Bot. 102 - L-1

IMPORTANCE OF PLANTS TO HUMAN LIFE

Introduction

- **Botany**, also called **plant science**(**s**), **plant biology** or **phytology**, is the science of plant life and a branch of biology. A **botanist** or **plant scientist** is a scientist who specializes in this field.

- Modern botany is a broad, multidisciplinary subject with inputs from other areas of science and technology.

- Research topics include the study of plant structure, growth and differentiation, reproduction, biochemistry and primarry metabolism, chemical products, diseases, and plant taxonomy.

Introduction

- Dominant themes in 21st century plant science are molecular genetics and epigenetics, which are the mechanisms and control of gene expression during differentiation of plant cells and tissues.

- Botanical research has diverse applications in providing staple foods, materials such as timber, oil, rubber, fibre and drugs, in modern horticulture, agriculture and forestry, plant propagation, breeding and genetic modification,

PLANTS ARE IMPORTANT TO HUMANS IN MANY WAYS

- **Plants** are multicellular eukaryotes of the kingdom **Plantae**.
- **Plants provide oxygen to animals.**
- **A** lawn of 4,000 sq. feet provides enough oxygen for a family of five.
- Plants in the world forests, rangelands and the tropical rain forest provide oxygen globally.
- Plants are a source (usually the first) of food for animals (including humans) in the food chain.

PLANTS ARE IMPORTANT TO HUMANS IN MANY WAYS

- Plants are essential to the balance of nature and in people's lives.
- Green plants, i.e., those possessing chlorophyll, manufacture their own food and give off oxygen in the process called photosynthesis, in which water and carbon dioxide are combined by the energy of light.
- Plants are the ultimate source of food and metabolic energy for nearly all animals, which cannot manufacture their own food.

PLANTS ARE IMPORTANT TO HUMANS IN MANY WAYS

- Starches and sugars, the foods that plants make and store for their own growth, are also the fundamental **nutrients** that humans and other organisms need in order to live.
- Besides foods (e.g., grains, fruits, and vegetables), plant products essential to humans include wood and wood products, fibers, drugs, oils, latex, pigments, and resins.
- Much human clothing is made from material that comes directly from plants.
- Cotton is the principal plant used for clothing manufacture. Artificial textile fibers, such as rayon, are manufactured chiefly from cellulose, which is found mainly in the cell walls of plants.

PLANTS ARE IMPORTANT TO HUMANS IN MANY WAYS

- Coal and petroleum are fossil substances of plant origin.

- Plants provide people not only food but shelter, clothing, medicines, fuels, and the raw materials from which number of other products are made.

- Cellulose, found in great abundance in many plant parts, is a basic ingredient of certain plastics and other synthetic substitutes for natural fibers, leather, glass, rubber, jewels, stone, and metal.

PLANTS ARE IMPORTANT TO HUMANS IN MANY WAYS

- Through the ages, people have found that certain plants could be used to relieve pains and considered them as medicinal plant

- Most physicians in ancient cultures were experts in medicinal plants.
- Medicinal substances are still being discovered in plants.

- Many plants are invaluable sources of **vitamins**, whose importance to human growth and health is very important

PLANTS ARE IMPORTANT TO HUMANS IN MANY WAYS

- Plants are essential parts of **ecosystems**.
- Most of the energy consumed in terrestrial ecosystems is provided by plants, Plants absorb minerals, such as potassium and phosphorus, from the **soil**.
- These are stored in plant tissues and are an essential part of the diet of animals that eat plants.

Plants can be used to modify the environment by providing:

- Shade
- Erosion control
- Protection for watershed
- Noise control
- Beautification
- Production of nitrogen to enrich the soil
- Plants act as settling chambers for particulate pollution (Particles of pollution taken from the air.)

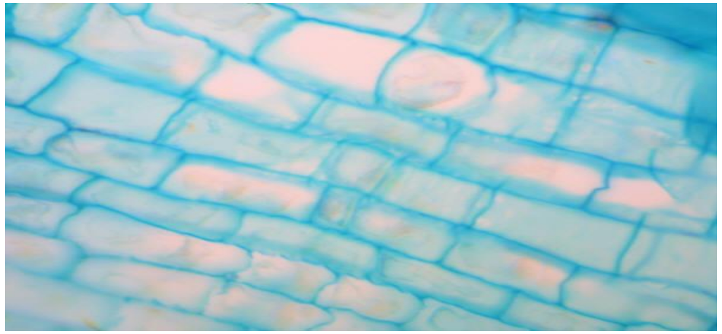
Answer the questions ?

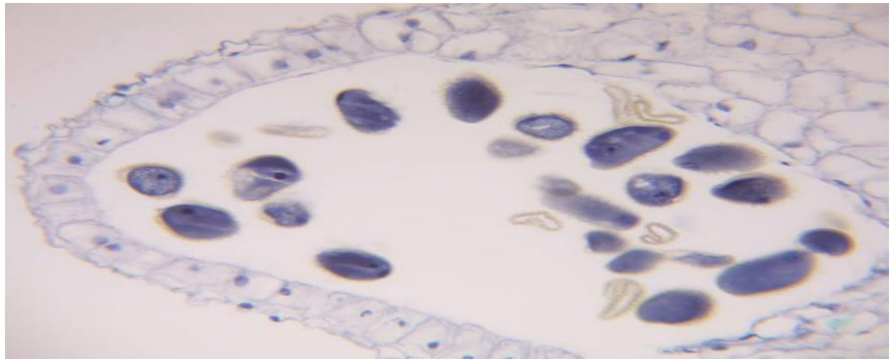
- Q.1. Write the uses of plants .
- Q.2. Give some example of uses of plants in your daily life.

Functions of Cell components/organelles

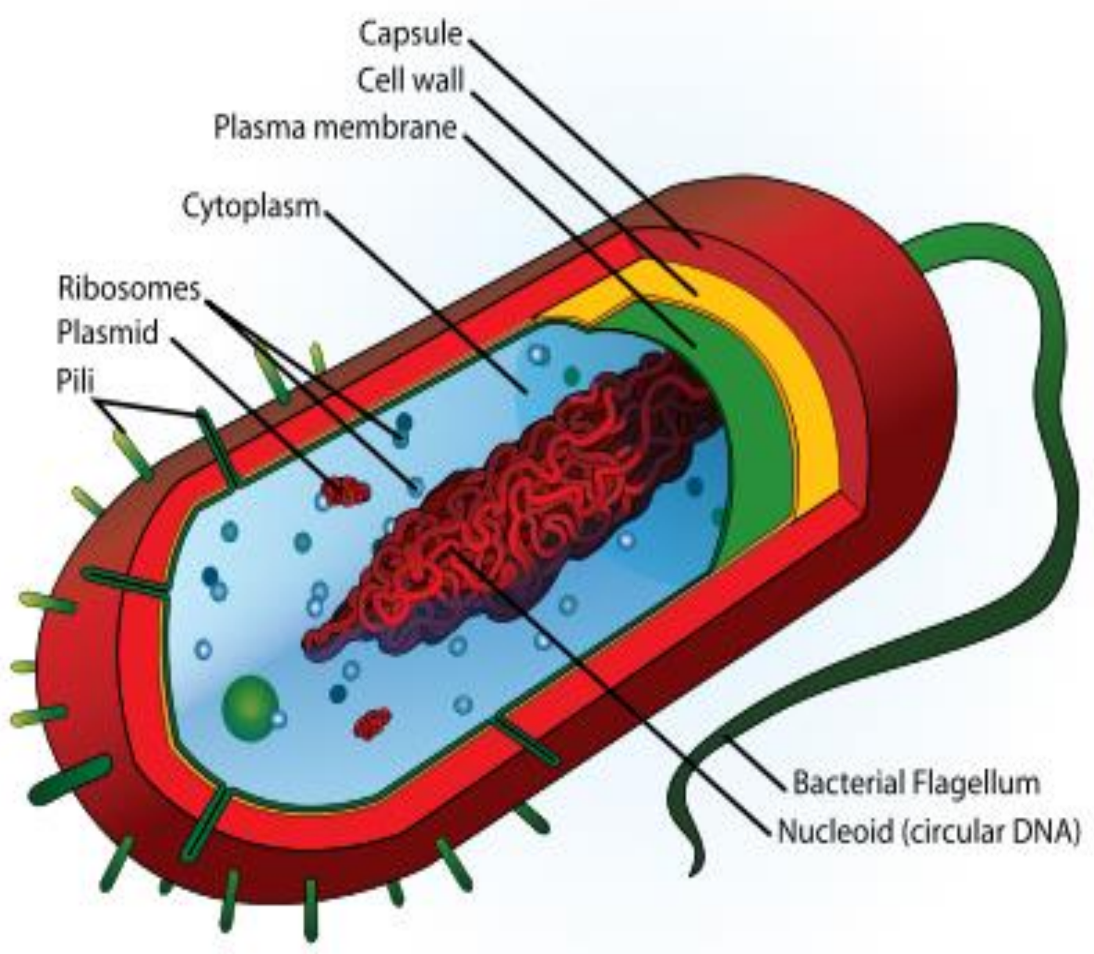
Cells

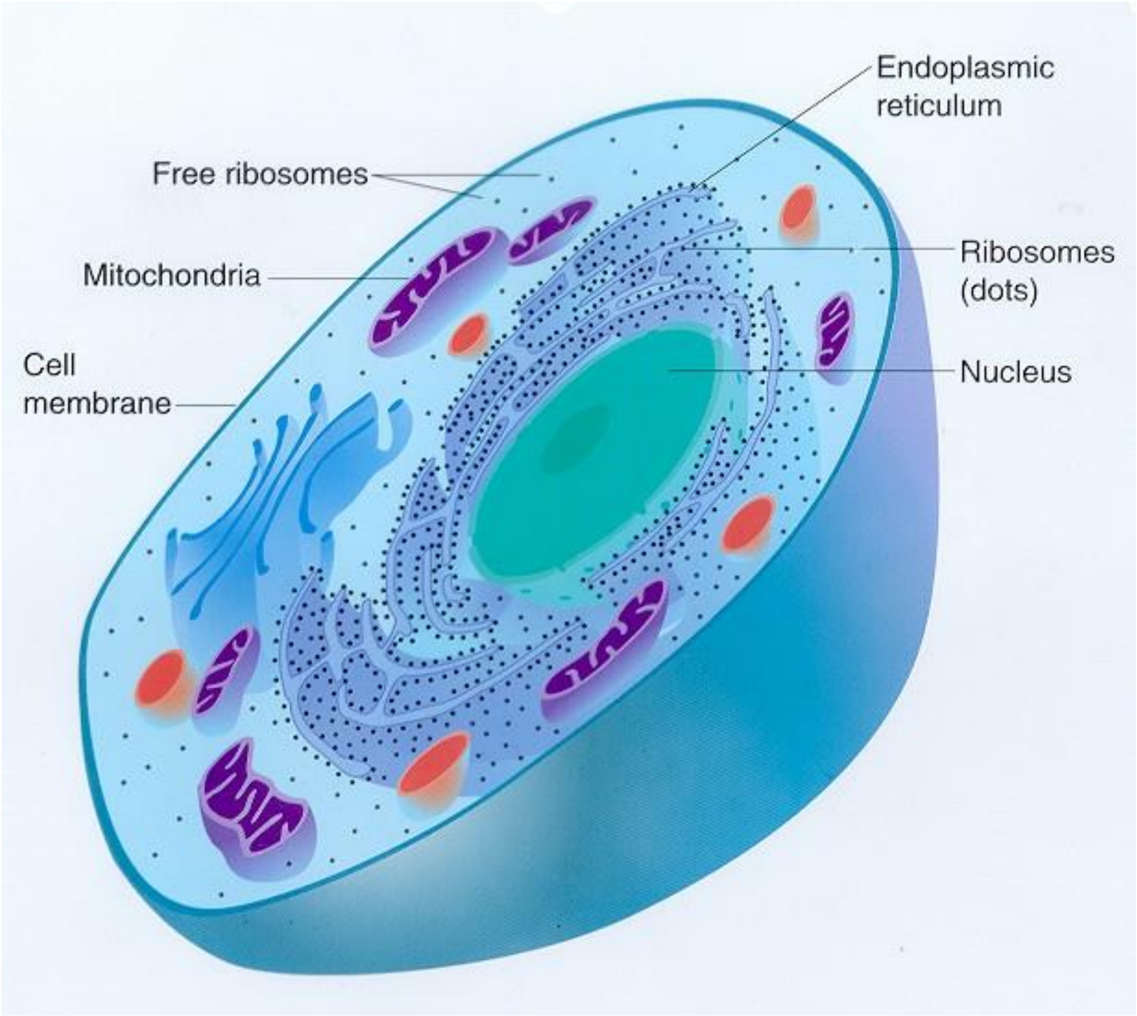
- Cells are the basic unit of all living things.
- IF IT IS ALIVE, IT HAS CELLS!
- Cell Theory:
  - All organisms are made up of one or more cells
  - The cell is the basic unit of all organisms
  - all cells come from cells





Two Types of Cells



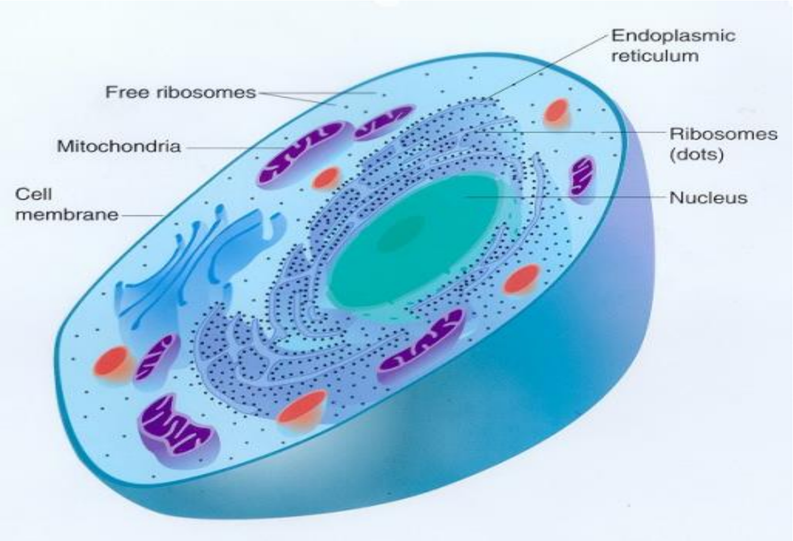


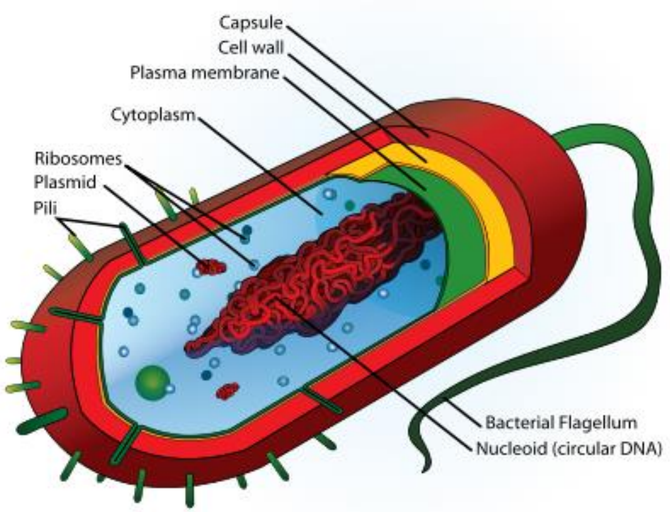
Prokaryotic

Eukaryotic

Parts in common

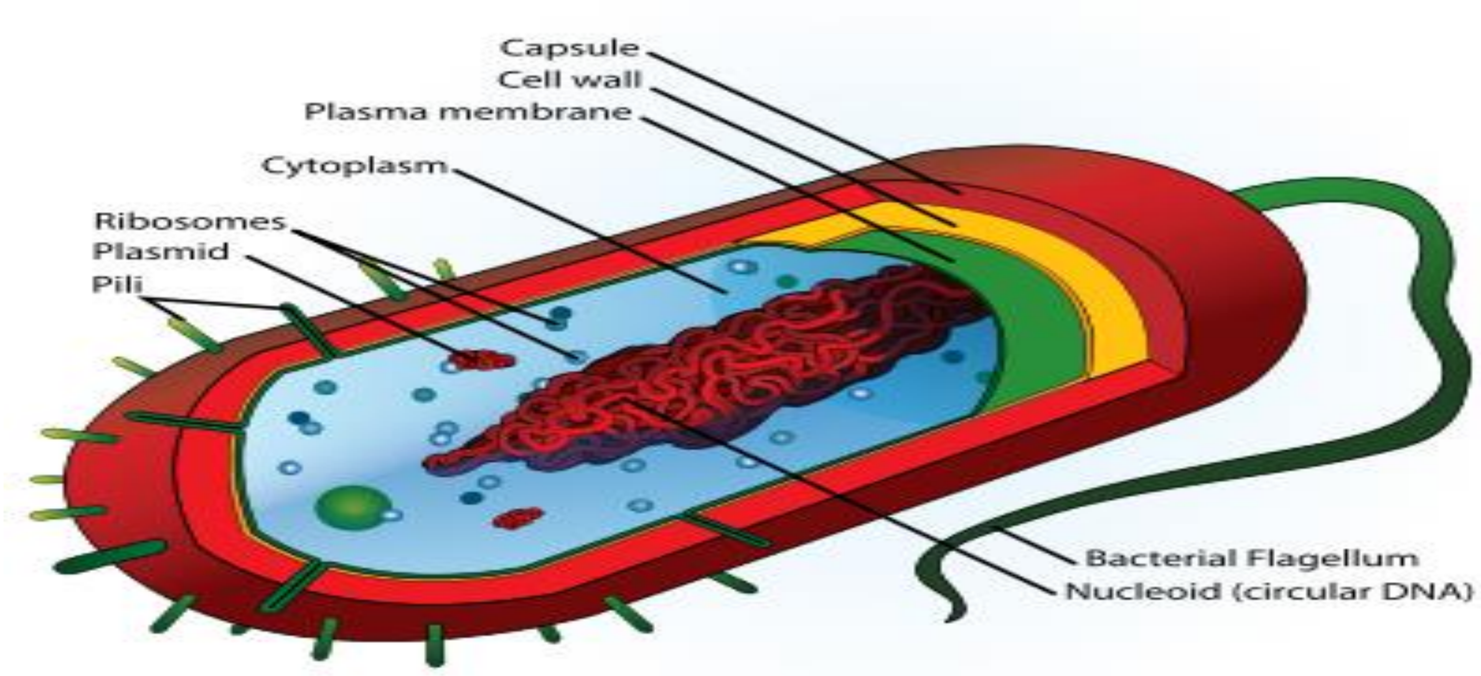
Cell Membrane
Cytoplasm
Organelles
DNA





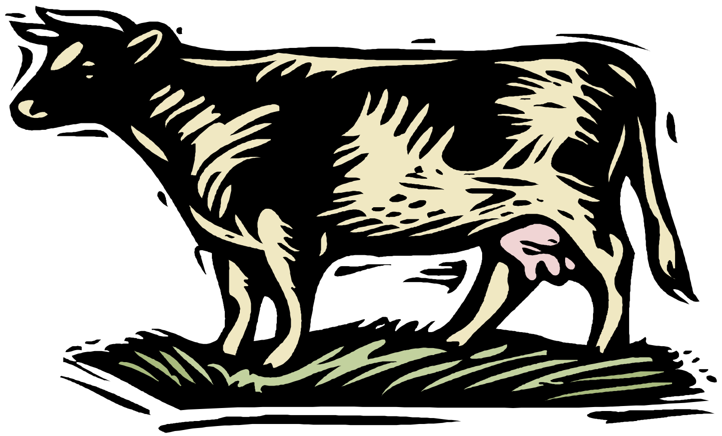
This is a prokaryotic cell

- Is a single celled organism that does not have a nucleus or membrane bound organelles.
- Its DNA is locked in the cytoplasm.



Eukaryotic Cells

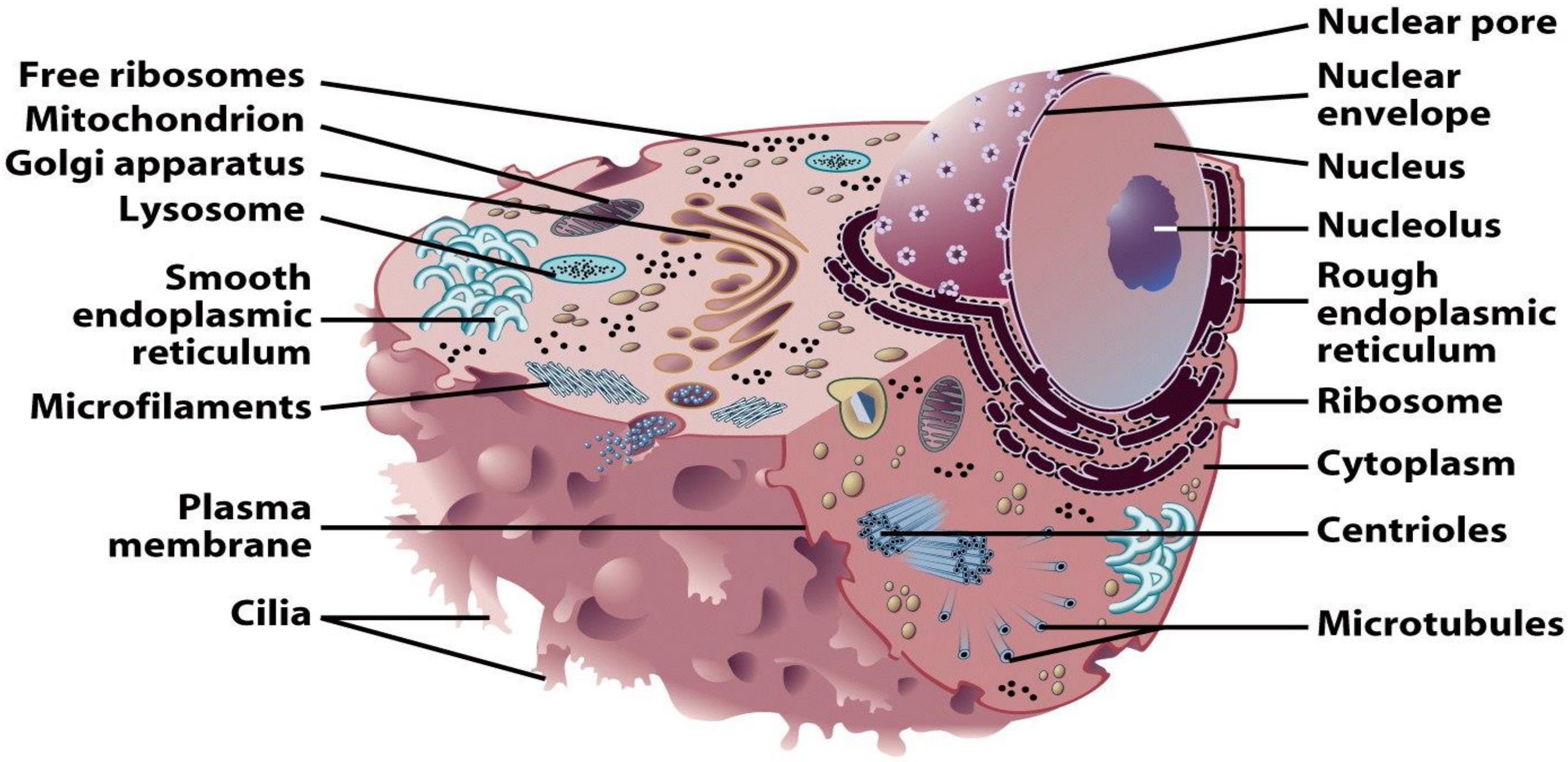
- Plant & Animal cells



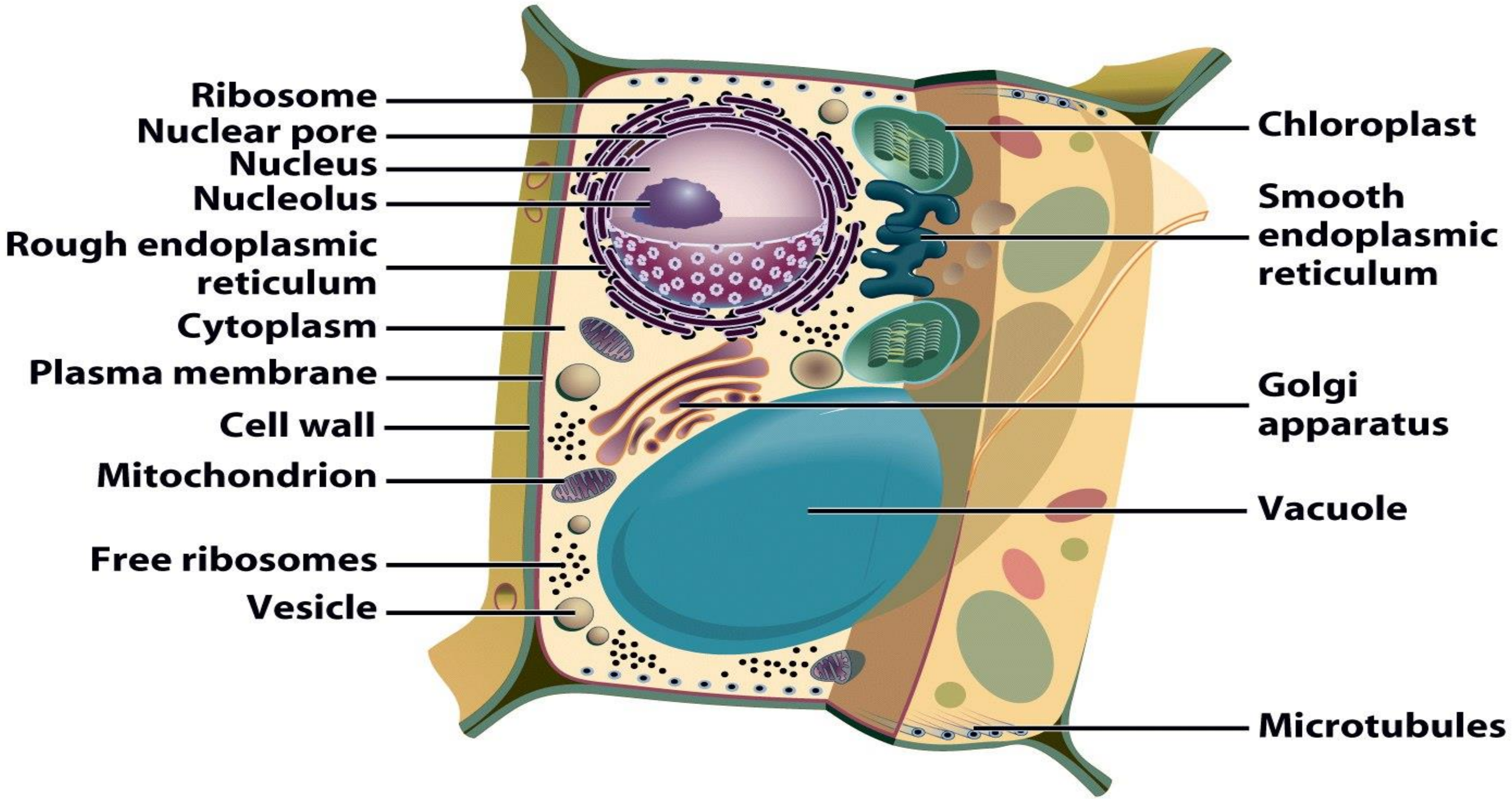
Eukaryotic Cells

- Nucleus bound by membrane
- Include fungi, protists, plant, and animal cells
- Possess many organelles

Representative Animal Cell



Representative Plant Cell



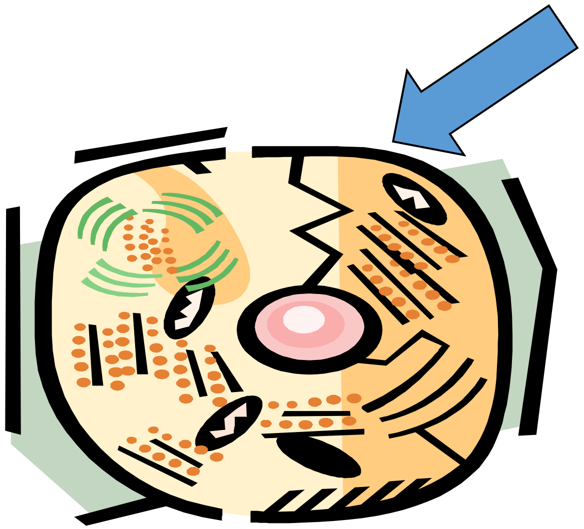
What is an organelle?

- Organelles are to cells what organs are to the body.

- They carry out the individual tasks of gaining and working with energy as well as directing the overall behavior of the cells.

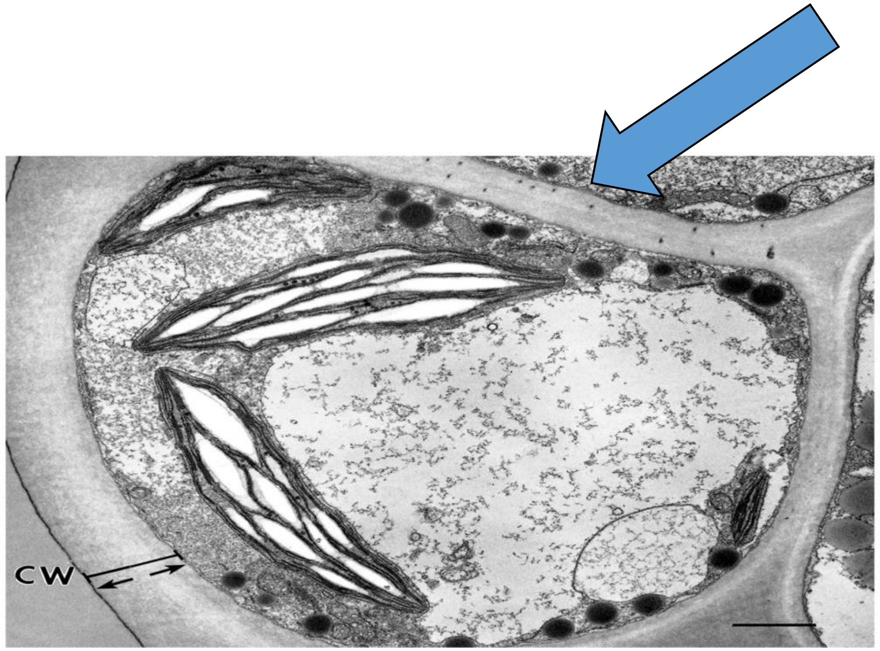
Cell Membrane

- The cell membrane holds the cell together and allows nutrients into the cell.



Cell Walls

- Found only in plants
- Surrounds plasma membrane
- They make the cell strong and rigid

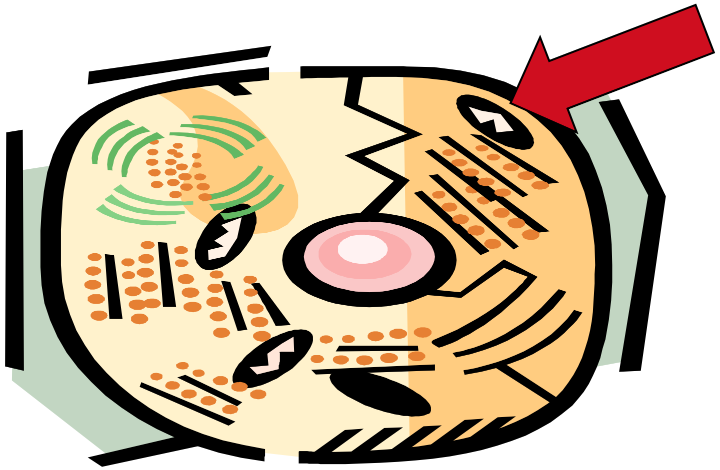


Cytoplasm

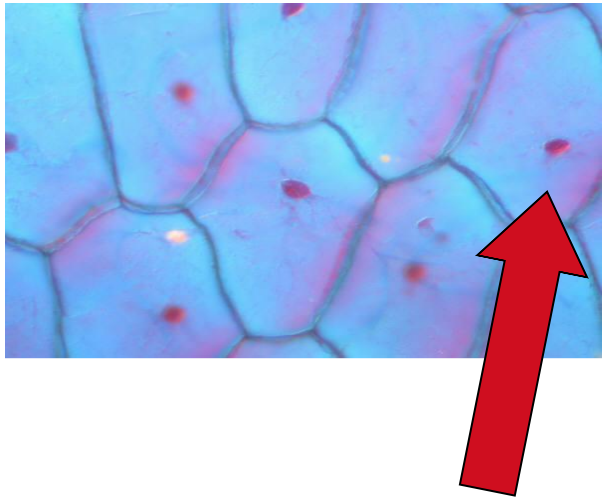
- Cytoplasm is the watery jelly-like material inside a cell surrounding the organelles

Mitochondria

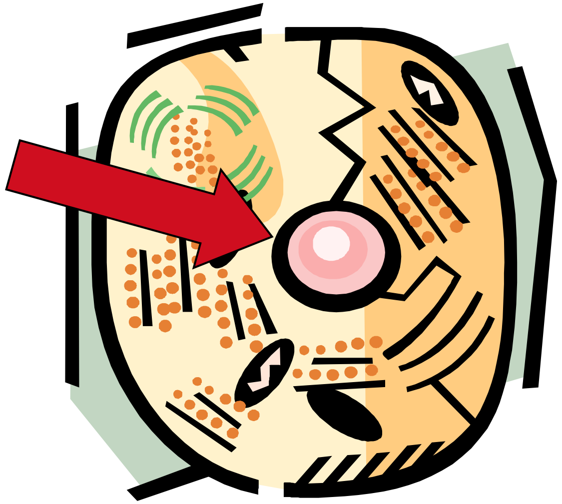
- Mitochondria is an ORGANelle that releases energy from food.
- Every type of cell has a different amount of mitochondria. There are more mitochondria in cells that have to perform lots of work.
- Other cells need less energy to do their work and have less mitochondria.



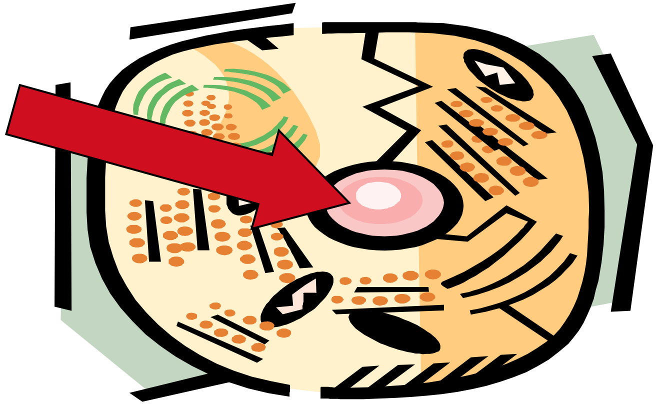
Nucleus



- The nucleus controls the cell.
- It is the largest organelle in the cell and contains the cell's DNA.



Nucleolus

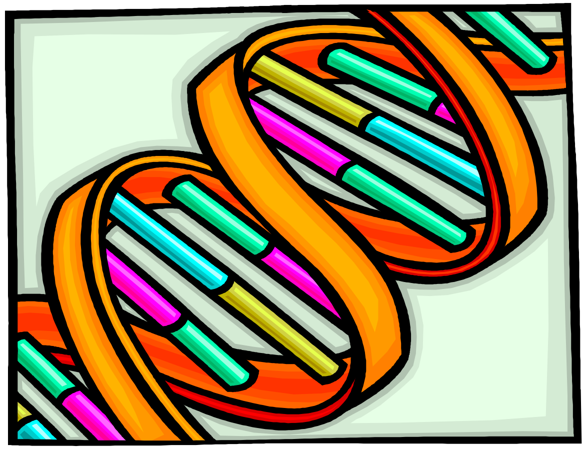


- Inside the nucleus is another organelle called the nucleolus.

- It is responsible for making ribosomes.

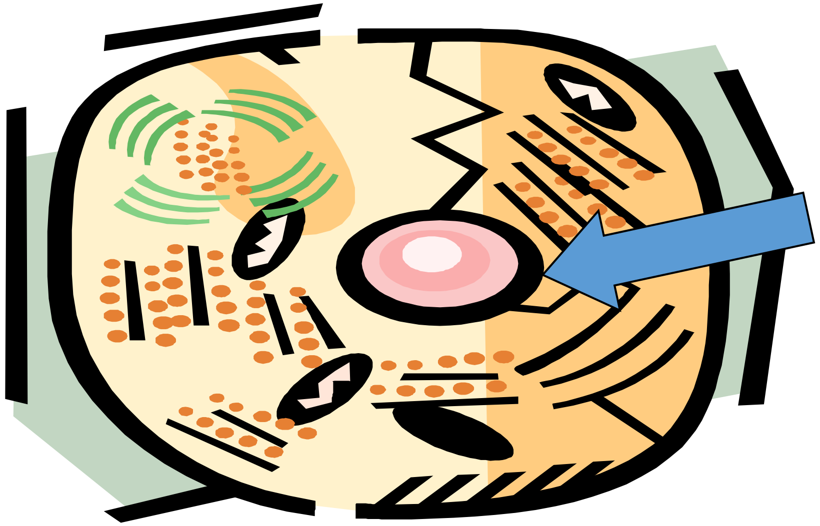
Chromosomes

- Chromosomes are inside the nucleus and are made of genes (DNA).
- Genes decide the cells traits and activities



Nuclear Membrane

- The nuclear membrane allows substances to pass in and out of the nucleus.



Vacuoles

- Vacuoles are spaces in the cytoplasm (gel) where food and chemicals are stored

Plant Vacuole

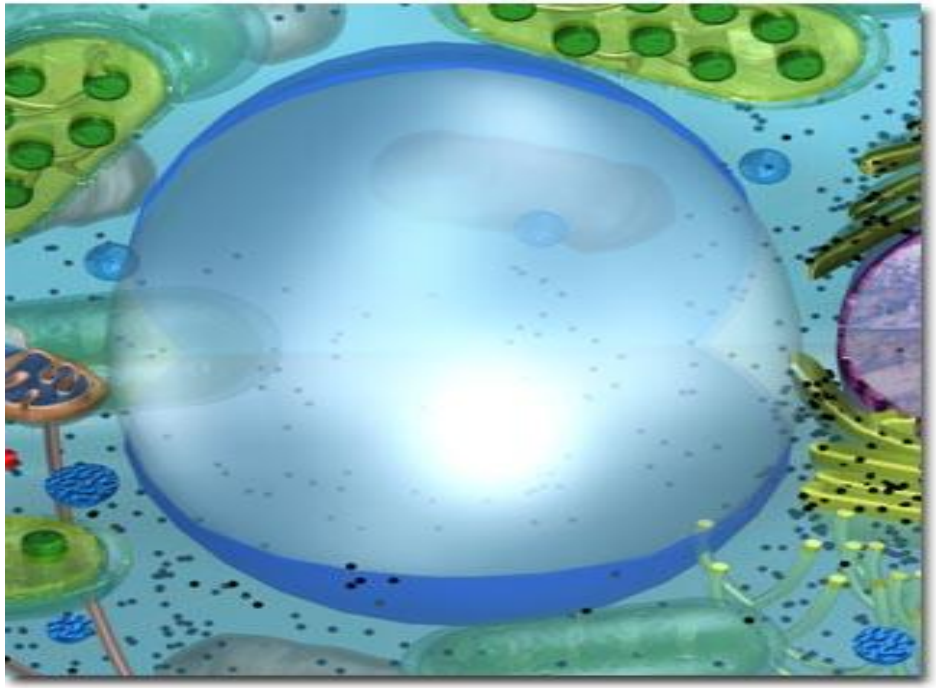
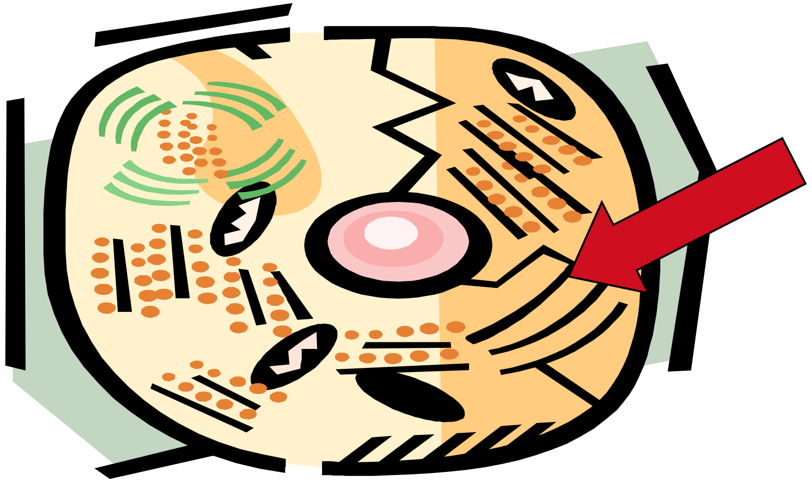


Figure 1

Endoplasmic Reticulum

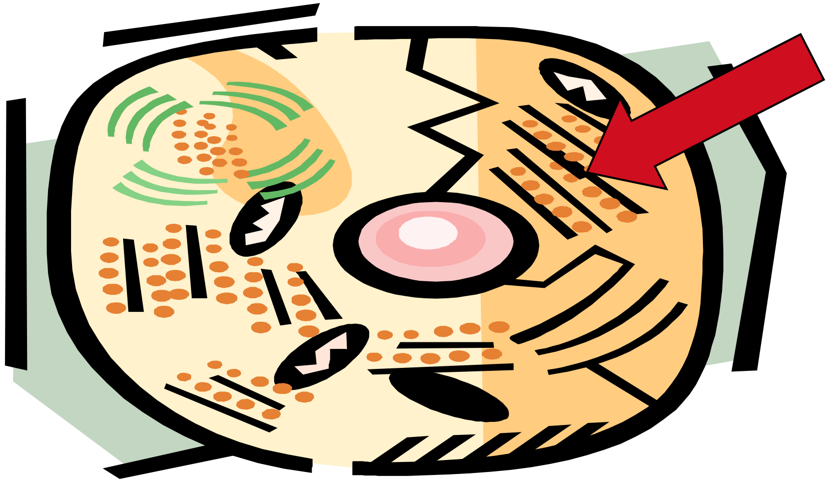
- It is a network of membranes throughout the cytoplasm of the cell.
- It helps to move materials around the cell.
- It is much like the blood vessels



Golgi apparatus

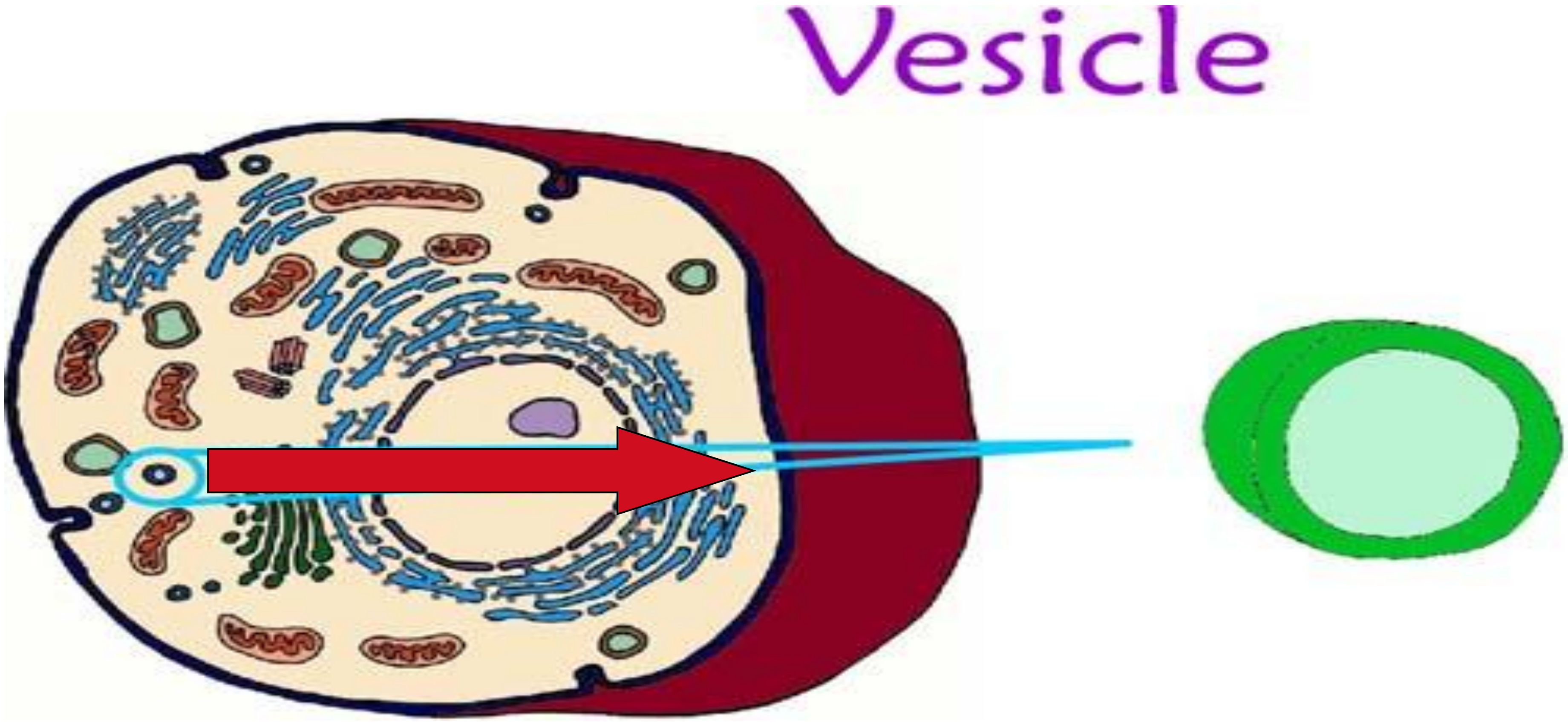
- It is organelle in the cell that is responsible for sorting and correctly shipping the proteins produced in the ER.

