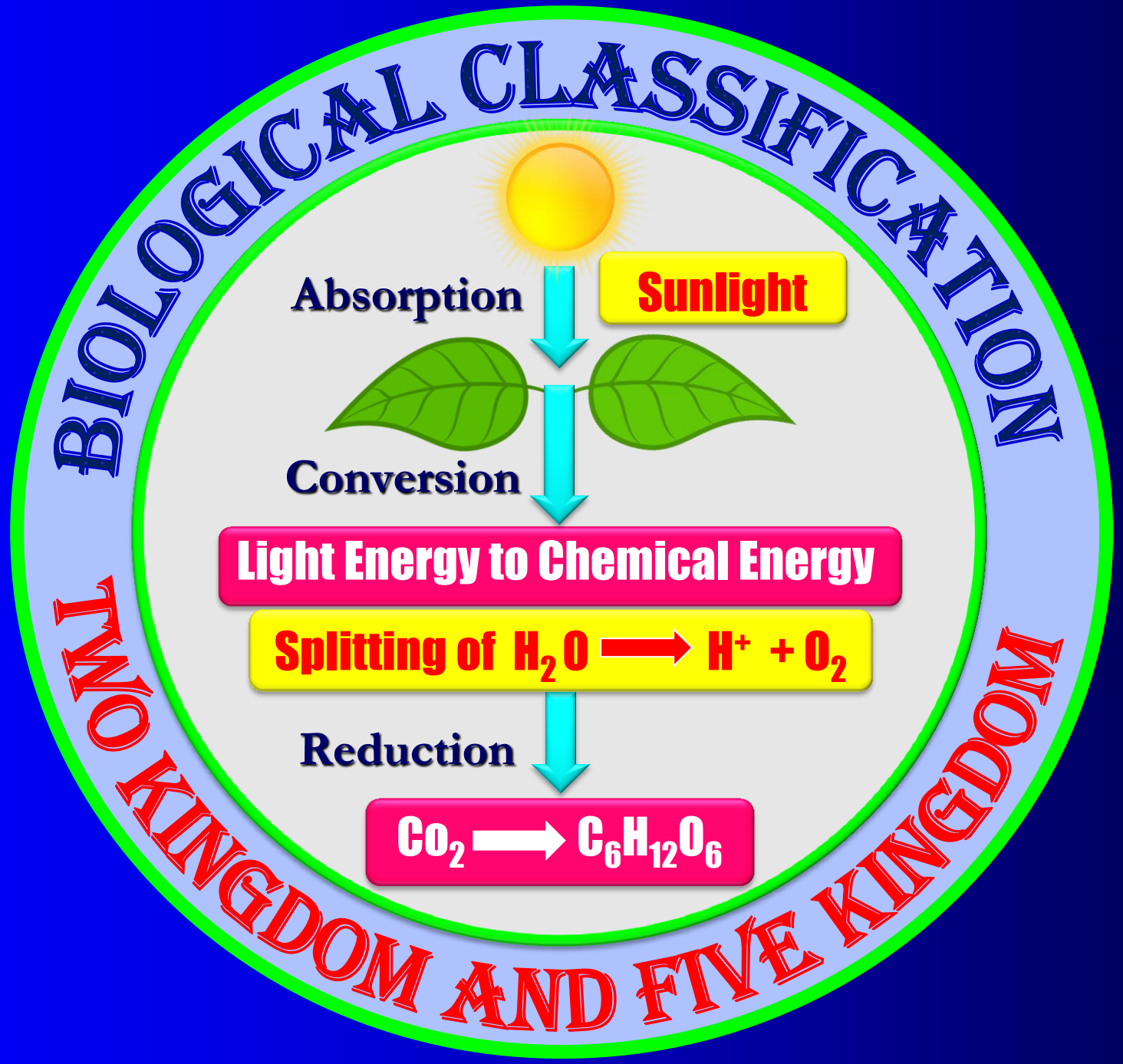
BIOLOGICAL CLASSIFICATION



TWO KINGDOM AND FIVE KINGDOM MODEL

The earliest system of classification

Aristotle was the earliest to attempt a more scientific basis for classification.

He used simple morphological characters to classify plants into **trees, shrubs and herbs.**

He also divided animals into two groups, those which had red blood and those that did not.

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Two kingdom system

In Linnaeus' time a Two **Kingdom** system of classification with **Plantae** and **Animalia.**

It included all plants *and Lichens* and animals respectively.

This system did not distinguish between the prokaryotes and eukaryotes,

unicellular and multicellular organisms and

photosynthetic (green algae) and non-photosynthetic (fungi) organisms.

Hence the two kingdom classification used for a long time was found inadequate.

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The demerits of two kingdom system

1. Prokaryotes and Eukaryotes have been placed together.
   E.g.. Prokaryotic bacteria and **eukaryotic** blue green algae were placed together.

2. Unicellular and Muticellular organisms were placed together.
   E.g. Chlamydomonas and *Spirogyra* were placed together under algae.

3. Autotrophs and heterotrophs were placed together.
   E.g. Green plants and fungi were placed together.

4. Primitive organisms were placed with advanced organisms.
   E.g. Protozoans and bacteria were placed with higher animals.

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The five kingdom system

R.H. Whittaker (1969) proposed the Five Kingdom system of Classification.

The five kingdoms were named

- **Monera**
- **Protista**
- **Fungi**
- **Plantae**
- **Animalia**

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The five kingdom system

Cell structure	Prokaryotic/ Eukaryotic
Thallus organization	Unicellular/ Multicellular
Mode of nutrition	Autotrophic/ Heterotrophic
Reproduction	Sexual/ Asexual
Phylogenetic relationships	Evolutionary history

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Demerits of five kingdom system

Five kingdom system **placed together groups which widely differed in other characteristics.**

It brought together the **prokaryotic** bacteria and the blue green algae with other groups which were **eukaryotic.**

It also grouped together the **unicellular organisms and the multicellular** ones, for example, *Chlamydomonas* and *Spirogyra* were placed together under algae.

The classification did not differentiate between the **heterotrophic group - fungi**, and the **autotrophic green plants,** though they also showed a characteristic difference in their walls composition - the fungi had chitin in their walls while the green plants had a cellulosic cell wall.

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The five kingdom system

Monera

Bacteria are the sole members of the Kingdom Monera.

They are the most abundant micro-organisms.

Bacteria occur almost everywhere. Hundreds of bacteria are present in a handful of soil.

They also live in extreme habitats such as hot springs, deserts, snow and deep oceans where very few other life forms can survive.

Many of them live in or on other organisms as parasites.

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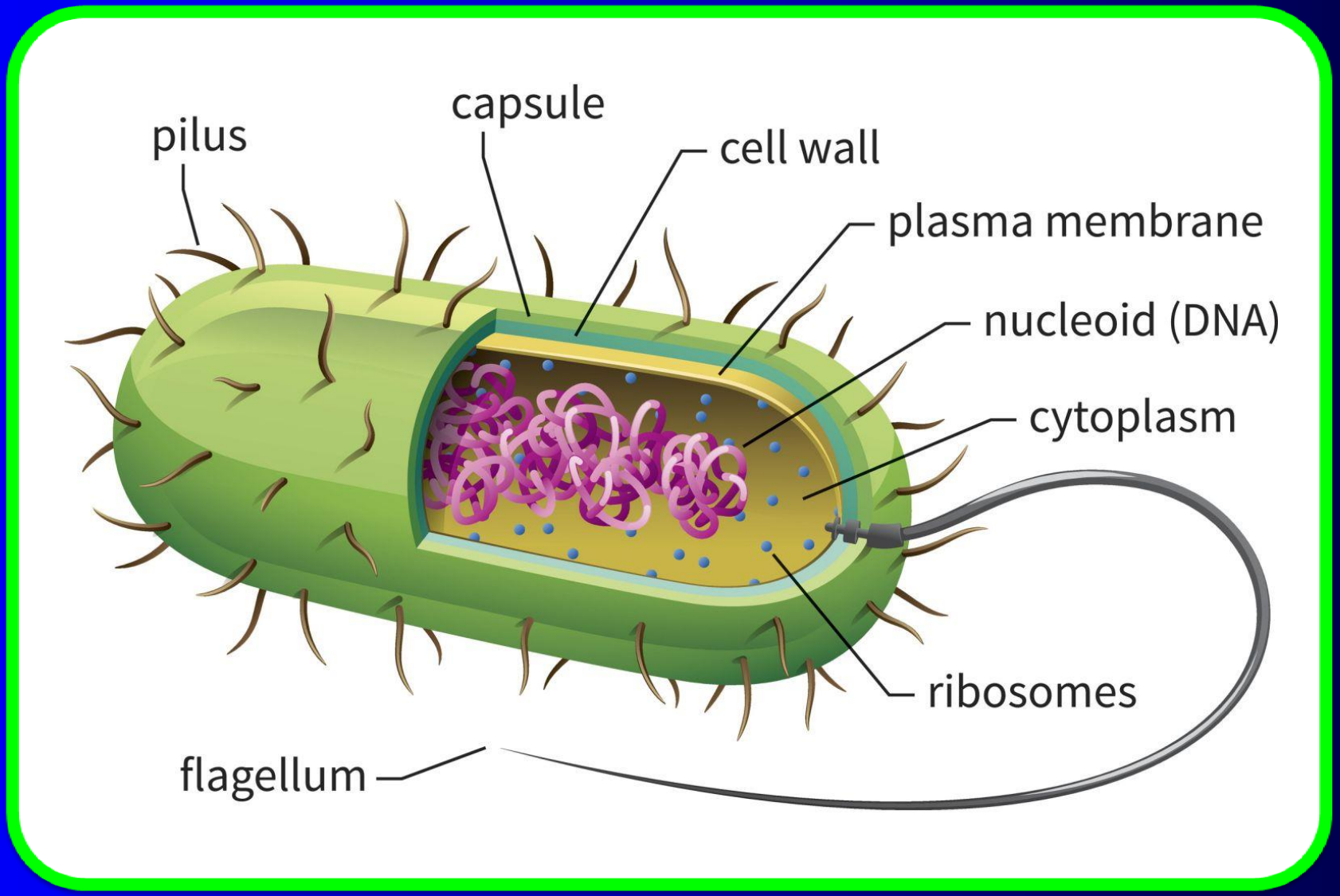
Prokaryotic Cell



