Ecology and phycology

For 2nd Year Biology & Gology

general education

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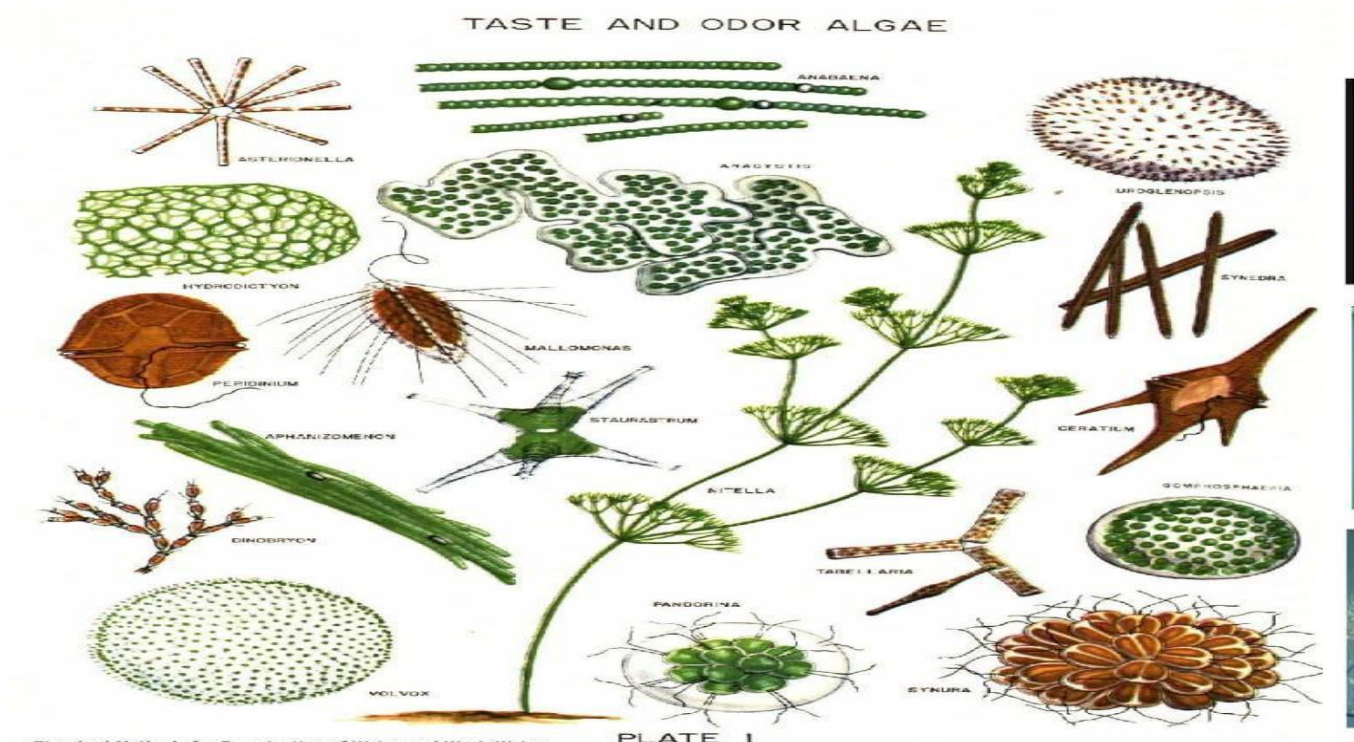

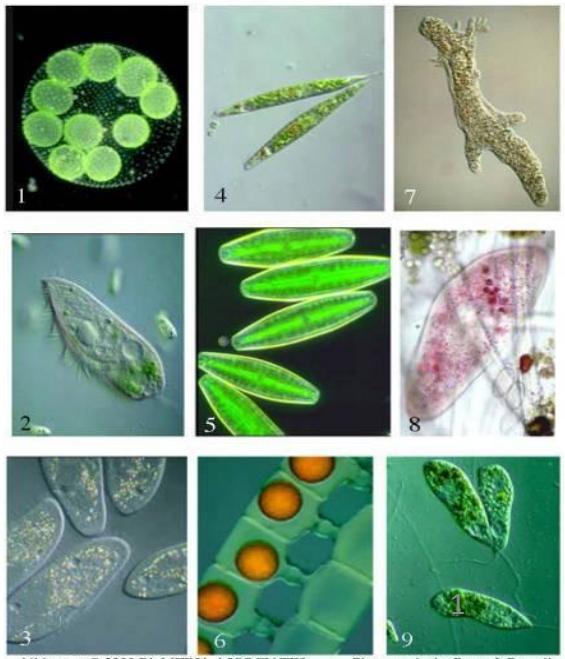

رؤية الكلية

تسعى الكلية الى مساعدة الجامعة فى تحقيق اهدافها الاستراتيجية من خلال ان تكون واحدة من الكليات المتميزة والمنافسة داخليا وخارجيا فى التعليم وخدمة المجتمع والبحث العلمى من خلال تحقيق مستوى رفيع من الاداء وتقديم خريج متميز يقابل الاحتياجات المتعددة بسوق العمل الداخلى والاقليمى والخارجى

رسالة الكلية

تهدف كلية التربية بالغردقة الى التميز من خلال:

- إعداد المربين والمعلمين المتخصصين والقادة إعداداً أكاديمياً ومهناً وثقافياً فى مختلف التخصصات التربوية.
- تنمية القدرات المهنية والعلمية للعاملين فى ميدان التربية والتعليم بتعريفهم بالاتجاهات التربوية الحديثة.
- إجراء البحوث والدراسات فى التخصصات التربوية والمختلفة بالكلية.
- نشر الفكر التربوى الحديث واسهاماتة لحل مشكلات البيئة والمجتمع.
- تبادل الخبرات والمعلومات مع الهيئات والمؤسسات التعليمية والثقافية المختلفة.
- تنمية جوانب شخصية الطلاب ورعاية الموهوبين والمبدعين.

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Phycology

- The Study of Algae is called ***Phycology***

Phycos = Algae, *logos* = Study(of/Discourse of.)

Phycos is a Greek word which means **seaweed** and the references to algae

Phycologists (algologists)

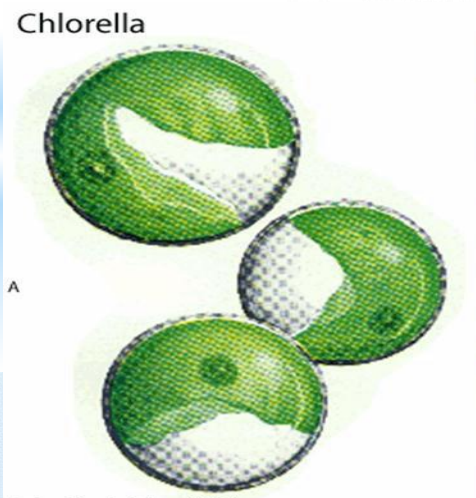
DEFINITION OF ALGAE

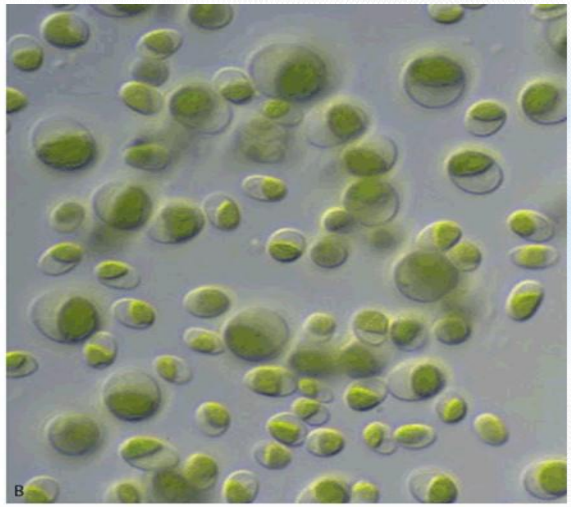
Algae

- a diverse group of simple, plant-like organisms.
- Lack the roots, leaves, and other structures typical of true plants.

➢ The algae **are chlorophyll bearing** organisms with a thallus-like plant body.

Most algae use the energy of sunlight to make their own food, a process called **photosynthesis**.





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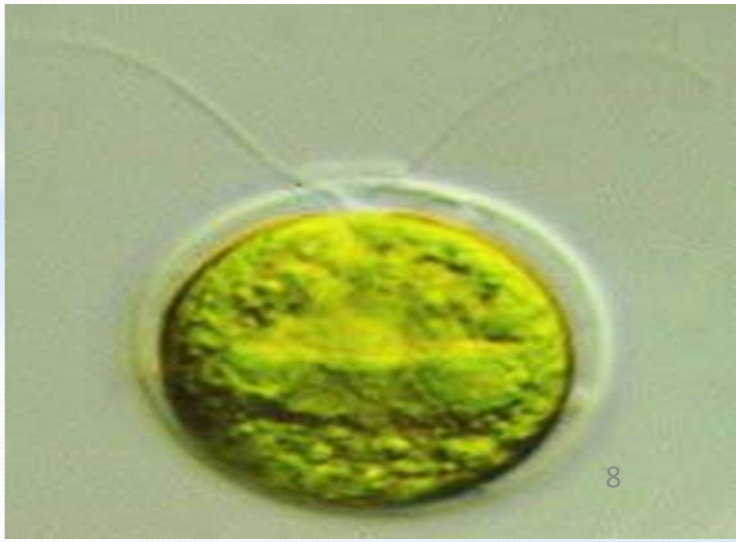
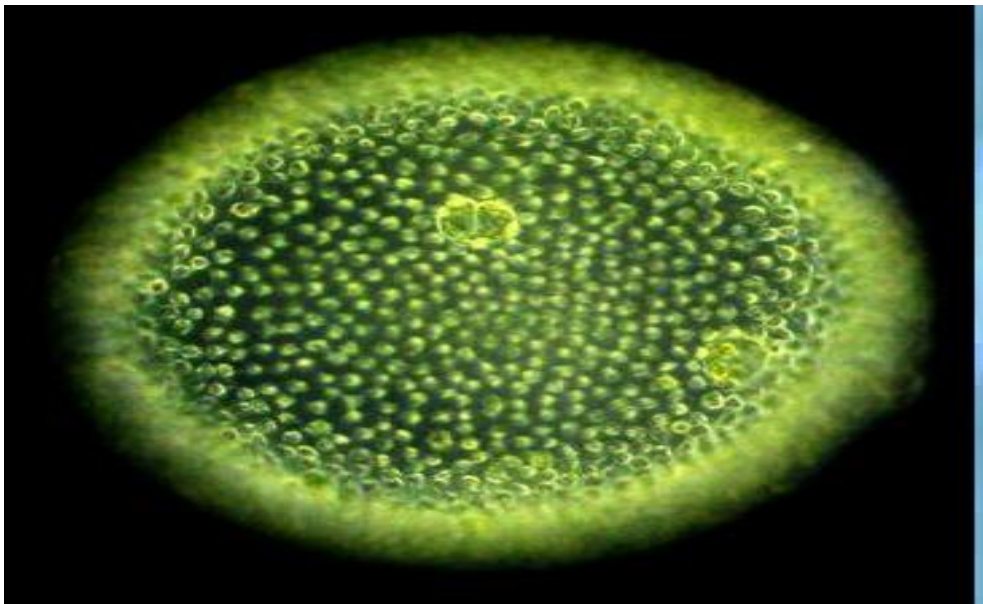


➢ The thallus shows little differentiation of true tissues.

-Even the complex thalli lack vascular tissue and epidermis with stomata.

- The sex organs are one-celled, when multicellular, each cell is fertile and there is no jacket of sterile cells.
- **There is no embryo formation after gametic union.**
- -There are no algae with a sporophyte parasitic on the gametophyte plant.
-

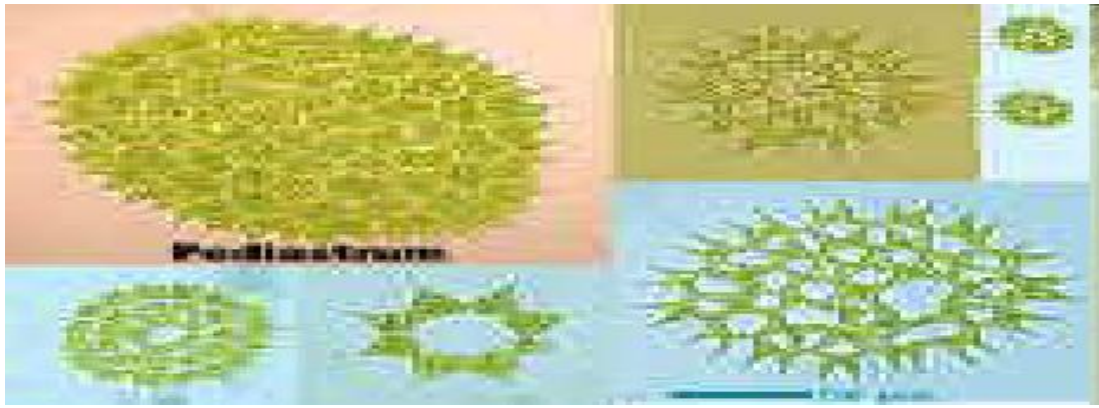


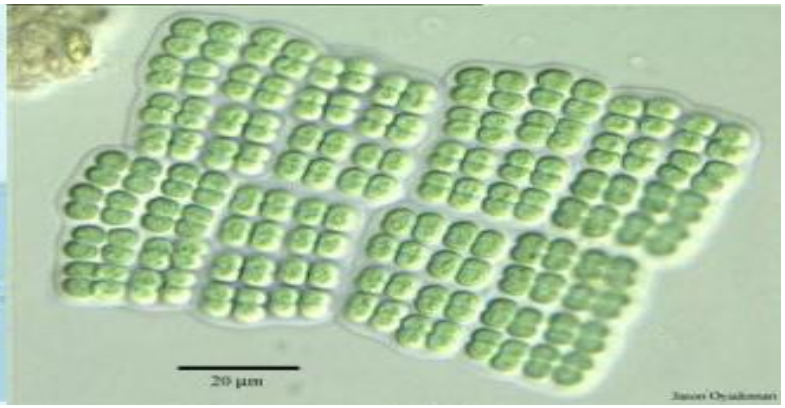
-The most important photosynthesizing organisms on earth.

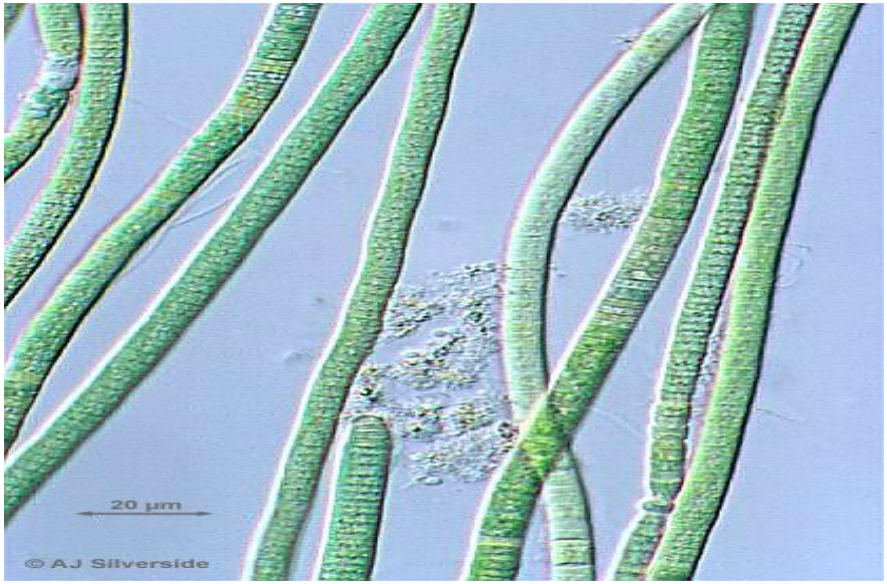
-Microscopic algae, called phytoplankton, float or swim in lakes and oceans.

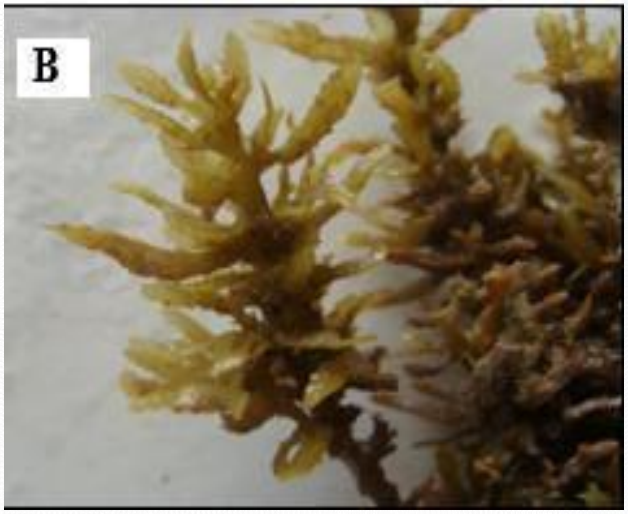
- Phytoplanktons are so small that 1000 individuals could fit on the head of a pin.

- The largest forms of algae are **seaweeds** that stretch 100 m (300 ft) from the ocean bottom to the water's surface









Cystoseira myrica

Sargassum cinereum

Padina boergesenii,

Characteristics

* Range in size from microscopic to single celled organisms to large seaweed
* Autotrophic
  * Form the reproductive structures - gametangia or gamete chambers
* Aquatic and have flagella at some point in life
  * Often contain **pyrenoids,** organelles that synthesis and store starch

Algae Taxonomy

Taxonomic Composition of Algae (Divisions and Classes)

Division Cyanophyta -blue green algae

Division Chlorophyta (Green Algae)

Division Euglenophyta (Euglenoids(

Division Phaeophyta (Brown Algae)

Division Chrysophyta

Division Bacilariophyta

Division Pyrrophyta

Division Rhodophyta (red algae)

Algal Pigments

The colour of the algal thallus which varies in different classes of algae is due to **the presence of definite chemical compounds** in their cells.

The photosynthetic pigments: three kinds, namely,

.

1 **Chlorophylls**,
2 **Carotenoids** and
3 **Phycobilins** or **Biliproteins**

photosynthetic pigments

-1- The algal chlorophylls are characterized by green colour and in solution . Fat soluble compounds

-There are five types of chlorophylls found in algae

*chlorophyll a, *b*, *c*, *d*, and *e*

*chlorophyll a is present in all groups of algae.

*Chlorophyll b is found only in Chlorophyceae

* Chlorophyll c in Phaeophyceae, Bacillariophyceae and Chrysophyceae.

* Chlorophyll d in some red algae, and

*chlorophyll e in certain Xanthophyceae.

.

Photosynthetic Pigments

***2- Carotenoids*:**

fat soluble yellow coloured pigments

***carotene*,**

Xanthophylls

carotenoid acids

photosynthetic pigments

3- -**phycobilins (biliproteins)**: water soluble blue (phycocyanin) present in Cyanophyta

and red (Phycoerythrin) coloured pigments present in the members of and Rhodophyta.

Taxonomic Group	Photosynthetic Pigments
Cyanobacteria	chlorophyll *a*, chlorophyll *c*, **phycocyanin**, phycoerythrin
Green Algae (Chlorophyta)	chlorophyll *a*, chlorophyll *b*, carotenoids
Red Algae (Rhodophyta)	chlorophyll *a*, phycocyanin, **phycoerythrin**, (phycobilins)
Brown Algae (Phaeophyta)	chlorophyll *a*, chlorophyll c, **fucoxanthin** and other carotenoids
Golden-brown Algae (Chrysophyta)	chlorophyll *a*, chlorophyll c, fucoxanthin and other carotenoids
Dinoflagellates (Pyrrhophyta)	chlorophyll *a*, chlorophyll *c*, peridinin and other carotenoids

3- Algal flagella

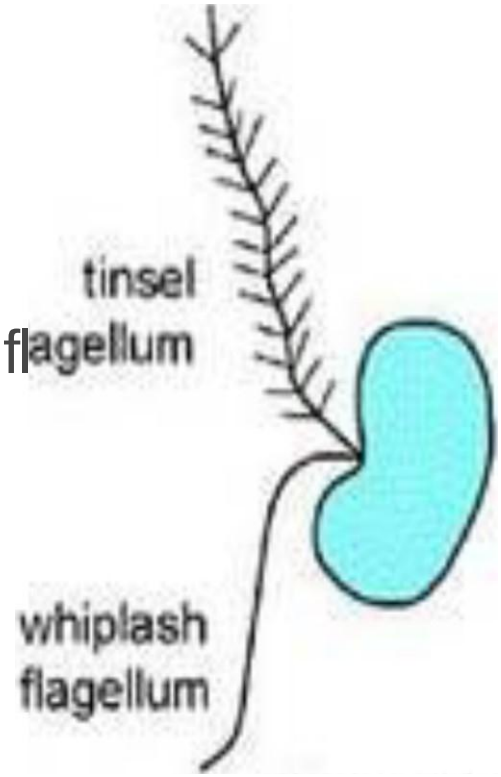
They are of two main types of **flagella**

1 - **whiplash flagellum** has a smooth surface

2 - **tinsel flagellum** has rows of fine, minute hairs

The flagella on the cell may be equal (isokont) or unequal (heterokont) in length

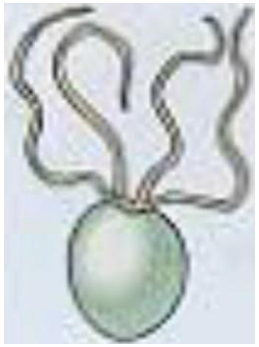
3- flagellum is covered by scales (*Chara*) and minute, short, stiff hairs (EM)


tinsel
flagellum
whiplash
flagellum

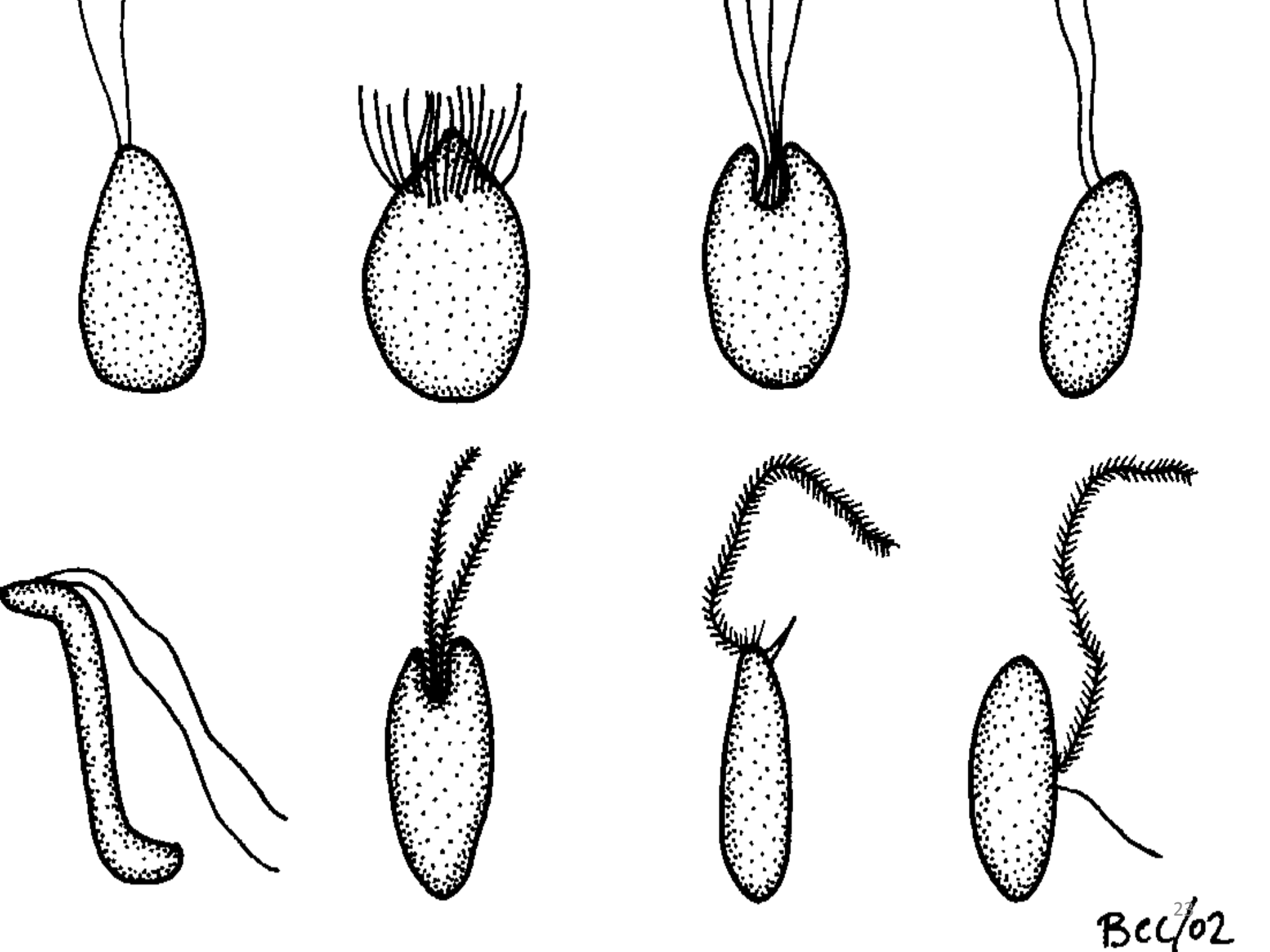

(a)


(b)


(c)




(f)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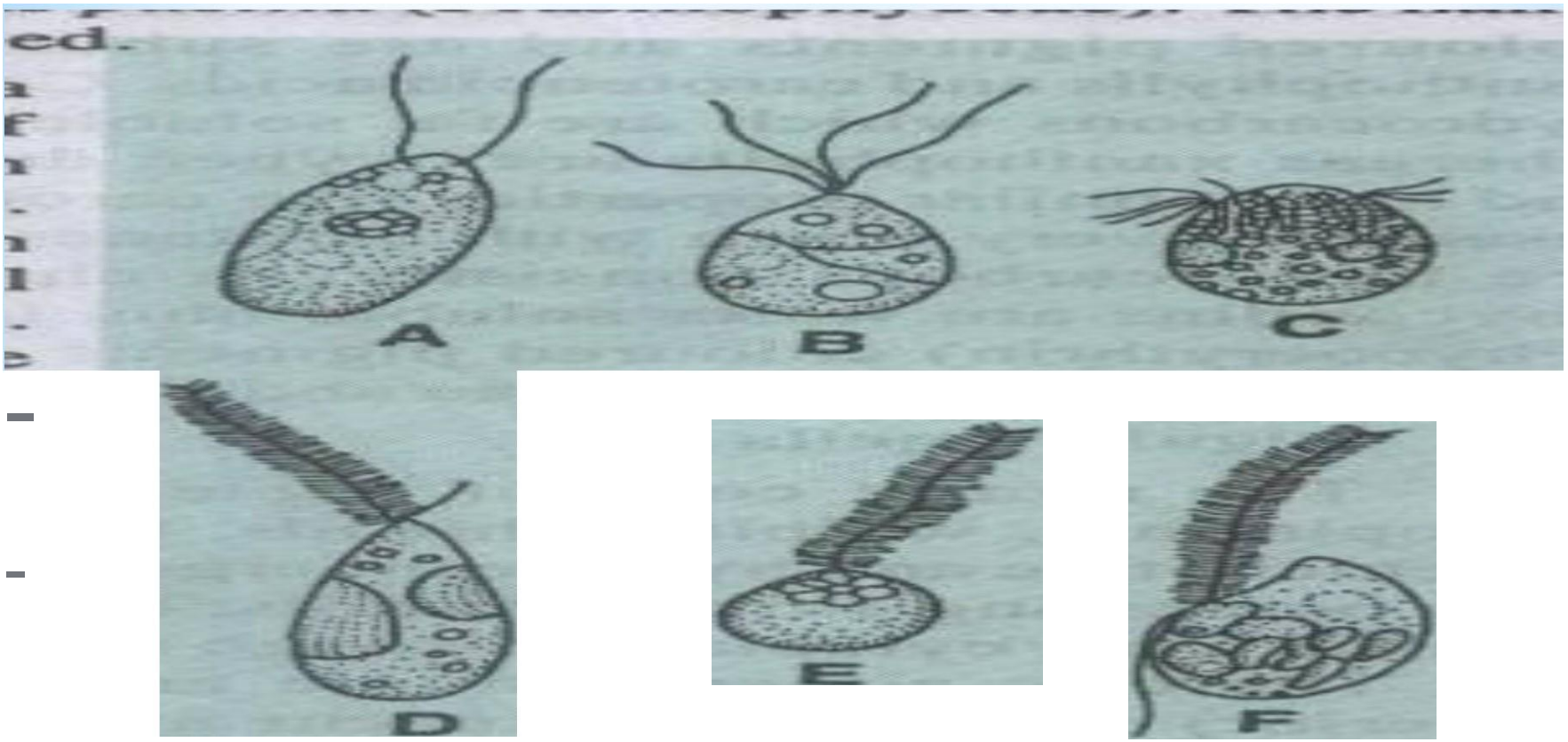


Fig. 1.5. (A-F) *Algae*. Flagellation., Chlorophyceae (A-C); Xanthophyceae (D); Bacillariophyceae (E) and Phaeophyceae (F).

Nutrition algae are autotrophic.

4- Food Reserves

The food materials which accumulate as food reserves in the form of polysaccharides, however, vary from group to group of algae .

1 **True starch : Chlorophyta and Charophyta.**

2 cyanophycean starch (glycogen) is characteristic of division **Cyanophyta**

3- floridean starch. is characteristic of division **Rhodophyta**

4 -**laminarin** found in the **brown algae**

5- paramylon characteristic of Euglenoids

6- leucosin **peculiar** غير مألوف to the Xanthophyta, Bacillariophyta and Chrysophyta.

7- Mannitol in brown algae

Economic important of algae


Biogas


Bioethanol


Biodiesel


Biobutanol

Biofuel


Cosmetics


Nutraceuticals
Pharmaceuticals
Vitamins


Food


Bioplastics

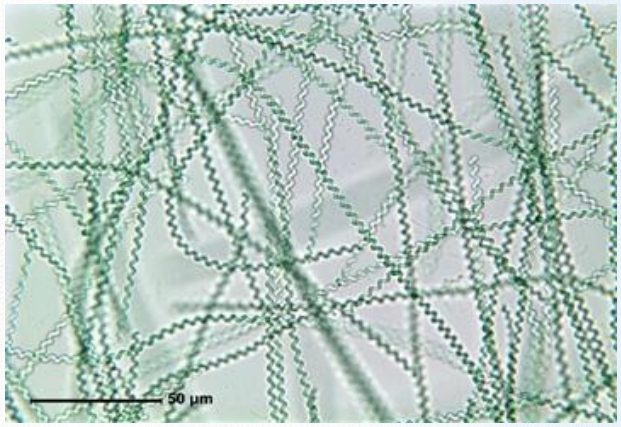

Feedstock

Animal feed


Fertilizer/nutrients

Economic important of algae

*Benefical role



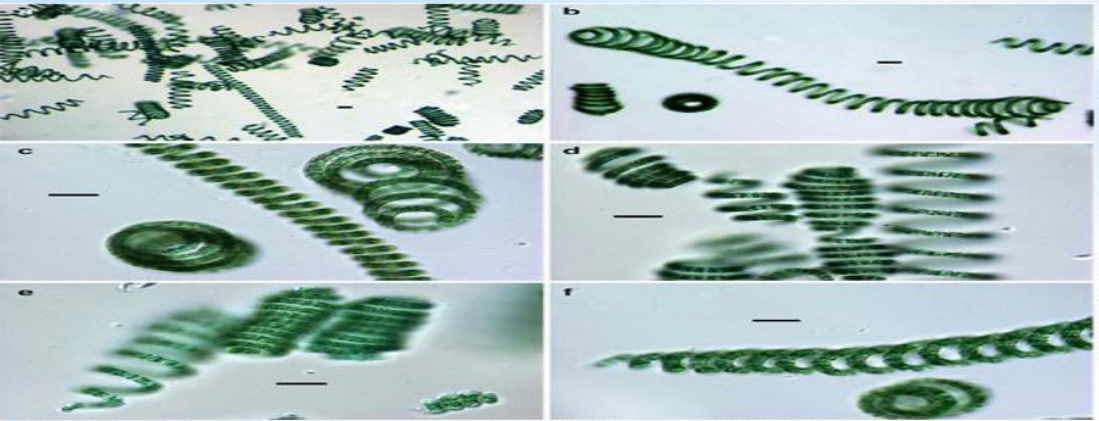
Algae as human food

mixed with rice and fish and consumed as

salad, soups

Spirulina : it is high in protein and other nutrients used as a **food supplement** and as a treatment for **malnutrition**

Chlorella ellipsoidea is used with tea in Japan.

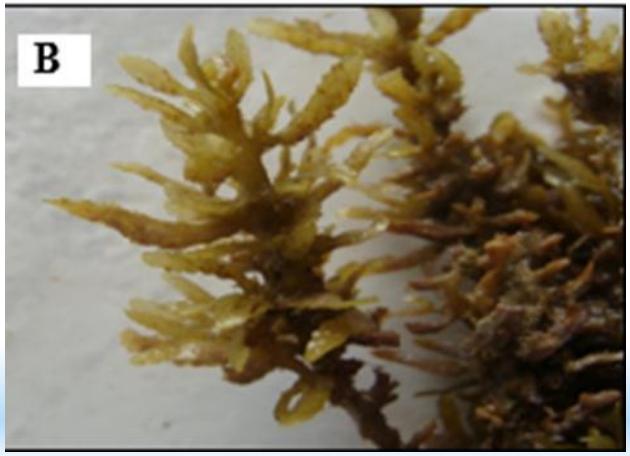


A after Mervin Palmer (1962)
B © National Institute for Environmental Studies, see http://www.nies.go.jp/biology/mcc/home.htm

Algae as fodder

Seaweeds (brown algae) are used as feed for domestic animals

Sargassum, focus and Laminaria are consumed by cattles (enhanced ten percent milk yield)



* Algae as nitrogen fixation

conversion of atmospheric nitrogen into nitrogenous compound

i.e., nitrogen fixation is one important attribute of blue - green algae

A large number of members belonging to order Chroococcales and Nostocales have been found to perform this function.

Algal role in fisheries:

oedogonium, *Microspora*, *Ulothrix*, *Spirogyra*, *Cladophora*, diatoms sever as fish food in freshwater systems

*Algae in sewage treatment

*The released oxygen is utilized by bacteria in rapid decomposition of the sewage.

