GENERAL BOTANY (BOT 102)

علم النبات العام
(نبت 102)

SECTION 1

INTRODUCTION

BIOLOGY

Study of living organisms

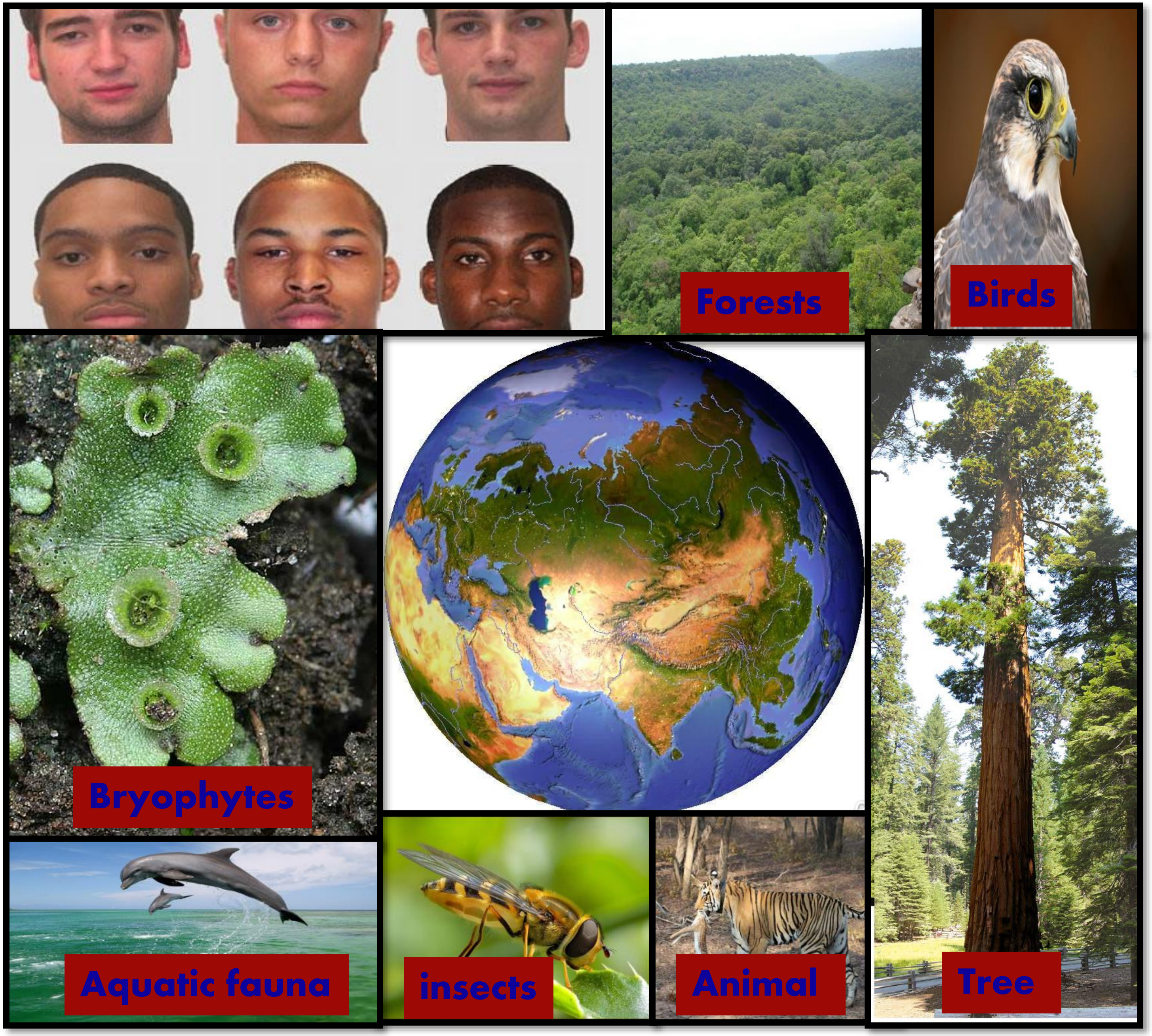
(Plants and Animals)

STUDY OF

BOTANY

ZOOLOGY

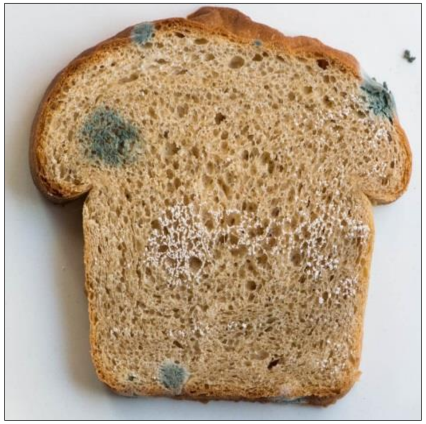
DIVERSITY IN THE LIVING ORGANISM



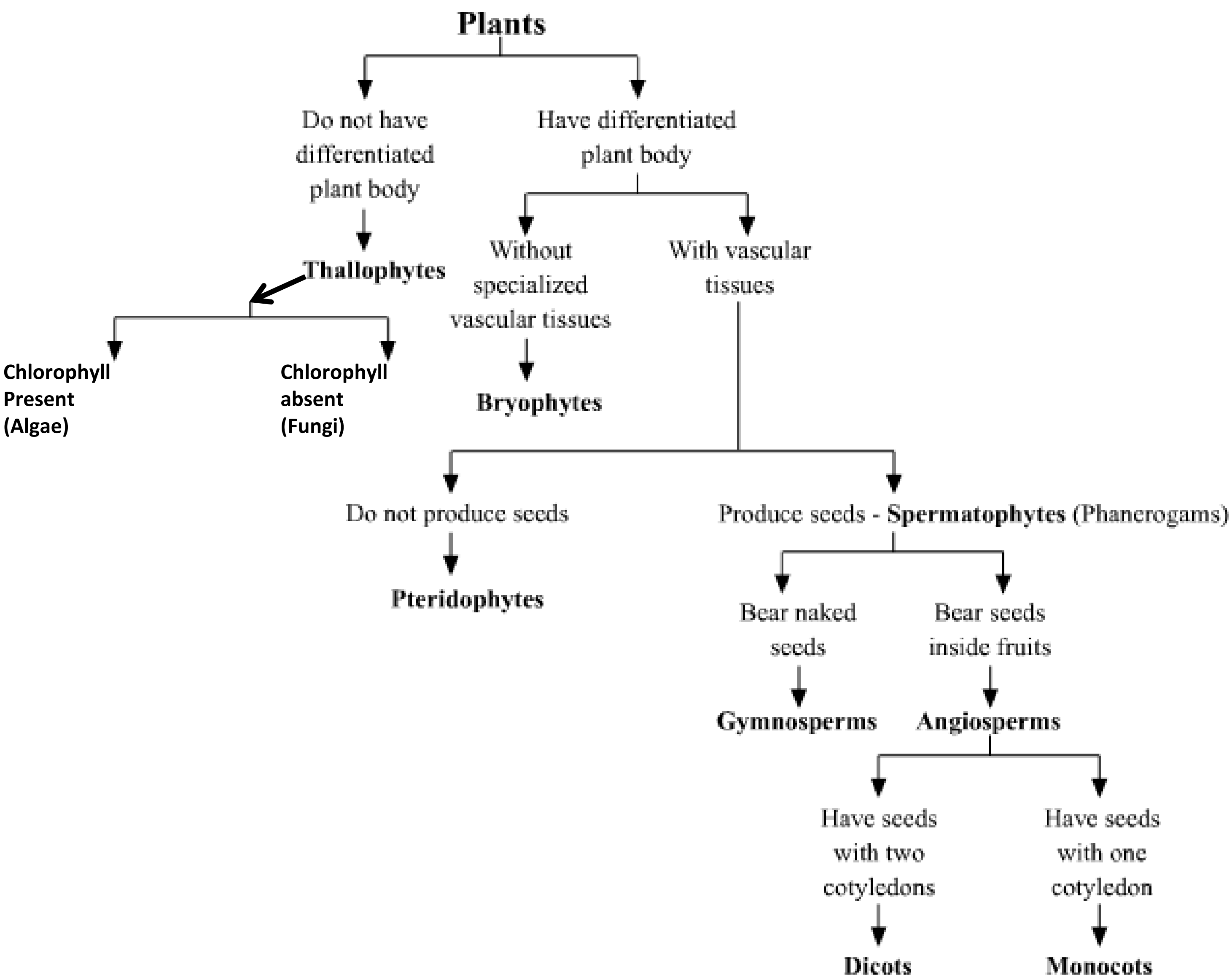
PLANTS

CHLOROPHYL
(GREEN COLOR)
PRESENT

CHLOROPHYL
(GREEN COLOR)
ABSENT



Different groups of plants

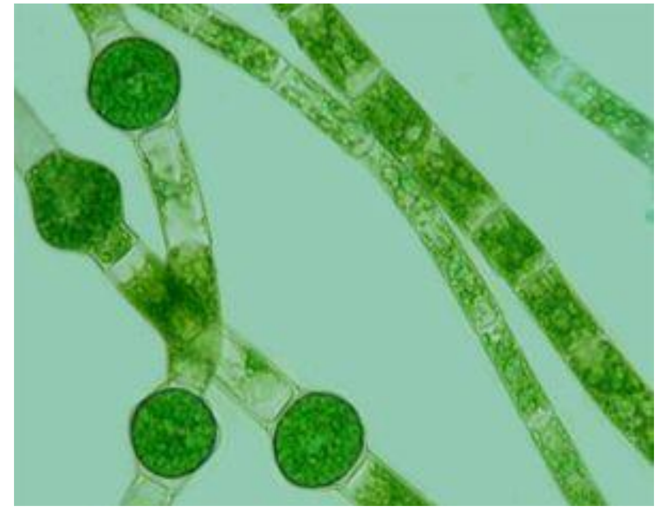


ALGAE

Number: 30,000 to over **1 million** species

Presence of algae in water

Algae on rocks



An algae seen under microscope

Algae-
a source of medicine

Edible algae (Example: Chlorella)

Examples of algae:

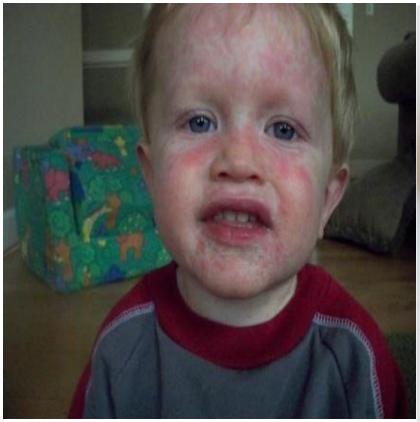
Volvox, Chlorella, Spirogyra, Ulothrix

FUNGI

(6 million species)

- *Example: Penecillum, Mucor, Aspergillus*
- Some fungi are edible like Mushroom
- Antibiotics Penecillin obtained from *Penecillium*
- Some fungi causing disease in plants and animal

