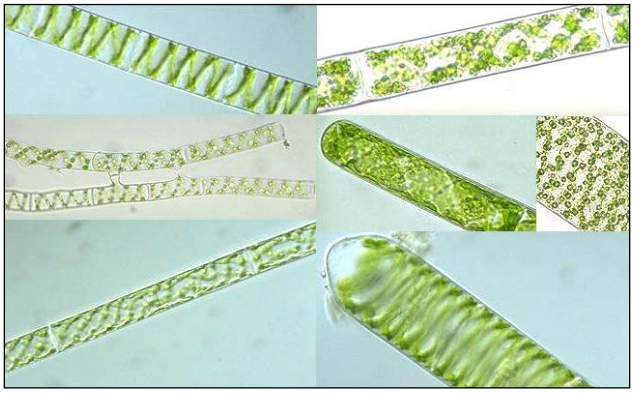
- **Aksial (tengah-tengah)**
- **Parietal - keliling**

JENIS KLOROPLAS

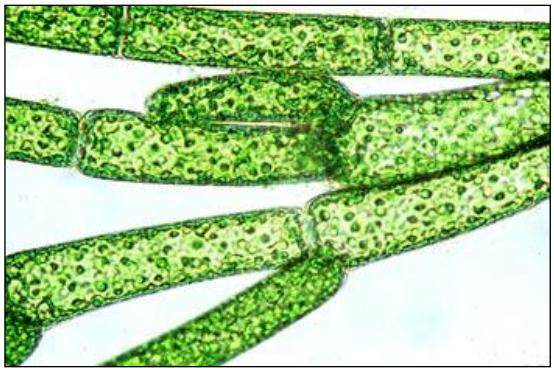
- Mikroskop cahaya
  - Stelat - (*Zygnema*)
  - Reben spiral - (S*pirogyra*)
  - Cakera - (*Cladophora*)
  - Retikulat - (*Oedogonium*)
  - Plat (aksial) – (*Mougeotia)*
  - Bentuk u atau gelang – (*Ulothrix)*
  - Bentuk cawan – (*Chlamydomonas, Volvox)*