*Ex: *Chlorella*, *Scenedesmus*, *Pediastrum* *Euglena*; *Phacus*

Algae as research material

Algae like: *Chlamydomonas*, *Chlorella* are very much useful in physiological, cytological and genetical studies

Algae as fertilizer

- increase the water holding capacity besides the addition of their chemical constituent in the soil.
- Seaweeds, brown algae improve the fertility of soil in cultured fields as their algin content helps in conditioning the soil, facilitating aeration, moisture retention and adsorption of nutrient elements.

Seaweed liquid fertilizers will be useful for achieving **higher agricultural production**, **because**

- The extract contains growth promoting hormones (IAA), gibberellins, cytokinins, trace elements and vitamins.
- Increased resistance to diseases upon treatment in various crops.
- **Ex.**

- Fucus spp., Padina spp., Laminaria spp., Sargassum spp., and Turbinaria spp. are used as biofertilizers in agriculture.
  - They are either mixed with some other organic materials or are allowed to rot in the field as such.

- A 30% increase in the total production of rice grains was reported by algologists when the rice fields were inoculated by some nitrogen – fixing blue- green algae.

* Algae and medicinal use

***Brown algae**

Sargassum ⟶ **goiter medicines** أدوية تضخم الغدة الدرقية

(high iodine content)

Insect diseases to humans

are treated with extract from Digenia, *Codium*, *Alsidium* and *Durvillea*

⟶

- compounds of laminarin are used as anticoagulant while
- **Carrageenin acts as blood coagulant.**

Algae treatment of kidney, bladder and lung disease

Gelidium is used in stomach disorders

* Antibiotic **chlorellin** is extracted from *Chlorella vulgaris* which inhibits the growth of bacteria and a few algae.
* The growth of *E. coli* is found to be reduced by *Nitzschia palea*

- **Microcystis** inhibitory action to *Staphylococcus*, *Closteridium* and zooplanktons like *Cyclops* and *Daphnia*.

Algae in uptake of heavy metals *

Chlorella, *Euglena*, *Spirogyra*, *Cladophora*, *Scenedesmus* and *porphyra* have been found to absorb the radioactive elements and heavy metals.

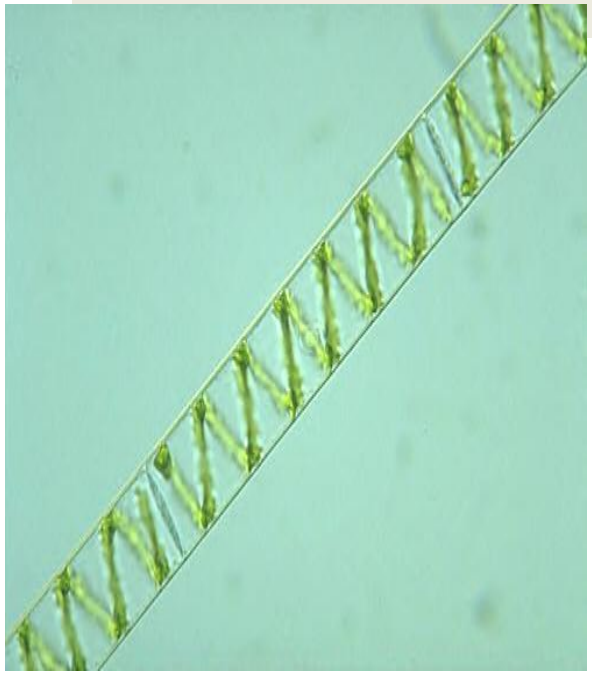
* **Lens paper**
* **Algae in the origin of petroleum and Gas**

Salient Features of Chlorophyta

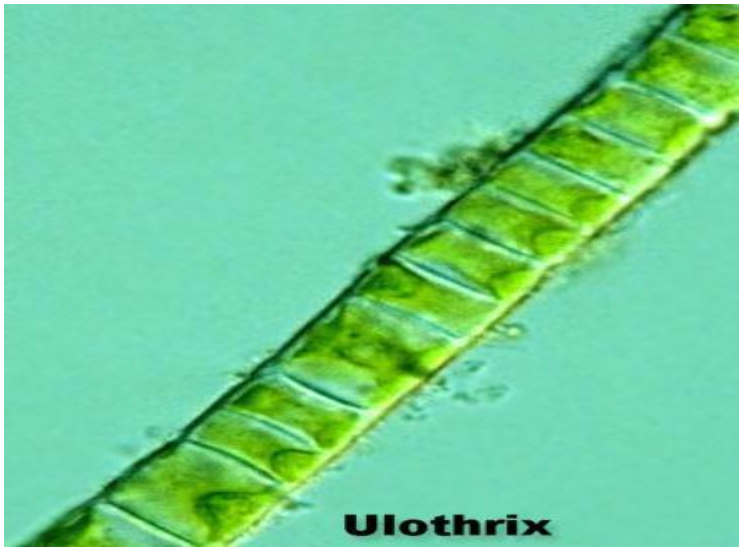
- **Chlorophyta** is a division of green algae
- Grass green in colour owing to the preponderance of **chlorophyll** *a* and *b* over **carotene** and **xanthophyll**.
- The pigments are localised in the green plastids known as **chloroplasts**.
- The reserve carbohydrate food is **stored as starch**.
- The chloroplasts normally contain the **pyrenoids**.
- The cell has a well defined **nucleus** and in the higher forms a central **sap cavity** in addition.

Common Chloroplasts Shapes include

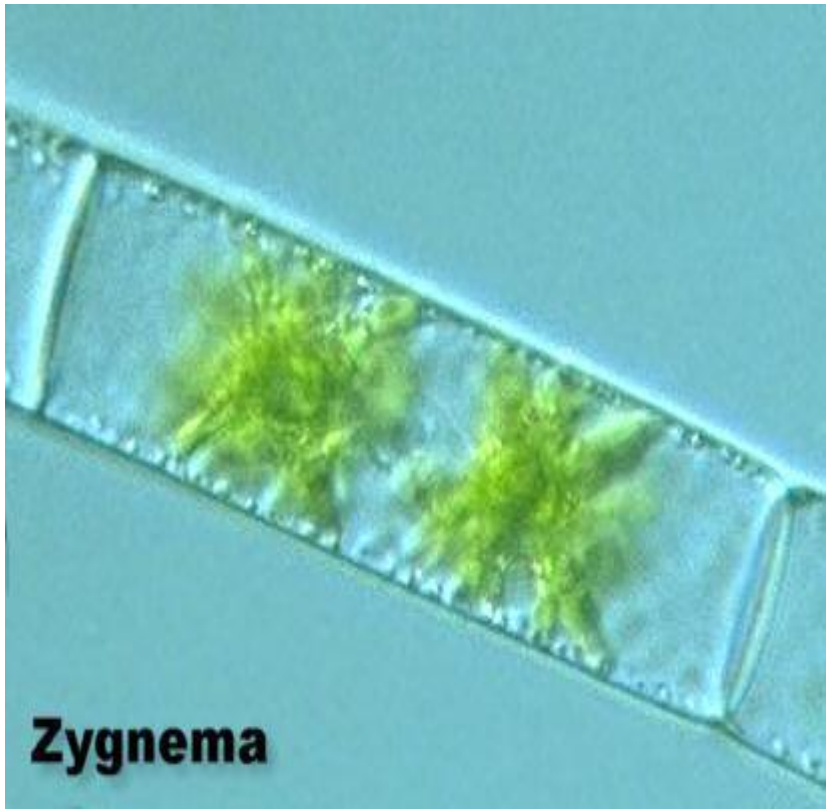
Cup Filament Star Reticulate (Net) Banded

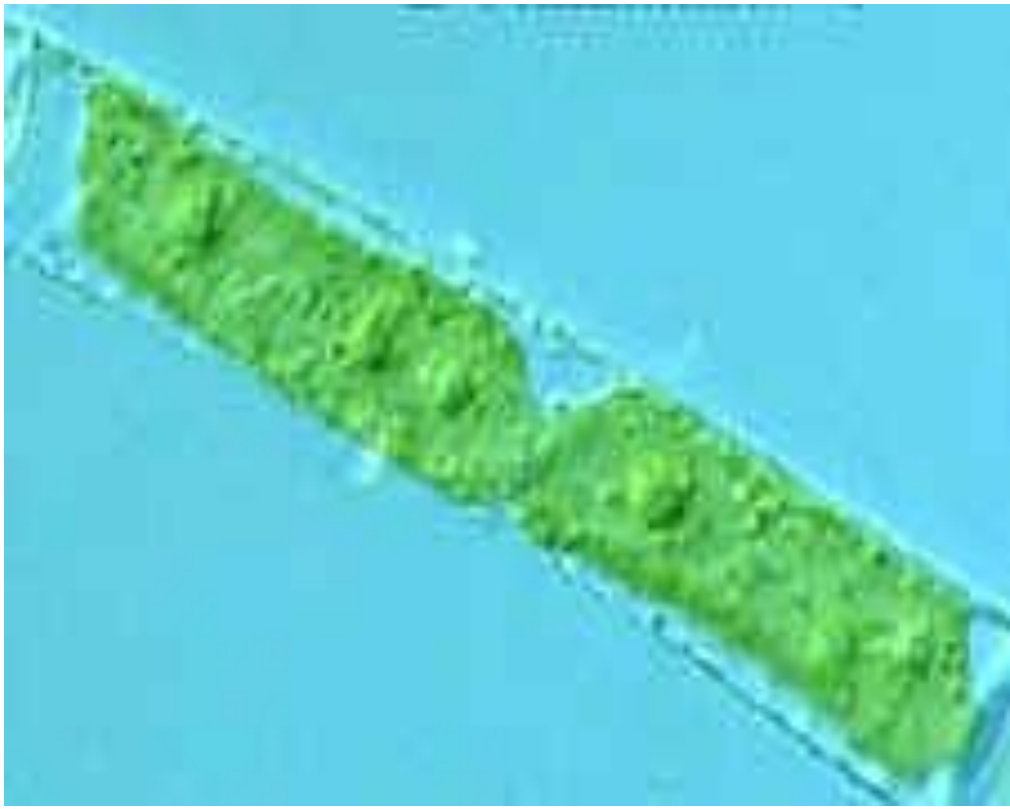


***Spirogyra* has spiral Chloroplasts**



Ulothrix has band-shaped Chloroplasts

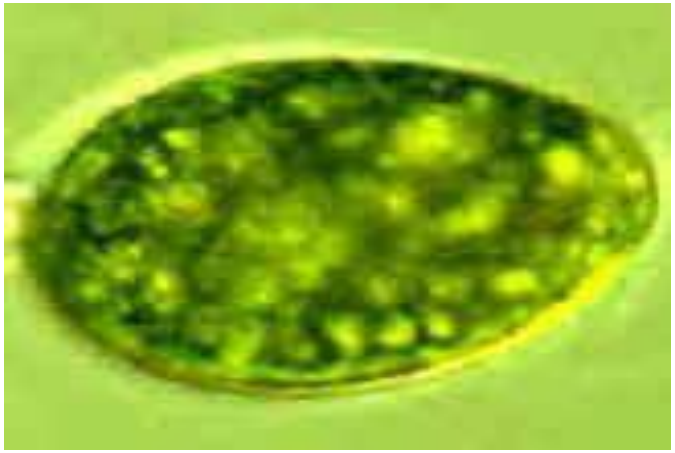




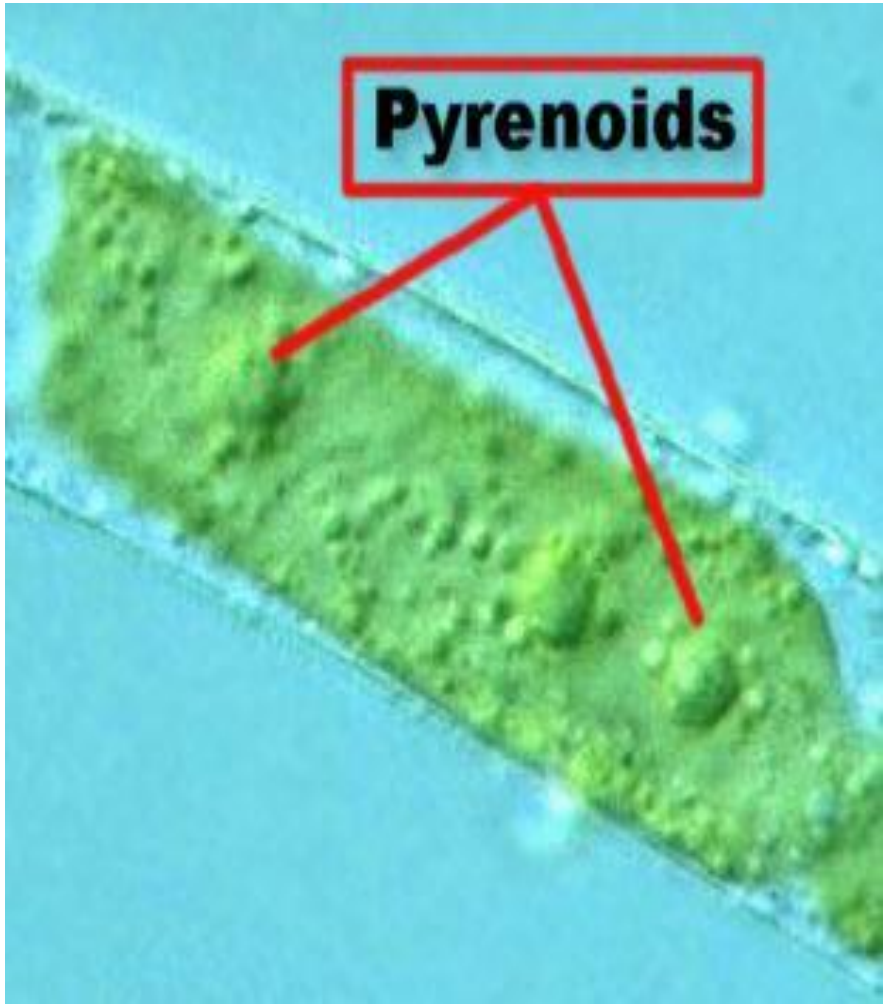
Zygnema has Star-shaped Chloroplasts

Mougeotia has a flat Chloroplast.
The disk-like areas are Pyrenoids

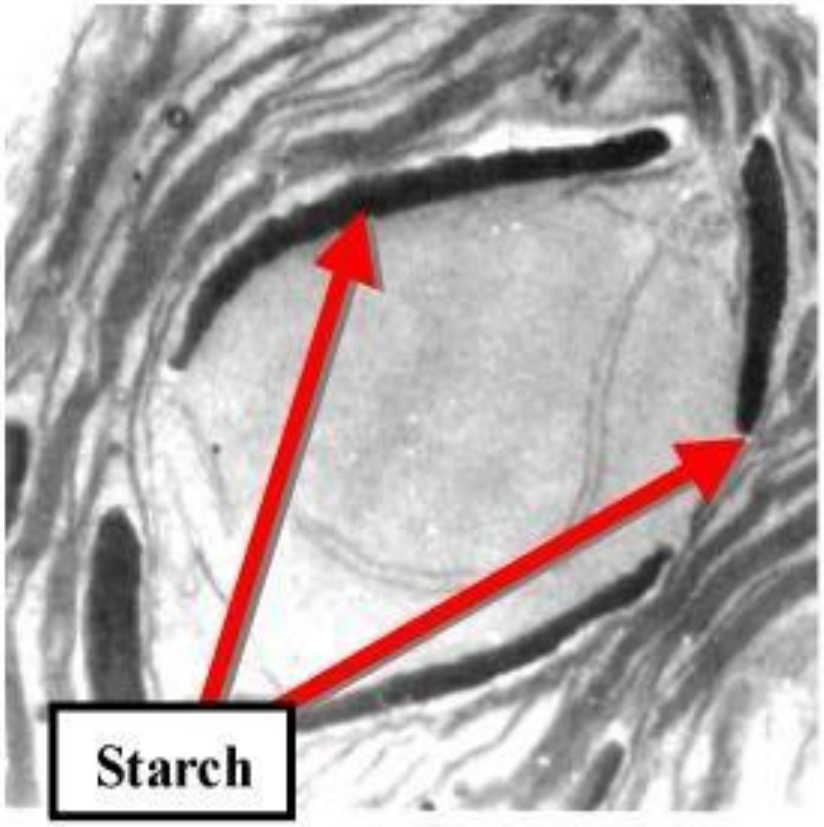
Cladophora **has many small oval Chloroplasts**



Chalmydomonas **has one cup-shaped Chloroplast**



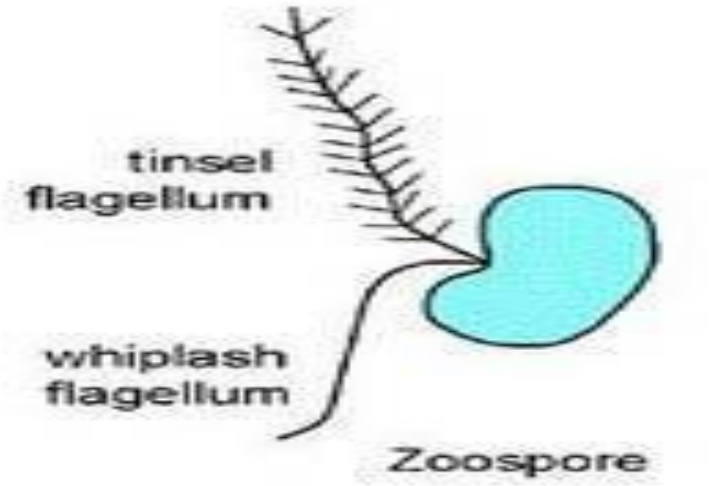
Light Microscope Photo of Pyrenoids in *Mougeotia* Chloroplast



EM Photo of a Pyrenoid in *Chlamydomonas*

Salient Features of Chlorophyta

- The cell wall is stable and invariably contains cellulose.
- The majority produce motile reproductive cells which may be bi-or quadriflagellate rarely with a ring of flagella as in oedogoniales.
- The flagella are of equal length and of whiplash type inserted at the anterior end.



Salient Features of Chlorophyta

- **Sexual reproduction ranges from isogamy to oogamy.**
- **The sex organs are always unicellular.**

.10 Zygote generally is the only diploid structure in the life cycle.

Reproduction in Chlorophyta

Reproduction In green algae it takes place by all the three methods, namely, vegetative, asexual and sexual.

-1Vegetative

It may take place by cell division, fragmentation or akinete formation.

Reproduction in Chlorophyta

Asexual reproduction

- **Spore** formation is common method of asexual **reproduction.**
- **They produce different types of spores:**

(a) **Zoospore**: These are motile spores.

- They have 2-4 flagella.
- They may be bi-or quadric-flagellate (*Ulothrix*), with a ring of flagella and thus multiflagellate (*Oedogonim*
- These spores are produced in zoosporangia.

Zoospores Formation

- They are usually formed during night and develop either in any of the **vegetative cells**
- or in specialized cells called the zoosporangia.

The protoplast of the cell may develop into a single zoospore (*Oedogonim*) **or it may divisions resulting in the formation of several zoospores (*Ulothrix*).**

They escape in the morning from the parent cell through a pore in the surrounding cell wall or by rupturing of the cell wall.

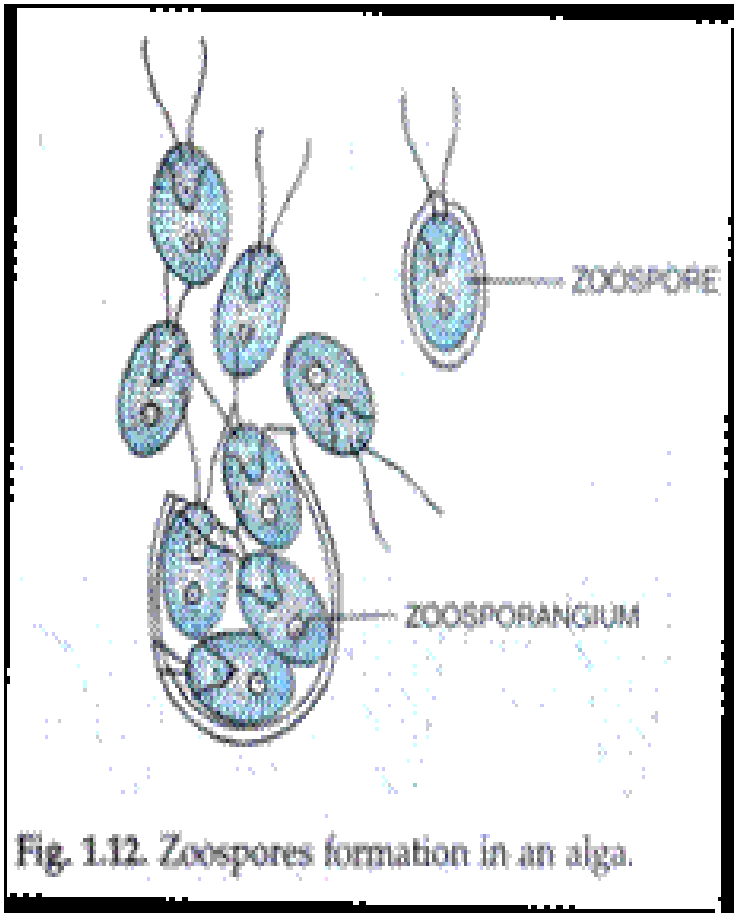
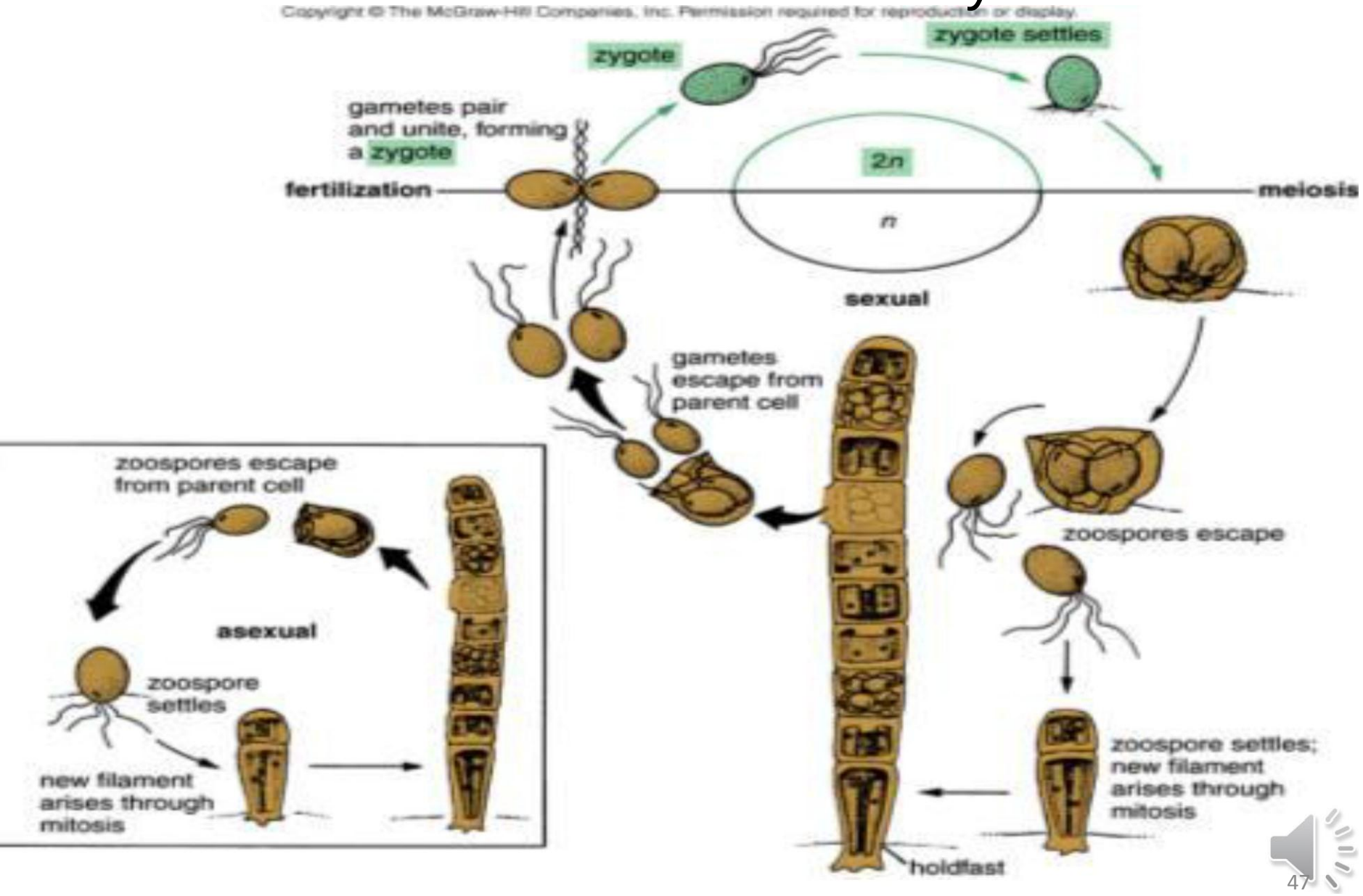


Fig. 1.12. Zoospores formation in an alga.

ULothrix Life Cycle



(iii) **By aplanospores:**

- When motille phase of zoospores is elimin ated, the bodies are called aplanospores.
- The aplanospore are produce when there is a lack of s ufficient waiter.
- These are covered by a thin wall but do not possess flagella like the zoospores.
- The also germ inate directly to give rise to new plant .

Akinetes

Aplanospores

(b) Aplanospores: These are non-motile spores. They have thin wall.

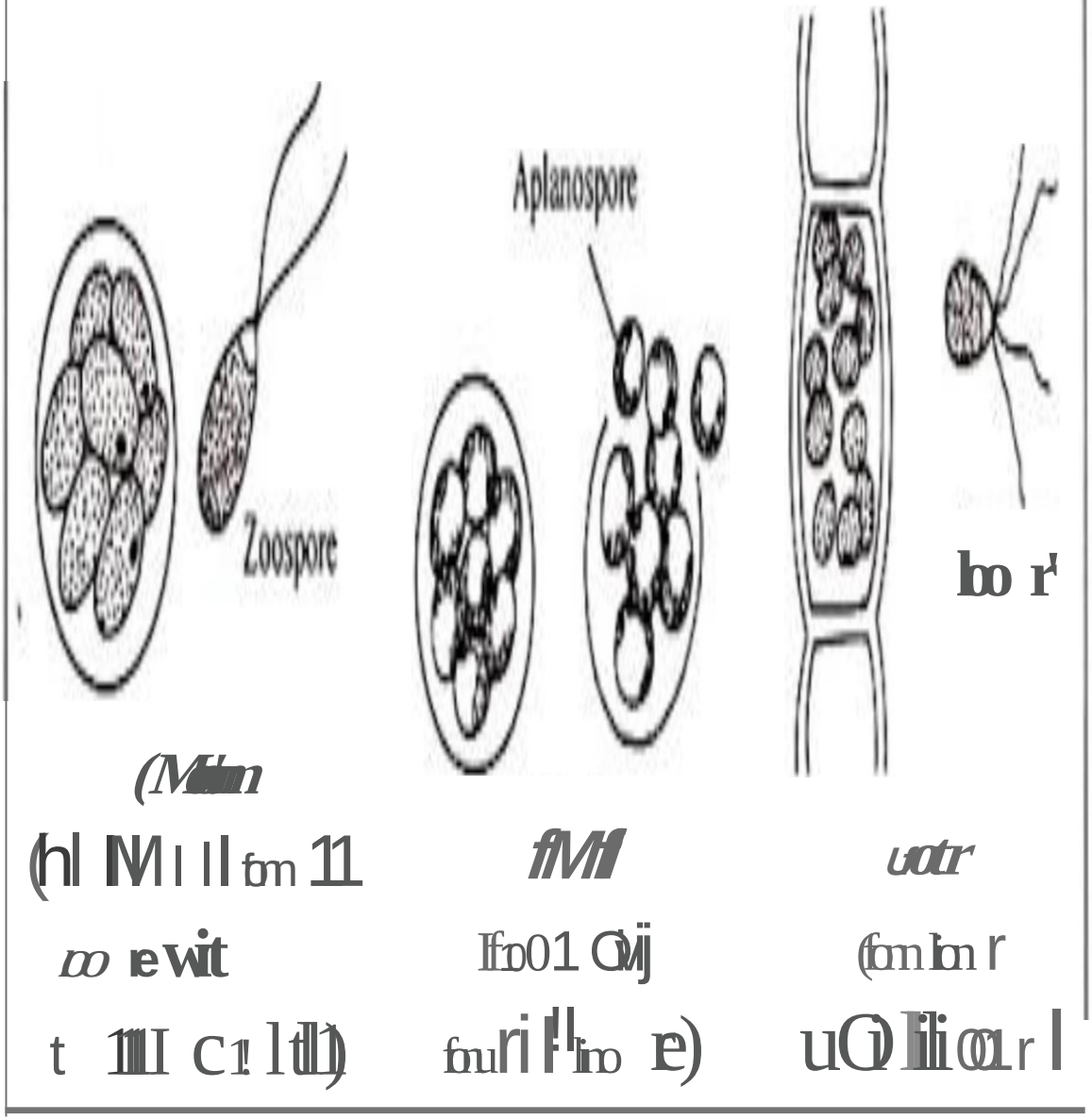
Types of Aplanospores

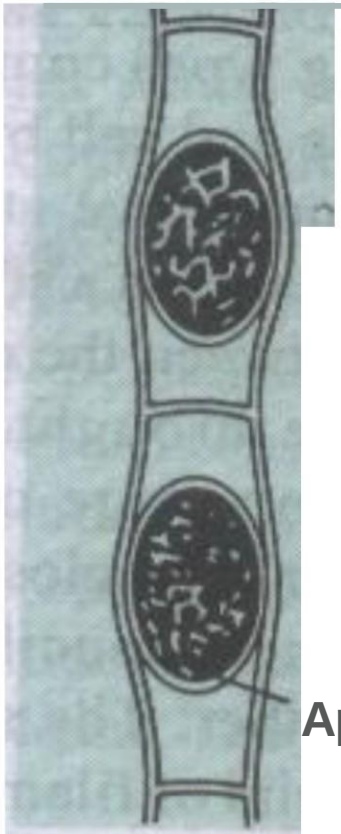
(1) Hypnospore: The non-motile spores with thick wall are called aplanospore.

-2- **Autospores**

when the non-motile spores produced appear identical to the parent cell, they are autospores (*Chlorella*).

The protoplast of the cell may form a single aplanospore (*Microspora*) or more than one.





Aplanospore

Fig. 11.19. *Spirogyra karnalae*. Aplanospore formation (After Randhawa).

Sexual reproduction

Sexual reproduction

- **Sexual reproduction may be**
- ✓ -Isogamy, (gametes both motile and same size– (
- ✓ Anisogamous (both motile and different sizes- female bigger) or
- ✓ Oogamous (female non-motile and egg-like; male motile(

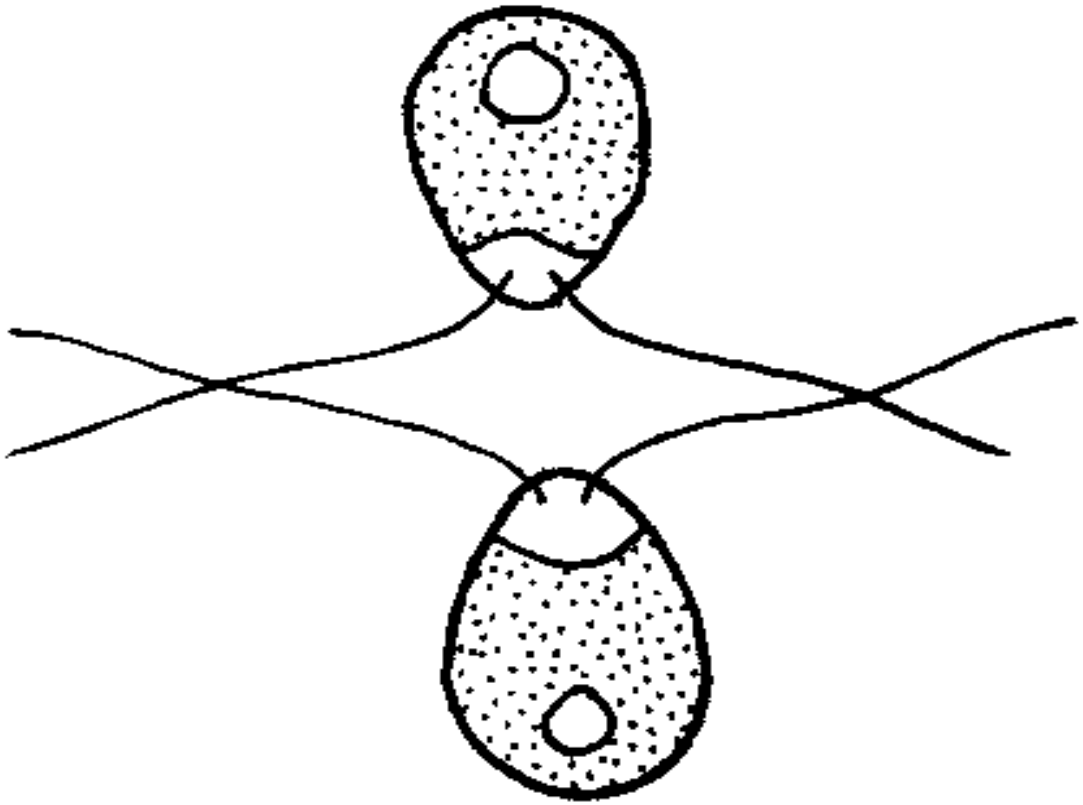
Gametes are produced in gametangia.

- ✓ When two gametes meet, fertilization takes place and a diploid zygote is formed.
- ✓ The zygote then germinates, undergoes meiosis and forms haploid spores.