Mushroom



BRYOPHYTES

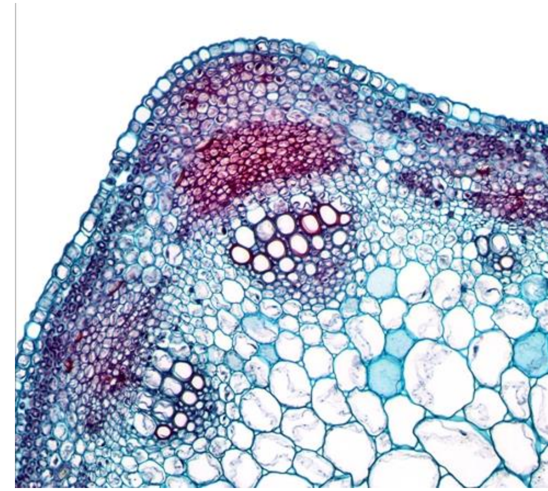
Number: about 18000 species

- NO ROOT
- NO STEM
- NO LEAF
- NO FLOWER
- NO FRUIT

- Example: *Marchantia*

PTERIDOPHYTES

Number: 11000 species



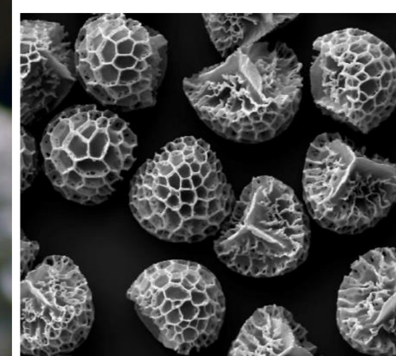
Vascular tissue

- **ROOT , STEM, LEAF: PRESENT**
- **Vascular tissue Present**

- **NO FLOWER**
- **NO FRUIT**

- **Use in decoration**

Sporangium: spore bearing organ of fern

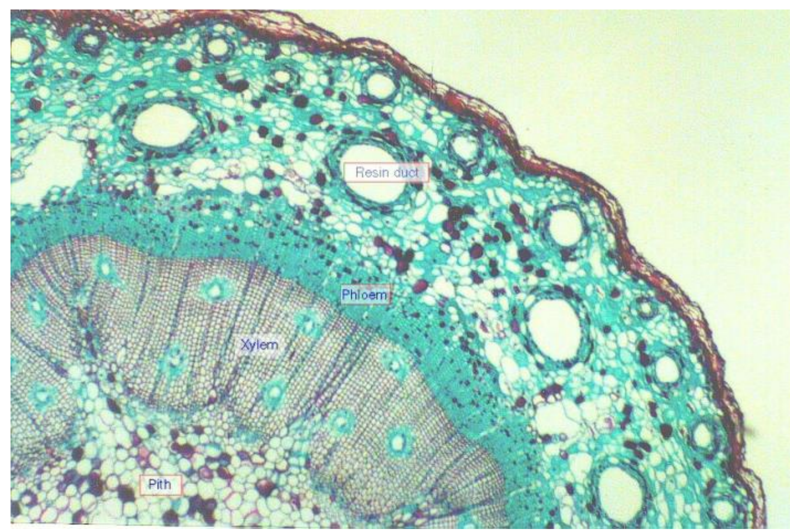


Fern spores

GYMNOSPERMS

- Reproductive organ of *Cycas*
- The reproductive organ of gymnosperm are called as cone

- **Root, stem, leaf: present**
- **Well developed vascular tissue**
- **No true flower and fruits**
- **Reproductive structures called as Cones**
- **Example: *Cycas, Pinus***



- Transverse section of stem of *Cycas* showing Vascular tissue

ANGIOSPERMS

-Flowering plants

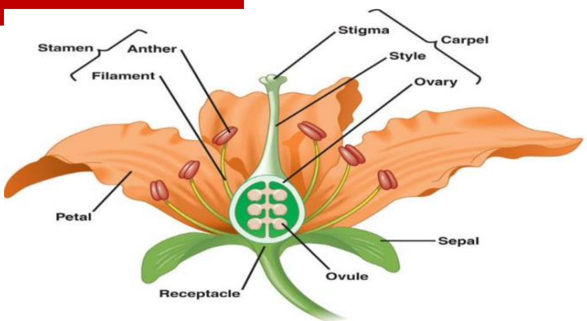
(352,000 species)

Monocot

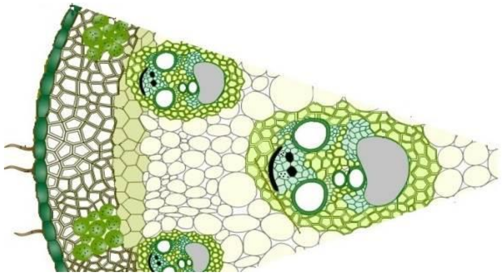




Dicot






Major Branches of Botany

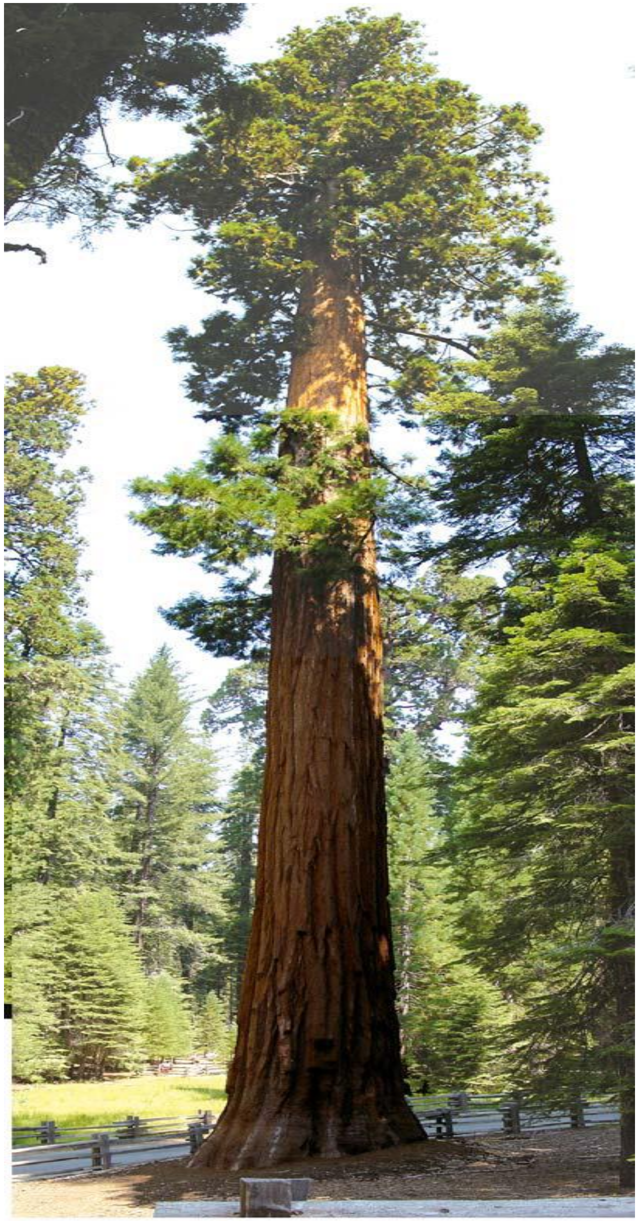
1. **Morphology :** Study of external structure of plant.
2. **Anatomy :** Study of external internal structure of plant.
3. **Histology :** The study of cells and tissues with the help of microscope,
4. **Cytology :** The study of the cells
5. **Plant Physiology :** The study of various vital activities of the plant.
6. **Taxonomy :** Study of the classification of the plants.
7. **Ecology :** Relations of organisms to one another and to their physical surroundings
8. **Plant geography :** Distribution of plants on the earth.
9. **Genetics :** The study of heredity and variations.
10. **Plant breeding :** The development of improved varieties of plants.
11. **Embryology :** the study of embryos and their development
12. **Paleobotany :** The study of fossil plants.

Major Branches of Botany

13. **Economic Botany :** the study of the relationship between people (individuals and cultures) and plants
14. **Plant Pathology :** This branch includes different types of disease of plants, their symptoms, causal agent and methods of control.
15. **Biochemistry (Phytochemistry) :** Study of chemistry of plants.
16. **Biophysics :** Study of plant activities on the basis of principles of physics.
17. **Microbiology :** Study of microorganisms. It includes the study of viruses, bacteria, microfungi, microalgae and protozoa in relation to plants.
18. **Molecular biology :** Study of biochemistry at molecular level.
19. **Palynology :** Study of pollen grains.
20. **Biometrics :** Statistical analysis of different results of biological experiments.
21. **Genetic Engineering :** Adding, removing or repairing part of genetic material, thereby changing the phenotype of organism as desired.
22. **Agronomy :** Study of the crop plants.
23. **Horticulture :** The study of flowering and fruiting plants.
24. **Pharmacognosy :** Study of the medicinal plants.

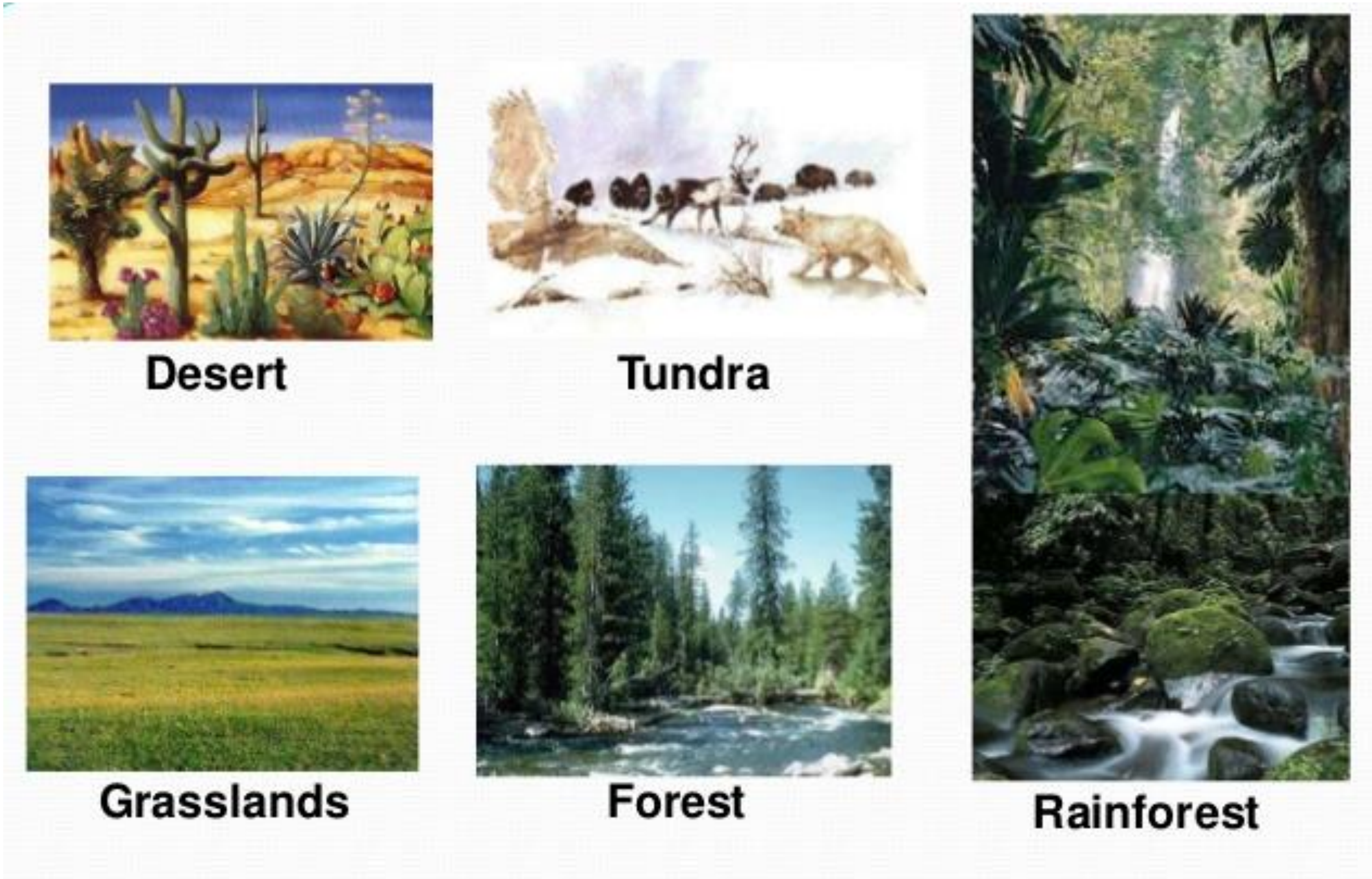
Even flowering plants are of diverse types (from mall to very large)