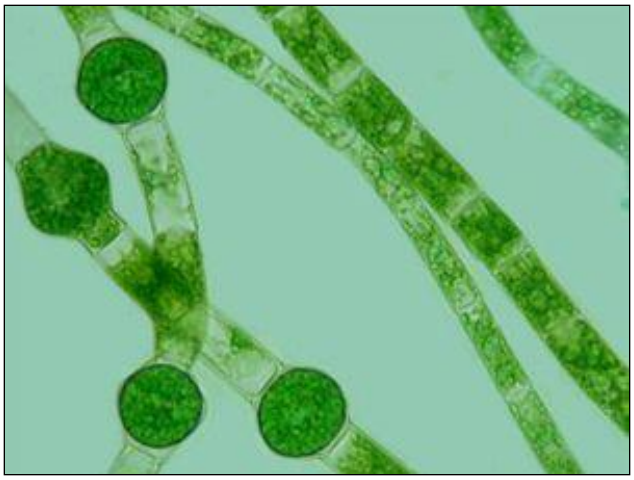
Zygnema



Spirogyra



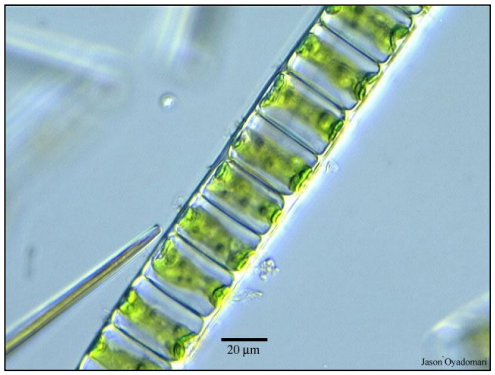
Cladophora



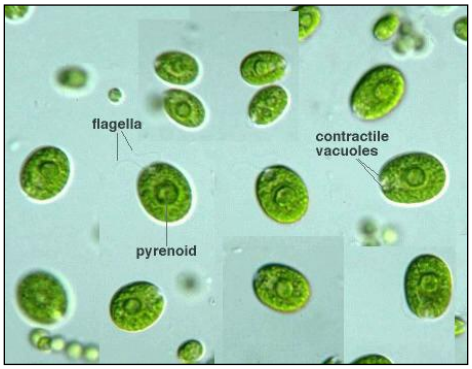
Oedogonium

Mougeotia

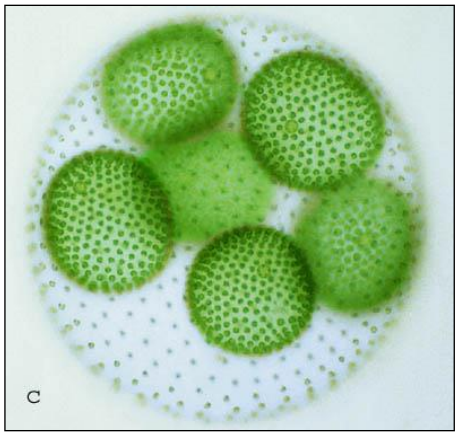
Mougeotia



Ulothrix

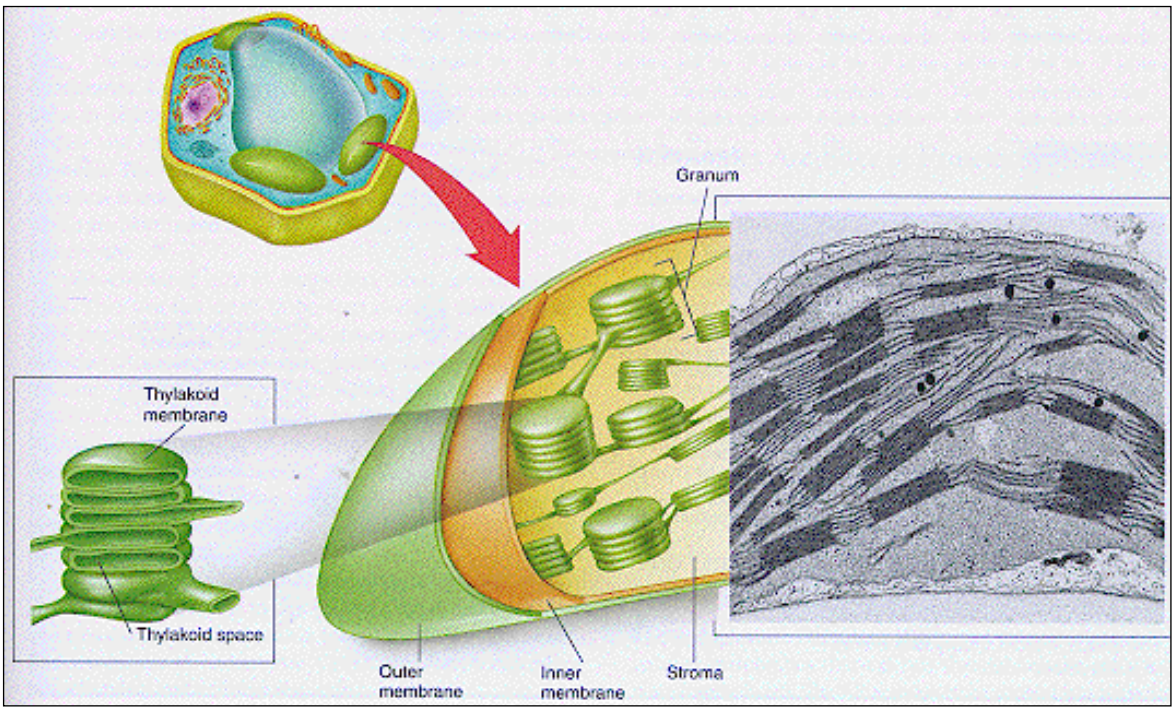


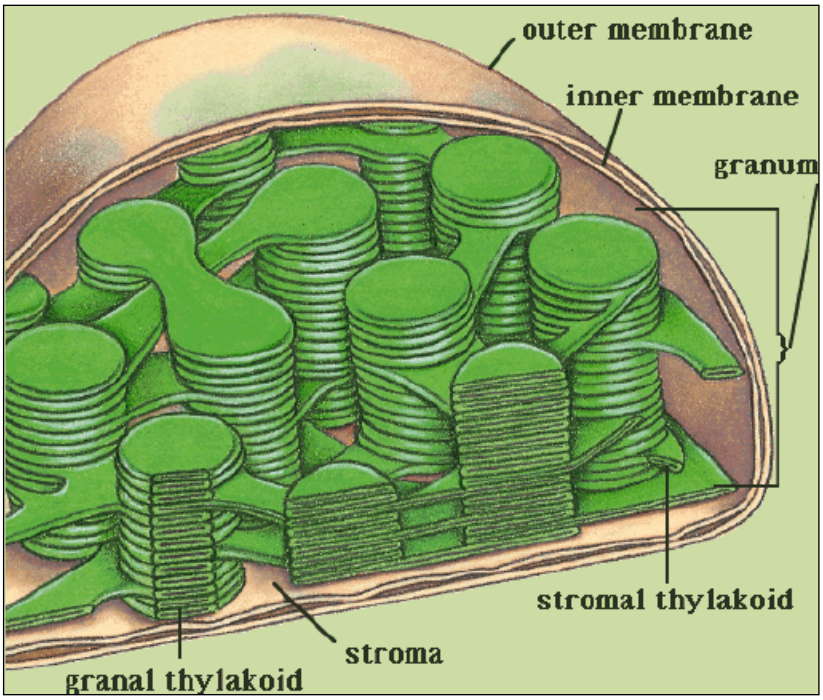
Chlamydomonas



Volvox

- Mikroskop elektron (tangguh)
    - Ultrastruktur
        - DNA dan ribosom
            - Ribosom – sintesis protein
        - Membran – 2 lapisan
            - Dinoflagelat & euglenoid – tiga lapisan
        - **ER kloroplas #**
            - Satu lapisan endoplasmik retikulum keliling kloroplas
            - ER kloroplas bersambung dengan membran nukleus
        - **Tilakoid**
            - Tempat klorofil tersimpan
                - Dalam timbunan (**granum**).





- **Rhodophyta – klorofil dalam fikobilisom**

- **Pirenoid**
  - Sintesis kanji dan enzim

ATURAN TILAKOID

- Tilakoid terasing (satu) dengan **fikobilisom** di permukaan
  - Fikobilisom ada fikobilin (Rhodophyta)
  - Sama dengan Cyanophyta (prokariot)
- Tilakoid bertindih (2-6) dengan **fret penyambung**
- Tilakoid berkumpul 3

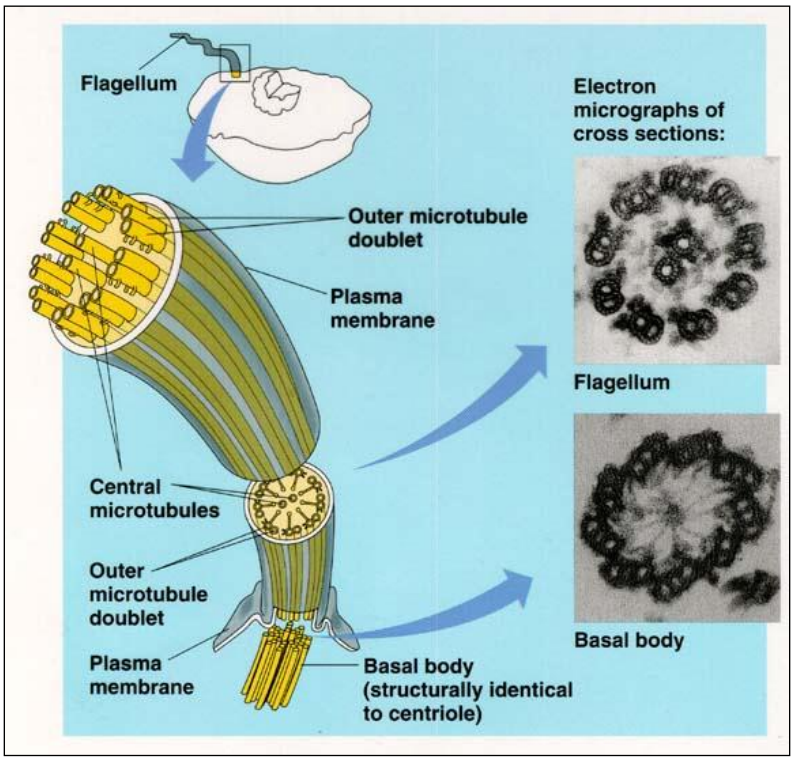
Divisi	Bilangan Membrane	Kloroplas ER	Bilangan Tilakoid
Chlorophyta	2	Tiada	2 - 6
Chrysophyta	2	Ada	3
Bacillariophyta	2	Ada	3
Phaeophyta	2	Ada	3
Xanthophyta	2	Ada	3
Pyrrophyta	3	Tiada	2 – 3
Cryptophyta	2	Ada	1 – 4 (biasa 2)
Euglenophyta	3	Tiada	2 – 6
Rhodophyta	2	Tiada	1