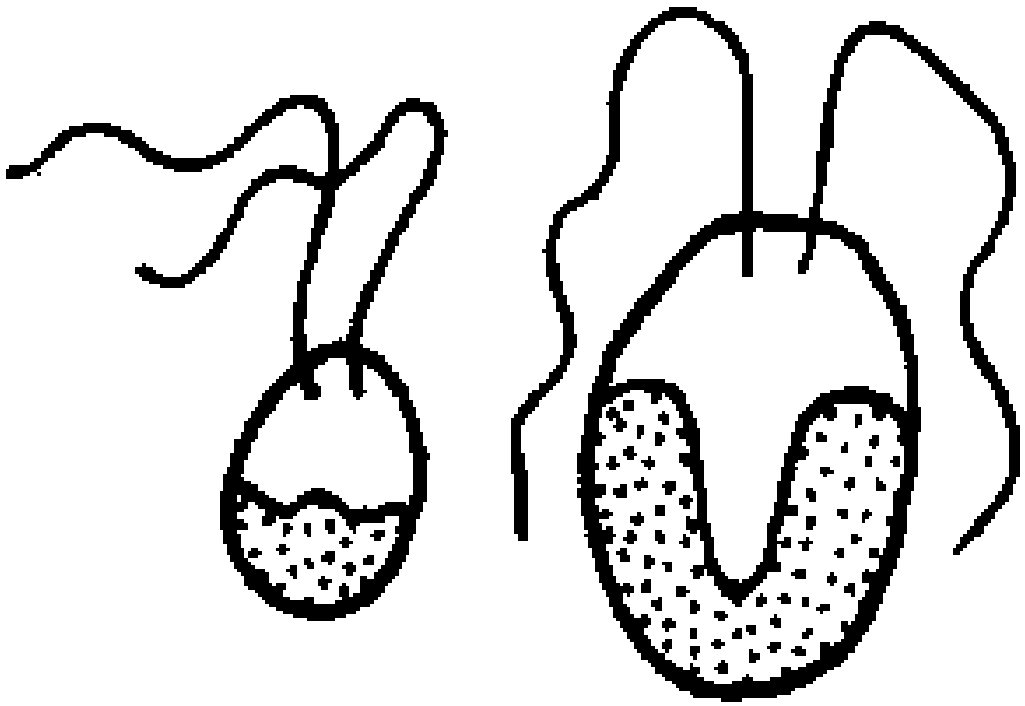
- ✓ Zygotes secretes thick wall to become zygospore.

Sexual reproduction

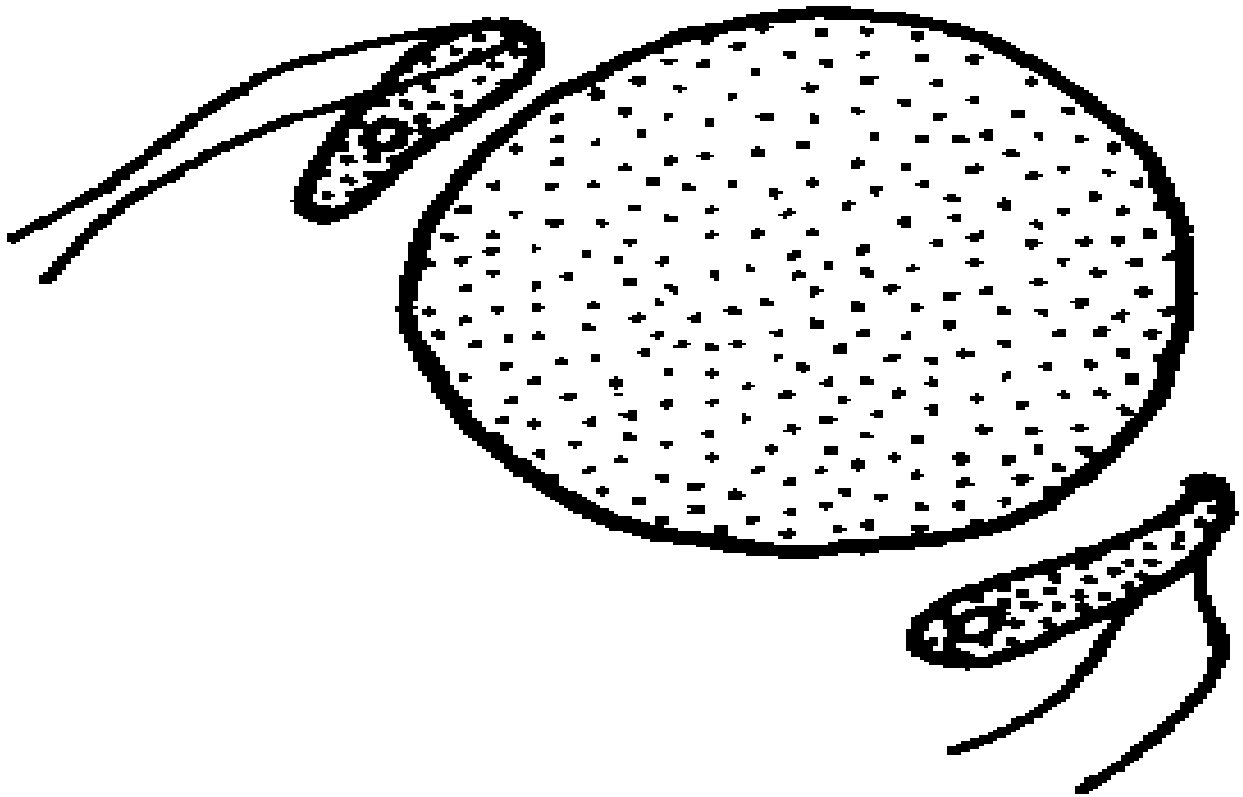
A- Isogamy



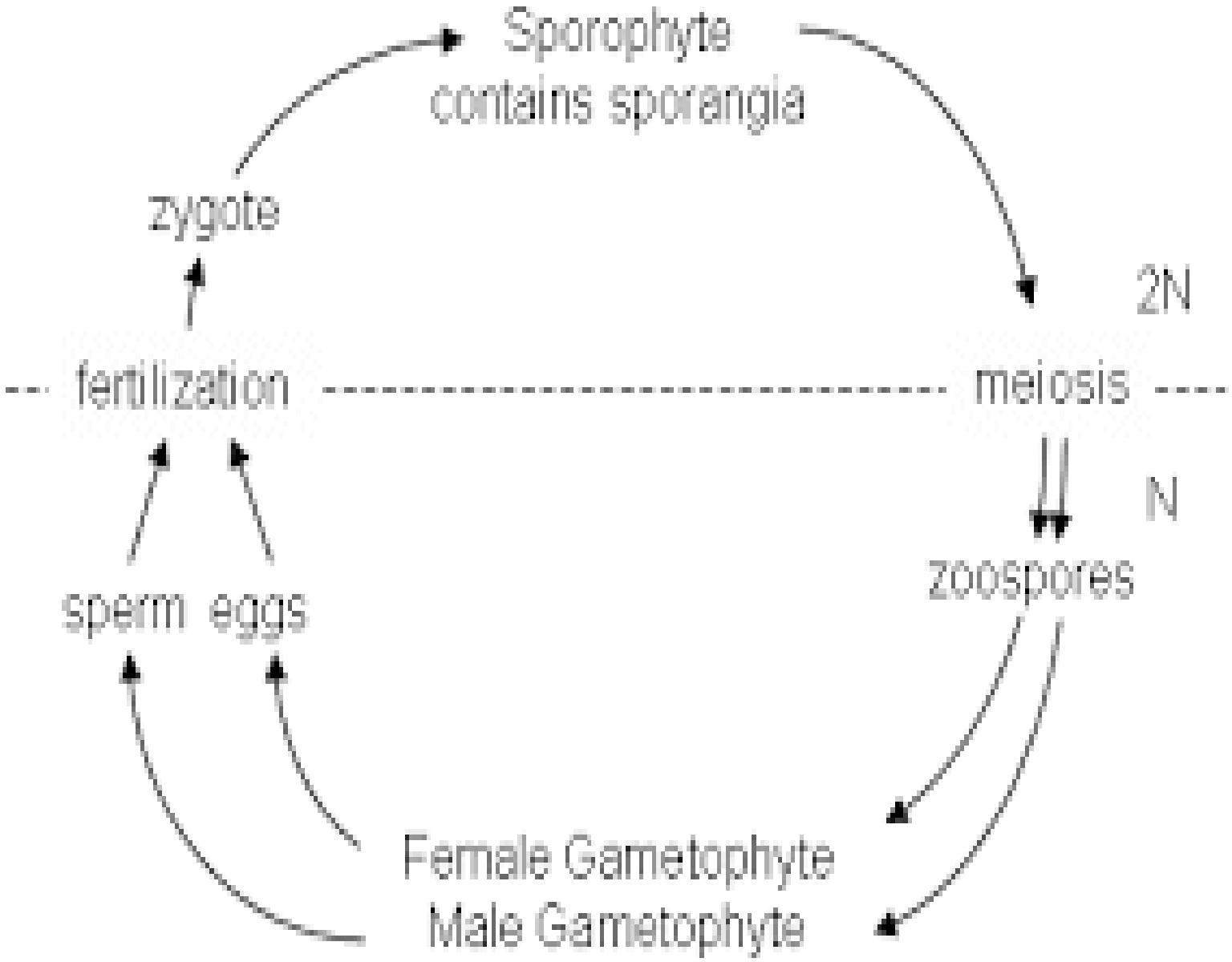
B- Anisogamy



C- Oogamy



Alternation of Generation in green algae



The alternation of generations allows algae to reproduce both sexually and asexually.

1- Sporophyte (2n.

- It is characterized by the diploid number of chromosomes in the nuclei of its cells.
- The diploid sporophyte is concerned with the production of haploid spores called the meiospores.

2- Gametophyte (1n.

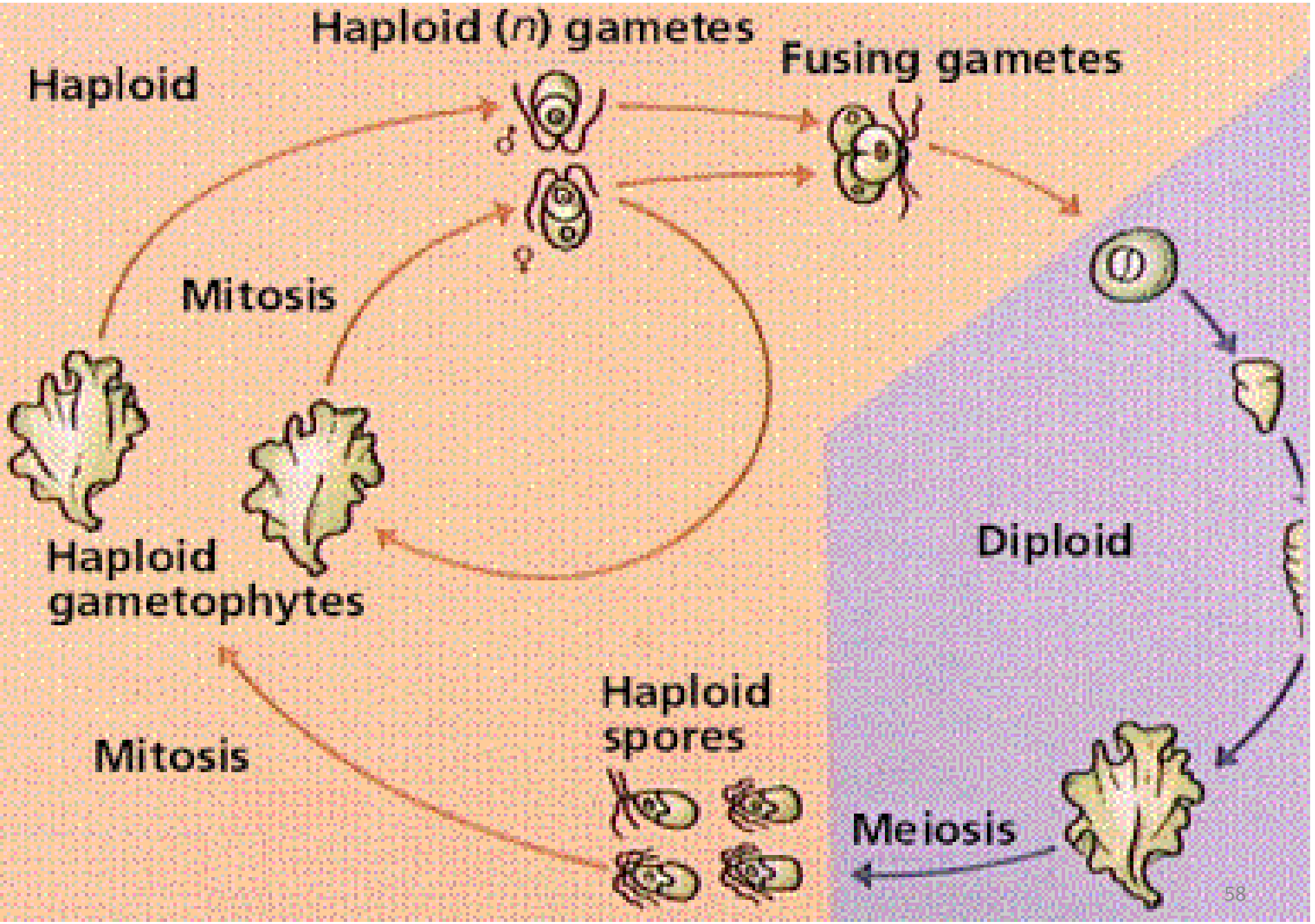
- It is charaterised by the haploid number of chromosomes in the nuclei of its cells.

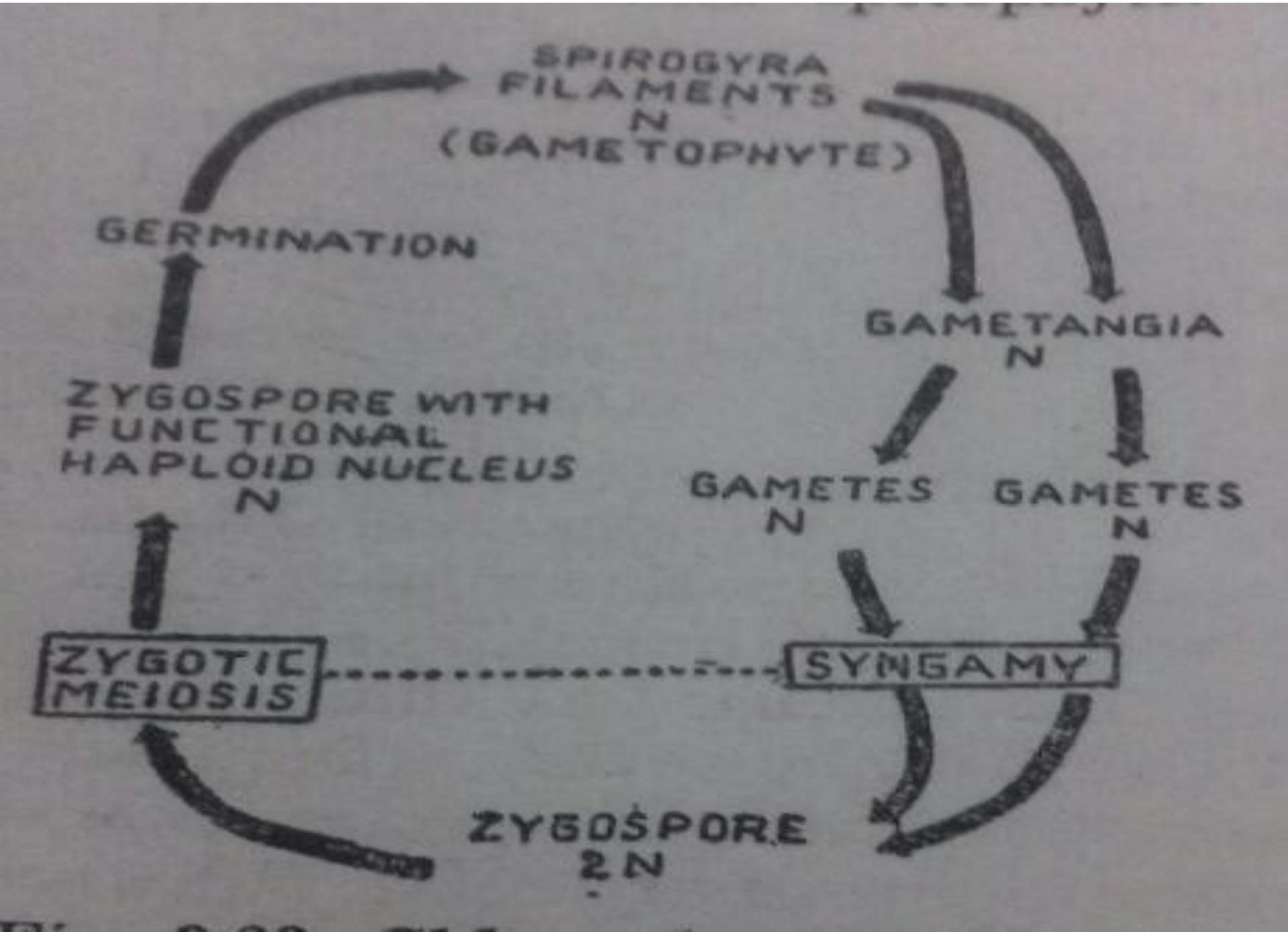
it is responsible for sexual reproduction.

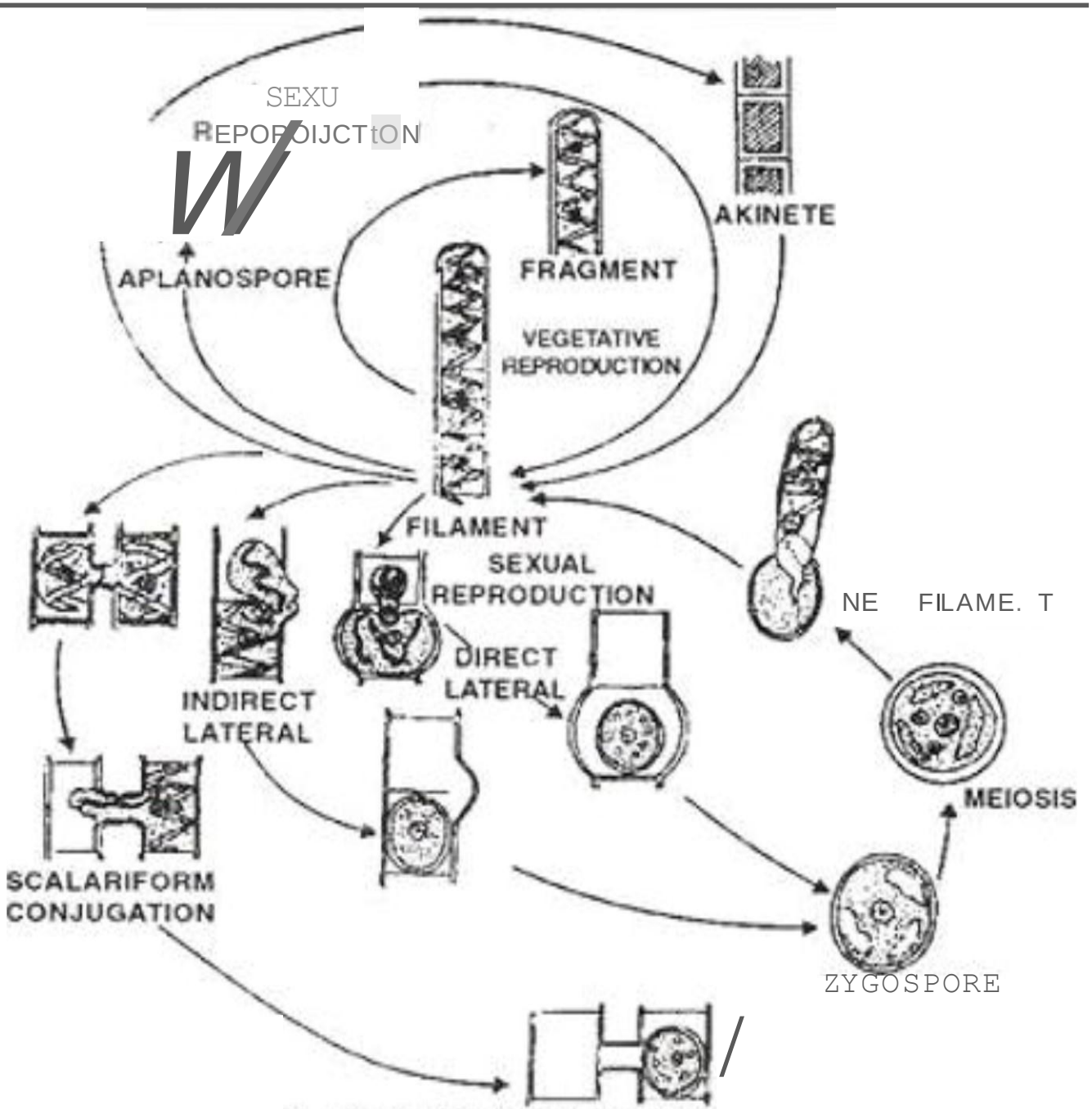
It bears the **haploid gametes**.

These two individuals normal follow each other.

- **In algae, the dominant phase is gametophyte (1n).**


Haploid (n) gametes
Haploid
Fusing gametes
Mitosis
Haploid
gametophytes
Diploid
Haploid
spores
Mitosis
Meiosis


SPIROGYRA
FILAMENTS
N
(GAMETOPHYTE)
GERMINATION
GAMETANGIA
N
ZYGOSPORE WITH
FUNCTIONAL
HAPLOID NUCLEUS
N
GAMETES
N
GAMETES
N
ZYGOTIC
MEIOSIS
SYNGAMY
ZYGOSPORE
2N



Figu r S.11 Diagrammatic life cycle of *Spirogyra*.

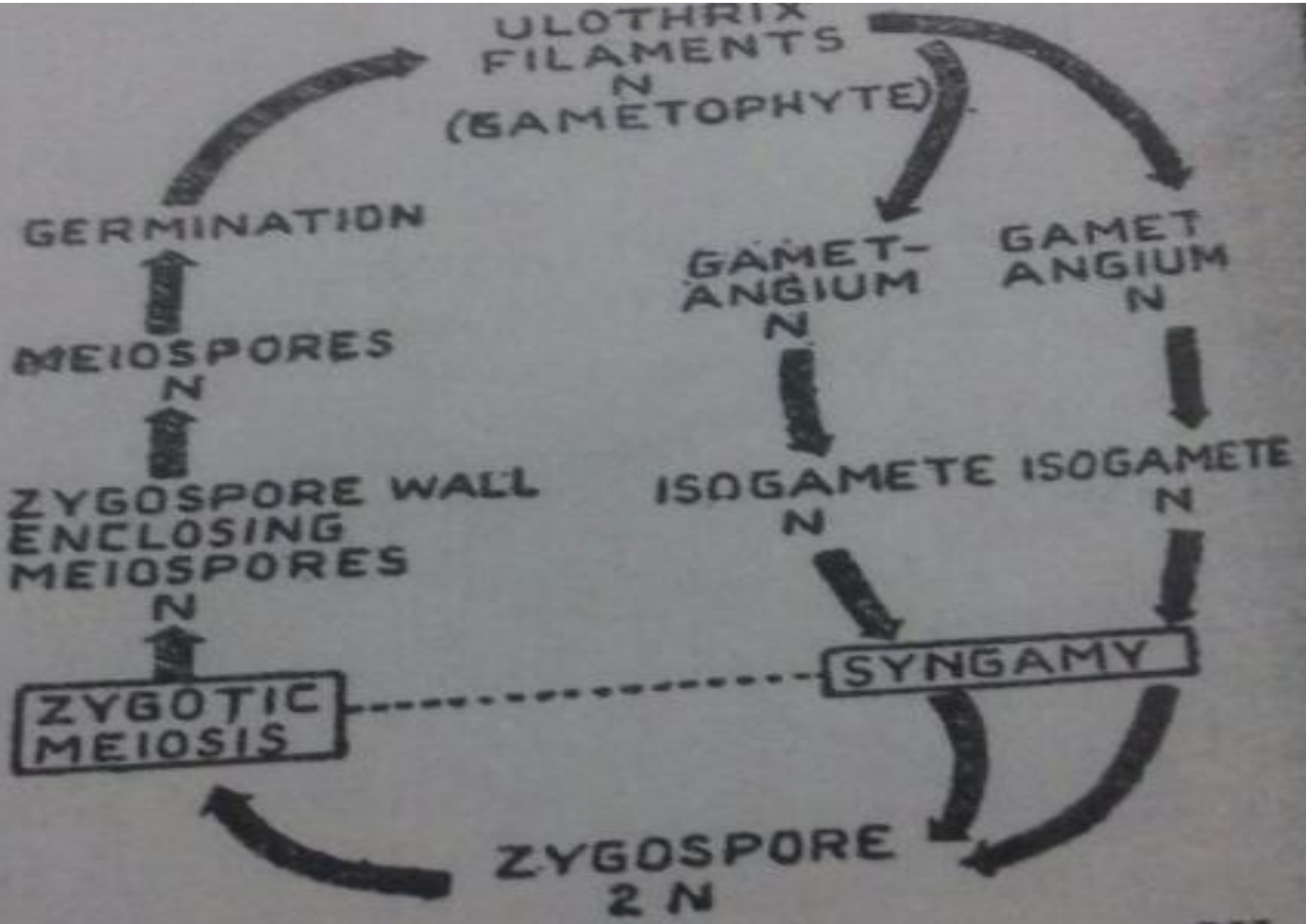
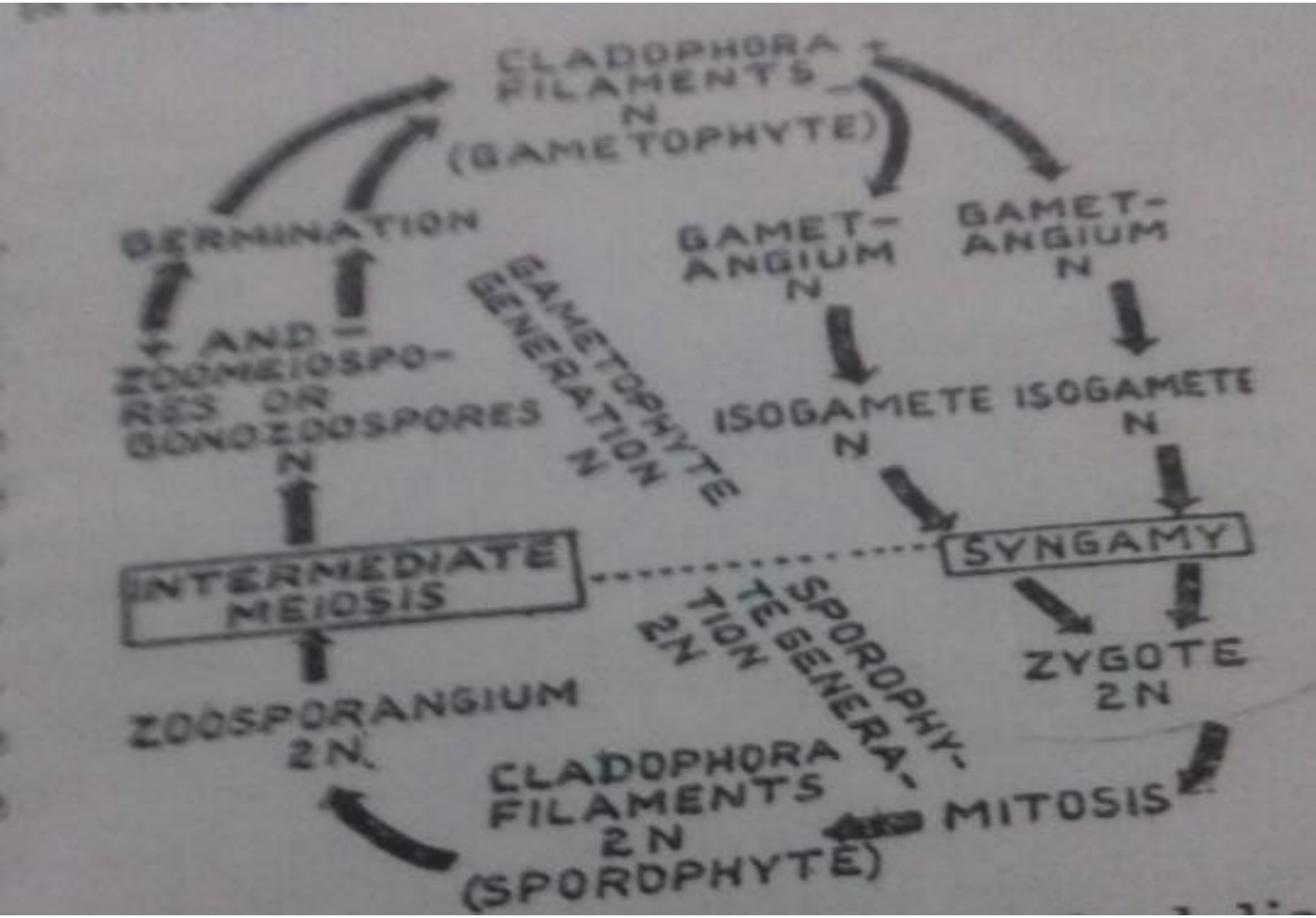


Fig. 3·24. diagram of **Chlorophyceae.** Word the **haplontic** life cycle of *Ulothrix*.


CLADOPHORA FILAMENTS + N (GAMETOPHYTE)
GERMINATION
GAMET-ANGIUM N
GAMET-ANGIUM N
+ AND - ZOOMEIOSPORES OR GONOZOOSPORES N
GAMETOPHYTE GENERATION N
ISOGAMETE N
ISOGAMETE N
INTERMEDIATE MEIOSIS
SYNGAMY
SPOROPHYTE GENERATION 2N
ZOOSPORANGIUM 2N
ZYGOTE 2N
CLADOPHORA FILAMENTS 2N (SPORDPHYTE)
MITOSIS

Similarities between Bacteria and Cyanophyta

1- Both bacteria and blue green algae are simple and their DNA is devoid of histone proteins and hence true chromosomes are not organised.

2. In both groups the cells are covered by mucilage sheath.

3- True cell organelles like plastids, golgi bodies, mitochondria etc are absent.

4- Bacteria are unicellular forms and some of the cyanophycean are also unicellular in nature.

-5- Both possess the ability to fix nitrogen from the atmosphere.

6-Formation of resting spores is characteristic in both.

7-Motile spores are not seen in both groups.

-8- Both organisms are capable of withstanding high rate of desiccation and high temperature.

Differences between Bacteria and Cyanobacteria

- Cyanobacteria is also known as blue-green algae.
- cyanobacteria possess chlorophyll-a, while most bacteria do not contain chlorophyll.

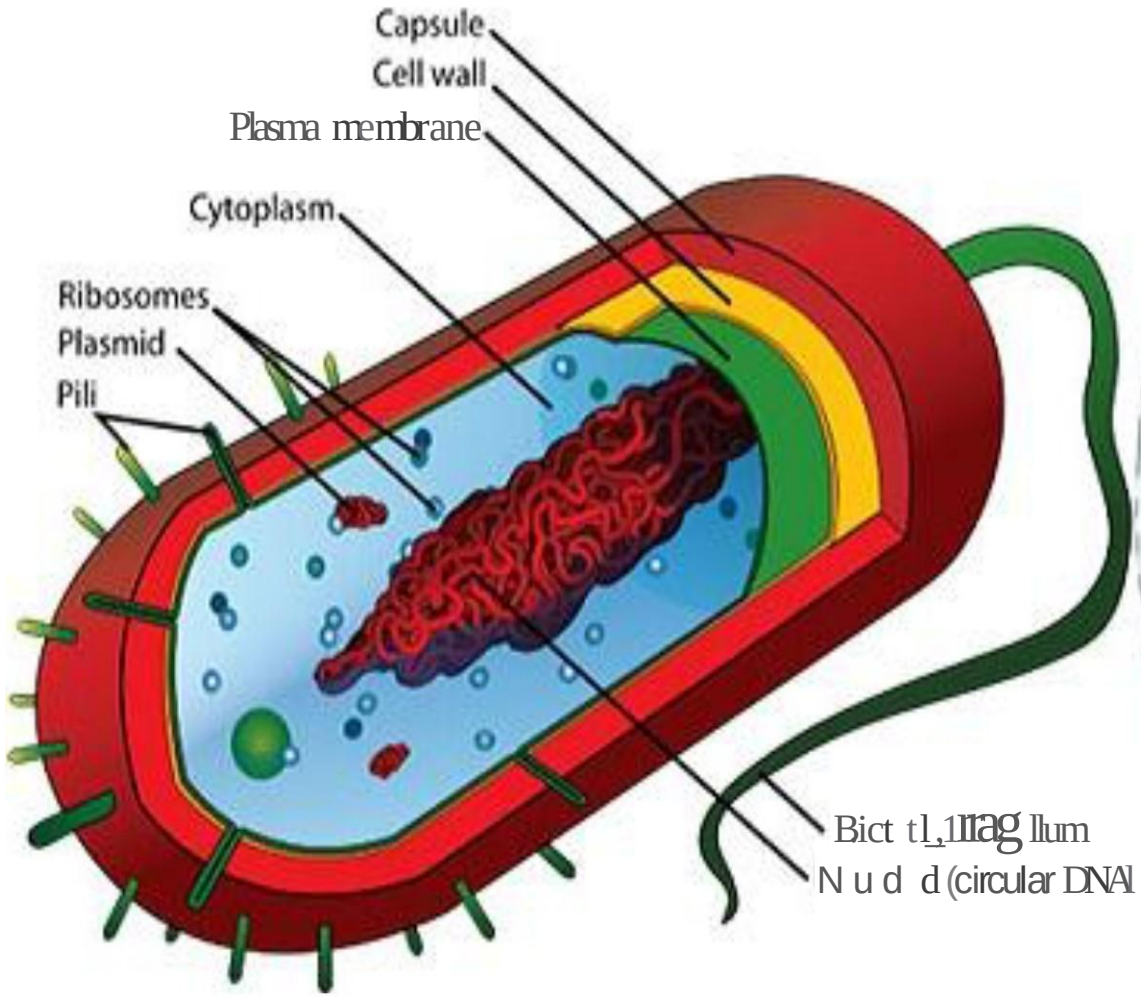
- Chlorophyll-a gives them their characteristic blue-green color.