- The Golgi apparatus are stacks of membrane-covered sacs.



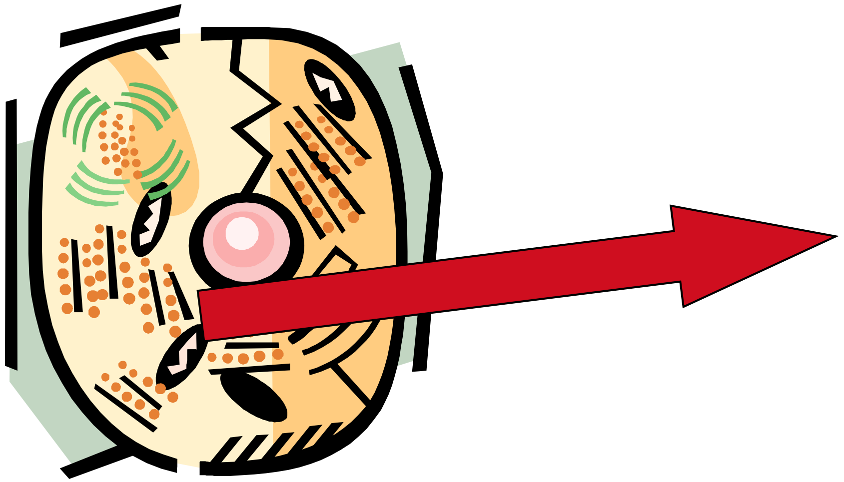
Vesicles

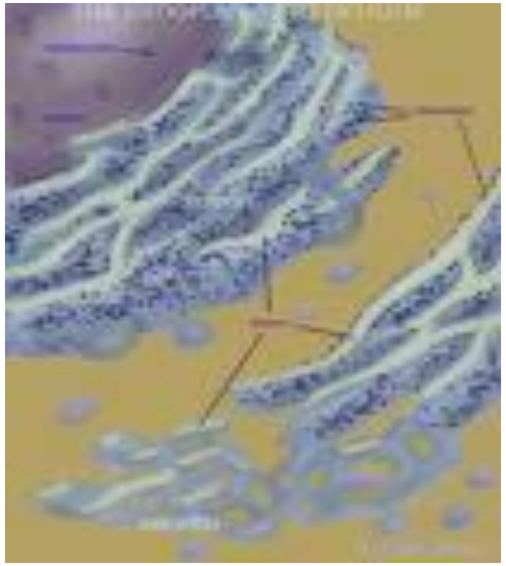
- It is a small sac that surrounds material to be moved into or out of a cell



Ribosomes

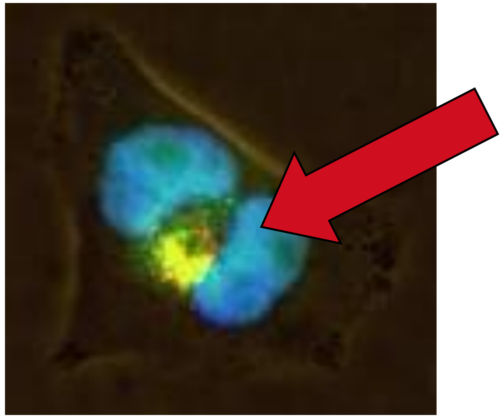
- Organelles that help in the synthesis of proteins.
- Some ribosomes are found in the cytoplasm, but most are attached to the endoplasmic reticulum.





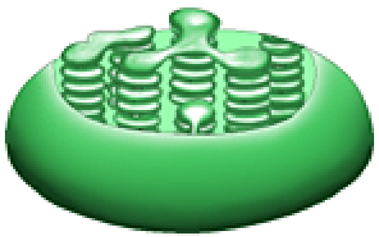
Lysosomes

- Lysosomes function as the cell's recycling compartment.
- Lysosomes contain digestive chemicals that help break down food molecules, wastes, and worn out cell parts.
- It’s similar to the digestive system!

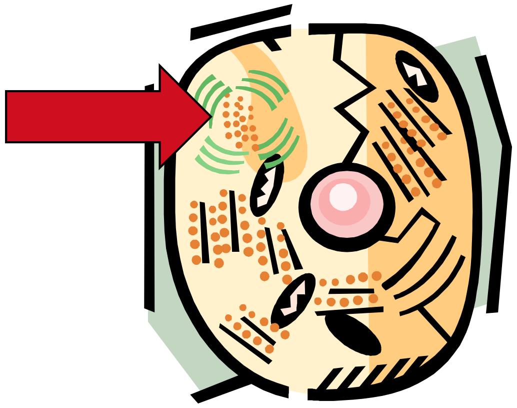


The lysosomes are stained RED!

Chloroplasts



- Chloroplasts are only in plant cells
- They contain chlorophyll, which helps make energy/food from sunlight
- Chlorophyll is green in color.

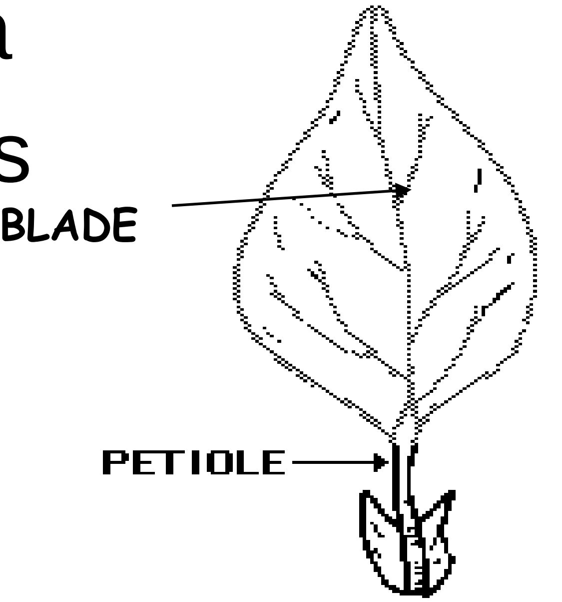


LEAVES: FORM & FUNCTION

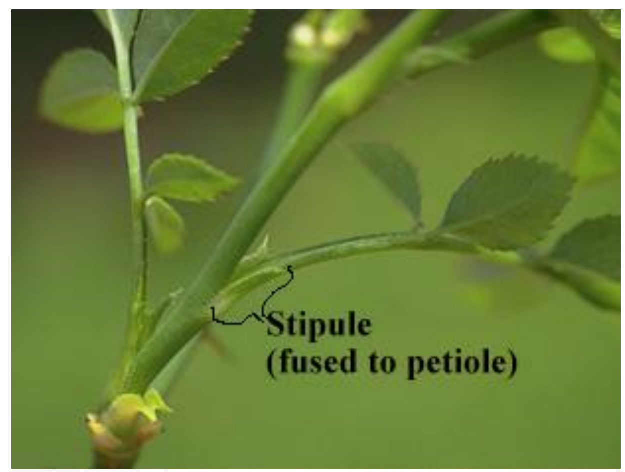
- Function
- External Anatomy
- Internal Anatomy
- Specialized Leaves

LEAVES:

- ‘Photosynthetic factories’ of the plant…
- Function: Photosynthesis – food production for the whole plant
- **Blade**: Flat expanded area
- **Petiole**: stalk that connects leaf blade to stem, and transports materials



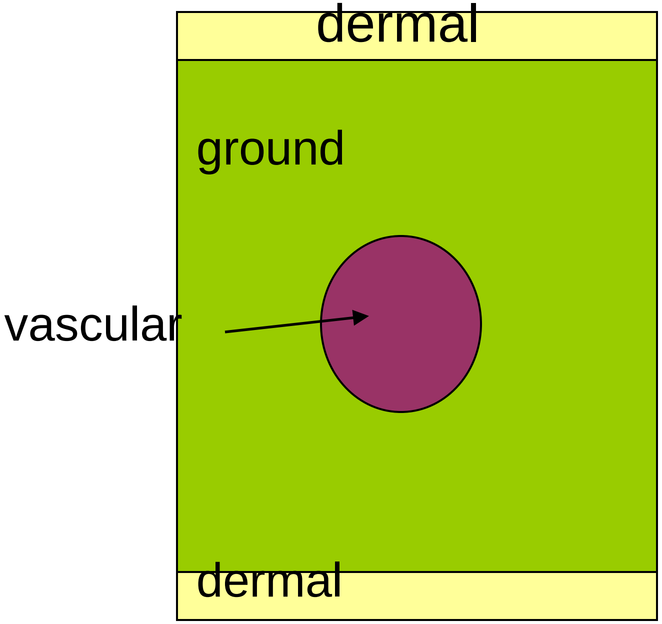
EXTERNAL ANATOMY

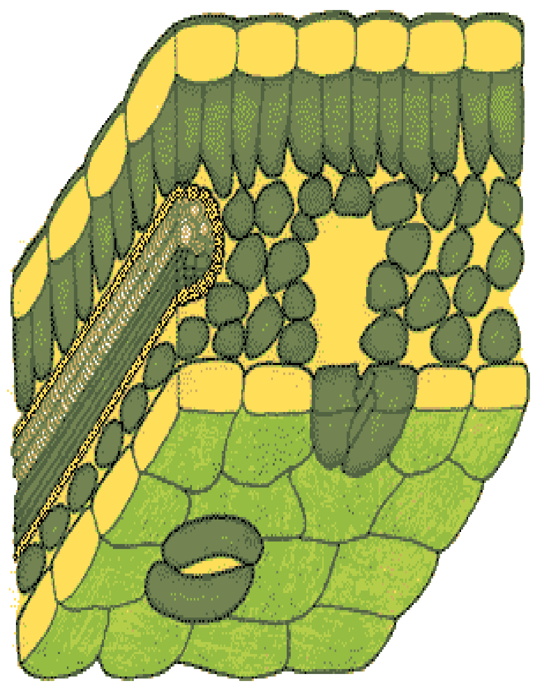


Leaf Anatomy

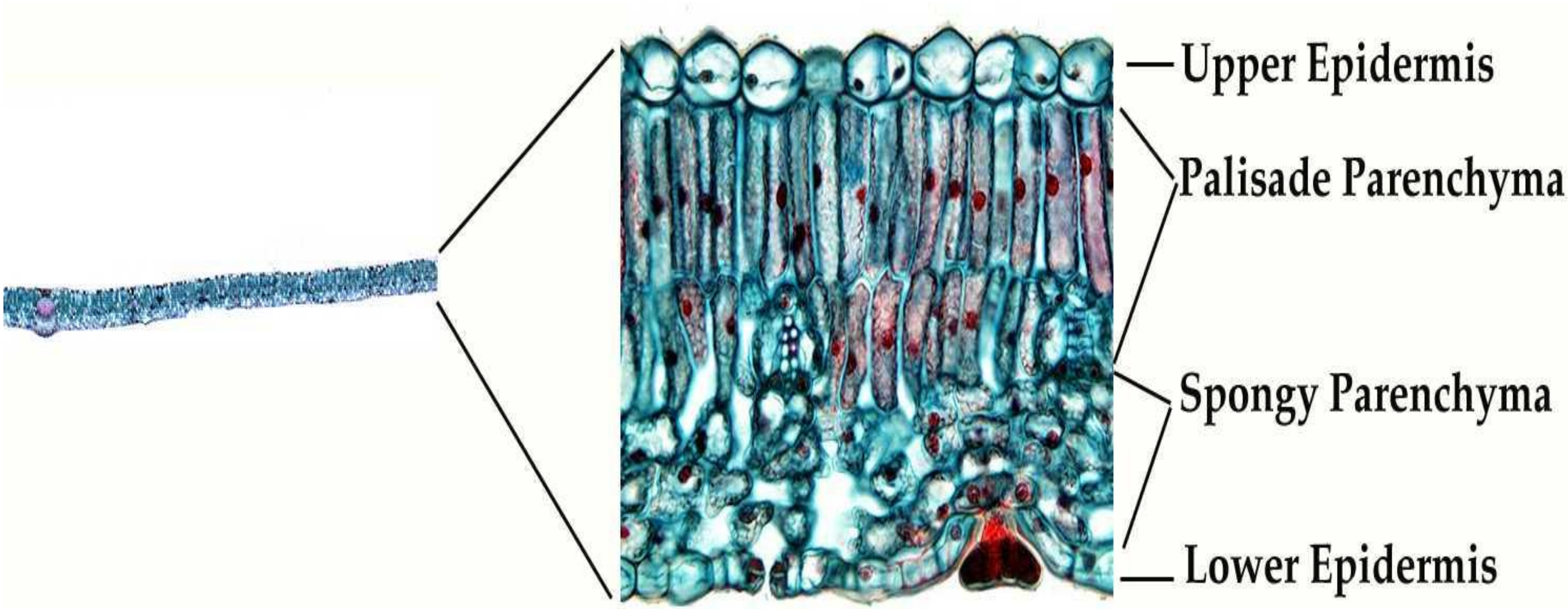
- Leaf anatomy is correlated to photosynthesis:

Carbon dioxide + Water → sugars + oxygen

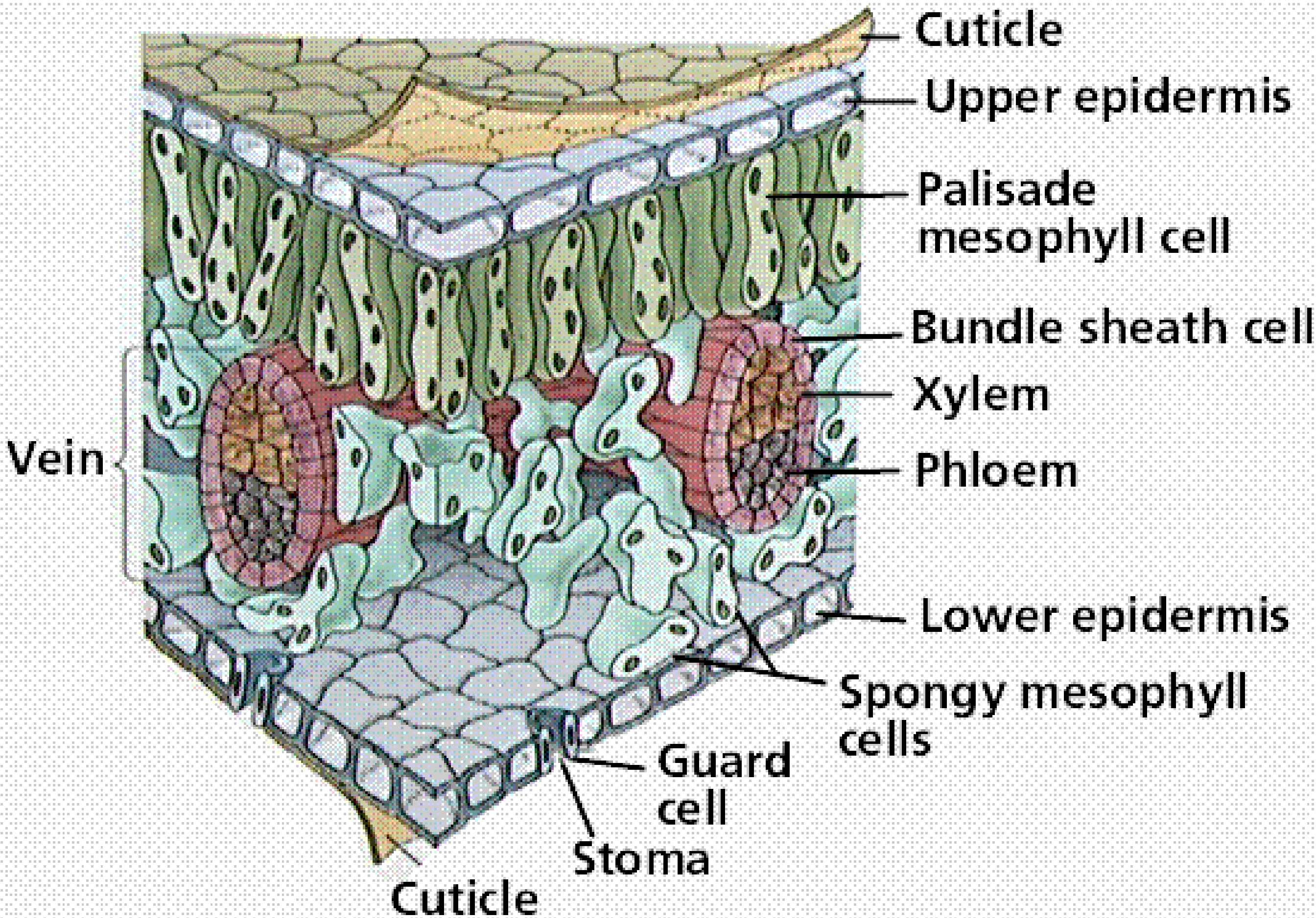




LEAF – Internal Anatomy

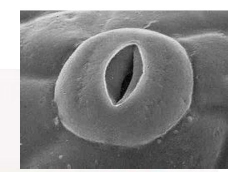


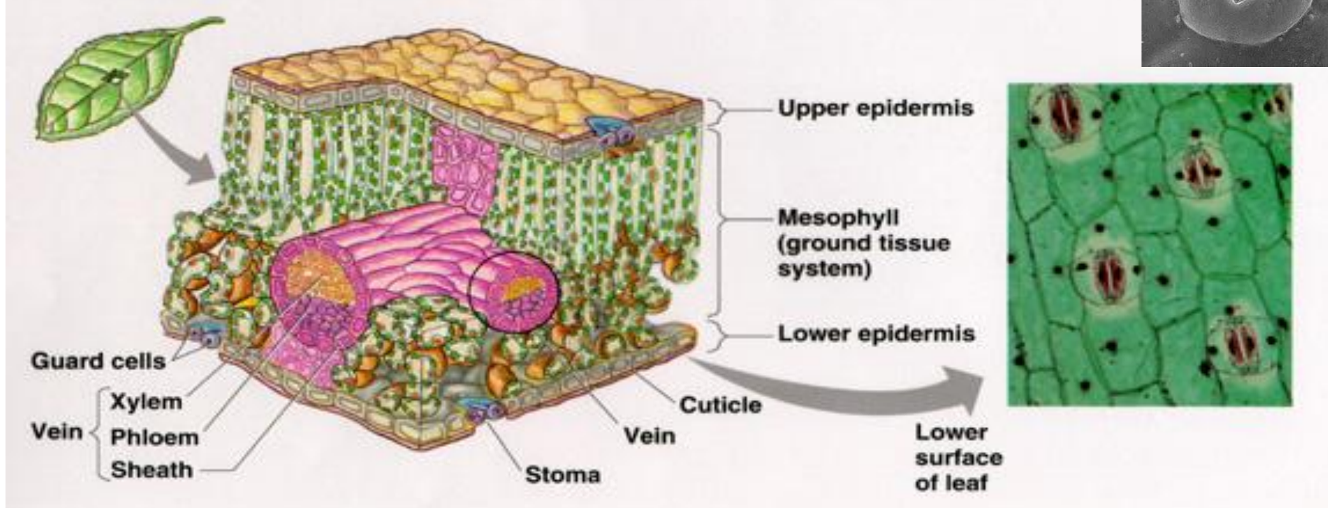
Leaf – Internal Anatomy



Leaf epidermis

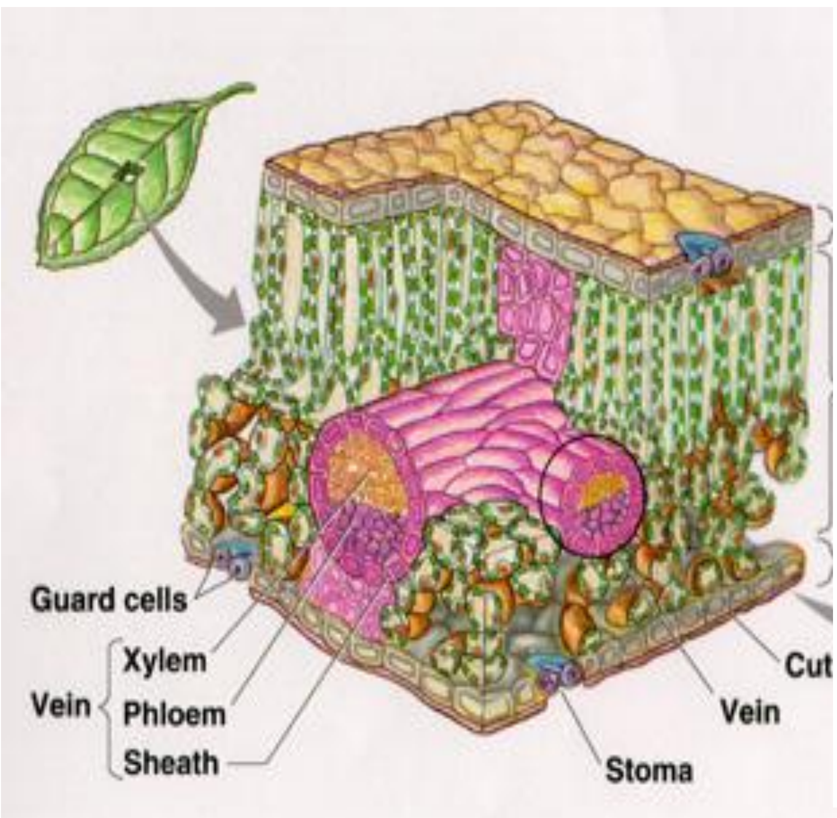
- Is transparent – so that sun light can go through.
- Waxy cuticle protects against drying out
- Lower epidermis: **stomata** with **guard cells** – for gas exchange (CO_2, H_2O in; O_2 out)





Leaf vascular tissue

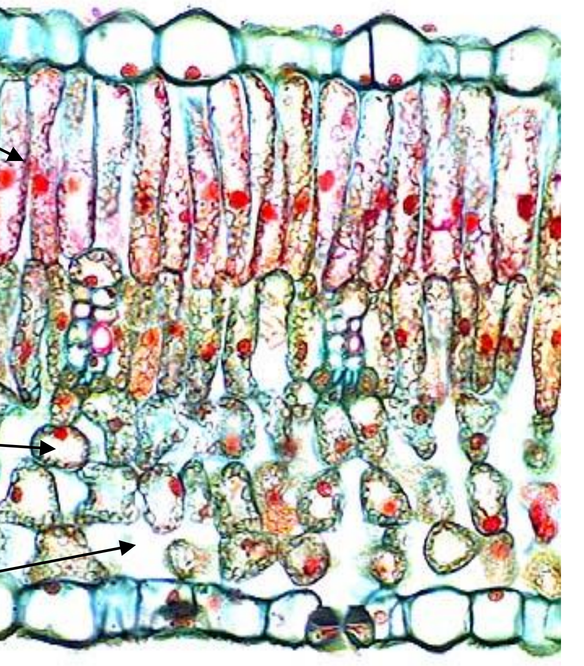
- **VEINS** → vascular tissue of leaves.
  - Veins are composed of **xylem** (water transport) **phloem** (food transport) and **bundle sheaths**, cells surrounding the xylem/phloem for strength & support



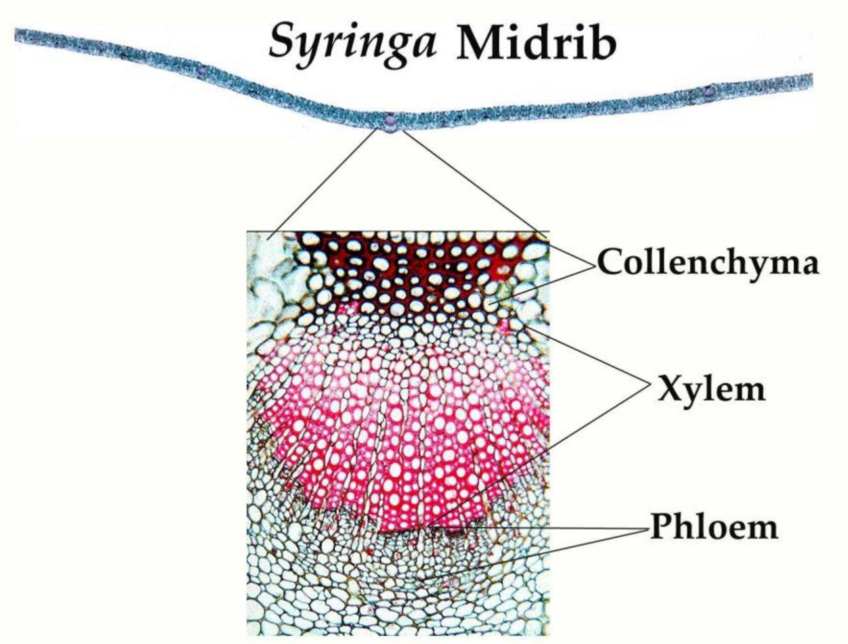
Leaf Mesophyll

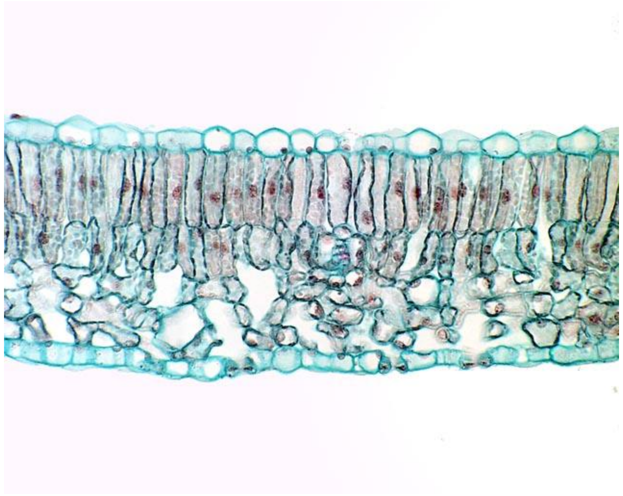
- Middle of the leaf (meso-phyll)
- Composed of photosynthetic ground cells:
- **Palisade** parenchyma (long columns below epidermis, have lots chloroplasts for photosynthesis)

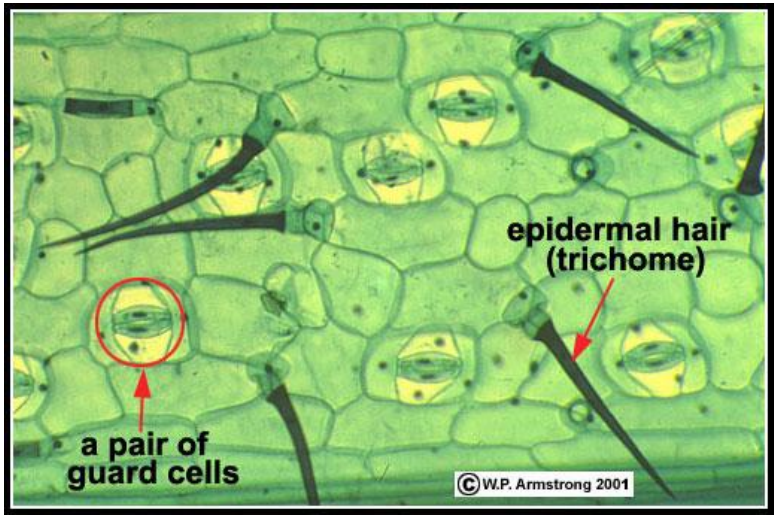
Spongy parenchyma (spherical cells) with **air spaces** around, (for gas exchange)



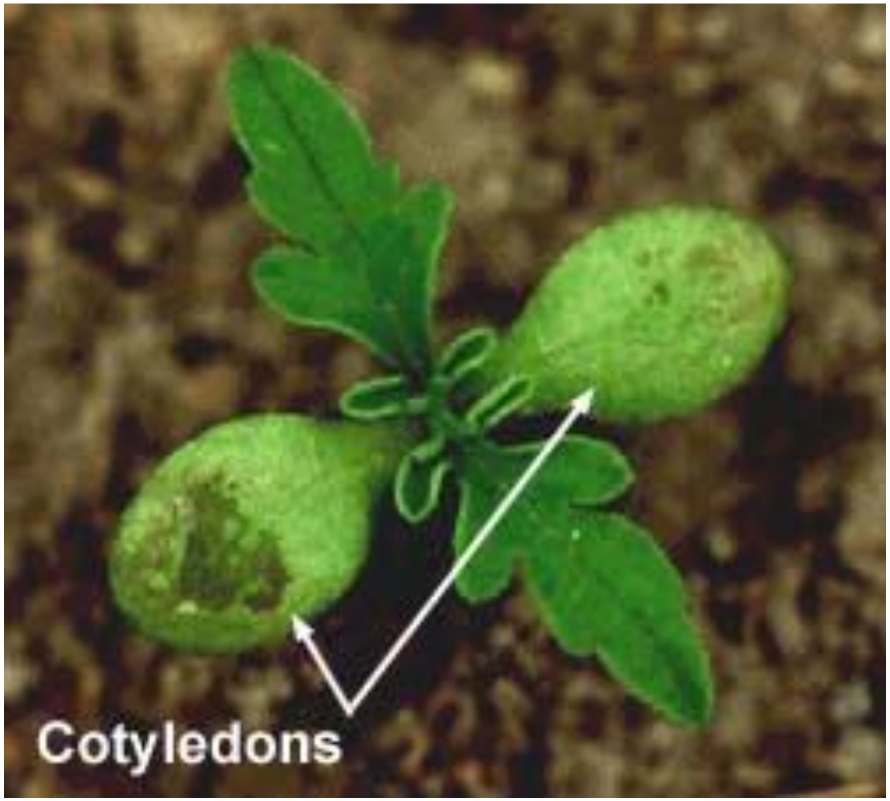
Internal and External Views

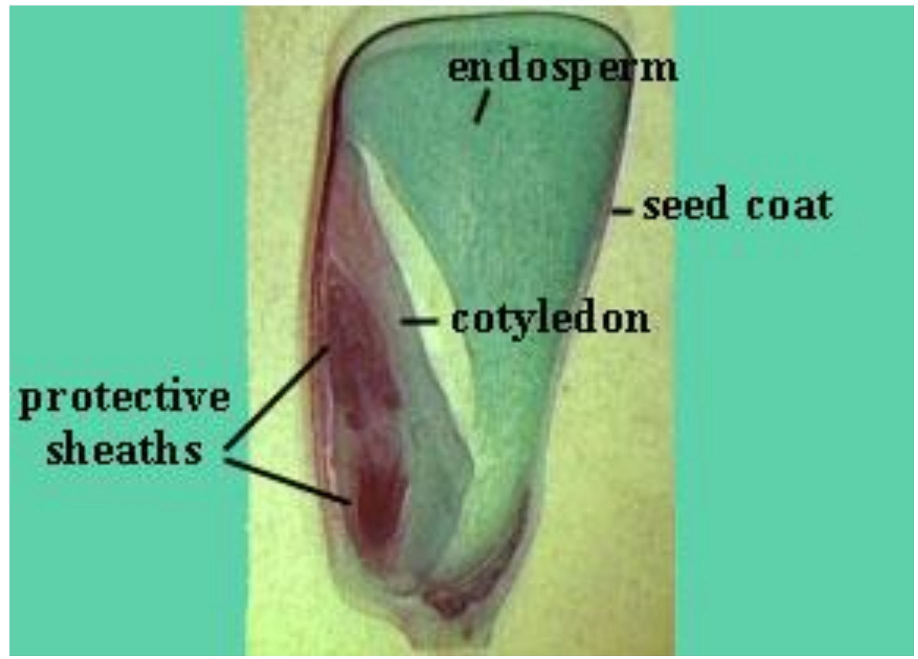






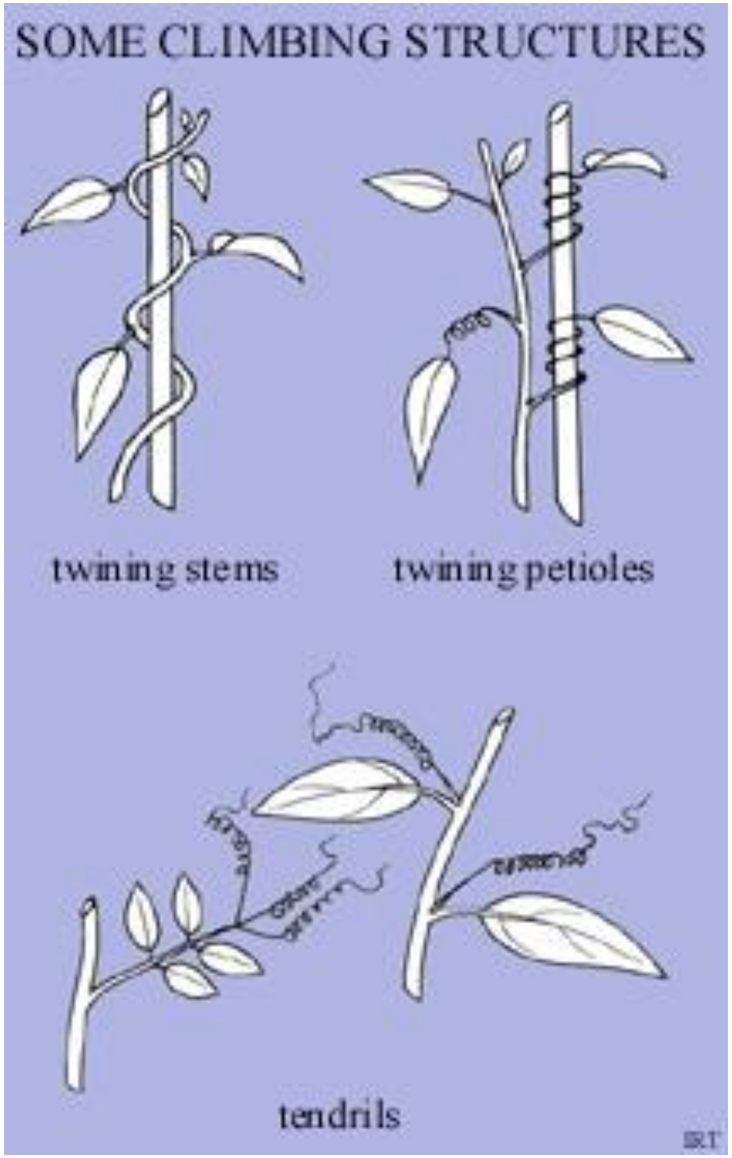
Cotyledons or “seed leaves”





Tendrils

Garden Pea



Leaves as Needles and Spines

Leaves as Colorful Bracts

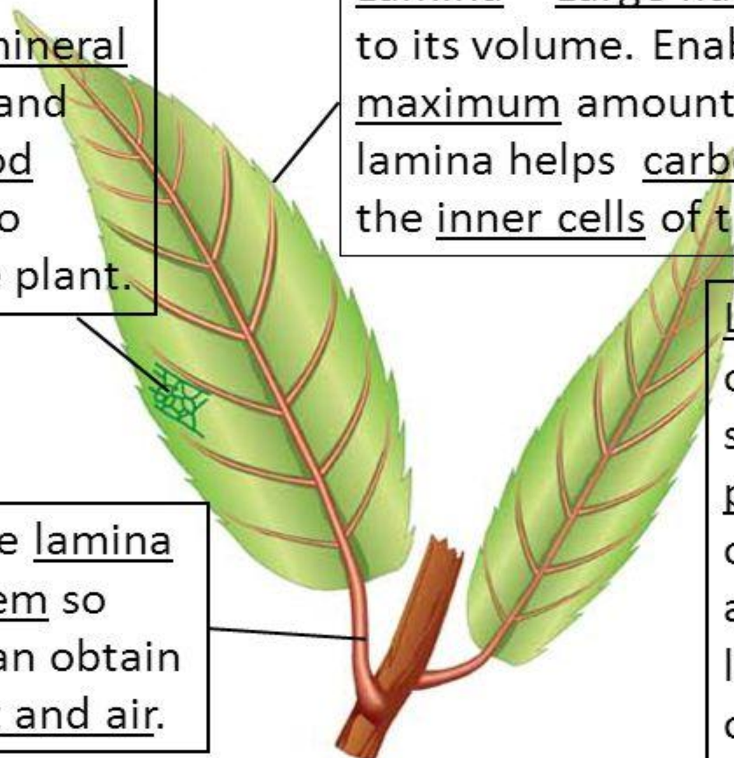
L-5- Leaf arrangement

Arrangement of leaf

External Features of Leaf

Network of veins – carry water and mineral salts to the cells, and manufactured food from these cells to other parts of the plant.

Lamina – Large flat surface compared to its volume. Enables leaf to obtain maximum amount of sunlight. Thin lamina helps carbon dioxide to reach the inner cells of the leaf rapidly



Petiole – holds the lamina away from the stem so that the lamina can obtain sufficient sunlight and air.

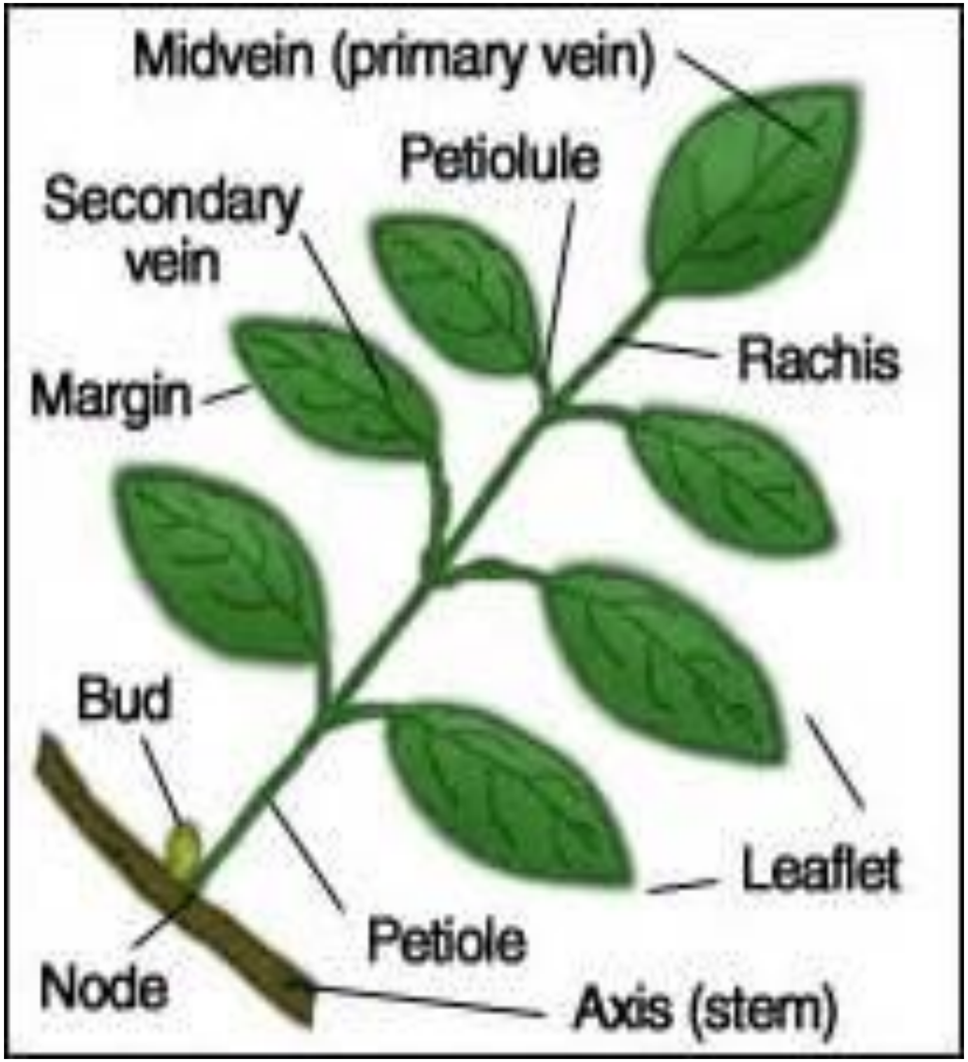
Leaf arrangement – organised around the stem in a regular pattern. Either in pairs or singly in an alternate arrangement. Thus, leaves are not blocking one another from sunlight, receiving optimum light.