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Classification of Bacteria based on their shape

Shape of bacteria	Example
Spherical Coccus	Streptococcus
Rod-shaped Bacillus	Streptobacillus
Spiral Spirillum	Rhodospirillum
Comma-shaped Vibrium	Vibrio cholerae

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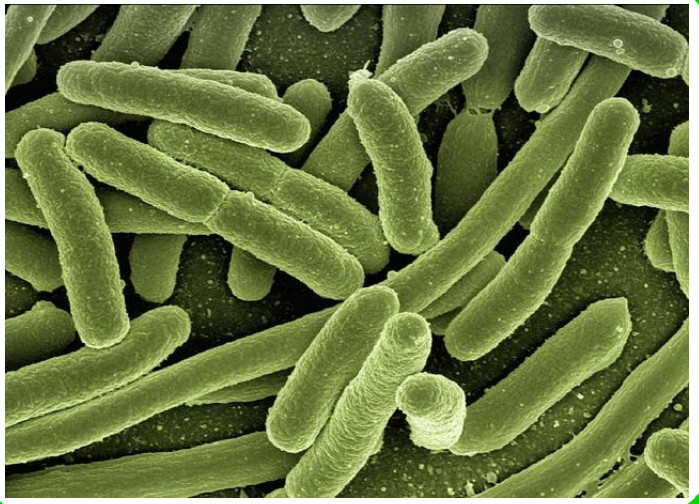
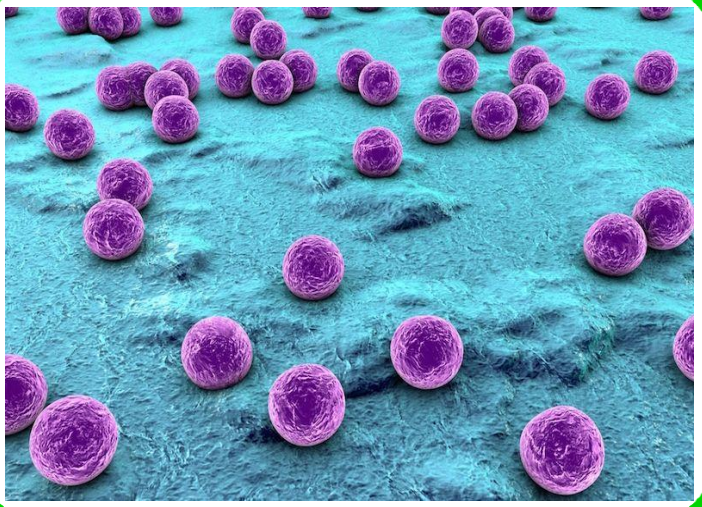
Rod Shaped

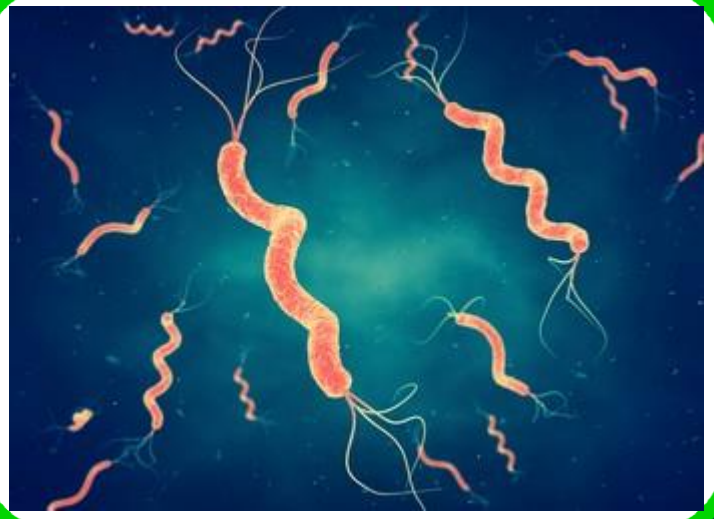


Spherical



Comma Shaped

Spiral Shaped



Bacteria are Unicellular

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Archaebacteria

These bacteria are special since they live in some of the harshest habitats

Extreme salty areas	**Halophiles**
Hot springs	**Thermoacidophiles**
Marshy areas	**Methanogens**

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Eubacteria

There are thousands of different **eubacteria** or ‘true bacteria’.

They are characterised by the presence of a **rigid cell wall**.

1. Photosynthetic Autotrophs

The cyanobacteria (also referred to as blue-green algae) have chlorophyll-a similar to green plants and are **photosynthetic autotrophs**.

The cyanobacteria are unicellular, colonial or filamentous, marine or terrestrial algae.

The colonies are surrounded by gelatinous sheath.

They often form blooms in polluted water bodies.

Some of these organisms can fix atmospheric nitrogen in specialised cells called **heterocysts,** e.g., *Nostoc* and *Anabaena*.

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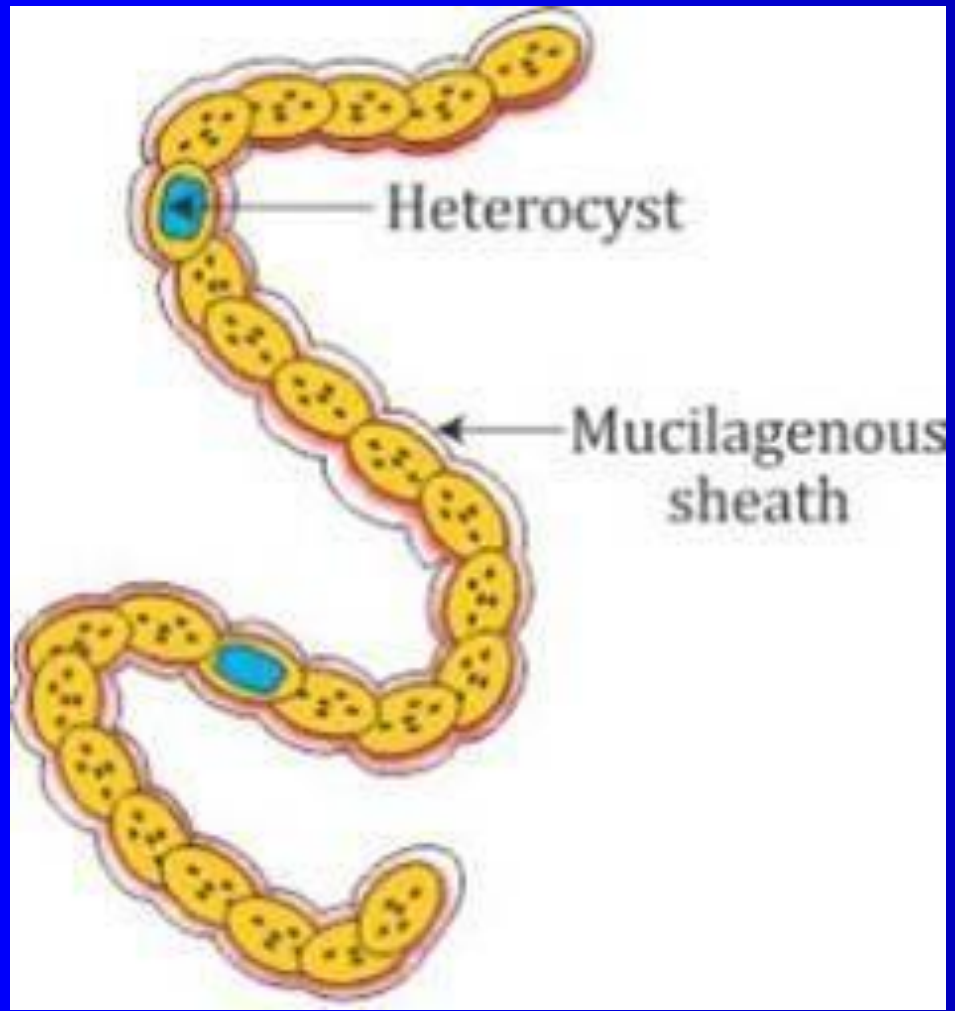
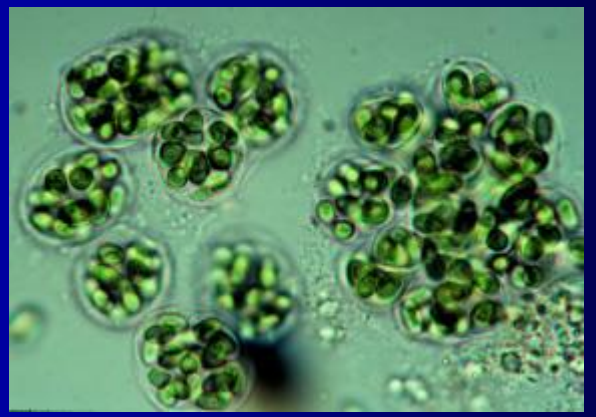
Filamentous Nostoc



Colonial Cyanobacteria



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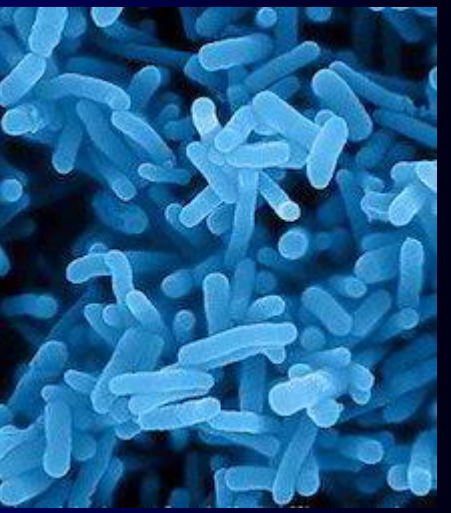
Photoautotrophs:
They perform photosynthesis; such forms are provided with bacteriochlorophyll, **e.g. Chlorobium, Rhodospirillum**.