Wolfia is a smallest Angiosperms



Sequoiadendron giganteum is a largest tree / angiosperms

Plant occurs in diverse land habitat



Aquatic plants

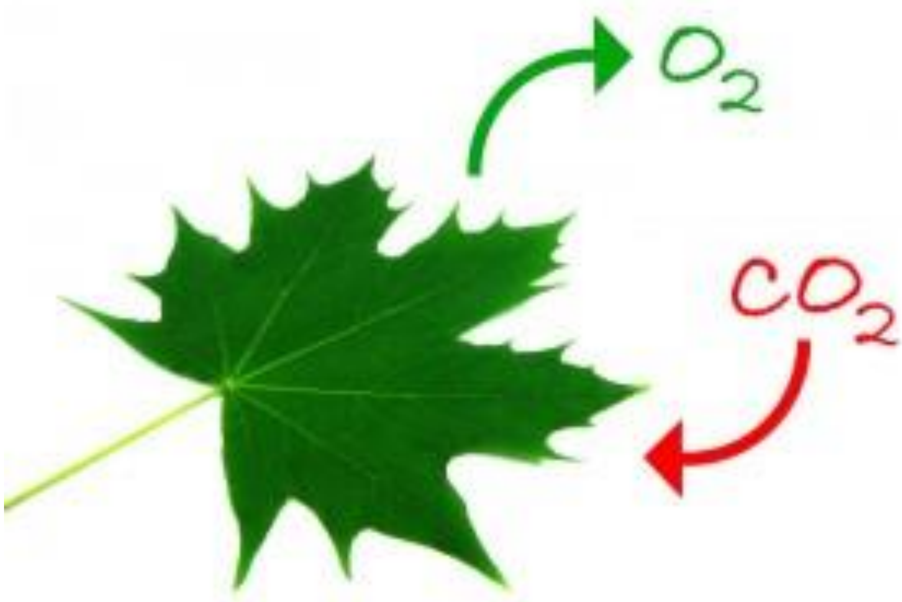
Nymphea

Desert plant

Agave

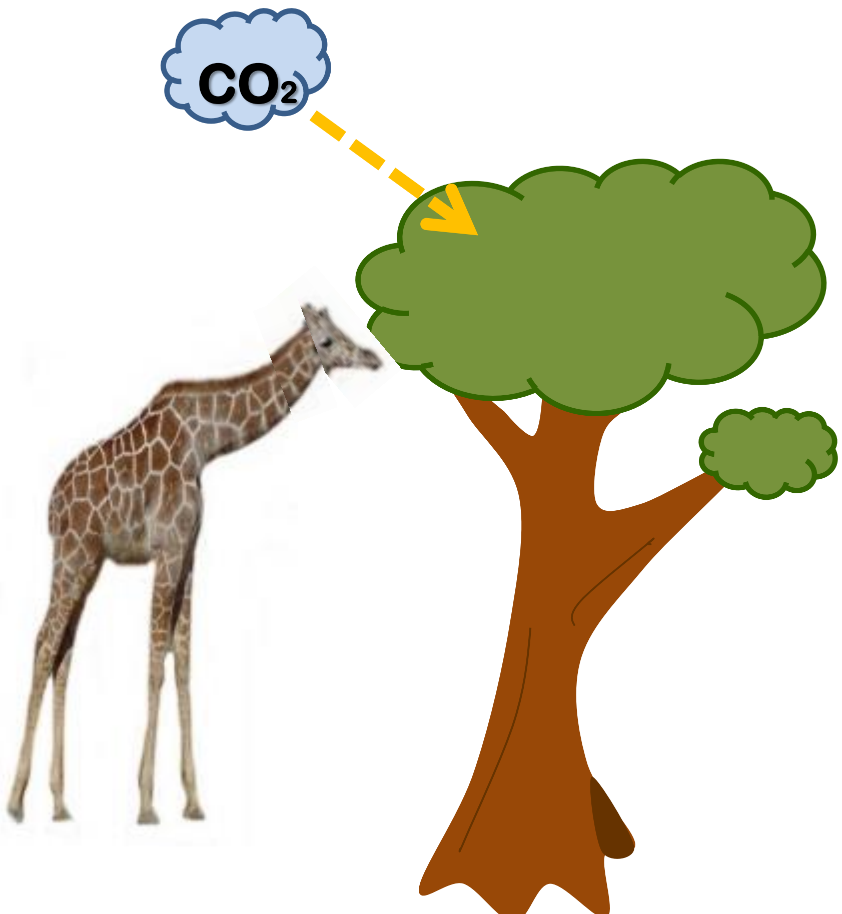
Why study plants?

Plants produce oxygen



We breathe oxygen. we cant not live without oxygen.

Plants fix carbon dioxide into energy- rich molecules which is eaten by human and animals



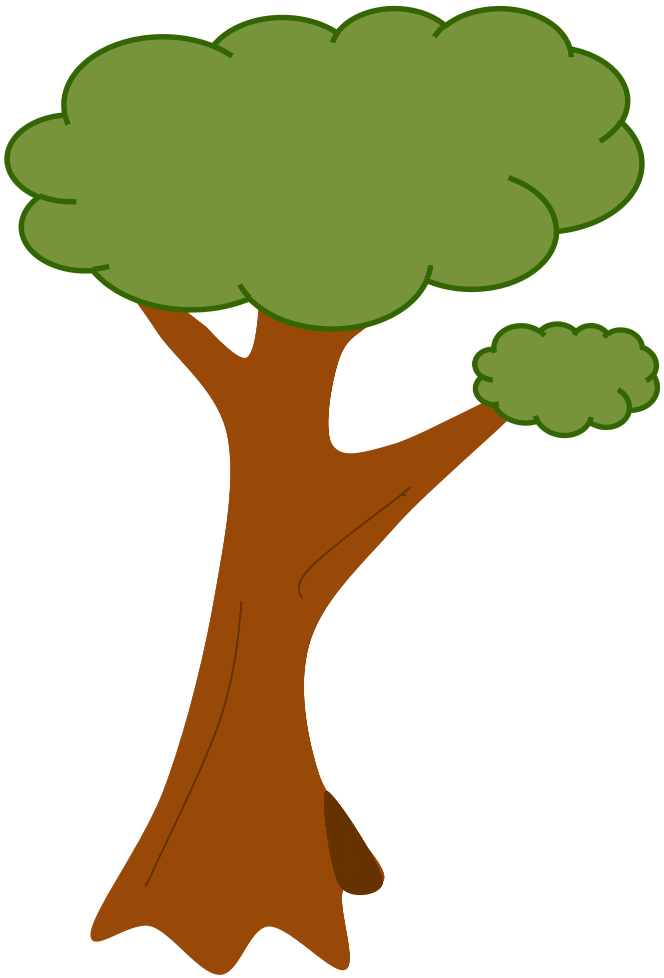
Plants convert CO_2 gas into sugars through the process of photosynthesis.

F O O D

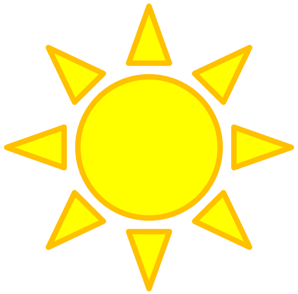
Every things we eat comes directly or indirectly from plants

Plants provide fibers for paper or fabric

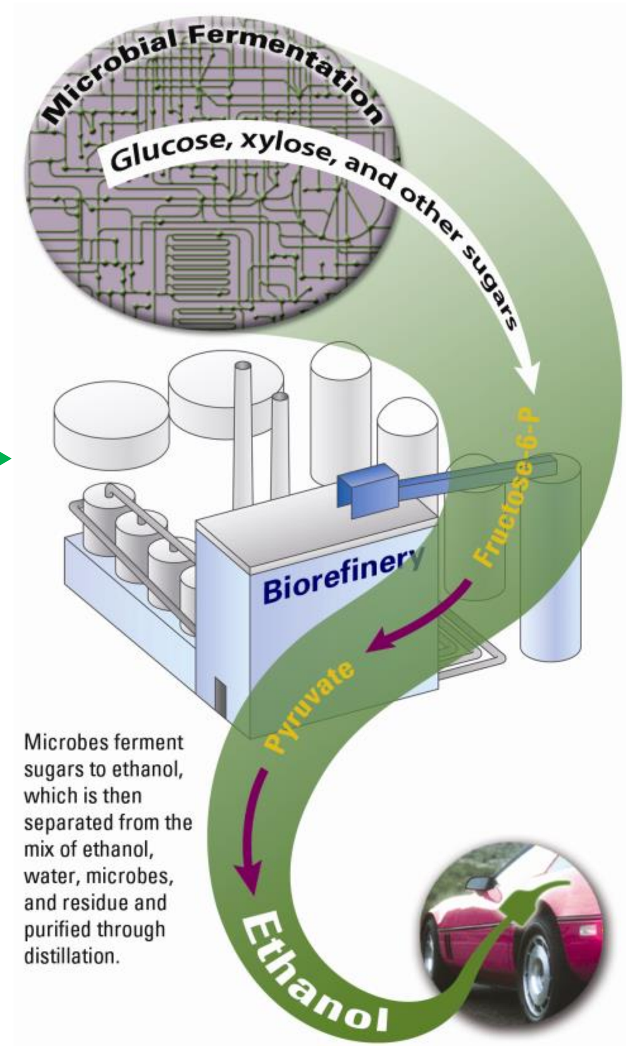
Many chemicals produced by the plants used as medicine



Plants can be a source of biofuels



Energy from sunlight



Sugars, starches and cellulose can be fermented into ethanol

More reasons ....?

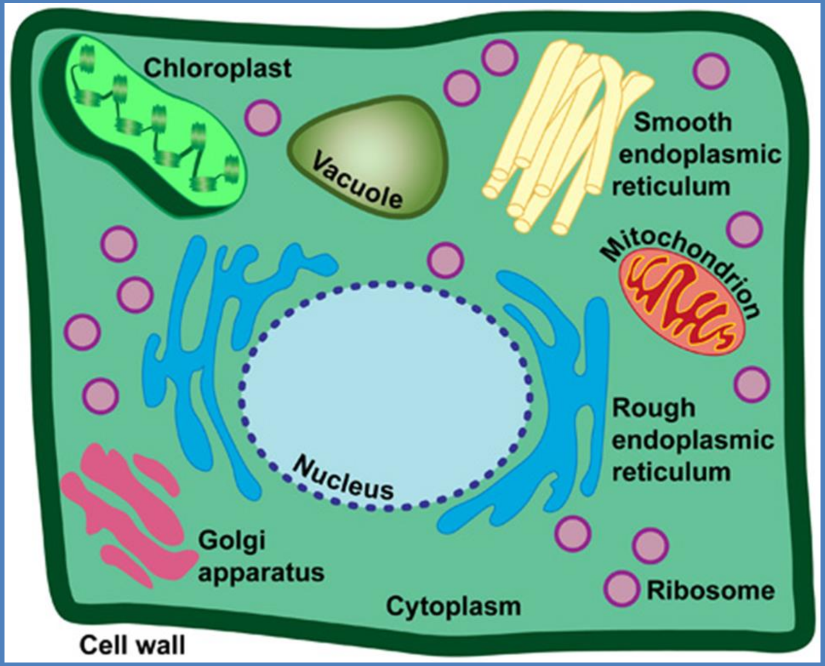
- To help conserve endangered plants
- To learn more about the natural world
- To enhance the abilities of plants to provide more food, medicines, and others useful things

SECTION 2

CYTO-GENETICS

CYTOLOGY

(Study of cell)



What is Life?

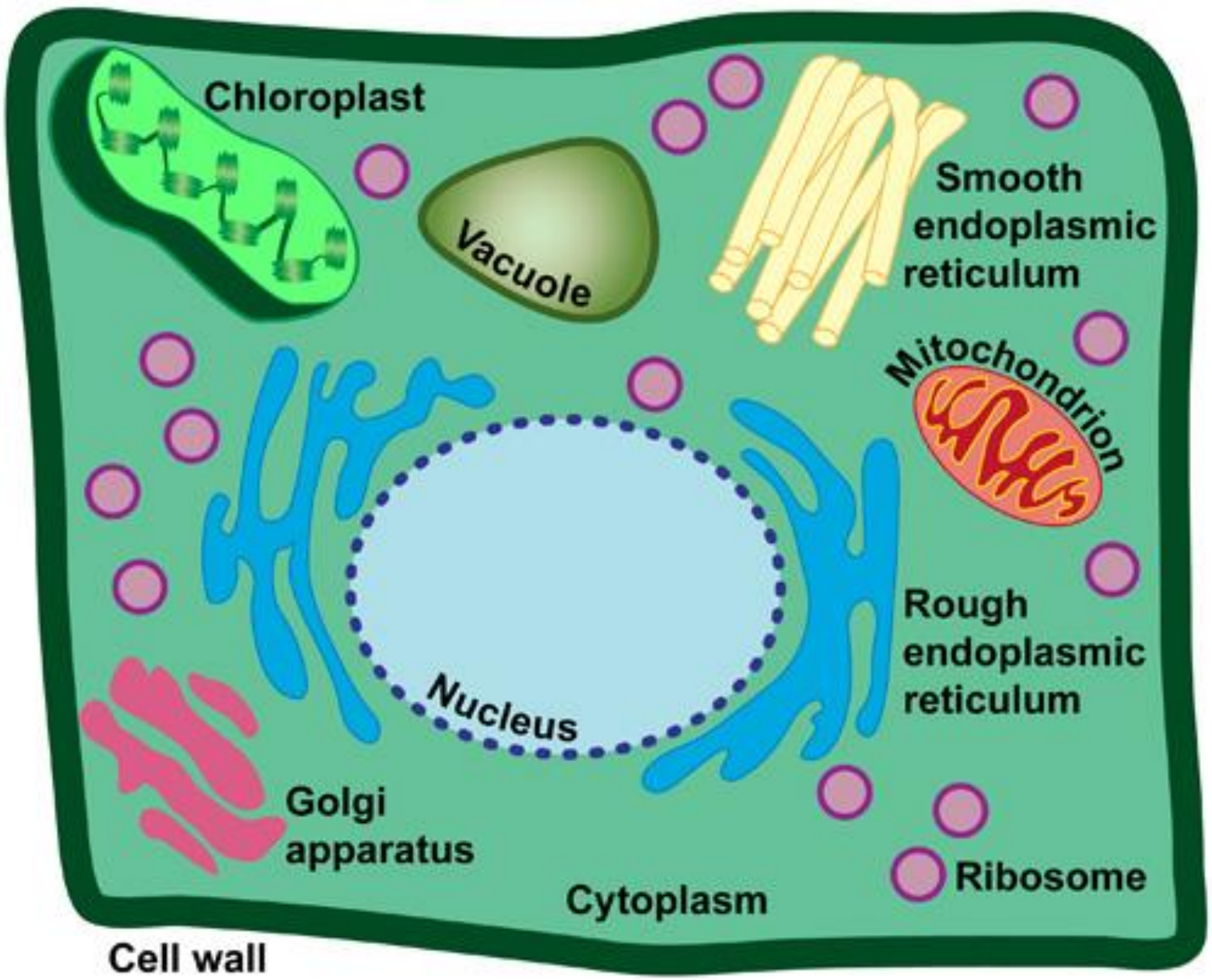
The condition that distinguishes animals and plants from inorganic matter