FLAGELUM

- Kesemua divisi (kecuali Rhodophyta & Cyanophyta)
    - Peringkat vegetatif
    - Gamet atau zoospora

STRUKTUR

- Mikroskop elektron
    - Aturan 9 + 2
        - 9 fibril yang berkembar dengan satu pasang fibril tunggal
        - Ciri biasa untuk semua sel berflagelum (kecuali bakteria)



JENIS

- **Akronematik** (whiplash)
    - Licin, rerambut halus, sisik
- **Pantonematik** (tinsel)
    - Bulu kasar dan tubular (mastigonem)
        - Kedua-dua belah atau sebelah sahaja

BILANGAN

- Uniflagelat, Biflagelat (biasa), Kuadriflagelat, Mutiflagelat

KEDUDUKAN

- Apikal / terminal / anterior, Subapikal, Lateral, Posterior

Divisi	Bilangan	Kedudukan	Jenis
Cyanophyta	Tiada		
Chlorophyta	1, 2, 4 atau lebih	Apikal	Akronematik
Chrysophyta	2	Apikal	Akronematik, Pantonematik
Bacillariophyta	1	Apikal	Pantonematik
Phaeophyta	2	Lateral	Akronematik, Pantonematik
Xanthophyta	2	Apikal	Akronematik, Pantonematik
Pyrrophyta	2	Apikal/Lateral	Akronematik, Pantonematik
Cryptophyta	2	Apikal/Lateral	Akronematik, Pantonematik
Euglenophyta	1	Apikal	Pantonematik
Rhodophyta	Tiada		

MAKANAN SIMPANAN

- Kanji
    - Fotosintesis
        - Bahan simpanan & sumber tenaga
    - Serbuk putih & bergranul
        - Tiada bau atau rasa
    - Molekul kanji terdiri daripada 2 jenis
        - Amilosa
        - Amilopektin
    - Kanji tidak larut dalam air sejuk atau alkohol
        - Bentuk suspensi koloid air dengan air panas
        - Jeli semasa penyejukan
    - Kanji terbentuk di sekeliling **pirenoid**
        - **Biru kehitaman** dengan iodid
- Kanji sianofisian
    - Alga biru-hijau
    - Ujian iodid negatif
    - Struktur – bak molekul amilopektin
        - Serupa dengan **glikogen**
            - Kanji haiwan
- Kanji floridean
    - Alga merah
    - Ujian iodid
        - Bertukar ke merah samar
    - Struktur – seperti amilopektin

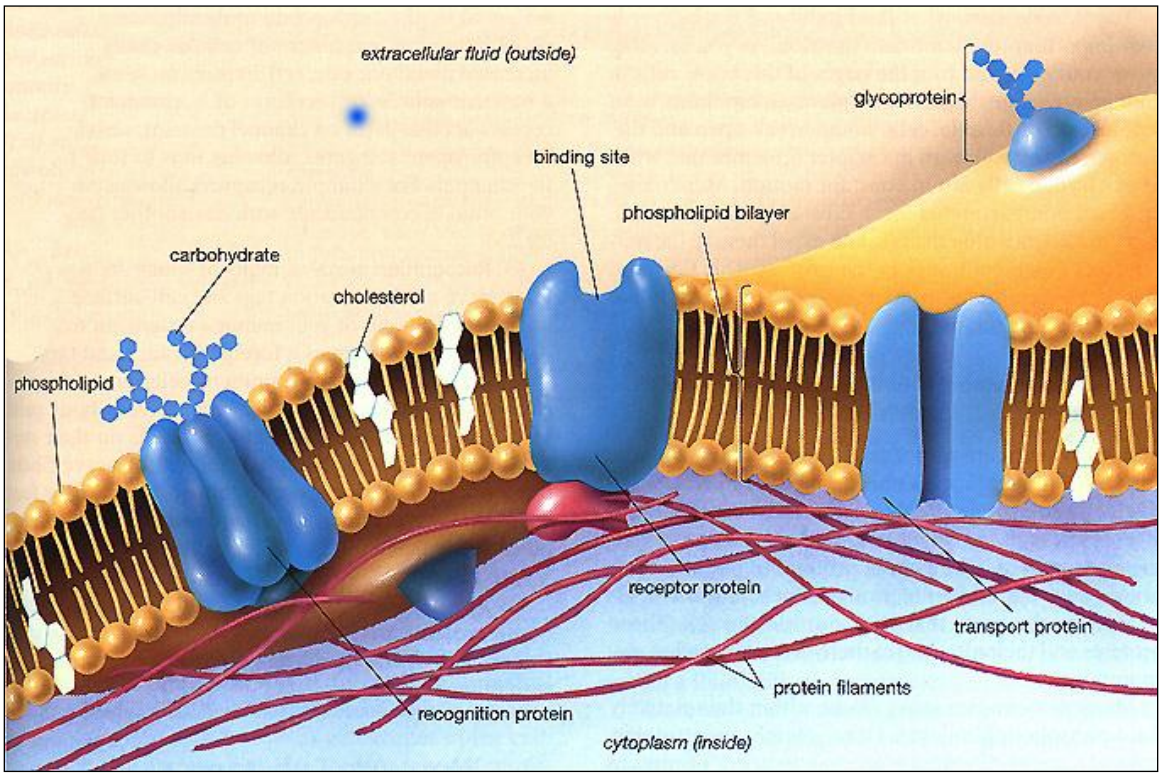
- **Paramilon**
  - Euglenoid
  - Ujian iodid – negatif
  - Dijumpai dalam vesikel (struktur satu membran)
  - β-1,3-glukan