Chemoautotrophs:
They oxidise inorganic chemicals to obtain energy for the synthesis of their organic food, **e.g. Nitrosomonos, Nitrobacter.**

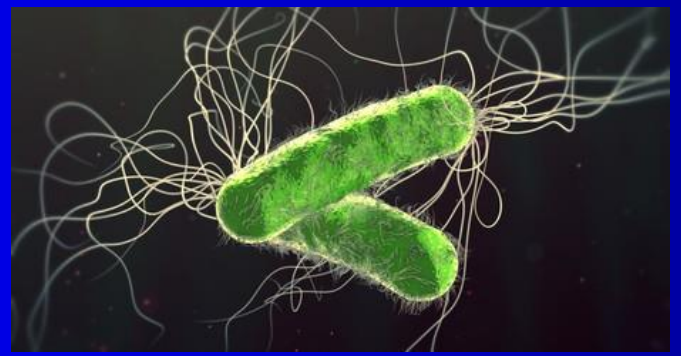
Saprotrophs:
They decompose larger organic molecules into smaller ones and derive their nutrients, **e.g. pseudomonas**

Nitrosomonas



Nitrobacter

Psuedomonas



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Parasites:

These bacteria take shelter and nutririon from other living organisms called host. They cause diseases in plants and animals, **e.g. Puccinia, Vibrio cholerae.**

Symbionts:

These bacteria live in in the body another organism and both are benefitted, **e.g. Rhizobium lives in the root nodules of leguminous plants.**

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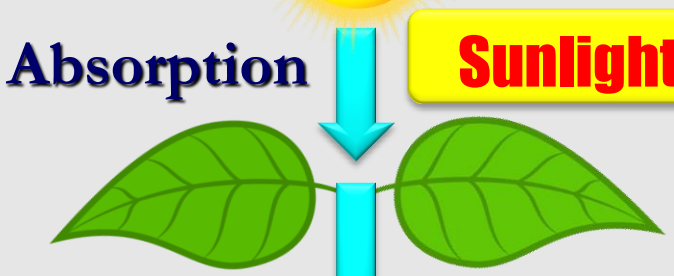
BIOLOGICAL CLASSIFICATION-2

KINGDOMS PROTISTA AND FUNGI



Absorption

Sunlight

Conversion

Light Energy to Chemical Energy

Splitting of $H_2O \longrightarrow H^+ + O_2$

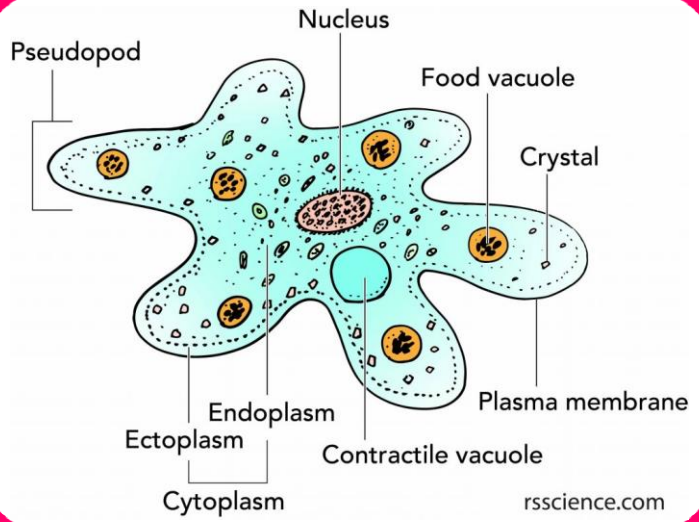
Reduction

$Co_2 \longrightarrow C_6H_{12}O_6$

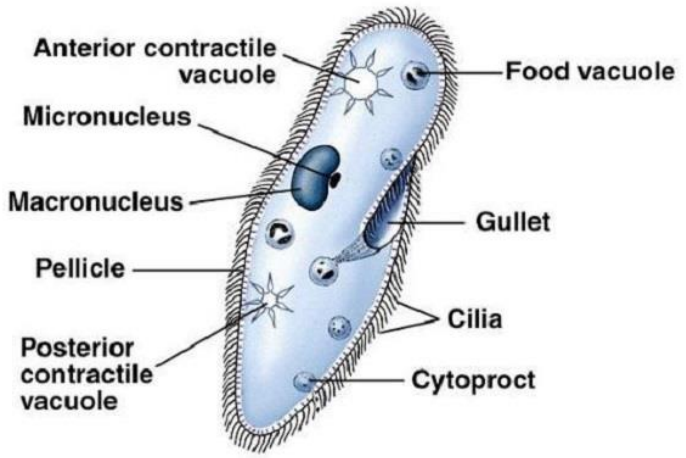
Kingdom Protista

Unicellular Organisms

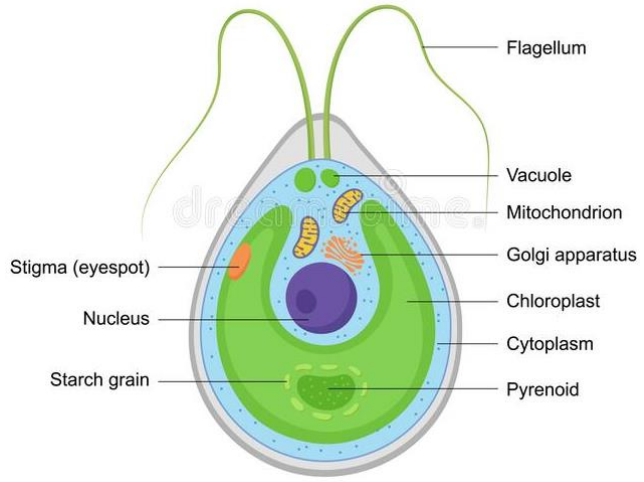
Amoeba



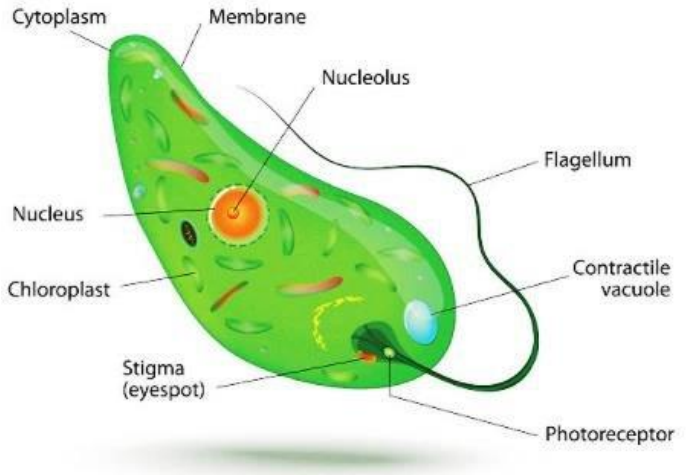
Paramoecium



Chlamydomonas



Euglena



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Kingdom Protista

They are unicellular **eukaryotes.**

They reproduce asexually and sexually.

They are classified into following classes.

Chrysophytes, Dianoflagellates, Euglenoids, Slime moulds and Protozoans.

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Chrysophytes

Chrysophytes

The members of this group are **diatoms** and **golden algae** (desmids).

They are found in **fresh water as well as in marine** water.

They are microscopic and float passively in water currents (plankton).

Most of them are photosynthetic.

The cell walls form two thin overlapping shells, which fit together as in a soap case.

The walls are embedded with silica and thus the walls are indestructible.

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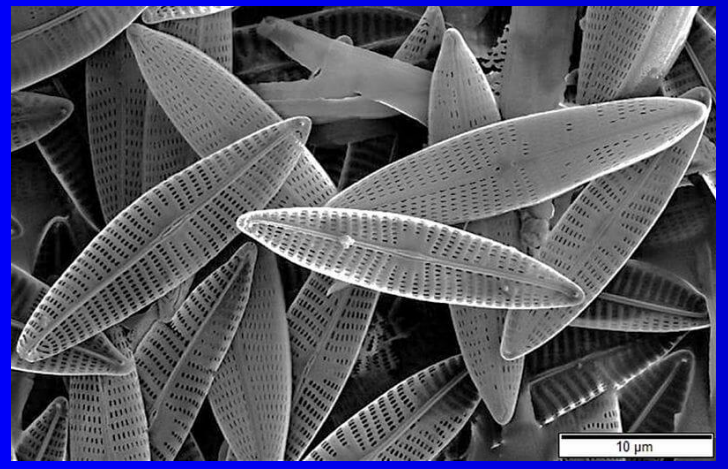
Economic Importance of Chrysophytes

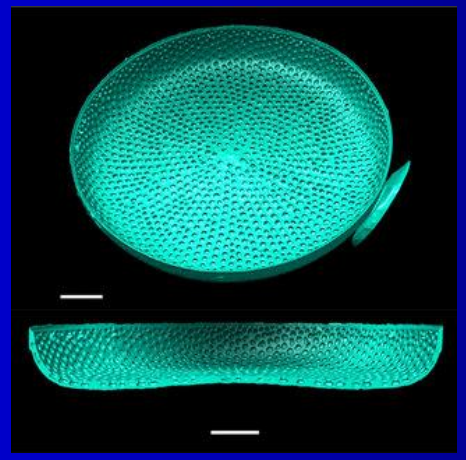
Large amount of **cell wall deposits** are found in the habitat of diatoms.

This accumulation over billions of years is referred to as **‘Diatomaceous Earth’.**

Being gritty this soil is used in **polishing, filtration of oils and syrups**.

Diatoms are the **main producers** in the oceans.





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Dinoflagellates

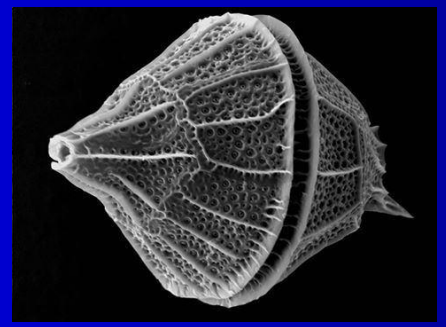
Dinoflagellates

They are mostly marine and photosynthetic.