The 7 Characteristics of Life

1. Living Things are Composed of Cells
2. Living Things Have Different Levels of Organization
3. Living Things Use Energy
4. Living Things Respond To Their Environment
5. Living Things Grow
6. Living Things Reproduce
7. Living Things Adapt To Their Environment

CELL

The basic structural, functional, and biological unit of all known living organisms

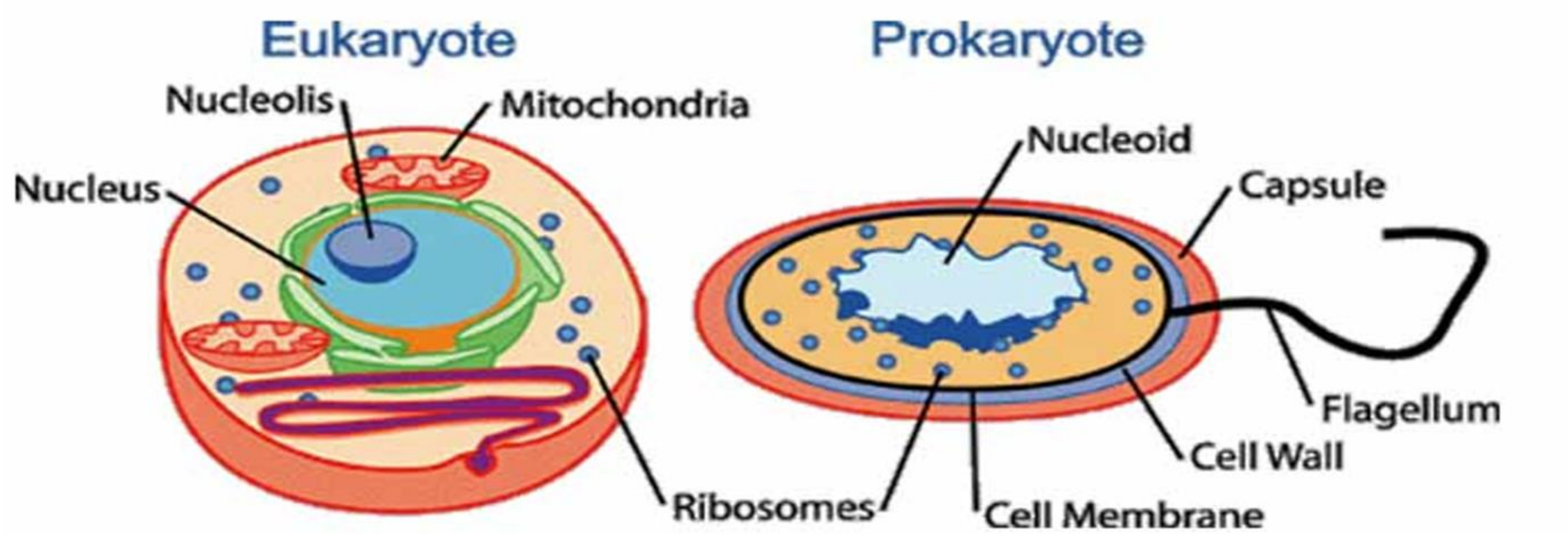


The Cell Theory states:

1. The cell is the basic unit of structure and function of all living things.
2. All living things are composed of one or more cells.
3. All cells come from pre-existing cells.
4. The cells of all living things carry on similar chemical activities.
5. All cells carry on their metabolic activities in organelles.

Types of cells

1. **Prokaryotic-cells:** do not have a well-defined nucleus or other cell organelles
2. **Eukaryotic-cells:** have a nucleus with nuclear membrane & cell organelles



Prokaryote Cells

- **Oldest cell types, first appeared 3.5 billion years ago.**
- **Cells do not contain a nucleus.**
- **Contains cell membrane.**
- **Do not have membrane-bound organelles.**
- **Smaller and simpler than eukaryotic cells.**

Example: Bacteria

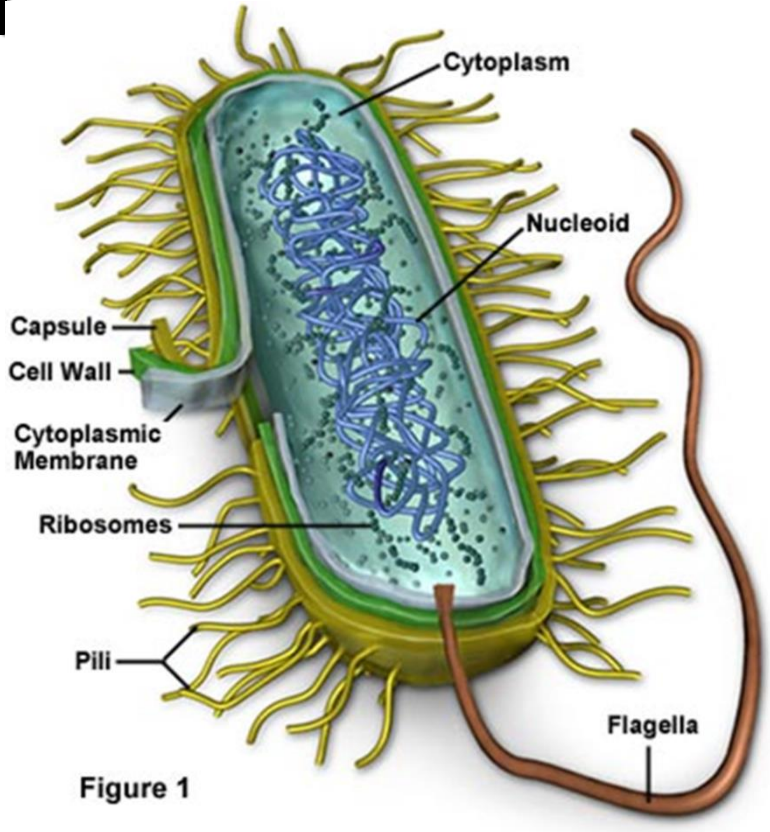
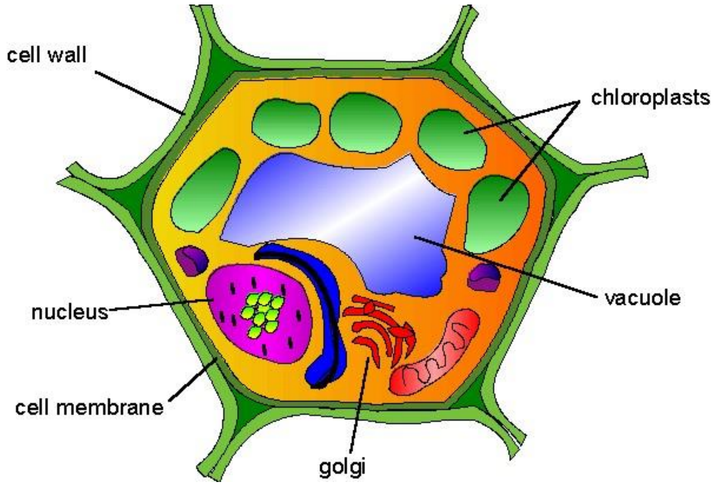


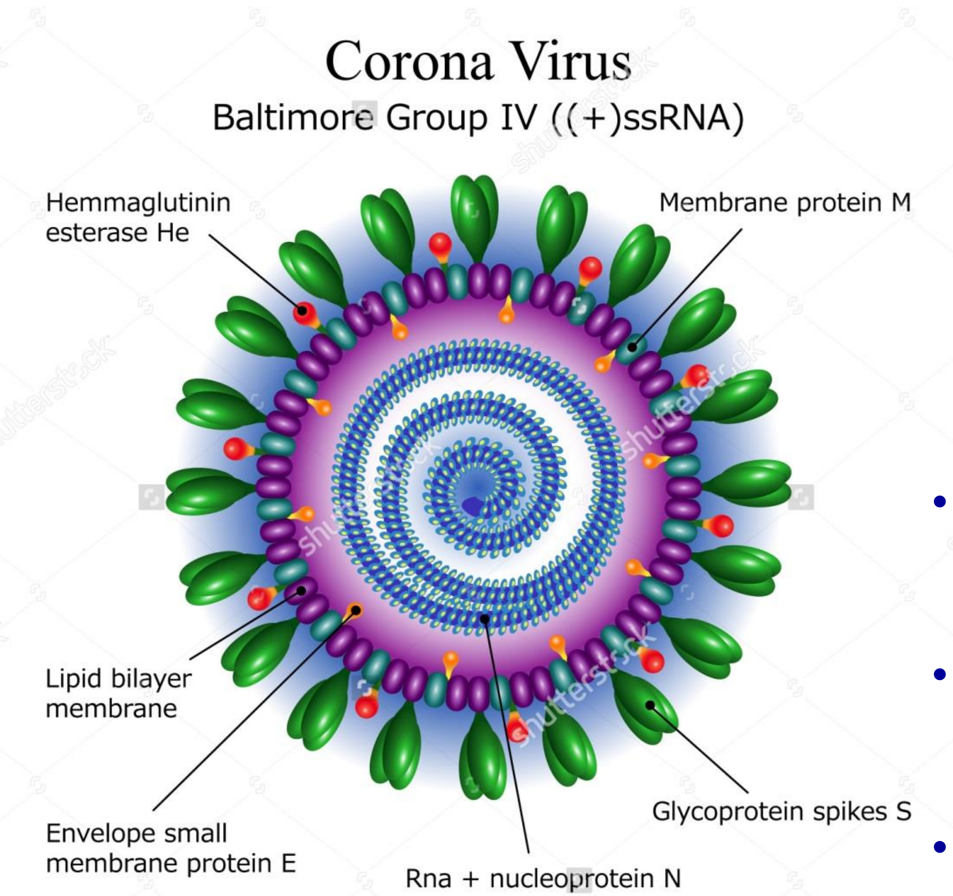
Figure 1

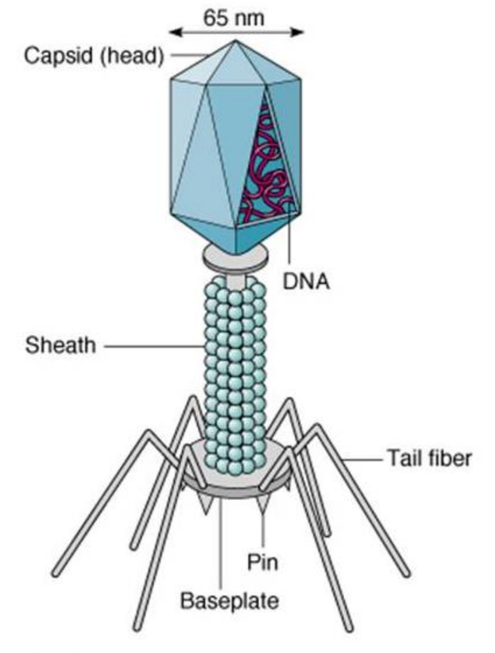
Eukaryote Cells

- First appeared in the fossil record 1.5 billion years ago.
- Eukaryotes are organisms that have a nucleus in each cell.
- The nucleus contains DNA.
- Have a cell membrane.
- Generally larger and more complex than prokaryotic cells.
- Have complex membrane bound organelles (mitochondrion, chloroplast, Golgi apparatus, etc.)
- Examples: Plants, animals, fungi