Leaves

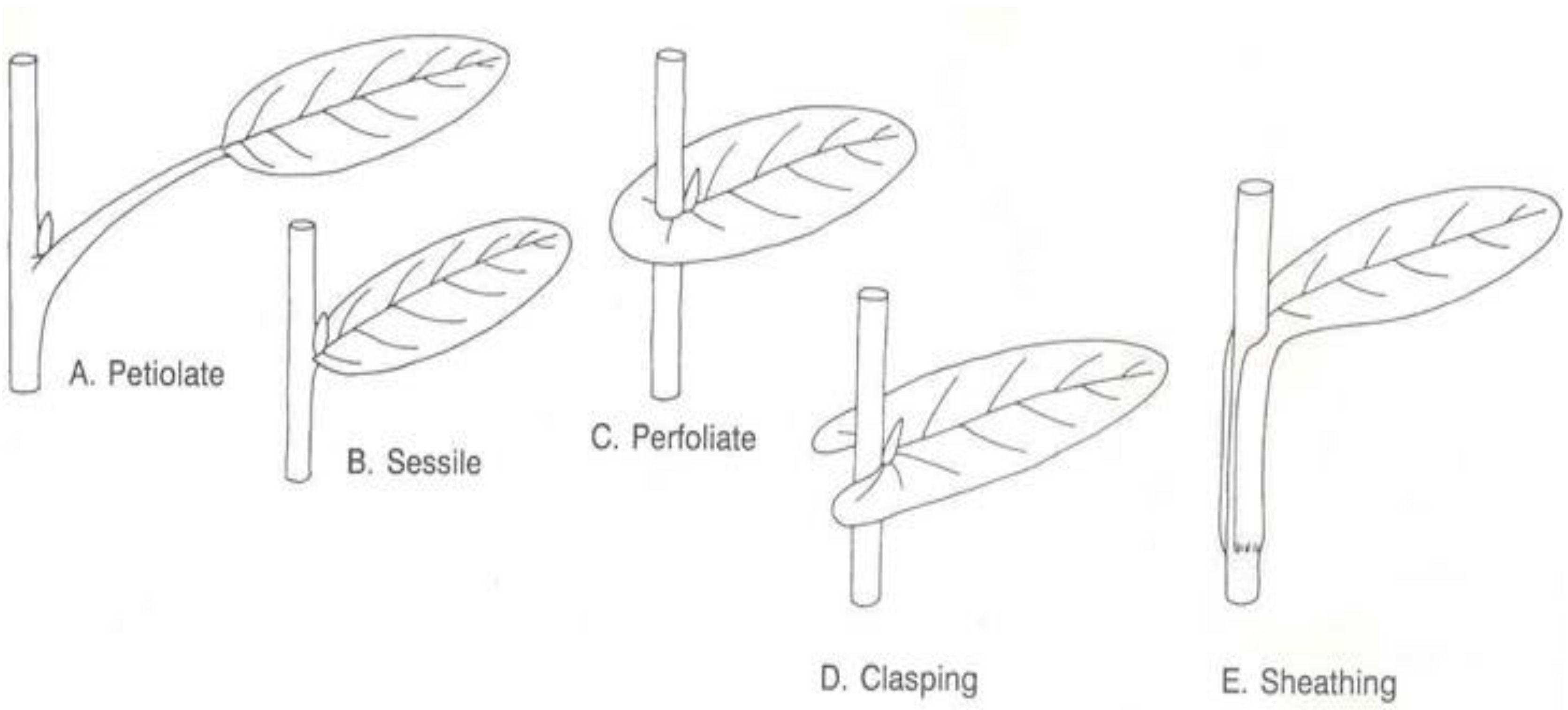
- FUNCTIONS
  - light capture, production of photosynthates, transpiration
- STRUCTURE
  - petiole, stipules, pulvinus, blade (lamina), veins
  - vestiture (minimally a cuticle), hairs, scales, etc.
  - simple vs. compound (blade divided into discrete parts)
  - many modifications, including extreme reduction
  - virtually always with a bud or branch in the axil
- DESCRIPTIVE TERMS:
  - Many, based on leaf shape, size, color, venation, margin, apex, base, arrangement, number, presentation

Leaf and its parts

Leaf and its parts

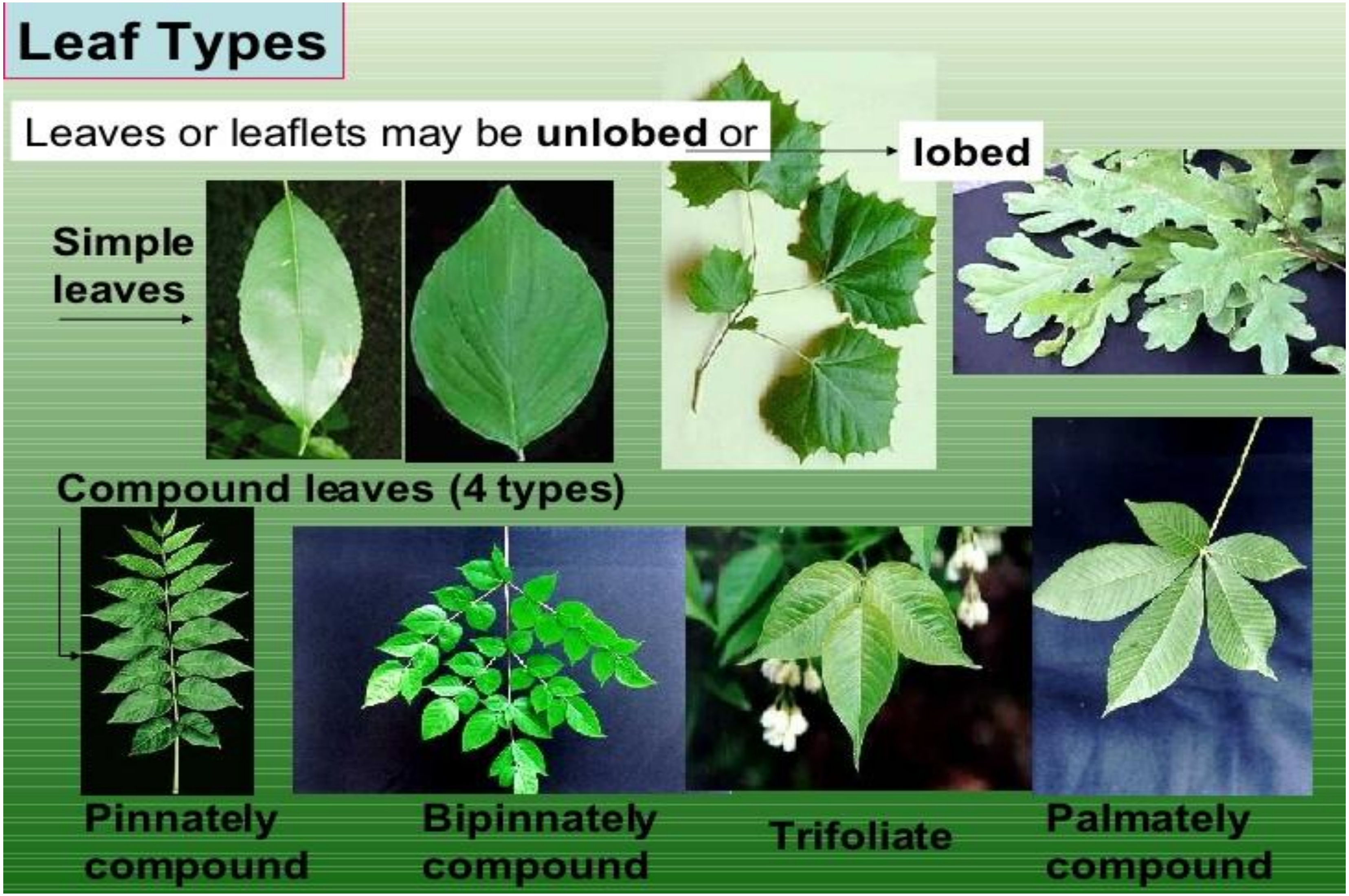


Leaf Attachments

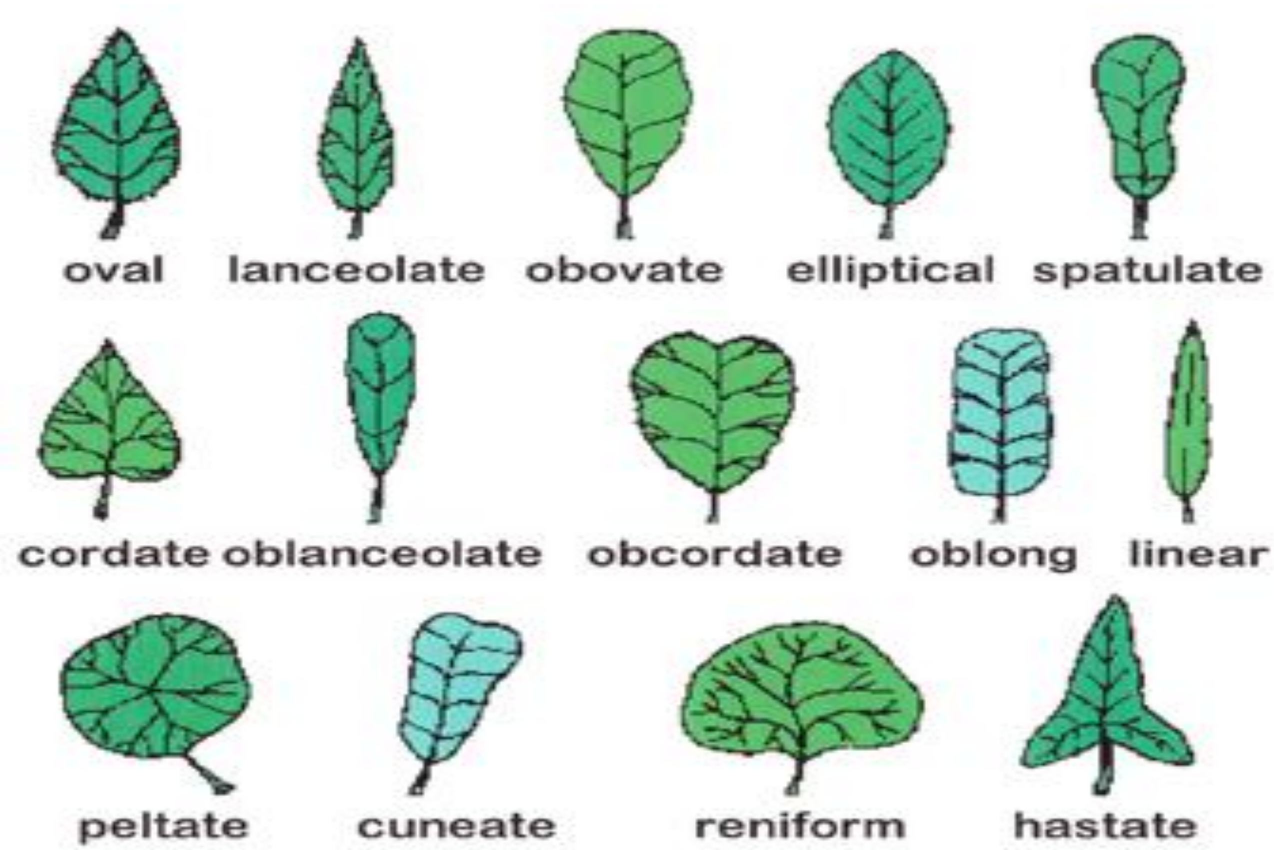


Leaf Arrangement

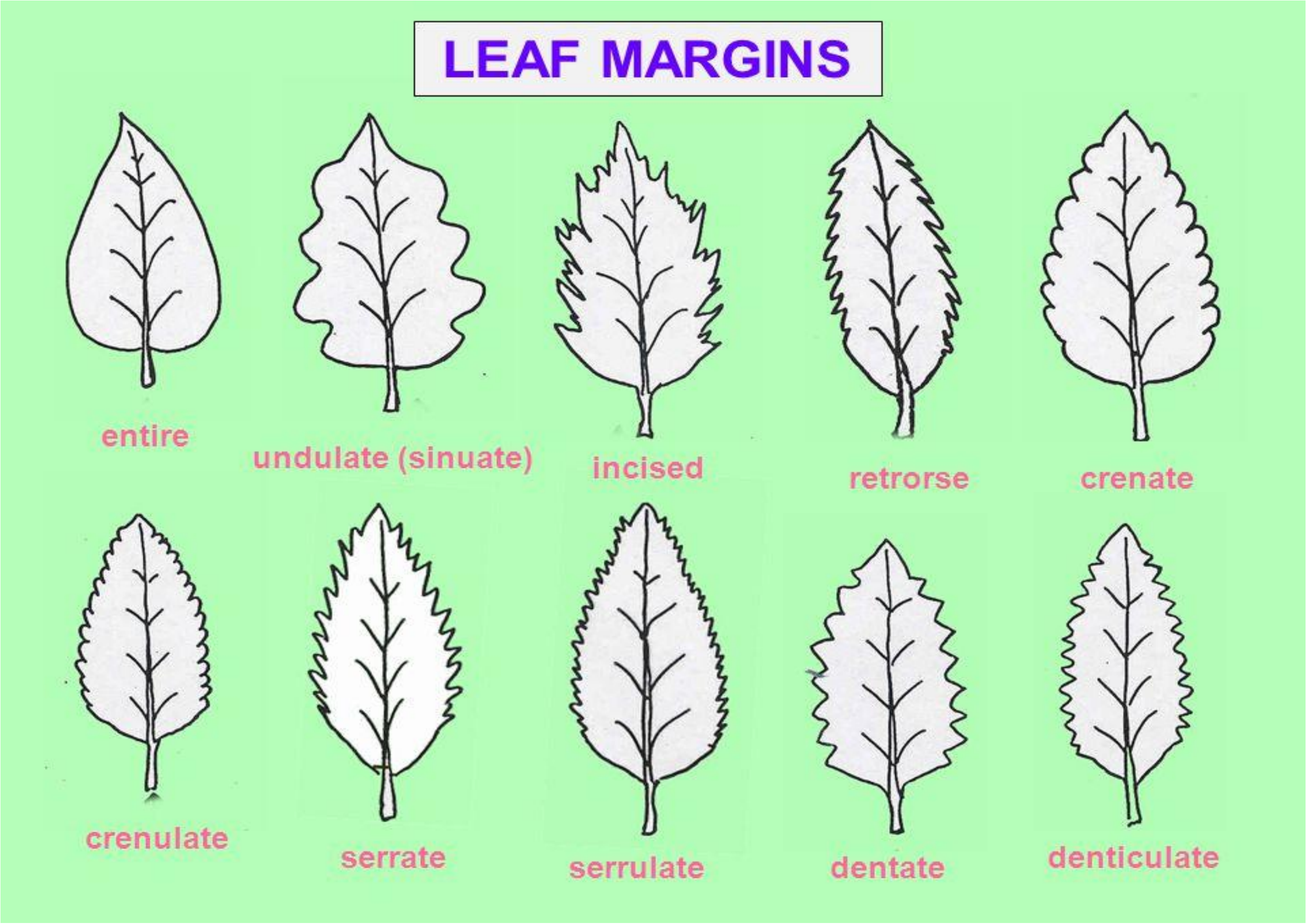
Leaf structure



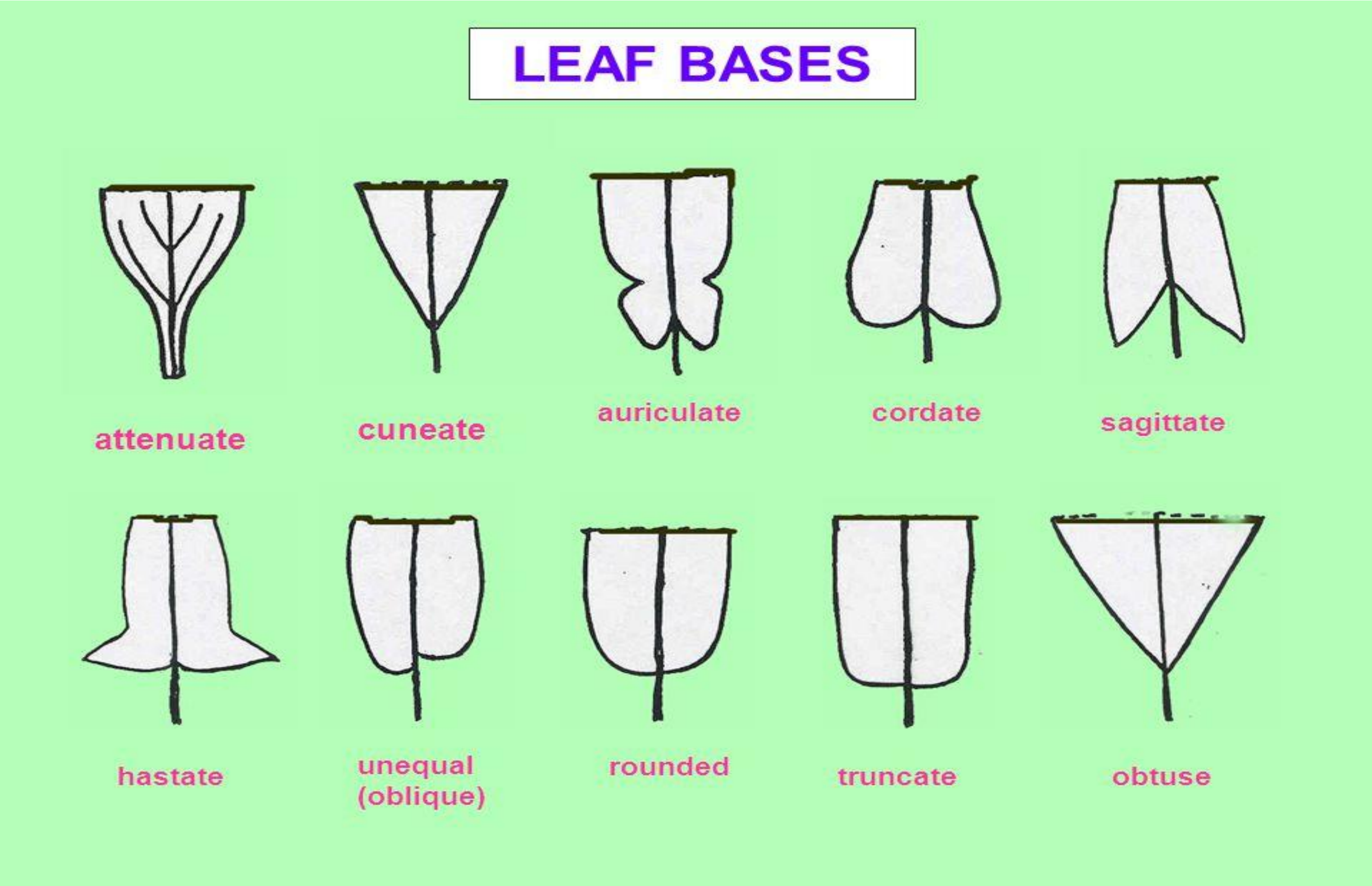
Leaf Shapes


oval
lanceolate
obovate
elliptical
spatulate
cordate
oblanceolate
obcordate
oblong
linear
peltate
cuneate
reniform
hastate

Leaf Margins

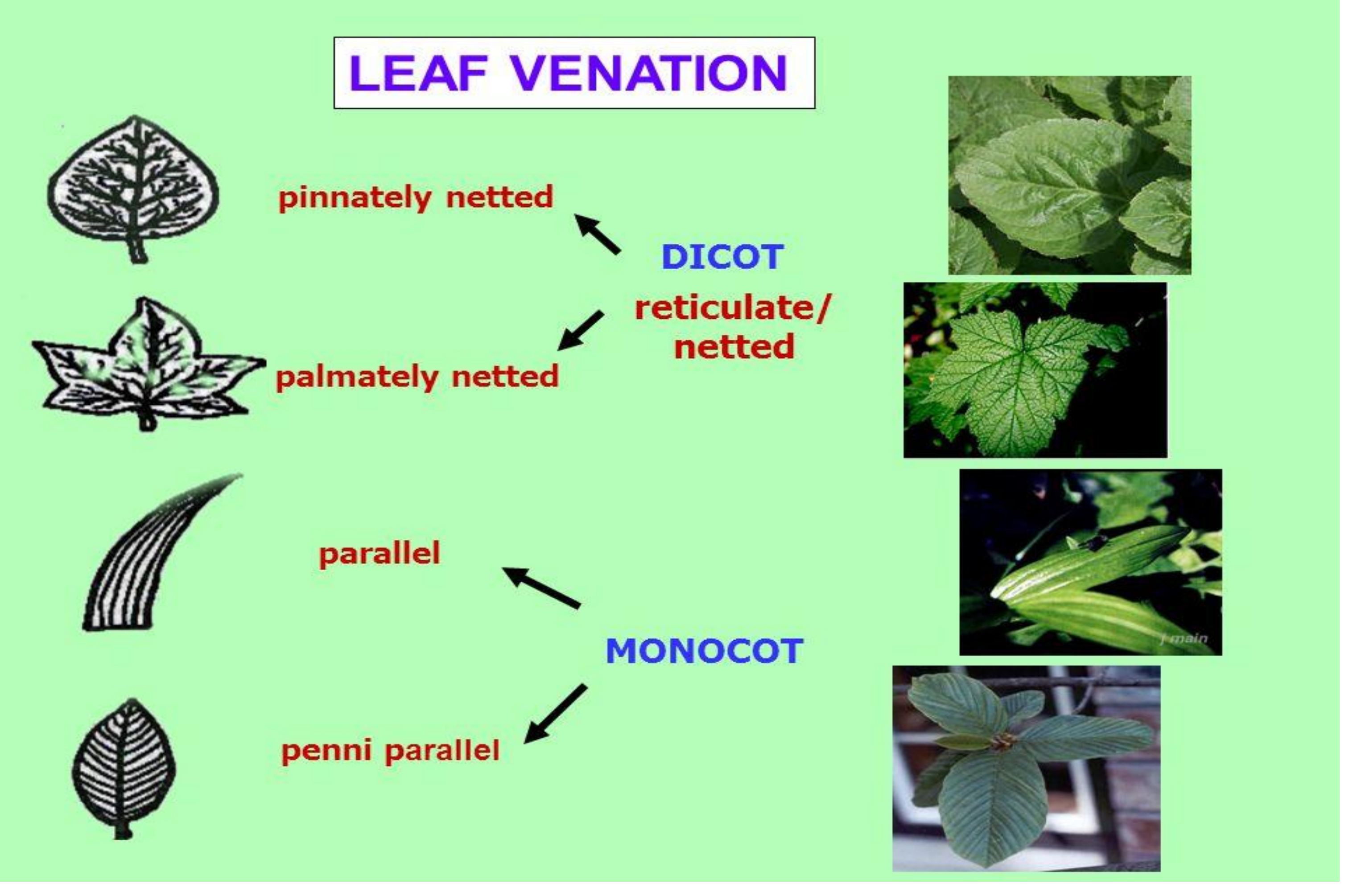


Leaf bases

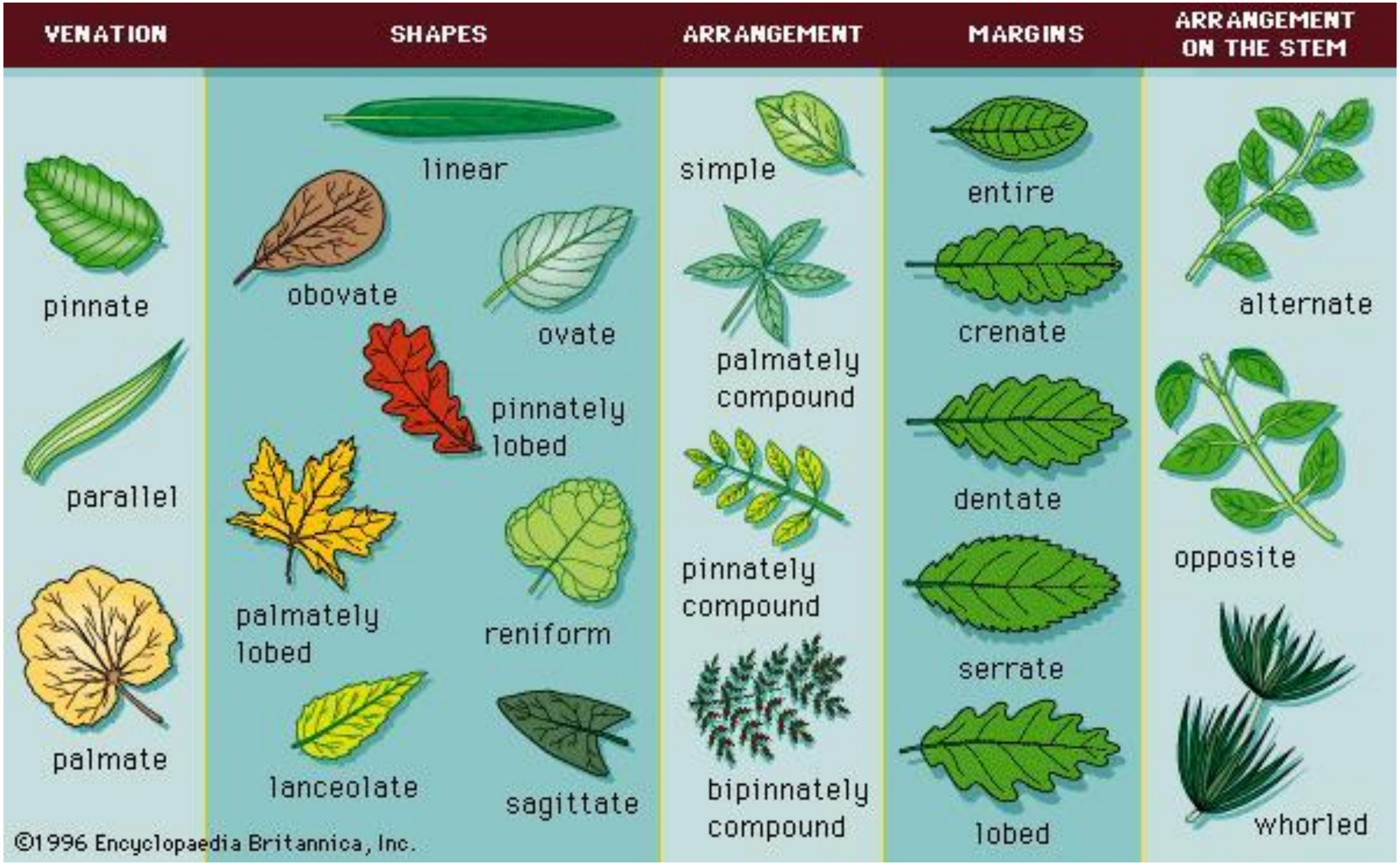


LEAF BASES
attenuate
cuneate
auriculate
cordate
sagittate
hastate
unequal (oblique)
rounded
truncate
obtuse

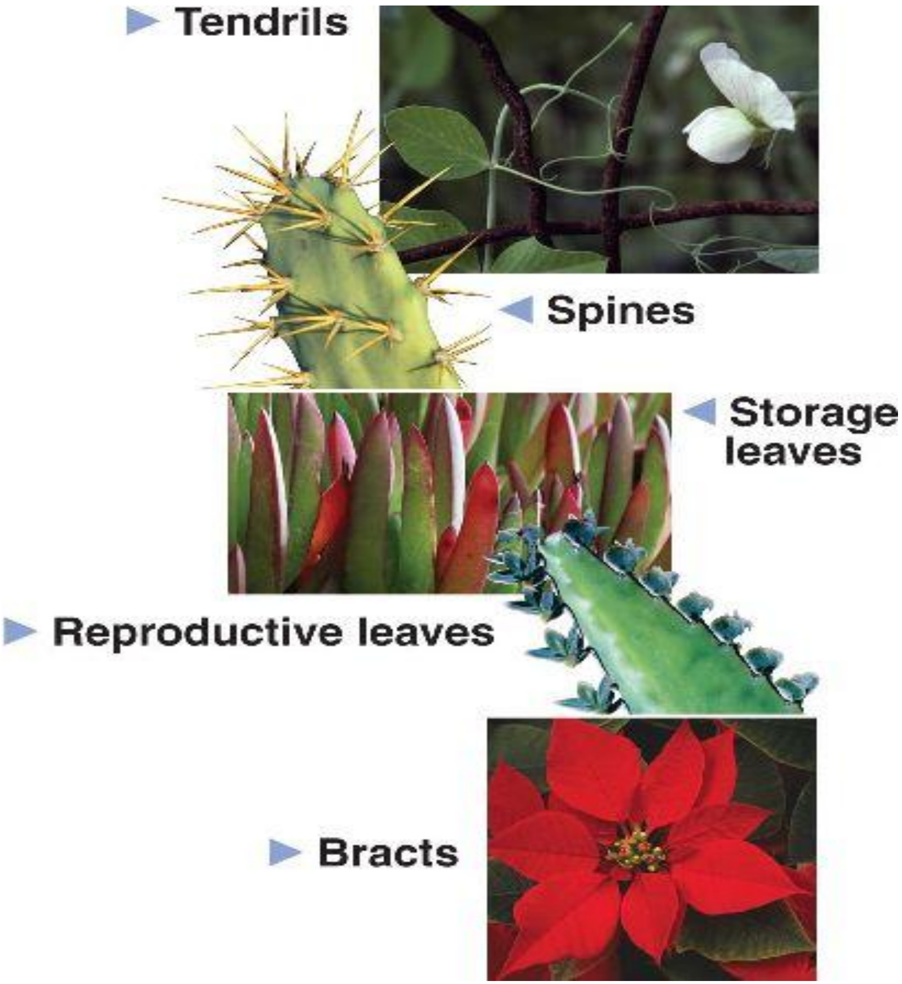
Leaf Venation

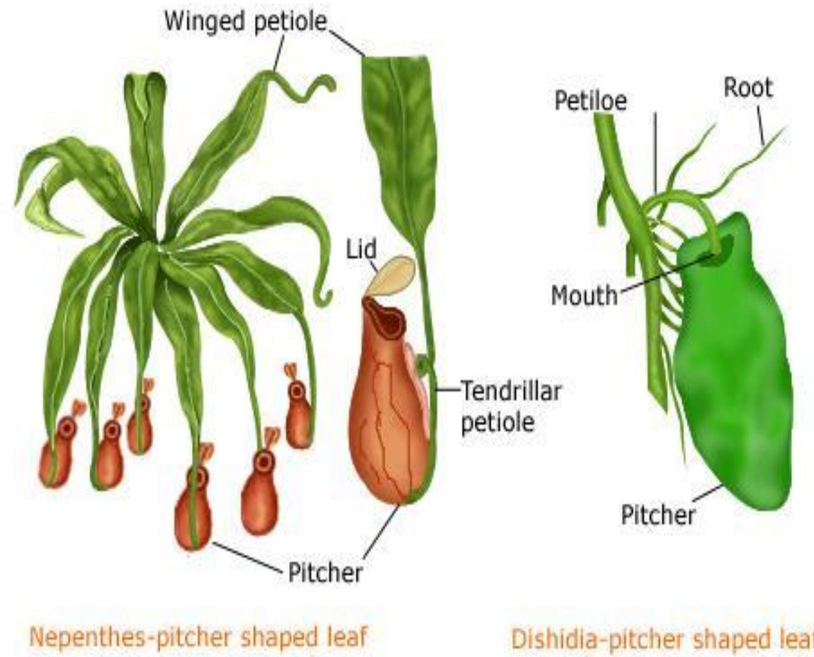


Patterns of leaf arrangement



Modified leaves

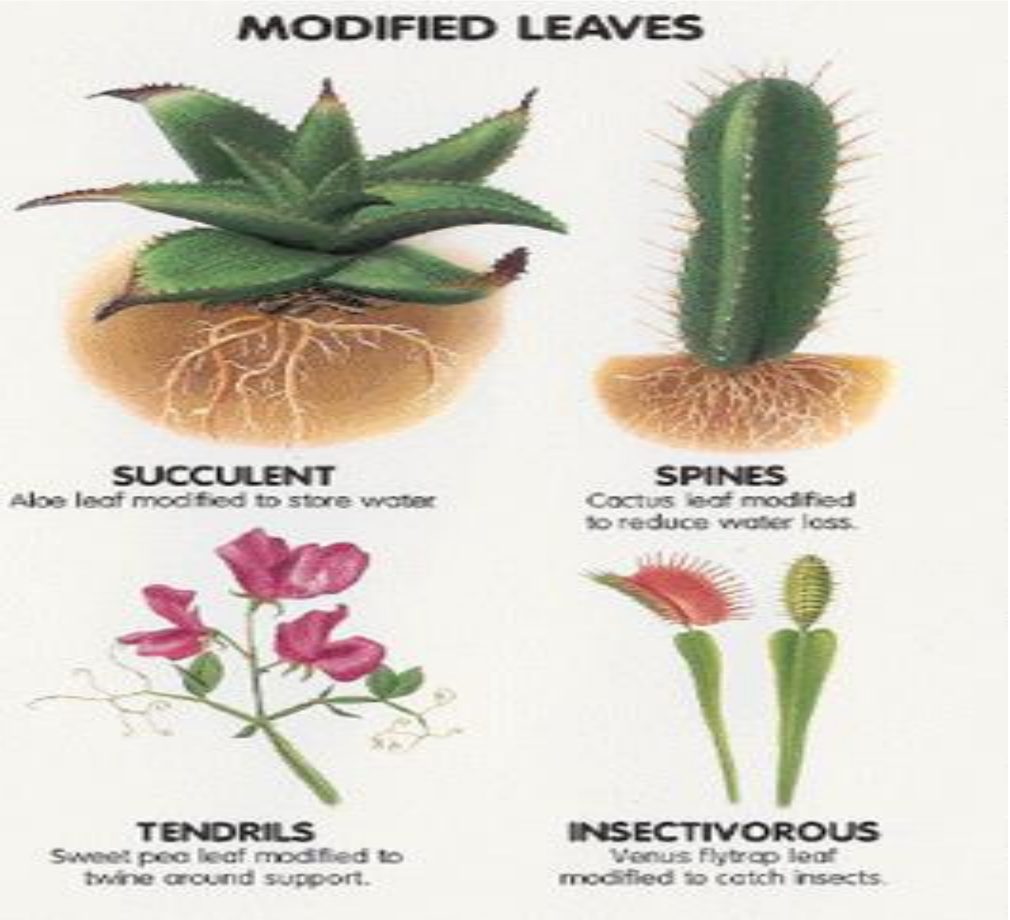




Modified leaves

- **Like other organs, leaves are often modified for functions other than photosynthesis. Below are a few examples:**
- **Tendrils-of plants are leaves modified for support. In some plants the entire leaf is a tendril; photosynthesis in these plants is delegated to leaf like structures called stipules at the base of each leaf.**
- **Tendrils, of many plants may be up to 30 cm long, which makes them well suited for seeking support in the plant's nearby environment.**

Modified leaves



- **Spines**-leaves modified for protection.

- **Bud Scales**-are tough, overlapping, waterproof leaves that protect buds from frost, desiccation, and pathogens. Bud scales form before the onset of unfavorable growing seasons i.e. winter.

Storage leaves- They are packed tightly into a flower pot like structure that catches falling water and debris.

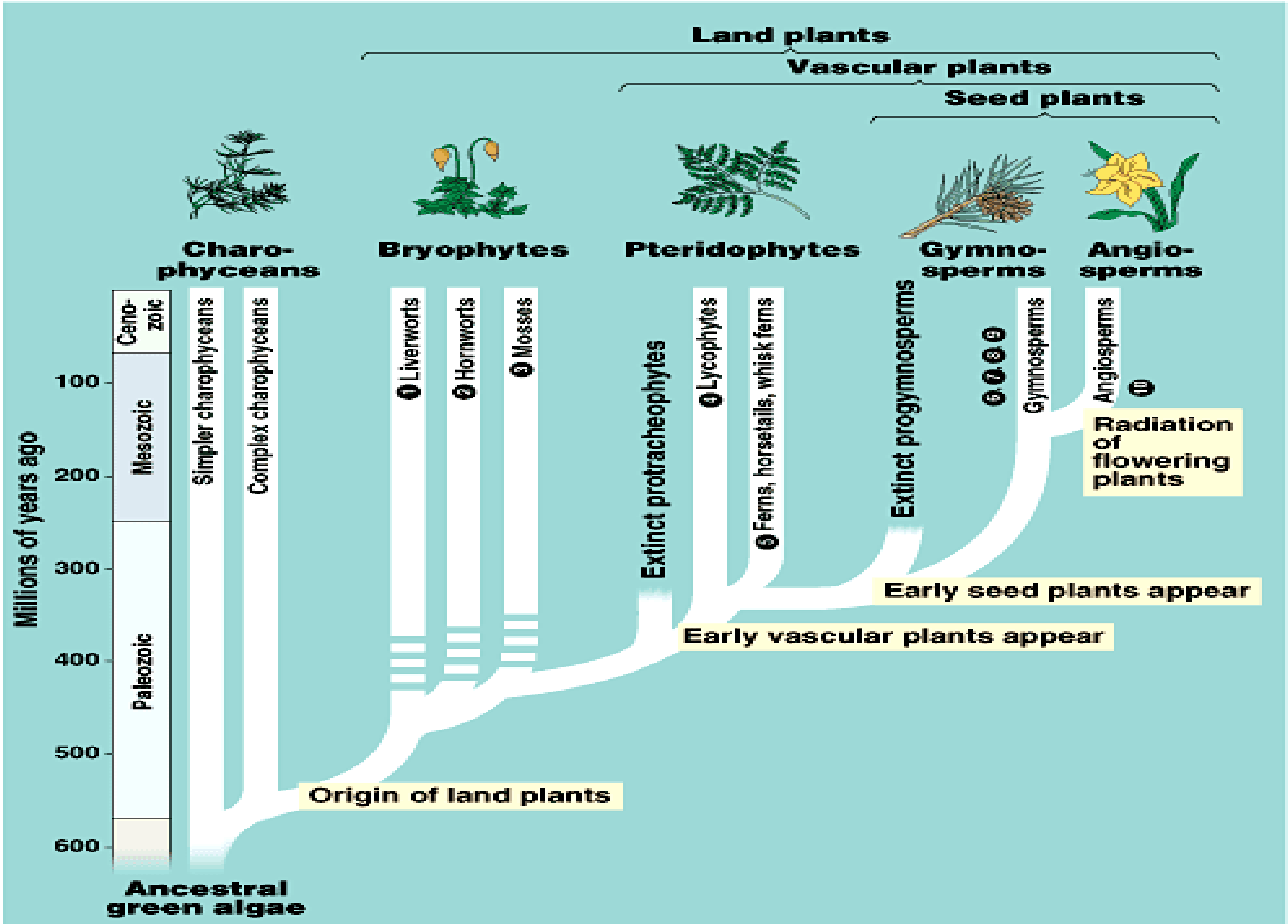
Classification

Grouping plants

Plants Groups

4 groups of land plants:
Bryophytes, Pteridophytes, Gymnosperms, and Angiosperms.

- Most common bryophytes - mosses.
- Pteridophytes - ferns.
- Gymnosperms – pines, conifers.
- Angiosperms - flowering plants.


Land plants
Vascular plants
Seed plants
Charo-phyceans
Bryophytes
Pteridophytes
Gymno-sperms
Angio-sperms
Millions of years ago
100
200
300
400
500
600
Ceno-zoic
Mesozoic
Paleozoic
Simpler charophyceans
Complex charophyceans
1 Liverworts
2 Hornworts
3 Mosses
Extinct protracheophytes
4 Lycophytes
5 Ferns, horsetails, whisk ferns
Extinct progymnosperms
6 7 8 9
Gymnosperms
Angiosperms
10
Radiation of flowering plants
Early seed plants appear
Early vascular plants appear
Origin of land plants
Ancestral green algae

BRYOPHYTES (NON-VASCULAR PLANTS)

❖ Earliest land plants

❖ Well-adapted to moist habitats (low-lying)

❖ The only land plants that have a dominant gametophyte(the sporophyte is parasitic to the gametophyte).

❖ **The following three divisions of non-vascular plants have been traditionally called "the bryophytes"**

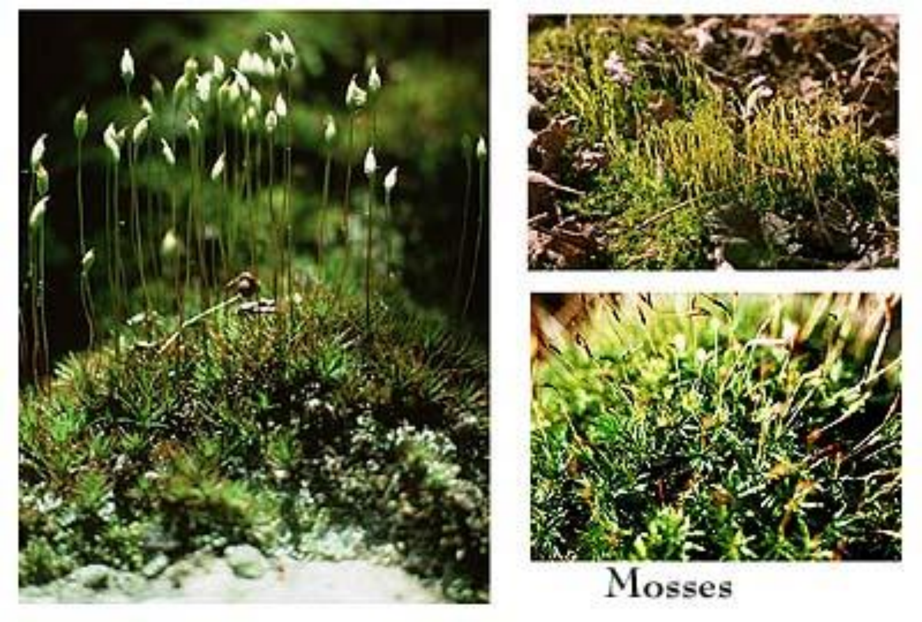
*** Division HEPATOPHYTA - the Liverworts**

*** Division ANTHOCEROPHYTA - the Hornworts**

*** Division BRYOPHYTA - the Mosses**

BRYOPHYTES (Mosses)

- Reproduce by spores
- Thin Leaves
- No roots or xylem vessels



Example of Bryophytes :

***Marchantia* – Asexual Reproduction by Gemmae**

Gemma cups on dorsal surface

Funaria

- **Sporophyte**

❖**only the female moss produces an erect sporophyte (at the terminal end of the stem exhibiting a long seta and short cylindrical capsule) and bears spores**

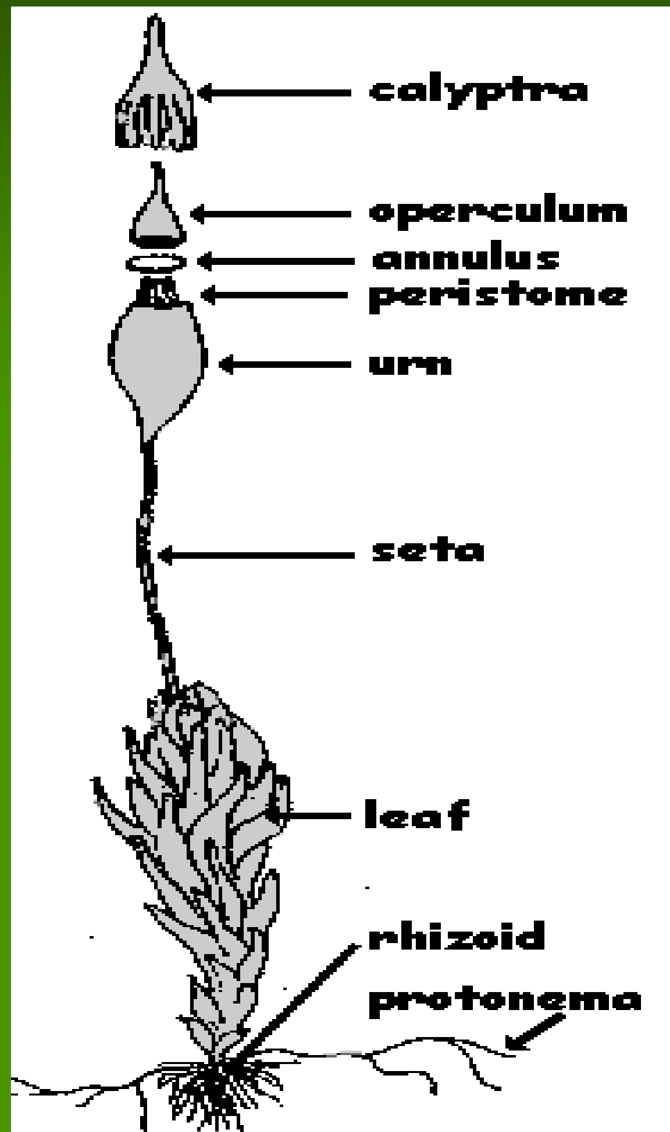
- **Gametophyte**

❖**Green, leafy and generally, upright**

Reproduction

❖**Asexually: spore formation in capsules (with calyptra, operculum and peristome teeth)**

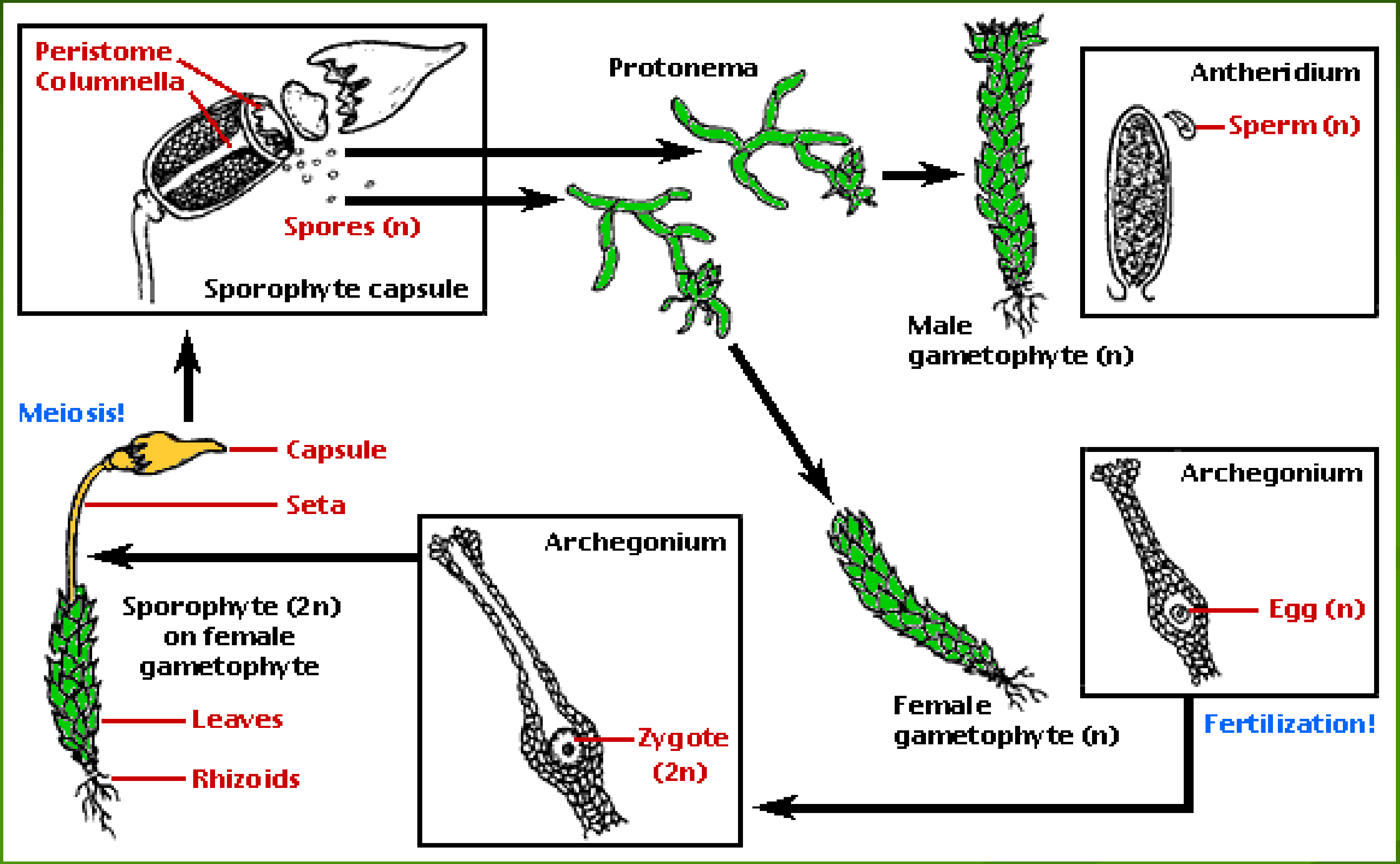
❖ **Sexually: gametophyte (dioecious) produces archegonia and antheridia (biflagellated sperm)**



Sporophyte

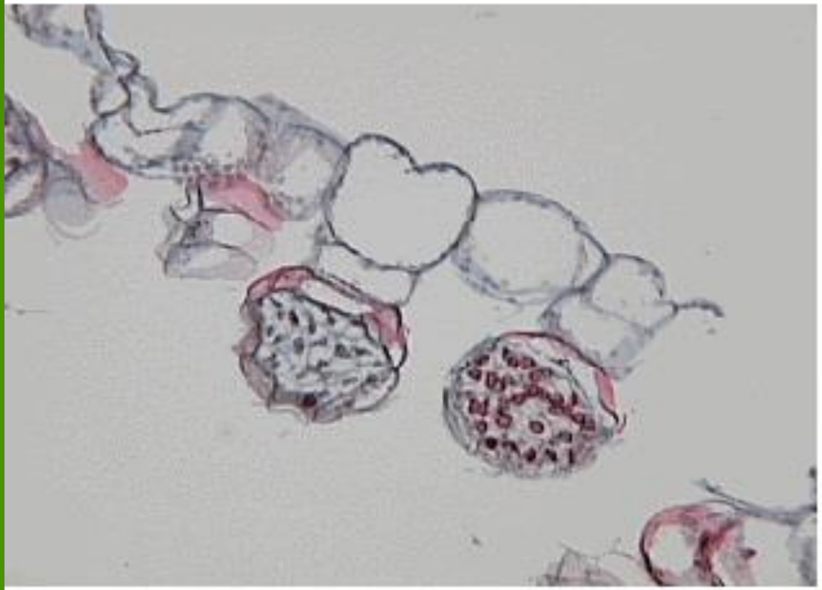
Gametophyte

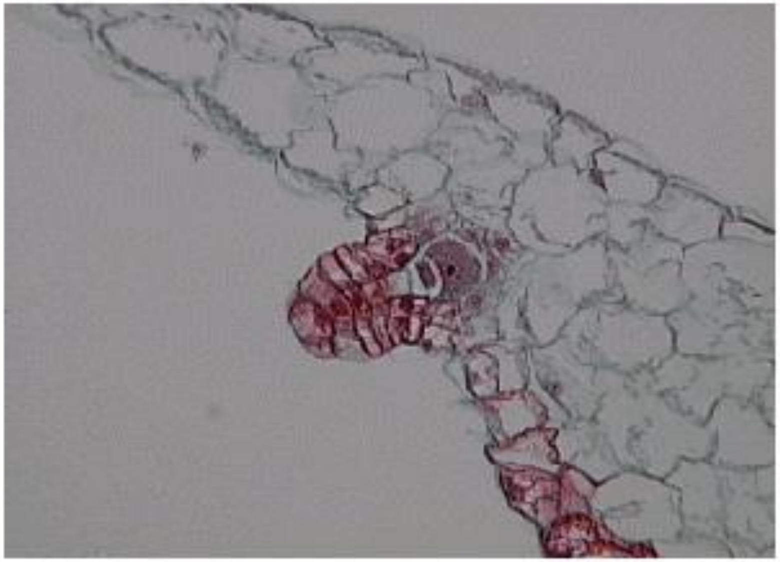
***Funaria* : A gametophyte with saprophyte**



Life cycle of Funaria

Fern Gametangia

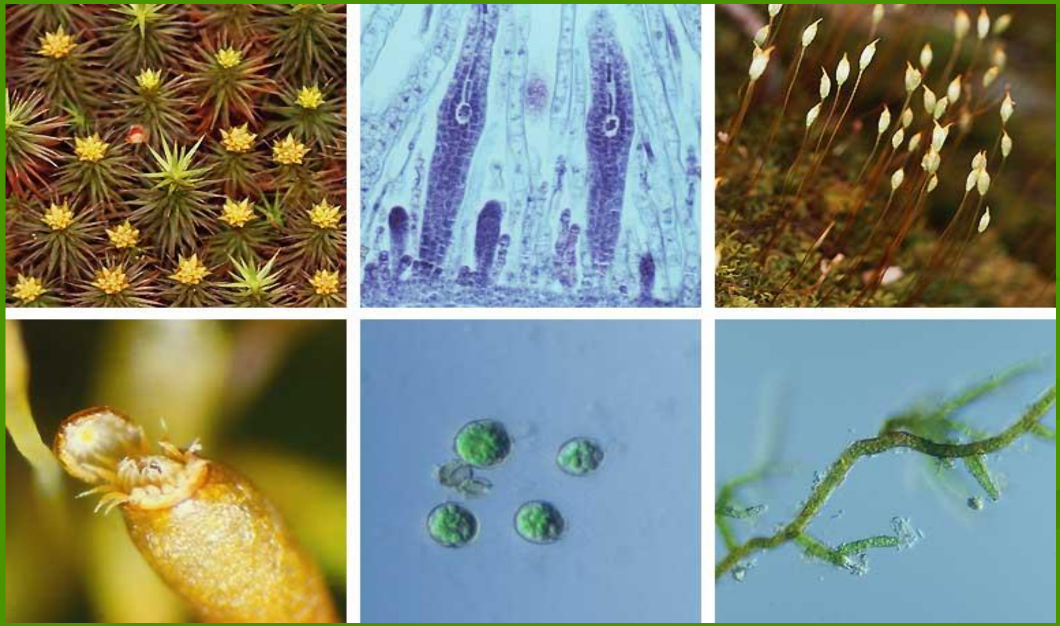




- **Archegonia**

- **Antheridia**

- Moss sporophytes consist of foot, elongated stalk (seta), and sporangium (capsule).
- Foot gathers nutrients and water from parent gametophyte via transfer cells.
- Stalk conducts materials to capsule.
- Capsule – disperse spores.