- Laminarin
  - Phaeophyta
  - Ujian iodid – negatif
  - Struktur – sama dengan paramilon
    - β-1,3-glukan
- Krisolaminarin atau leukosin
  - Ujian iodid – negatif
  - Struktur – sama dengan paramilon
  - β-1,3-glukan
- Minyak atau lipid
  - Ujian iodid – negatif
  - Struktur – molekul gliserol terikat dengan karboksil
- Manitol
  - Ujian iodid – negatif
  - Struktur – alkohol gula manol

Divisi	Makanan Simpanan
Cyanophyta	Kanji sianofisian
Chlorophyta	Kanji
Chrysophyta	Krisolaminarin
Bacillariophyta	Krisolaminarin
Phaeophyta	Laminarin & Manitol
Xanthophyta	Minyak & Krisolaminarin
Pyrrophyta	Kanji
Cryptophyta	Kanji
Euglenophyta	Paramilon
Rhodophyta	Kanji Floridean

MEMBRAN & PELINDUNG SEL

- Plasma membran
  - Lapisan dubel berterusan
  - Sempadan sel dan persekitaran luar
  - Lapisan fosfolipid & protein
    - Model Mozaik Cecair (fluid mosaic model)
    - Semipermeable
  - Fungsi
    - Benarkan sebatian tertentu lalu, rembes antibiotik

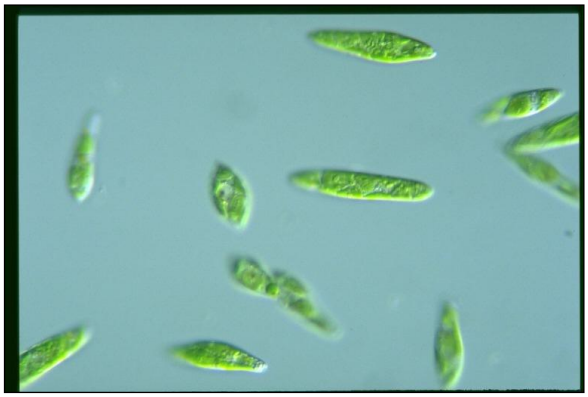


- **Pelikel**

Pellicle - a thin layer supporting the cell membrane

- Euglenophyta
  - Tiada dinding sel
- Dalam membran sel
- Plat pelikel keliling sel membentuk stria (garisan halus)
  - Pelikel keras (*Phacus*)
  - Plastik – berubah bentuk (*Euglena*)