Virus



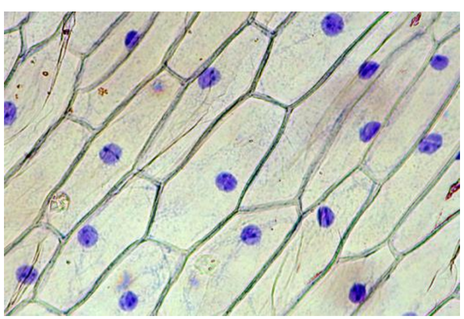


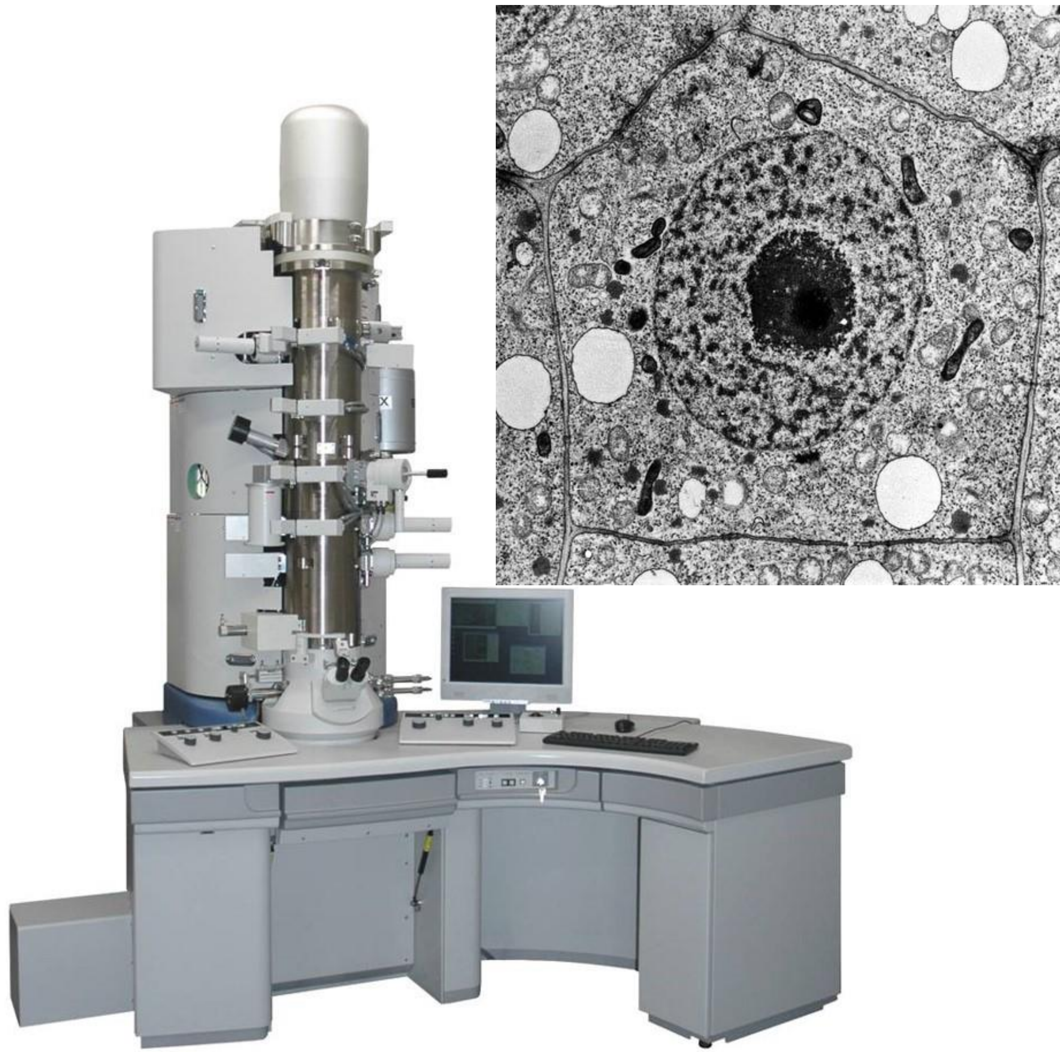
(a) A T-even bacteriophage

- Viruses are in between living organism and nonliving things.
- It is very small infective agent consists of a nucleic acid molecule in a protein coat,
- Virus do not exhibit characteristics of life outside the host cell.
- Harmful, causing disease in plants and animals

PLANT CELL

Microscope: is an optical instrument used for viewing very small objects like animal or plant cells



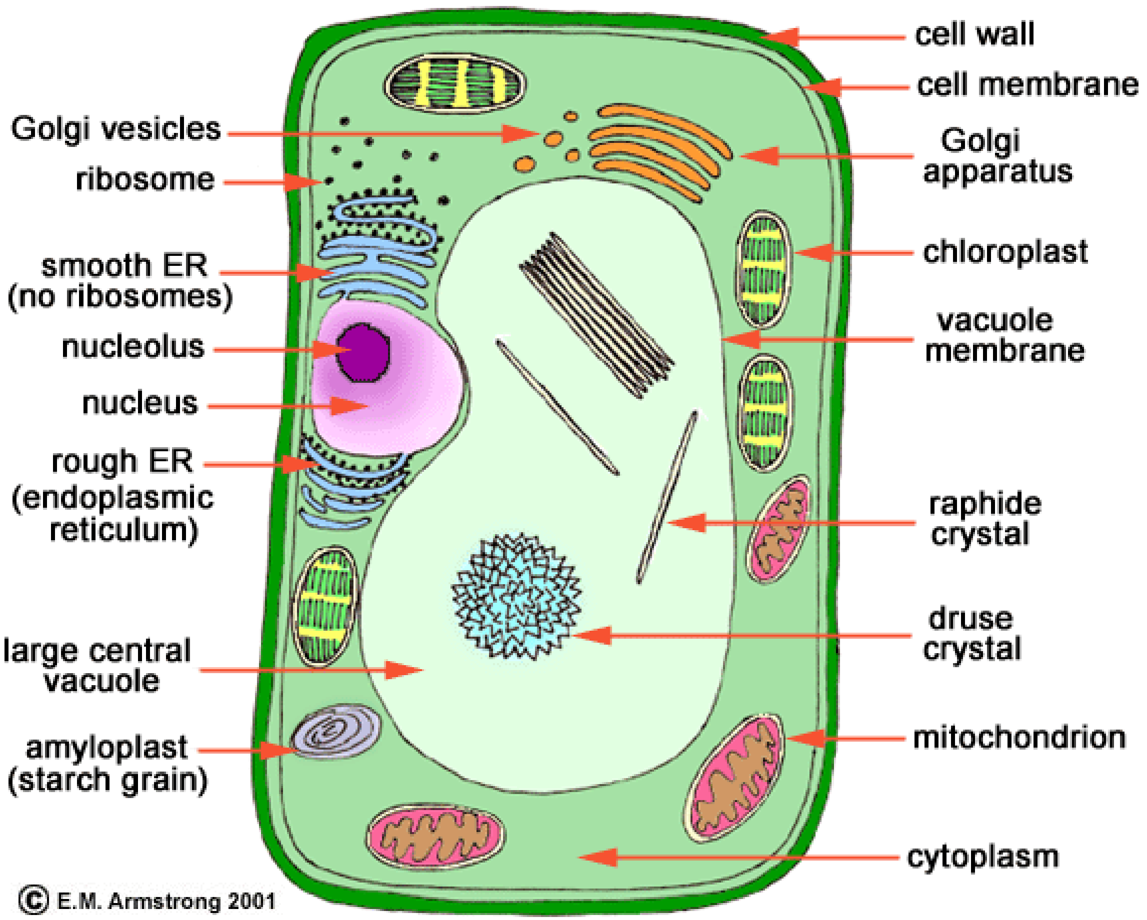


Compound microscope

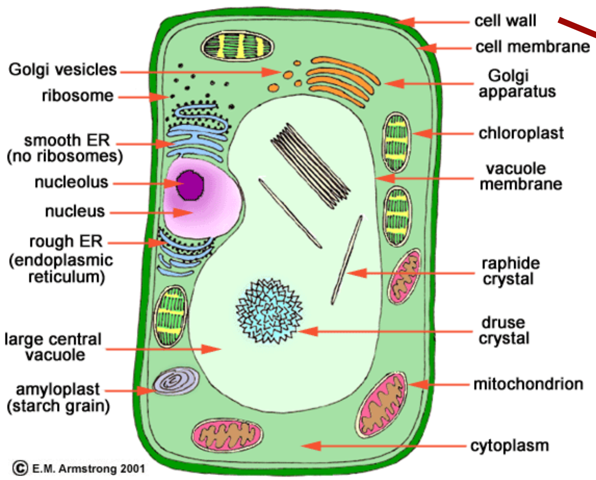
Transmission electron microscopy (TEM)

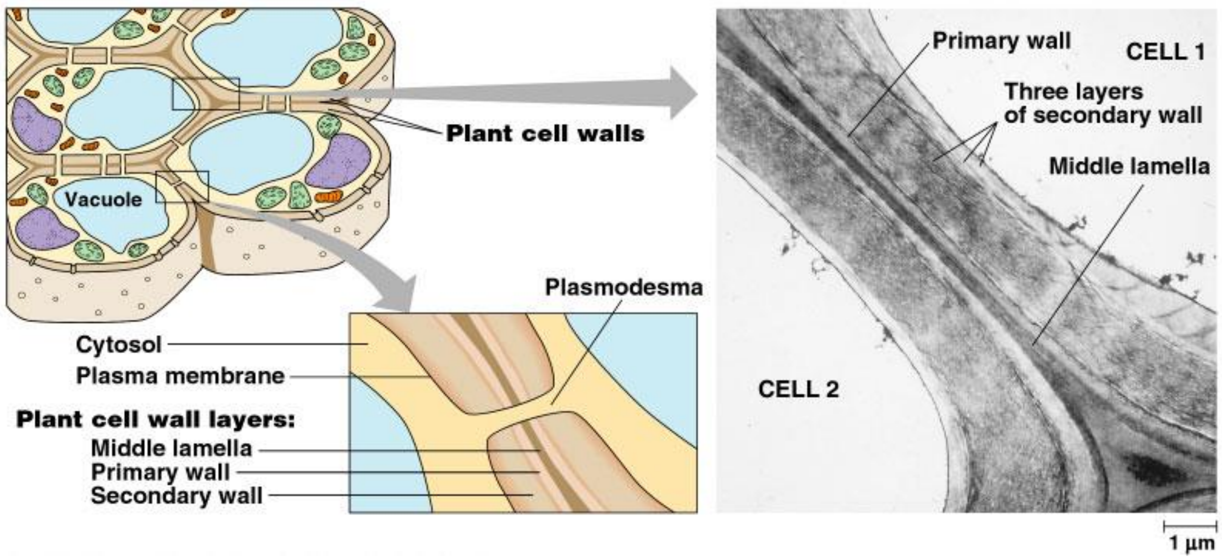
Eukaryotic Cell
(Structure and Function)

- **Plasma Membrane**
- **Nucleus**
- **Ribosomes**
- **Nucleolus**
- **Endoplasmic Reticulum**
- **Golgi Bodies**
- **Plastids**
- **Chloroplasts**
- **Mitochondria**
- **Vacuoles**
- **Microtubules**
- **Cytoplasm**



Cell Wall





Cell wall is absent in animal cell

Cell wall consists of:

(1) Middle lamella – mostly chemcially made up of pectin

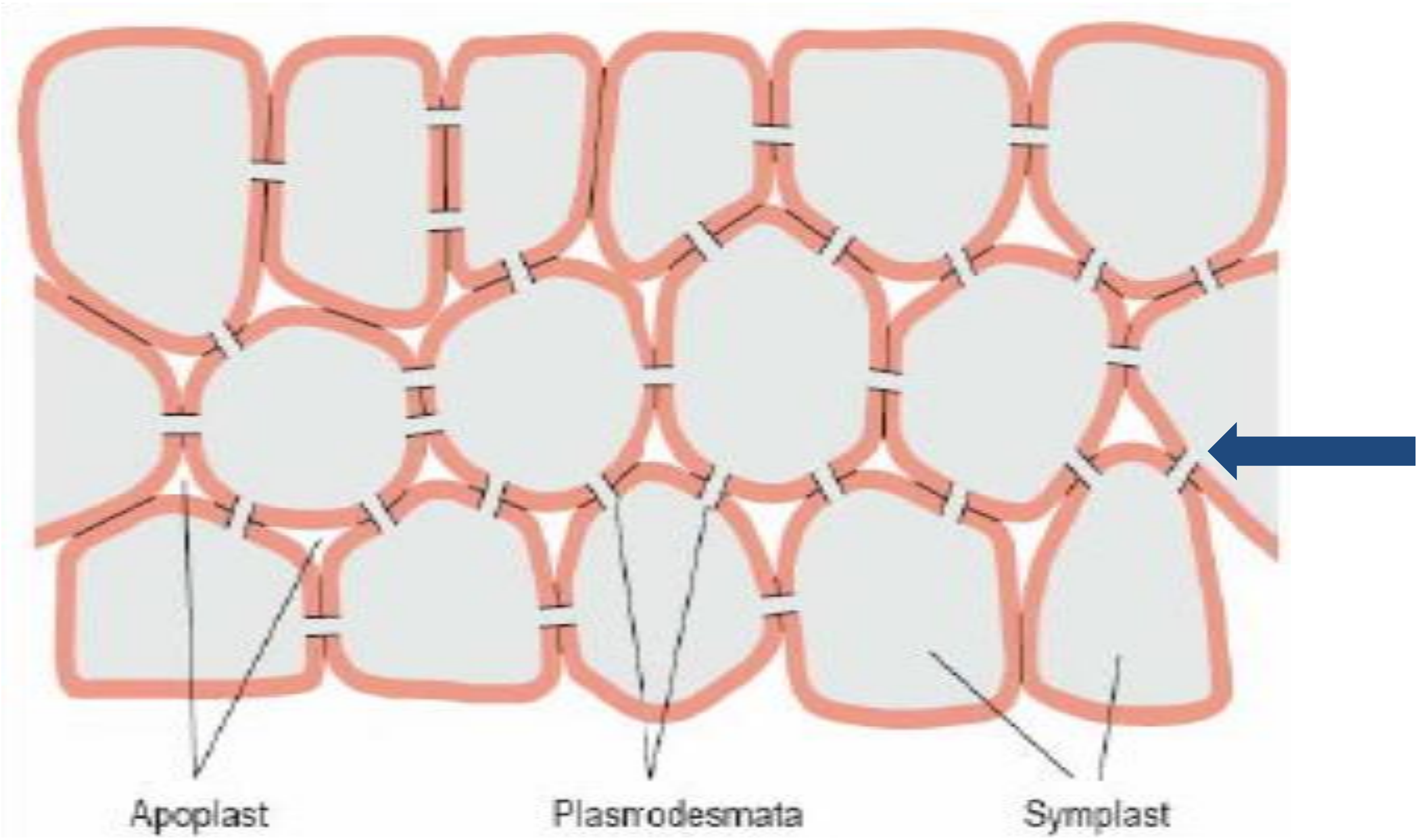
(2) Primary cell wall

- Found in all plant cells
- Cellulose matrix with hemicellulose, proteins, pectin, lignin, cutin and wax
- Characteristic of undifferentiated cells or ones that still are growing

(3) Secondary cell wall

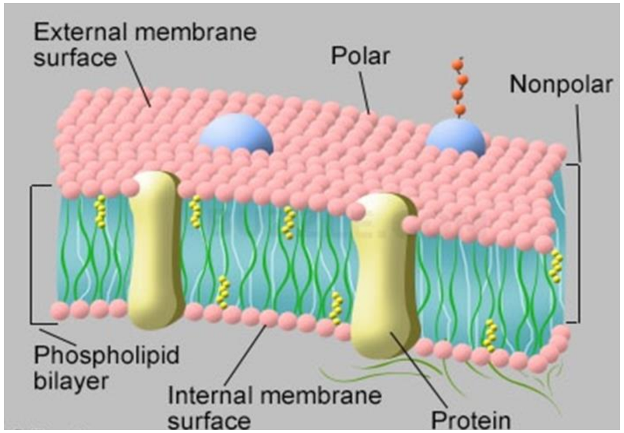
- Just inside primary cell wall
- Characteristic of mature cells
- chemically comprised of hemicellulose and lignin

Plasmodesmata
(connections between cells)

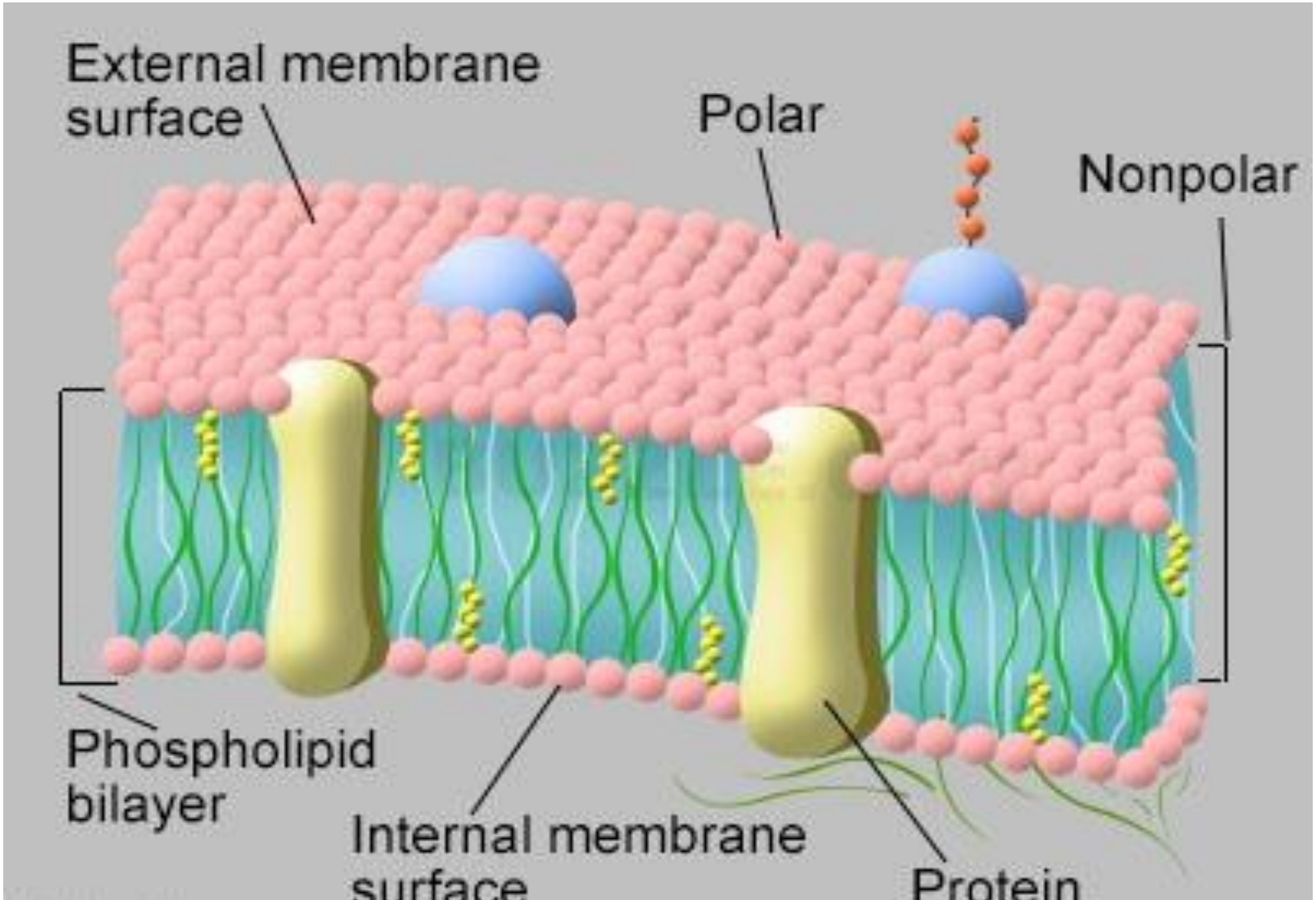


Cell or Plasma Membrane

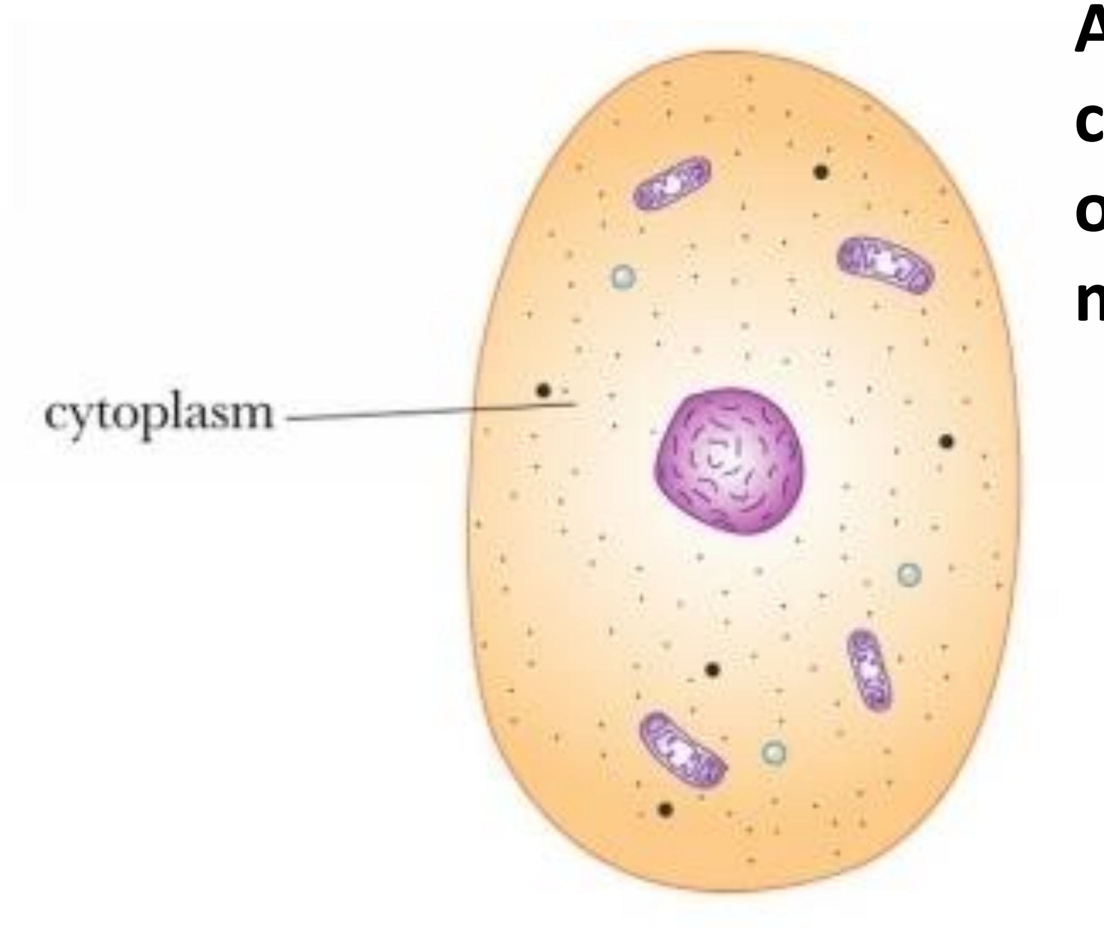
- The cell membrane's function is to form a barrier between the cell's inner and outer environment.
- The plasma membrane selectively permeable meaning that it allows certain materials to pass through and prevents the movement of other through it.
- It is composed of a phospholipid bilayer with protein molecules (integral proteins) embedded within in the bilayer.
- The fluid-mosaic model of plasma membrance: The membrane is literally a mosaic of protein and liptid molecules that have the ability to move from area to area on the surface of the membrane.