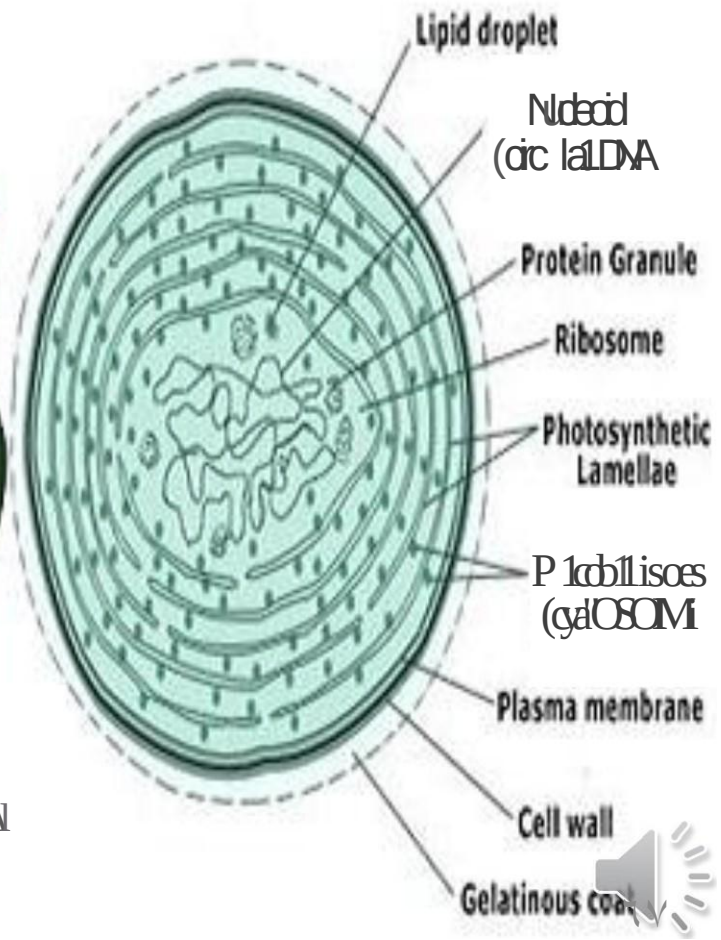
S.N.	Characters	Bacteria	Cyanobacteria
	Size	Comparatively smaller.	Comparatively larger.
	Distribution	Found every possible places in earth.	Only found in presence of sunlight and moisture.
	Flagella	May bear flagella.	Flagella always absent.
	Cell wall	2-1layered.	4layered.
	Composition of cell wall	Glycolipids and peptidoglycan.	Cellulose and pectin.
	Nutrition	May be autotrophic or heterotrophic.	Usually autotrophic.
	Photosynthetic pigments	Photosynthetic pigment is bacteriochlorophyll.	Photosynthetic pigments is chlorophyll a.
	Accessory pigment	Absent	Accessory pigment like phycocyanin and phycoerythrin are present in dominating form.
	Reserve food	Glycogen	Cyanophycean starch
	Heterocyst	Absent	Present.

Differences between Bacteria and Cyanobacteria

Bacteria

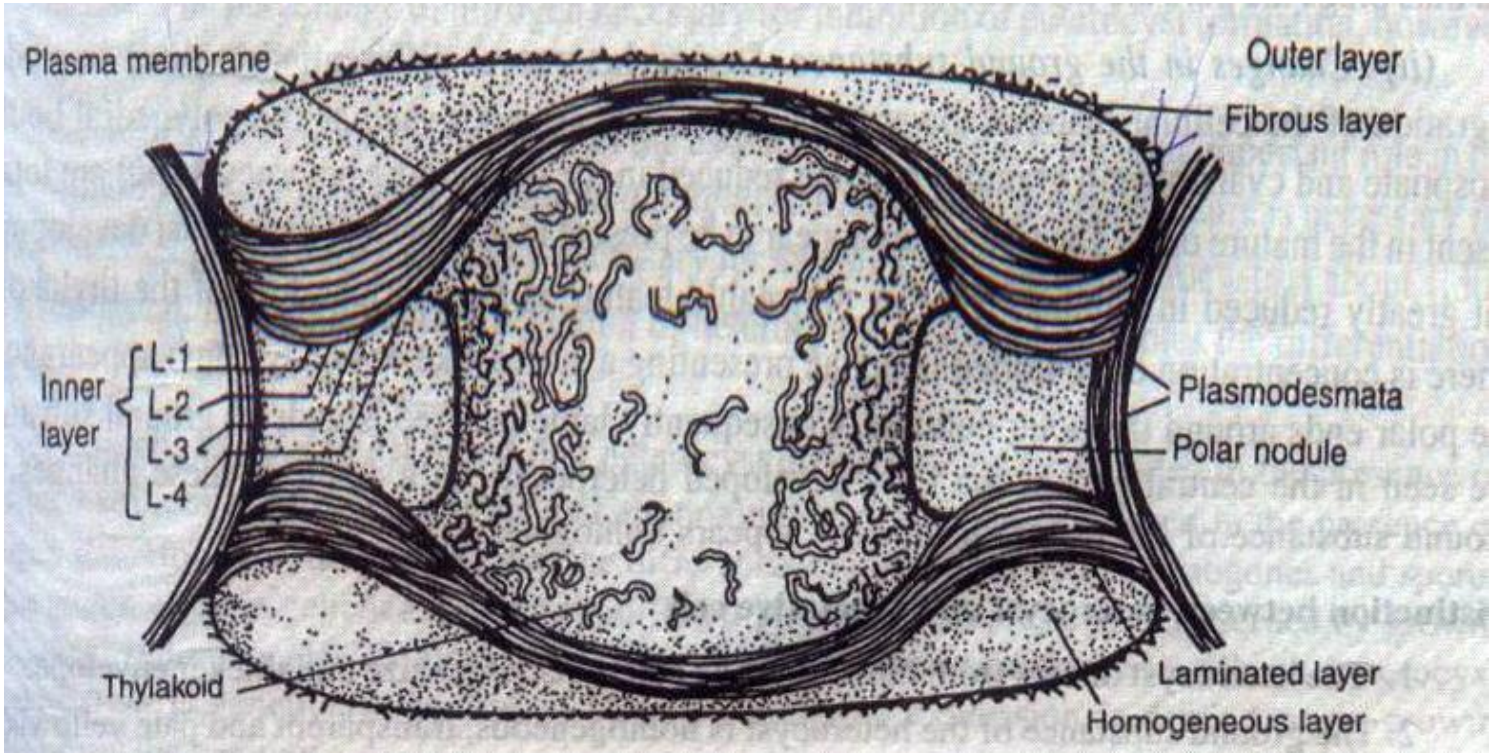
Cyanobacteria





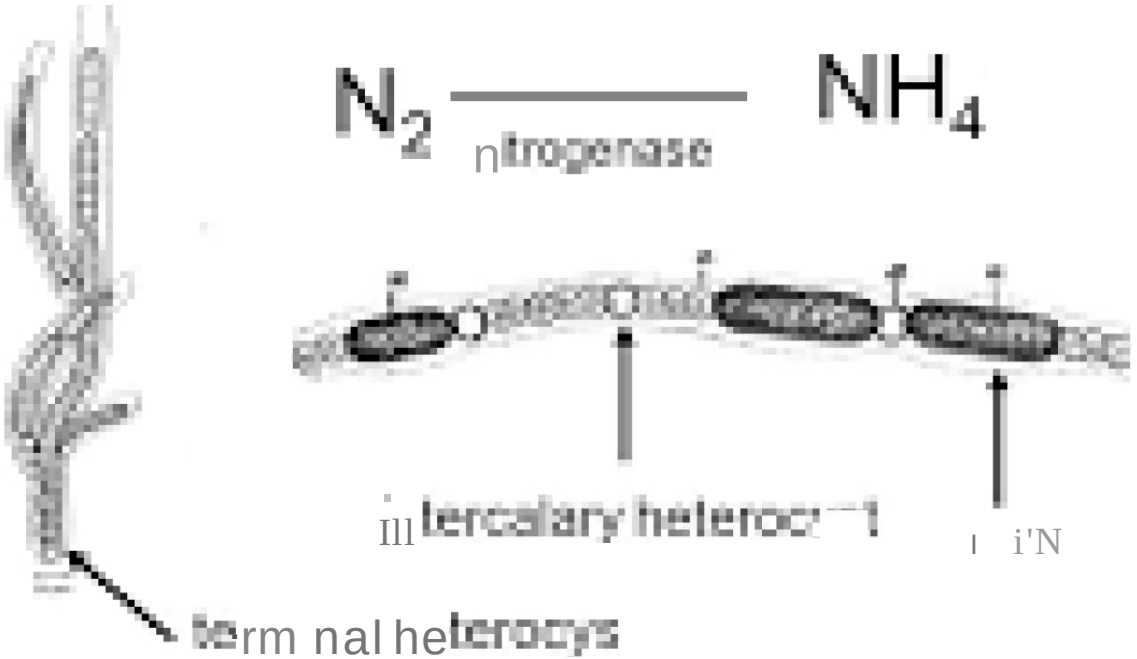
Heterocysts

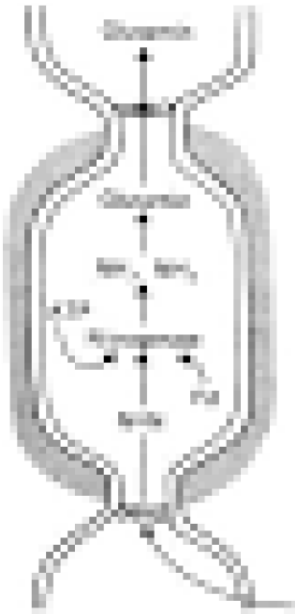
The heterocysts differ from the vegetative cells and occur between them along the length of the trichome at some regular intervals



Cyanobacteria: systematic characters

Heterocytes (heterocysts) are cells with nitrogen fixation as a special function.Heterocytes only present in some filamentous forms (Nostocales, Stigonematales), though N-fixation may occur also in some erocysteous rms





Shape of Heterocysts

1They are identical to the vegetative cells.

2They are also round *Nostoc, anabena , Rivularia*

3- Some time rectangular in *Hapalosiphon, Aulosira, Scytonema* •

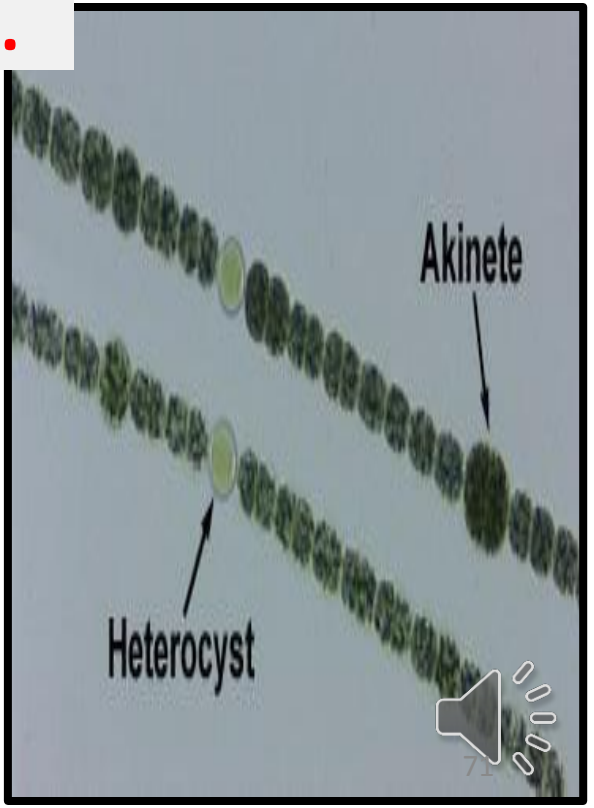
Hapalosiphon

Heterocysts

i) large size, ii) thicker walls,
iii) homogenous transparent, pale yellowish contents iv) a distinct pore either at both ends.

Position of heterocysts in the trichomes.

In some genera they occur in **pairs** (Anbaenopsis, and rarely in **chain**.
When they **singly** are either **terminal** (Anbaena) or **intercalary** in position (Nostoc.(,



Factors controlling heterocyst formation

➢The reproduction of heterocysts increases under conditions of low light , increase in the amount of phosphate in the medium

depends on the availability of carbon and ATP

➢ Absence of carbon dioxide inhibited heterocyst formation

-The concentration of nitrogen in the medium above a certain level results in complete inhibition of heterocyst production

Function of Heterocysts

- Storehouses of reserve food material or enzymatic substances
- produce substances which stimulate growth and cell division
- Play role in sporulation
- Sites of nitrogen fixation
- Locus for filament breakage

Economic Importance of Cyanophyta

-1- Beneficial Activities:

- Nostoc commune is boiled and used as soup in China.
- The blue-green algae furnish food for fish and other aquatic animals. Oscillatoria is the most favoured blue-green alga consumed by 56 species of fishes.
- The blue-greens add organic matter to the soil and increase fertility.
- some of the blue-green algae increase the fertility of the soil by fixing atmospheric nitrogen.

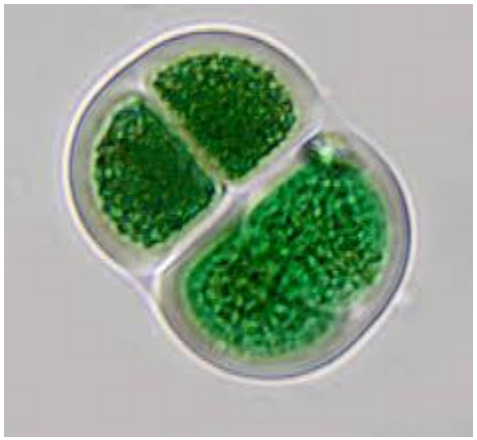
Ex: *Oscillatoria princeps, O. formosa* and some species of *Anabaena, Spirulina, Nostoc,* and some species of *Scytonema*.

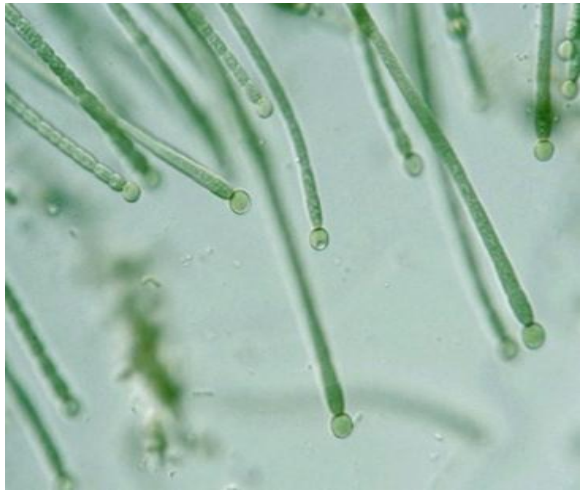
-2-Harmful Activities

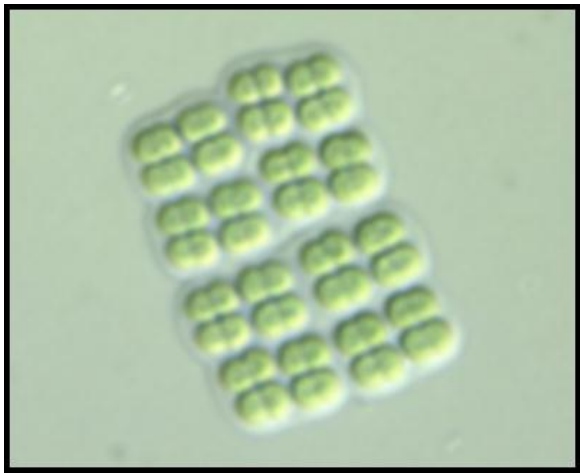
- Some members of Cyanophyceae cause damage of building plasters

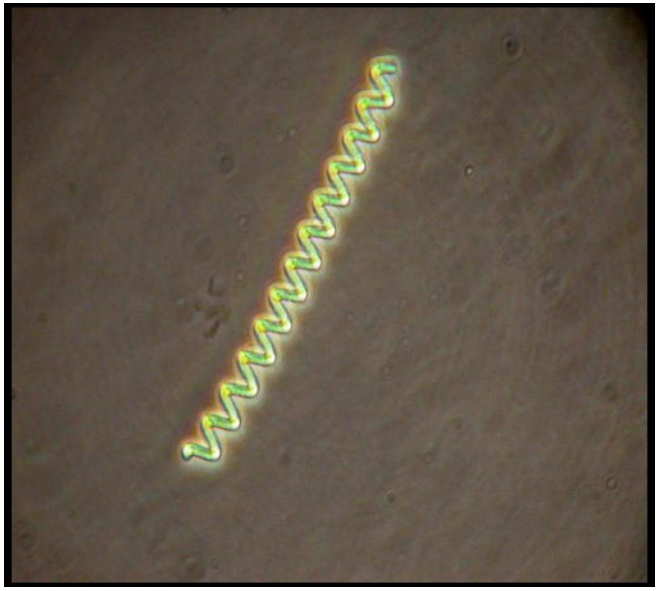
  - Some members like Microcystis, Anabaena, form water blooms and can grow well in O2 deficient water

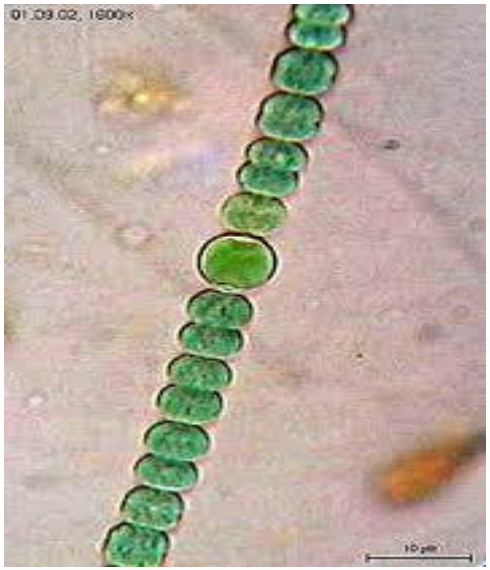
Examples of Cyanophyta

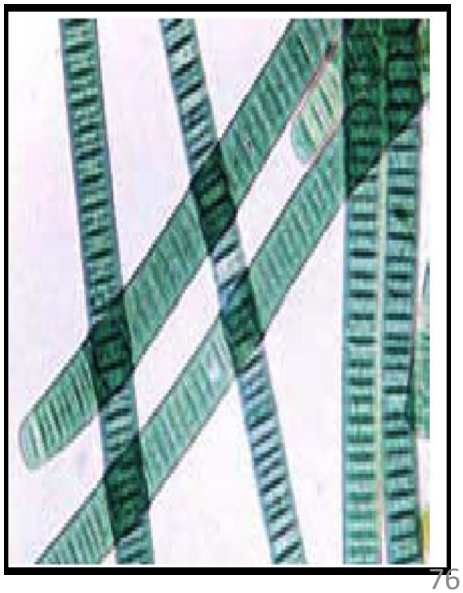












Chroococcus

Reproduction

Multiplication takes place by **two methods**, **cell division** and **colony fragmentation**.

(i) Cell division or fission :

- Single cell may be released from the colony by the **disorganisation** of the parent sheath. Each released cell grows **into a new colony** by cell division.
- **The mother cell divides into two**.

The process may be repeated.

All the daughter cells are held together within the original sheath of the mother cell to form the colony.

(ii) **Colony Fragmentation**.

- Reaching a certain size the colony may break into **fragments**.
- Each fragment by cell division forms a new colony.

Oscillatoria sp.

❖ fresh water, filamentous, dark, blue-green alga

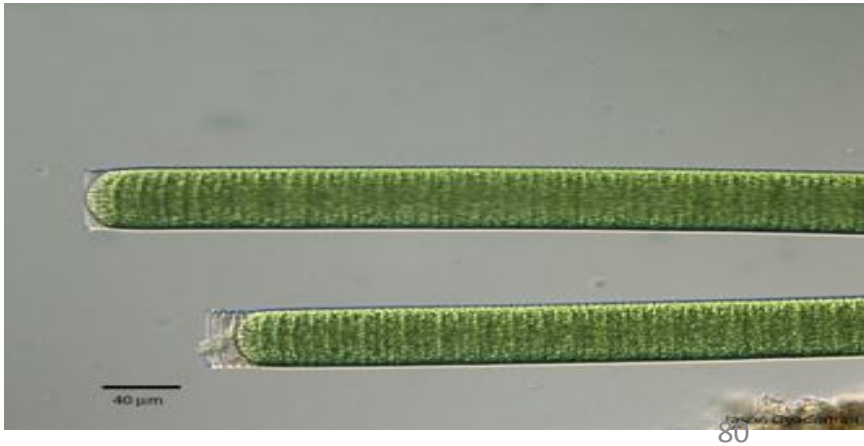
A few species are marine.

❖ **Movement:**

Under the microscope the movements are seen to be of the following types:

1. Gliding or creeping movements. Defined gliding as, "the active movement

2. Oscillatory movements. Oscillatoria also exhibits slow waving movements.



Taxonomic Position:

Division: Cyanophyta
Class : Cyanophyceae
Tribe : Hormogoneae
Order : Oscillatoriales
Family : Oscillatoriaceae
Genus : *Oscillatoria*

Reproduction:

Oscillatoria reproduces vegetatively.

❖ The only known method is by the formation of **hormogones**.

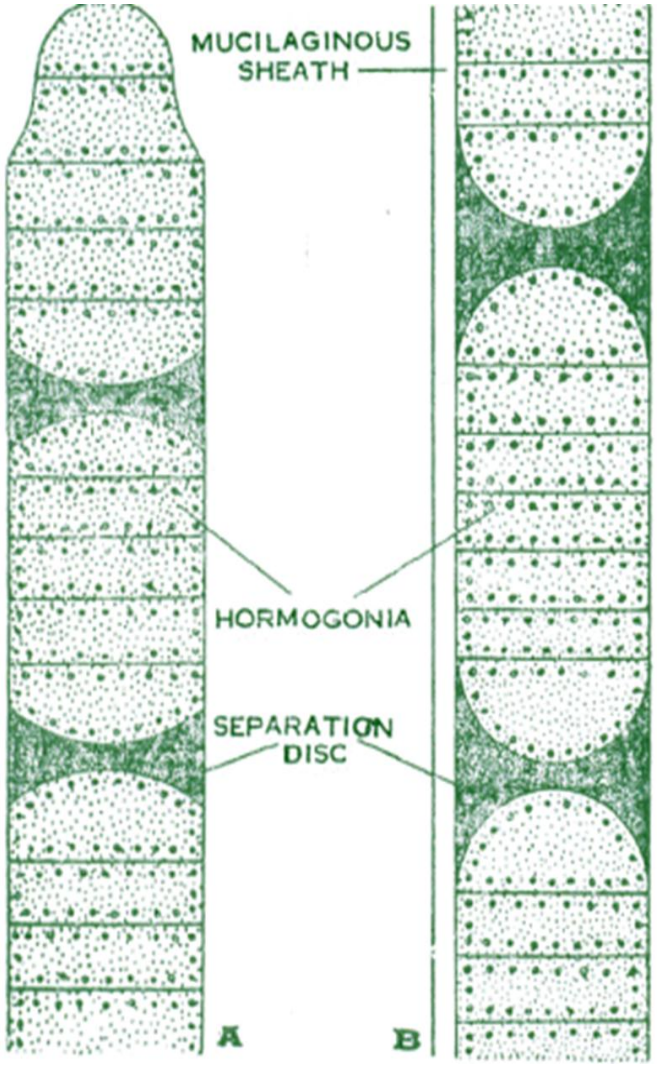
-The hormogones are short sections or lengths or living cells separated from the trichomes.

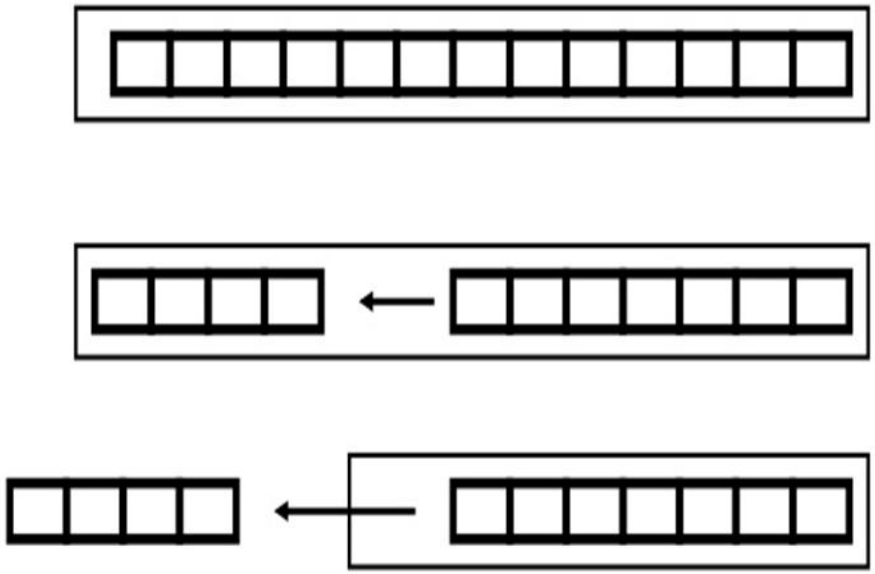
- The break takes place where a dead cell (**necridium**) is situated.

- The protoplast of such cells changes into a transparent, viscous substance called the mucilage.

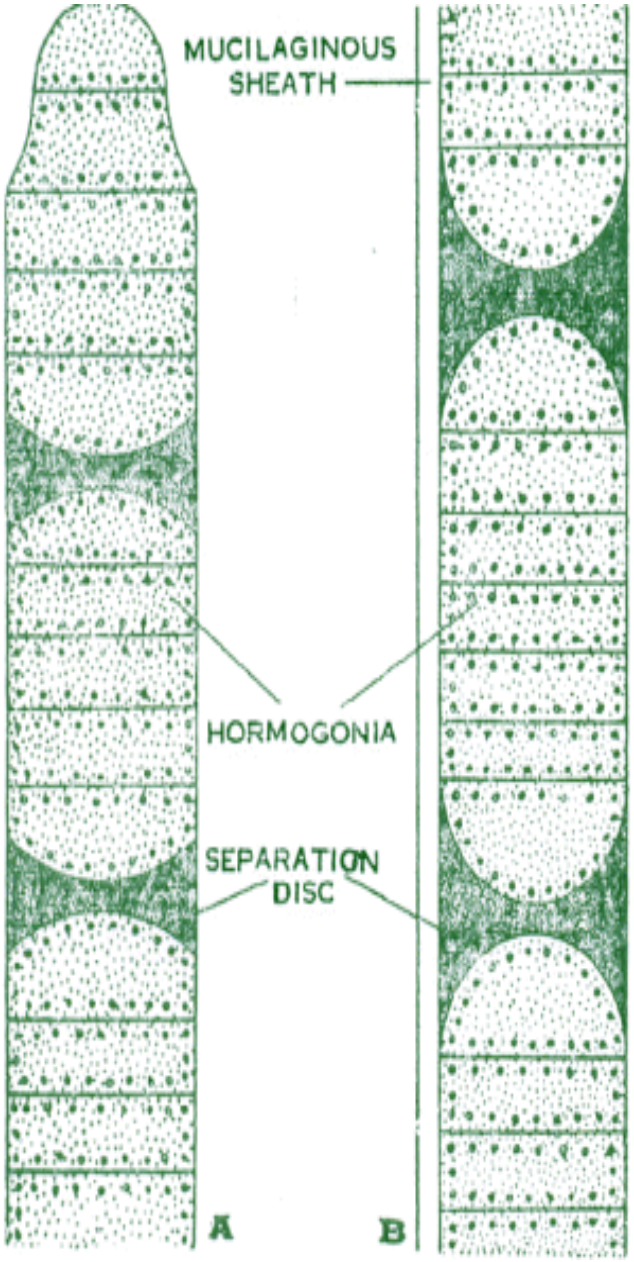
❖ **The mucilage filled dead cells are called necridia.**

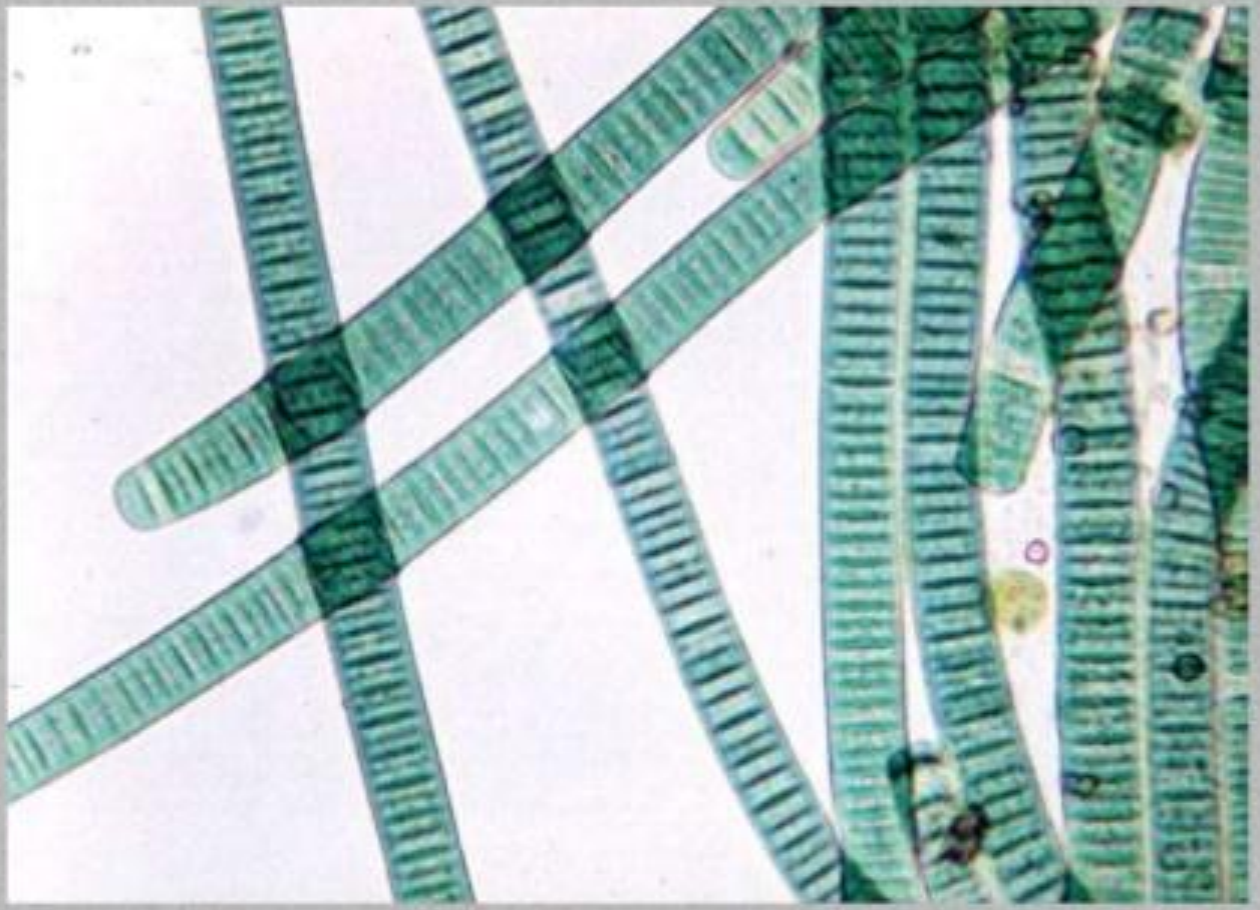
The mucilage swells and necridia break down releasing the hormogones





Hormogonia





Oscillatoria with hormogonia

- short pieces of a trichome that become detached from the parent filament and glide away to form new filament.

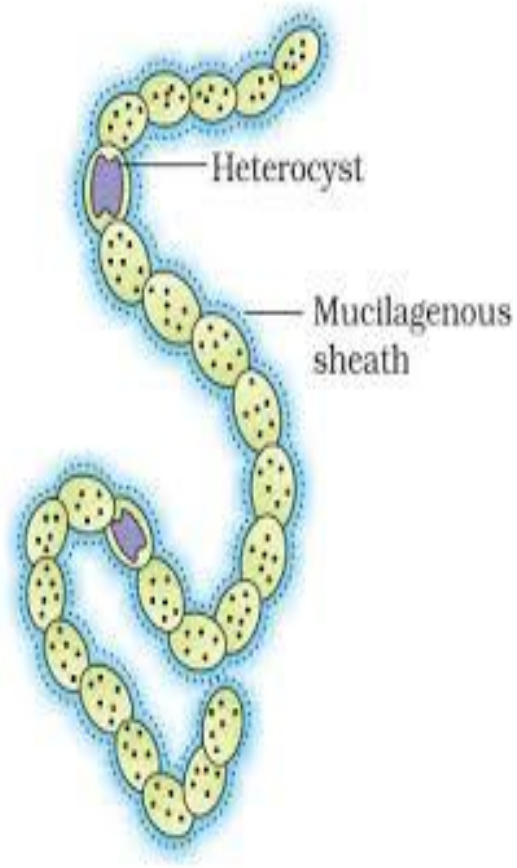
Oscillatoria (filamentous) with hormogonia

NOSTOC

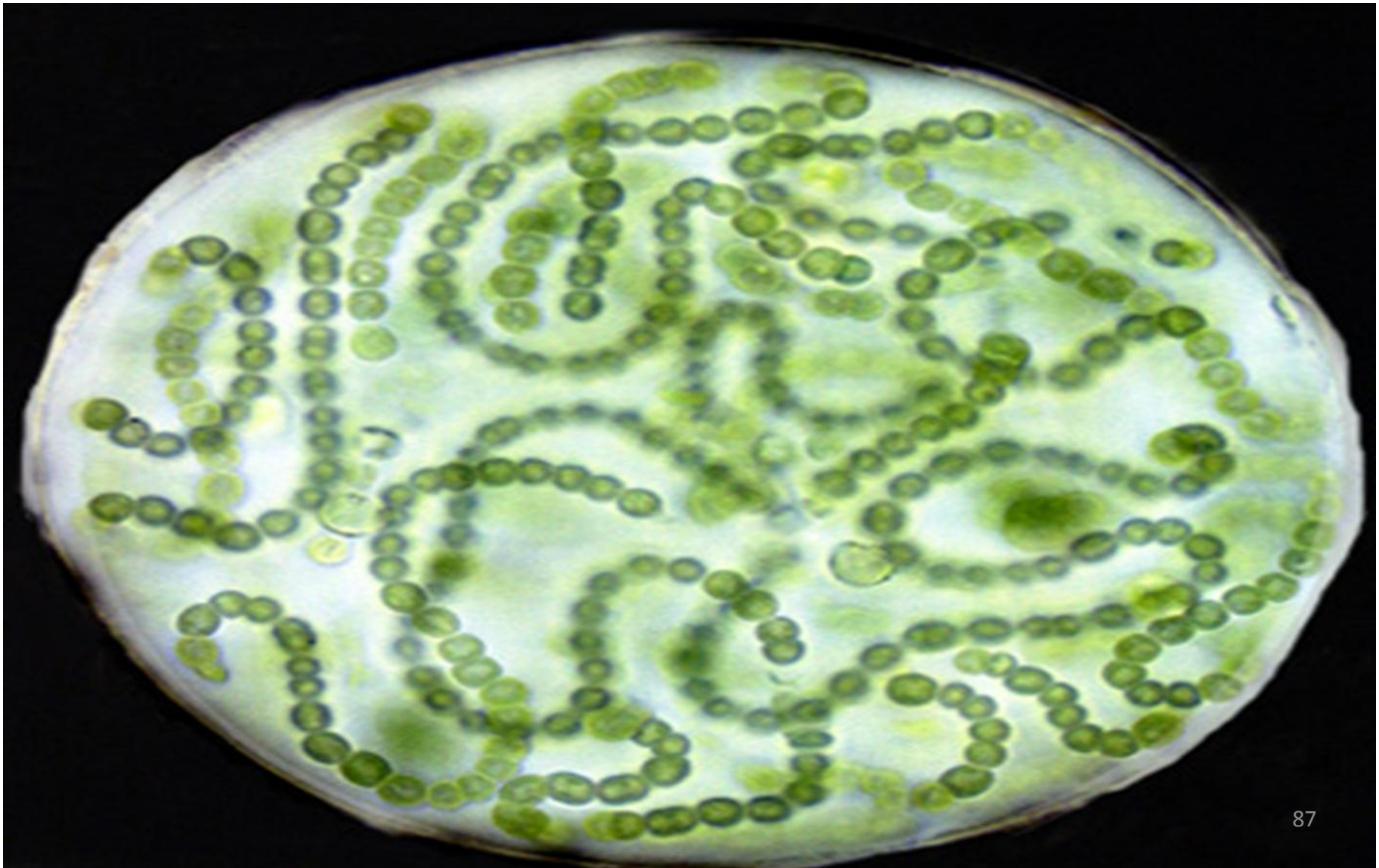
-Nostoc colony thus forms a mucilaginous lump or thallus which occurs floating or attached.