They appear yellow, green, brown, blue or red depending on the main pigments present in their cells.

The cell wall has stiff cellulose plates on the outer surface.

Most of them have two flagella; one lies longitudinally and the other transversely in a furrow between the wall plates.



Gonyaulax

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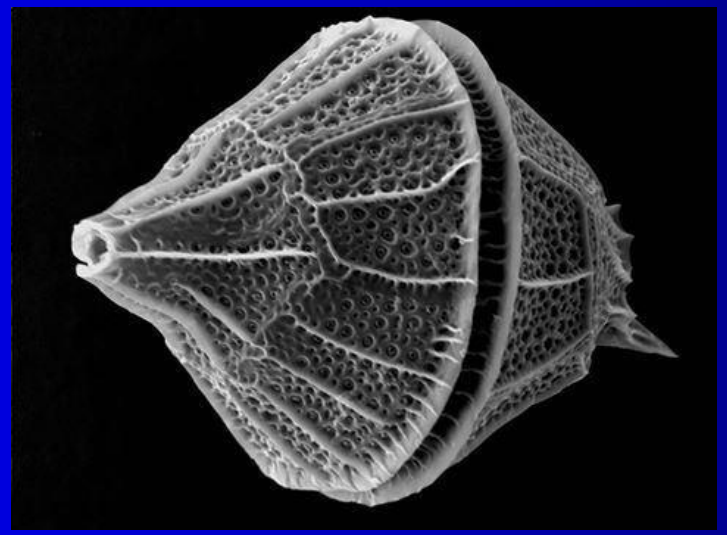
Very often, red dianoflagellates (Example: *Gonyaulax)* undergo such rapid multiplication that they make the sea appear red (red tides).

Toxins released by such large numbers may even kill other marine animals.



Gonyaulax

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Euglenoids

Euglenoids

Most of them are fresh water organisms found in stagnant water.

Instead of a cell wall, they have a **protein rich layer called pellicle** which makes their body flexible.

They have two flagella, a short and a long one.

They are autotrophs in the presence of sunlight, but behave like heterotrophs by feeding on other smaller organisms in the absence of light.

The pigments of euglenoids are identical to those present in higher plants. Example: *Euglena*.

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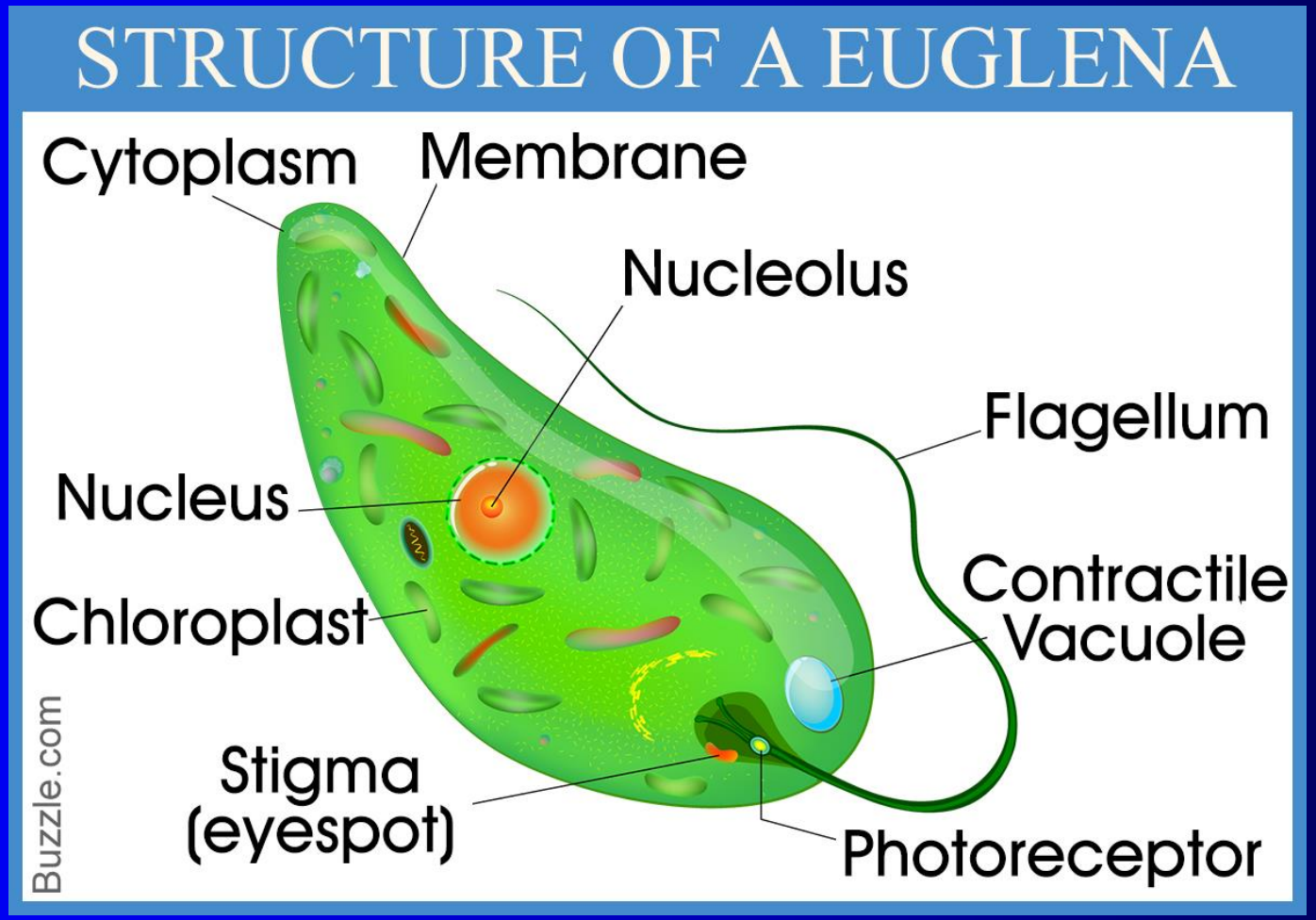
Euglenoids



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Slime Moulds

Slime Moulds

Slime moulds are saprophytic protists.

The body moves along decaying twigs and leaves engulfing organic material.

During favourable conditions, they form an aggregation called **plasmodium** which may grow and spread over several feet.

During unfavourable conditions, the plasmodium differentiates and forms fruit bodies bearing spores at their tips. The spores possess true walls.

The spores are resistant and survive for many years, even under adverse conditions. The spores are dispersed by air currents.

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Protozoans

Protozoans

All protozoans are heterotrophs and live as predators or parasites.

They are believed to be primitive relatives of animals.

There are four major groups of protozoans.

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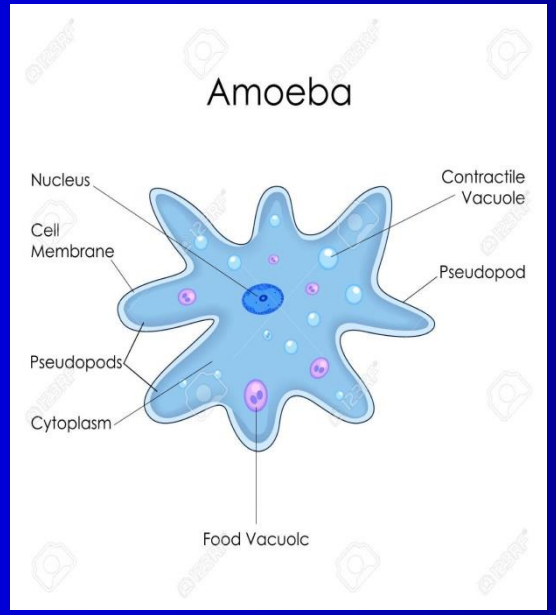
Amoeboid Protozoan

These organisms live in fresh water, sea water or moist soil.

They move and capture their prey with the help of pseudopodia.

Marine forms have silica shells on their surface.

Entamoeba are parasites.



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Flagellated Protozoan

The members of this group are either free-living or parasitic.

They have flagella.

The parasitic forms cause diseases such as sleeping sickness.

Example: *Trypanosoma*.

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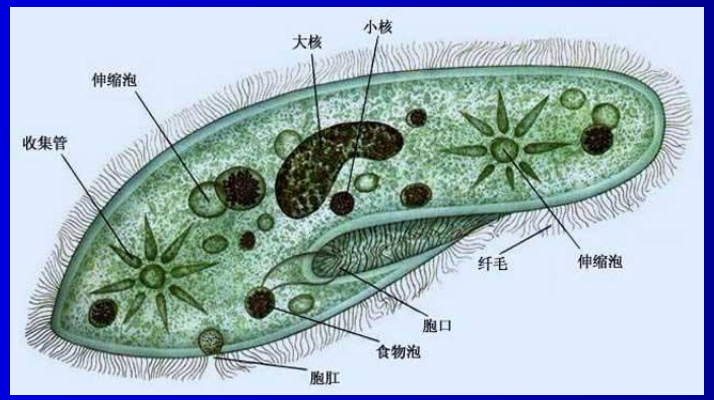
Ciliated Protozoan

These are aquatic, actively moving organisms due to the presence of thousands of cilia.

They have a cavity (gullet) that opens to the outside of the cell surface.

The movement of cilia moves the food to enter the gullet.

Example: *Paramoecium*.