Cell or Plasma Membrane Structure

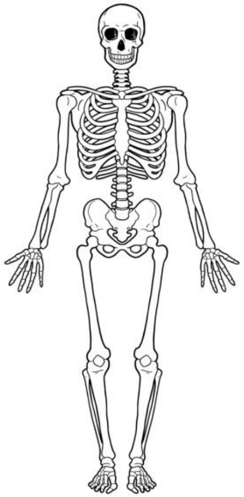


Cytoplasm

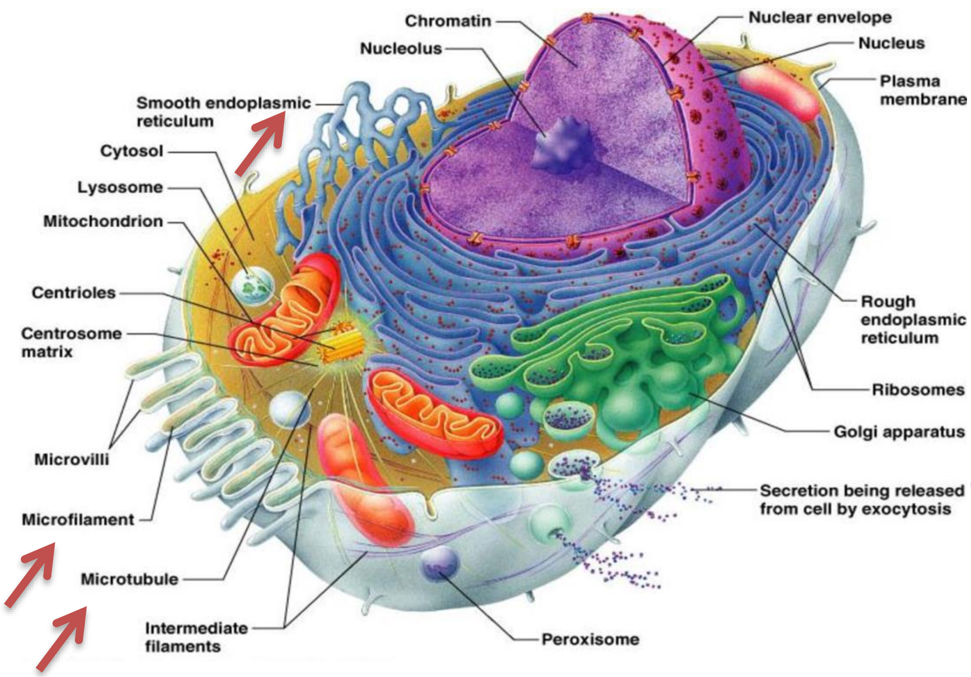


A watery solution that contains the cell organelles, salts, organic molecules, enzymes

Cytoskeleton



The cytoskeleton is a “framework” that supports the cell membrane and other cell structures within the cytoplasm of Eukaryotic cells



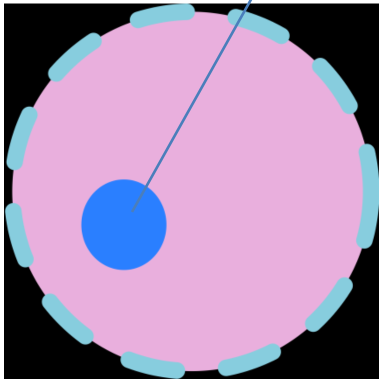
The cytoskeleton is made up of Endoplasmic reticulum, Microfilaments and microtubules

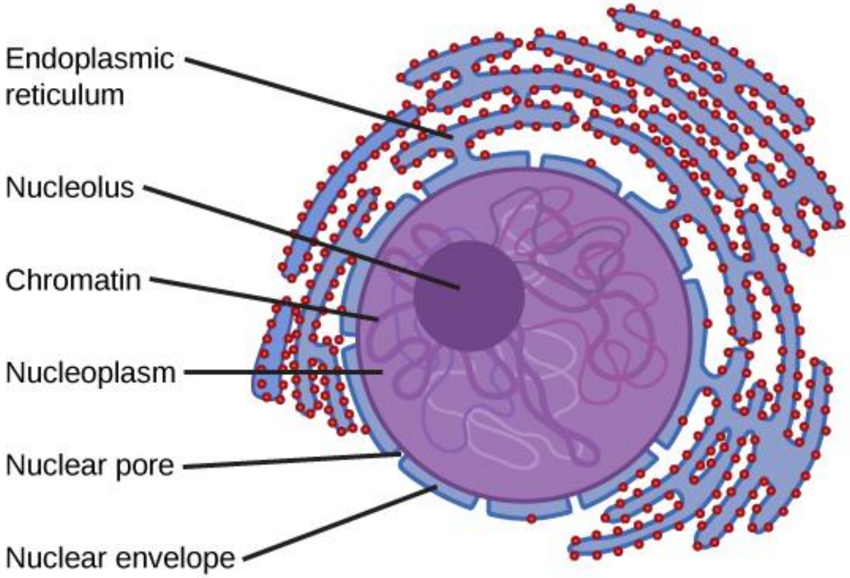
Endoplasmic reticulum is a membranous tubules within the cytoplasm of a eukaryotic cell

Microfilaments are threadlike structures made up of the protein actin.

Microtubules are hollow structures made up of proteins known as tubulins. It maintain cell shape. Microtubules are important in cell division.

Nucleus





- The Nucleus is enclosed in an envelope which is a double membrane structure.

- The Nucleus has pore in the membranes which allow the movement of materials in and out of the structure.

- The Nucleus contains DNA and proteins in the form of loose threads called chromatin.

- The nucleolus is a structure composed of RNA located in the nucleoplasm. There maybe be more than one nucleolus present in a nucleus. The nucleolus produces ribosomes.

- The overall function of the nucleus is the regulation of cellular activities.

Plastids

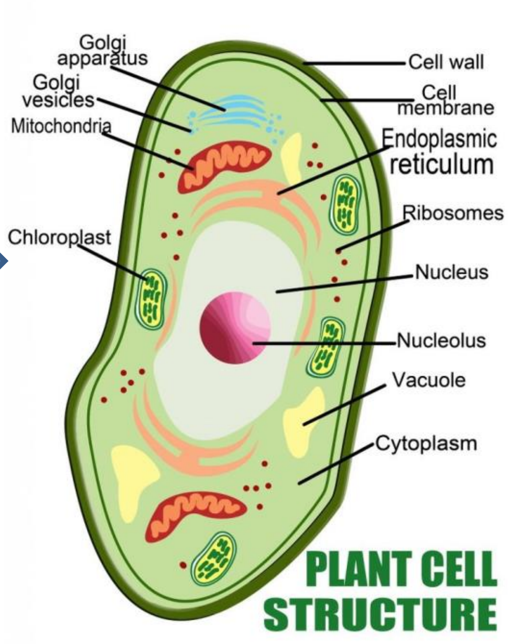
Plastids are double membranous cellular organelles found only in the plant cell.

Plastid are meant for <u>photosynthesis and storage</u>

Plastids are of three types - chloroplasts, chromoplasts and leucoplasts.

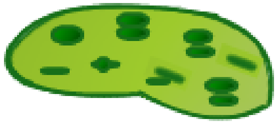
CHLOROPLASTS

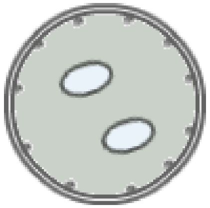
- ❑ **Chloroplast occurs in the cytoplasm of the cell**
- ❑ **Chloroplast are elongated disc shaped cell organelles which contains chlorophyll. Chlorophyll is present in green plants which helps them make food by the process of photosynthesis.**
- ❑ **Green plants takes carbon dioxide (CO_2) from the air, and water (H_2O) from the soil. The plants combine the CO_2 with the H_2O to make the sugar (Glucose ($C_6H_{12}O_6$)**
- ❑ **Photosynthesis is the conversion of light energy to chemical energy by chlorophyll in chloroplasts**



- *Chromoplasts* are plastids which are found in fruits and are yellow, orange and red in color.
- *Lecuoplasts* are colorless plastids. They found in roots, seeds and underground stems.

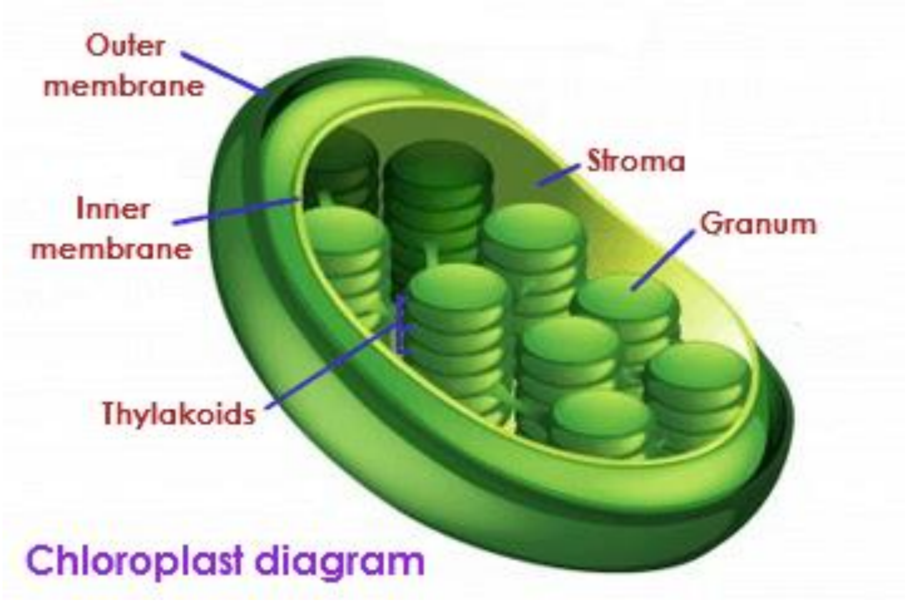

Chromoplast


Chloroplast


Leukoplast

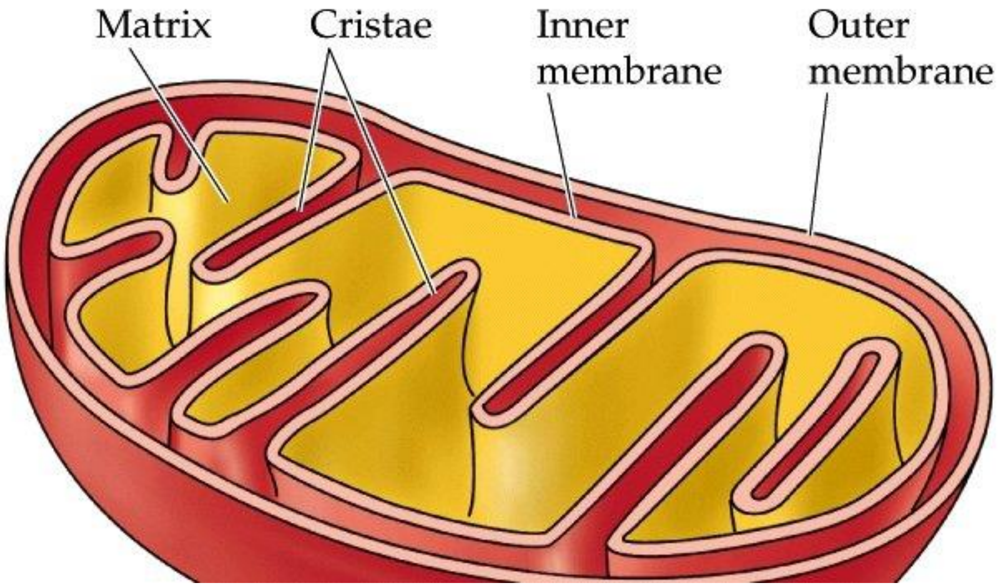
Chloroplast

- The chloroplast are double membrane bound organelles
- The chloroplast occurs in the cytoplasm
- The chloroplast is the are the site of photosynthesis
- The chloroplast contains flattened sacs called thylakoids.
- The thylakoids are stacked one on top of another
- A stack of thylakoids is called a granum
- The space in between the grana is called the stroma



Mitochondria

The mitochondria is a double membrane structure
The mitochondria occurs in cytoplasm.
The inner membrane of the mitochondria has finger like projection called cristae
The mitochondria produces energy in the form of ATP.
The mitochondria is also called as power house of the cell

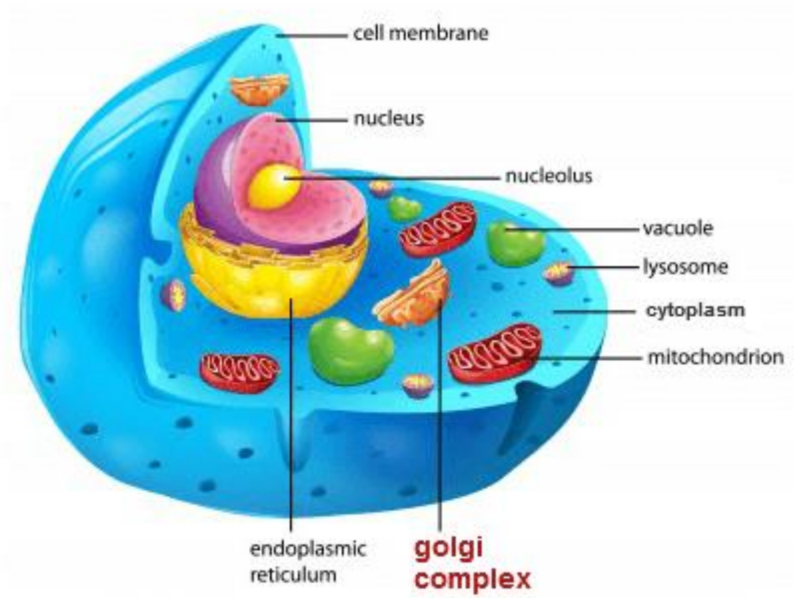


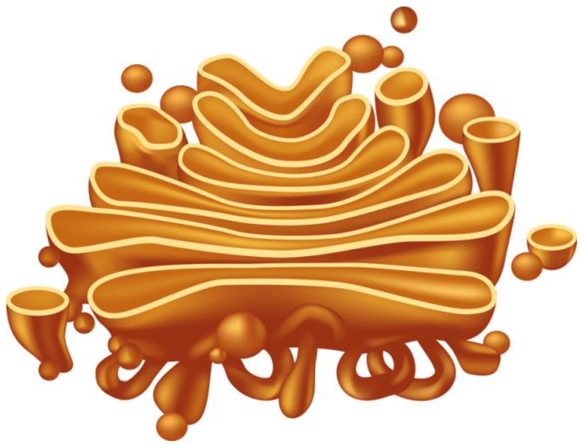
Golgi Apparatus (Dictyosome)

The Golgi apparatus is single membranous cell organelles occurs in cytoplasm.