Pteridophytes (Ferns)

- Reproduce by spores

PTERIDOPHYTES (SEED LESS VASCULAR PLANTS)

These are plants with vascular tissues for transporting water and minerals throughout the plant

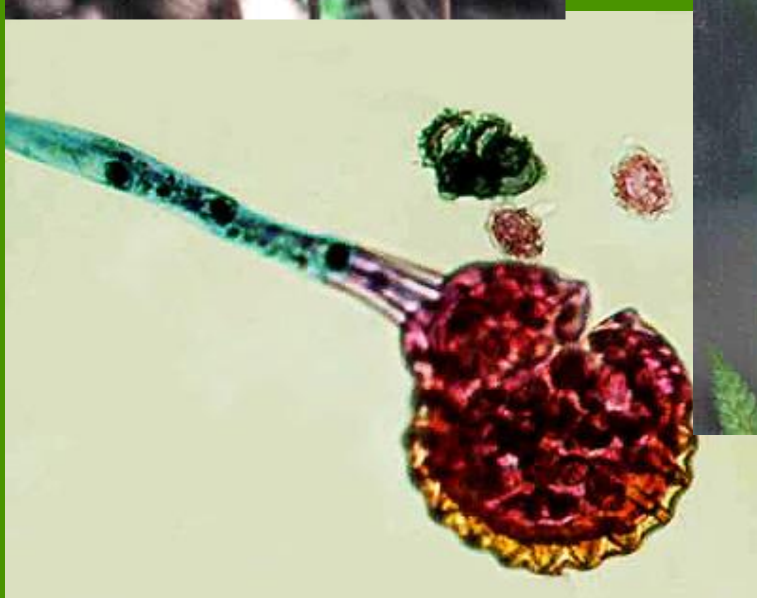
Differences from Bryophytes

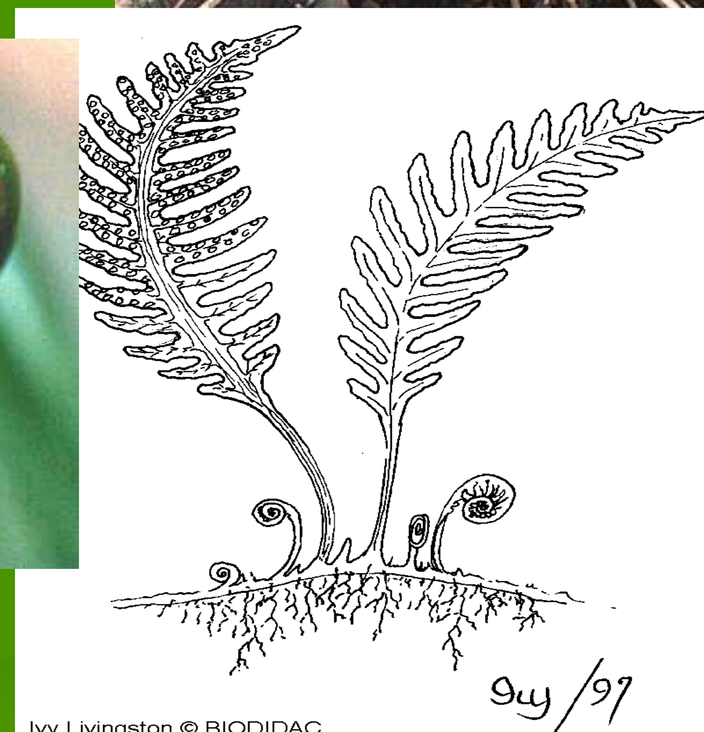
- Sporophyte not attached to a gametophyte
- Has vascular tissues
- Longer phase in life cycle

•Characteristics

- Found in Moist places
- Gametophytes lack vascular tissue
- Sperm needs water to reach egg
- They do not produce seeds, but produce spores
- Spores are a single cell with a protective coat


Benjamin
Cummings




Guy /97
Ivy Livingston © BIODIDAC

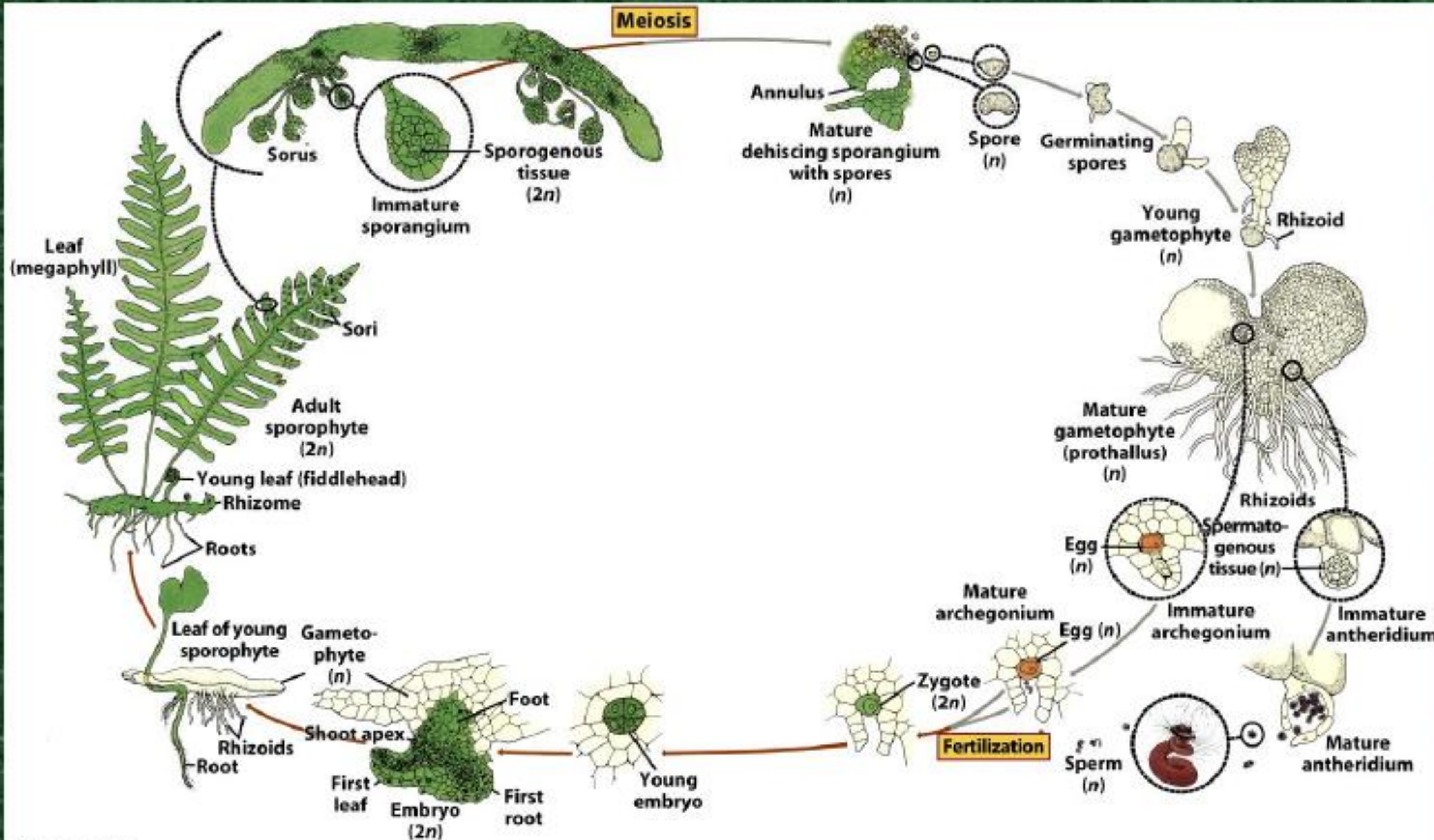


Figure 17-30
Biology of Plants, Seventh Edition

Life cycle of fern

Gymnosperms: Produce seeds

- Gymnosperms are plants that have seeds but no flowers or fruits

- The gymnosperm (pine tree) life cycle takes about two years to complete

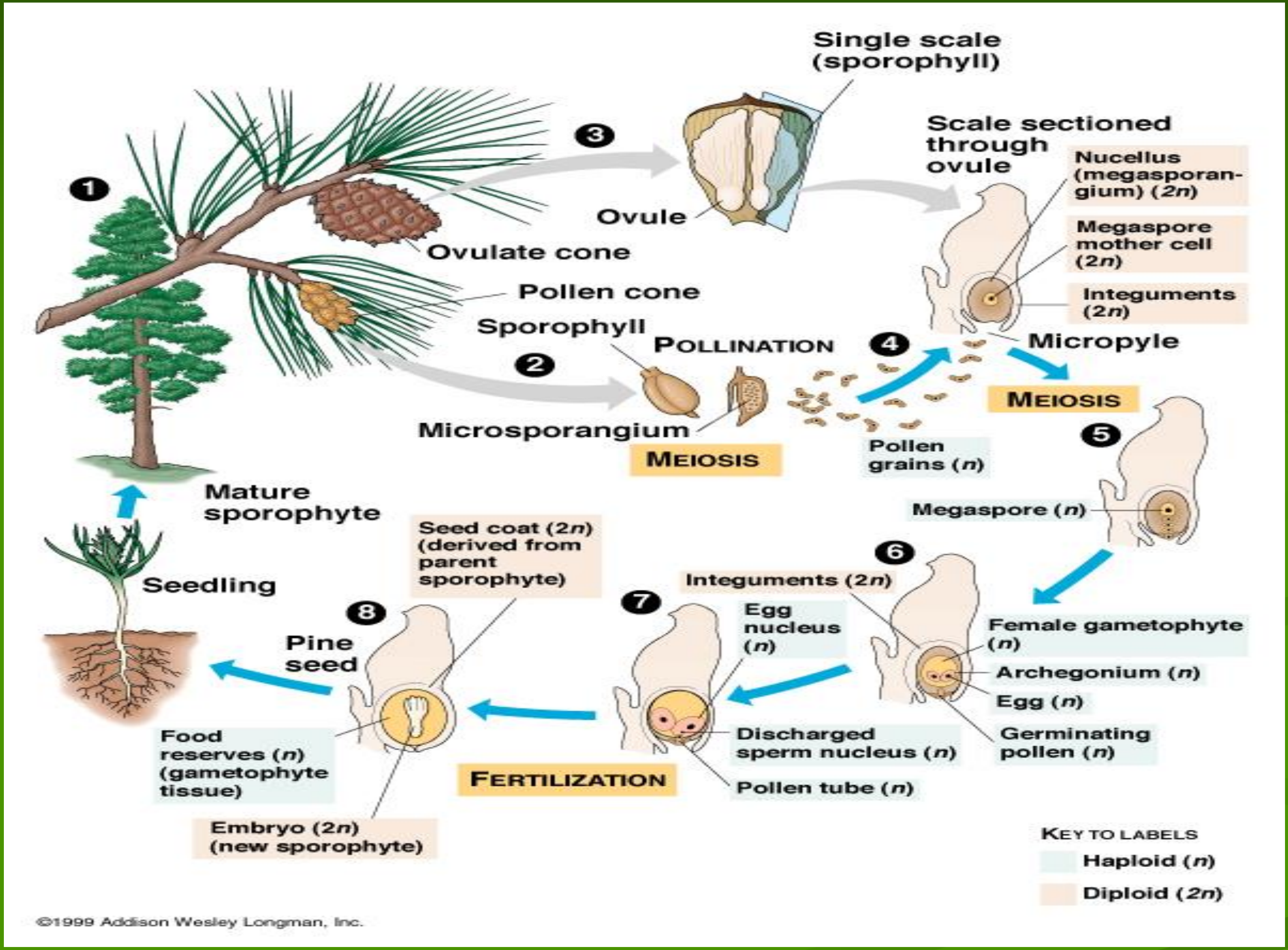
- The dominant photosynthetic part of the life cycle is the sporophyte (the spore producing part).

- The pine cones are the pine's specialized reproductive elements where meiosis takes place.
- Pollen grains are produced by male cones and contain the male gametophyte.

- When pollen is released, it is carried by the wind to the female cones.

Conifers

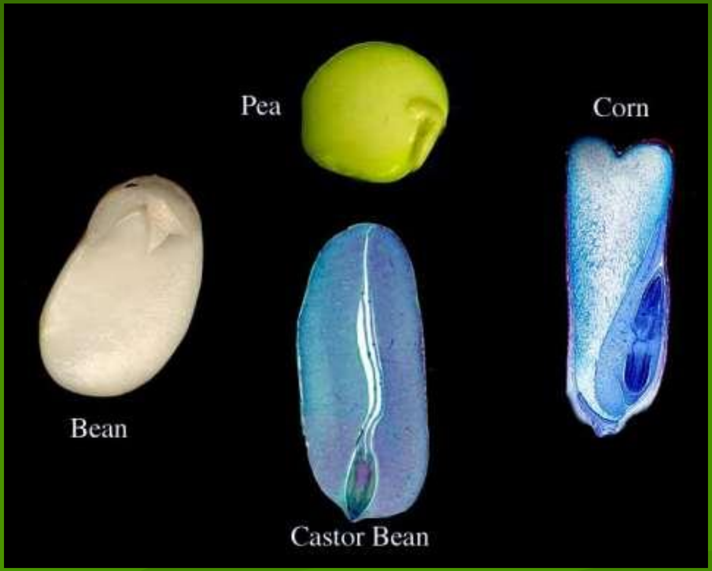
- Reproduce using seeds found in cones
- Needle-shaped leaves

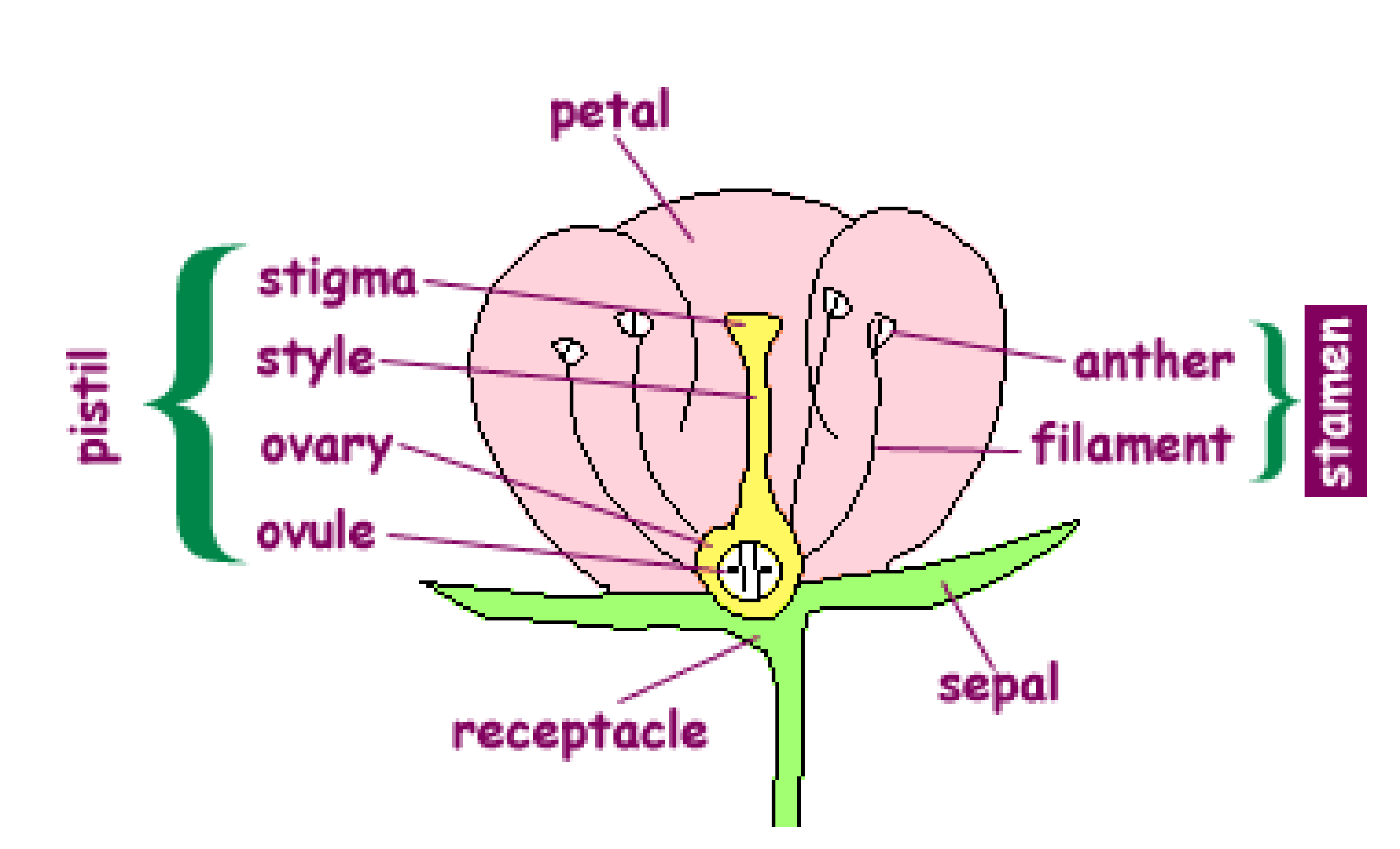


Gymnosperm life cycle

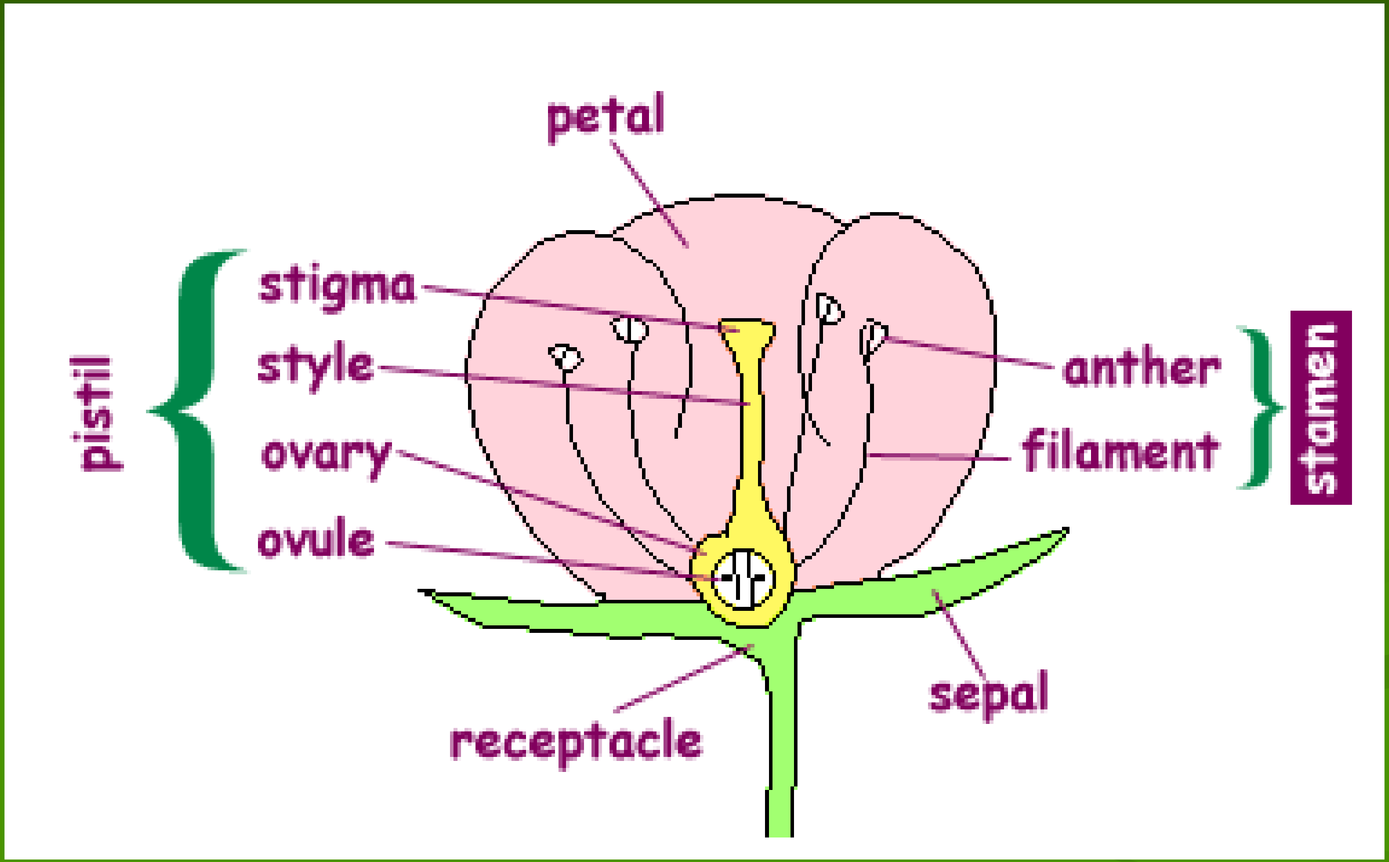
Angiosperm: Flowering Plants

- Reproduce using seeds found in fruits
- Large flat leaves
- Have flowers



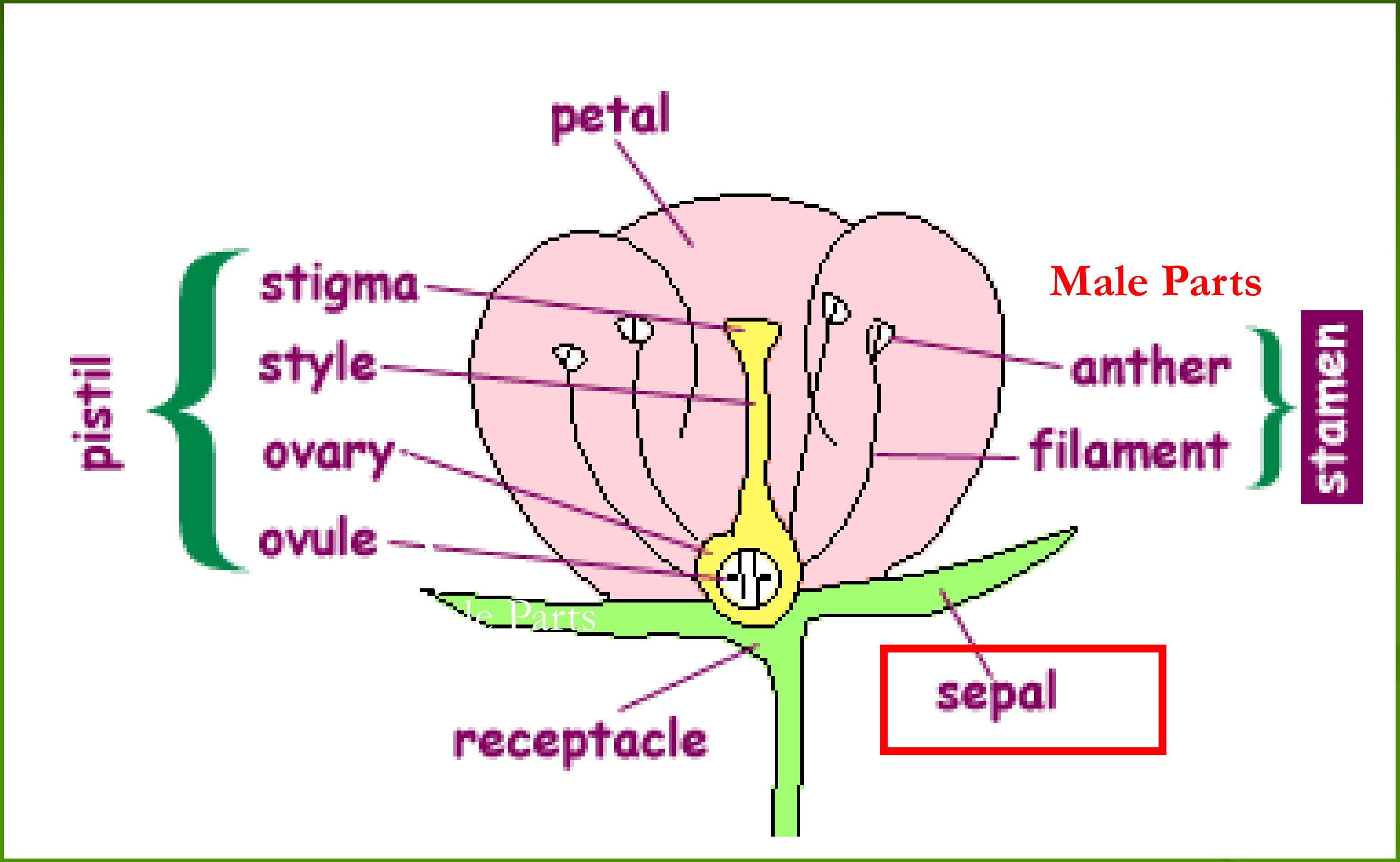


Parts of a Flower



- ❖ The stamen consists of two parts: the anther and the filament.
- ❖ The filament holds the anther.
- ❖ The anther produces and carries the pollen.

Parts of a Flower



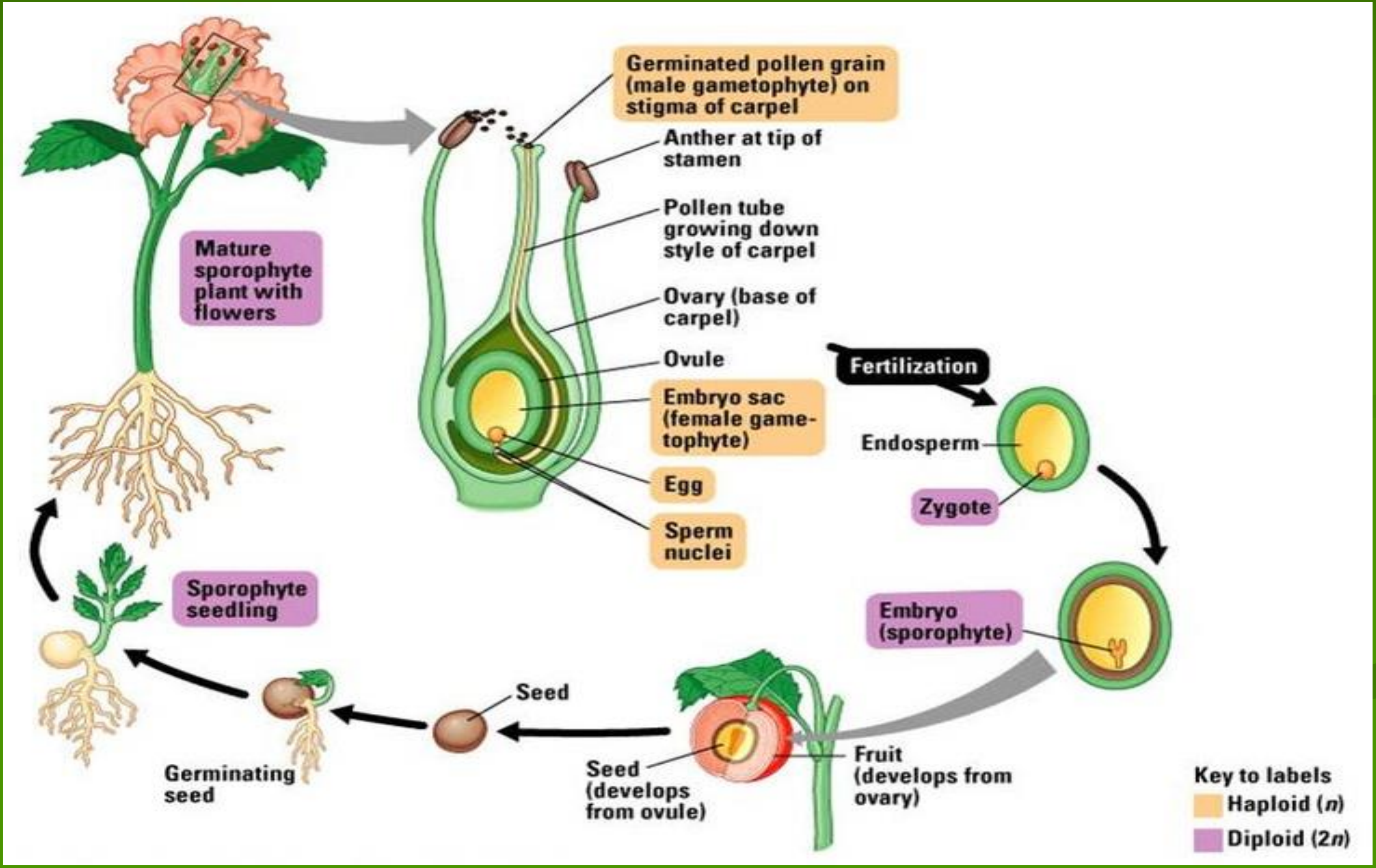
✓The sepals are the green petal-like parts at the base of the flower.

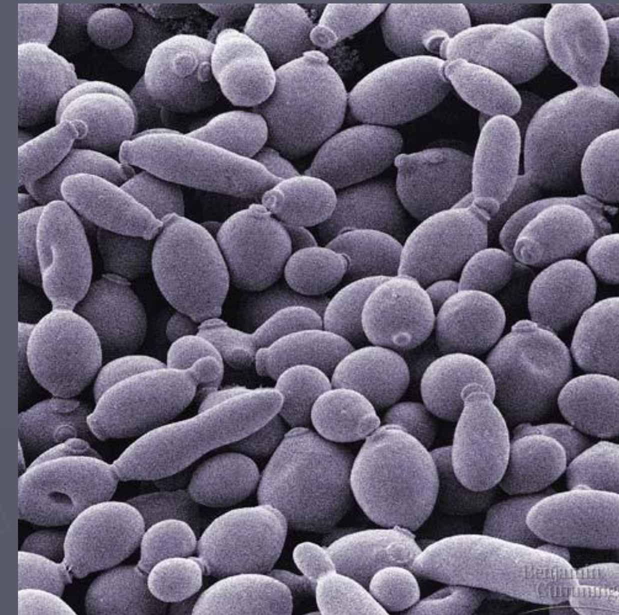
✓Sepals help protect the developing bud.

Functions of parts of a flower

	Part	Function
1	Petal	Often large and coloured, to attract insects
2	Sepal	Protects the flower while in bud
3	Petiole (stalk)	Supports the flower to make it easily seen by insects, and to be able to withstand wind
4	Nectary	Produces nectar, to attract insects
5	Stamen	The male reproductive part of the flower, made up of anther and filament
6	Anther	Contains pollen sacs, in which pollen grains are formed. Pollen contains male sex cells.
7	Filamen	Support the anther
8	Carpel	The female reproductive part of the flower, made up of stigma, style and ovary
9	Stigma	A sticky surface to the ovary, through which pollen tubes grow
10	Style	Links the stigma to the ovary, through which pollen tubes grow
11	Ovary	Contains ovules, which develop into seeds when fertilised.

Angiosperm: Life cycle





FUNGI

Characteristics of Fungi

- Eukaryotic
- Nonphotosynthetic (heterotrophic)
- Most are multicellular
- Most are microscopic molds or yeasts

The study fungi is known as **MYCOLOGY.**

The Characteristics of Fungi

- Cell wall present, composed of cellulose and/or chitin.
- Food storage - generally in the form of lipids and glycogen.
- Eukaryotes - true nucleus and other organelles present.
- All fungi require water and oxygen (no obligate anaerobes).
- Fungi grow in almost every habitat imaginable, as long as there is some type of organic matter present and the environment is not too extreme.
- Diverse group : (estimated 1.5 million species total).

Mushrooms – "Club Like" Fungi or Basidiomycete Fungi

Bracket Fungi – Basidiomycete Fungi

Bread Mold – a Zygomycete Fungi

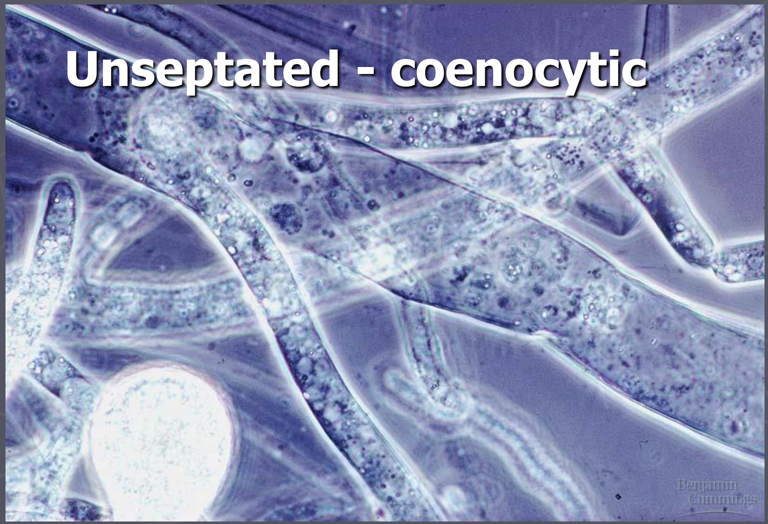
Orange-peel cup- Ascomycete

Cup Fungi – Ascomycete Fungi

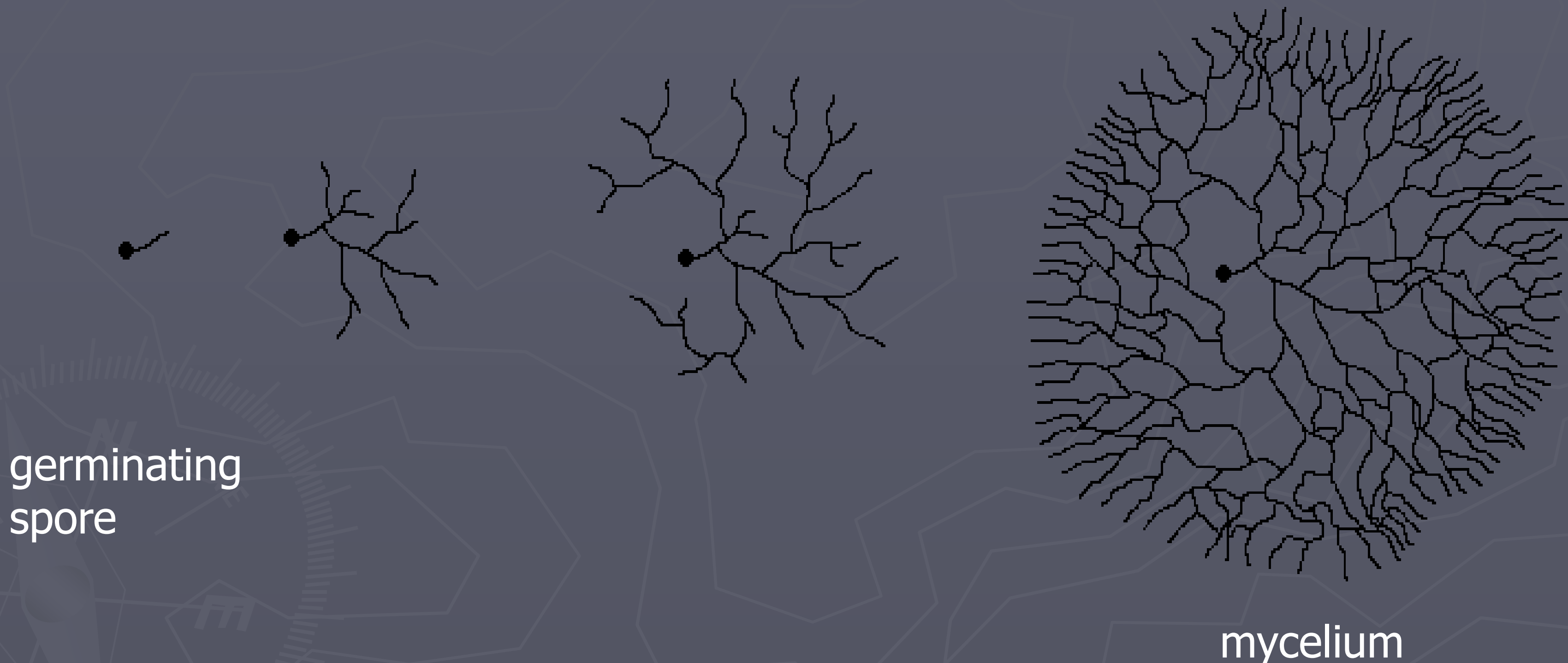
Note the cup shapes and orange peel colour

Structure of Fungi

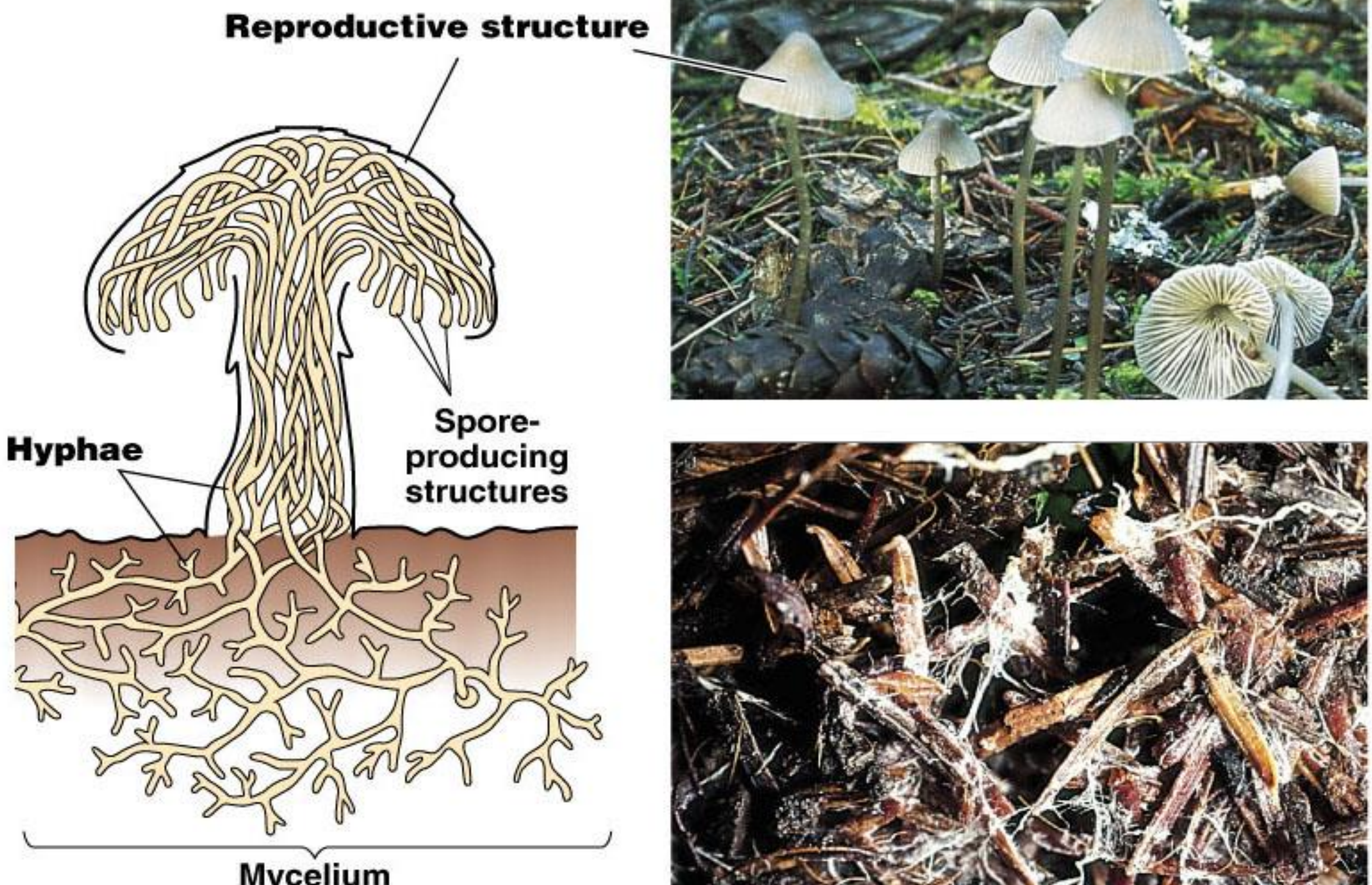
- Filaments of fungi are called hyphae.
- The cell walls contain chitin.
- The MYCELIUM is a mat of hyphae visible to the unaided eye
- Some hyphae may divided by cross sections called septa