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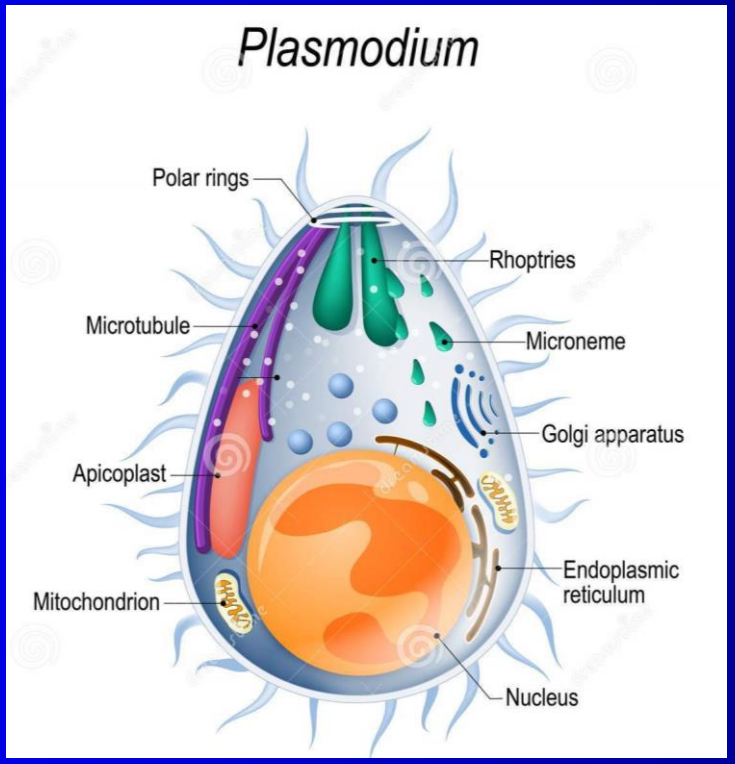
Sporozoan

They have spore-like stage in their life cycle.

Example. *Plasmodium* (malarial parasite).



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Four Major Groups of Protozoans

Amoeboid protozoa	Amoeba, Entamoeba
Flagellated protozoa	Trypanosoma
Ciliated protozoa	Paramoecium
Sporozoans	Plasmodium (Malarial parasite)

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Kingdom Fungi

Kingdom Fungi

The kingdom fungi is unique among heterotrophic organisms.

They prefer to grow in warm and humid places.

They show a great diversity in morphology and habitat.

The common mushroom you eat and toadstools are also fungi.

White spots seen on mustard leaves are due to a parasitic fungus.

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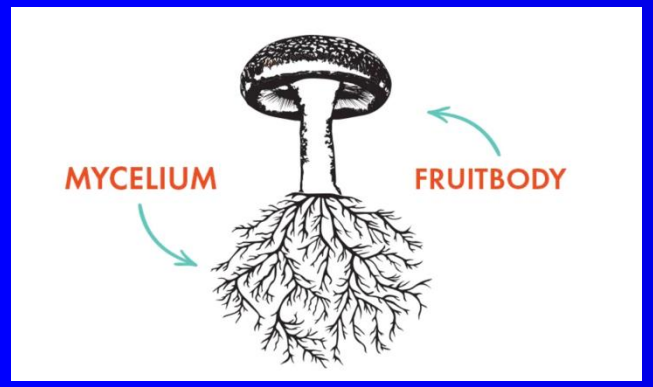
Structure of Fungi

Yeast



Yeast is unicellular.

But other fungi are **filamentous**.

The body of fungi consists of a long, slender thread-like structures called **hyphae.**

The network of hyphae is known as mycelium.

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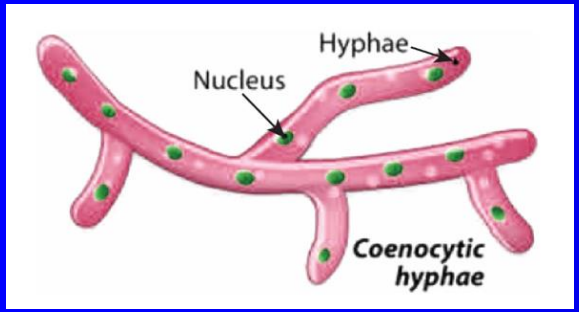
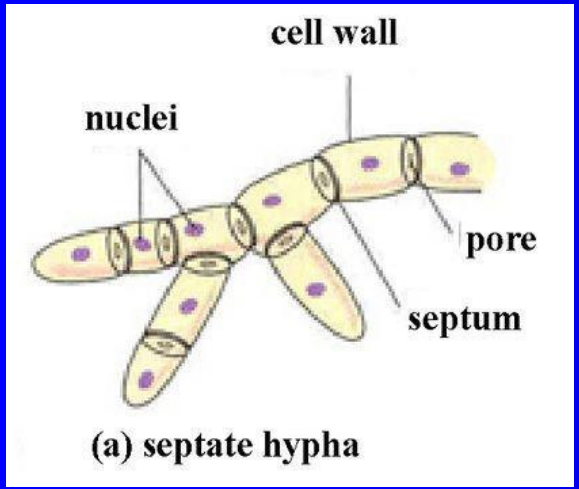
Structure of Fungi





Some hyphae are continuous tubes filled with multinucleated cytoplasm. These are called **coenocytic hyphae**.

Others have septae or cross walls in their hyphae.

The cell walls of fungi are composed of **chitin** and **polysaccharides**.

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Mode of Nutrition

Lichens

Most fungi are heterotrophic and absorb soluble organic matter from dead organic matter and hence are called **saprophytes.**

Those depend on living plants and animals are called **parasites.**

They can also live as **symbionts** as in **lichens** and **mycorrhiza.**

The symbiotic relation between algae and fungi is known as lichen.

The symbiotic relation between fungi and roots of higher plants is mycorrhizae.

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Reproduction

Reproduction in fungi can take place by fragmentation, fission and budding.

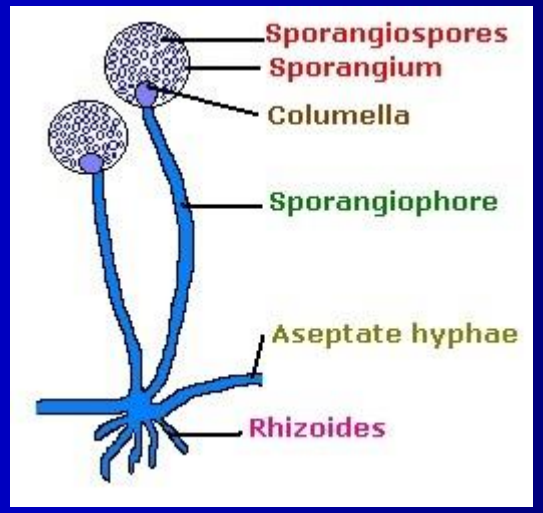
Asexual reproduction is by spores called **conidiospores or sporangiospores or zoospores**.

Sexual reproduction is by **oospores, ascospores and basidiospores.**

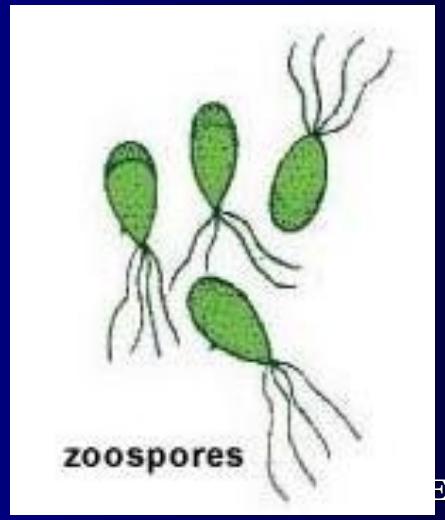
The various spores are produced in fruit bodies.

Conidiospores

Sporangiospores



Zoospores



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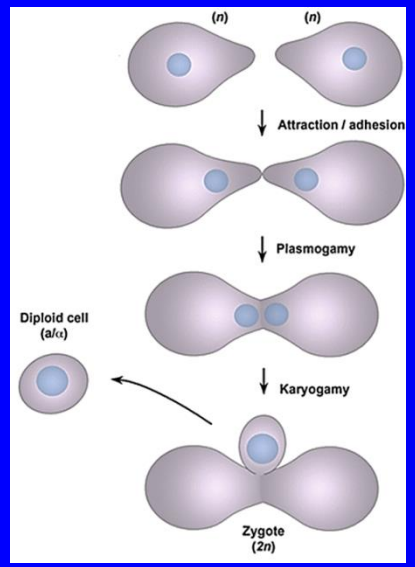
Reproduction

The sexual cycle involves the following three steps:

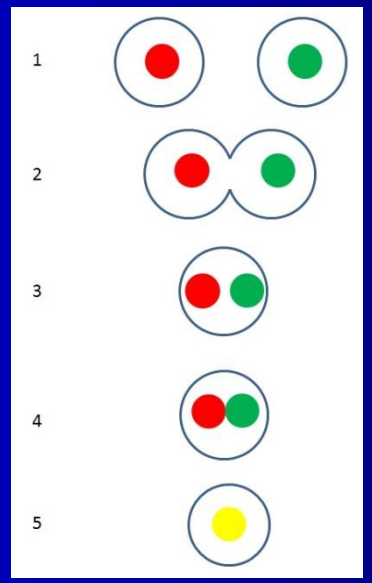
(i) Fusion of protoplasms between two motile or non-motile gametes called **plasmogamy.**

(ii) Fusion of two nuclei called **karyogamy.**

(iii) Meiosis in zygote resulting in haploid spores.