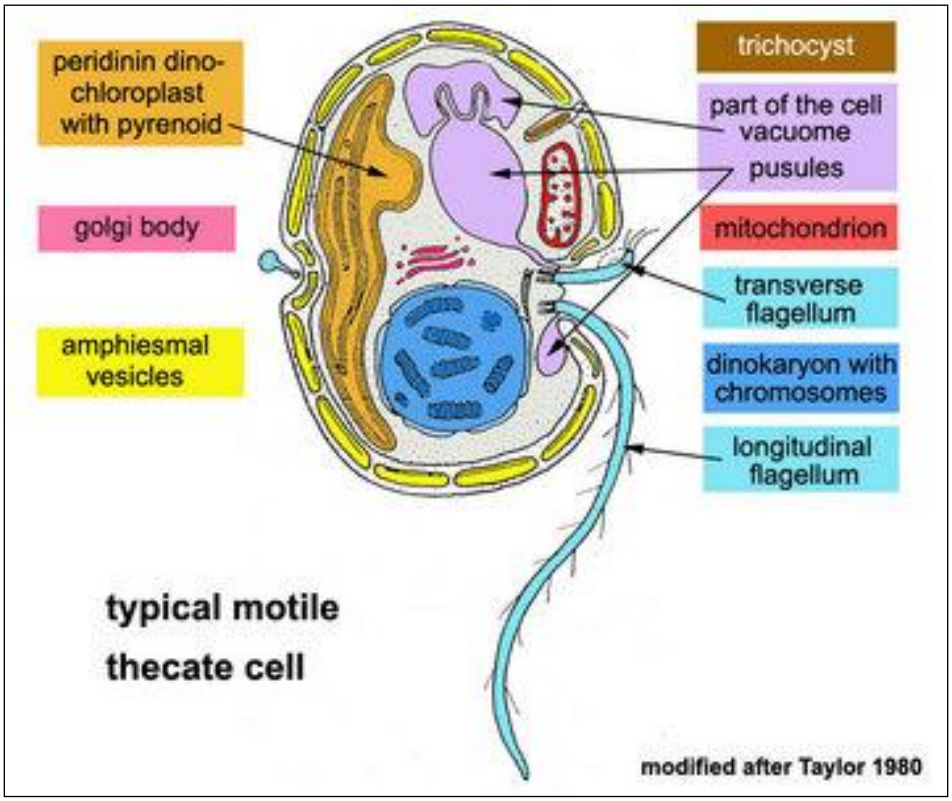
Phacus

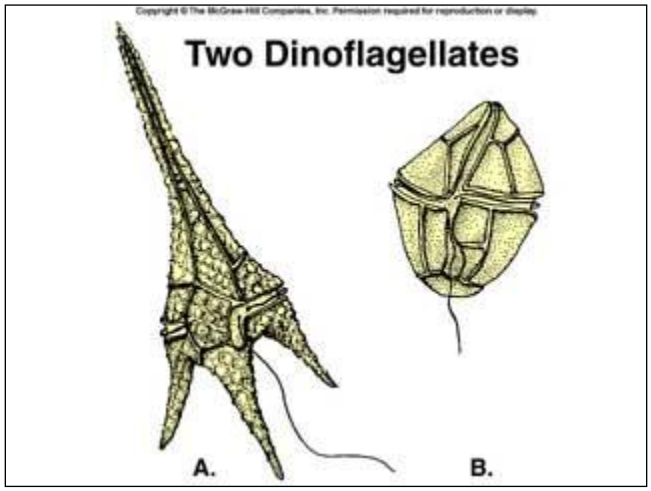


Euglena

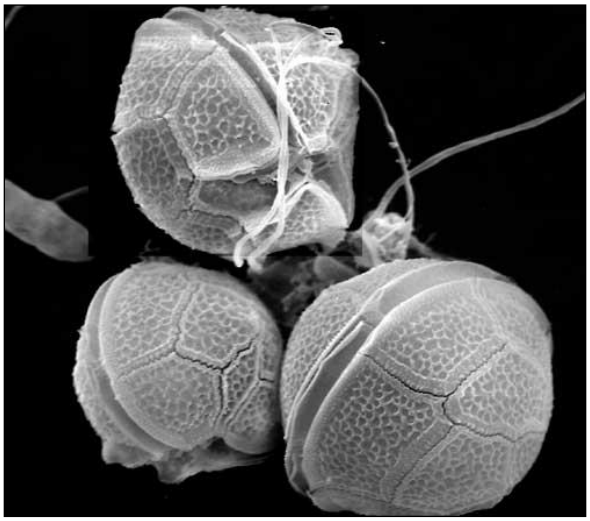
- **Amfiesma (Amphiesma)**
  - Dinoflagelat
  - Bawah membran sel
    - Menghasilkan plat (armored)

The amphiesma is a complex cell covering found in some dinoflagellates; it's composed of flattened vesicles called alveoli that sometimes support overlapping cellulose plates to form a type of scaly armor called a theca. Dinoflagellate species and even developmental stage determine the form the amphiesma takes in the organism.





Ceratium & Gonyaulax

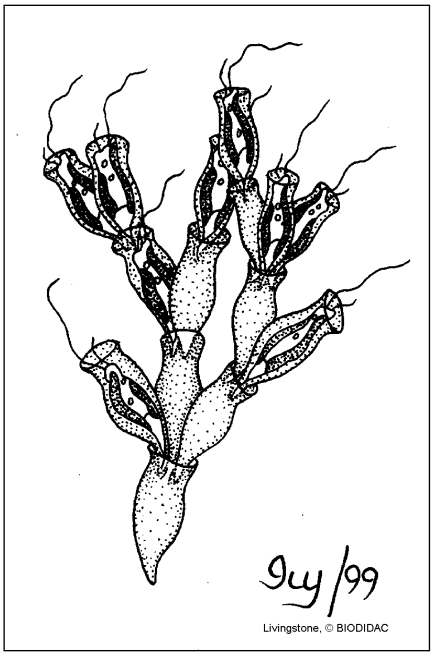


Gonyaulax

- **Lorika**

Lorica is a Latin word literally meaning body armour. A protective covering surrounding flagellated cells of some algae groups

- Luar membran sel
- Satu hujung terbuka
- Struktur kimia
  - Polisakarida, selulosa, silika, besi & aluminium (berwarna oren)



Dinobryon

Trachelomonas

LENDIR

- Disintesis oleh sel hidup
    - Dirembeskan di luar dinding atau struktur bak dinding
- Fungsi – lindung daripada mikroorganisma

KOMPONEN

- Agar

Agar or **agar-agar** is a gelatinous substance derived from a polysaccharide that accumulates in the cell walls of agarophyte red algae

    - Alga merah
    - Diasingkan dengan air panas
    - Nilai ekonomi
        - Medium kultur – mikrobiologi
        - Penstabil – pemakanan, kosmetik & farmasi

- Karagenan

Carrageenans or **carrageenins** (pronounced /ˌkærəˈgiːnənz/, with a hard *g*) are a family of linear sulfated polysaccharides which are extracted from red seaweeds.

    - Alga merah
    - Diekstrak dengan air panas
    - Punya nilai ekonomi

- Ubat batuk, industri tekstil, kosmetik, minuman keras

Divisi	**Pelindung Sel**	**Bahan Dinding Sel**	**Bahan Lendir**
Cyanophyta	Dinding sel	Mukopolimerik (Peptidoglikan)	
Chlorophyta	Dinding sel	Selulosa, Xilan, Manan	
Chrysophyta	Lorika, Dinding sel	Selulosa, silika, kalsium karbonat	
Bacillariophyta	Dinding sel	Silika (frustul)	
Phaeophyta	Dinding sel	Selulosa & asid arginik	Fukoidan
Xanthophyta	Dinding sel	Pektin & Selulosa	
Pyrrophyta	Amfiesma, Pelikel, Dinding sel	Selulosa	
Cryptophyta	Pelikel (periplas)	Tiada Dinding Sel	
Euglenophyta	Pelikel atau lorika	Tiada Dinding sel	
Rhodophyta	Dinding sel	Selulosa, xilan, galaktan	Agar, Karagenan, Porfiran

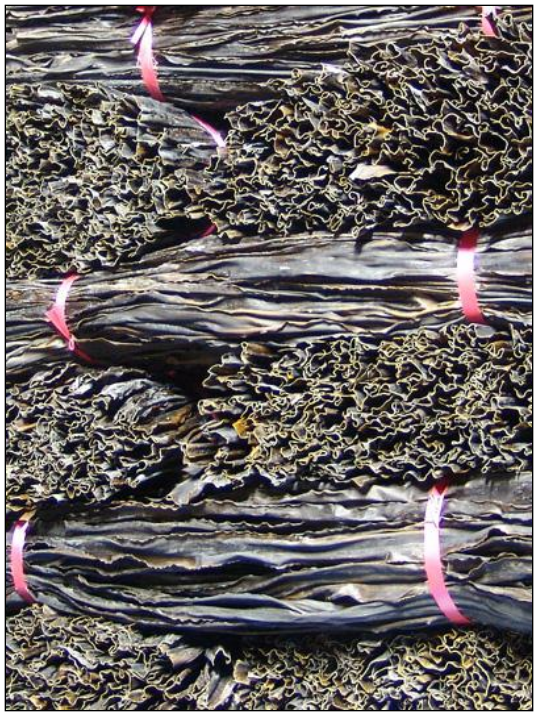
KEPENTINGAN & NILAI ALGA

- Nilai ekologi
    - Pengeluar utama
        - Asas jaringan makanan
        - Makanan protozoa, krustasia & ikan
    - Habitat untuk hidupan lain
        - Perlindungan daripada ombak & pemangsa
    - **Penetap nitrogen** (alga biru-hijau berheterosista)
    - Kesan penenang
        - Benteng dan kurang daya ombak