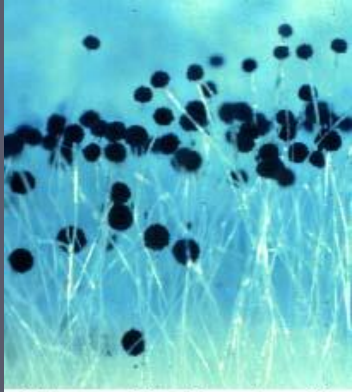
Hyphal growth from spore



- Mycelia have a huge surface area


Reproductive structure
Hyphae
Spore-
producing
structures
Mycelium

Kingdom Fungi – you must know 5 Major Phyla


Rhizopus -black bread mold

1. **Phylum Zygomycota = the Bread Molds**

   Rhizopus – black bread mold

2. **Oomycota = the Water Molds**

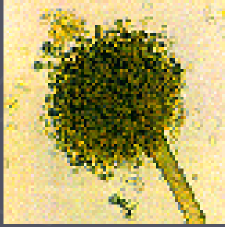
   Water mold, potato blight,

3. **Phylum Ascomycota = the Sac Fungi**

   Yeast, morels, truffles

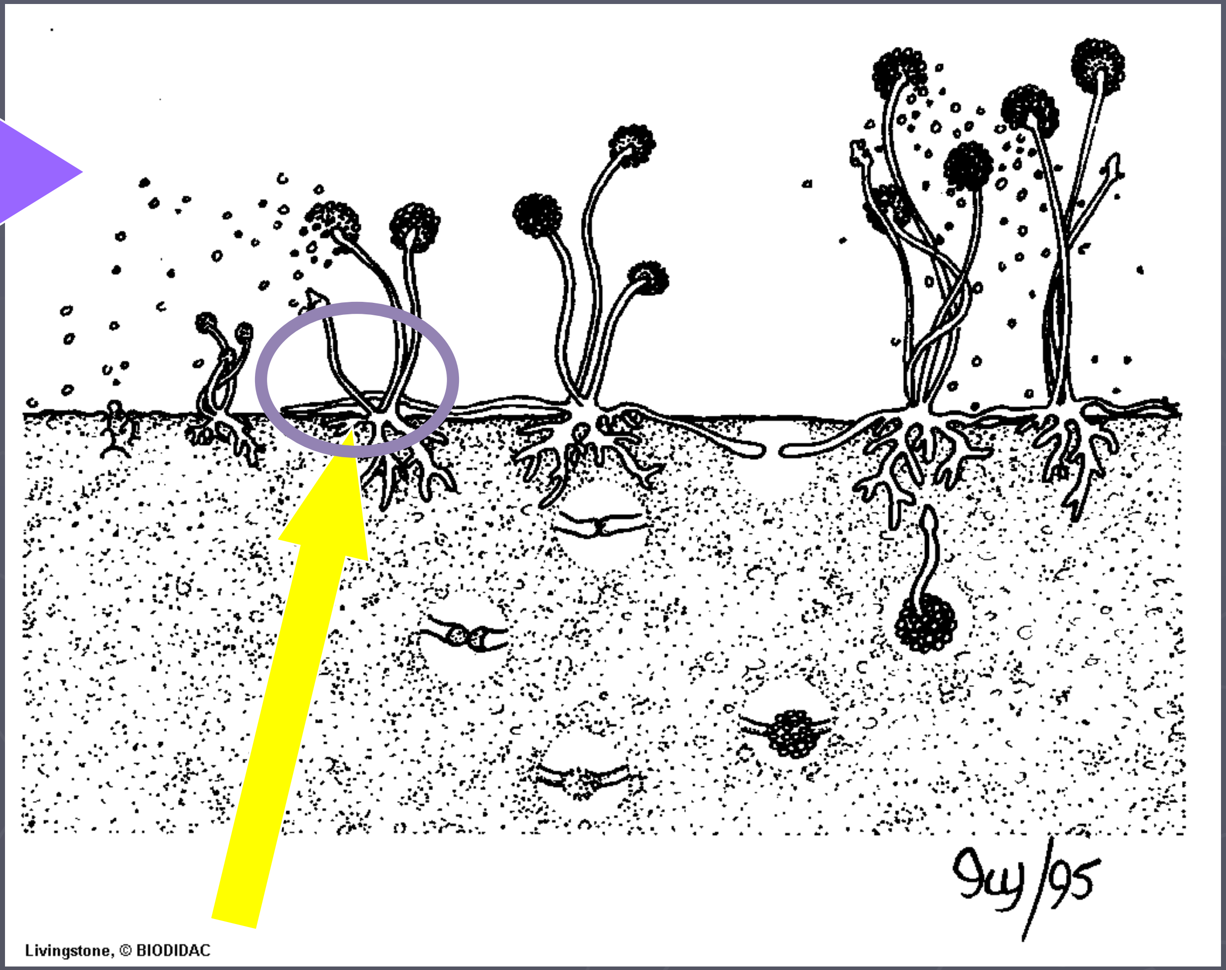
4. **Phylum Basidiomycota = the Club Fungi**

   Mushrooms, puffballs, bracket fungi, rusts, smuts, toadstools



5. **Phylum Deuteromycota = the Fungi Imperfecti**

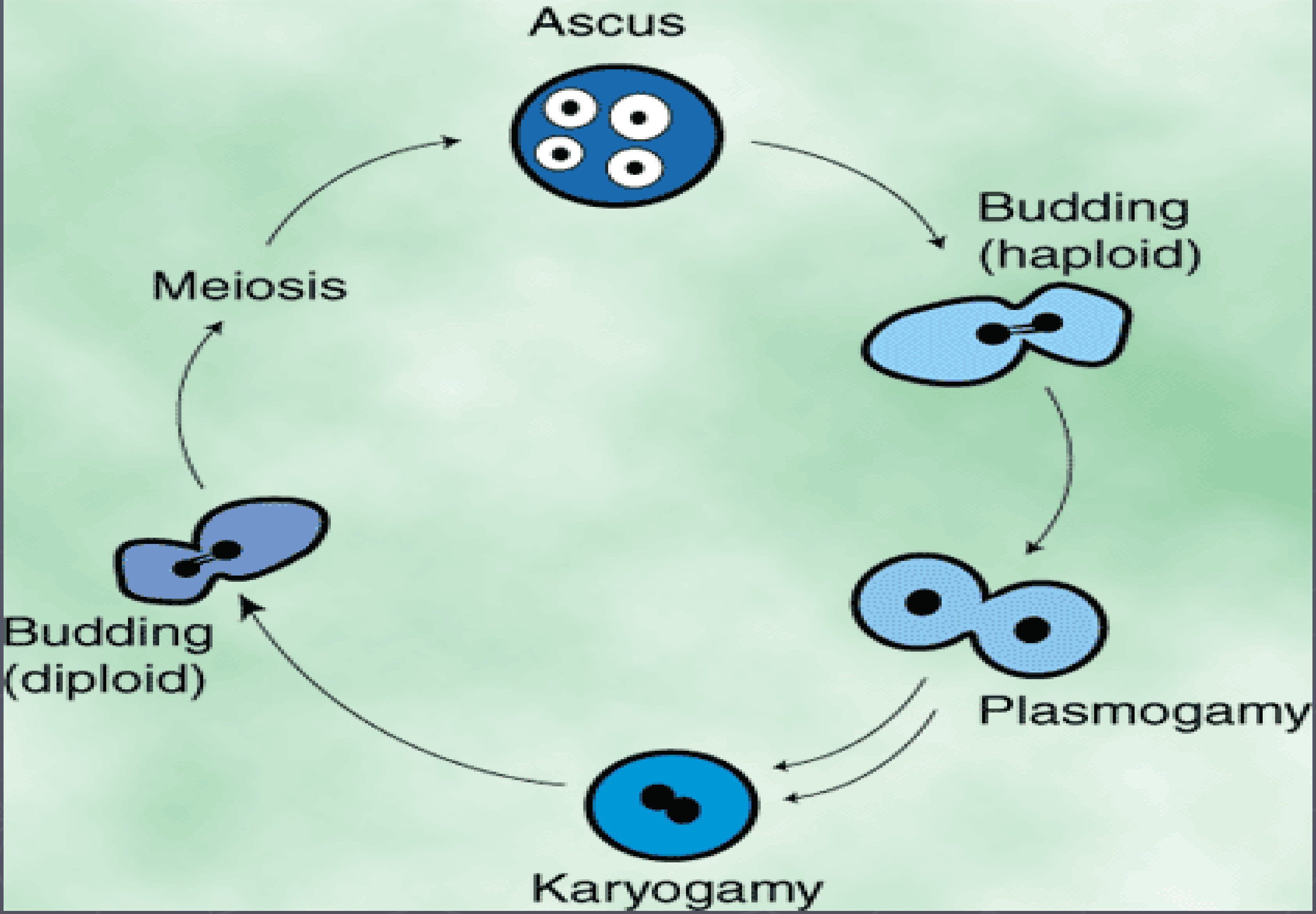
(Rhizopus: Zygomycota – common molds



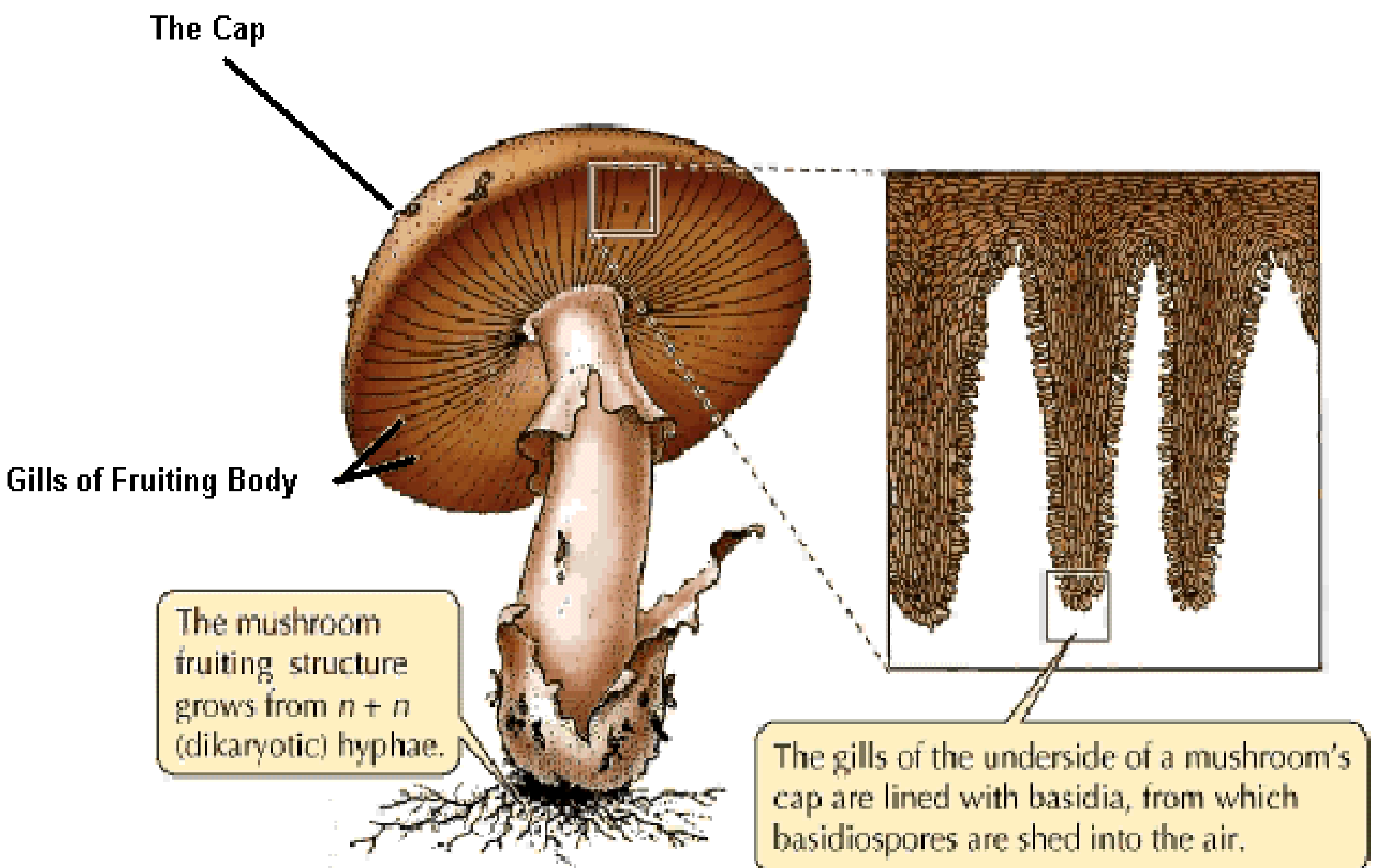
The fungal mass of hyphae, known as the MYCELIUM penetrates the bread and produces the fruiting bodies on top of the stalks

Mycelia = a mass of hyphae or filaments

Yeast is an Ascomycete Fungus



Basidiomycete or Club Fungi



Bracket Fungi

Puff Balls

<u>Basidiomycete: Fungi that all produce Basidiospores</u>

Mushrooms

Jelly Fungi

Jelly fungus-Basidiomycete

Other Basidiomycetes Rusts and Smuts

Rust infecting wheat leaves

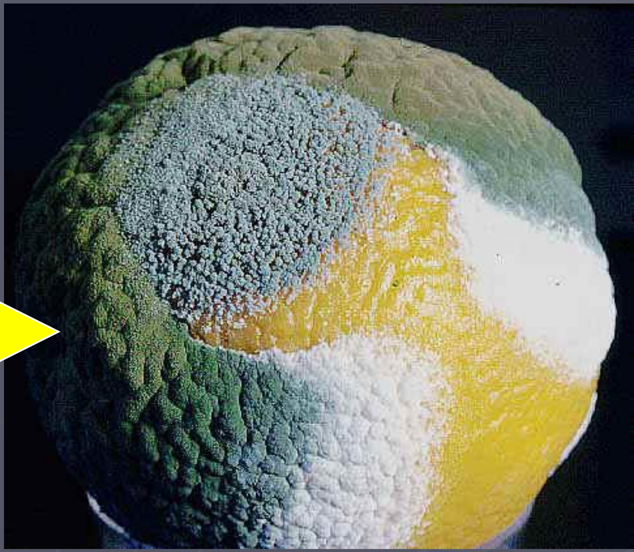
Rust infecting a Leaf

Whitrot Smut digesting old wood

Deuteromycota – the Fungi Imperfecti

- Resemble Ascomycetes, but their reproductive cycle has never been observed

Penicillium fungi

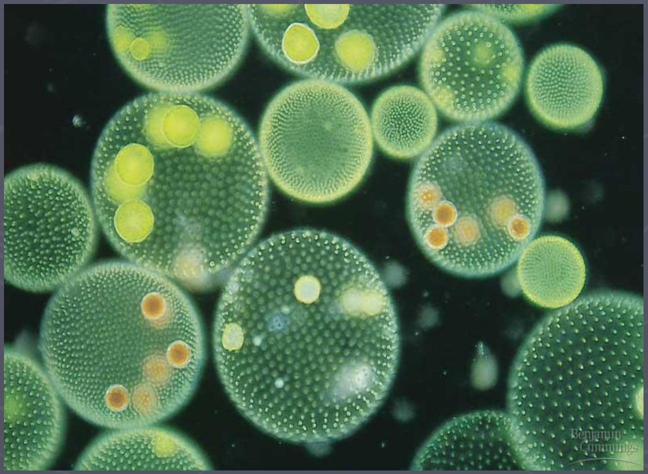


- Different from Ascomycetes because there is a definite lack of sexual reproduction, which is why they are called Imperfect Fungi

Algae

Characteristics

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



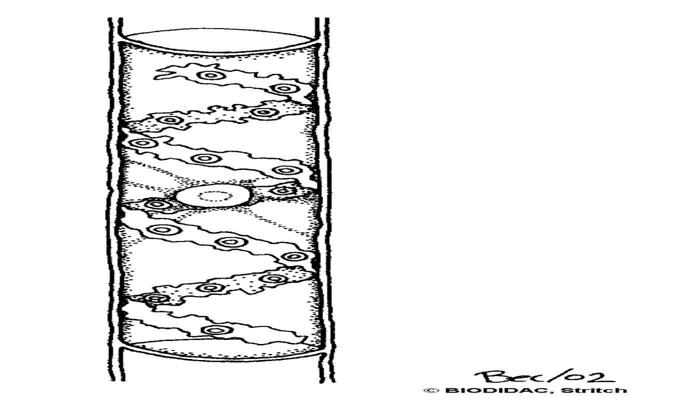
Spirogyra

•Spirogyra is a genus of filamentous green, named for the helical or spiral arrangement of the chloroplasts that is diagnostic of the genus.

• It belongs to chlorophyta.

•It is commonly found in freshwater areas.

• Spirogyra is unbranched with cylindrical cells connected end to end in long green filaments.



Euglena

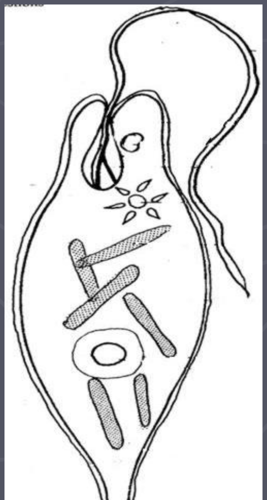
- Euglena are unicellular organisms.

- All euglena have chloroplasts and can make their own food by photosynthesis.

- They have two flagella (one does not protrude the membrane, so it is not as visible)

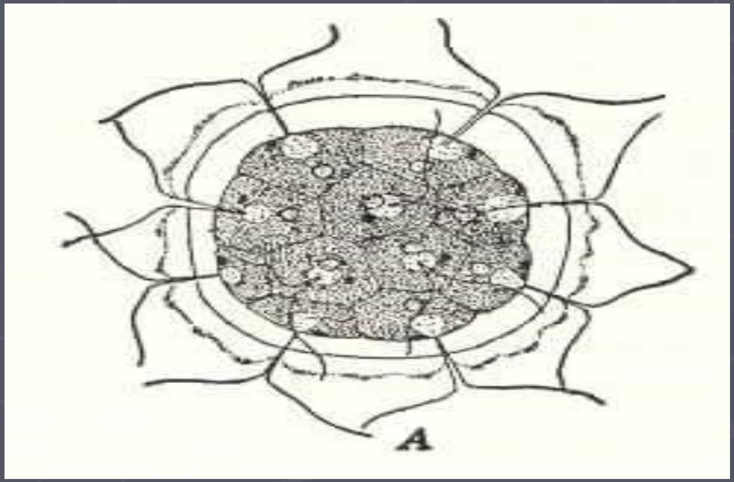
- The euglenoids lack a true cell wall, and are bounded by a proteinaceous cell covering known as a pellicle

- The primary photosynthetic pigments are chlorophylls a and b, while their accessory pigments are carotenoids and xanthophylls.



Pandorina

- Pandorina have cells, which are closely connected to another.
- It is a member of Chlorophyta.
- A thick mucilage layer surrounds the colony.
- Each cell contains chloroplast, prominent stigma, basal pyrenoid and contractile vacuoles.



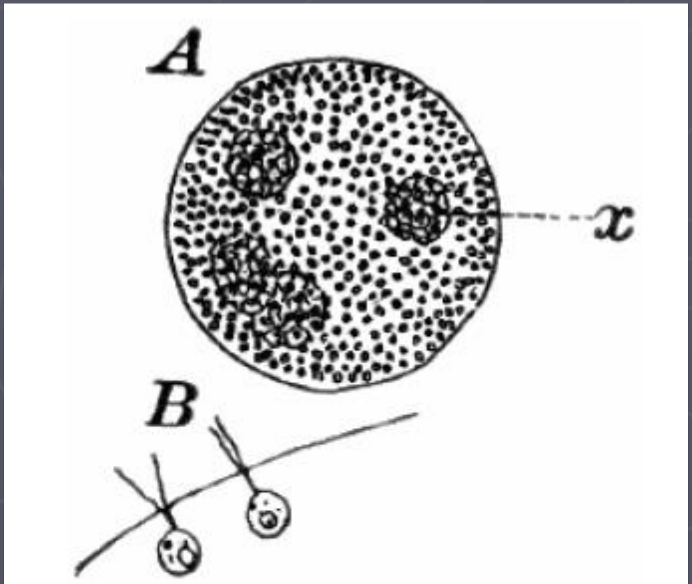
Volvox

•Volvox is a spherical, freshwater colony of Chlorophyta that is composed of flagellate cells.

•Volvox is the member of chlorophyta

•Each mature Volvox colony is composed of numerous flagellate cells.

•In a number of species, protoplasmic connections between cells are maintained



Polysiphonia

- Member of Rhodophyta

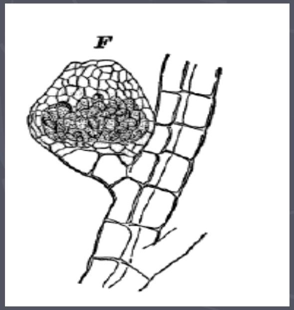
- Phycobilins mask color of chlorophyll a - give red algae their distinctive color.

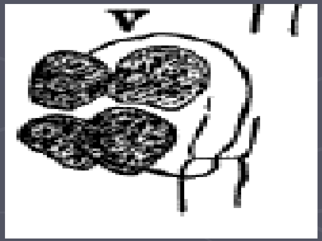
- Filamentous - held together by intercellular mucilage

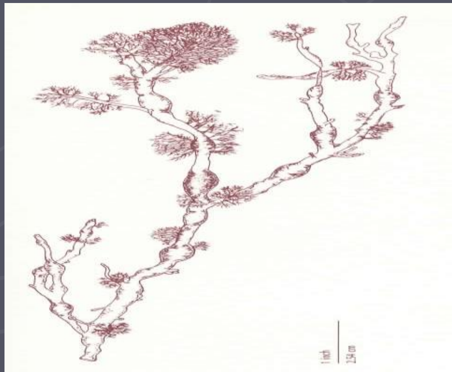
- Tetraspores develop into gametophytes (male and female)

- Male gametophytes produce spermatangia that produce non-motile spermatia (v)

- Female gametophytes produce carpogonium the basal portion of which contains a nucleus that acts as an egg







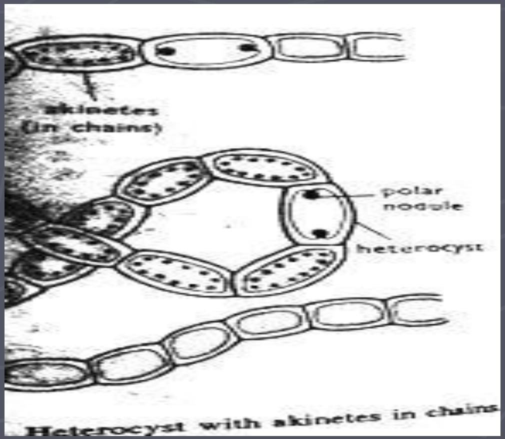
Nostoc

•Nostoc is a very simple alga, belonging to the Cyanophyta group (Blue-Green algae).

•The gelatinous bodies shown above consist of numerous internal filaments called **trichomes** encapsulated within a sheath or skin.

•Each trichome being simple, free and often curved or coiled.

•.

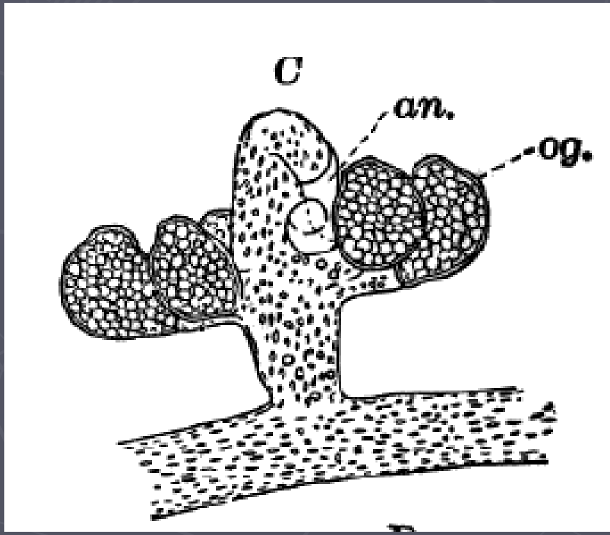


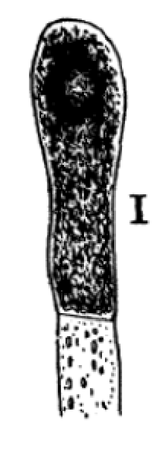
Vaucheria

•They usually occur in shallow ditches and ponds, growing on the bottom,

•They form large, dark green, felted masses, and are sometimes known as “green felts.”

It is made up of closely matted, hair-like threads, each of which is an individual plant. Member of Xanthophyta.





Lichens

- "Mutualism" between
  - Fungus – structure
  - Alga –food
- Thallus is a plant-like body that doesn't have roots, stems or leaves

Lichens

•It is a close partnership between a fungus and an alga.

•On the basis of their general growth, form and nature of attachment to the substratum, lichens are of three types:

1.Crustose or crustaceous

2.Foliose or foliaceous

3.Fructicose or filamentous

Crustose or crustaceous

These are forms which spread over surface of their habitat. They cannot be removed from the surface without crumbling away.

Foliose or foliaceous

- These are lichens with leafy lobes, which spread out in a horizontal layer over
- the surface.

- They are attached by root-like threads and can be easily removed with a knife.

Fructicose or filamentous

•Fruticose lichens are shrubby forms with many branches.

•They can be removed from the surface by hand.

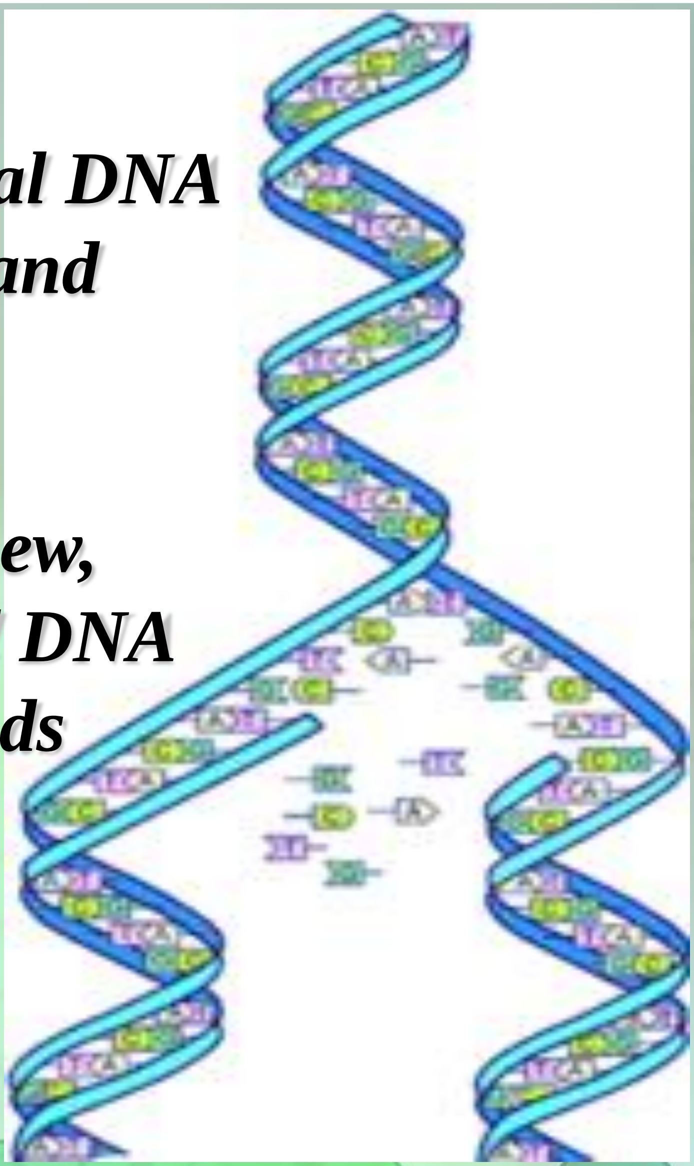
Cellular Division

Keeping Cells Identical

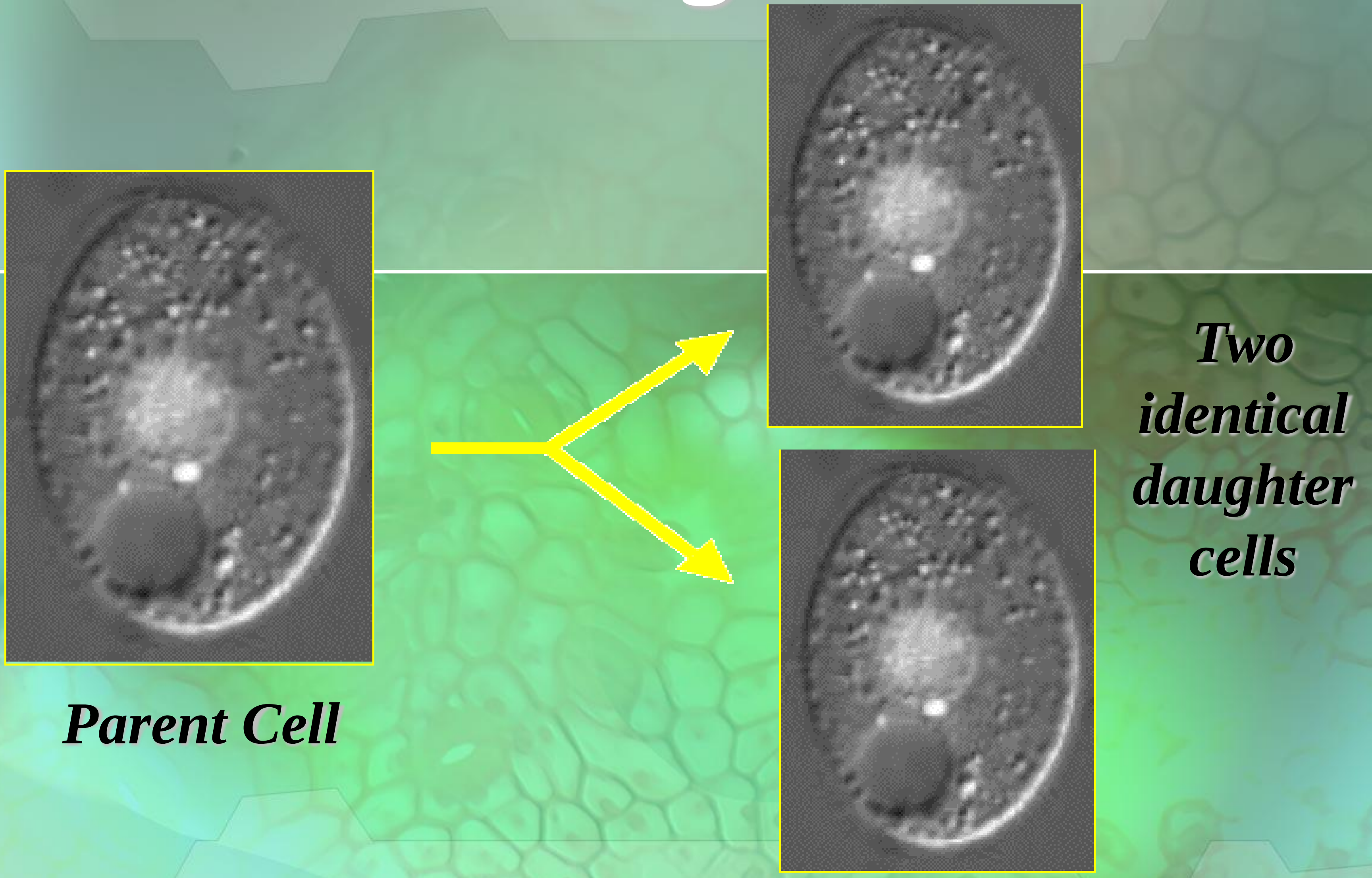
The **instructions for making cell parts** are encoded in the **DNA**, so each new cell must get a **complete set of the DNA molecules**

DNA Replication

- ✓DNA must be copied or **replicated** before cell division
- ✓Each new cell will then have an **identical copy** of the DNA

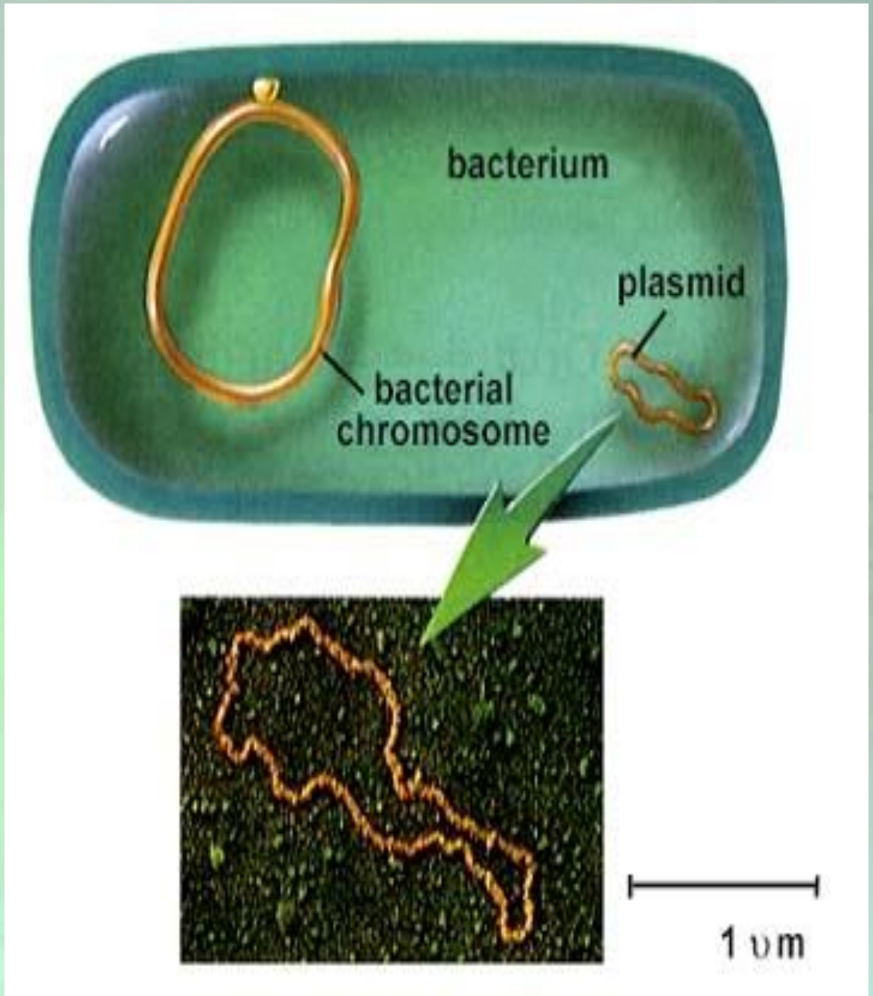


Identical Daughter Cells



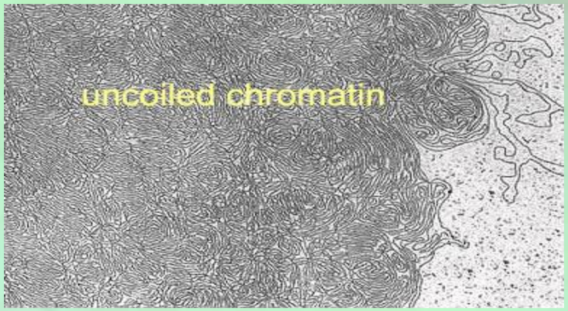
Prokaryotic Chromosome

- ✓ The DNA of prokaryotes (bacteria) is **one, circular chromosome attached to the inside of the cell membrane**

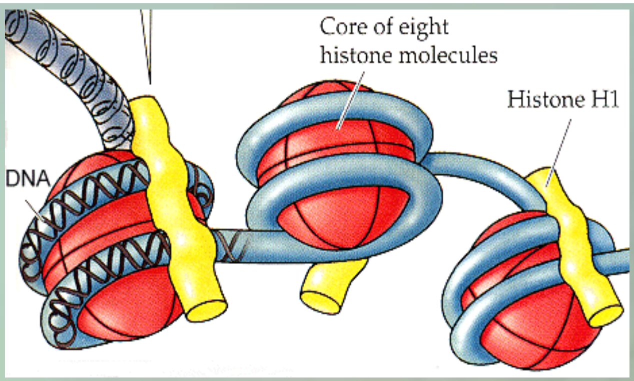


Eukaryotic Chromosomes

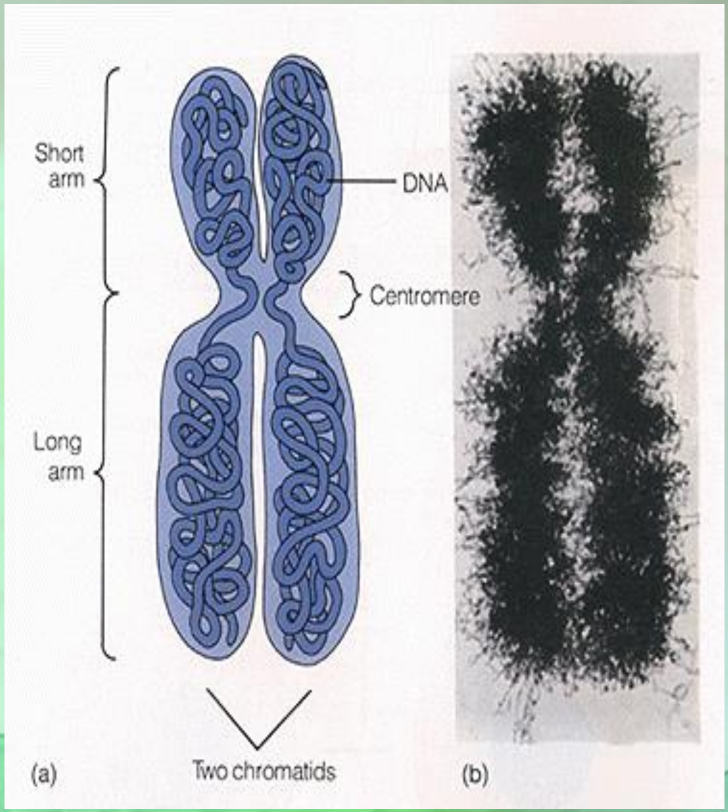
- All **eukaryotic** cells store genetic information in chromosomes
- Most eukaryotes have between **10 and 50 chromosomes** in their body cells
- Each chromosome is composed of a **single, tightly coiled DNA** molecule
- Chromosomes **can't be seen** when cells **aren't dividing** and are called **chromatin**



- DNA is tightly coiled around **proteins called histones.**



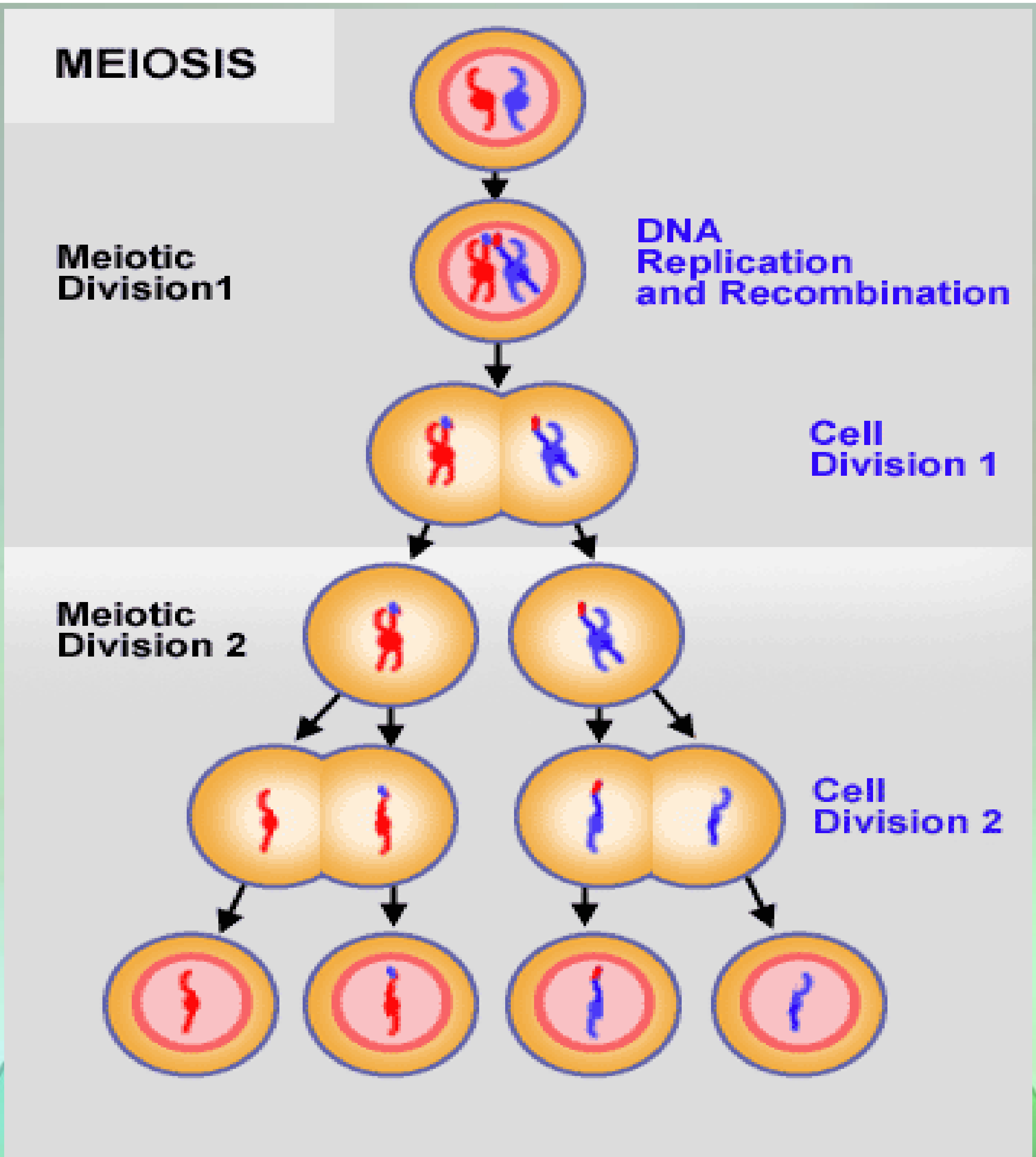
- Duplicated chromosomes are called **chromatids** & are held together by the **centromere**



Types of Cell Division

- ✓ **Asexual reproduction involves a single cell dividing to make 2 new, identical daughter cells: Mitosis & binary fission are examples of asexual reproduction**

- ✓ **Sexual reproduction involves two cells (egg & sperm) joining to make a new cell (zygote) that is NOT identical to the original cells: Meiosis is an example**


MEIOSIS
Meiotic Division1
DNA Replication and Recombination
Cell Division 1
Meiotic Division 2
Cell Division 2