Plasmogamy
Fusion of Protoplasm



Karyogamy
Fusion of Nuclei

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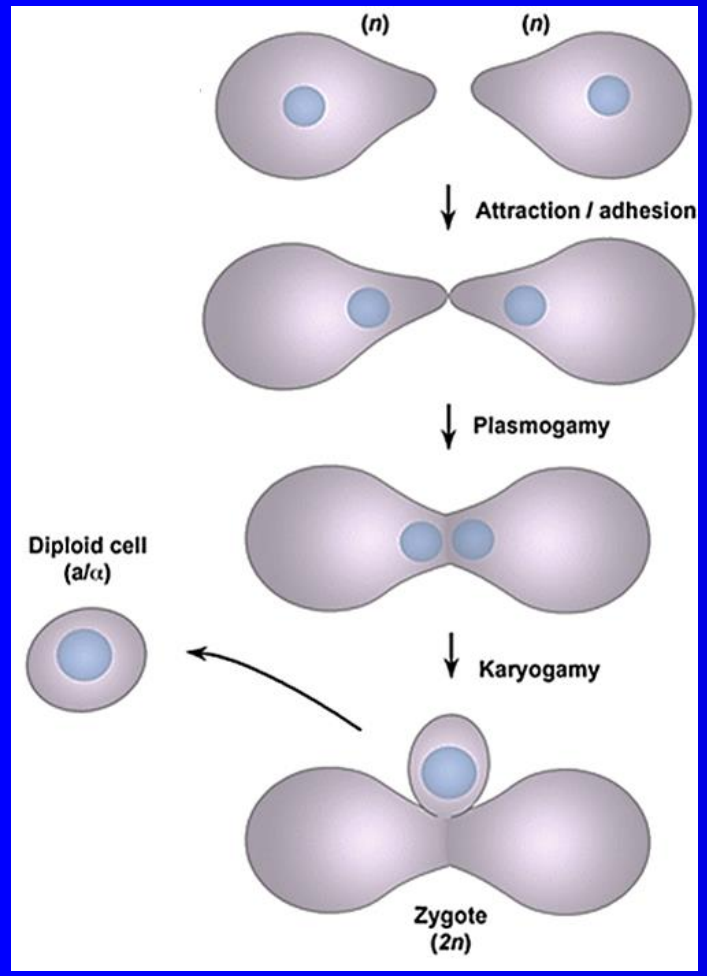
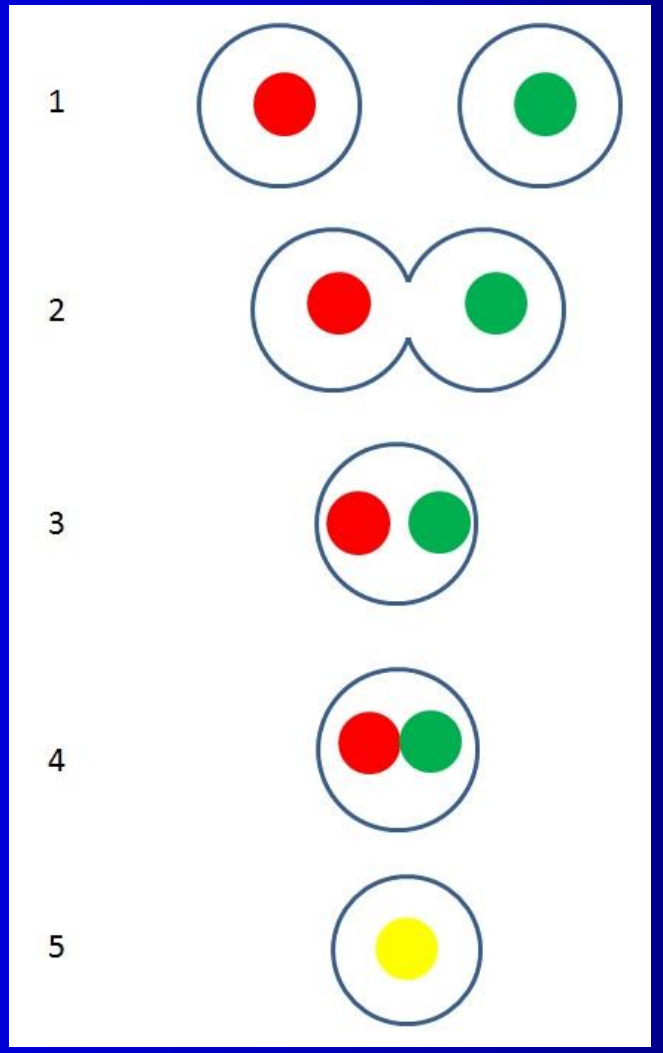
Plasmogamy
Fusion of Protoplasm



Karyogamy
Fusion of Nuclei



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Structure of Fungi

Mycelium	It is the body of fungi, made of a network of hyphae
Hyphae	They are long, slender thread-like structures
Caenocytic Hyphae	Hyphae filled with multinucleated cytoplasm
Septate Hyphae	Presence of cross walls in the hyphae

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Economic Importance

Yeast is used for making bread and beer.

Some fungi like Agaricus are edible.

Other fungi cause diseases in plants and animals;

Puccinia causes wheat-rust disease.

Some are the sources of antibiotics, e.g., *Penicilliuim.*

They are cosmopolitan and occur in air, water, soil and on plants and animals.

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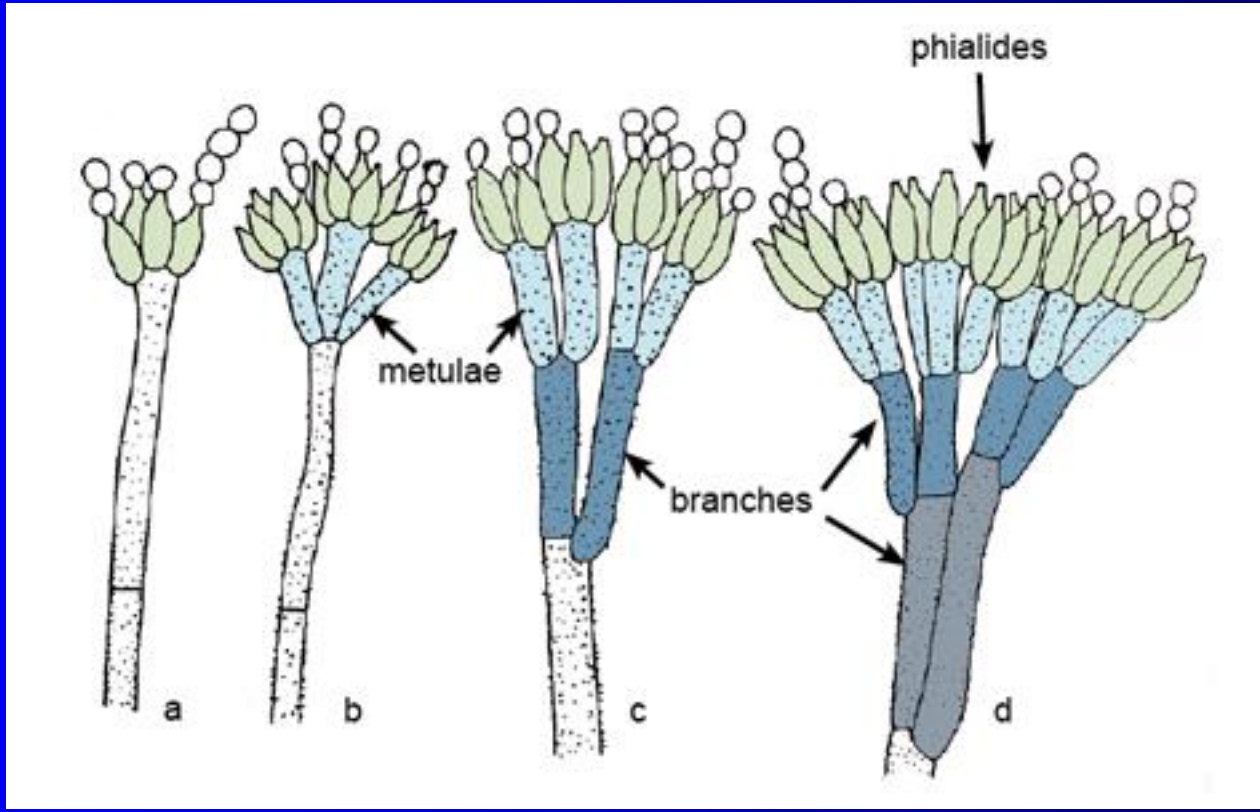
Penicillium



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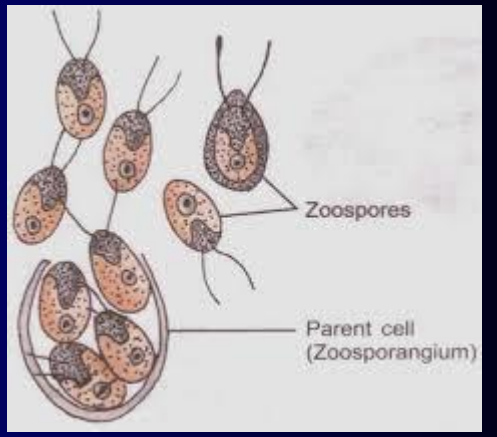
Phycomycetes

Phycomycetes

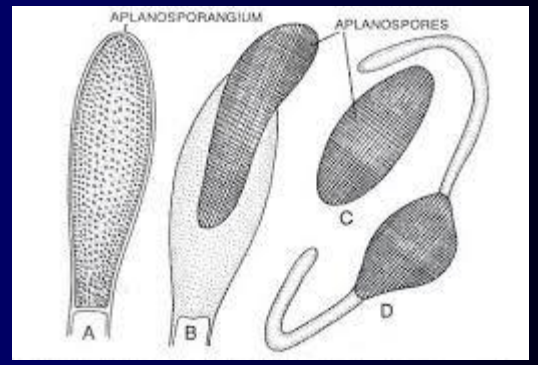
Habitat

Members of phycomycetes are found in aquatic habitats and on decaying wood in moist and damp places or as obligate parasites on plants.



Structure:

The mycelium is **aseptate and coenocytic.**



Asexual reproduction takes place by **zoospores** (motile) or by **aplanospores** (non-motile).

These spores are **endogenously produced** in sporangium.