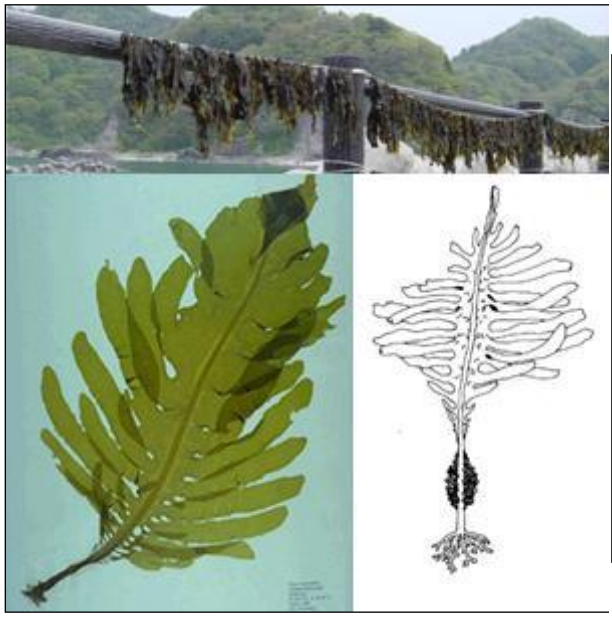
- **Nilai ekonomi**
    - Makanan
    - Alga merah dan perang
    - Mentah, dimasak atau dikeringkan
    - Kaya dengan iodin, vitamin b & c, asid folik
    - Jepun
        - **Kombu** (*Laminaria* & *Alaria*) - Phaeophyta
            - Dikeringkan & dimasak

Alaria

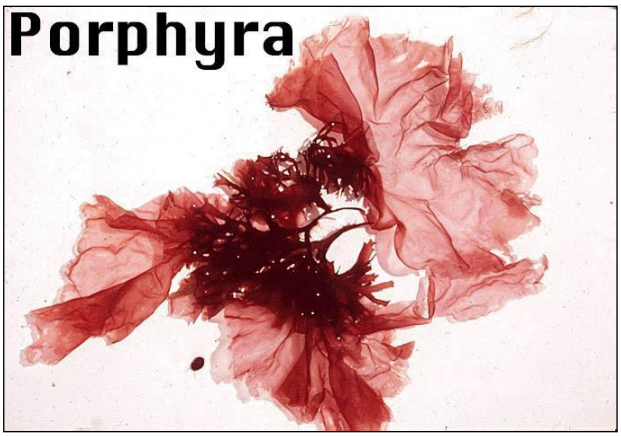
Laminaria



- **Wakame** (*Undaria*) – Phaeophyta
- dimakan mentah



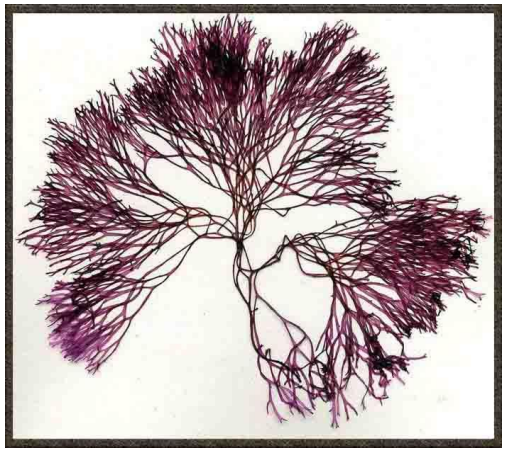
- **Nori** (*Porphyra*)
  - Sup dan pembungkus sushi #



Porphyra

- Britain
  - Purple laver (*Porphyra*)
  - Roti laverbread
- Malaysia
  - *Caulerpa* (lato) dimakan mentah
  - *Gracilaria* (sarei) – Kelantan & Terengganu

Caulerpa



Gracilaria

- Mineral
  - Alga coklat
  - Kaya dengan soda & potash
    - Industri sabun & bahan kaca
- Perubatan
  - *Macrocystis, Laminaria, Fucus & Sargassum*
  - Ubat goiter (beguk) – iodin
  - Cirit birit
  - Antibiotik, antibakteria, antikulat, antitumor
    - Ekstrak daripada *Cladophora* & *Lyngbya* bunuh *Pseudomonas*
  - Ubat cacing
  - Rendah tekanan darah dan aras kolesterol

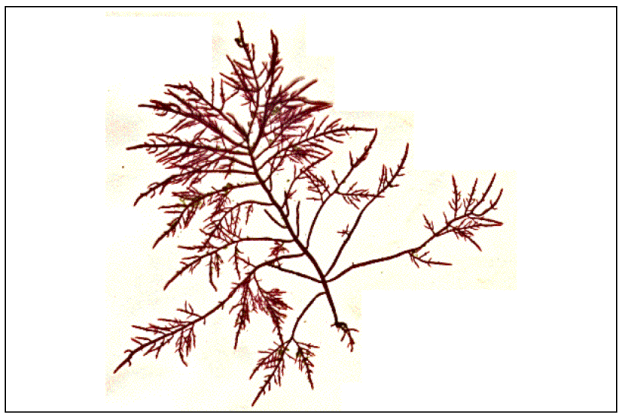
Sargassum

Fucus

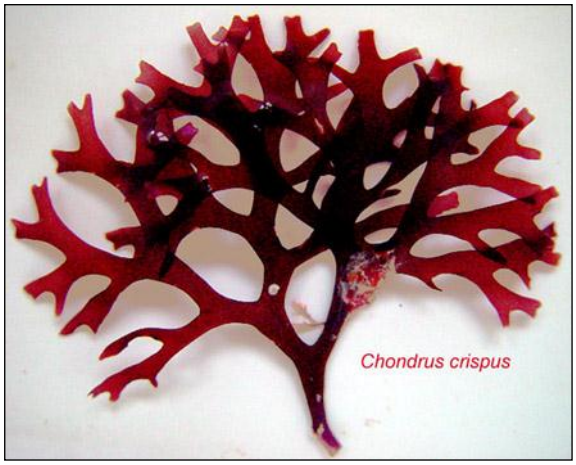
Macrocystis

- **Fikokoloid**
  - Industri pembuatan makanan
    - Bentuk gel
    - Bahan penebal, pengampai, penstabil dan pembentuk gel