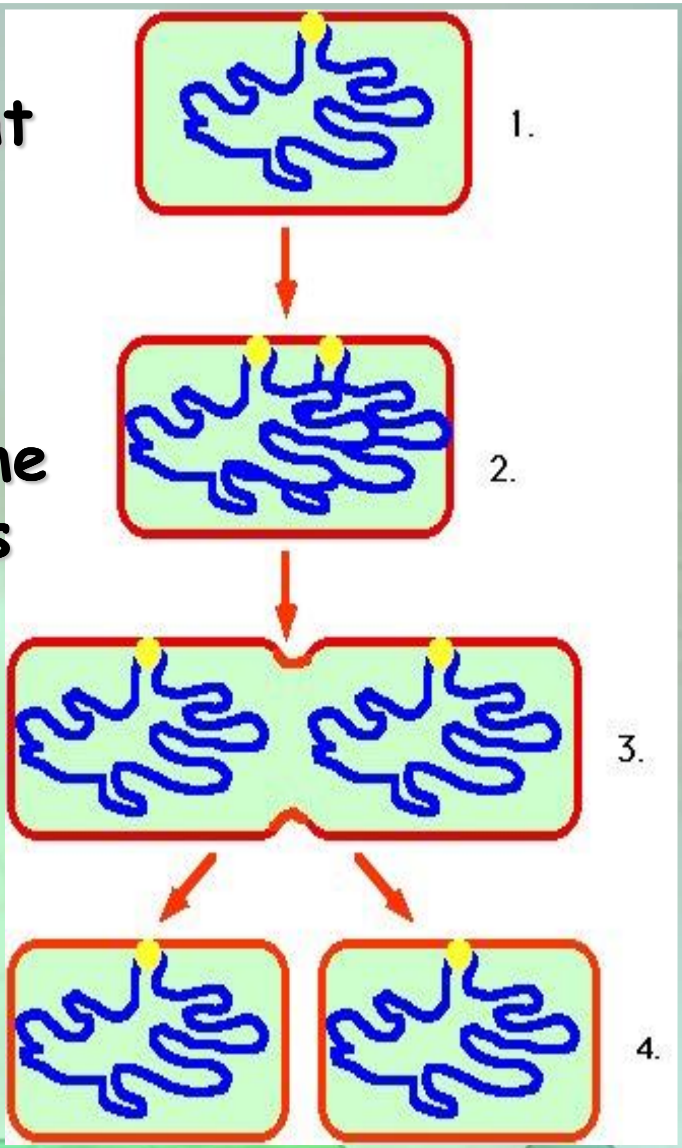
Meiosis: Cell Division in Prokaryotes

- ✓ Prokaryotes such as bacteria divide into 2 identical cells by the process of binary fission
- ✓ Single chromosome makes a copy of itself
- ✓ Cell wall forms between the chromosomes dividing the cell

Parent cell

Chromosome replicates

Cell splits

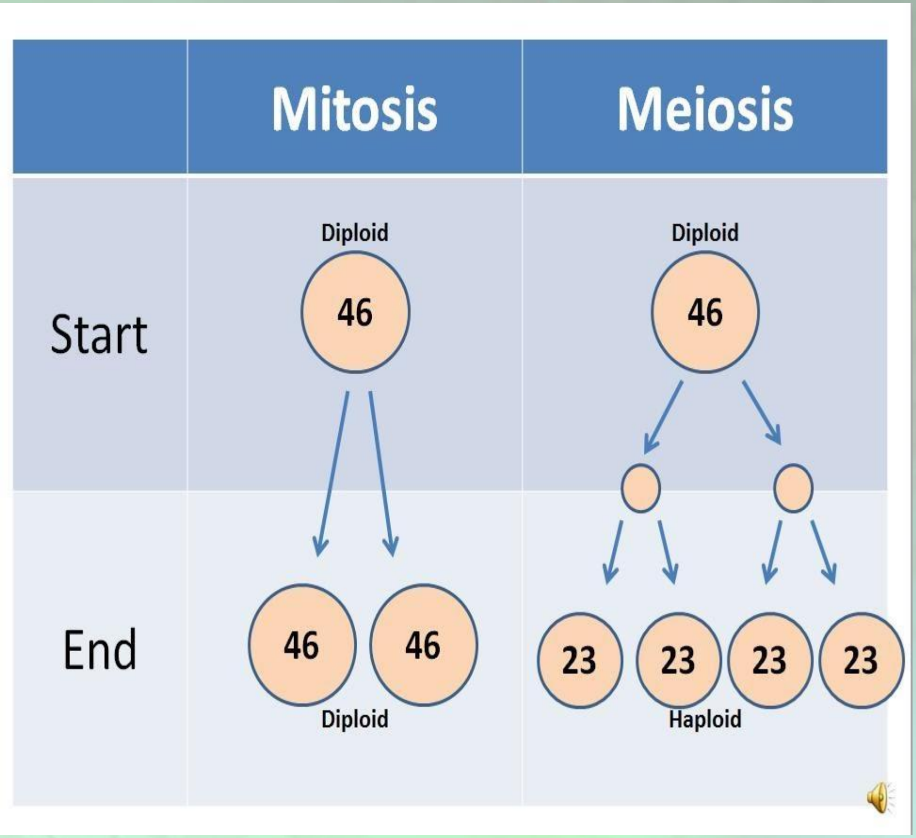


2 identical daughter cells

Mitosis and Meiosis

- **Mitosis:**
  -division of **somatic** (body) cells

- **Meiosis**
  -division of gametes (sex cells)



Mitosis

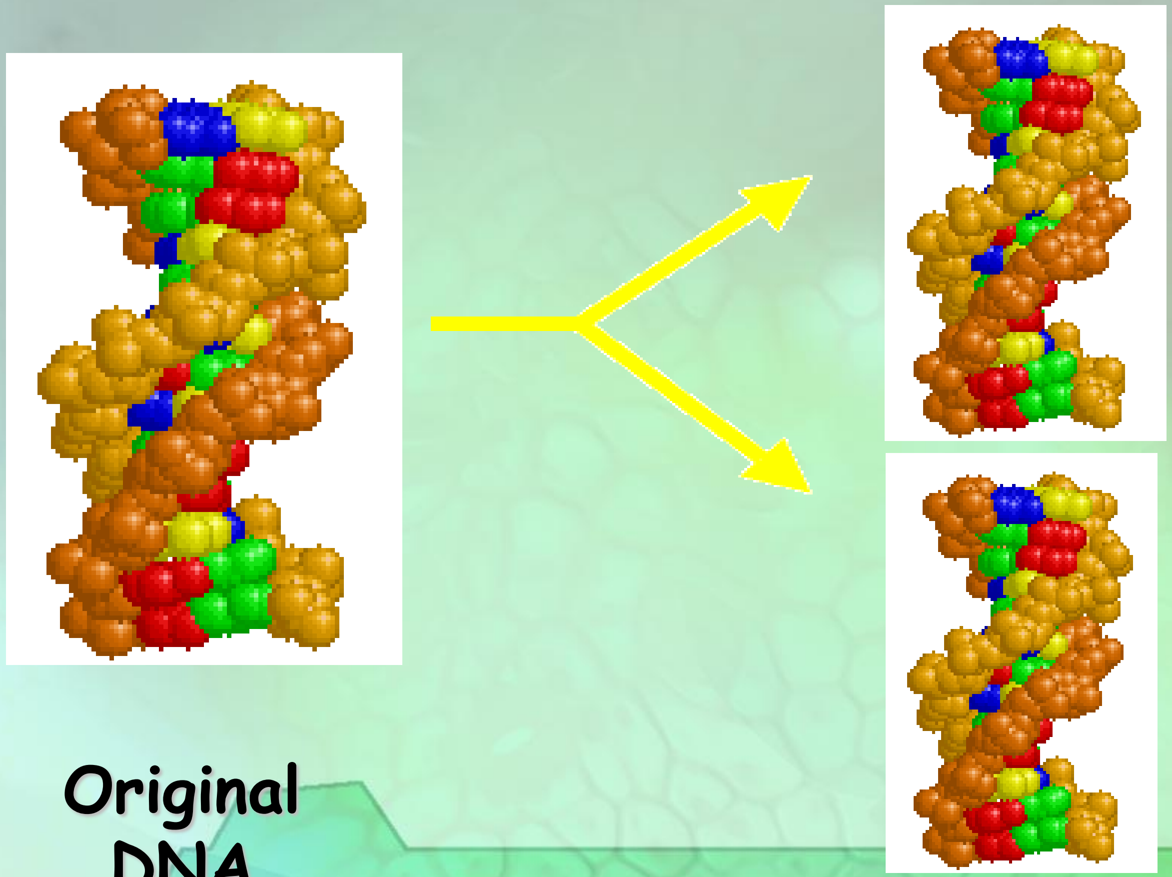
- Interphase
- Prophase
- Metaphase
- Anaphase
- Telophase

Interphase - G_1 Stage

- ✓ 1st growth stage after cell division
- ✓ Cells mature by making more cytoplasm & organelles
- ✓ Cell carries on its normal metabolic activities

Interphase - S Stage

- ✓Synthesis stage
- ✓DNA is copied or replicated



Original DNA

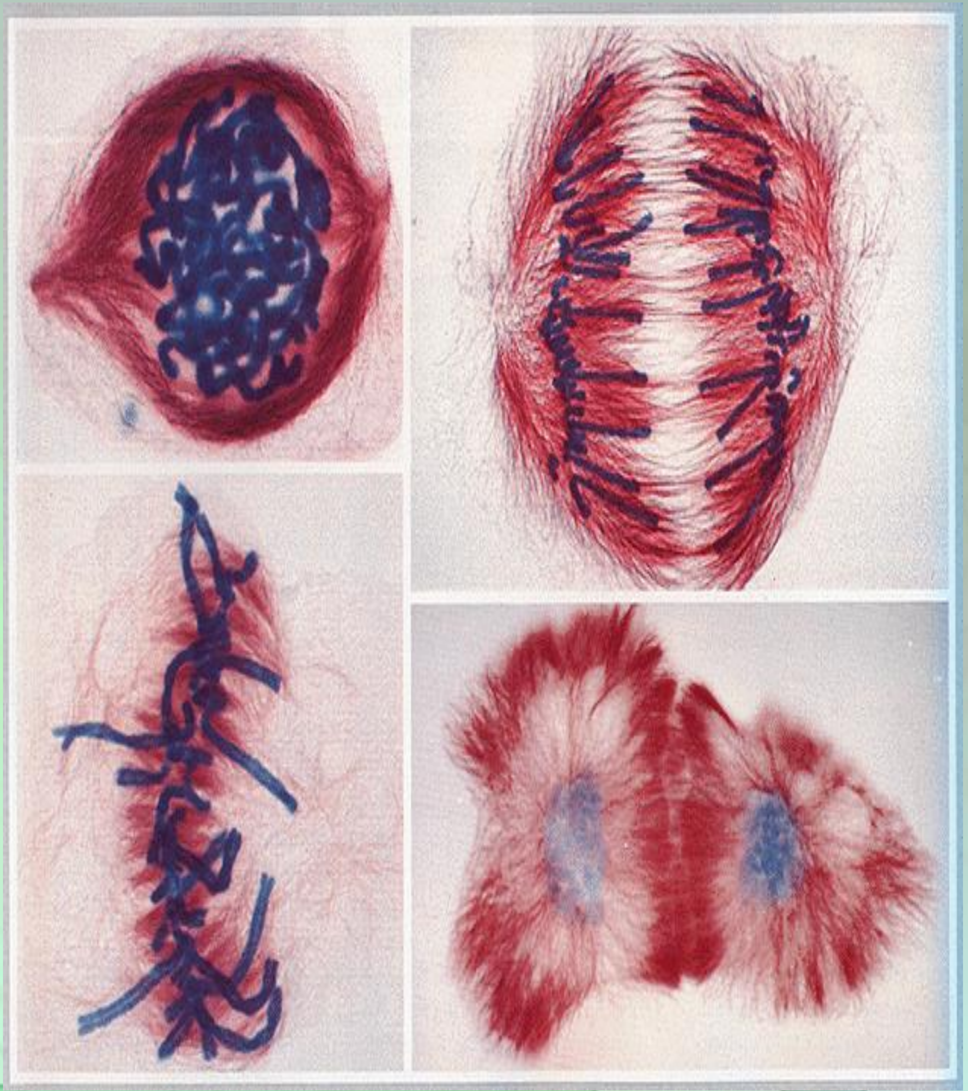
Two identical copies of DNA

Interphase – G_2 Stage

- 2nd Growth Stage
- Occurs after DNA has been copied
- All cell structures needed for division are made (e.g. centrioles)
- Both organelles & proteins are synthesized

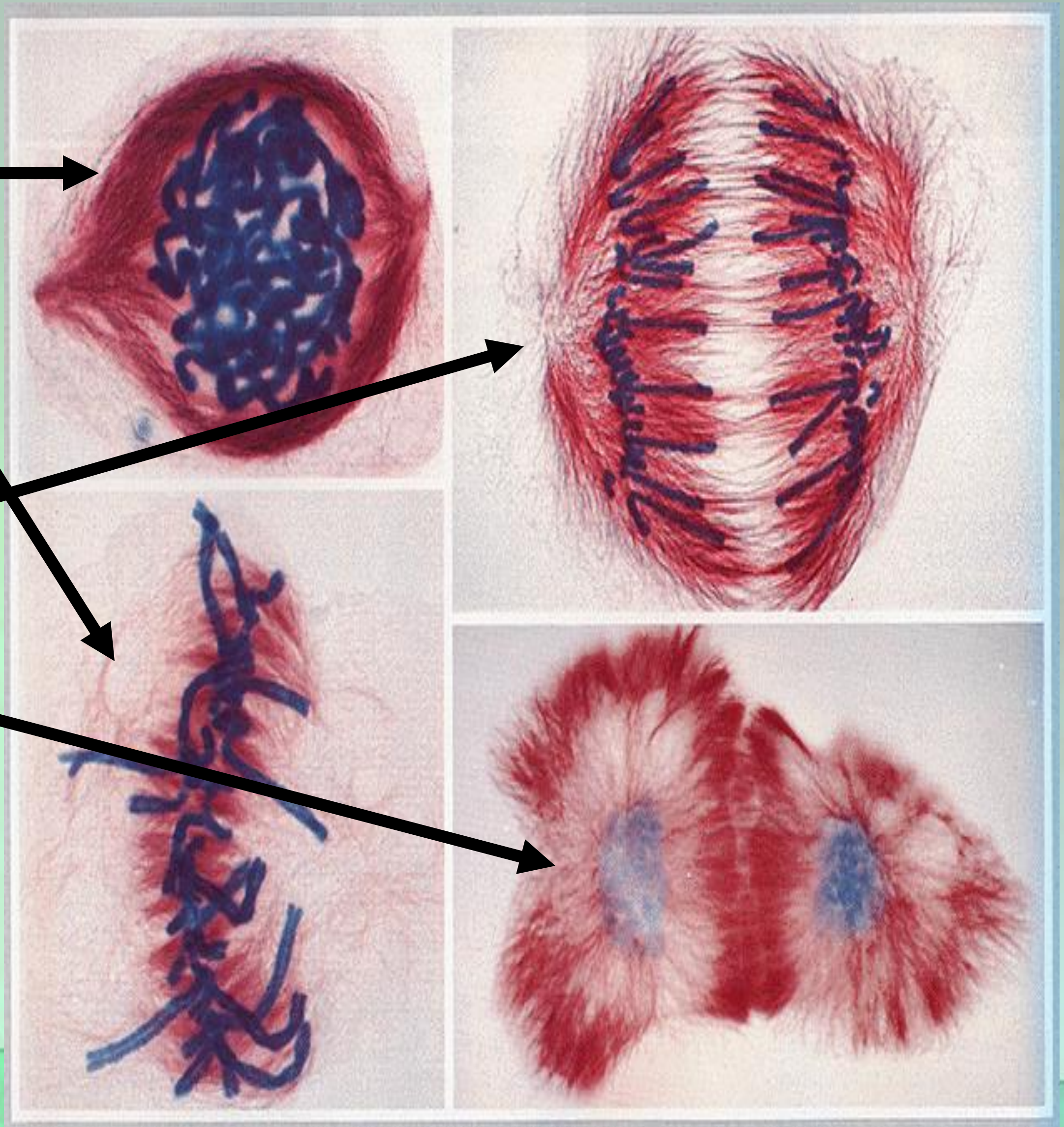
Mitosis

- ✓Division of the **nucleus**
- ✓Also called **karyokinesis**
- ✓Only occurs in **eukaryotes**
- ✓Has **four** stages
- ✓Doesn't occur in some cells such as **brain cells**



Four Mitotic Stages

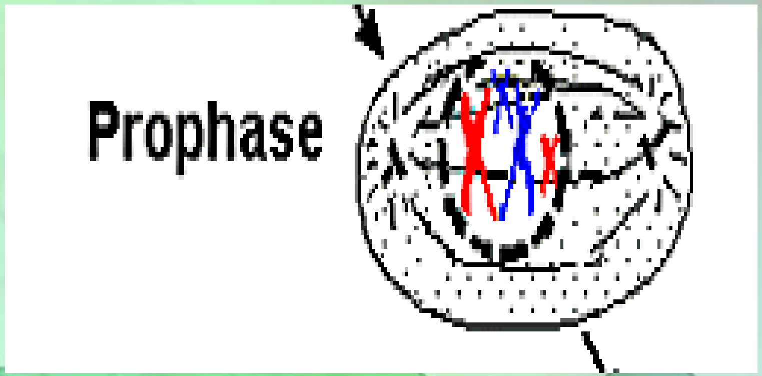
- ✓Prophase
- ✓Metaphase
- ✓Anaphase
- ✓Telophase



Prophase

- Chromosome pair up!

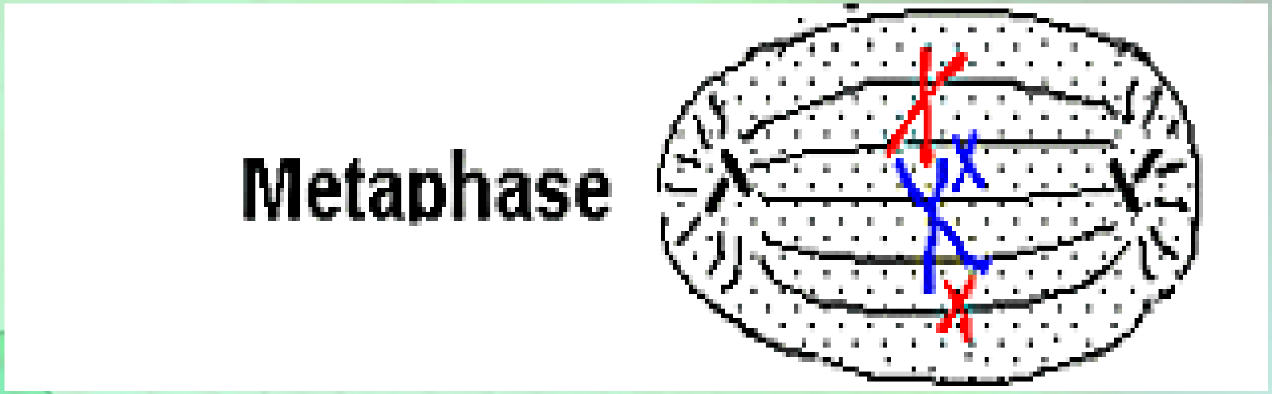
1. Chromosomes thicken and shorten
   -become visible
   -2 **chromatids** joined by a **centromere**
2. **Centrioles** move to the opposite sides of the nucleus
3. **Nucleolus** disappears
4. Nuclear membrane disintegrate



Metaphase

- Chromosomes **meet in the middle!**

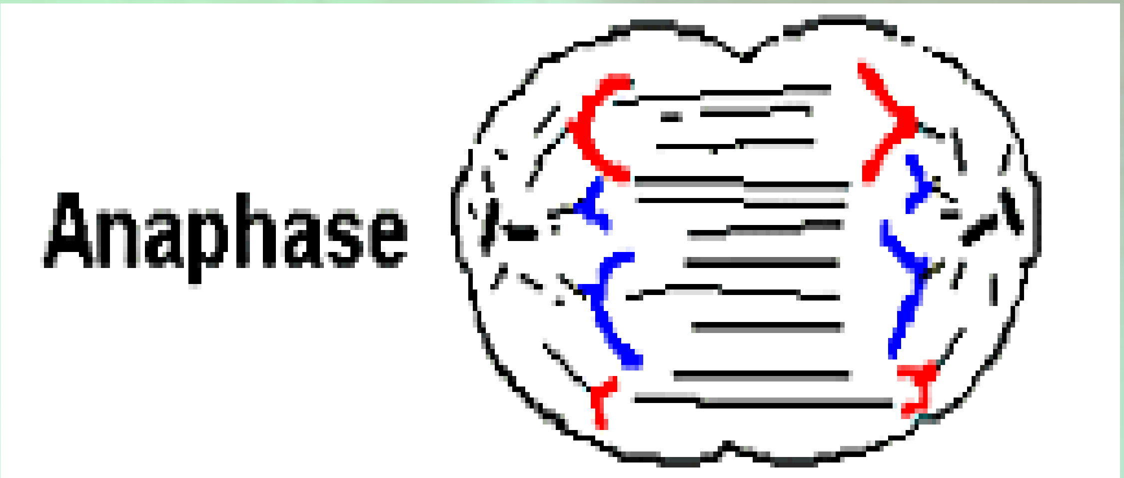
1. Chromosomes arrange at **equator** of cell
2. Become attached to **spindle fibres** by **centromeres**
3. **Homologous** chromosomes **do not associate**



Anaphase

- Chromosomes get pulled **apart**

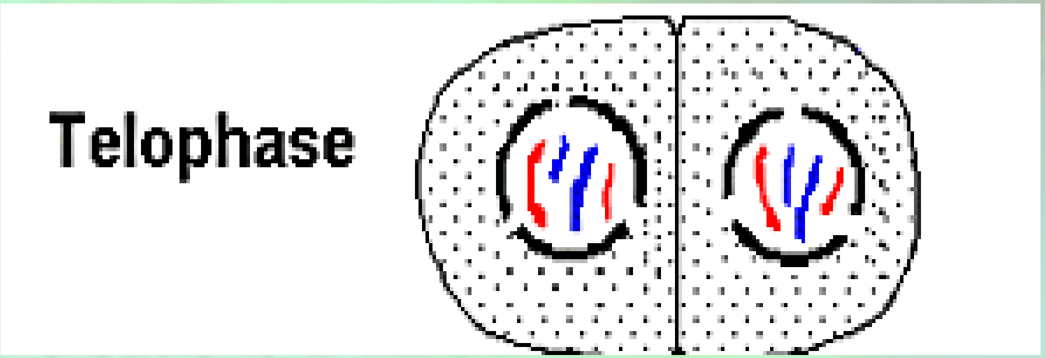
1. Spindle fibres contract pulling chromatids to the opposite poles of the cell

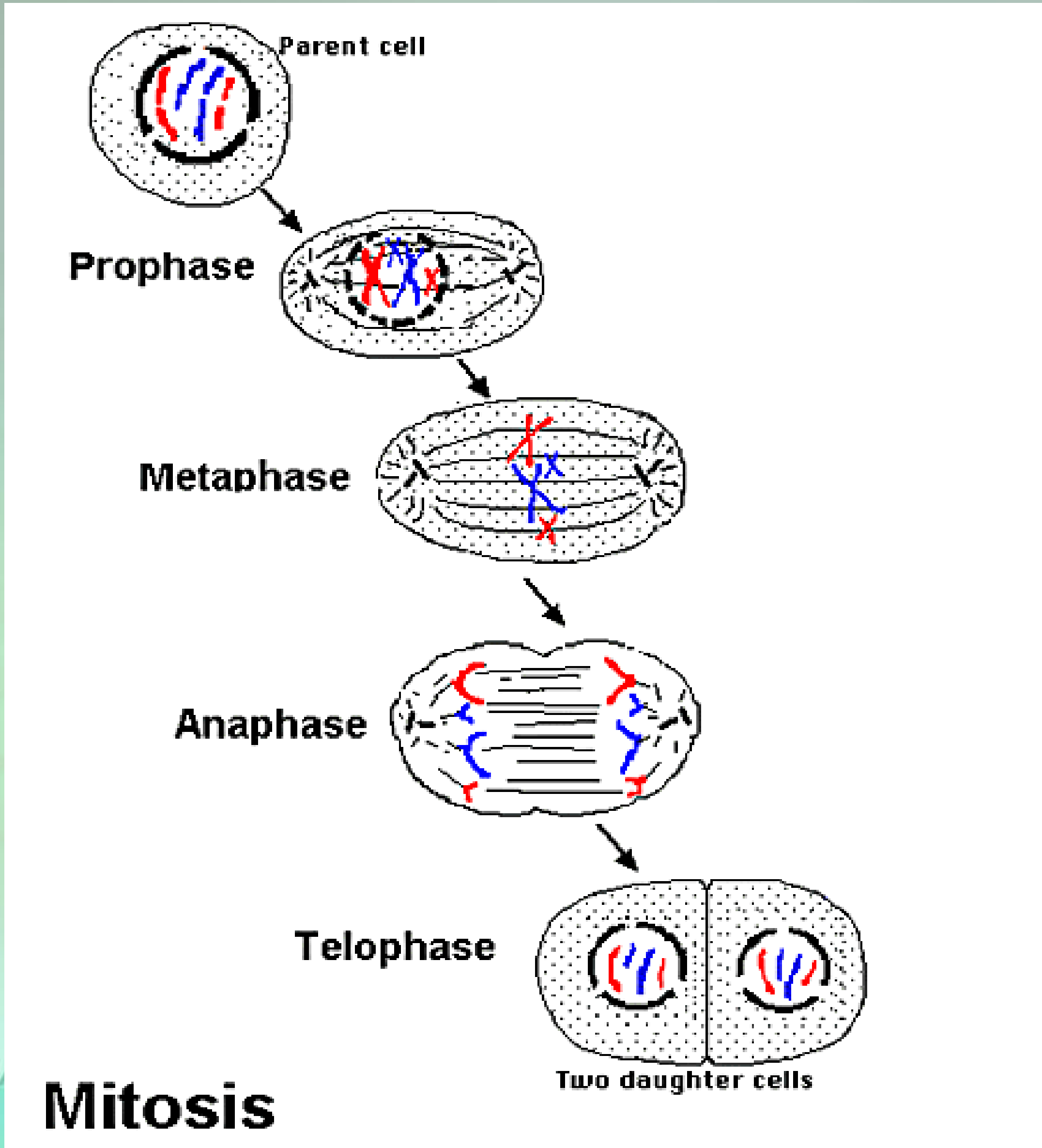


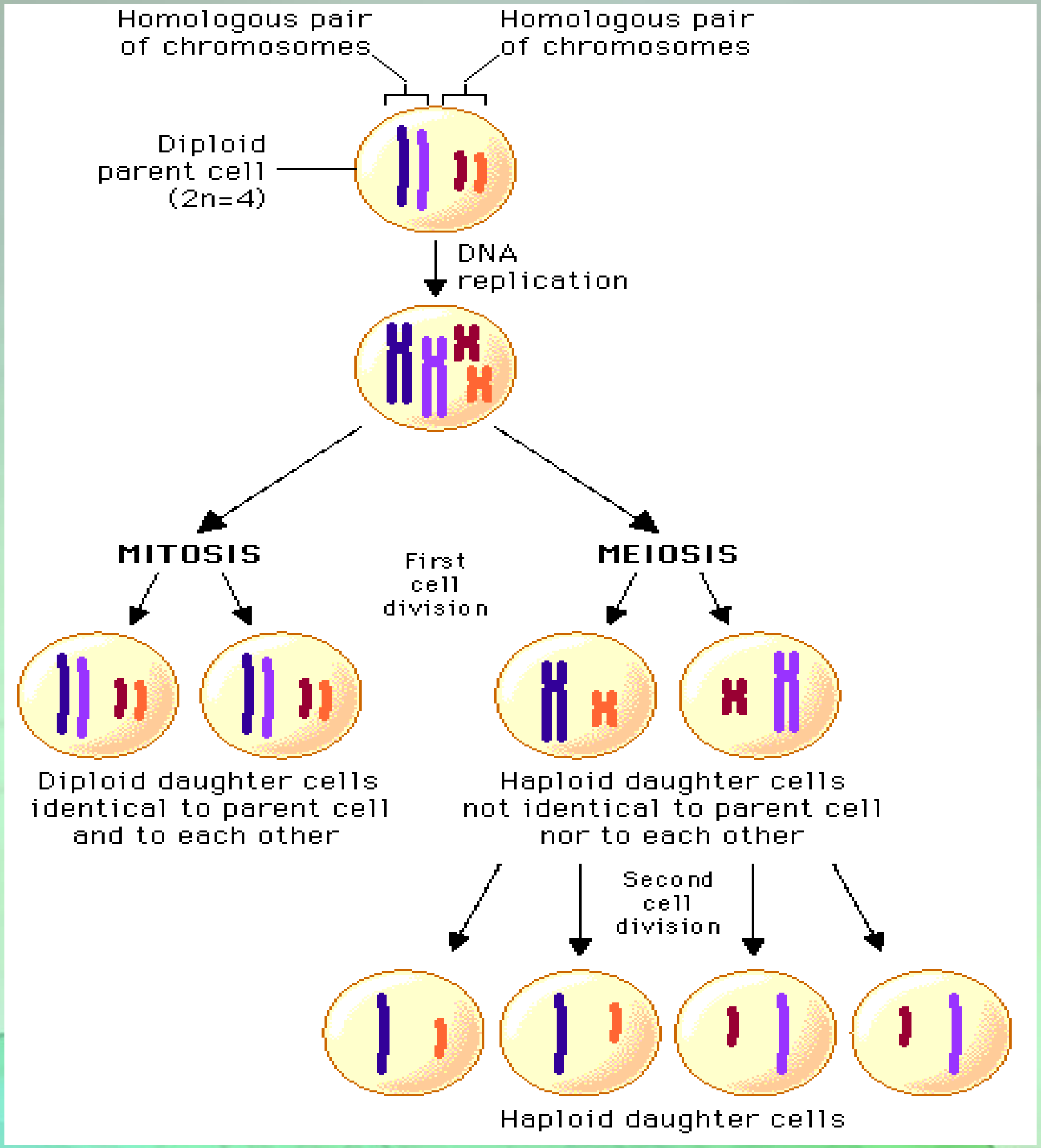
Telophase

- Now there are **two!**

1. **Chromosomes uncoil**
2. **Spindle fibres disintegrate**
3. **Centrioles replicate**
4. **Nucleur membrane forms**
5. **Cell divides**

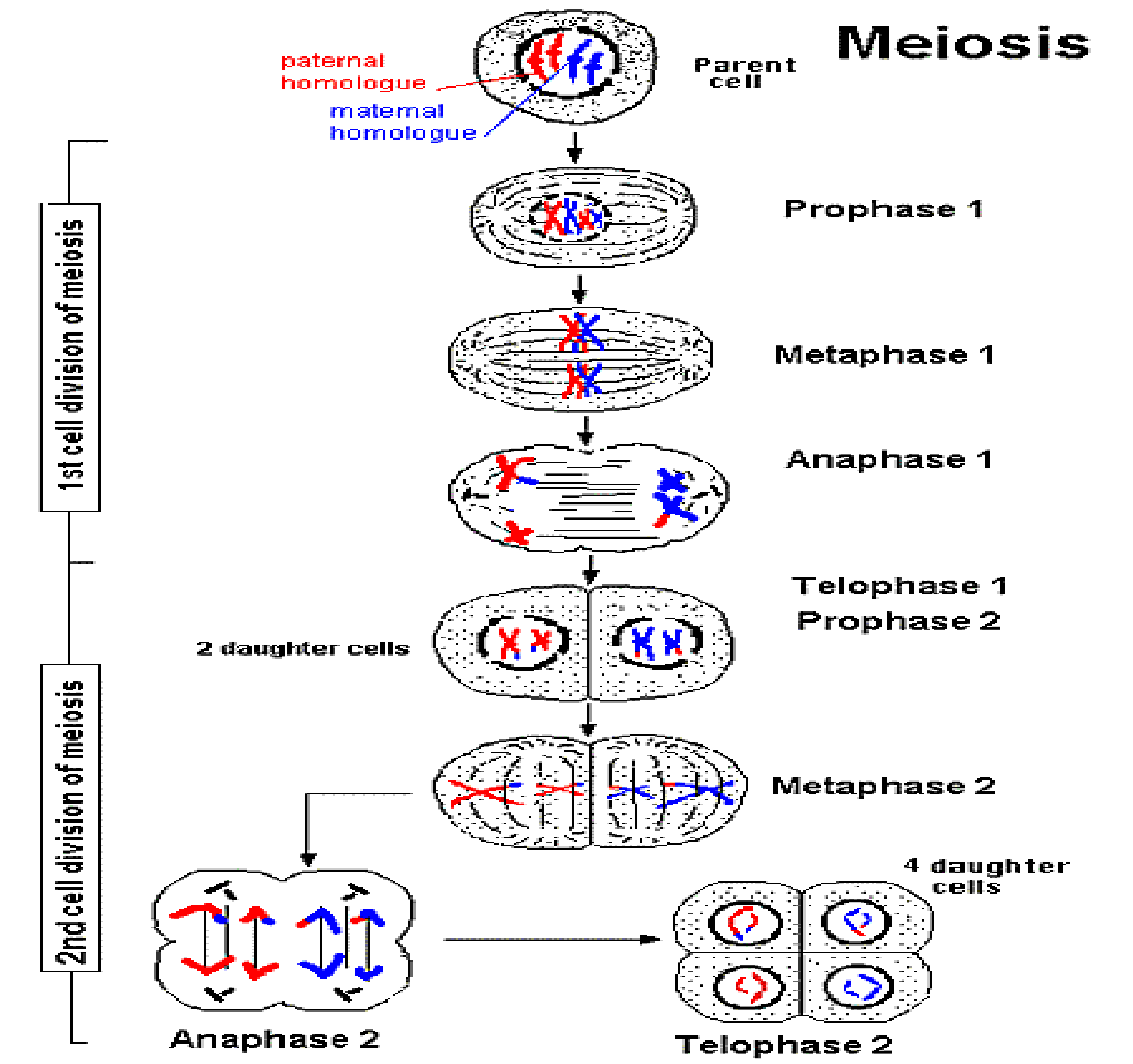



Parent cell
Prophase
Metaphase
Anaphase
Telophase
Two daughter cells
Mitosis


Homologous pair of chromosomes
Homologous pair of chromosomes
Diploid parent cell (2n=4)
DNA replication
MITOSIS
First cell division
MEIOSIS
Diploid daughter cells identical to parent cell and to each other
Haploid daughter cells not identical to parent cell nor to each other
Second cell division
Haploid daughter cells

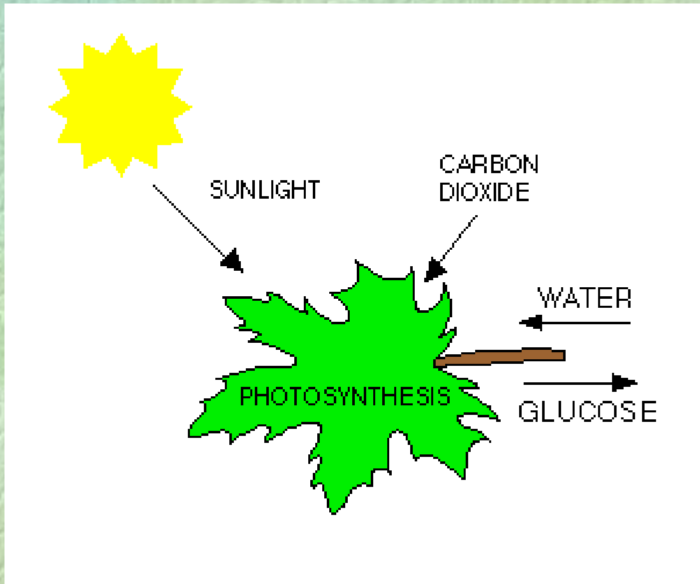
Meiosis

- 4 daughter cells produced
- Each daughter cell has half the chromosomes of the parent
- 2 sets of cell division involved



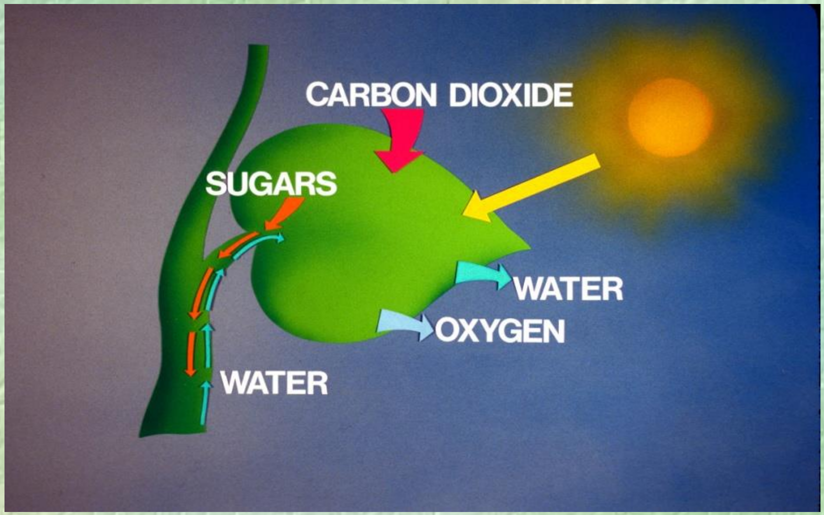
PHOTOSYNTHESIS

- Autotrophic Process: Plants and plant-like organisms make their energy (glucose) from sunlight.
- Stored as carbohydrate in their bodies.
- $6CO_2 + 6H_2O + \text{sunlight} \rightarrow C_6H_{12}O_6 + 6O_2$

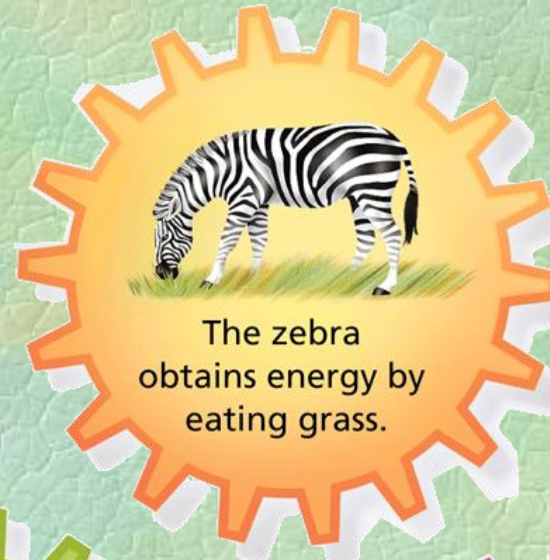


Why is Photosynthesis important?

- Makes organic molecules (glucose) out of inorganic materials (carbon dioxide and water).
- It begins all food chains/webs. Thus all life is supported by this process.
- It also makes oxygen gas!!



Photosynthesis-starts to ecological food webs!



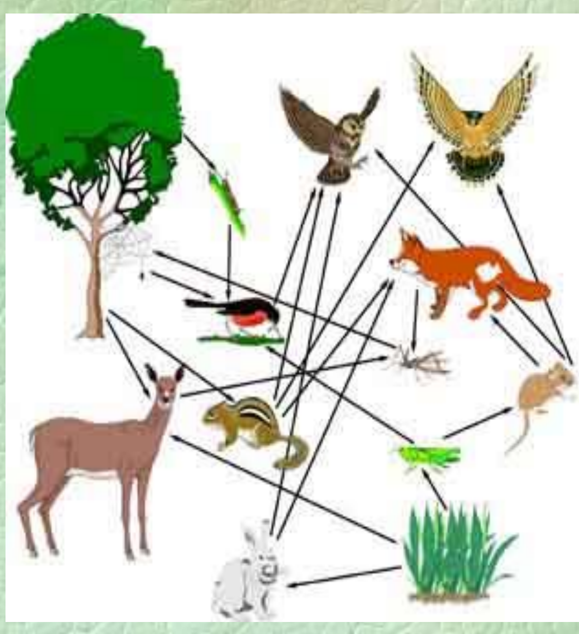
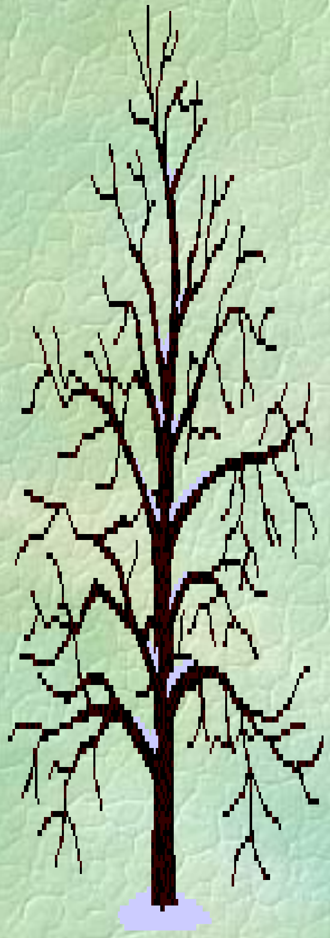
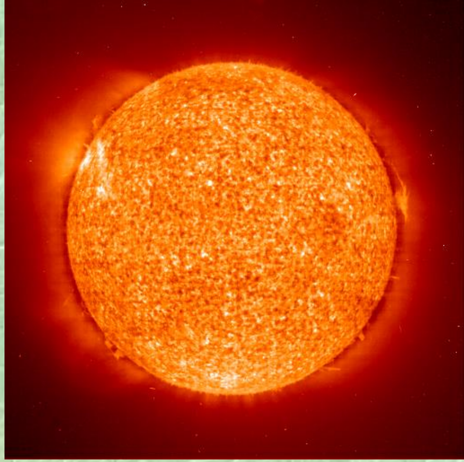


Photo-synthesis

- Plants use sunlight to turn water and carbon dioxide into glucose. Glucose is a kind of sugar.
- Plants use glucose as food for energy and as a building block for growing.
- Autotrophs make glucose and heterotrophs are consumers of it.