-*Nostoc* occurs in symbiotic association with fungi to form lichens.

- Some species of *Nostoc* have been reported to fix atomspheric nitrogen and tend to maintain fertility of paddy fields.



Nostoc sp



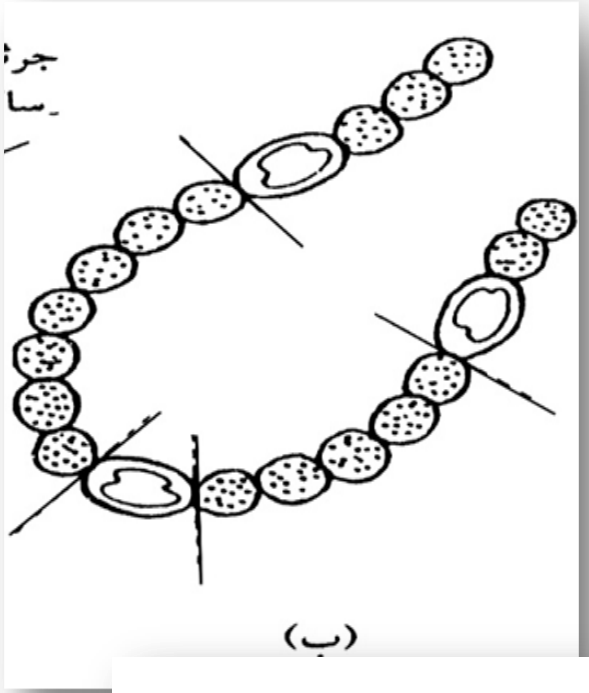
Reproduction

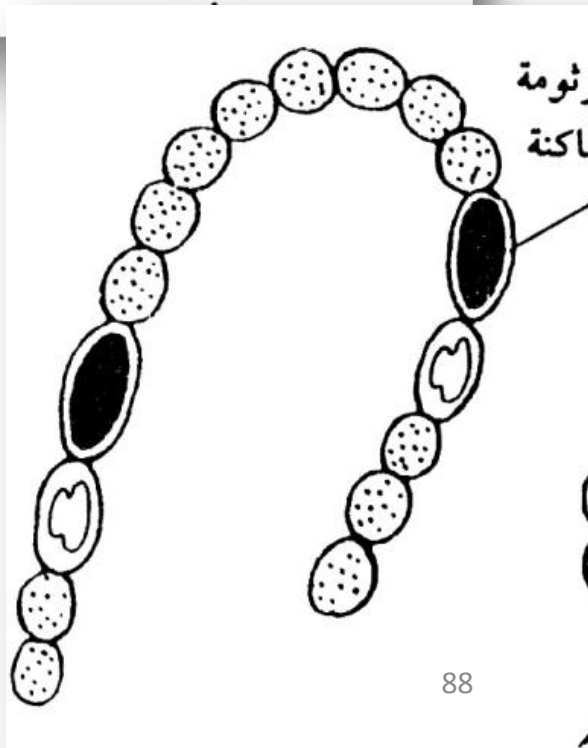
Nostoc reproduces entirely vegetatively by the following methods:-

1. Colony Fragmentation.
2. **Hormogonia**

Hormogone formation is very common in *Nostoc*. The trichome ruptures at places where a heterocyst and the vegetative cell adjoin.

3. **Resting spores or akinetes**





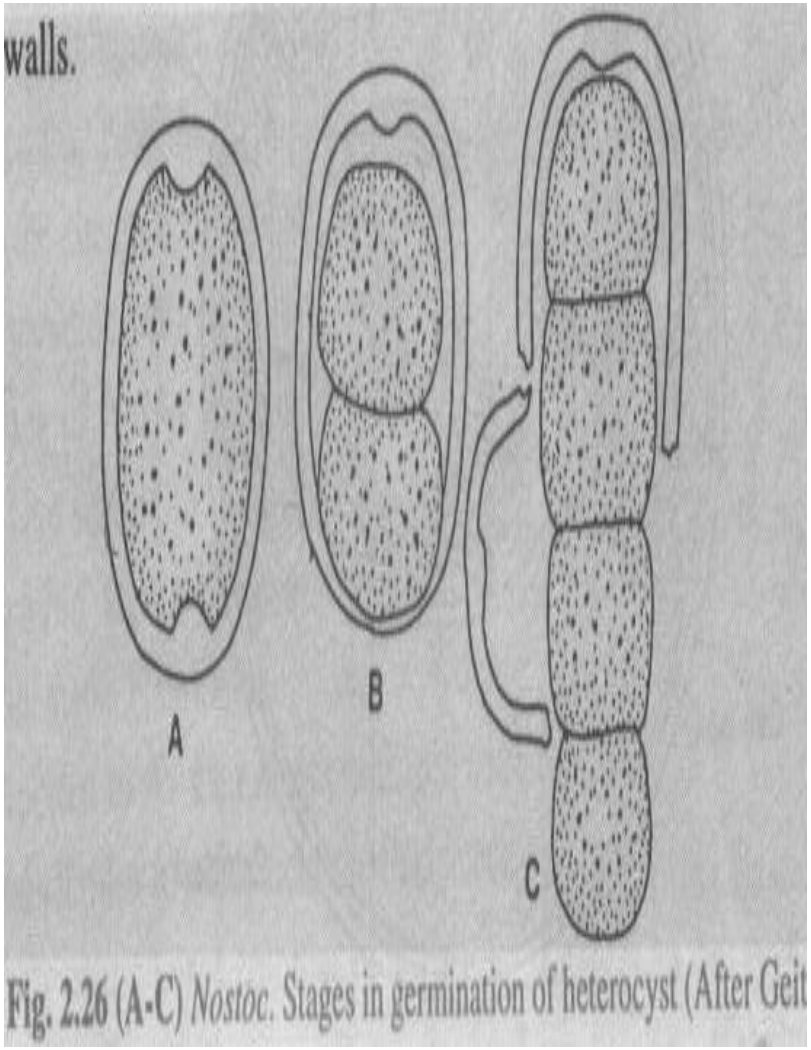


Fig. 2.26 (A-C) *Nostoc*. Stages in germination of heterocyst (After Geit

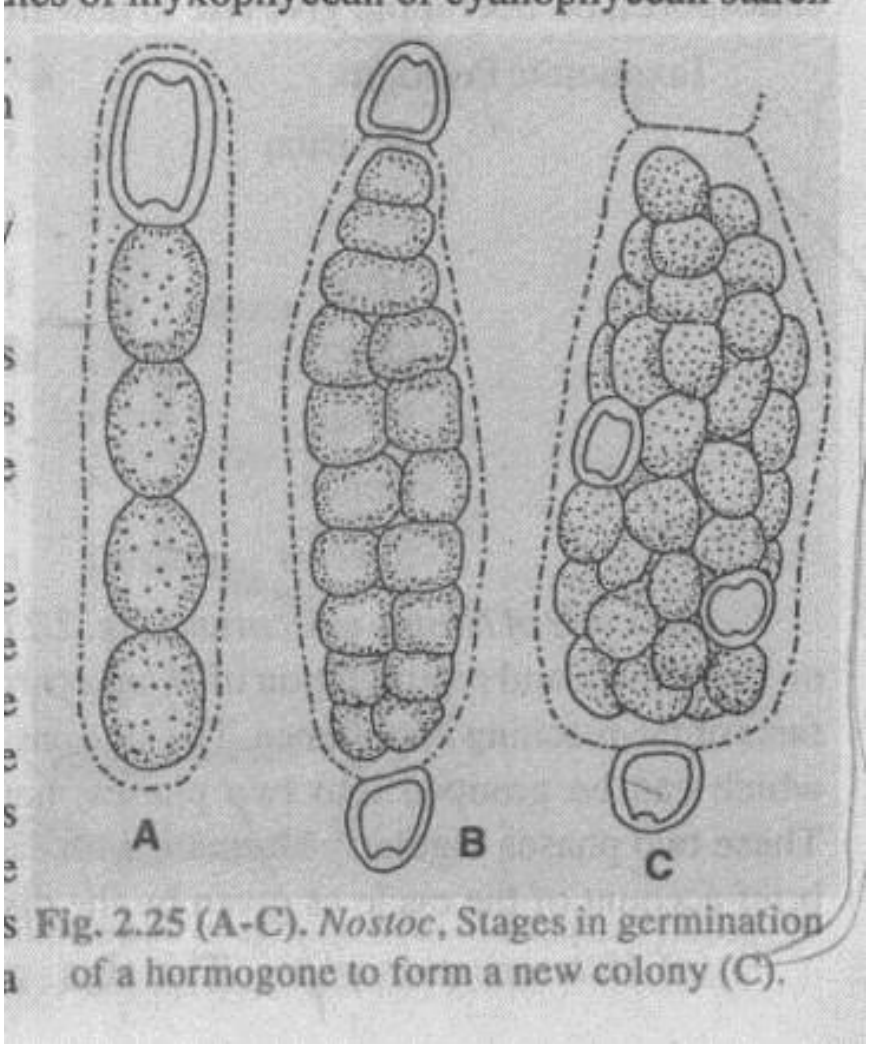
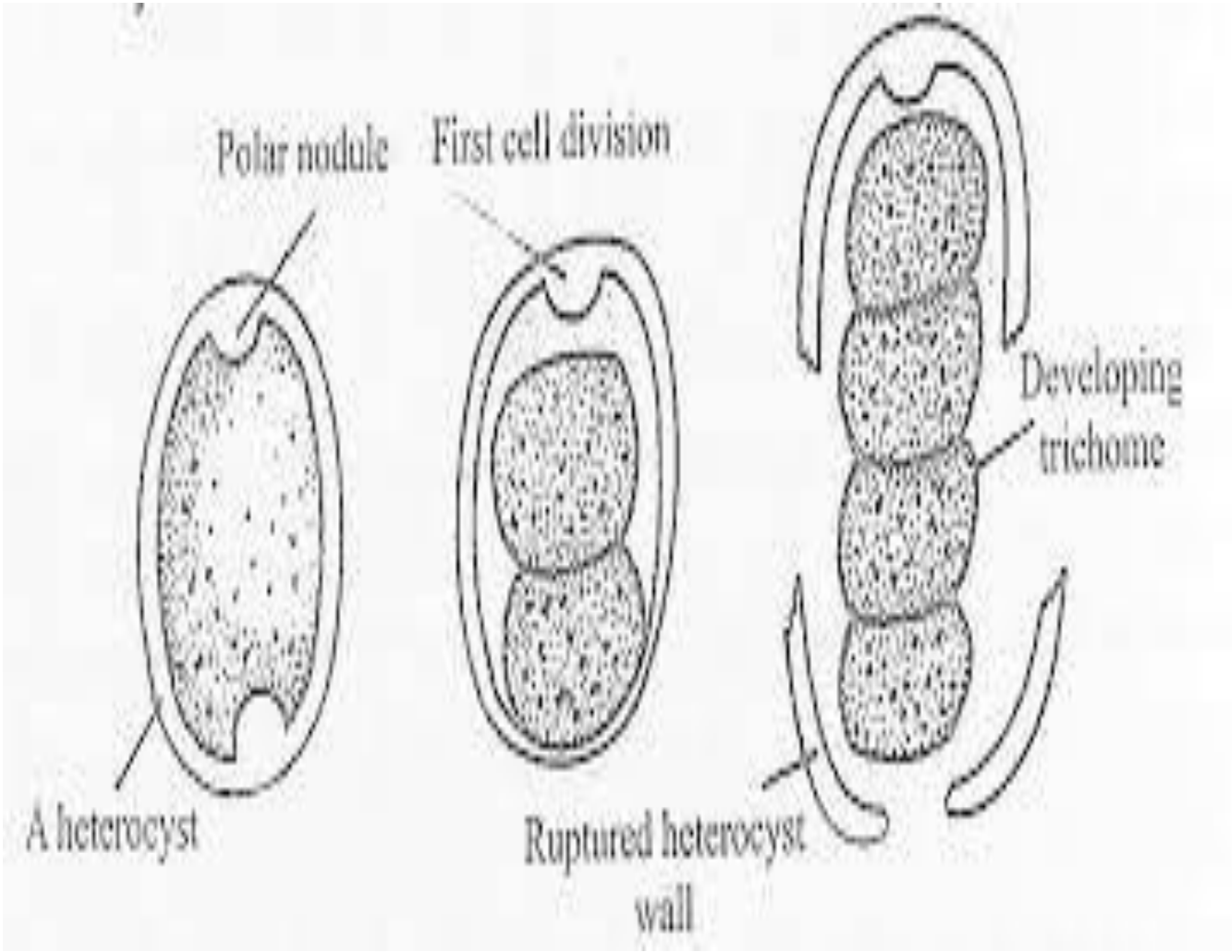


Fig. 2.25 (A-C). *Nostoc*, Stages in germination of a hormogone to form a new colony (C).

Heterocyst germination of Nostoc


Polar nodule
First cell division
Developing trichome
A heterocyst
Ruptured heterocyst wall

Taxonomic Position:

Division: Cyanophyta

Class : Cyanophyceae

Tribe : Hormogoneae

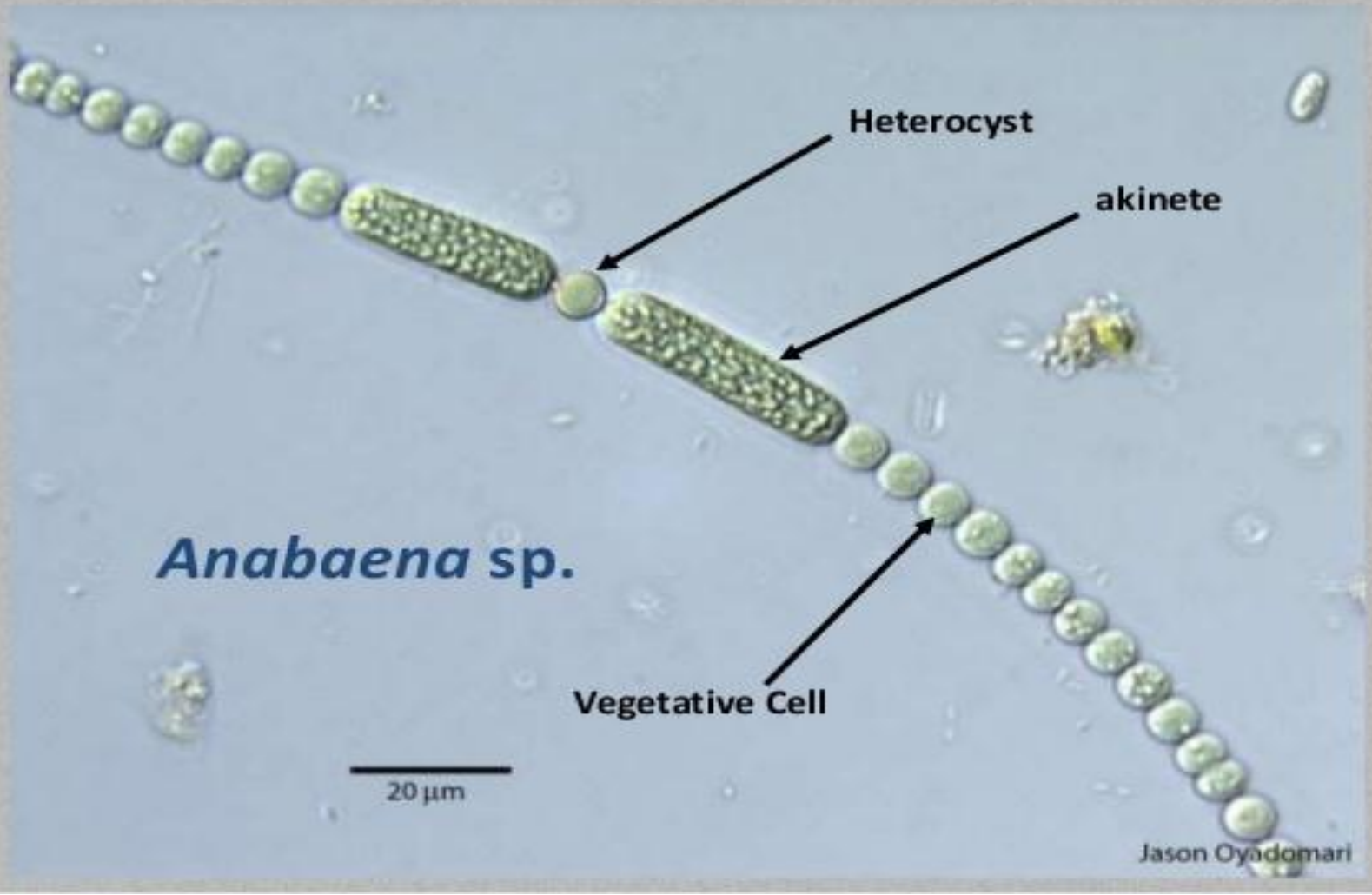
Order : Nostocacales

Family : Nostocaceae

Genus : Nostoc

Species : muscorum

Cyanobacteria /Cyanophyceae: Nostocales



Classification

Domain – Bacteria
Phylum – Cyanobacteria
Class - Cyanophyceae
Order – Nostocales
Family – Nostocaceae
Genus - Anabaena

Introduction

- Anabaena is a genus of filamentous cyanobacteria, or blue-green algae.
- It found as plankton. It is known for its nitrogen fixing abilities.
- They form symbiotic relationship with certain plants, such as the mosquito ferns.
- Some species of anabaena are endophytes. They live in the roots of Cycas and Azolla.

Heterocyst

- A heterocyst is a differentiated cyanobacterial cell that carries out nitrogen fixation.
- The heterocyst function as the site for nitrogen fixation under aerobic conditions.
- They are formed in response to a lack of fixed nitrogen (NH_4 or NO_3).
- They contain only photosystem 1, which enables them to carry out cyclic photophoshorylation and ATP regeneration

Akinetes

- An akinete is a thick walled dormant cell derived from enlargement of a vegetative cell.
- It serves as a survival structure. It is a resting cell of cyanobacteria.
- Akinetes appear thick walled with granular looking cytoplasm, under magnification.
- The akinetes are filled with food reserves, and have a normal cell wall surrounded with 3 layer coat.

Reproduction

- Anabaena is reproduced only by vegetative and asexual methods.
- The sexual reproduction is completely absent.

Anabaena reproduce vegetatively by the following methods-

- Fragmentation
- Old trichome becomes very large and irregular due to which it gets to break up into short fragments.

- These short fragments of trichome divide vegetative cells and develop into new trichome.
- Hormogones
- Hormogones are the short fragments of trichomes. Developed in the region of heterocyst.
- Then they came out of th trichome due to some movement.

- They divide vegetative cells and developed heterocyst and again surrounded by sheath. In this way new trichome is formed.

Anabaena reproduce asexually by following methods

- Akinetes
- The akinetes are produced in mature colonies. They are formed in unfavorable conditions.
- They are also called arthrospore or resting spore. They are penetrating bodies.
- In favorable conditions they directly or indirectly giving rise to new filaments.
- The contents of akinete divide into bits prior to germination.

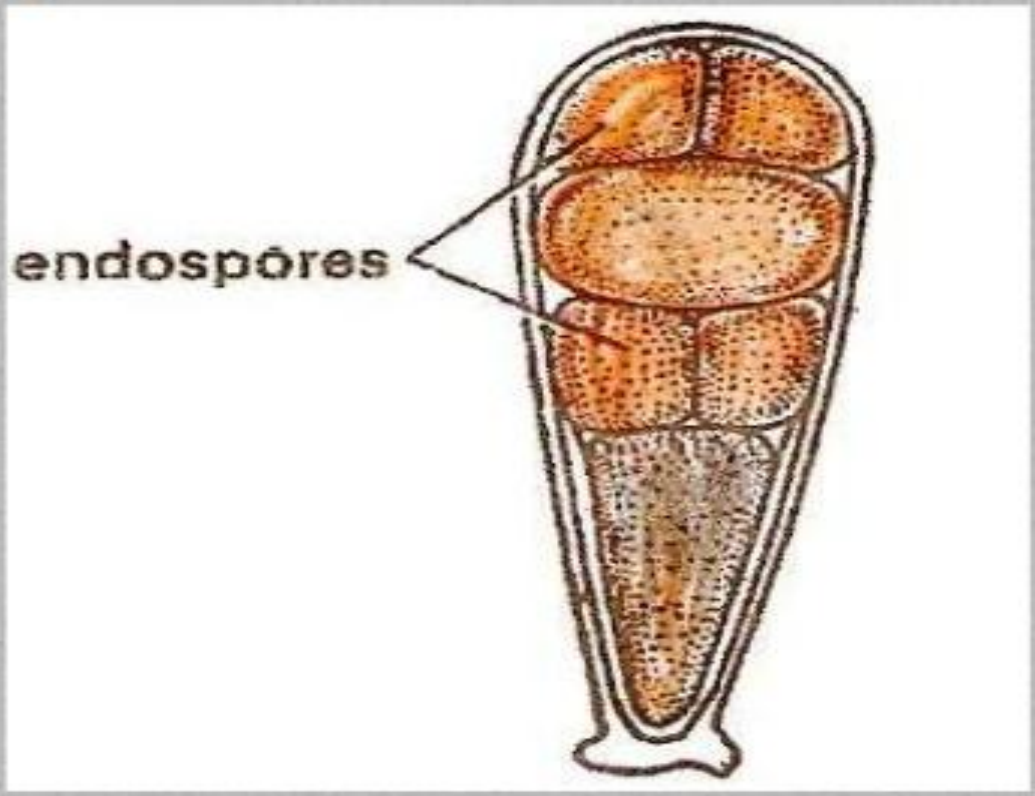
- Heterocyst
- Heterocyst cell divide transverly and form (2-4) celled hormogones.
- These hormogones come out by bursting the thick wall of heterocyst and germination occurs to give rise to new trichome.

Spirulina

- Filamentous
- Common in lakes with high pH
- Major food for flamingo populations
- Commercial food source

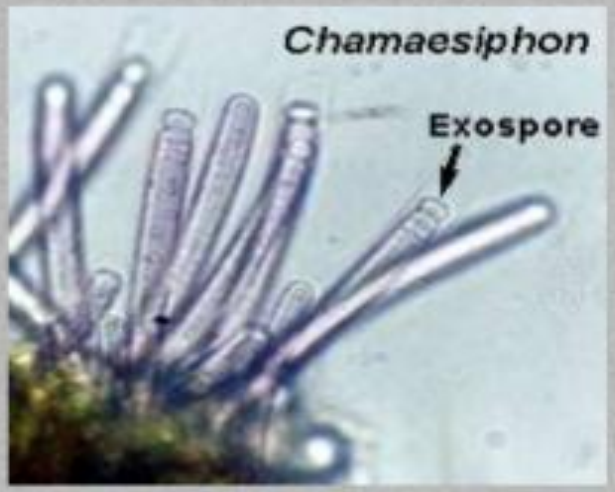
Asexual Reproduction

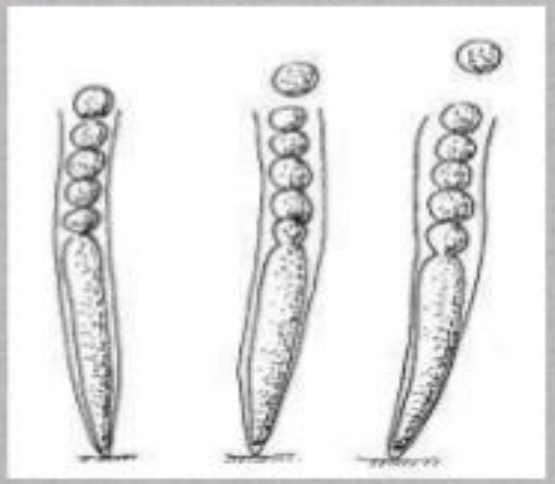
- Endospore

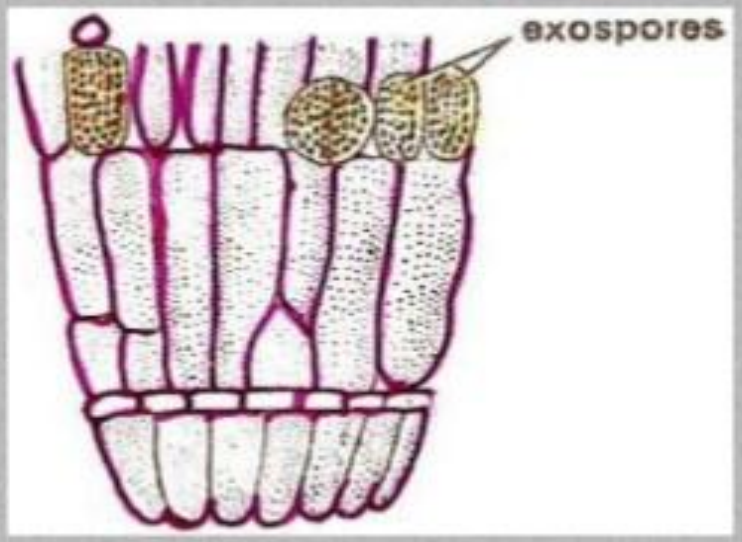


Dermocarpa clavata

Asexual Reproduction





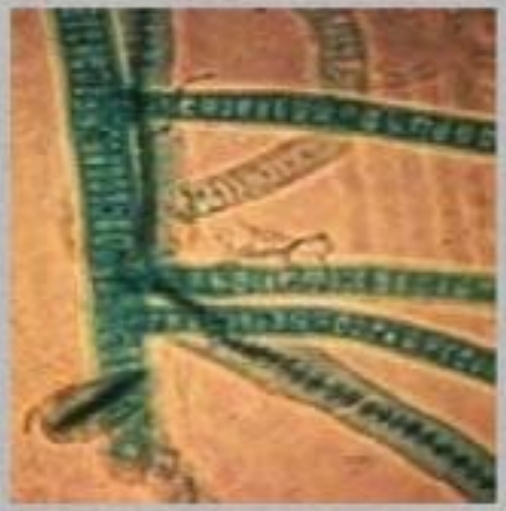


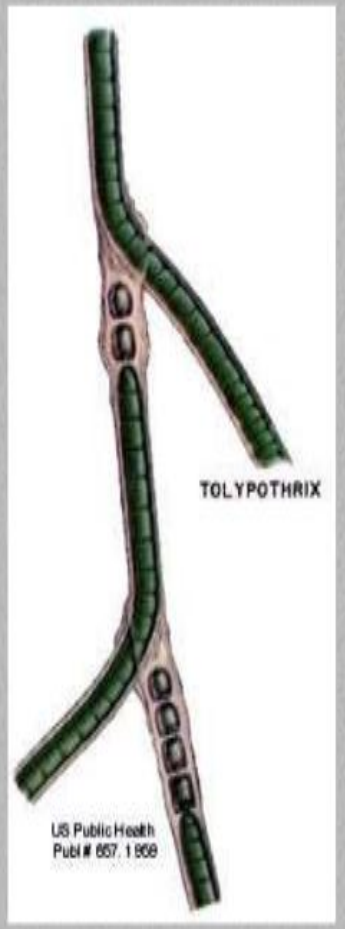
Chamaesiphon clavata

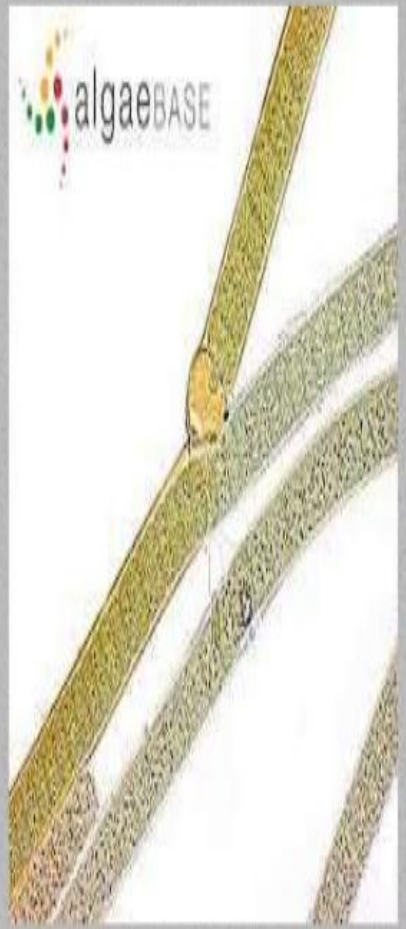
BRANCHING IN CYANOBACTERIA

False branching = outgrowth of filaments adjacent to dead or specialized cells; filament curves

True branching = outgrowth from cells that change their axis of division, 90 degrees from axis of trichome

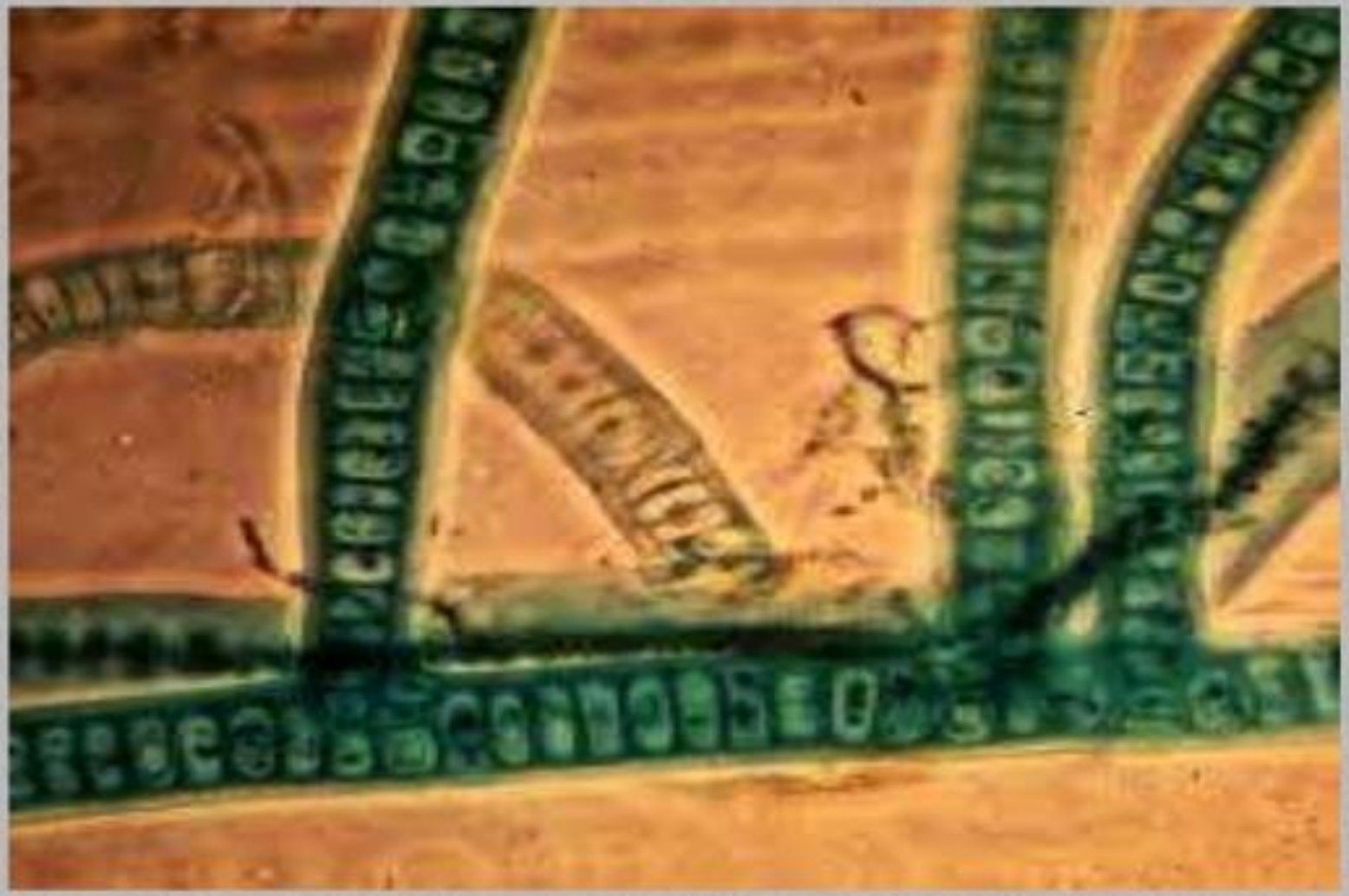






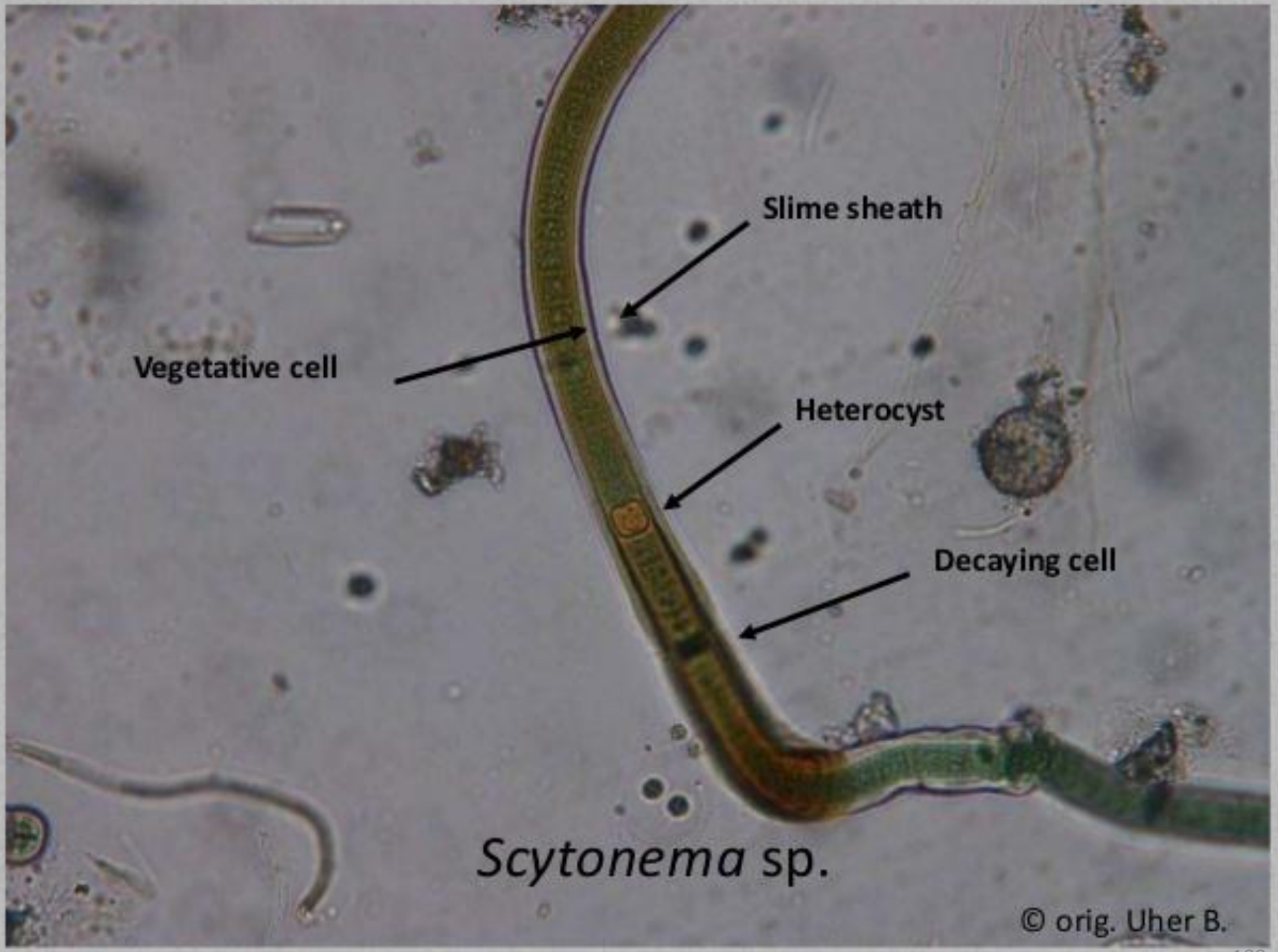
Tolypothrix (False Branching)

Scytonema (False Branching)



Mastigocladus (Fischerella)

True Branching


Slime sheath
Vegetative cell
Heterocyst
Decaying cell
Scytonema sp.
© orig. Uher B.