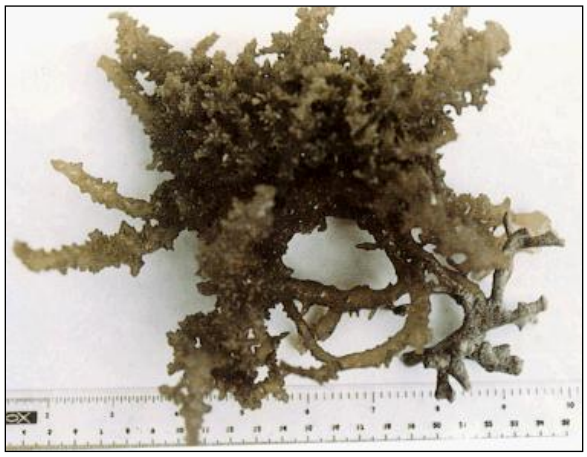
    - **Algin** (terdiri daripada asid alginik dan garamnya alginat)
      - Kelpa gergasi (*Macrocystis*)
        - California – kawasan utama penghasilan algin di dunia
      - *Laminaria & Sargassum*
        - Bahan penstabil dan pengemulsi
        - Hasil tenusu (aiskrim & keju)
          - Tekstur licin pada aiskrim dengan menghalang pembentuk ais
        - Agen pengampai dalam industri cat, farmasi, dadah dan antibiotik
        - Agen memekat
          - Syampu, krim pencukur, plastik & pestisid
        - Pengemulsi dalam industri cat dan kosmetik
    - **Agar**
      - *Gelidium & Gracilaria* (alga merah)
      - Bentuk jeli dengan mudah
      - Ikan dan daging dalam tin
      - Agen penstabil dalam kosmetik dan farmasi
      - Kertas, filem, krim pencukur dan losyen
      - Medium kultur bakteria, kulat & kultur tisu



Gelidium



Chondrus (Irish moss)



Eucheuma

Ascophyllum

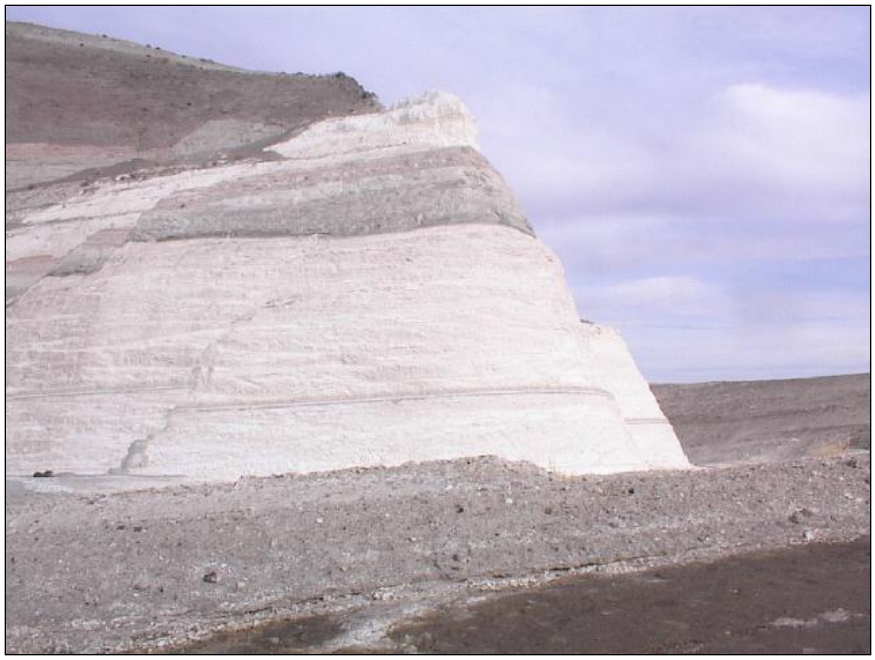
- **Karagenin**
  - *Chondrus* (Irish moss) di temperat & *Eucheuma* di Asia
  - Serupa agar tetapi kandungan abu tinggi
  - Agen penstabil dalam aiskrim, ubat gigi, sirap, ubat batuk, minuman keras dan hasil tenusu.

- Makanan binatang (fodder)
  - Alga coklat (*Ascophyllum, Laminaria* & *Fucus*)
  - Kambing, lembu, ayam
  - Kaya dengan mineral & vitamin
    - Susu lembu tinggi kandungan lemak
    - Telur ayam tinggi iodin
- Baja
  - Alga perang (*Fucus*)
  - Kaya dengan kalium & fosforus
  - Perkaya tanah dengan nutrien & baiki struktur tanah
  - Alga biru-hijau di sawah padi
    - Alga berheterosista

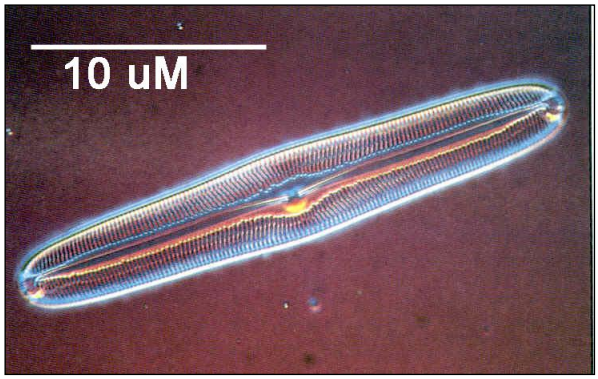
- **Diatomit (Bacillariophyta)**
  - **Frustul**

Diatomaceous earth also known as **diatomite** or **kieselgur**, is a naturally occurring, soft, siliceous sedimentary rock that is easily crumbled into a fine white to off-white powder. It has a particle size ranging from less than 1 micron to more than 1 millimeter, but typically 10 to 200 microns.[1] This powder has an abrasive feel, similar to pumice powder, and is very light, due to its high porosity. The typical chemical composition of oven dried diatomaceous earth is 80 to 90% silica, with 2 to 4% alumina (attributed mostly to clay minerals) and 0.5 to 2% iron oxide.