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Reproduction in Phycomycetes

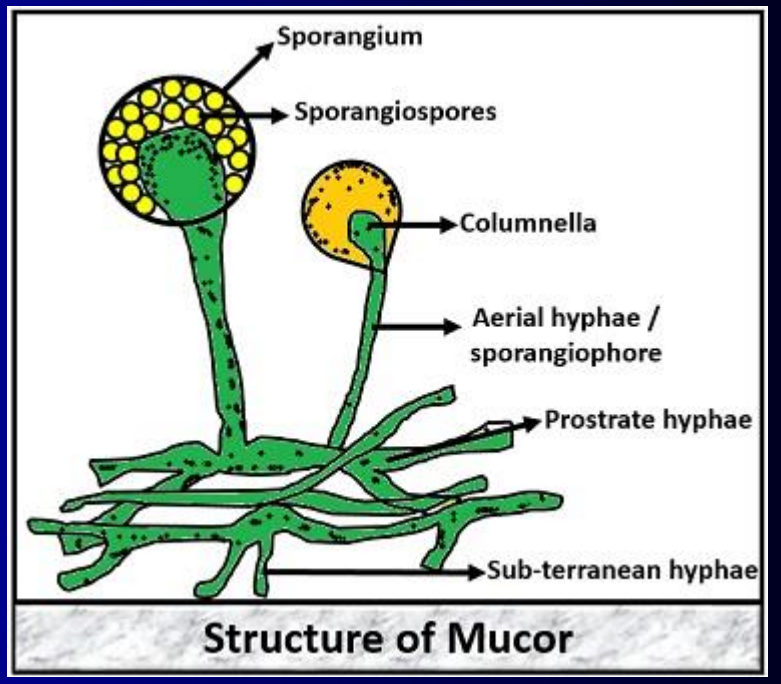
Sexual Reproduction occurs with the help of gametes.

The gametes are similar in morphology (isogamous) or dissimilar (anisogamous or oogamous).

Some common examples are:

Mucor, *Rhizopus* (the bread mould)

Albugo (the parasitic fungi on mustard).



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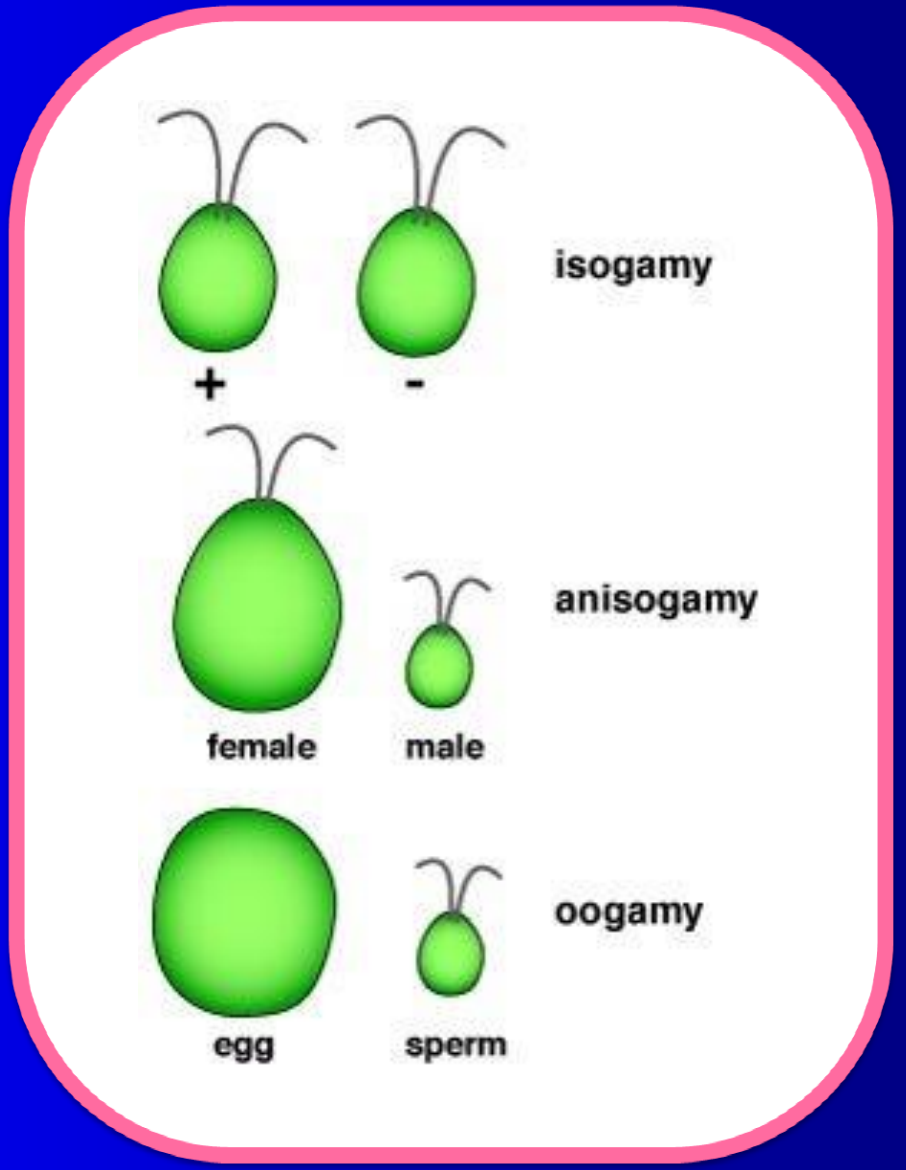
Isogamy, Anisogamy and Oogamy



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Ascomycetes

Ascomycetes

They are commonly known as sac-fungi.

The ascomycetes are unicellular as in **yeast** or multicellular as in **Penicilliuim.**

Structure

The mycelium is **branched and septate.**

They are **saprophytic** decomposers, **parasitic** or **coprophilous** (growing on dung).

Neurospora is used in biochemical and genetic work.

Many members like morels and buffles are edible and are considered delicacies

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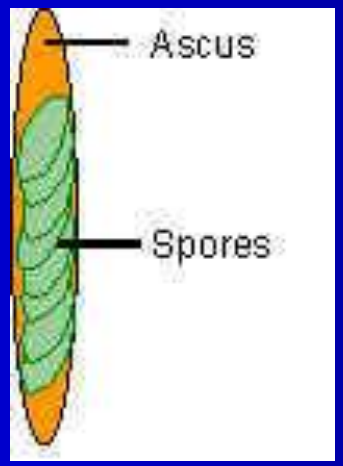
Reproduction in Ascomycetes

The **asexual spores** are **conidiospores** produced **exogenously** on the special mycelium called conidiophores. Conidia on germination produce mycelium.

Sexual spores are called **ascospores** which are produced **endogenously** in sac like asci (singular ascus).

These asci are arranged in fruit bodies called ascocarps.
Some examples are *Aspergillus*, *Claviceps* and *Neurospora*.



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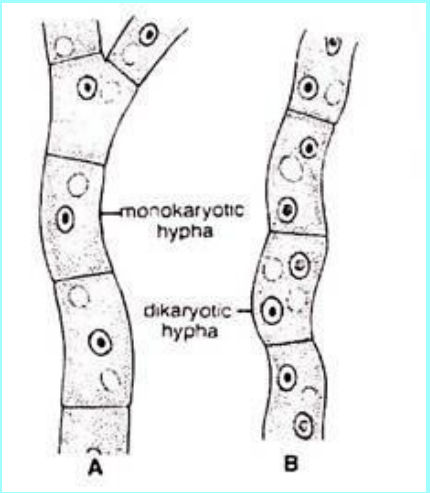
Basidiomycetes

Basidiomycetes

The common forms of basidiomycetes are mushrooms, bracket fungi or puffballs.

They grow in soil, on logs and in living plant bodies as parasites, e.g., rusts and smuts.

The mycelium is **branched and septate.**



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Reproduction in Basidiomycetes

Reproduction by **fragmentation** is common.

The **asexual spores** are **not found**.

The **sex organs are absent**, but **plasmogamy** occurs the by fusion of two somatic cells of different strains or genotypes.

The resultant structure is dikaryotic which ultimately gives rise to basidium.

Karyogamy and meiosis take place in the basidium producing four **basidiospores**.

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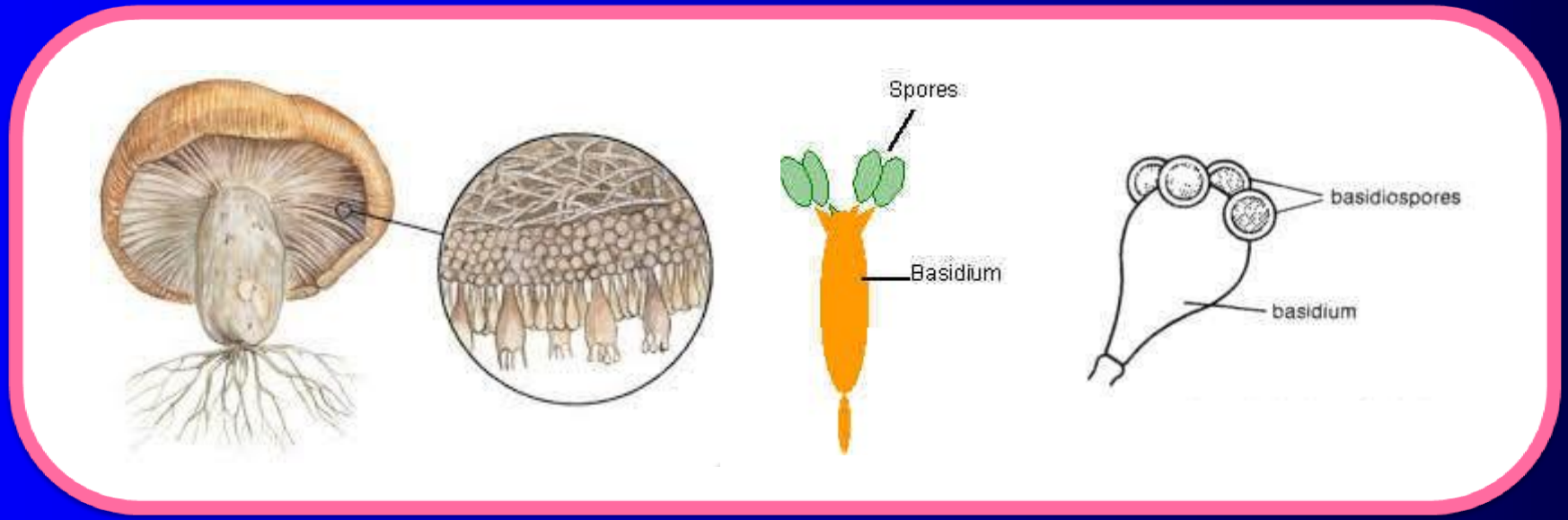
Sexual Reproduction in Basidiomycetes

The basidiospores are exogenously produced on the basidium.