Reproduction in Cyanophyta (Cyanobacteria)

1. Vegetative Reproduction

It occurs by following methods:

(i) Fission: Unicellular cyanobacterial cells divide and reproduce by fission.

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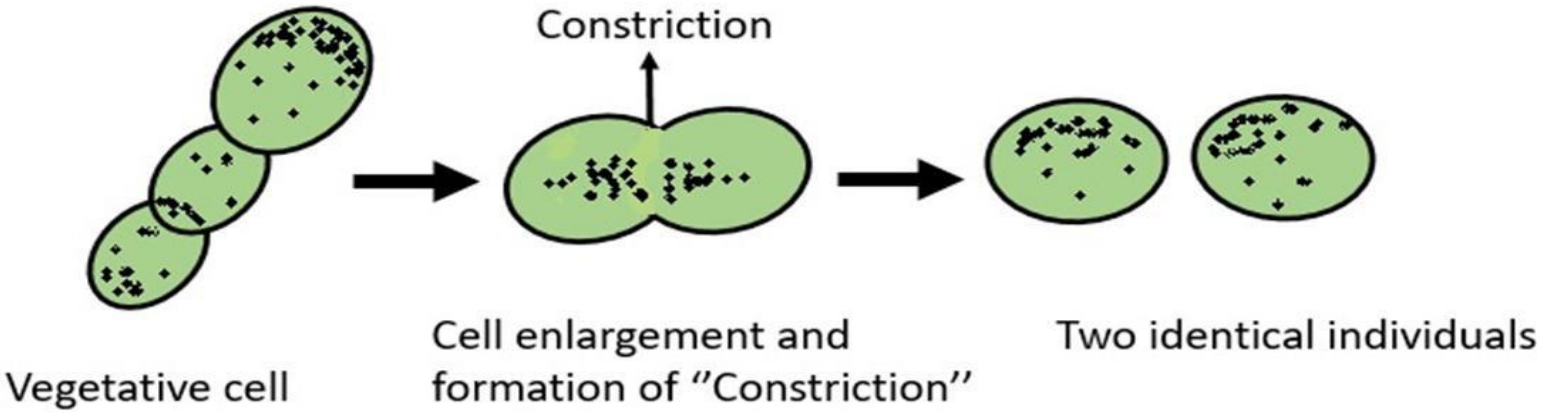
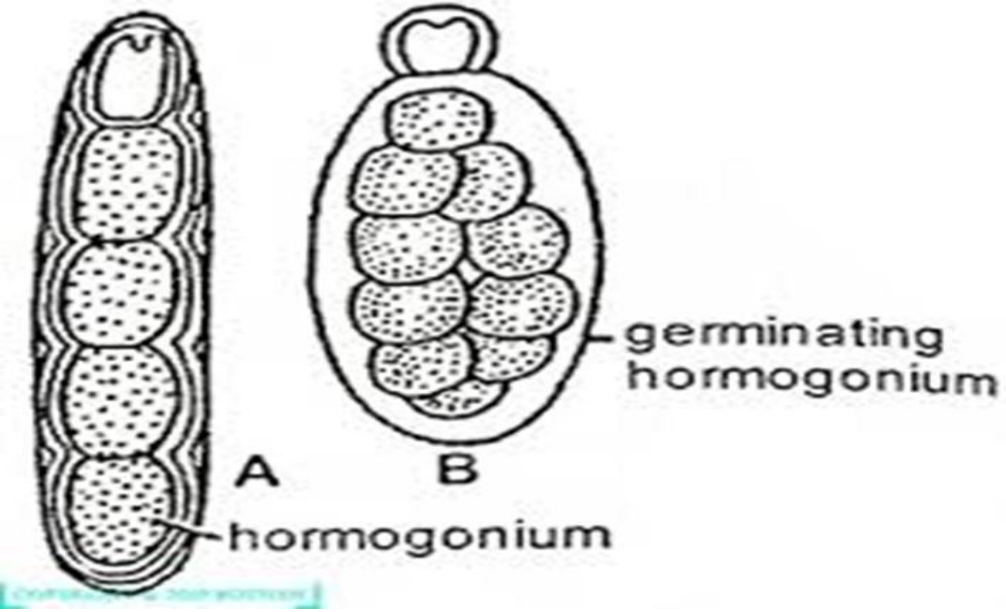
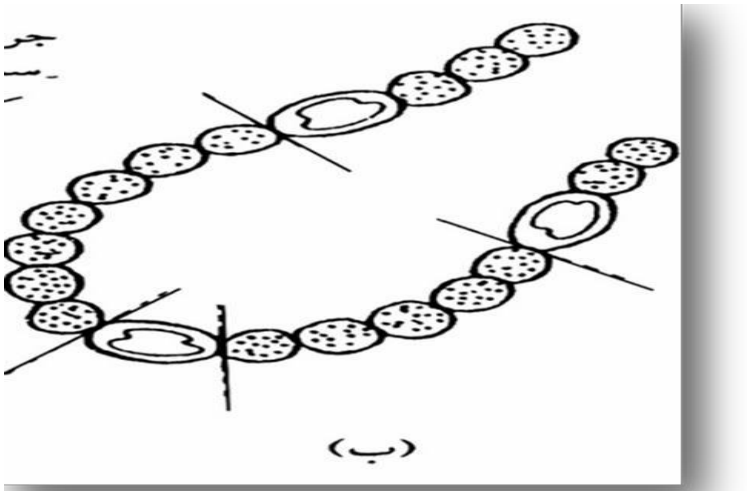


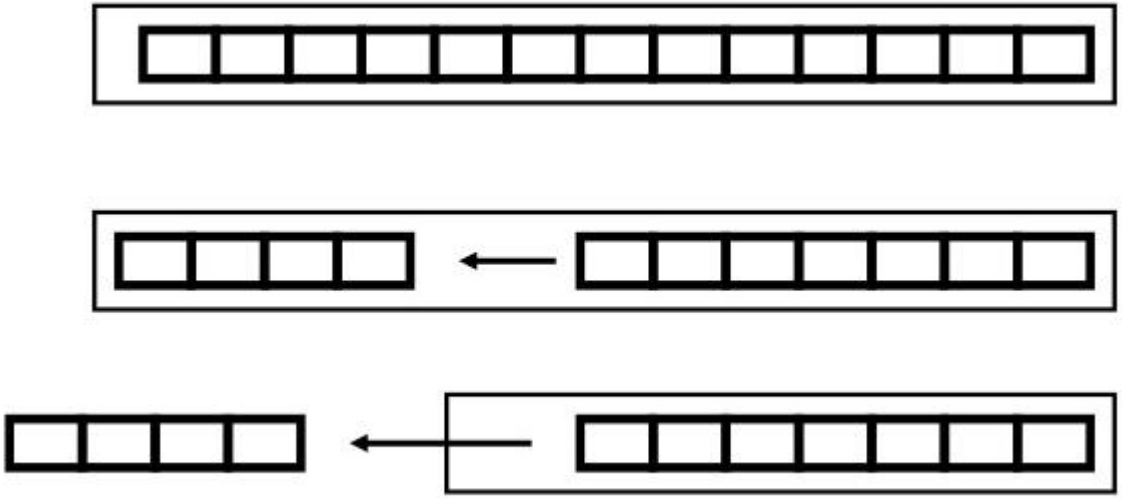
(ii)Fragmentation: in this method, filaments break down into small pieces and each piece develops into a new colony.

(iii)Hormogonia: in this method, filaments break into pieces or trichomes, which are called hormogonia and develop into new filaments

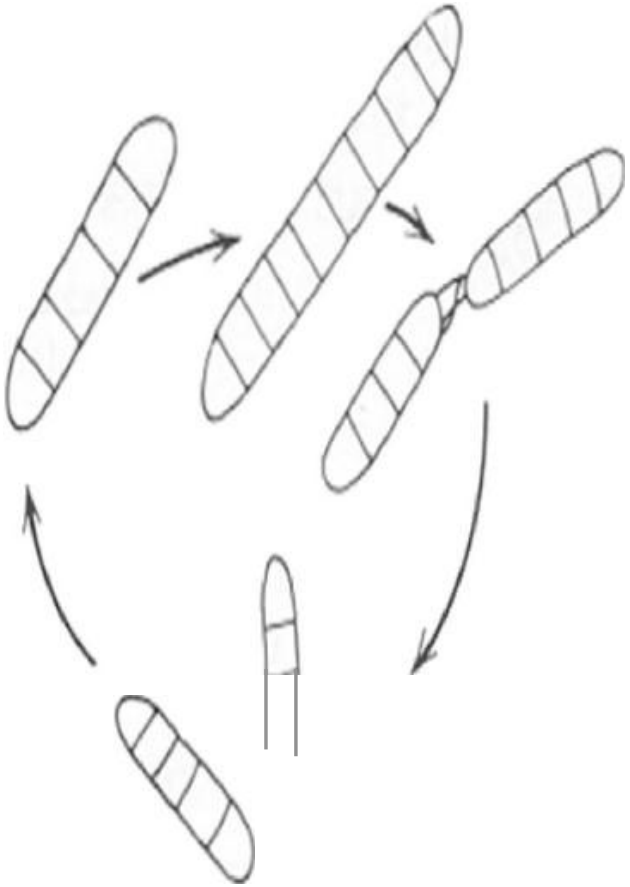




Hormogonia - short piece of trichome found in filaments. It detaches from parent filament and glides away



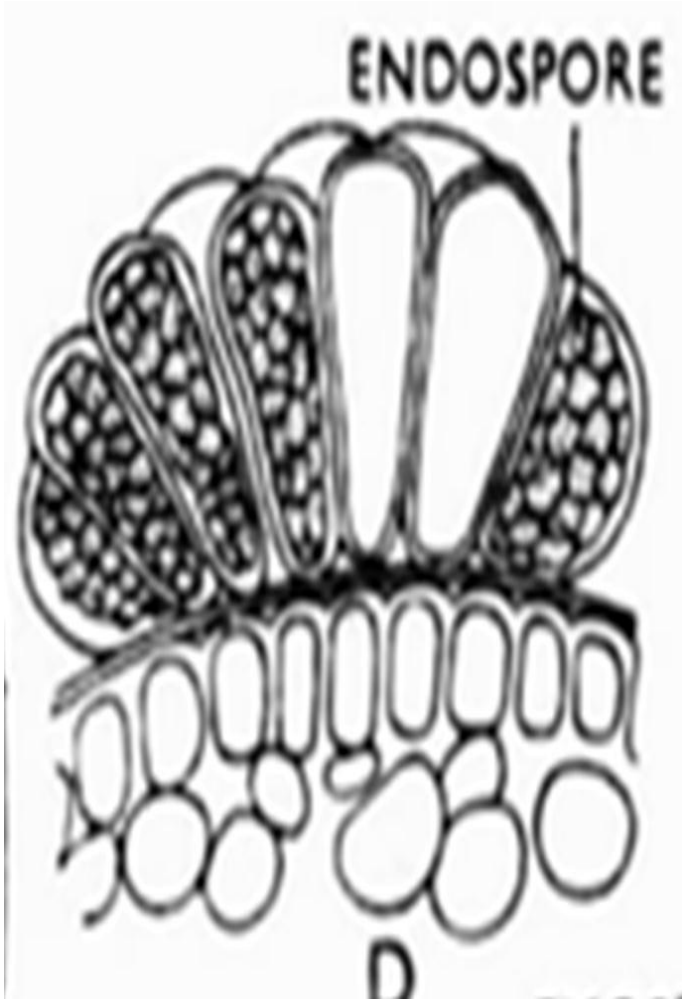
Hormogonia



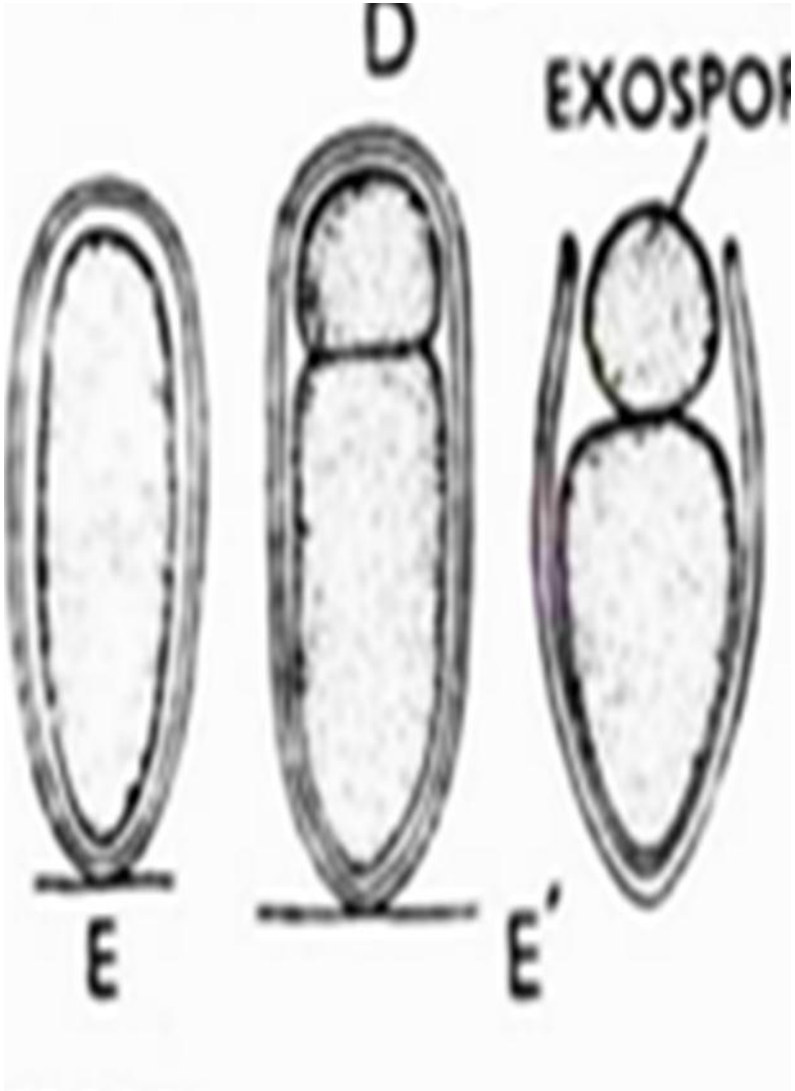
Asexual Reproduction in Cyanophyta

Many non-motile Cyanobacteria reproduce by **spores**, which are of the following types:

)i) **By Endospore:** In this condition one or more cells increase in size and their protoplasm divides into many parts to form endospores, e.g., ***Dermocarpa***.



-2- By Exospore: These structures are formed in the distal part of the protoplasm, e.g., ***Chaemosiphon***.



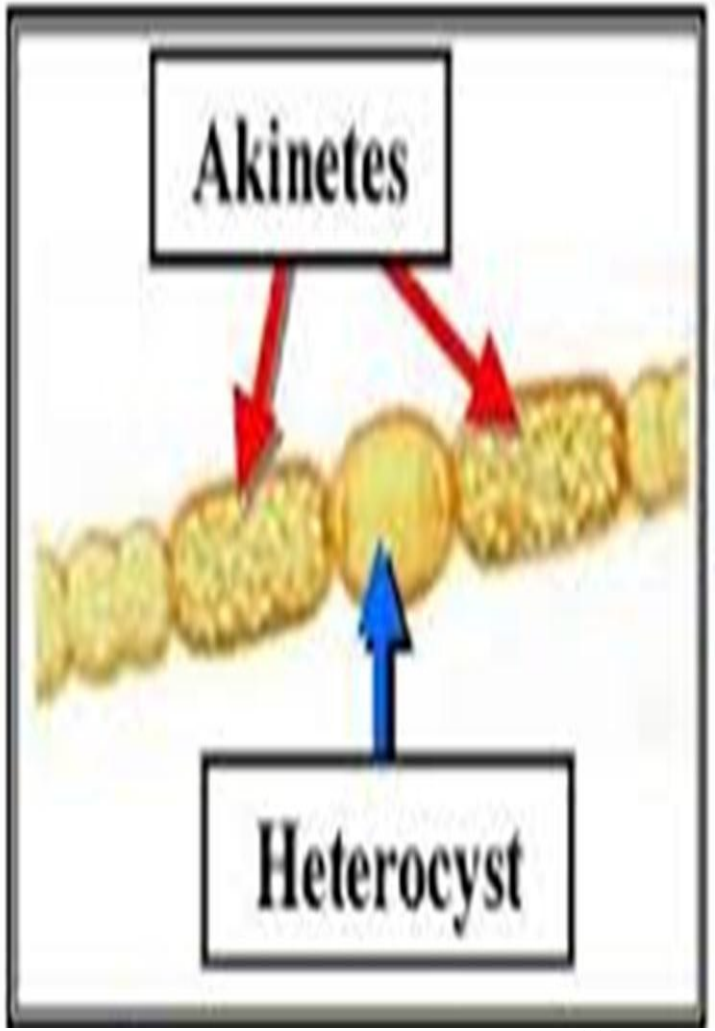
(iii) By Akinetes

-Thick walled resting spores.

-These are formed close to the heterocysts.

- In this case, cells increase in size and a thick layer is formed around it.

- Appear as larger cells in the chain and different than - heterocyst.
- Akinete resistant to unfavourable environmental conditions.
- Under favourable conditions, they give rise to new filaments,
- e.g., *Anabaena*.



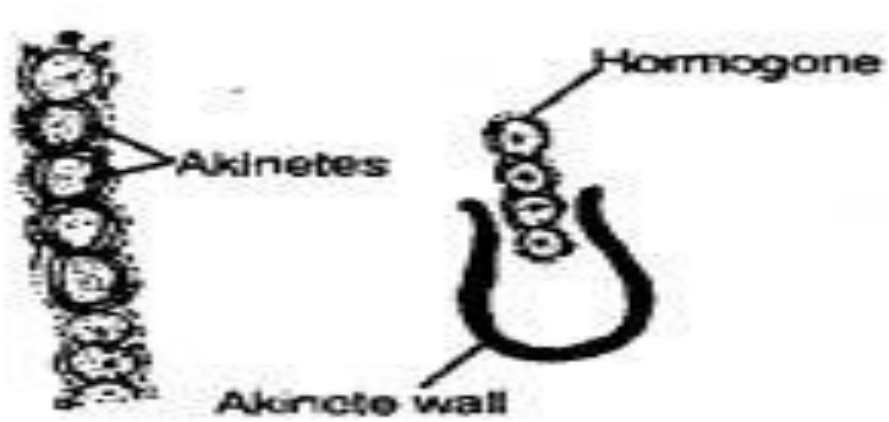
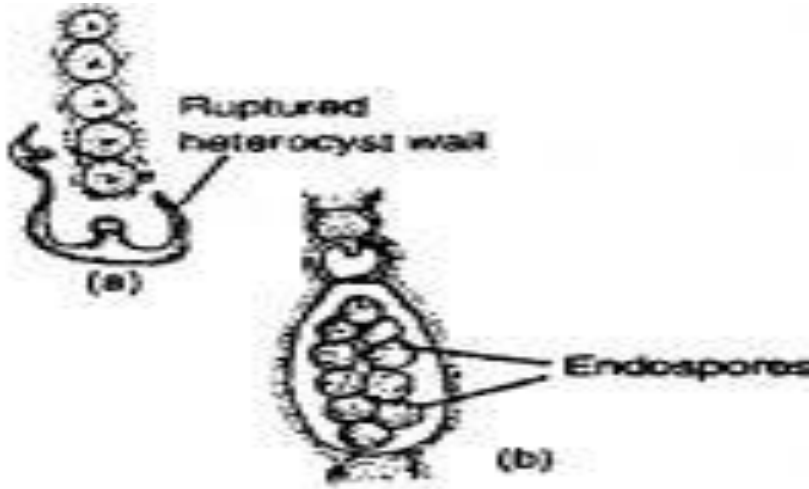


Fig. Akinete germination



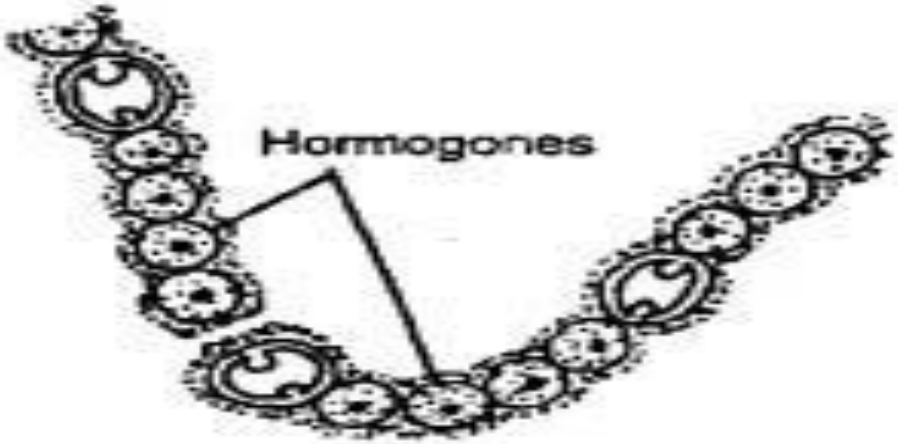
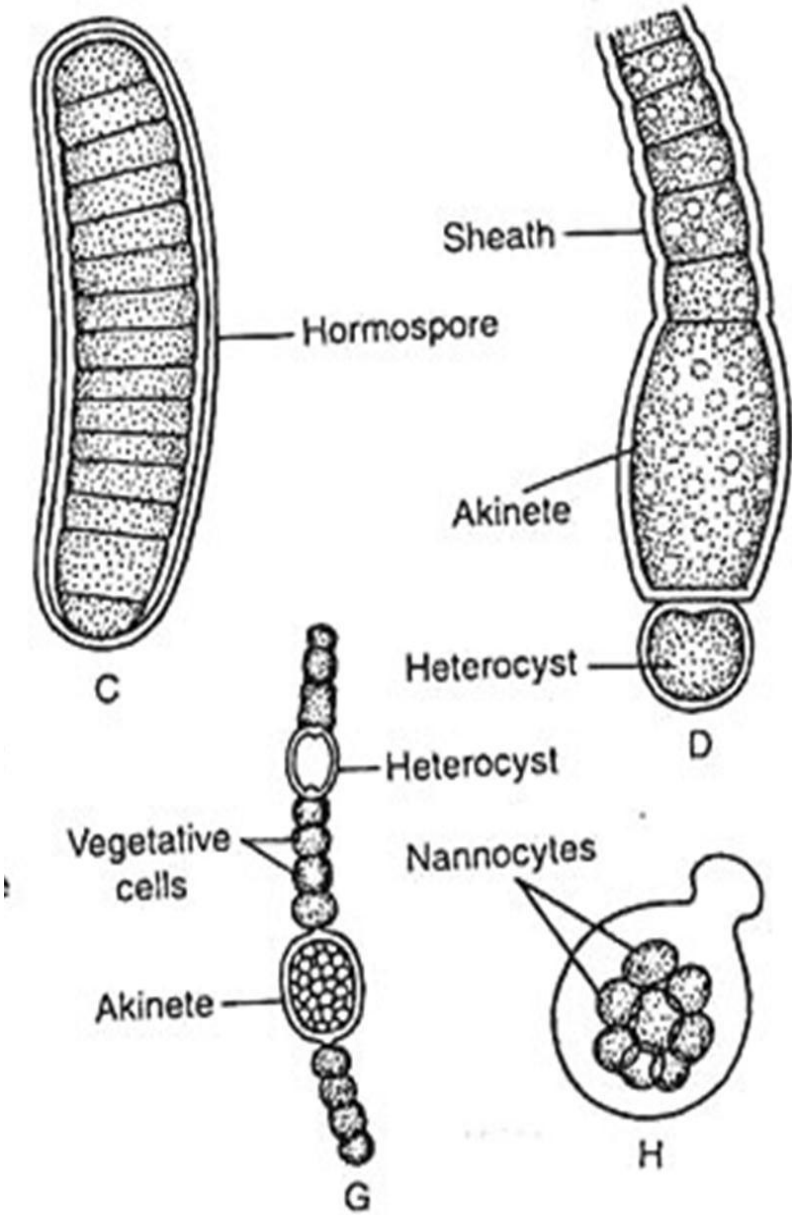


Fig. Hormogones

(iv) **By Nannocytes**

- In some of the filamentous Cyanophyta, cells may divide into many parts without any change in shape.

In this way so many bodies are formed which are known as **nanocysts**, e.g., ***Microcystis***




plant ecology-ecosystem

Plant Ecology

Dr. Mohamed Abdel-Rahiem Ali Abdrabo

PLANT ECOLOGY

- The term ecology is derived from the Greek words **Oikos** meaning home and **logia** which means the study of it.
- **Ecology** is: "the study of organisms in relation to their environment".
- **PLANT ECOLOGY** is a subdiscipline of ecology which studies the distribution and abundance of plants, the effects of environmental factors upon the abundance of plants, and the interactions among and between plants and other organisms. Ecology also includes the study of the effects of both **climate** and **soil water supply** on plant growth.

THE ORGANISMS

It refers to all plants and all animals, including man.

- This means not only the larger organisms such as trees, grasses, deer, cows etc., but also any of the other lesser species in such environments. Some of these may be dependent on the larger organisms, some may be parasites, but all have relationships to each other and are using the resources available in their environments.
- The least of these such as bacteria and protozoa, contribute to the breakdown of dead organic matter and the release of its components to be used again, fix nitrogen or they may cause diseases.
- All the organisms in an environment are subjects for ecological consideration, all affect each other in some way and all have relationships to the environment.

THE ENVIRONMENT

- The term "**Environment**" includes everything that may affect an organism such as:

1- **Substances**, such as soil and water

2- **Forces**, such as wind and gravity

3- **Condition** such as light and temperature

4- **Other organisms**.

- These factors may be studied or measured individually, but they must always be considered in terms of their interacting effects upon organisms and upon each other.

- The environment may be analyzed into a number of factors which may be grouped into **three** major categories:

1) **Climatic** (aerial), such as rainfall, and air temperature.
2) **Edaphic** (related to soil), such as soil moisture and soil temperature. (A condition of the soil, whether physical, biological or chemical, that influences the organisms and processes that occur in the soil.)
3) **Biotic** (related to other organisms) such as parasitism, herbivore and symbiosis.
4) **A fourth factor**, which is not commonly recognized as being of **universal occurrence** , is the "**pyric**" factor which refers to the effect of fires caused by natural forces (such as , **thunder storms**) in forest and grass areas or by accidentally man-made fires.

THE HABITAT

- It is the place where an organism or a community of organisms lives.
- A habitat has a particular set of environmental conditions such as a sand-dune habitat, salt-marsh habitat etc.

SYNECOLOGY

Deals with the study of groups of organisms which are associated together as a unit. *In other words*, **synecology** is concerned with populations and communities rather than with individuals.

Useful subdivisions may be also based on the kind of environment or habitat such as:

1- **Marine ecology**: concerned with the organisms living in the seas and oceans.

2- **Fresh water ecology**: deals with organisms having rivers, and fresh water courses as their habitats.

3- **Terrestrial ecology**: which is the study of land plants in their relatively dry habitats.

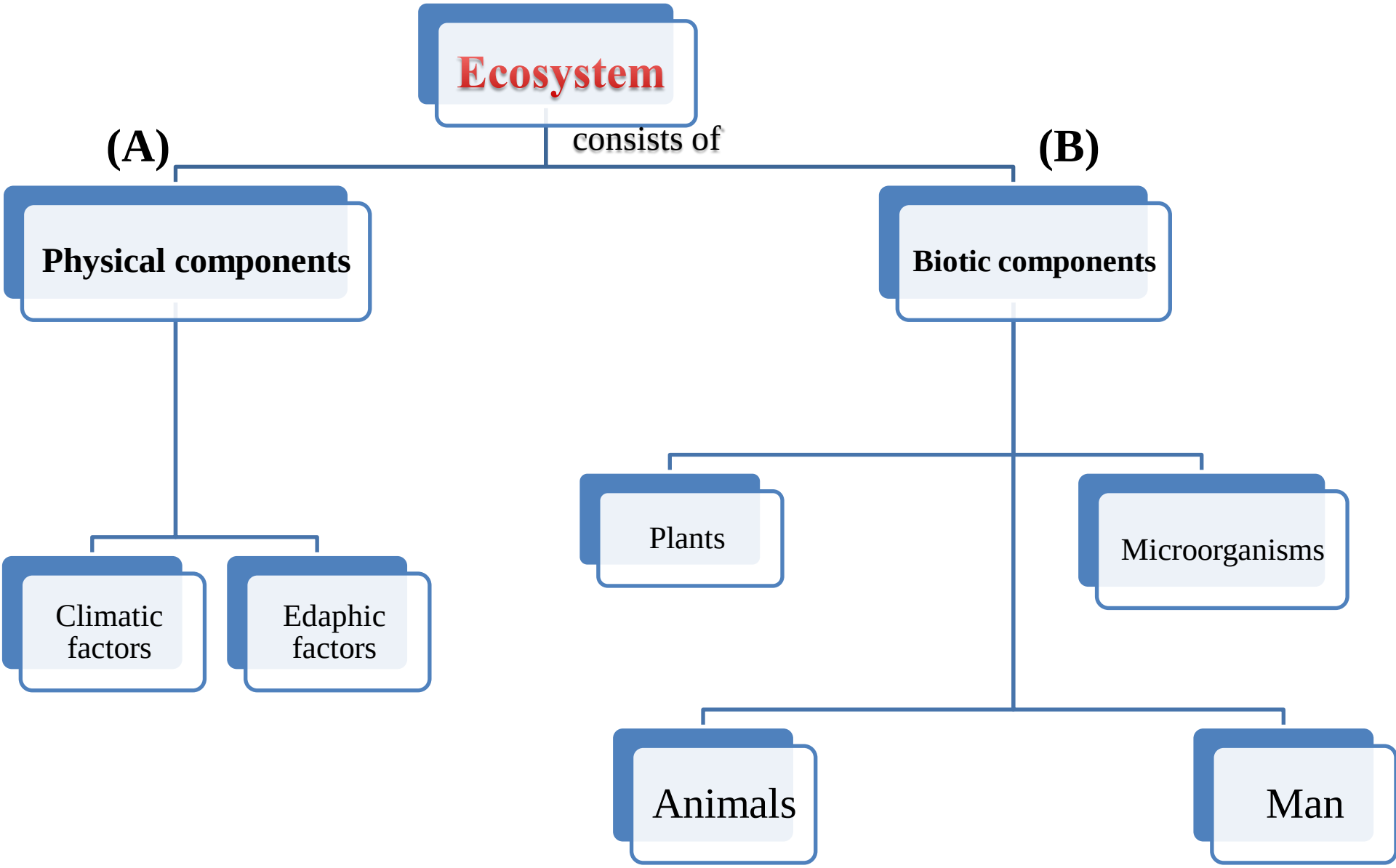
Ecology may also subdivide according to taxonomic groups such as: Animal ecology plant ecology, insect ecology etc.

THE ECOSYSTEM

The whole complex of the plant and animals forming a community, together with all the interacting physical factors of the environment really form a single unit, which has been called the **ECOSYSTEM**.