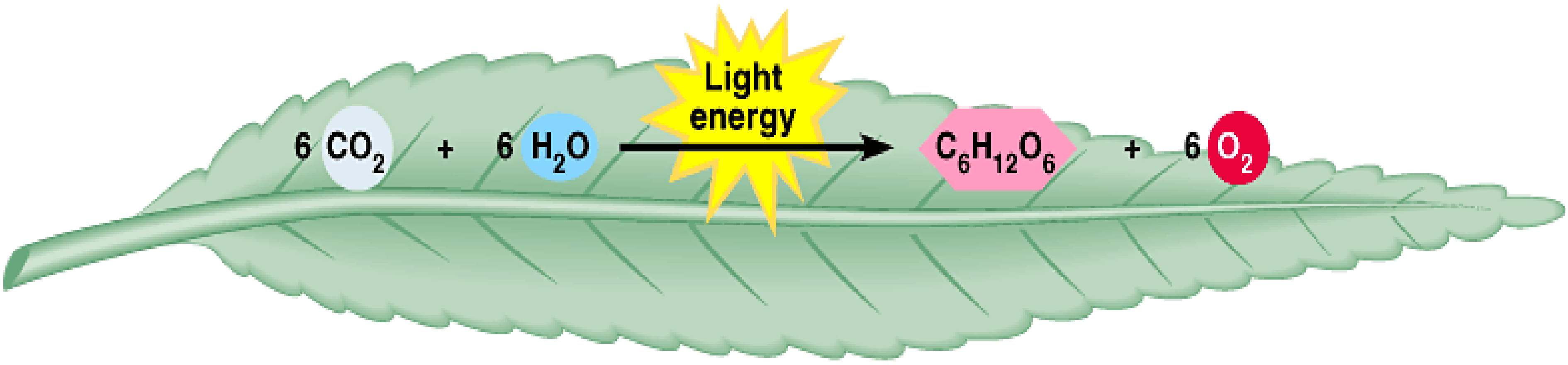


Photosynthesis



Carbon dioxide + water $\xrightarrow[\text{absorbed by chlorophyll}]{\text{sunlight}}$ **glucose + oxygen**

$$6CO_2 + 6H_2O + \text{energy} \rightarrow C_6H_{12}O_6 + 6O_2$$



Plants

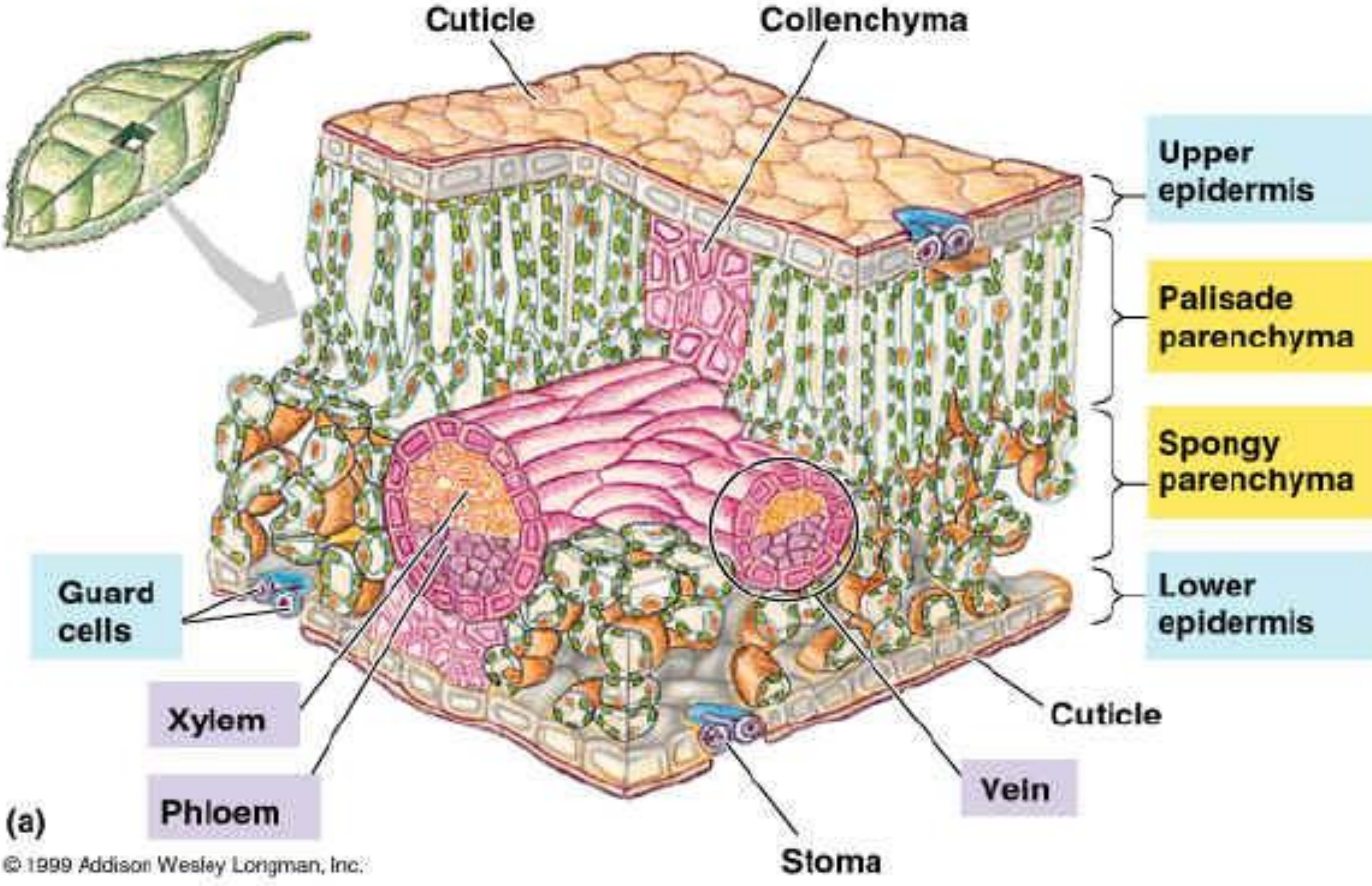
Leaves are green because they contain

the pigment:

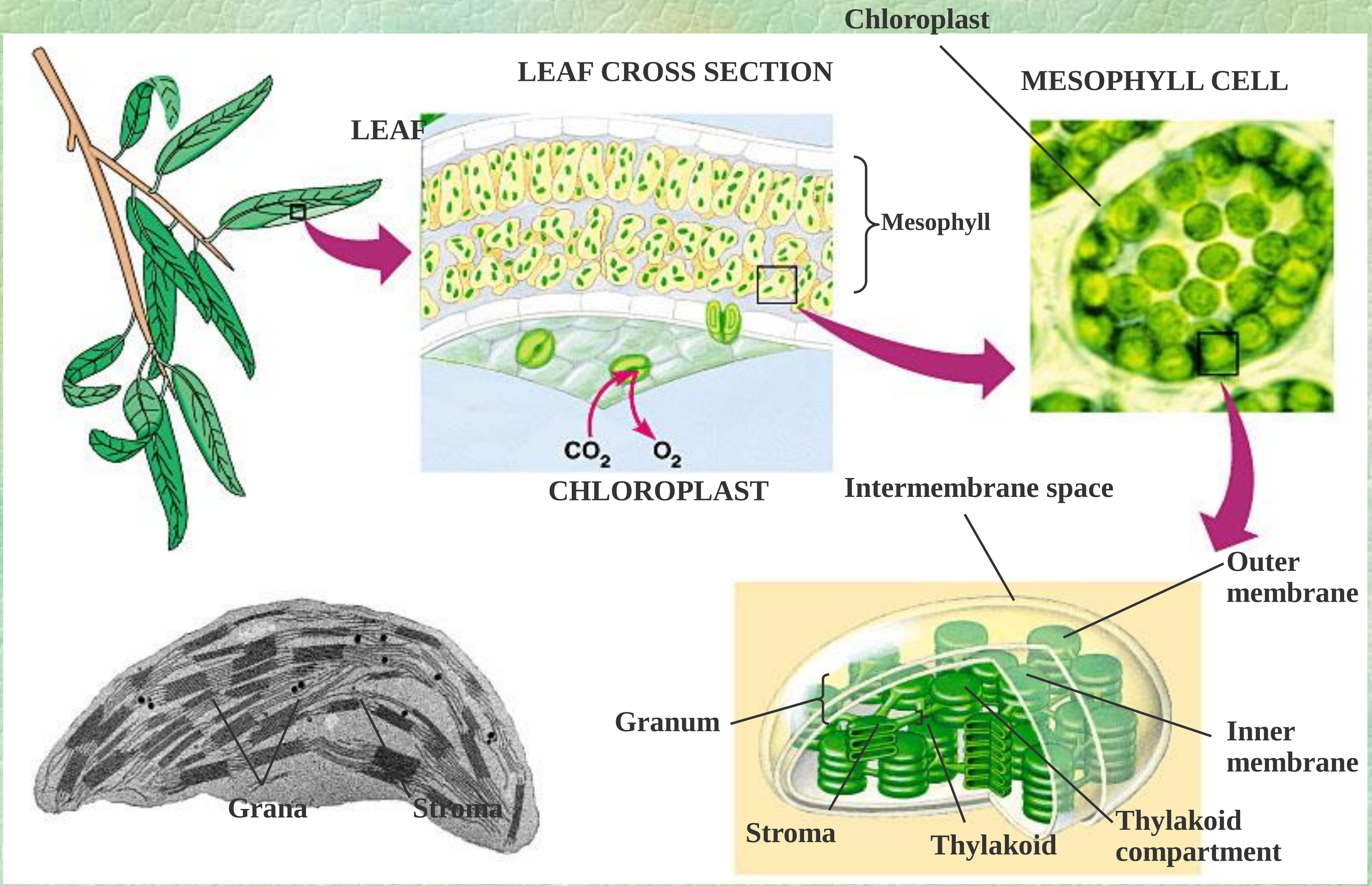
chlorophyll

Leaves have a large surface area to absorb as much light as possible

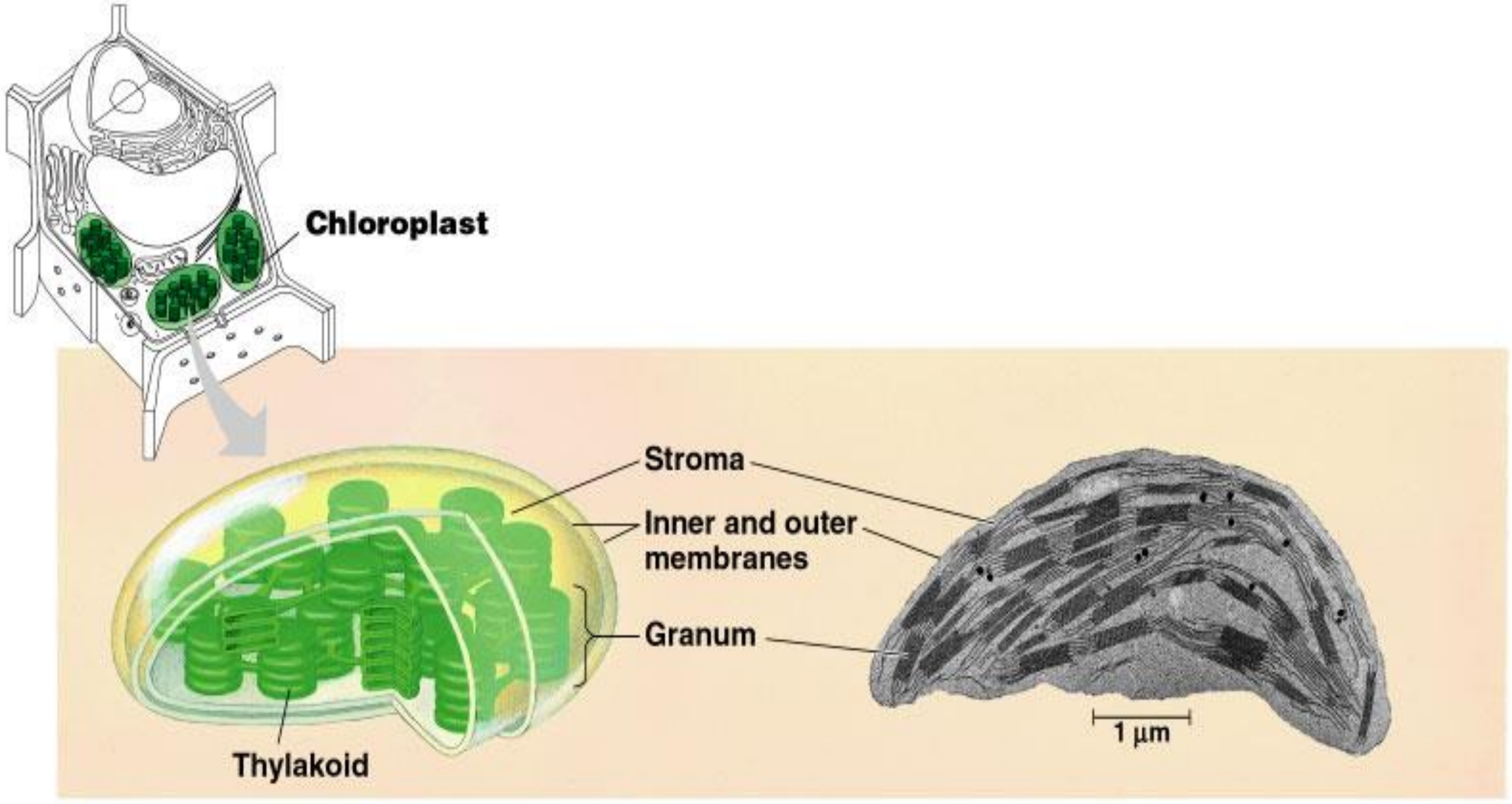
Plant leaves have many types of cells!



The location and structure of chloroplasts



Chloroplasts make the sugars!
Chloroplasts make the oxygen too!

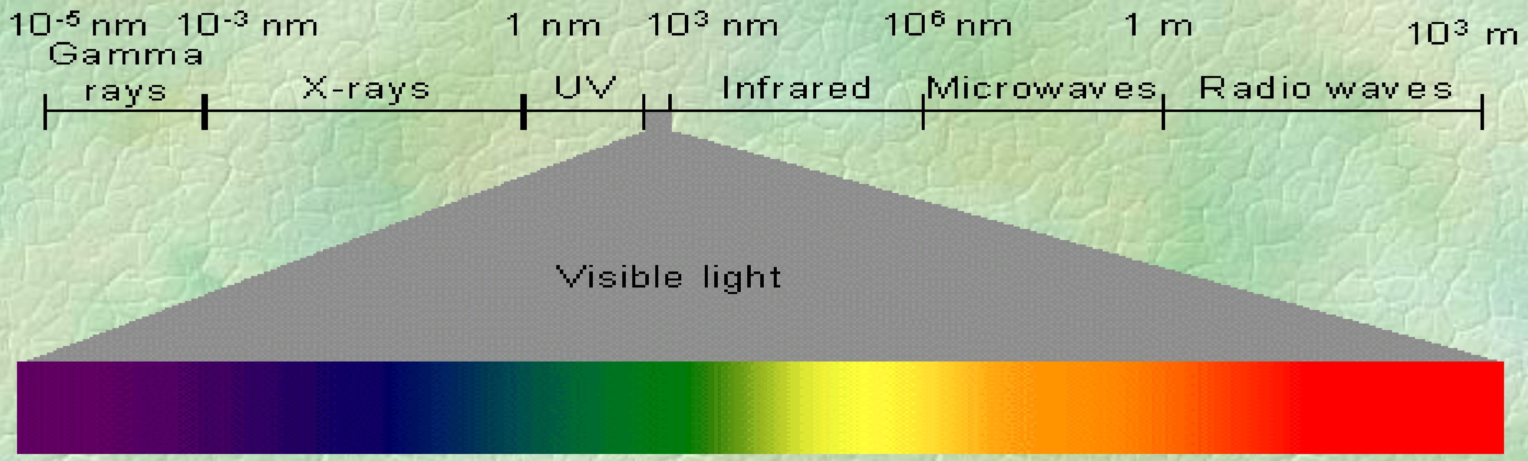


Chloroplast Pigments

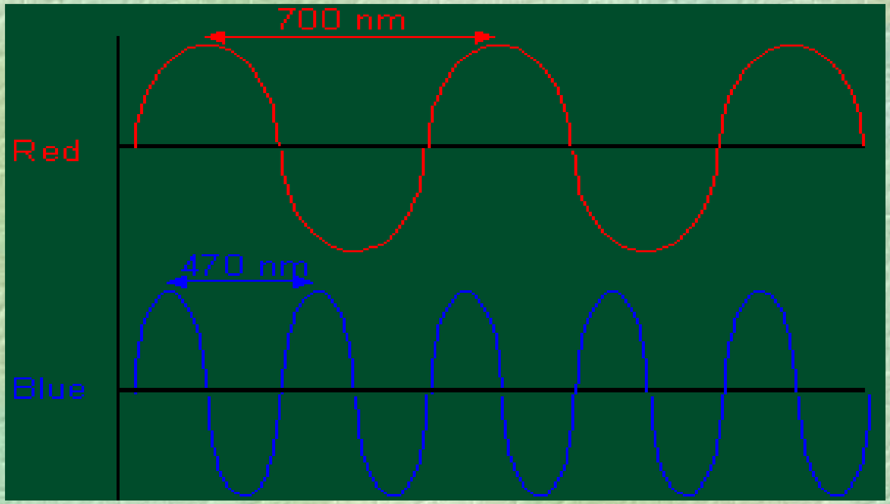
- Chloroplasts contain several pigments
  - Chlorophyll a
  - Chlorophyll b
  - Carotenoids

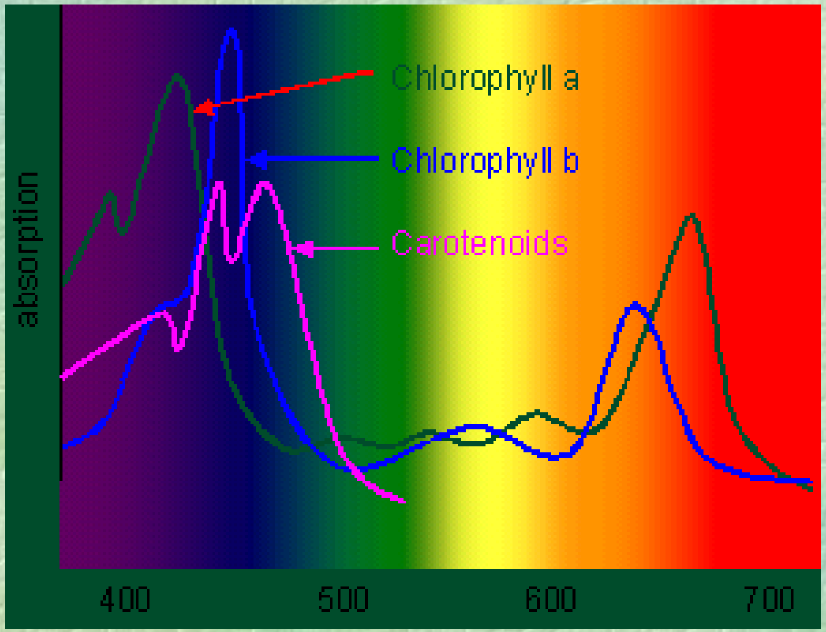
PHOTOSYNTHESIS

- Pigments: Absorb different colors of white light (ROY G BIV)
  - Main pigment: Chlorophyll a
  - Accessory pigments: Chlorophyll b and Carotenoids
  - These pigments absorb all wavelengths (light)
  - Green color from white light reflected NOT absorbed

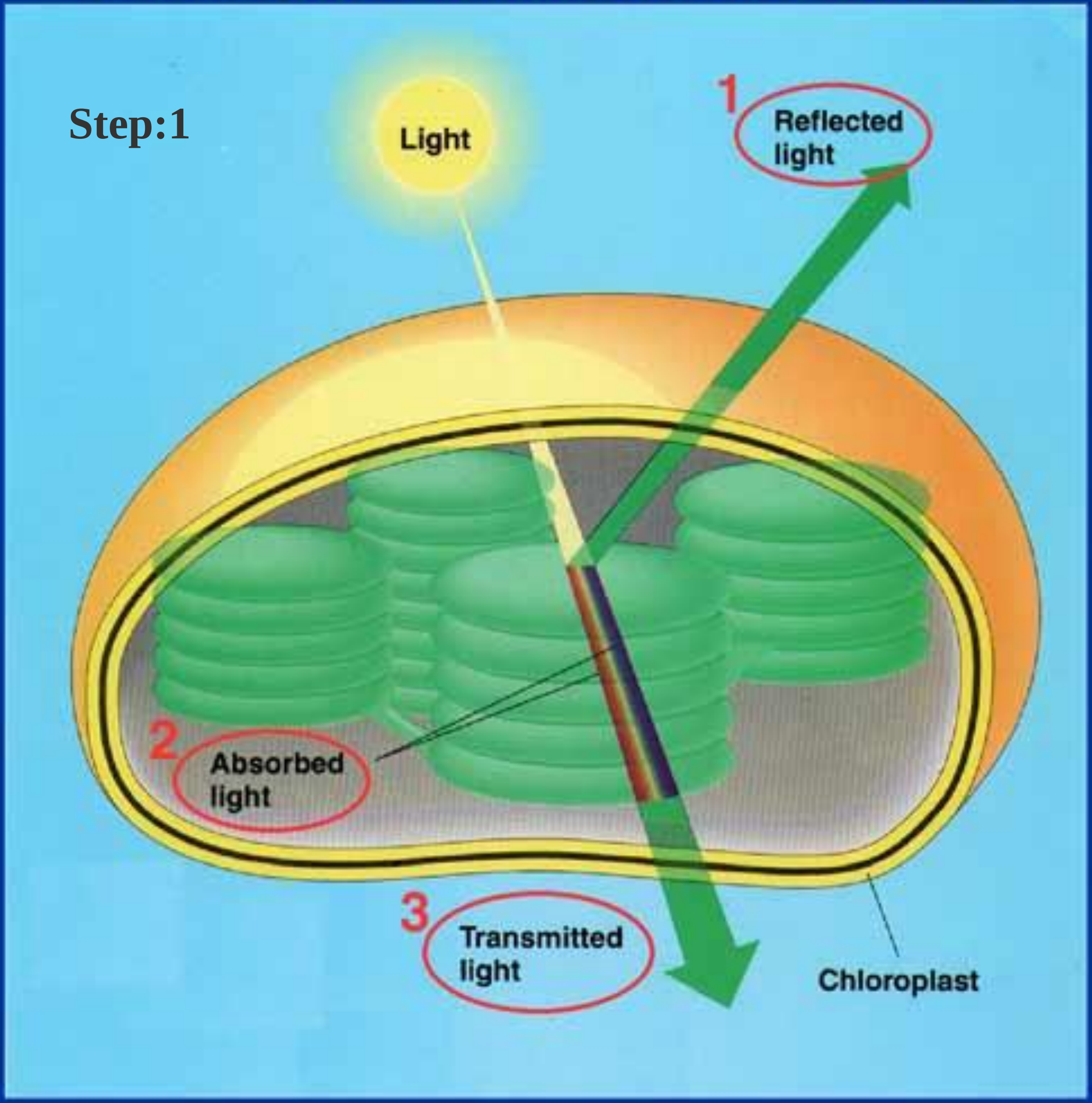


- **LIGHT** behaves as if it were composed of "units" or "packets" of energy that travel in waves. These packets are **photons**.
- The wavelength of light determines its color.



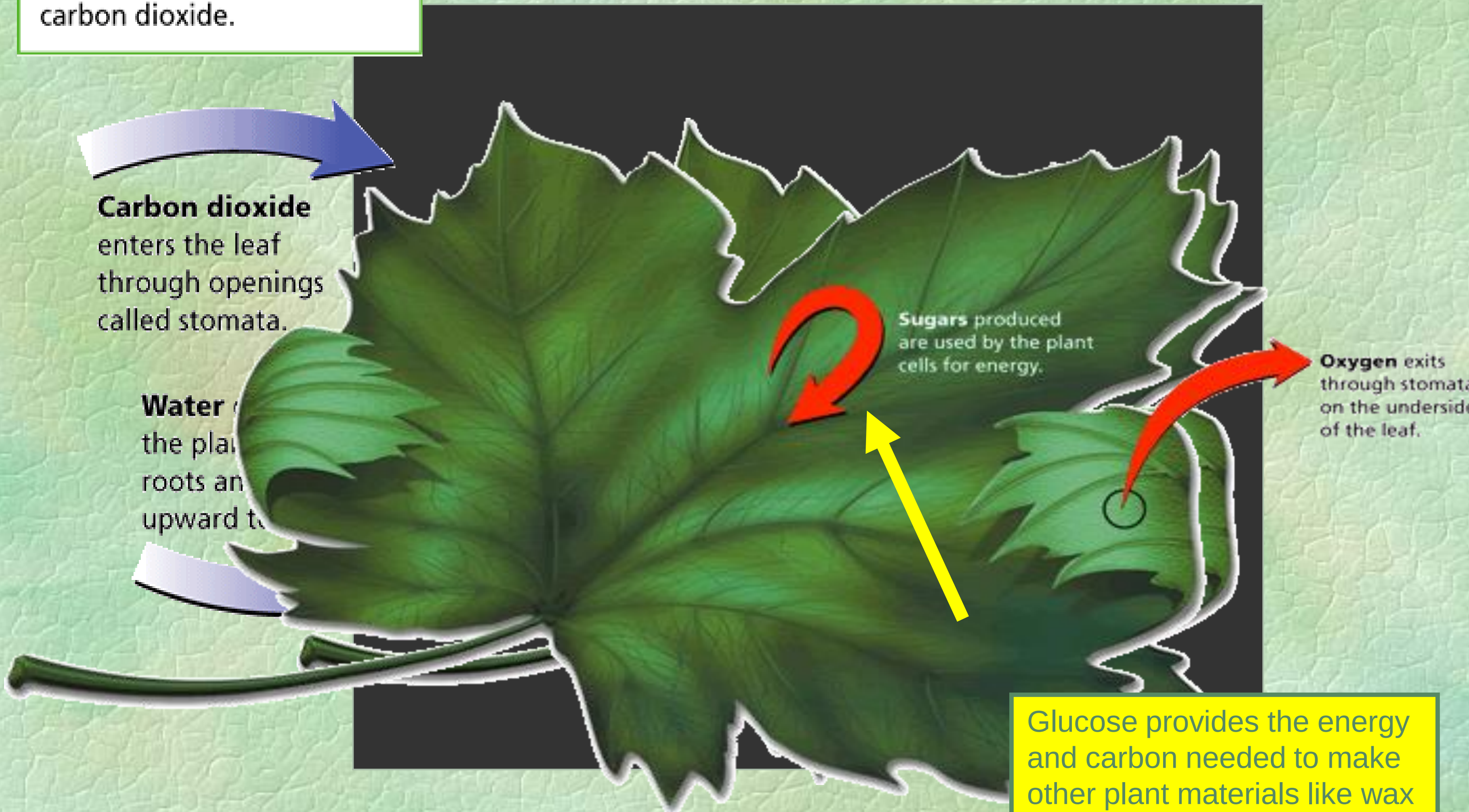


INTERACTION OF LIGHT WITH MATTER IN CHLOROPLAST; LIGHT DIVIDED INTO THREE PARTS



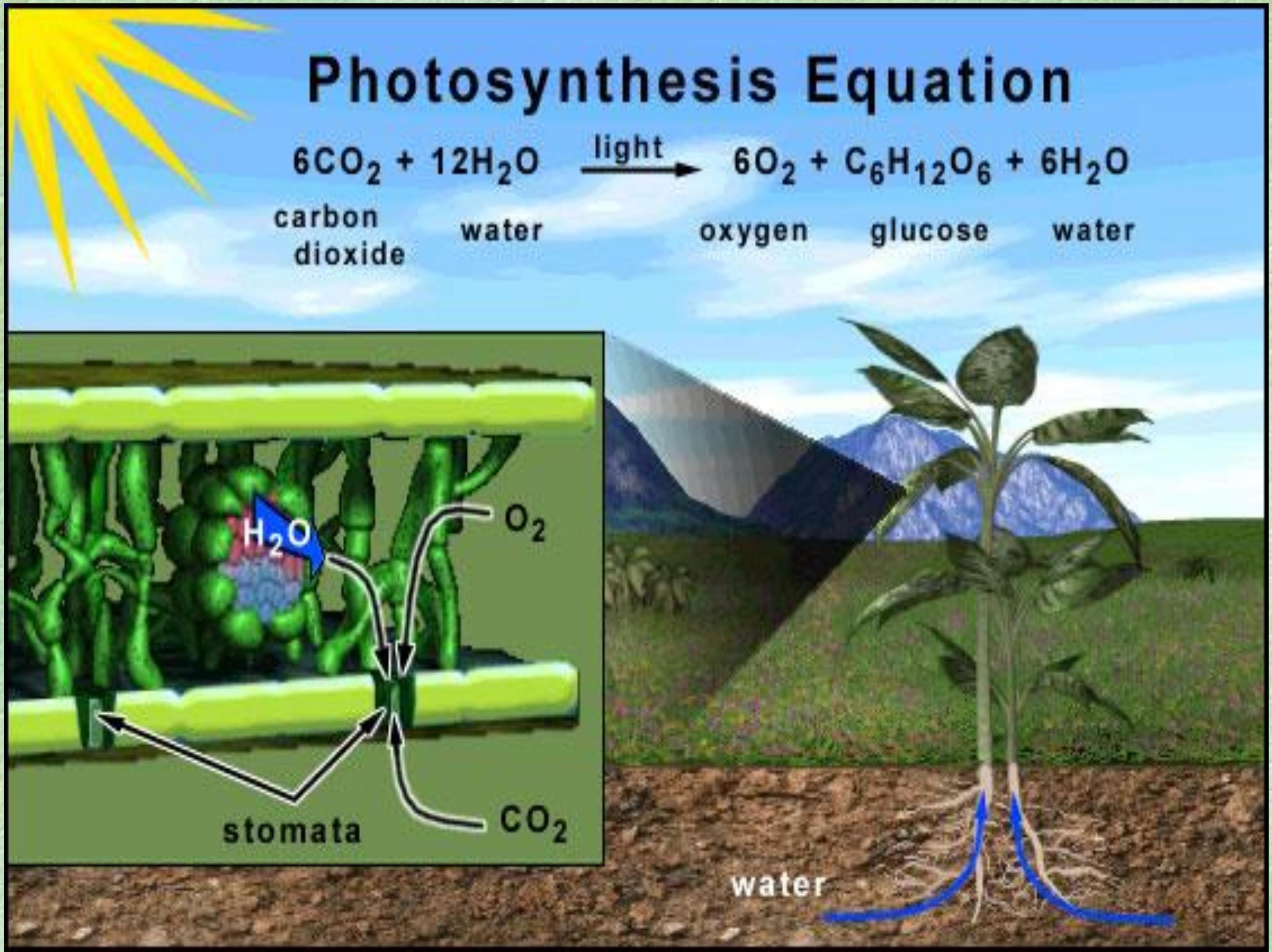
Photosynthesis

Stage 2
The captured light energy is used to produce sugars and oxygen from water and carbon dioxide.



Glucose provides the energy and carbon needed to make other plant materials like wax and proteins.

- In plants, waste products are removed by **diffusion**. Plants, for example, excrete O_2, a product of photosynthesis.

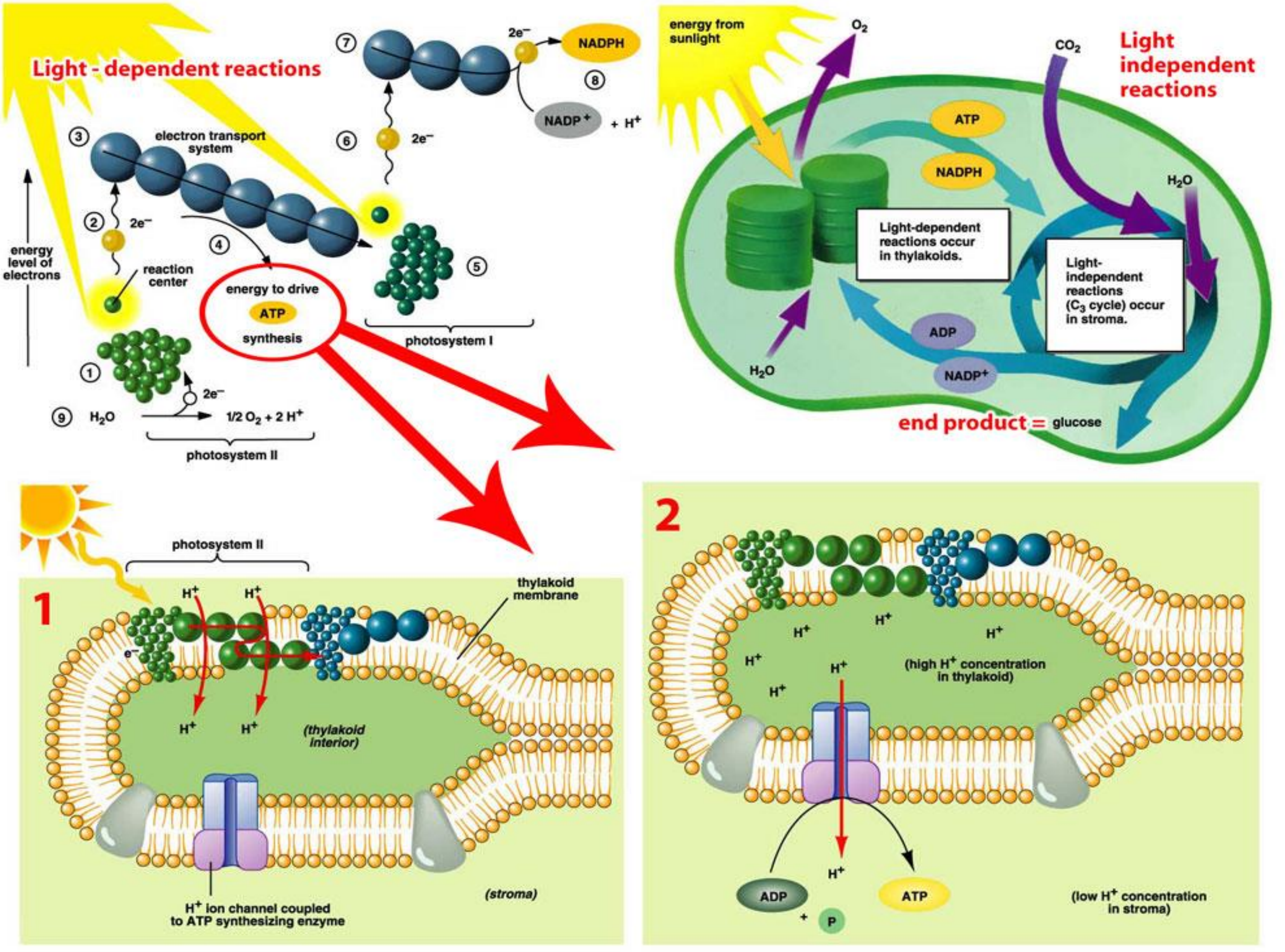


PHOTOSYNTHESIS

- 2 Phases
  - Light-dependent reaction
  - Light-independent reaction

- **Light-dependent:** converts light energy into chemical energy; produces ATP molecules to be used to fuel light-independent reaction

- **Light-independent**: uses ATP produced to make simple sugars.



Light - dependent reactions
energy level of electrons
① ② ③ ④ ⑤ ⑥ ⑦ ⑧ ⑨
electron transport system
2e⁻
reaction center
energy to drive
ATP
synthesis
photosystem I
NADPH
NADP⁺
+ H⁺
H₂O
1/2 O₂ + 2 H⁺
photosystem II
energy from sunlight
O₂
CO₂
Light independent reactions
ATP
NADPH
H₂O
Light-dependent reactions occur in thylakoids.
Light-independent reactions (C₃ cycle) occur in stroma.
ADP
NADP⁺
end product = glucose
1
photosystem II
H⁺
e⁻
thylakoid membrane
(thylakoid interior)
(stroma)
H⁺ ion channel coupled to ATP synthesizing enzyme
2
(high H⁺ concentration in thylakoid)
ADP
+ P
ATP
(low H⁺ concentration in stroma)

PHOTOSYNTHESIS

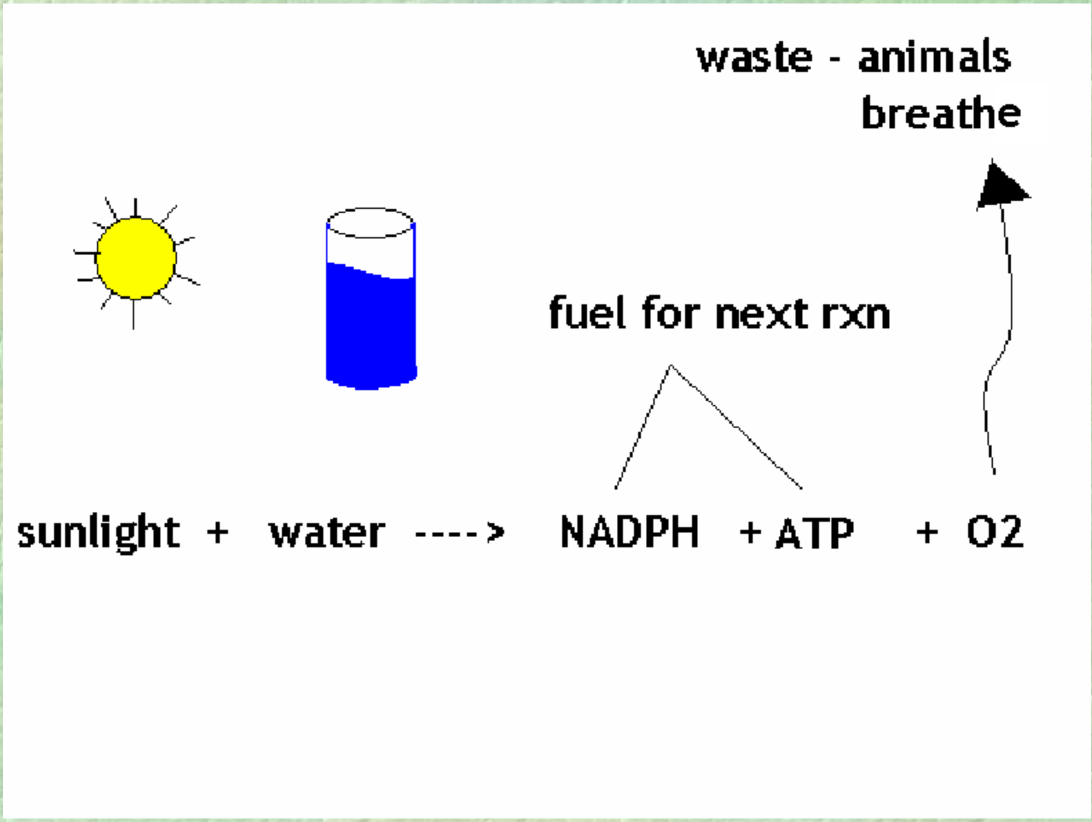
- Light-dependent reaction (LIGHT Reaction)
  - Requires light
  - Occurs in chloroplast (in thylakoids)
  - Chlorophyll (thylakoid) traps energy from light
  - Light excites electron (e-)
    - Kicks e- out of chlorophyll to an electron transport chain
    - Electron transport chain: series of proteins in thylakoid membrane

PHOTOSYNTHESIS

- Light-dependent reaction (LIGHT Reaction)
  - Energy lost along electron transport chain
  - Lost energy used to recharge ATP from ADP
  - NADPH produced from e- transport chain
    - Stores energy until transfer to stroma
    - Plays important role in light-independent reaction
  - Total byproducts: ATP, NADP, O_2

PHOTOSYNTHESIS

- How did we get O_2 as a byproduct?!
  - Photolysis: replaces lost electrons by splitting water

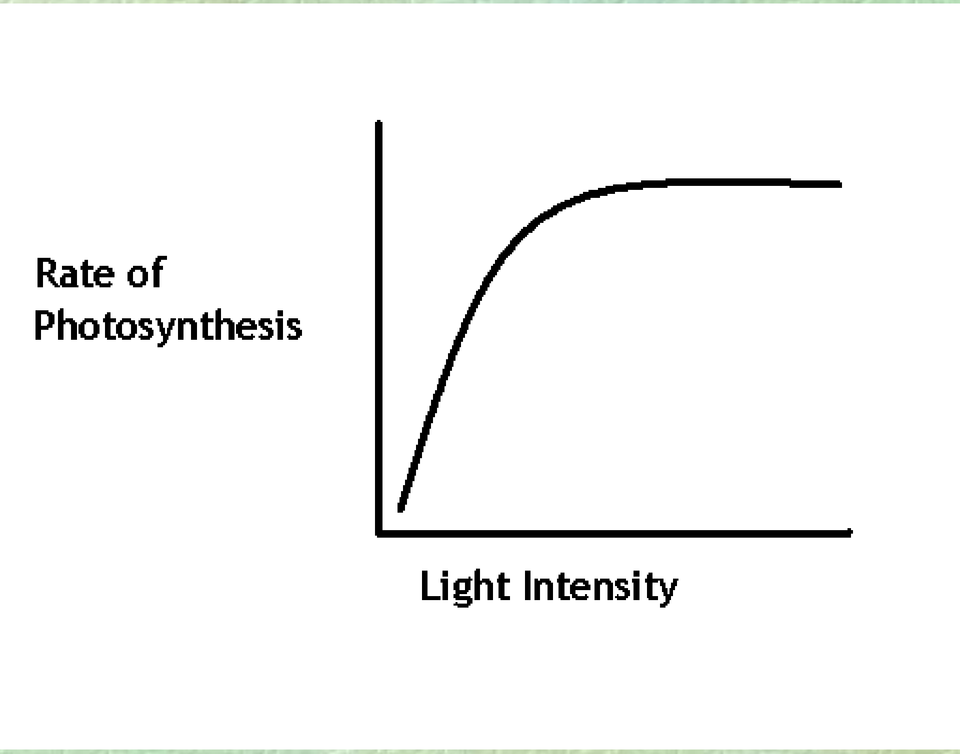


PHOTOSYNTHESIS

- Light-independent reaction (Dark Reaction)
  - Does not require light
  - Calvin Cycle
    - Occurs in stroma of chloroplast
    - Requires CO_2
    - Uses ATP and NADPH as fuel to run
    - Makes glucose sugar from CO_2 and Hydrogen

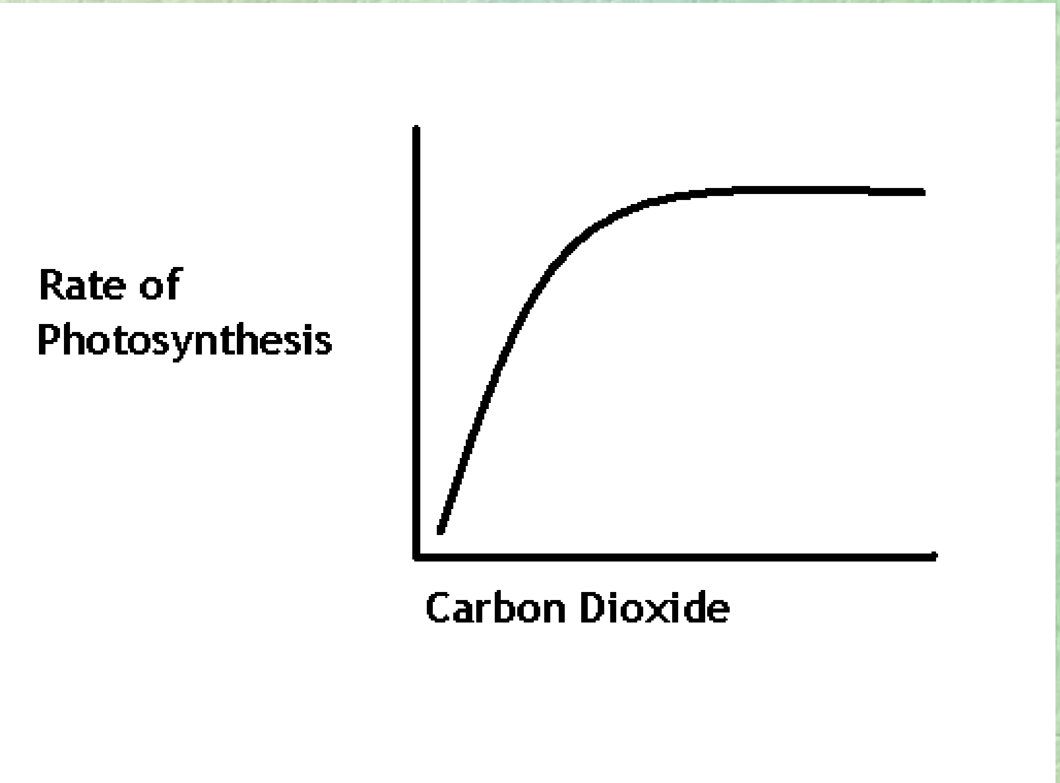
PHOTOSYNTHESIS

- What affects photosynthesis?
  - Light intensity: as light increases, rate of photosynthesis increases



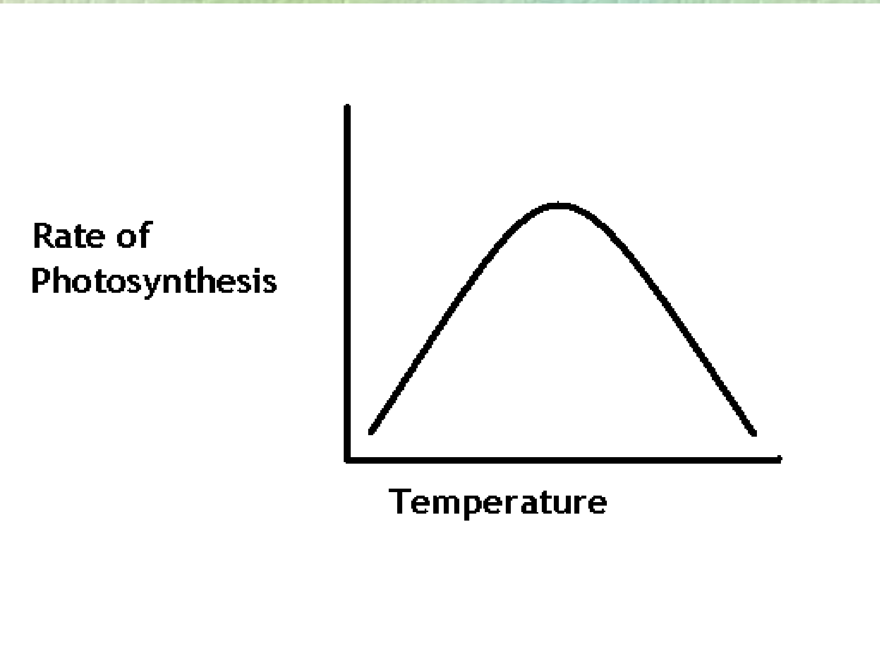
PHOTOSYNTHESIS

- What affects photosynthesis?
  - Carbon Dioxide: As CO_2 increases, rate of photosynthesis increases

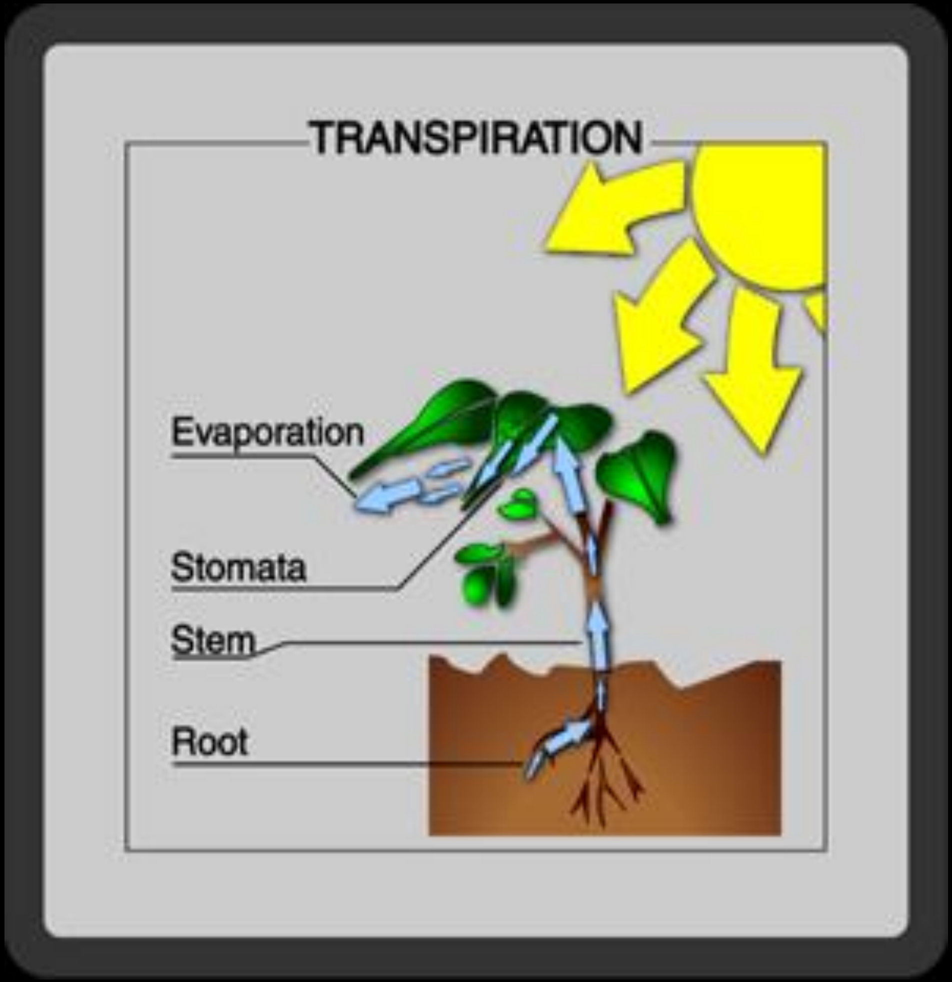


PHOTOSYNTHESIS

- What affects photosynthesis?
  - Temperature:
    - Temperature Low = Rate of photosynthesis low
    - Temperature Increases = Rate of photosynthesis increases
    - If temperature too hot, rate drops



Transpiration



Transpiration

- Transpiration- loss of water vapor from the aerial part of plant
- Water diffuses out of the plant from a 100%
- concentration in leaves to an area of low concentration

Water moves through plants

Into the air

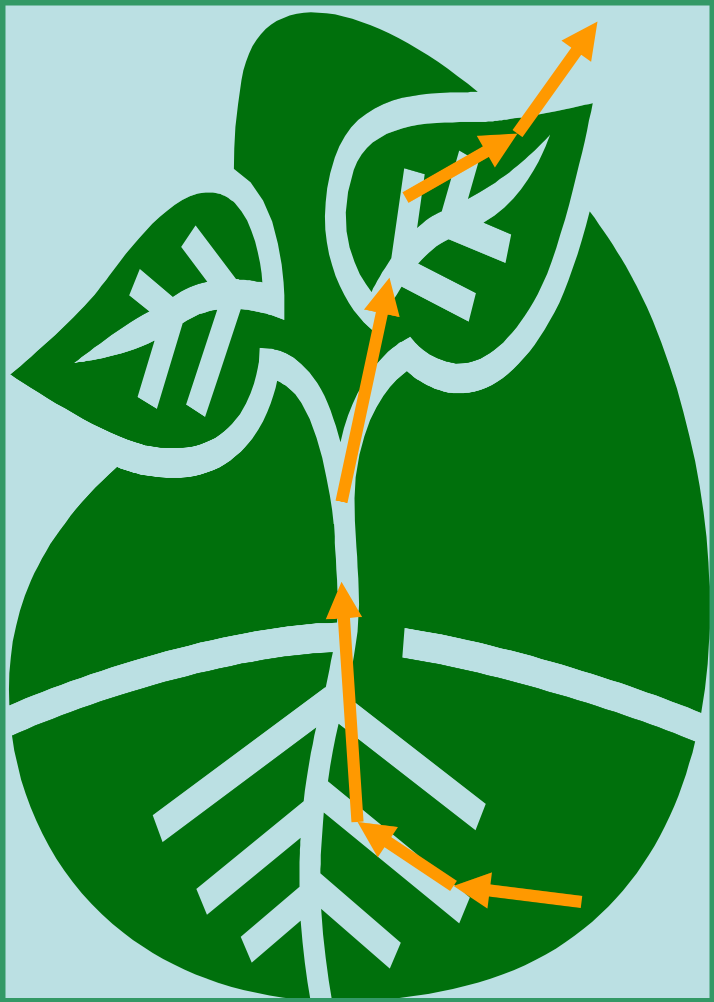
Through the plant

From soil to plant

Key questions

- What is the route? (cell types)
- Why does it move? (Energy source)
  - Whole system (soil/plant/air)
  - Locally (cell to cell)
- What are the forces involved?
- What special properties are involved?
  - Special properties of water
  - Special properties of the plant
- How can the plant control it?