Diatomaceous earth consists of fossilized remains of diatoms, a type of hard-shelled algae. It is used as a filtration aid, as a mild abrasive, as a mechanical insecticide, as an absorbent for liquids, as cat litter, as an activator in blood clotting studies, and as a component of dynamite. As it is also heat-resistant, it can be used as a thermal insulator.



Diatomaceous Earth (nicknamed DE) is often also called Earth or Shell Flour. This fine powder substance, mined in North America, is the skeleton of a microscopic sea creature, somewhat like present day algae, called Diatoms. Millions of years ago, when great seas covered the earth, these creatures lived and died by the thousands leaving large deposits at the bottoms of these now dried up seas. Modern mining processes harvest these diatoms from the former sea beds to give us one of nature's wonder products Diatomaceous Earth.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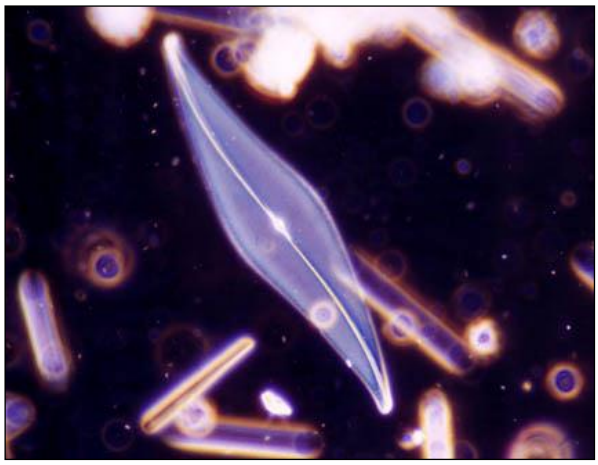
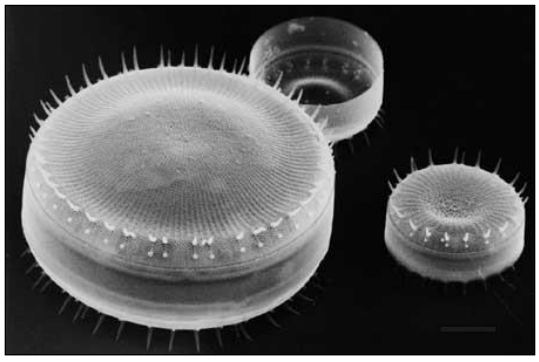
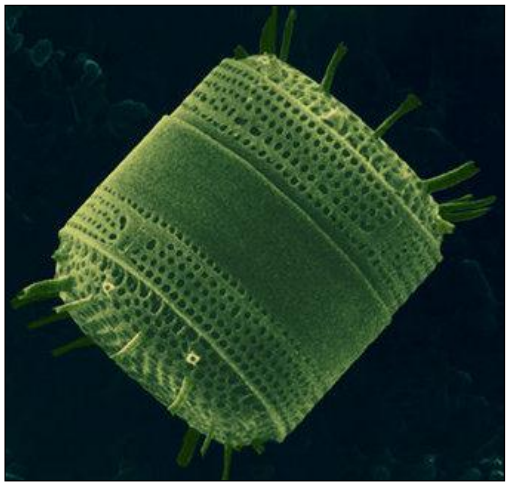






KESAN BURUK

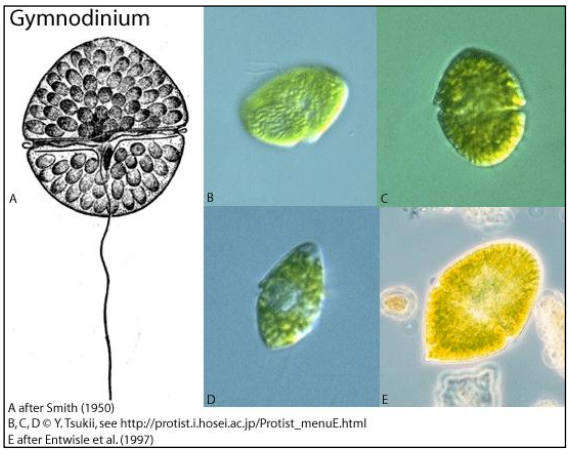
- **Ombak merah** (red tide)

Dinoflagellates are perhaps best known as causers of harmful algal blooms (HAB)

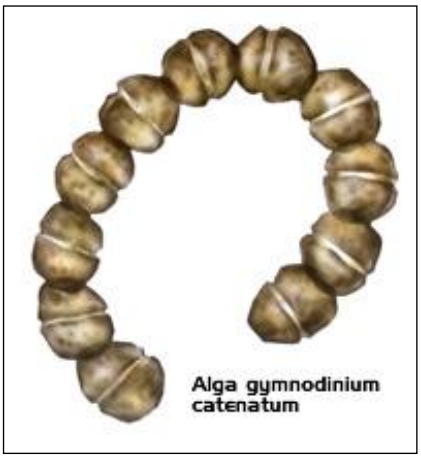
About 75-80% of toxic phytoplankton species are dinoflagellates, and they cause "red tides" that often kill fish and/or shellfish either directly, because of toxin production, or because of effects caused by large numbers of cells that clog animal gills, deplete oxygen, etc.

Dinoflagellate toxins are among the most potent biotoxins known. They often accumulate in shellfish or fish, and when these are eaten by humans they cause diseases like paralytic shellfish poisoning (PSP), neurotoxic shellfish poisoning (NSP), diarrheic shellfish poisoning (DSP) and ciguatera /(sē-gwə-tĕrə)/

- *Gonyaulax & Gymnodinium*



Gymnodinium



Gymnodinium catenatum

- **Cetusan alga (algal bloom)**
  - Cyanophyta
  - *Microcystis, anabaena & Aphanizomenon*
    - Air tidak selamat diminum
    - Membataskan kegiatan rekreasi
    - Masalah kulit, masalah gastrointestin
    - Masalah kekurangan oksigen
      - Kematian ikan (fishkill)

algal bloom

Fishkill