- This takes into account all the living creatures in the community, from the fungi, bacteria and worms living in the soil to the mosses (**algae**), caterpillars (**larva**) and birds up in the tree and all the factors of the environment, from the composition of the soil atmosphere and soil solution to wind, length of day, relative humidity and atmospheric pollution. etc.

- The ecosystem differs everywhere in the world e.g the ecosystem in tropical region differs than in alpine region but both have the same components.


Ecosystem
consists of
(A)
(B)
Physical components
Biotic components
Climatic factors
Edaphic factors
Plants
Microorganisms
Animals
Man

Ecosystem consists of

A- Physical components, which are:

1- Climatic factors. 2- Edaphic factors.

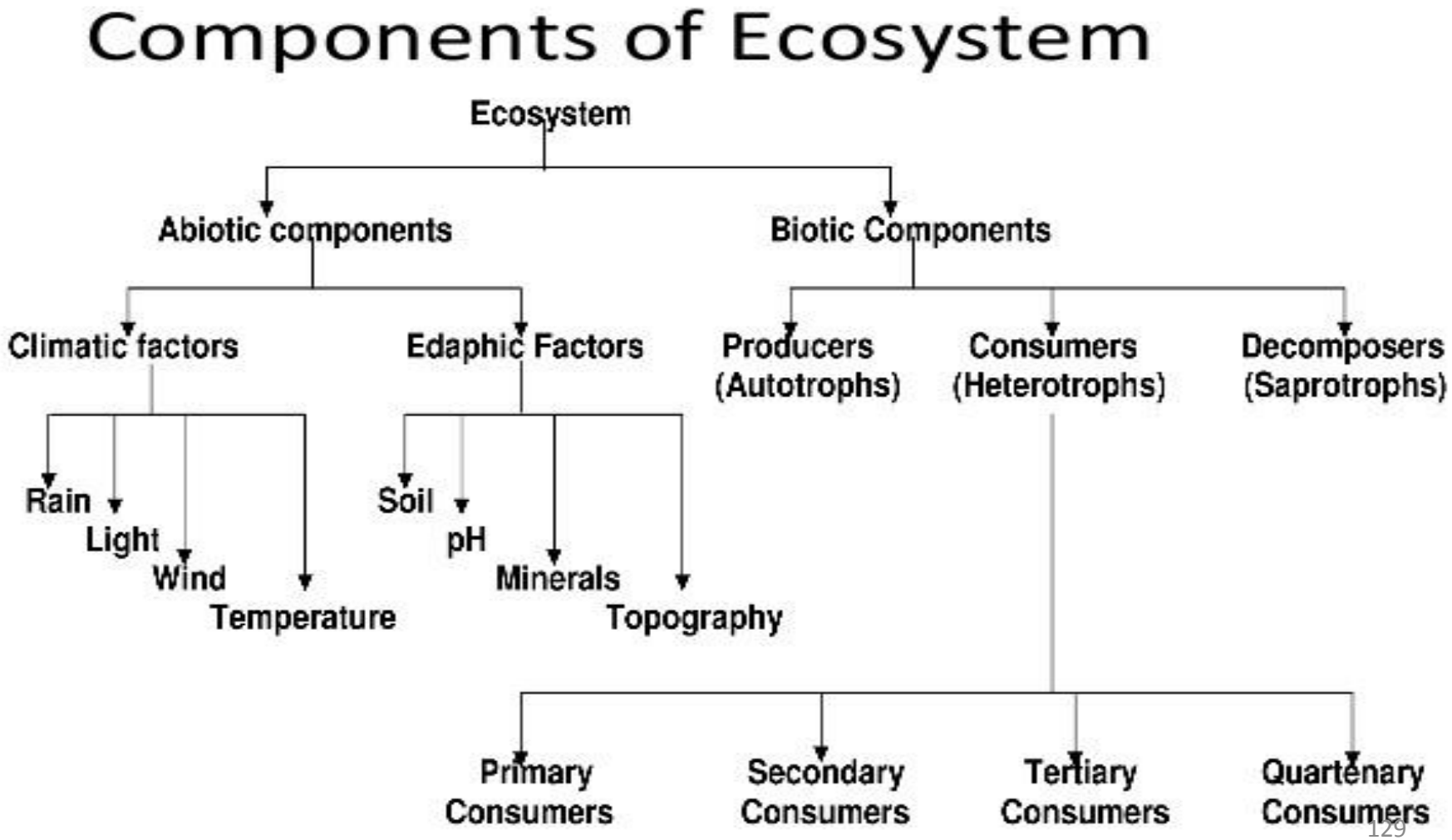
B- Biotic components which are:

1- Plants. 2- Animals. 3- Microorganisms. 4- Man.

- All these components are in balance with each other every factor affect and effect in each other, the reactions between them are reversible and finally they are in balance state. Man represents the top on all the components of the ecosystem because he can affect and change them.

The following figure represents the ecosystem components in the natural vegetation:-

Man - Climate - Animals & Plants - Soil



➢ **Biotic (living components).**

In most ecosystems the Kinds of organisms are numerous, and diverse and include producers, consumers, and decomposers.

A- Autotrophs or producers (plants).

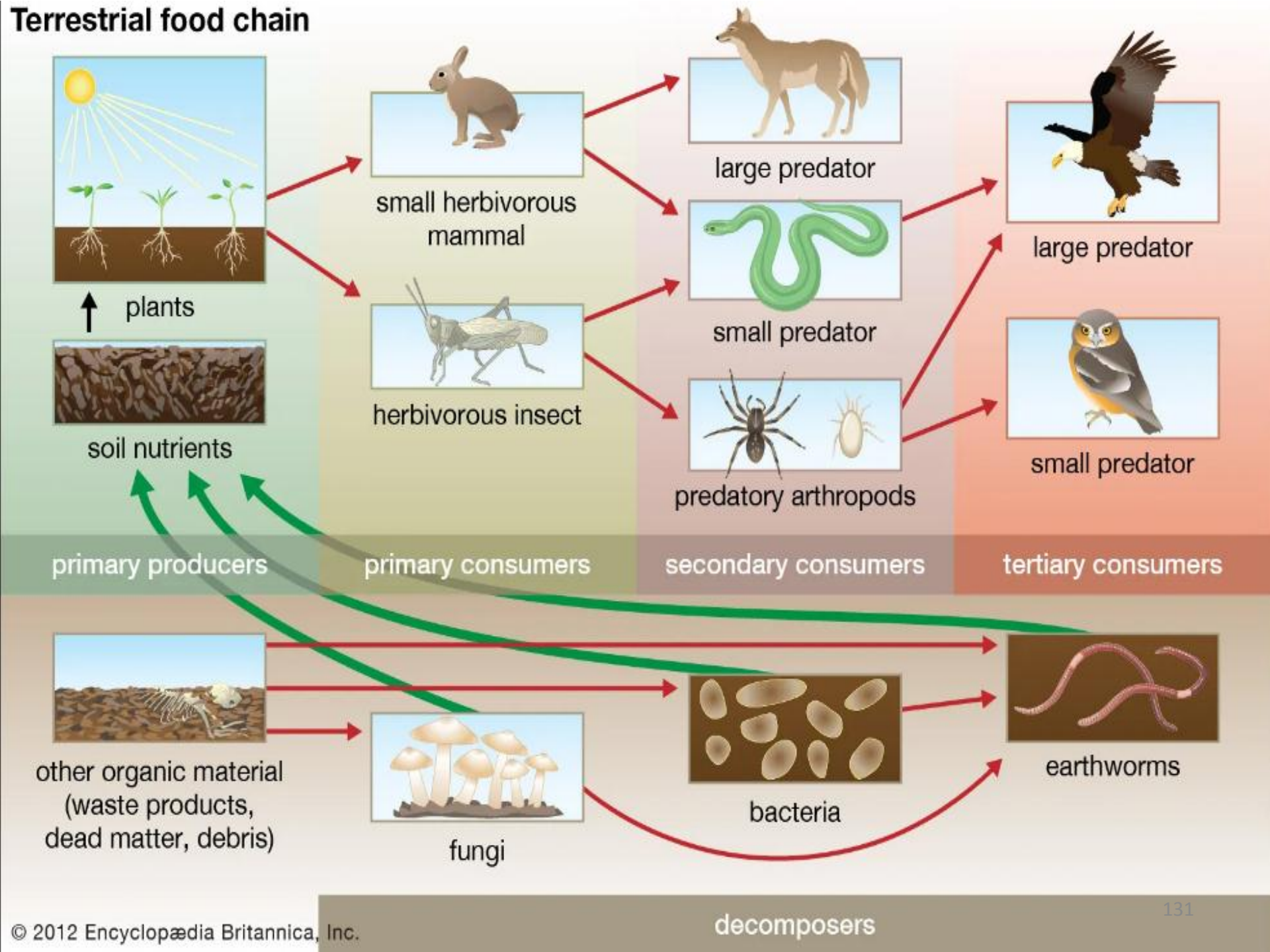
B- Heterotrophs or consumers (animals).

1- **First order**: Consumers - herbivores.

2- **Second order**: Consumers – Carnivores (animals which eat the flesh (Meat) of other animals).

3- **Third order**: Top Consumers (Carnivorous eat other carnivores) ……..**human called**……

C- Decomposers,(decompose dead substances) like fungi, bacteria and protozoa.


Terrestrial food chain
plants
soil nutrients
small herbivorous mammal
herbivorous insect
large predator
small predator
predatory arthropods
large predator
small predator
primary producers
primary consumers
secondary consumers
tertiary consumers
other organic material (waste products, dead matter, debris)
fungi
bacteria
earthworms
decomposers
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CHARACTERISTICS OF THE ECOSYSTEMS

1- The ecosystem consists of living (biotic) and non living (A biotic Factors or physical) components.

2- The relationships between the components of the ecosystem are always in balance (in two direction). Each factor affect and effect in each other, the reactions between them are reversible; finally, they are in balance state.

3- The relationships between the components of the ecosystem are energetic i,e. The energy is not stable in the ecosystem.

4- The energy transfers between the components of the ecosystem in two ways:

- a- between the living components through nutritional relations.
- b- from living to non-living components through decaying (by microorganisms).

5- Energy transfers between the living components called the food chain. Energy transfers from living to non-living components called the mineralization chain.

6- The energy in the ecosystem transfers either in food chains or in mineralization chains through definite levels called energy levels.

RADIANT ENERGY

- The sun's radiant energy comes to the earth’s surface as "electromagnetic waves", the lengths of which are measured in microns (1/1000 mm) or mill microns,(1/10^6 nm).

- This energy (called the electromagnetic spectrum) includes those wavelengths of the "visible spectrum" called **light** and those that lie just beyond the visible spectrum التي تقع خارج الطيف المرئي، which call "**heat**“ ،or infrared radiation الأشعة تحت الحمراء if slightly longer or "ultraviolet" if slightly shorter.

- The ultraviolet (UV) light includes all wavelengths below 400 nm.
- visible light (v.) includes wavelengths between 400-720 nm.
- Infra-red (I.R.) includes wavelengths above 720 nm.
- The amount of solar radiation that falls on earth is much less than that received outside the earth's atmosphere, because of the absorbing effect of the different gases contained in the atmosphere around the earth.
- The amount of radiation reaching' the earth is always reduced because of absorption by the atmosphere (6 - 8 %) and sometimes 40% may be reflected by clouds.

- The remainder reaching soil or water on the earth may be further varied by such factors as distance from the sun at different seasons, duration of radiation مدة الإشعاع، and the angle of the rays with the earth's surface.
- The reduction in radiant energy, caused by the earth's atmosphere is as follows:

Absorption wavelength	Component
120 - 180 n.m. U.V.	1- Oxygen atoms in upper air
200 - 330 n.m. U.V.	2- Ozone
750 - 1470 n.m. I.R.	3- Water vapour
2700 n.m. I.R.	4- CO_2

❖ For these reasons, ultra-violet and infra -red radiation is reduced much more on a cloudy day than on a clear sunny day.

Environmental Abiotic Factors
Climatic Factors
TEMPERATURE

- Temperature differs from one part of the world to the other. Since Insolation is the basic source of energy for the atmosphere, the distribution of insolation would determine the temperature of the earth.

- Thus **latitude**, **altitude**, **distance from sea**, **features of the surface**, **nature of the landscape** are some important factors that affect the distribution of temperature.

- Since, the insolation is highest at equator; temperature should be highest at the equator and lowest near the poles, however actually it is not.

- Highest temperature on earth **is recorded at a few degrees north of equator.**

- **Altitude** is the second major control of temperature of a place. The temperature depends upon **albedo** of the surface also

- One major factor affecting the distribution of the temperature of Earth is **distribution of Land and Oceans**.

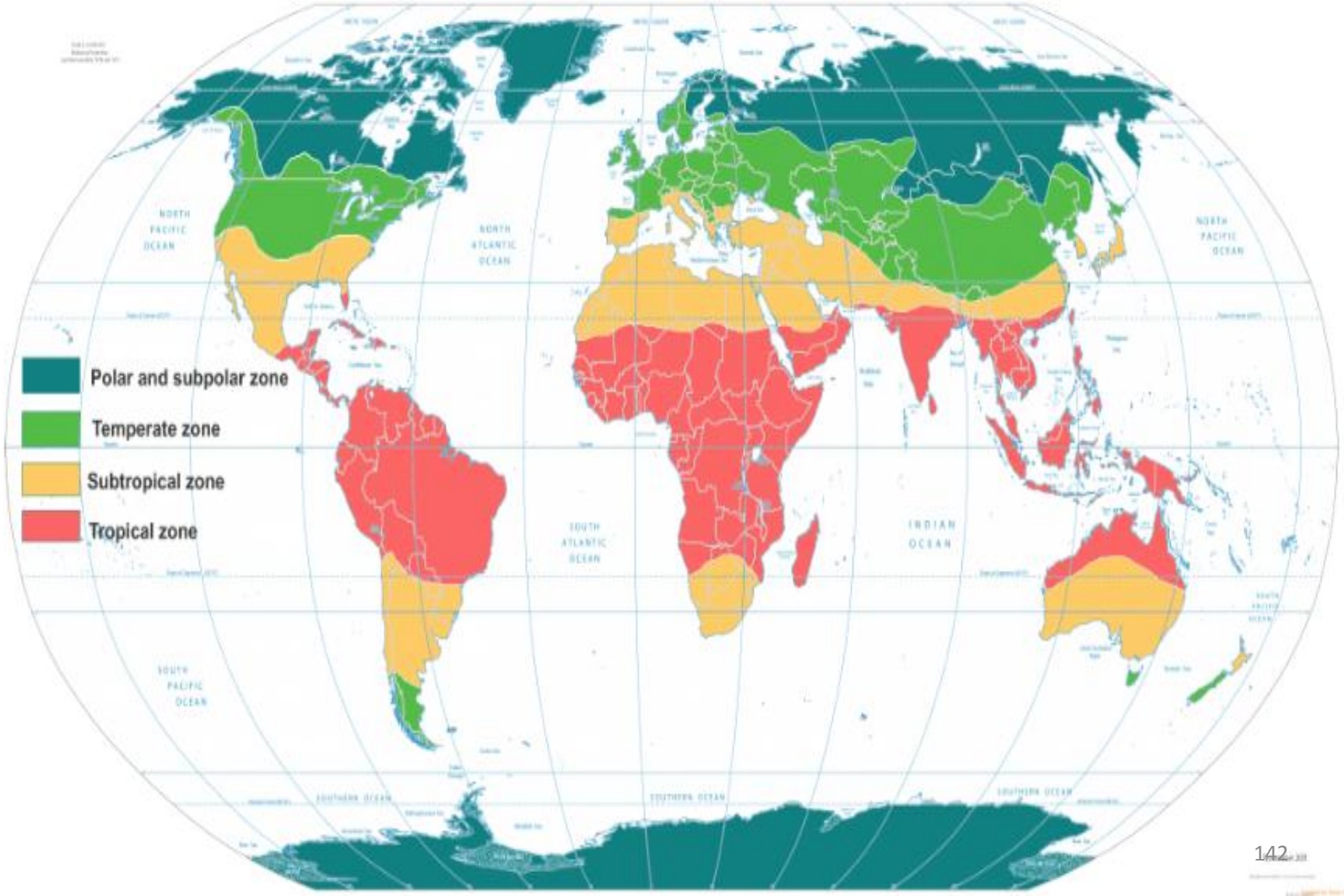
- Since there is more land in Northern Hemisphere and more waters in Southern hemisphere and there is a big difference between the specific heat of land and water; the loss of heat from the continents is bigger than the oceans.

- The continents get heated faster and get cooled faster in comparison to the Oceans. This is the reason that the temperatures of the Oceans are moderate while that of continents is extreme.

- The moderating effect on temperature of the land due to proximity of the seas is called **Maritime influence**التأثير البحري

- The increasing effect on temperature of the land at interior of the continents is called **Continental Influence**التأثير القاري

Climate zones

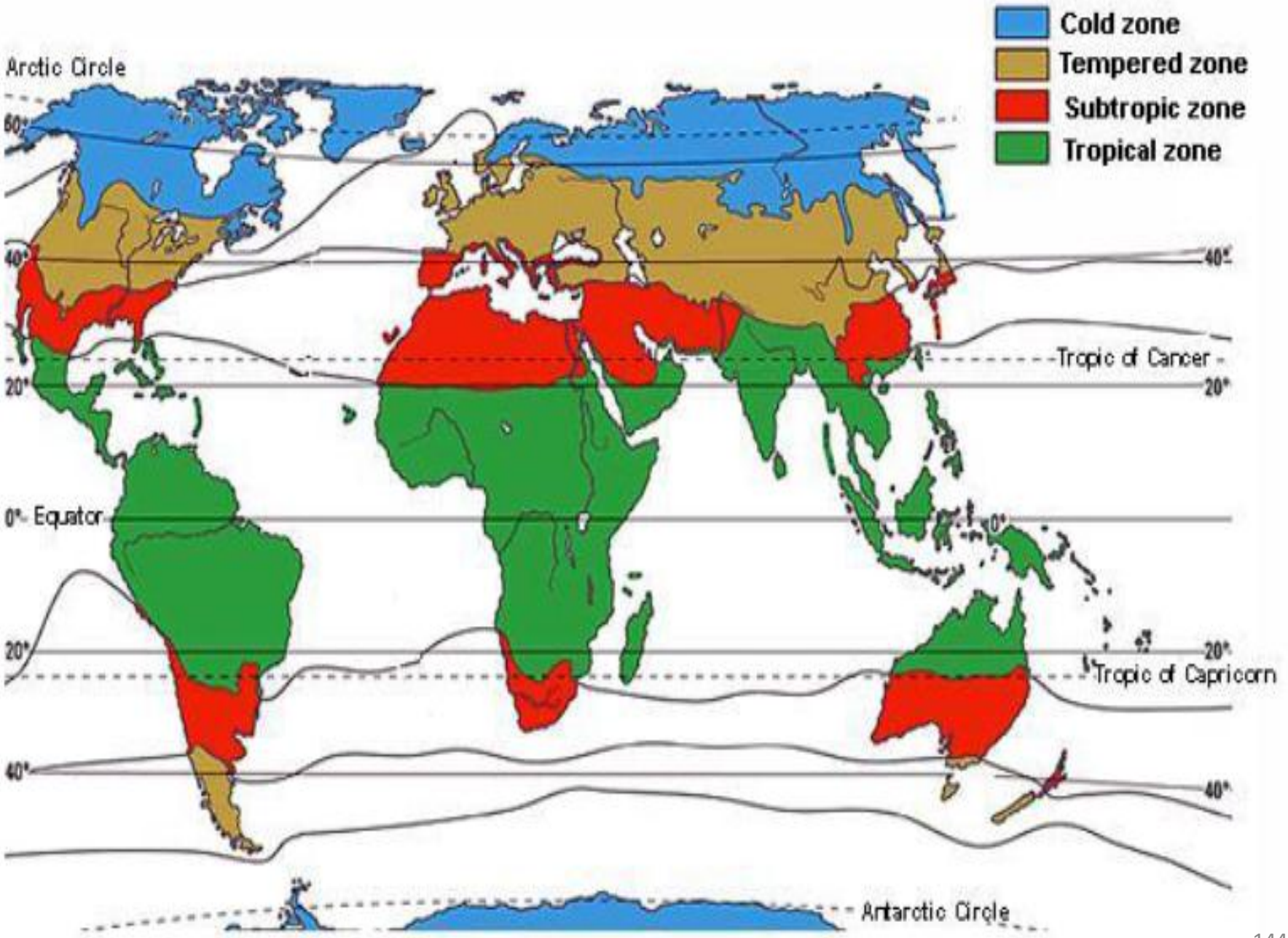


➢ TROPICAL ZONE **from 0°–23.5°(between the tropics)**

- In the regions between the equator and the tropics (equatorial region), the solar radiation reaches the ground nearly vertically at noontime during almost the entire year.
- Thereby, it is very warm in these regions. Through high temperatures, more water evaporates, and the air is often moist.
- The resulting frequent and dense cloud cover reduces the effect of solar radiation on ground temperature.

➢ SUBTROPICS **from 23.5°–40°**

The subtropics receive the highest radiation in summer, since the Sun's angle at noon is almost vertical to the Earth, whilst the cloud cover is relatively thin. These regions receive less moisture, what increases the effect of radiation. Therefore, most of the deserts in the world are situated in this zone. In winter, the radiation in these regions decreases significantly, and it can temporarily be very cool and moist.


Cold zone
Tempered zone
Subtropic zone
Tropical zone
Arctic Circle
60°
40°
20°
0° Equator
20°
40°
40°
20°
20°
40°
Tropic of Cancer
Tropic of Capricorn
Antarctic Circle

➢**TEMPERATE ZONE** from 40°–60°

- In the temperate zone, the solar radiation arrives with a smaller angle, and the average temperatures here are much cooler than in the subtropics. The seasons and daylength differ significantly in the course of a year. The climate is characterised by less frequent extremes, a more regular distribution of the precipitation over the year and a longer vegetation period - therefore the name "**temperate**".

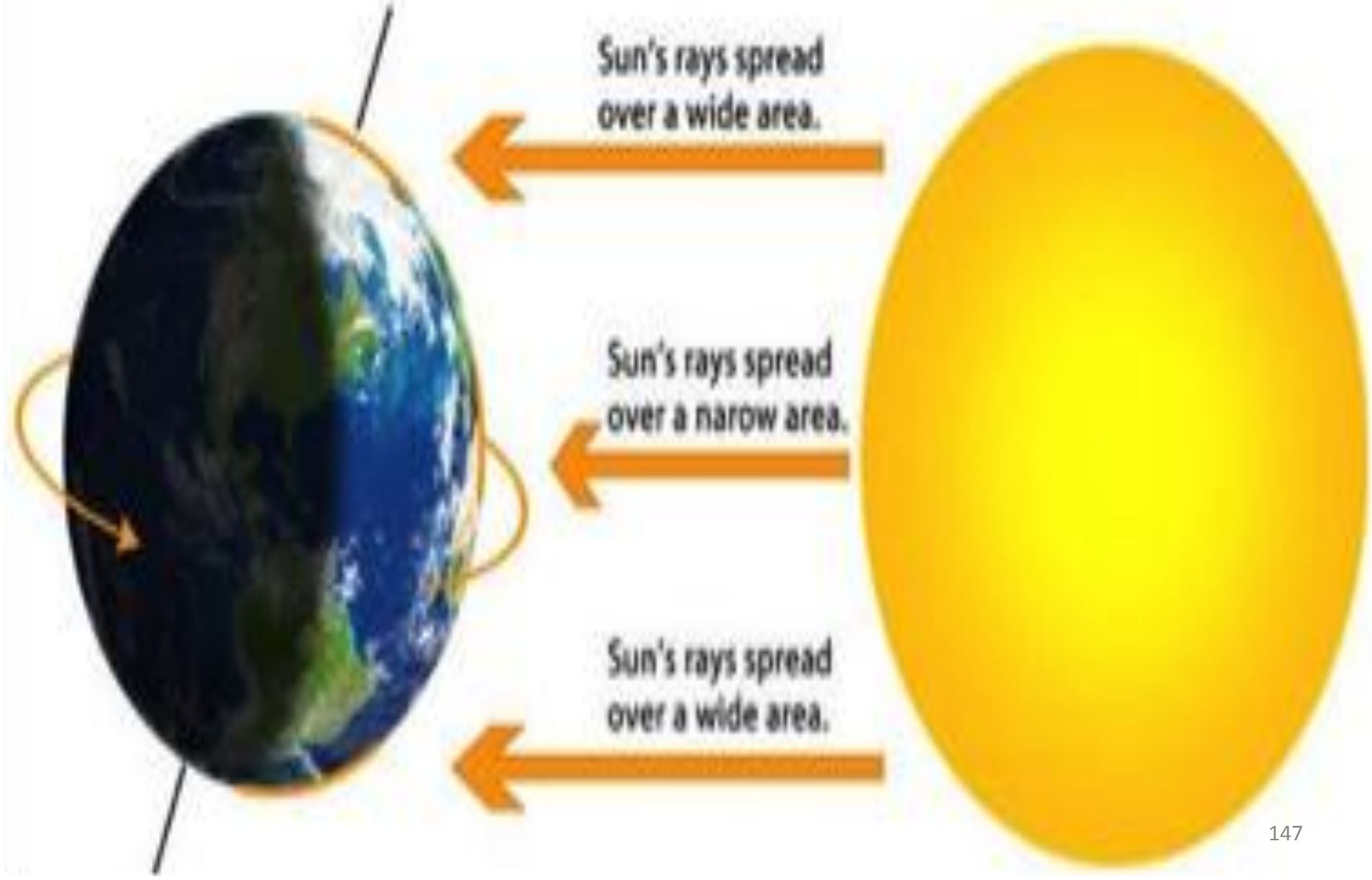
➢COLD ZONE (POLAR & SUBPOLAR)

from 60°–90°

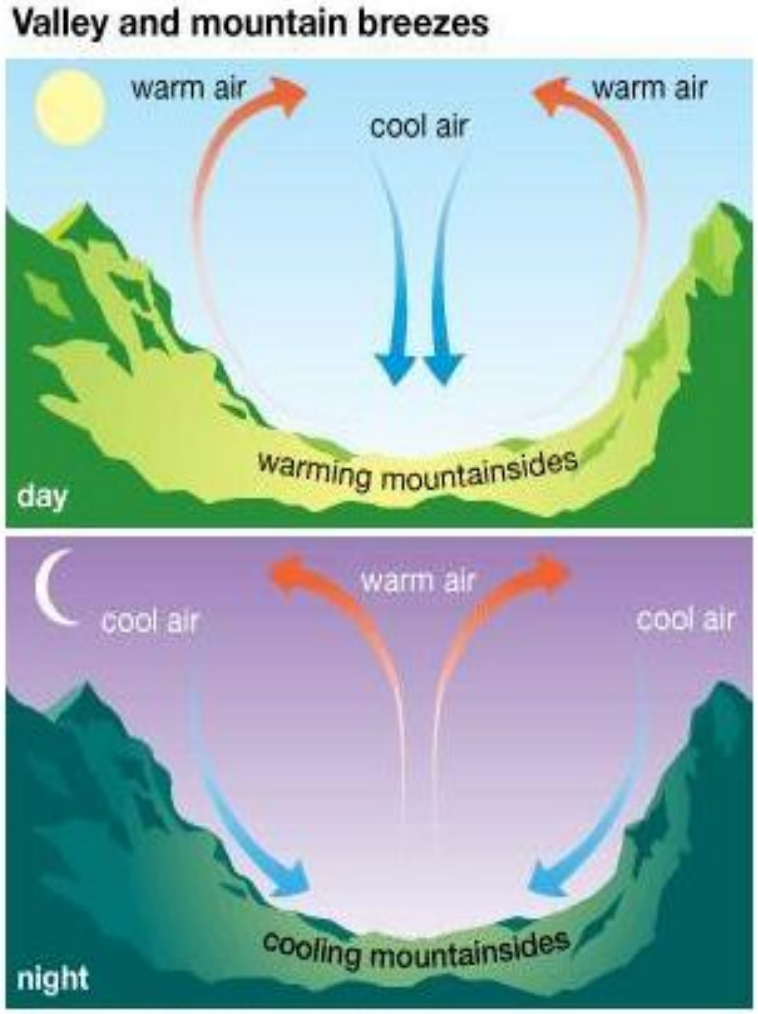
- The polar areas between 60° latitude and the poles receive less heat through solar radiation, since the Sun has a very flat angle toward the ground. Because of the changes of the Earth axis angle to the Sun, the day length varies most in this zone. In the summer, polar days occur. Vegetation is only possible during a few months per year and even then is often sparse. The conditions for life in these regions are very hard.

- The characteristics of the climate zones change with great altitude differences within a small area, like in mountain areas, since temperatures decrease rapidly with altitude, changing the climate compared to valleys.

The Sun's Rays and Latitude



Inversion of the Temperature

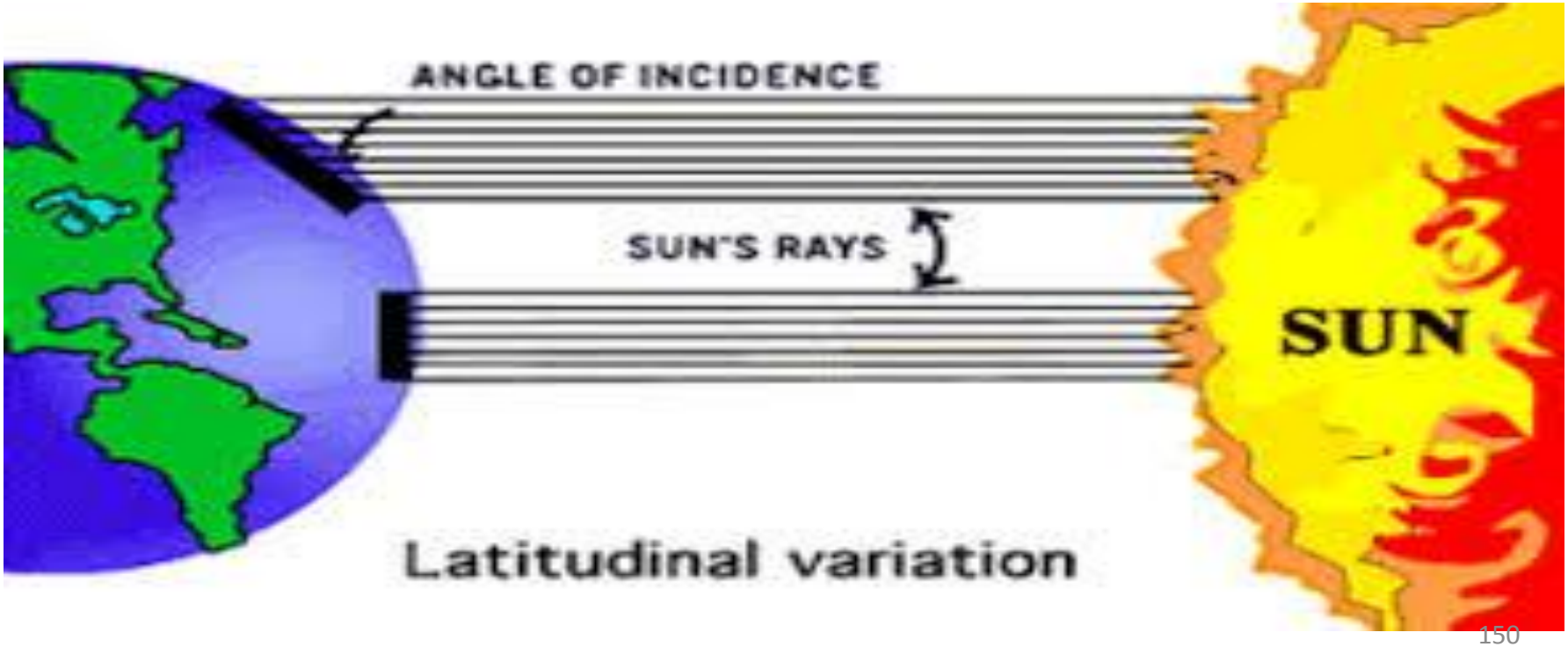


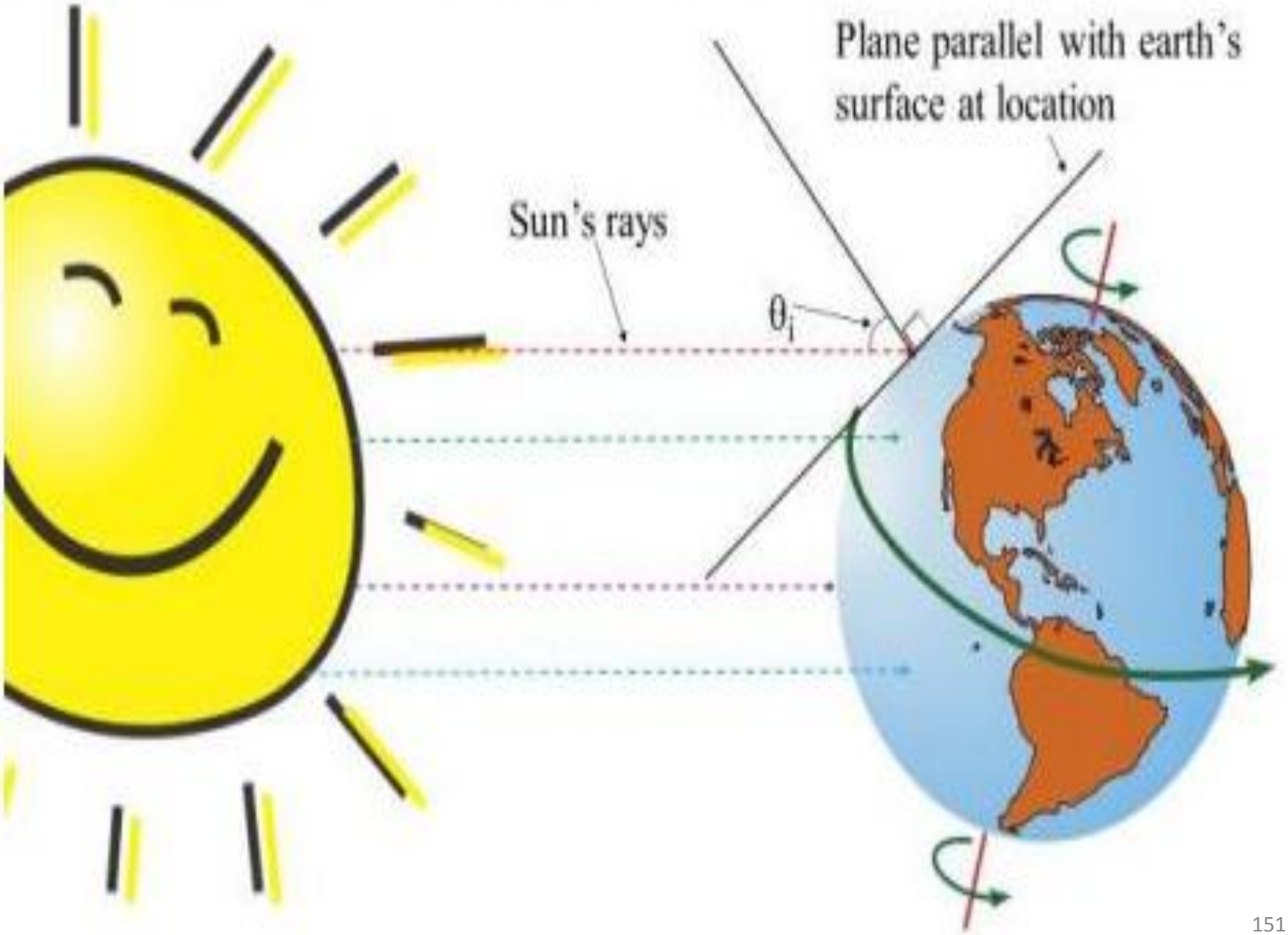
In the mountain valleys, the temperature of the air is found increasing with increasing altitude. Thus, there is an inversion of the temperature. This is because during the night, the quick radiation from the upper exposed slopes of the mountains causes the surface and air over it to cool rapidly. This cooler air is denser and gets drained by the valley slopes and displaces the warmer air toward up. Therefore, when we go up in a valley, the temperature seems to getting increased. This phenomenon is also called ***drainage inversion***.