The route



From leaf cells to air

From leaf xylem to leaf cells

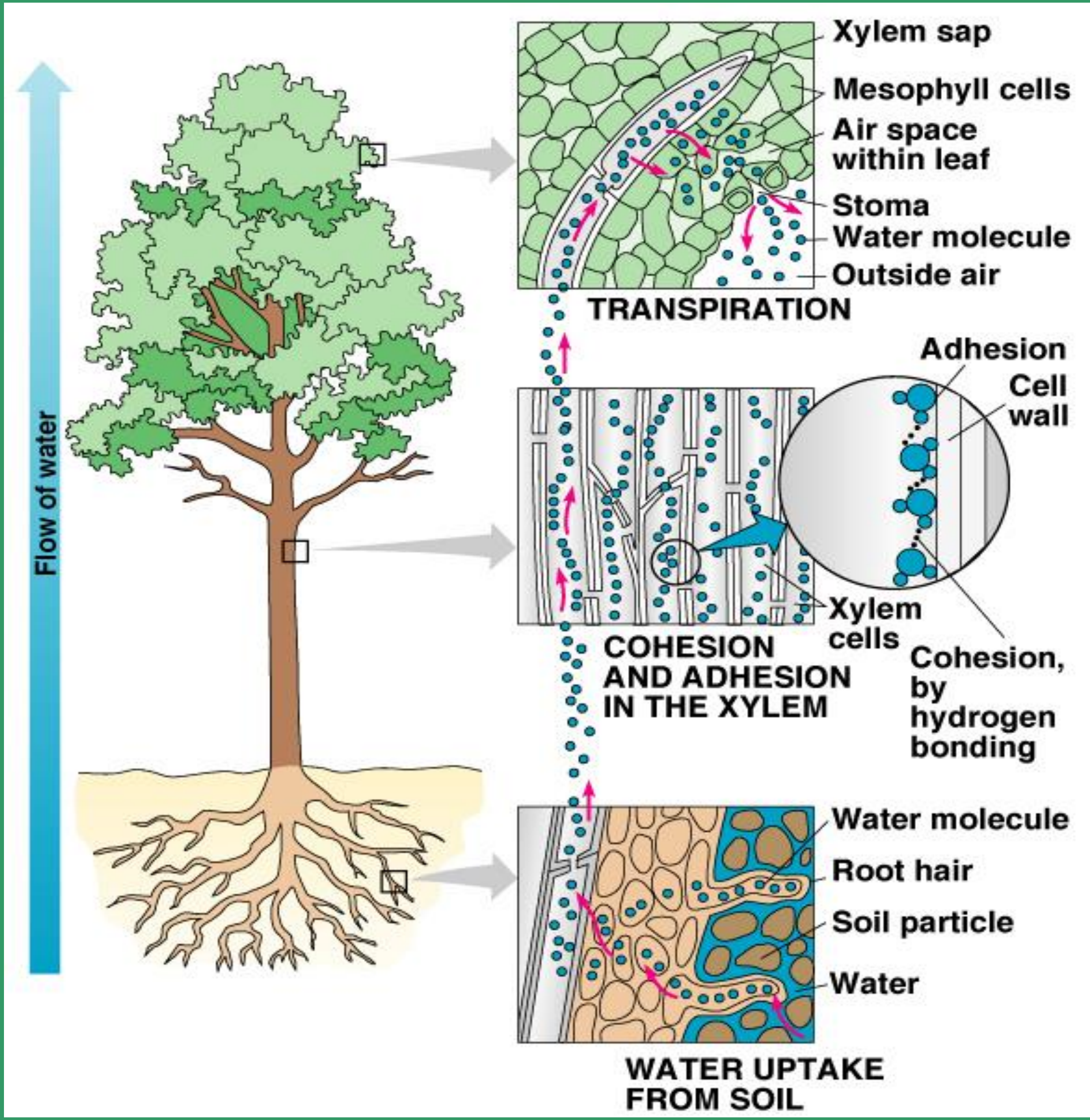
From stem xylem to
leaf xylem

From root xylem to
stem xylem

From root cells to
root xylem

From soil to root cells

The route



Flow of water
Xylem sap
Mesophyll cells
Air space within leaf
Stoma
Water molecule
Outside air
TRANSPIRATION
Adhesion
Cell wall
Xylem cells
COHESION AND ADHESION IN THE XYLEM
Cohesion, by hydrogen bonding
Water molecule
Root hair
Soil particle
Water
WATER UPTAKE FROM SOIL

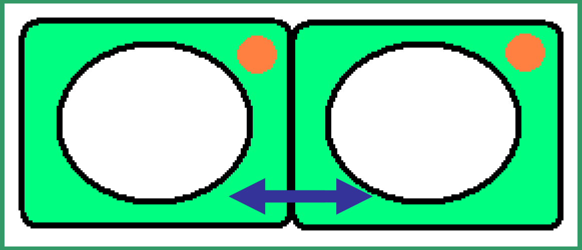
What drives Transpiration ? (Energy)

- Differences in energy make things move
- Also need a route
- For water movement in plants
  - *Water potential* (pressure and solute effects) differences move water across membranes
  - *Pressure* differences cause bulk flow in xylem
- Water evaporate into the air due to **Water potential differences.**

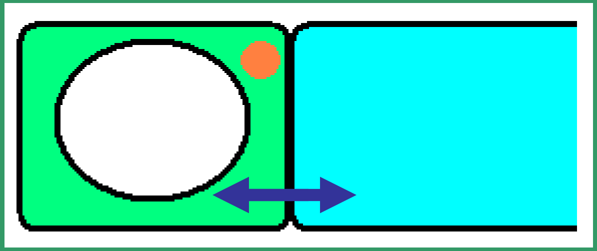
Overall water movement

- Water potential
  - Air < plant <soil
- Water flows “downhill” energetically
  - From higher to lower water potential
  - From soil to plant to air
- Difference in the water potential between soil and air drives transpiration

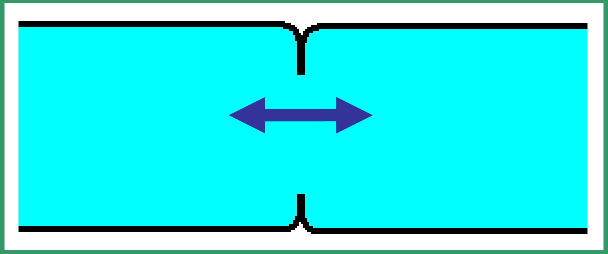
Cell-to-cell movement



- Live cells (with central vacuole)
  - Membranes present
  - Water potential difference drives movement

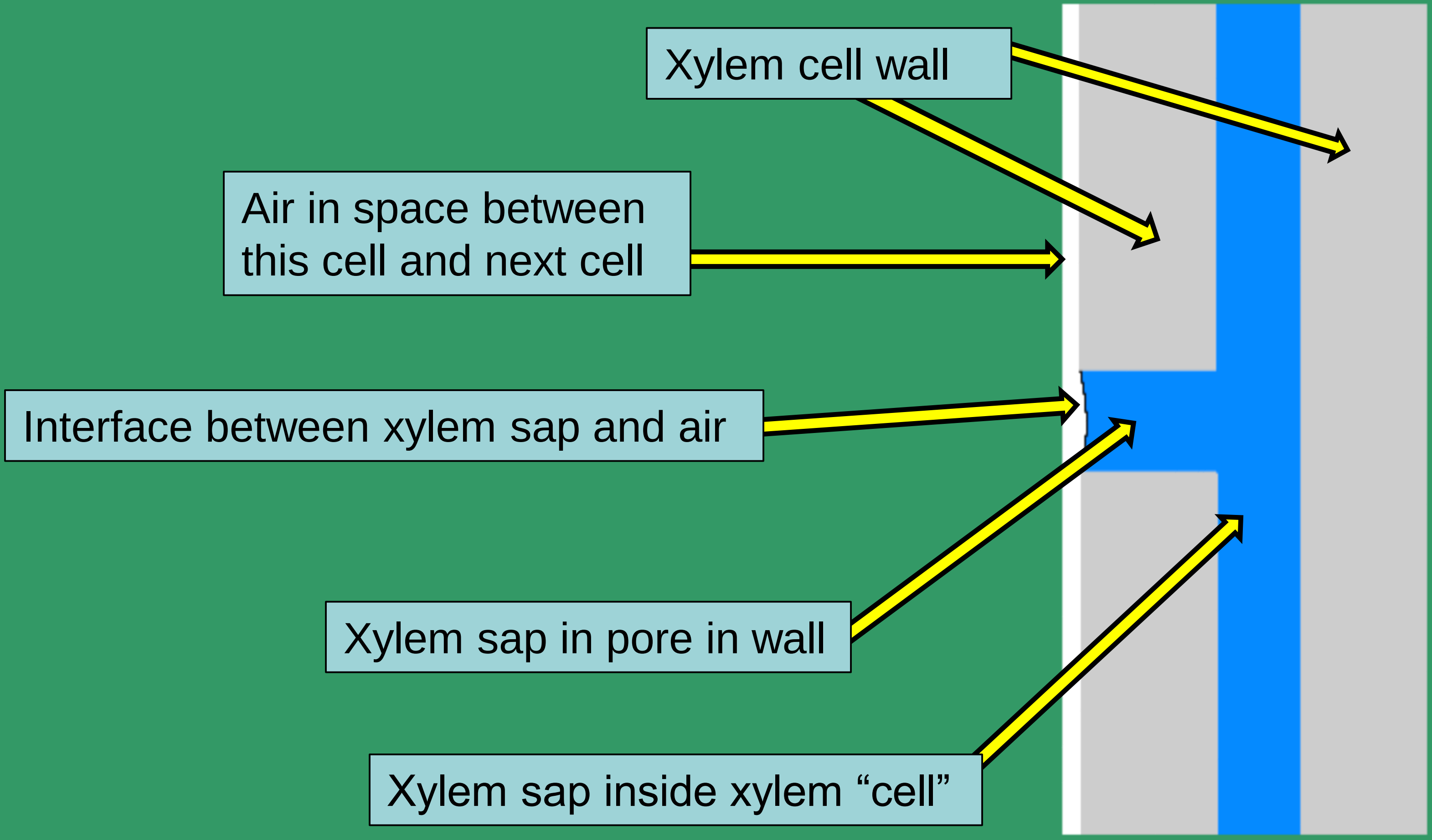


- Live cell and xylem “cell”
  - Membrane present
  - Water potential difference drives movement



- Xylem “cells”
  - NO Membrane present
  - Pressure potential difference drives movement

Air, wall & tracheid



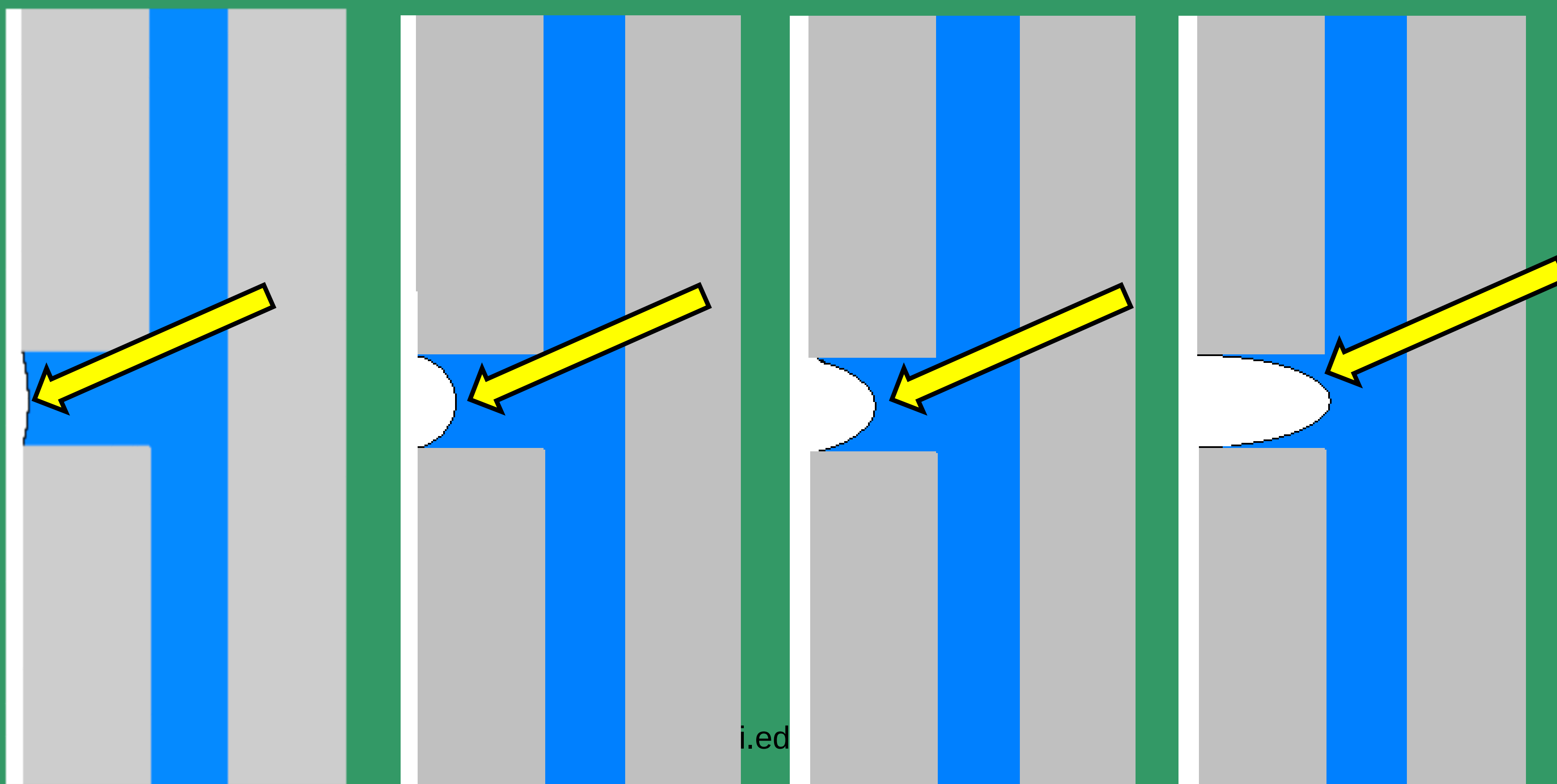
Capillary action holds water in

Well watered plant—not much tension on water in tracheid

Plant starts to dry—more tension on water in tracheid

Drier still—more tension

Quite dry—more tension



Factors Affecting Transpiration

- Temperature
- Humidity
- Air Currents
- CO_2
- Soil Water Availability

Air Currents Affect Transpiration

- Wind removes water vapor from the plant.
- This removal of water vapor decreases the water potential of the air in that area.
- Since water moves from higher to lower potential areas, the decrease in potential increases the **rate of transpiration**

Affects of CO_2 on Transpiration

- If carbon dioxide concentration in the air increases, the plant will have its stomata open less.

- **With the stomata** open less, the amount of transpiration decreases.

Soil Water Availability

- As soil water availability increases, the plant will have more excess water to move through the plant.

- Therefore, increasing water availability in the soil will increase the rate of transpiration.

Transpiration

- 95 % of water is lost through the stomata
- 3-5% is lost through the leaf cuticle
- A corn plant will transpire up to 4 quarts of water per day

Respiration in Plants

Three Types of Respiration

- Aerobic Respiration- when oxygen is adequate
- Anaerobic Respiration- when oxygen is low
- Photorespiration- occurs only in chloroplasts
  - Plants get no usable energy from it
  - C4 plants very little photorespiration so plants can accumulate more dry matter

What is Cellular Respiration?

- Once the energy that was in sunlight is changed into chemical energy by photosynthesis, an organism has to transform the chemical energy into a form that can be used by the organism.

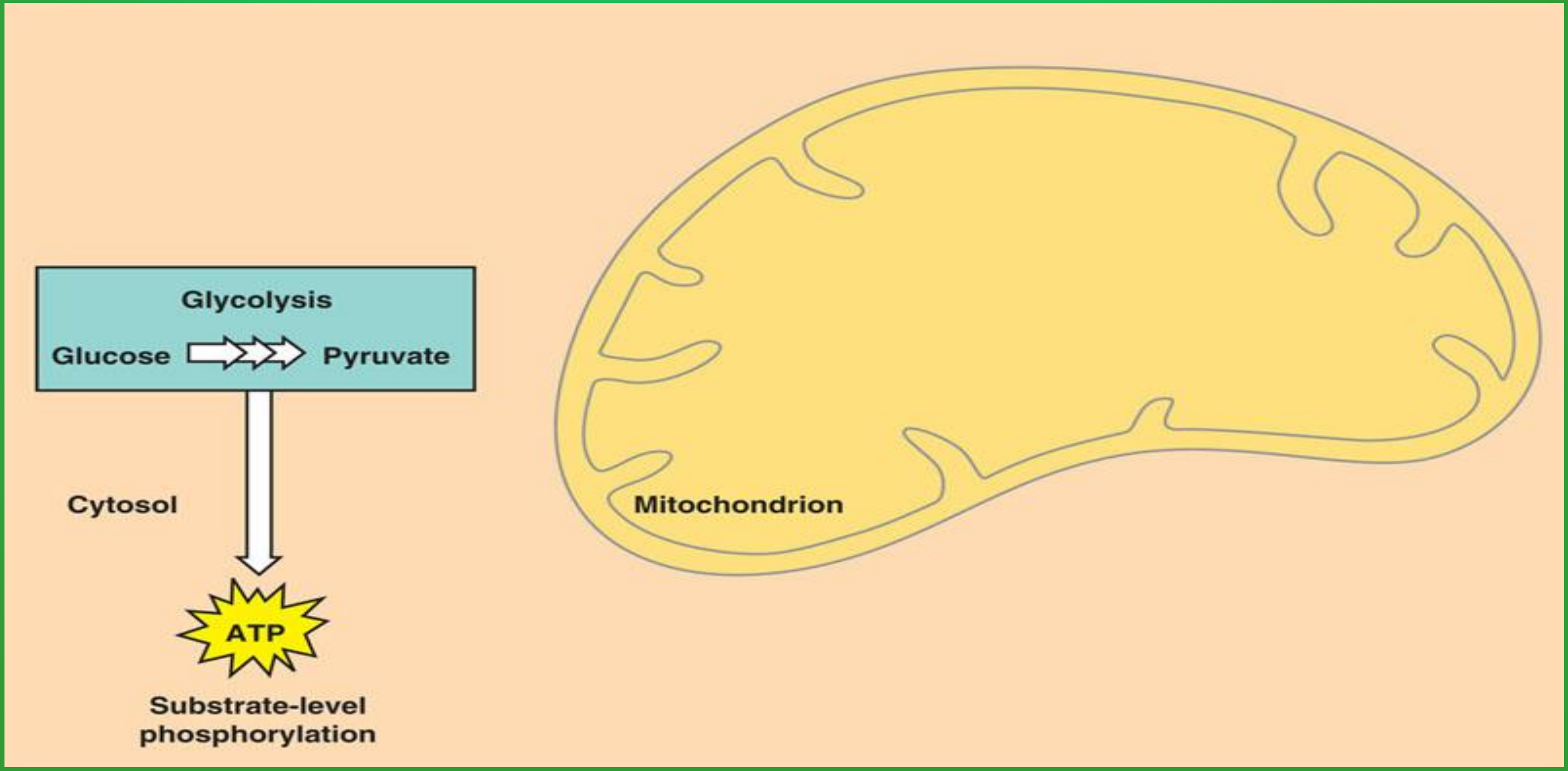
- **Cellular respiration** is the process that releases energy by breaking down food molecules in the presence of oxygen.

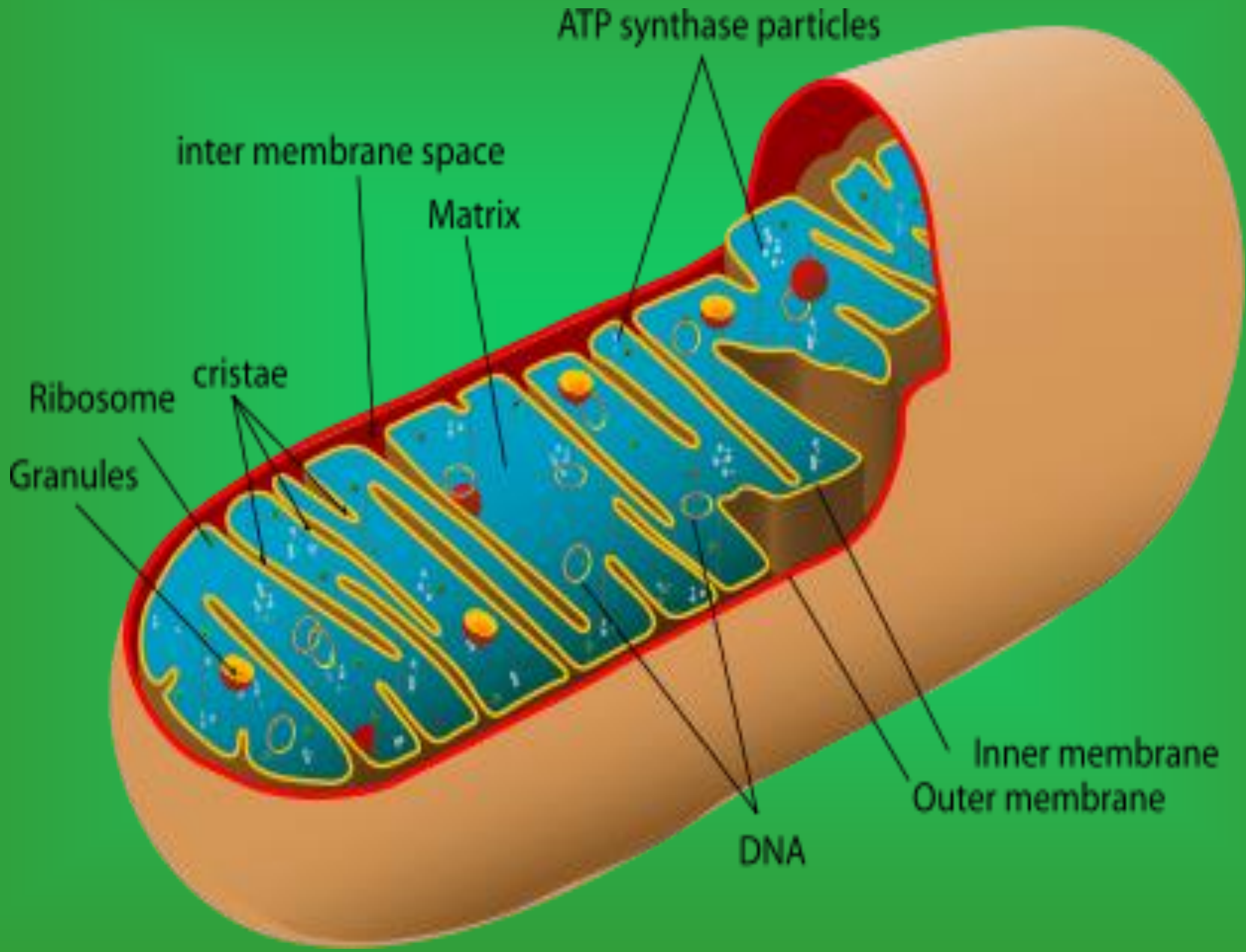
Cellular Respiration can be described as

- The breakdown of glucose molecules to release energy
- Takes place in all living things
- Is a step by step process

Where does cellular respiration happen?

- In the mitochondria of living things.





ATP synthase particles
inter membrane space
Matrix
cristae
Ribosome
Granules
Inner membrane
Outer membrane
DNA

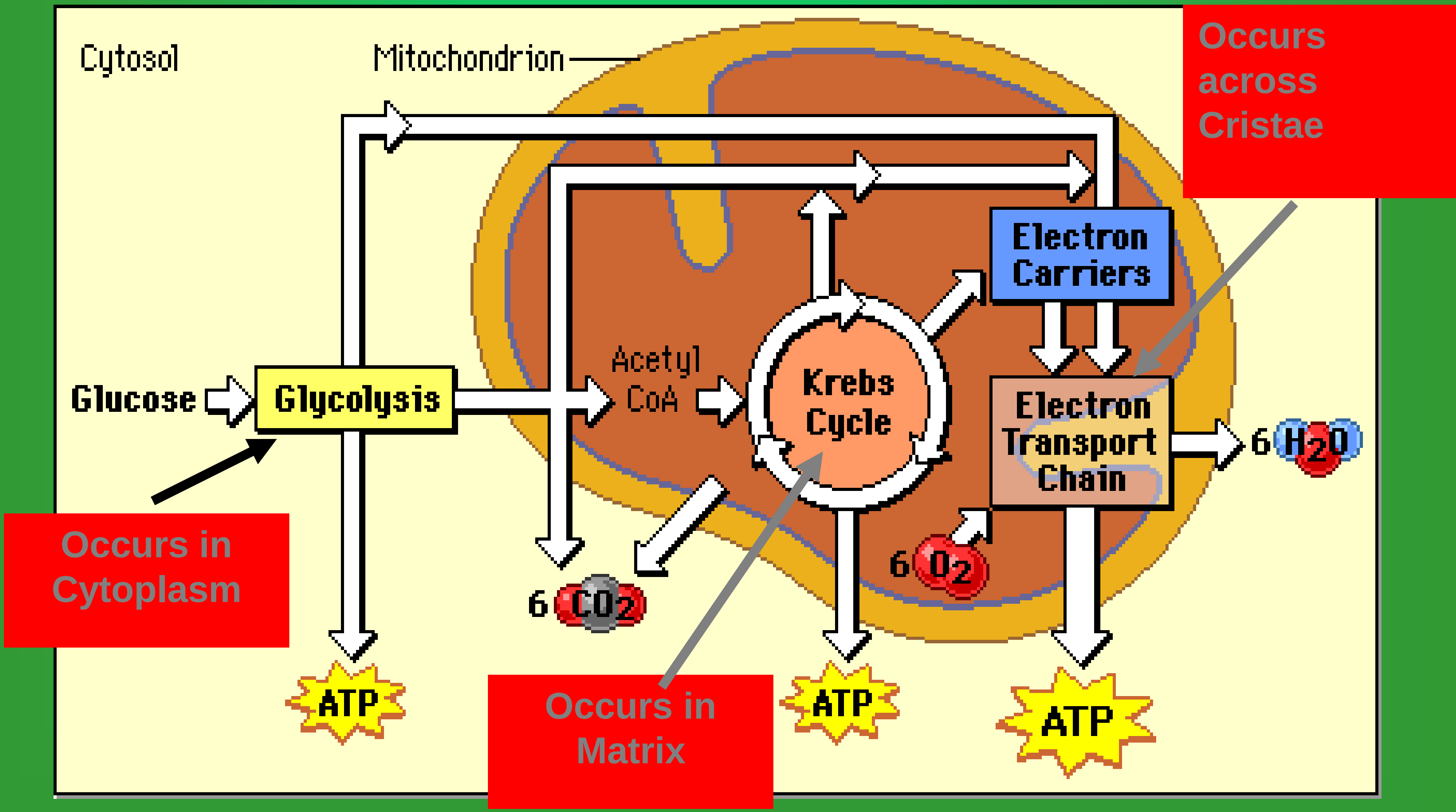
What is the chemical equation for cellular respiration?

The chemical equation for respiration is:

$$C_6H_{12}O_6 + 6O_2 \Rightarrow 6CO_2 + 6H_2O$$

Glucose + Oxygen ⇒ Carbon Dioxide + Water

Diagram of the Process

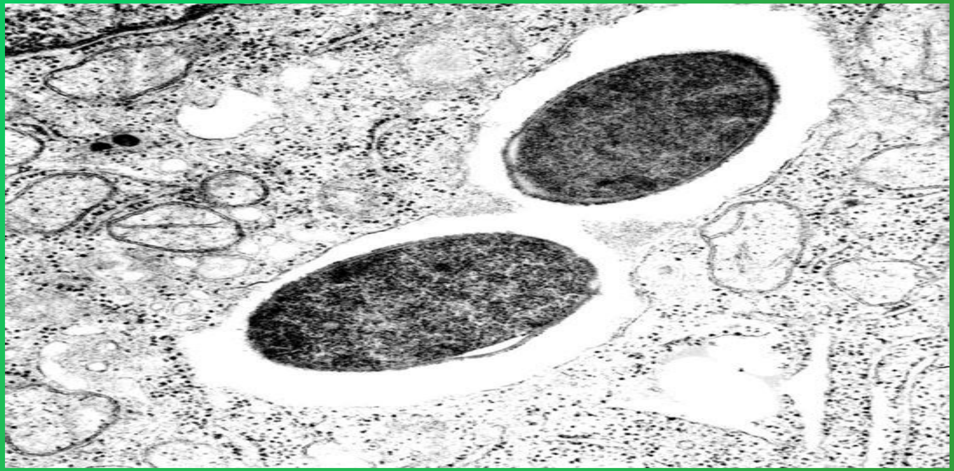


What are the Stages of Cellular Respiration?

- **Glycolysis**
- **The Krebs Cycle**
- **The Electron Transport Chain**

Anaerobic Processes

- No oxygen is required for these processes.
- Includes glycolysis, the breakdown of glucose, and fermentation.
- Some bacteria and yeast are examples of anaerobes.



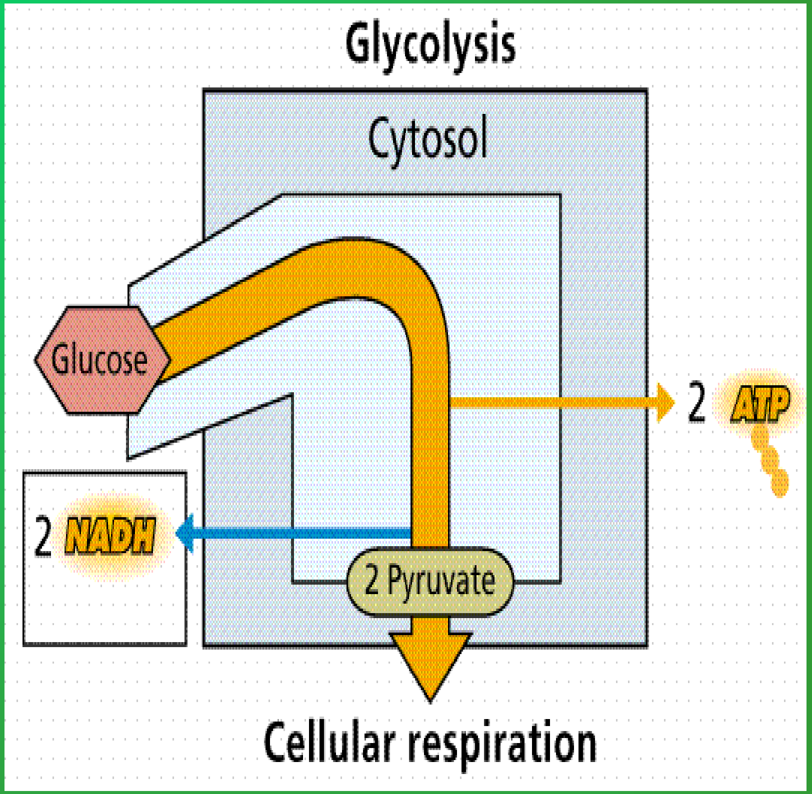
http://www.biol.vt.edu/research/images/C._perfringens_in_mac._jpg.jpg

http://www.utoronto.ca/greenblattlab/images/a/yeast%201.jpg

Glycolysis

- Occurs in the cytoplasm.
- Breaks down glucose into 2 molecules of pyruvate
- 2 ATP molecules are formed.

- The series of reactions in which pyruvate is broken down into carbon dioxide is called the Krebs cycle.



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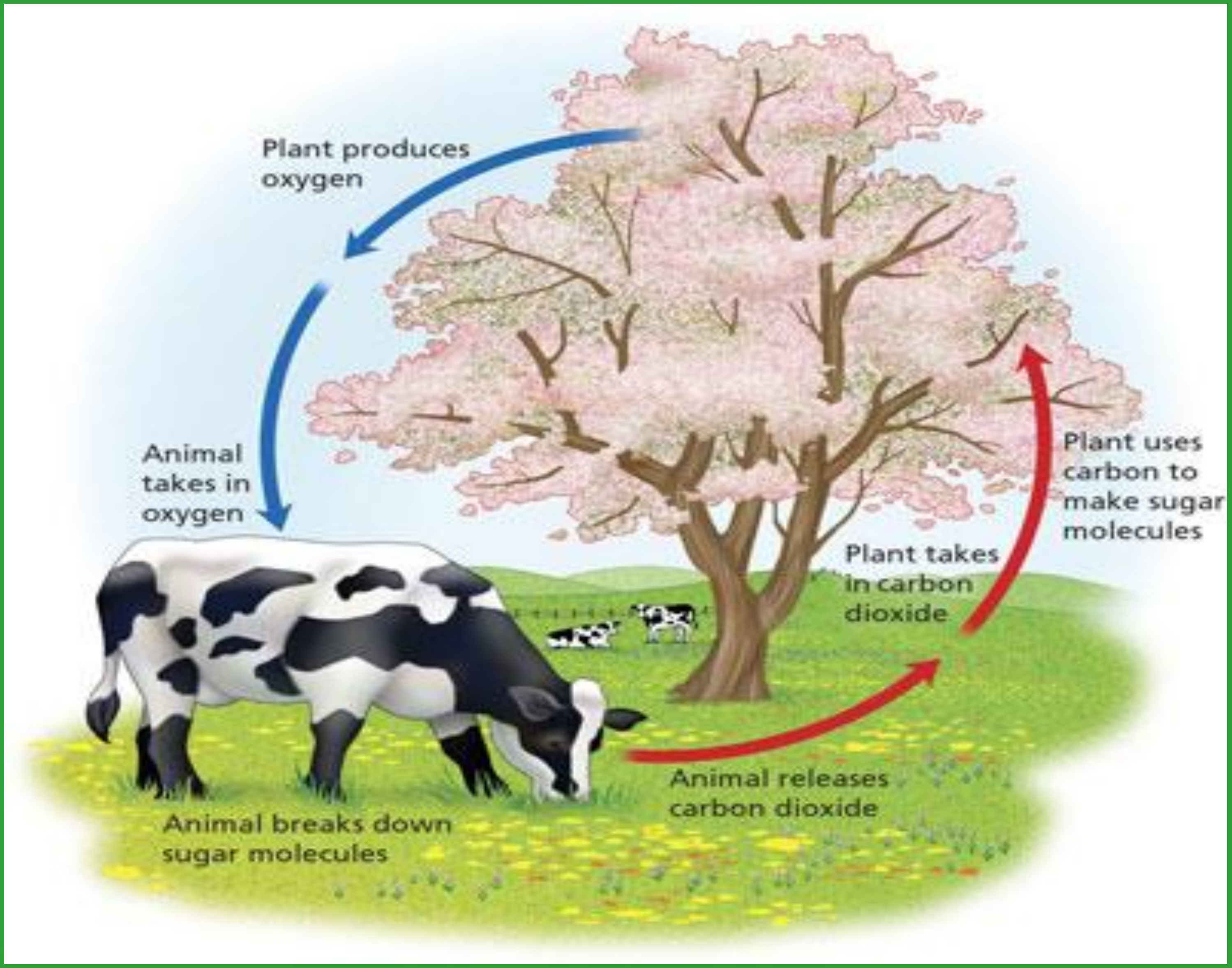

Plant produces
oxygen
Animal
takes in
oxygen
Plant uses
carbon to
make sugar
molecules
Plant takes
in carbon
dioxide
Animal releases
carbon dioxide
Animal breaks down
sugar molecules

- **What is The Krebs cycle. .?**

- **The Krebs cycle is where energy is released. Kind of like the Calvin Cycle in reverse…**

What happens during the Krebs cycle?

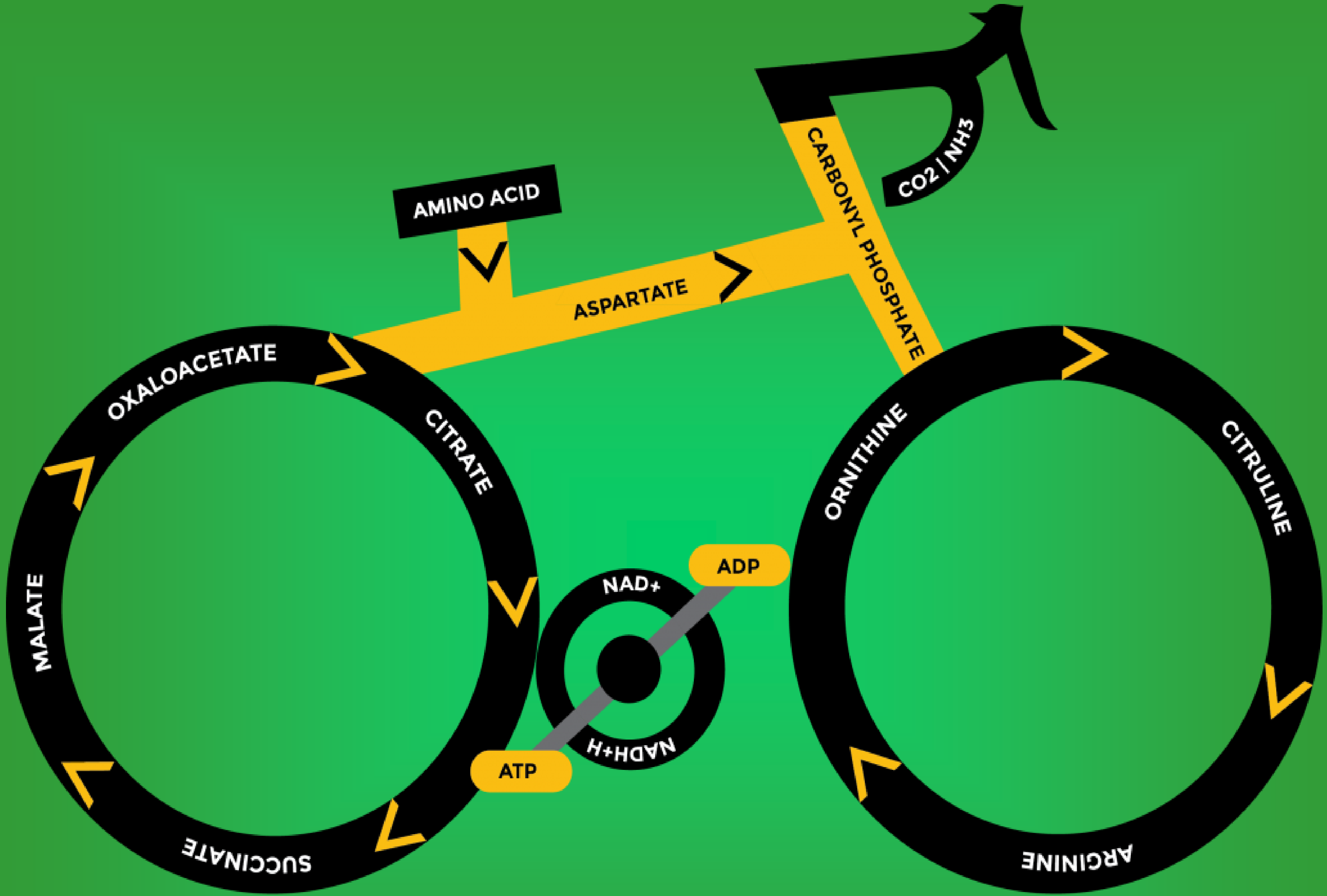
- **Energy is freed from the chemical bonds. The excited electrons are FREE!**
- **The electrons make ATP.**
- **Carbon dioxide is released.**

- **Where do the electrons go?**

- **The** electrons **get to ride the electron transport train, the** Final step in the breakdown of glucose at which ATP is produced

What happens to ADP on the train?

- Ions rush back and forth and spin the ADP in circles.
- This creates enough energy to produce three molecules of ATP per molecule of ADP
- ATP and ADP are special molecules that store energy



THE KREBS CYCLE

Photosynthesis	Respiration
Requires Carbon Dioxide and Water	Requires Oxygen and Carbohydrates (CHOs)
Produces Oxygen and Carbohydrates (CHOs)	Produces Carbon Dioxide and Water
Light Energy Trapped by Chlorophyll	Energy Released
Takes Place in Light Only	Takes Place in Both Light and in Darkness
Occurs Only in Cells With Chlorophyll (the mesophyll cells of the leaf)	All Living Cells Respire (animals and plants)