The basidia are arranged in fruit bodies called basidiocarps.

Common members are *Agaricus* (mushroom), *Ustilago (smut)* and *Puccinia* (rust fungus).



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Deuteromycetes

Deuteromycetes

The mycelium is **septate and branched.**

Some members are saprophytes or parasites while a large number of them are decomposers of litter and help in nutrient cycling.

The deuteromycetes reproduce only by **asexual spores known as conidia.**

Commonly known as **imperfect fungi** because only **the asexual phases** of these fungi are known.

When the sexual forms of these fungi were discovered they were moved into classes they rightly belong to.

Example, Alterniaria, Colletotrichum and *Trichoderma.*

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Alternaria

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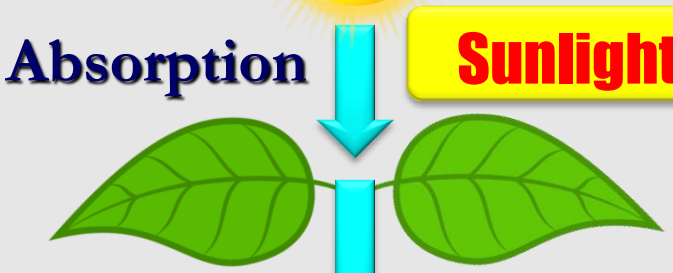
BIOLOGICAL CLASSIFICATION-3

KINGDOMS PLANTAE, ANIMALIA



Absorption

Sunlight

Conversion

Light Energy to Chemical Energy

Splitting of $H_2O \longrightarrow H^+ + O_2$

Reduction

$Co_2 \longrightarrow C_6H_{12}O_6$

Kingdom Plantae

Kingdom Plantae

Kingdom Plantae includes all eukaryotic chlorophyll-containing organisms commonly called plants.

A few members are partially heterotrophic such as the insectivorous plants or parasites.

Bladderwort and Venus fly trap are examples of insectivorous plants.

Cuscuta is a parasite.

The plant cells have a eukaryotic structure with prominent chloroplasts and cell wall mainly made of cellulose.

Plantae includes algae, bryophytes, pteridophytes, gymnosperms and angiosperms.

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Life cycle of plants has two distinct phases - **the diploid sporophytic and the haploid gametophytic -** that alternate with each other.

The lengths of the haploid and diploid phases, and whether these phases are free-living or dependent on others, vary among different groups in plants.

This phenomenon is called **alternation of generation.**

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Kingdom Animalia

Kingdom Animalia

This kingdom is characterised by heterotrophic eukaryotic organisms that are multicellular and their cells lack cell walls.

They directly or indirectly depend on plants for food.

They digest their food in an internal cavity and store food reserves as glycogen or fat.

Their mode of nutrition is holozoic by ingestion of food.

They follow a definite growth pattern and grow into adults that have a definite shape and size.

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Higher forms show elaborate sensory and neuromotor mechanism. Most of them are capable of locomotion.

The sexual reproduction is by copulation of male and female followed by embryological development.

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Viruses

Viruses

Viruses did not find a place in classification since they are not truly ‘living’, if we understand living as those organisms that have a cell structure.

The viruses are non-cellular organisms that are characterised by having an inert crystalline structure outside the living cell.

Once they infect a cell they take over the machinery of the host cell to replicate themselves, killing the host.

The name virus that means **venom or poisonous fluid** was given by Pasteur.

D.J. Ivanowsky (1892) recognised certain microbes as causal organism of the mosaic disease of tobacco.

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These were found to be smaller than bacteria because they passed through bacteria-proof filters.

M.W. Beijerinck (1898) demonstrated that the extract of the infected plants of tobacco could cause infection in healthy plants and called the fluid as *Contagium vivumfluidum* (infectious living fluid).

W.M. Stanley (1935) showed that viruses could be crystallised and crystals consist largely of proteins.

They are inert outside their specific host cell. Viruses are obligate parasites.

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In addition to proteins viruses also contain genetic material that could be either RNA or DNA.

No virus contains both RNA and DNA. A virus is a **nucleoprotein** and the genetic material is infectious.

Viruses that infect plants have single stranded RNA.

Viruses that infect animals have either single or double stranded RNA or double stranded DNA.

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Bacterial viruses or bacteriophages (viruses that infect the bacteria) are usually double stranded DNA viruses.

The protein coat called capsid made of small subunits called capsomeres, protects the nucleic acid.

These capsomeres are arranged in helical or polyhedral geometric forms.

Viruses cause diseases like **mumps, small pox, herpes and influenza**. AIDS in humans is also caused by a virus.

In plants, the symptoms can be mosaic formation, leaf rolling and curling, yellowing and vein clearing, dwarfing and stunted growth.

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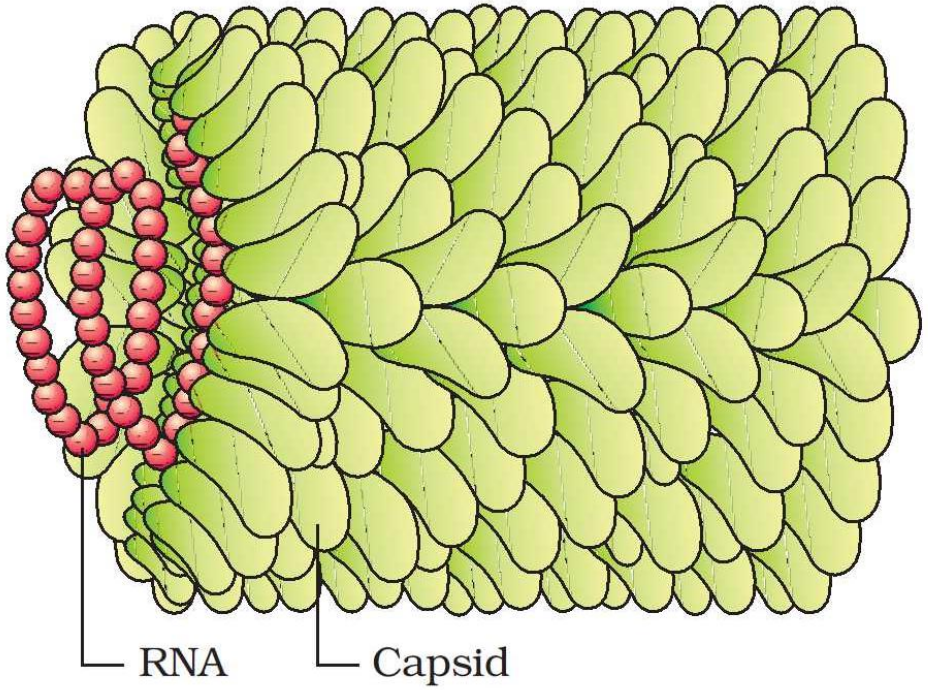
Tobacco Mosaic Virus



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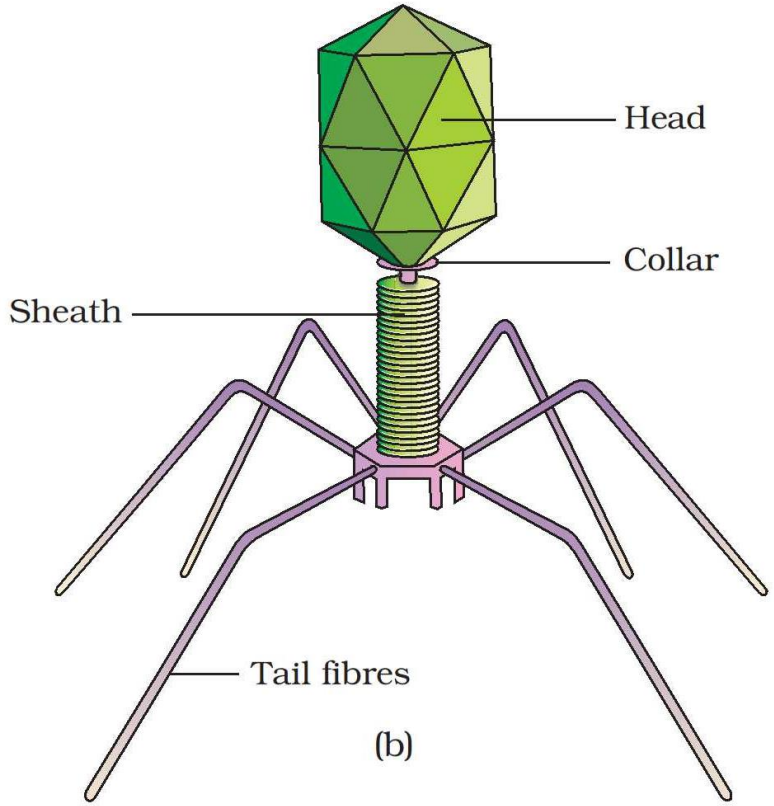
Bacteriophage



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Viroids

Viroids

In 1971 T.O. Diener discovered a new infectious agent that was smaller than viruses and caused potato spindle tuber disease.

It was found to be a free RNA; it lacked the protein coat that is found in viruses, hence the name viroid.

The RNA of the viroid was of low molecular weight.

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Lichens

Lichens

Lichens are symbiotic associations i.e. mutually useful associations, between algae and fungi.

The algal component is known as **phycobiont** and fungal component as **mycobiont,** which are autotrophic and heterotrophic, respectively.

Algae prepare food for fungi and fungi provide shelter and absorb mineral nutrients and water for its partner.

Lichens are very good pollution indicators - they do not grow in polluted areas.

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God Bless You!