Thermal Equator
also known as "the heat equator

- The highest absolute temperatures are recorded in the Tropics but the highest mean annual temperatures are recorded at equator.
- Earth reaches **perihelion** (the minimum distance from the Sun in its orbit) in early January and is at **aphelion** (maximum distance) in early July. During winter season of the respective hemispheres, the angle of incidence of the sun's rays is low in tropics. The average annual temperature of the tropical regions is therefore lower than the observed near the equator, as the change in the angle of incidence is minimum at equator.

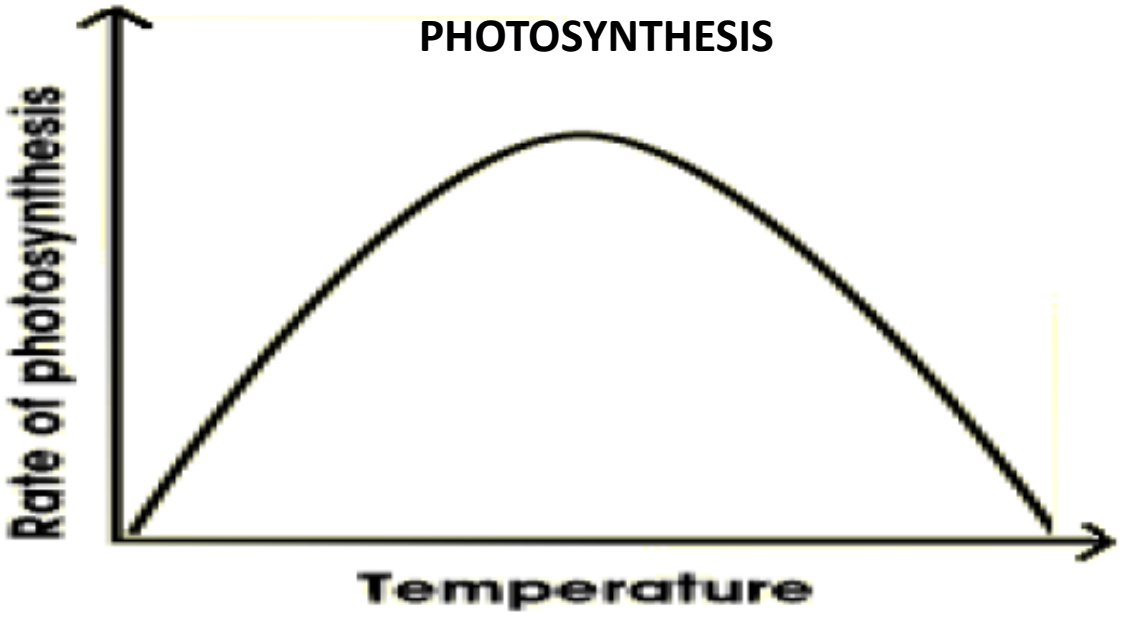
- The thermal equator shifts towards north and south with north south shift in the position of vertical rays of the sun. However, annual average position of the Thermal equator is 5° N latitude. The reason is that highest mean annual temperature shifts towards northwards during the summer solstice to a much greater extent than it does towards south at the time of winter solstice.




Plane parallel with earth's surface at location
Sun's rays
θ_i

Effect of temperature on plants

- There is an initial increase in the rate of photosynthesis at this temperature. But this is soon followed by a decline. Higher the temperature the more rapid is the decline.



The decline may be due to one or more of the following causes:

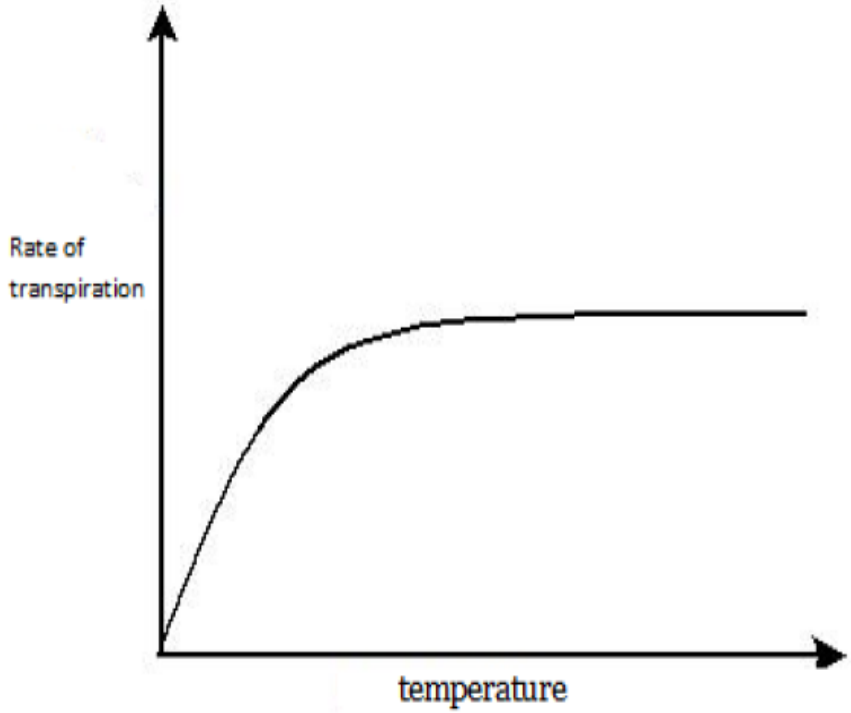
- Accumulation of the end products of photosynthesis.
- Inhibitory effect of high temperature on the activity of enzymes.
- Failure of carbon dioxide to diffuse rapidly.
- Increased consumption of the photosynthate in photo- respiration
- Destructive effect of high temperatures on chlorophyll.

Effect of Temperature on water absorption

- Low temperatures cause a decrease in the absorption and movement of water in plants. This reduction is less in species native to cool environments than in species which normally grow in warm ones. This has been attributed to the combined effects of decreased permeability of the root membranes and the increased viscosity of the water.
- **Kramer** observed that water flow through root systems increased as temperature was increased to 35 C, the highest temperature studied.

Effect of Temperature on water transpiration

- As the temperature increases, the water molecules gain تكتسب more energy. This means they move around more and therefore they evaporate and diffuse out of the leaf faster. This is why the rate of transpiration increases as the temperature increases.



Effect of Temperature on seed germination

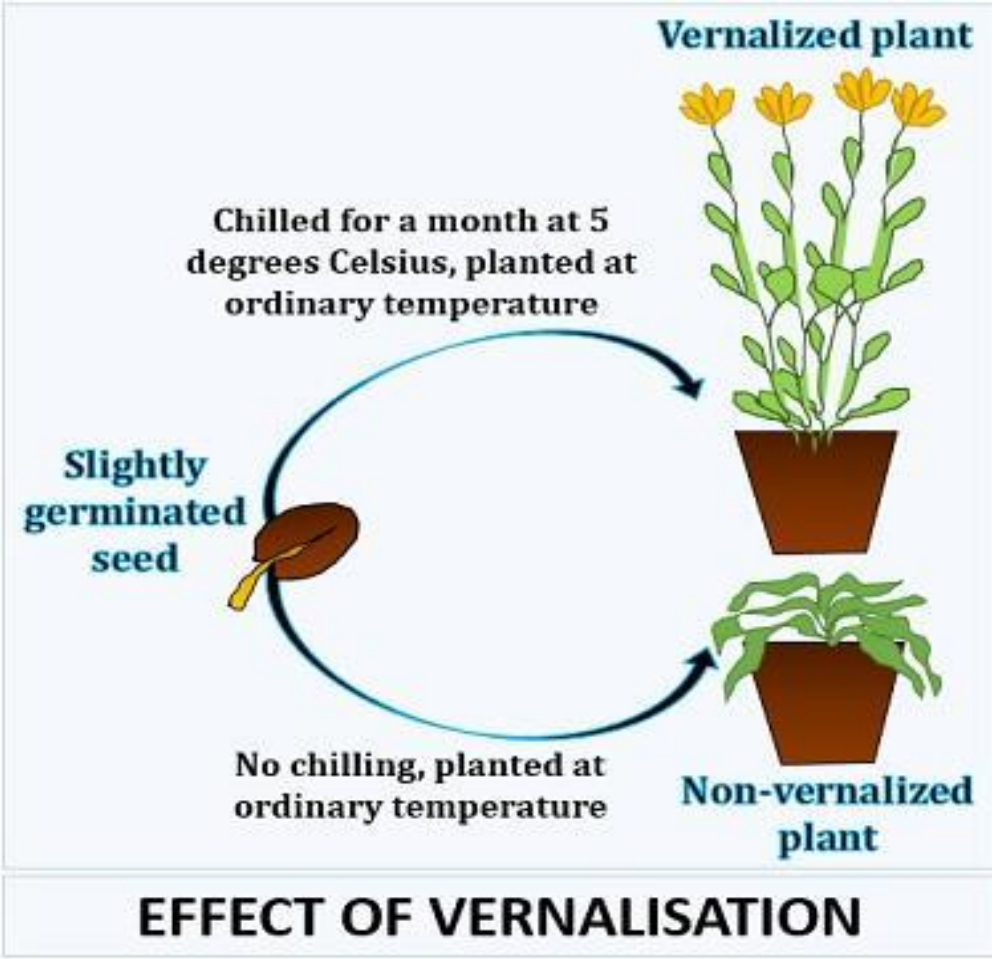
- Germination is a miraculous event حدث خارق that involves a number of factors that include air, water, light, and, of course, **temperature**. Germination increases in higher temperatures – up to a point الى حد ما. Once the seeds reach optimum temperatures, which depends on the plant, germination begins to decline.

Temperature affects germination in three primary ways:

moisture, hormone production, and enzyme activity. For seeds to germinate, they need to imbibe water. For this to occur, sufficient moisture must be present. A warmer climate may increase evaporation and decrease moisture, which would negatively affect germination.

Vernalization

- the artificial exposure of plants (or seeds) to low temperatures in order من اجل to stimulate flowering or to enhance seed production.



Cardinal temperatures

Minimum and **maximum** temperatures that define limits of growth and development of an plant, and an **optimum** temperature at which growth proceeds with greatest rapidity. Cardinal temperatures may vary with the stage of development

- These three temperature points are the cardinal temperatures for a given plant نبات معين; the cardinal temperatures are known for most plant species, at least approximately.

- **Cool-season** crops (oats, wheat and barley) have low cardinal temperatures: **minimum** 32° to 41° F (0° to 5° C), **optimum** 77° to 88° F (25° τo 31° C), and **maximum** 88° τo 99° F (31° to 37° C).
- For **hot-season** crops, such as melons and sorghum, the span of cardinal temperatures is much higher. The cardinal temperatures may vary with stage of development..

Cardinal Temperatures for Physiologic Processes:

- Cardinal temperatures differ for the same function in different plants.

For example, the minimal temperature for growth in melons, sorghums, and the date palm lie between 15 and 18°C, and the corresponding value القيمه المقابله for peas and wheat lie between -2 and 5°C.

- Certain arctic marine algae and the snow algae complete their life cycles in habitats where the temperature never rises above 0°C, whereas hot-spring algae may live in water as hot as 77°C. Because their evolutionary adaptation التكيف التطوري.

- Different functions of the same plant may have different cardinal temperatures.

the optimal temperature for photosynthesis is lower than the optimum for respiration.

In the white potato the rate of photosynthesis rises to a sharp maximum at about 20^{o}C, but respiration at this temperature is only 12% of its maximum rate. With an increase to 48^{o}c respiration reaches its optimum, but the photosynthetic rate has declined to zero.

- Various organs of the same plant may have different cardinal temperatures for the same function.

Roots, the temperature of which follows that of the soil' appear to have lower temperatures for growth than do shoots.

- In many plants of temperate regions, the roots continue growing is not frozen, although in general the roots of most plants in temperate climates become relatively inactive for at least a part of the winter.

- Cardinal temperatures vary also with the age of the plant, with its physiologic condition, with the duration of particular temperature levels, and with variations in other environmental factors.
- The temperature requirement of different functions at each stage of development must lie within the variations in temperature which prevail تسود the season corresponding to that stage of development.
- At each phase of development there is an optimum range which is most conductive to the harmonious interaction of all physiologic processes.

Beneficial (Stimulating) effect of Low Temperatures:

- Many plants native to cool and cold climates must each year undergo a rest period that is not enforced primarily المقام الاول by low temperatures. After growing vigorously for a time they become dormant even though external conditions remain favorable for growth.
- Ordinarily this dormancy is broken only by temperatures below about 5 to 8°C, the effect of short periods of exposure below this level being cumulative, yet susceptible of being nullified by subsequent high temperatures.
- Low temperatures are often necessary to stimulate the formation of flower buds.
- Certain plants need low temperature during germination in order to complete their life cycles quickly. For example, winter wheat sown in spring does not flower before the plants are subject to the following dry summer, but if soaked grains are subjected to a temperature just above freezing for a period, it can be sown in spring and a crop quickly produced.

- Since cold treatment is effective through promoting the formation of an essential metabolite. Thus, if seed wheat is moistened to 50 % of the dry weight, then chilled at 2°C for about two weeks, it can be dried again and sown many weeks later.
- ***Cold (Chilling) Injury and Frost (Freezing) Injury:-***
- The migration of plants from their ancestral اسلافها environment of the seas onto the land necessitated marked adaptation for enduring the wide variations in temperatures that characterized the newer environment.
- When temperature drops below the minimum for growth a plant' becomes dormant, even though respiration and sometimes photosynthesis slowly continue.
- Chlorosis may result from such chilling.
- With further loss of heat a point is usually attained below which the protoplasm is fatal injured

- Molisch (1897) has called low temperature damage, in the absence of freezing, "Chilling Injury" as opposed to "Frost Injury" caused by freezing.
- Three main phenomena involved in killing by low temperature:
- A-proteins may be precipitated directly, especially in plants that are killed before temperatures drop to the freezing point of water.
- b-At lower temperatures, intercellular ice forms, drawing water out of the protoplasts. This causes a dehydration Also, when the ice crystals melt rapidly the cell walls may expand more rapidly than the protoplasts can swell, and thus may tear التمزيق the two apart.

C- Rapid freezing causes ice to form within the protoplasts. This ice formation is fatal because crystal growth disrupts protoplasmic organization.

- The ability of plants to endure تحمل low-temperature extremes varies widely among species.
- Certain plants of tropical affinity such as cotton, sudan-grass etc. are injured to exposure by temperatures which are low but yet above the freezing point (5^{o}C).
- Other plants are not injured until they are frozen; still others native to cold climates can endure periods when the tissues are frozen solidly and the temperature drops to -62^{o}C.

- وعادة ما تكمن درجة التجمد في سائل النبات، بسبب محتواه من الذائبات، عدة درجات تحت الصفر، ولكن بعض النباتات، ومعظمها cryptogams والبذور، لا يمكن تجميدها في أي درجة حرارة (حتى -٢٧٠ وهذه هي في مأمن من الإصابة بدرجة الحرارة المنخفضة.

- The freezing point of plant sap, because of its solute content, usually lies several degrees below 0°c, but certain plants, mostly cryptogams and seeds, cannot be frozen at any temperature (even -270°C) and these are immune to low temperature injury.

- A plant is not equally resistant to low temperatures at all stages of its life cycle. Seeds and spores are the most resistant stages.

- Among trees seedlings are commonly more sensitive to cold than older plants, but with grasses the relationship may be reversed.
- Even for the same plant, the frost killing temperature may vary widely with the manner of the temperature change, the season and the physiological state of the plant.
- Killing may occur at higher temperatures if the freezing is rapid, rather than gradual.

- Greater injury to the plant may occur after long continued freezing than that after short freezing periods at the same temperature.
- Freezing- some plants that survive the cold in winter may be killed by a very slight freezing during spring.

TYPES OF ECOSYSTEMS

Ecosystems can be classified to terrestrial or aquatic.

- ***Aquatic ecosystem***

An aquatic ecosystem is an ecosystem in a body of water. Communities of organisms that are dependent on each other and on their environment. The two main types of aquatic ecosystems are

1- marine ecosystems

2-freshwater ecosystems.

- ***Terrestrial ecosystems***

Terrestrial ecosystems are found on land. There are main types of terrestrial ecosystem:

1-tundra, 2-**taiga**, 3-**temperate deciduous forest**, 4-**grassland**, 5-**desert** 6-**tropical forest**.

1- Tundra

- Tundra is an ecosystem found at very high northern latitudes, such as northern Canada, Greenland, and Siberia (Fig. 2). This ecosystem marks a point called **the tree line** because **this is where it gets so cold** and there is such **minimal sunlight** that tree growth is severely hindered.
- لأن هذا هو المكان الذي يصبح فيه الجو باردًا جدًا وهناك حد أدنى من ضوء الشمس بحيث يتم إعاقة نمو الشجرة بشدة.

Fig. 2: The tundra ecosystem

2- Taiga غابة صنوبر سبخة

Taiga is suitable to tree growth because it is lower in latitude, but it is still fairly cold لكنه لا يزال باردًا إلى حد ما . It is also found in **northern latitudes** خطوط العرض الشمالية, and **is the largest terrestrial ecosystem on Earth**. As shown in Fig. 3, the types of trees you would likely find here are **conifers (Christmas trees)**. .أشجار صنوبرية (أشجار عيد الميلاد)

- Fig 3: Taiga ecosystem

3- Temperate deciduous forests

- **Means trees that lose their leaves every year**. These are trees that turn beautiful colors of **red**, **yellow**, and **orange** in **the fall** في الخريفbefore dropping those leaves for the winter. This type of ecosystem is found **in latitudes lower than the taiga**, and is where we start seeing alternating seasonal changes such as **warm summers** and **cold winters**.
- حيث نبدأ في رؤية التغيرات الموسمية المتناوبة مثل الصيف الدافئ والشتاء البارد.

4- Grassland ecosystems

- Grasslands are areas where **the vegetation is dominated by grasses (Poaceae),**. Grasslands are found in most ecoregions of the Earth. توجد الأراضي العشبية في معظم المناطق البيئية من الأرض.

4- Desert ecosystem

- These are harsh قاسية ecosystems with poor soil. The most important adaptations of organisms involve the scarcity of water ندرة المياه. Where **less than 10 inches** of rain fall a year
- ***Rainforests*** الغابات الاستوائية المطيرة
- Rainforests (Tropical Forest Ecosystems) are **thought to be the oldest ecosystem on earth** (some as old as 100 million years), accounting for the greatest diversity of plants and animals.

5- Tropical rainforests exist in **three major global areas** ثلاث مناطق عالمية رئيسية: **Central & South America**, **Africa and Indo-Malaysia**.They are rainforests, averaging between بمتوسط يتراوح 125 to 660 cm of rainfall annually.

Fig. 4: The evergreen broad leaf tropical forest (Rain forest).

- ***Temperature and plant diseases:***
- **The ability of a parasitic fungus** to gain entrance into a host organism is **often strongly by temperature**. **For example**, at temperatures **below 13ºC** the seedlings of most strains of maize become **very susceptible to disease** whereas **flax** becomes susceptible to ***Fusarium*** at **temperatures above 14ºC**. Host plants commonly extend into climates where **temperature restricts their parasites** and **it is often possible to subject a diseased plant** to temperatures lethal only to its parasites. تمتد النباتات (العائل) عادةً في المناخات حيث تقيد درجة الحرارة الطفيليات الخاصة بها وغالبًا ما يكون من الممكن إخضاع النبات المصاب لدرجات حرارة مميتة فقط لطفيلياته.

- ***Temperature and Transpiration:***
- Transpiration, which is **the loss of water vapour from the plant leaves through the stomata**, **increases directly with the magnitude** حجم **of the difference in temperature between the leaf surface and the adjacent air**. Temperature also changes the ratio of cuticular to stomatal transpiration.
- **The higher the temperature the greater cuticular transpiration is**. Thus, at a temperature of 49°C the nocturnal (night time) rate of transpiration in ***Helianthus annuus*** was observed to rise to 91% of the diurnal (day time) rate, even though the stomata remained closed at night.

• WATER

- **Characteristics of Water**
- Water on the surface of **the globe** is present under its three physical states: solid, liquid and gaseous.
- **Water and Life on Earth**
- **The human body consists of 65% of water for an adult, 75% for new-born babies** and **94% for embryos of 3 days.**
- **The electrical properties of the water dipole give to water some specificities allowing life on Earth:**
- **high temperature stability of liquid form of water: water evaporates with difficulty. The temperature range where the water is liquid is great;**
- **solvent characteristic allow a very large number of biochemical reactions occur;**

- **high surface tension** allows **the phenomenon of capillarity which** allows, among other things, **the rising of plants sap** and **moving of many beings live on the surface of the water.**
- **Chemical characteristics of water**
- The water molecule is a **polar molecule** or dipole.
- **Others important characteristics follow** this character, such as **hydrogen bonding** and **solvant characteristic**.

- **Hydrogen bonding**
- The polarity of water means that water molecules **attract** each other. **The positive side of one attracting the negative side of another.** Such **a power** link between two molecules is **called hydrogen bonding**. **A water molecule can create up to 4 hydrogen bonds.**
- **Universal solvent**
- **A solvent is a liquid which has the property to dissolve and dilute other substances without change chemically and without modification for itself**. **Water is the most common solvent**. It dissolves large numbers ions, mineral salts as well as some substances formed of polar molecules. **A number of vital substances are transported by water through the human body or plants.**

- **Finally,** during its journey, **it laundry (cleans) soils, draining all soluble toxic substances that it encounters, as from nitrate fertilizers, thus becoming a real vector of pollution.**
- **Thermal agitation**
- **When thermal energy is no longer sufficient, the molecules are beginning** to **bind to each other**. They combine to **form liquid water drops that fall under their weight.** When **liquid water cools down**, the thermal agitation of **the molecules still gradually decreases**. **The bonding stiff to become almost straight**. Water molecules then **formed a highly organized rigid structure**. **The water turns into ice**.

- **Ice floats on the water**
- **The fact that the density of water is greatest at liquid state than solid state** has a remarkable result: **ice floats on liquid water**. In addition, **the fact that the density of fresh water is maximum at 4 ° C** is **that the temperature at the bottom of a Lake** does not descend **below 4 ° C** (except in extreme cases). **This allows the aquatic life to survive ice periods because water will remain liquid under an insulating coat of ice.**

- **Water inertia**
- **Vaporization and fusion heat** are very high and are **due to the energy required to break the hydrogen bonds** between molecules of water. These quantities of energy **include** high stability of the temperature of the water. It is also known as **inertia** that has an essential biological meaning: **important biochemical reactions** usually **occur between narrow temperature ranges.** **FEATURE OF WATER IN THE NATURE**
- **Humidity**
- **Humidity** is **the amount of water vapor present in the air.** **Water vapor** is **the gaseous state of water and is invisible**.
- Humidity indicates the probability **of precipitation** , dew , or fog.

- **Higher humidity reduces the effectiveness of sweating** in cooling the body by reducing the rate of evaporation of moisture from the skin.
- **The amount of water vapor that is needed to achieve saturation increases** as **the temperature increases**
- **There are three main measurements of humidity: absolute, relative and specific**.
- **Absolute humidity** is **the water content of air at a given temperature expressed in gram per cubic meter.**
- **Relative humidity**, **expressed as a percent, measures the current absolute humidity relative to the maximum (highest point) for that temperature.**

- **Specific humidity** is **the ratio of the mass of water vapor to the total mass of the moist air.**
- Relative humidity (RH) is the amount of water vapor in the air at any given time is usually less than that required to saturate the air. The relative humidity is the percent of saturation humidity, generally calculated in relation to saturated vapor density.
- **Relative humidity**=actual vapor density x 100
- saturated vapor density
- The most common units for vapor density are gm/m^3

- **Fog**
- **Fog consists of visible cloud water droplets or ice crystals suspended in the air near the Earth's surface.**
- **, fog has affected many human activities, such as shipping, travel, and warfare.**
- **Fog occurs** at **a relative humidity near 100%**.
- **However**, **fog can form at lower humidities, and can sometimes fail to form with relative humidity at 100%. At 100% relative humidity**, the air cannot hold additional moisture, thus, the air will become **supersaturated** if additional moisture is added.
-

- **Fog can form suddenly**. The sudden formation of fog is **known as "flash fog".**
- **Fog produces precipitation in the form of drizzle or very light snow Drizzle occurs when the humidity of fog reaches 100% and the minute cloud droplets begin to coalesce into larger droplets**.
- **Drizzle becomes freezing drizzle when the temperature at the surface drops below the freezing point.**

Dew

- **Dew is water in the form of droplets that appears on thin**, exposed objects in the morning or evening due to condensation. **When temperatures are low enough, dew takes the form of ice; this form is called frost.**
- **Dew should not be confused** with guttation, which is the process by which plants release excess water from the tips of their leaves.
- **Water vapor will condense into droplets depending on the temperature**.
- **The temperature at which droplets form is called the dew point**.
- **Dew is usually formed at night.**

- **Cloud**
- On Earth, clouds are formed by the saturation of air in the homosphere (which includes the troposphere, stratosphere, and mesosphere).
- The air may be cooled to its dew point by a variety of atmospheric processes or it may gain moisture (usually in the form of water vapor) from an adjacent source.
    - على الأرض ، تتكون السحب من تشبع الهواء في الغلاف الجوي المتجانس (الذي يشمل طبقة التروبوسفير والستراتوسفير والميزوسفير).يمكن تبريد الهواء إلى نقطة الندى من خلال مجموعة متنوعة من العمليات الجوية أو قد يكتسب الرطوبة (عادة في شكل بخار الماء) من مصدر مجاور.
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- **Rain**
- **Rain is liquid water in the form** of **droplets that have condensed** from **atmospheric water vapor and then precipitated** that is, **become heavy enough to fall under gravity. Rain is a major component of the water cycle and is responsible for depositing most of the fresh water on the Earth.** It provides suitable conditions for many types of ecosystems and crop irrigation.
- **Rainfall** is **measured using rain gauges. Rainfall amounts** can be **estimated by weather radar.**

- Rain may be composed of methane, neon, sulfuric acid, or even iron rather than water.
- **Factors affecting precipitation**
- Different areas of the Earth's surface receive different amounts of precipitation.
- **Latitude**: it rain more in the areas near the equator than in the temperature zones and polar regions. **The temperature is higher near the Equator so there is more evaporation**.
- **Altitude**: it rains more in high areas than in low areas.
- **Level of humidity: it rains more on the coast than inland**. **Seas are a source of humidity.**

- **Water cycle**
- **The water cycle renews our valuable water supply on Earth.** We have kept **the same amount of water on Earth as solid ice, liquid rain and gaseous water vapor throughout time. It continually cycles and moves from the ocean, rivers, lakes, wetlands, snow, underground aquifers and water vapor in the clouds.**
- **The water cycle is driven by the sun**, which evaporates the water **on Earth to rise as vapor**. It then **cycles back to earth** as **rain or snow** and starts all over again. To follow **the water cycle you can start in the ocean**, which **stores more than 95%** of the Earth's water.

- 1) Water, **heated by the sun**, **evaporates up from the ocean and other waterways** to **form clouds** in the sky. **Some water evaporates from plants (*transpiration*)** and a **small amount evaporates directly from glacial ice (*sublimation*)**. Without this **vital cycle**, there **would not be life on Earth as we know it.**
- 2) **The clouds gather all the tiny water droplets** together until **they are big enough to fall as rain or snow**. **This is *precipitation***. **Precipitation falls much more in warm tropical places than in deserts**. **In colder places precipitation falls as snow.**
- 3) **When rain falls on land**, it **soaks into the groundwater** and **runs into rivers and streams, on their way to the ocean. Here the cycle starts all over again!**

- **SOIL MOISTURE**
- **Soil moisture content**
- **The soil moisture** content **indicates the amount of water present in the soil.**
- It is expressed as **the amount of water present in a depth of one meter of soil.** For example: when **an amount of water of 150 mm** is present in a depth of one meter of soil, **the soil moisture content is 150 mm/m**

- **The soil moisture content** can also be **expressed in percent of volume.**
- **Note: The amount of water stored** in **the soil is not constant with time,** but **may vary.**
- **Saturation**
- During a rain shower or irrigation application, the soil pores will fill with water. If all soil pores are filled with water the soil is said to be saturated. There is no air left in the soil. Plants **need air and water** in the soil. **At saturation**, no air is present and the plant **will suffer**.

- **Many crops cannot endure saturated soil conditions for a period of more than 2-5 days. Rice is one** of the exceptions to this rule.
- **After the rain or the irrigation has stopped, part of the water present in the larger pores will move downward. This process is called drainage or percolation.**
- **The water drained from the pores is replaced by air. In coarse textured** (sandy) soils, drainage is completed within a period of **a few hours**. **In fine textured (clay) soils, drainage may take some (2-3) days.**
-

- **Field capacity**
- **After the drainage has stopped, the large soil pores are filled with both air and water**. At this stage, **the soil is said to be at field capacity**.
- **At field capacity, the water and air contents of the soil are considered to be ideal for crop growth.**
- ***Permanent wilting point***
- Little by little, the water stored in the soil is taken up by the plant roots or evaporated from the topsoil into the atmosphere. If no additional water is supplied to the soil, **it gradually dries out**.
- **The dryer the soil becomes, the more tightly the remaining water is retained and the more difficult it is for the plant roots to extract it.**
-

- At a certain stage, **the uptake of water is not sufficient to meet the plant's needs. The plant looses freshness and wilts**; **the leaves change colour from green to yellow. Finally the plant dies**.
- **The soil water content at the stage where the plant dies, is called permanent wilting point.**
- **The soil still contains some water, but** it is too difficult for the roots to suck it from the soil .

- **When the soil reaches permanent wilting point**, the remaining water **is no longer available to the plant.**
- **The amount of water actually available to the plant** is **the amount of water stored in the soil at field capacity** minus **the water that will remain in the soil at permanent wilting point**. This is illustrated in.
- **Available water content = water content at field capacity - water content at permanent wilting point**
-

- **The available water content depends** on **the soil texture and structure**.
- A range of values for different types of soil is given as following. **Soil Available water content in mm water depth per m soil depth (mm/m)**
- **sand** 25 to 100
- **loam** 100 to 175
- **clay** 175 to 250
- **The field capacity, permanent wilting point (PWP)** and **available water content** are **called the soil moisture characteristics**. **They are constant for a given soil**, but **vary widely from one type of soil to another.**

- **Groundwater table**
- **Part of the water applied to the soil surface drains below the rootzone and feeds deeper soil layers which are permanently saturated**; **the top of the saturated layer is called groundwater table** or sometimes just **water table**.
- **Depth of the groundwater table**
- **It varies from** place to place, due to **changes in topography of the area.**
- After heavy rainfall or irrigation, the groundwater table rises. **It may even reach and saturate the rootzone**. If prolonged, this situation can be **disastrous for crops which cannot resist "wet feet"** for **a long period**. Where the groundwater table appears at the surface, **it is called an open groundwater table**. This is the case in **swampy areas.**

- **Capillary rise**
- **The groundwater can be sucked upward by the soil** through **very small pores that are called capillars.** This process is **called capillary rise**.
- **In fine textured soil** (clay), **the upward movement of water is slow** but **covers a long distance.** On the other hand, **in coarse textured soil (sand)**, **the upward movement of the water is quick** but **covers only a short distance**.
- **Soil texture** **Capillary rise (in cm)**
- **coarse (sand)** 20 to 50 cm
- **medium** 50 to 80 cm
- **fine (clay)** more than 80 cm up to several metres

- IMPORTANCE OF WATER TO PLANTS
- **Water is important for plants <u>because of the following reasons:</u>**
- Water helps in the germination of seeds.
- Water helps in the process of photosynthesis by which plants prepare their food.
- Water helps in the transport of nutrients and minerals from the soil to the plants.
- Water helps in the maintenance of the plant structure by providing the turgor pressure توفير ضغط التمزقto the plant tissues
- <u>Water provides habitat in</u> the form of ponds, rivers, lakes and sea <u>for a large number of plants</u>.
-

Classification of plant according to water conditions

1- Hydrophytes

- **Hydrophytes** are plants that have adapted to life in very wet places في الأماكن شديدة الرطوبة.
- Hydrophytes have little to no root system, **because roots simply** aren't as necessary - **water is so readily available**.
- **Most leaves in hydrophytes are thin**, and can float freely. **The stomata**, are located only on the part of the plant surface that is exposed to air.

2- Mesophytes

- **Mesophytes** include plants like tulips, and grasses.

- **Mesophytes** are **plants that are able to grow and thrive** تزهر **under average conditions**.
- Mesophytes are the plants with developed root systems, They have leaves with their stomatas located on their lower surfaces for gas exchange.

3- Xerophytes

- Xerophytes are plants that have adapted to grow in locations **that receive very little water like deserts or Arctic habitats** .For example of a xerophyte is the **cactus** الصبار.
- **These plants develop** long, deep root systems, whose primary purpose is to search out water.
- leaves, or needles instead of leaves **because they require less water to maintain their structure. Many have waxy textures**, which **help to prevent water loss through evaporation.**

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