The Golgi apparatus appears as a series of flattened, stacked, membrane sacs.

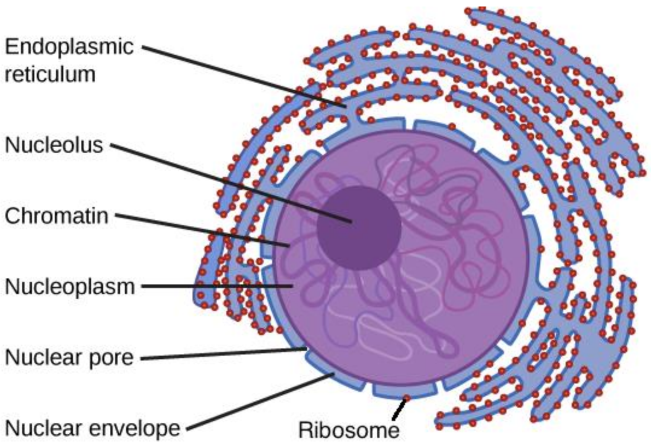
The Golgi apparatus is the center for manufacturing, modifying, and packaging of protein.

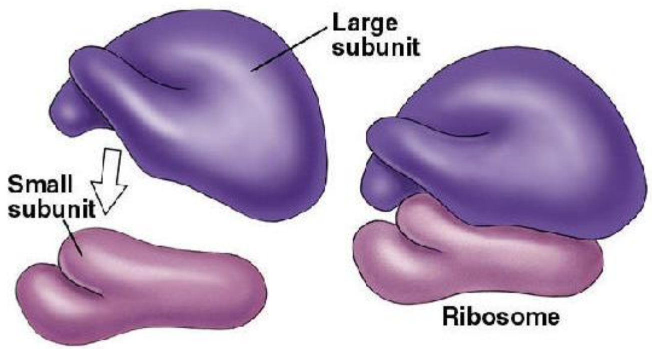




Ribosomes

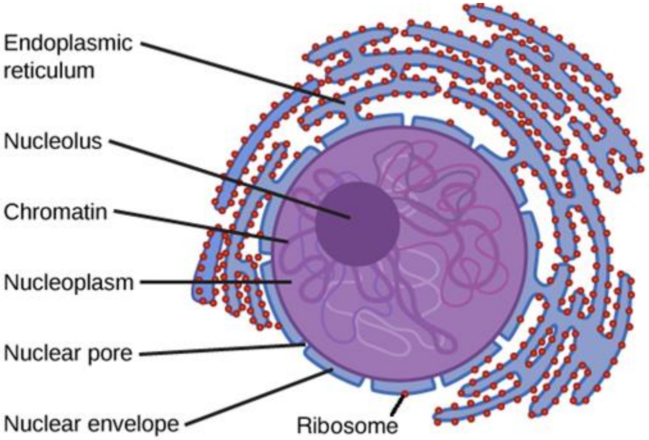
- Ribosomes are found freely floating in the cell or bound to Endoplasmic reticulum.
- Ribosomes are the site for protein synthesis of the cell.
- Ribosomes are composed of two subunits, a small subunit and a large subunit.
- Prokaryotic cells have smaller ribosomes (70s) and eukaryotic cells have the larger (80s) form

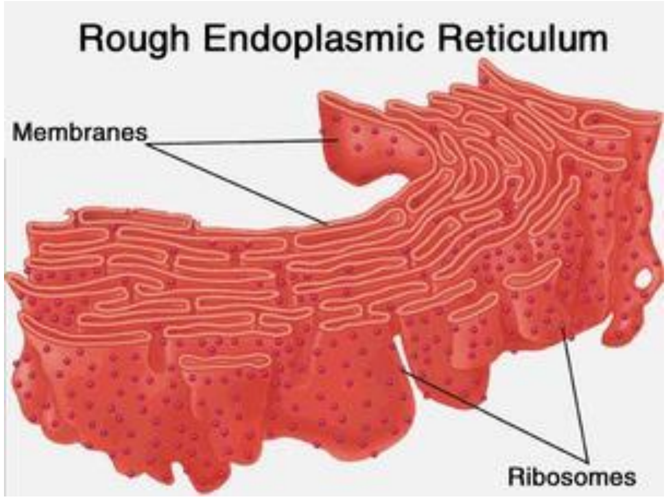




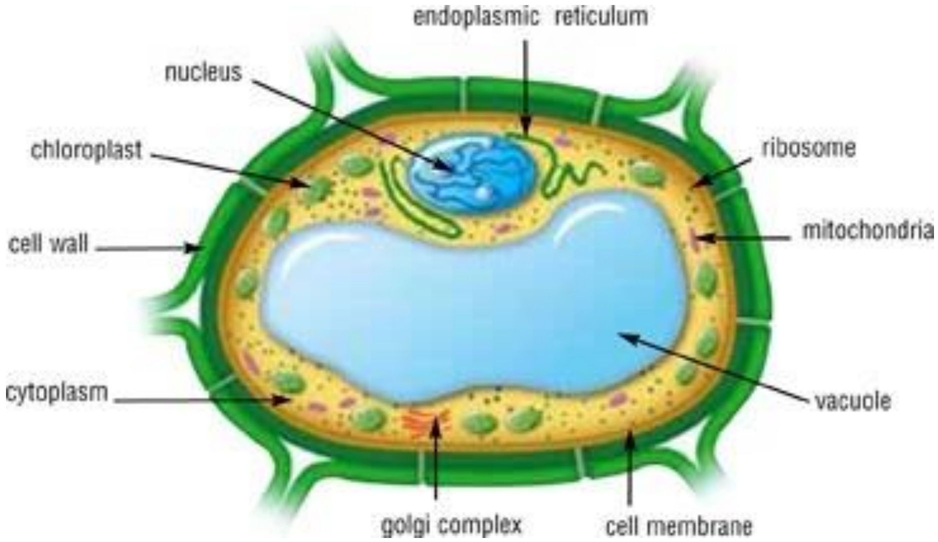
Endoplasmic Reticulum

- **The endoplasmic reticulum (ER) is a series of single membrane channels which run throughout the cytoplasm of the cell.**
- **There are two types of ER (Smooth ER and Rough ER)**
- **The smooth endoplasmic reticulum (SER) is free of ribosomes and functions in lipid synthesis and metabolism of carbohydrates.**
- **The rough endoplasmic reticulum (RER) has ribosomes bound to its outer membrane layer and is the active site of protein synthesis.**





Vacuoles



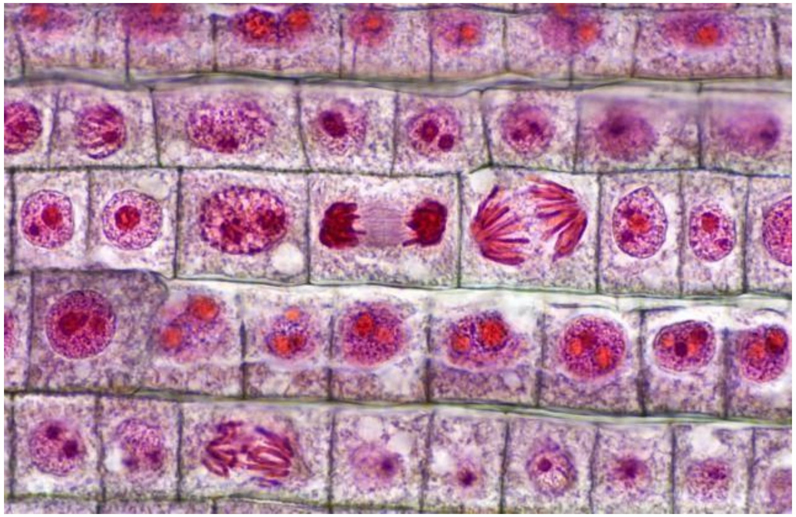
- **Vacuoles are storage areas of the cell.**
- **Vacuoles also serve as the site of chemical digestion.**
- **Vacuoles in animal cells are often small.**
- **The plant cells have a large centrally located vacuole which contains water and dissolved solutes.**

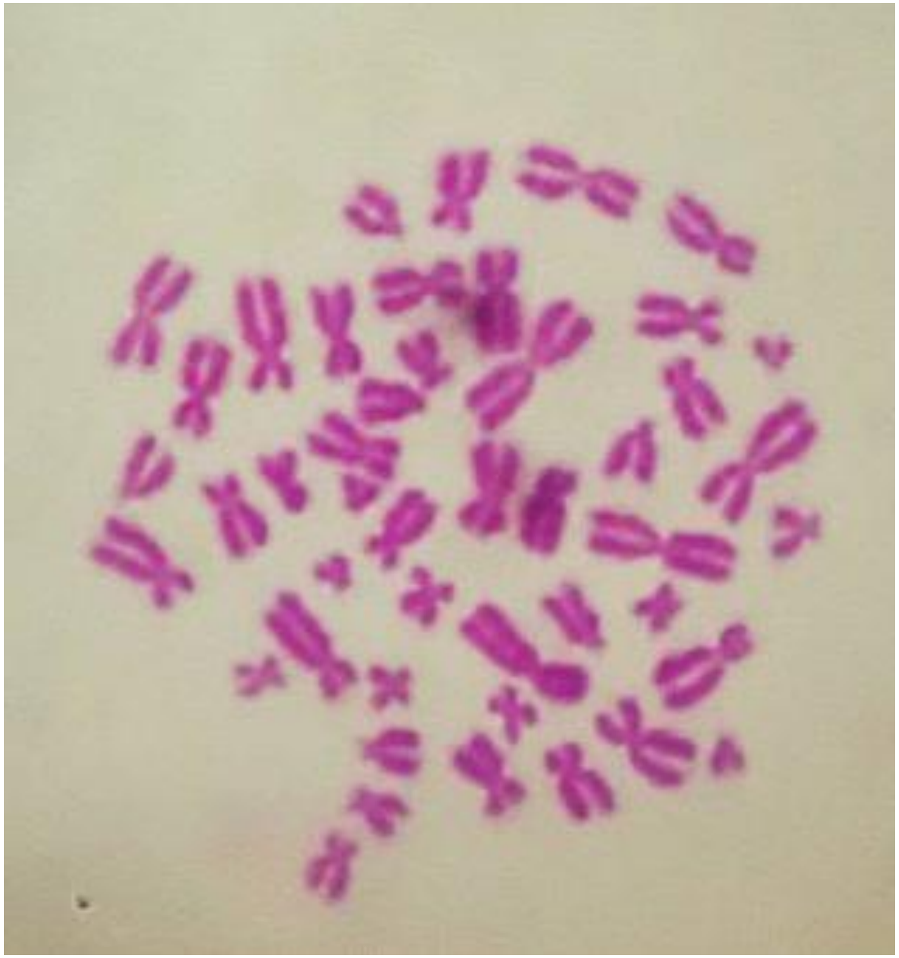
Why an offspring of dates tree is always dates tree ?




- Genes passes genetic information from one generation to another generation
- Genes are made up of DNA
- Genes lies on Chromosomes
- There are large number of genes occurs in each cell on each chromosomes

CHROMOSOME





A thread-like structure of nucleic acids and protein found in the nucleus of the living cells, carrying genetic information in the form of gene

Number of chromosome are fixed for a species

Chromosome Set:

- **Number of chromosome can be counted in the metaphase stage of cell division**
- **One copy of each of the different chromosomes in the nucleus containing one copy of each different gene.**

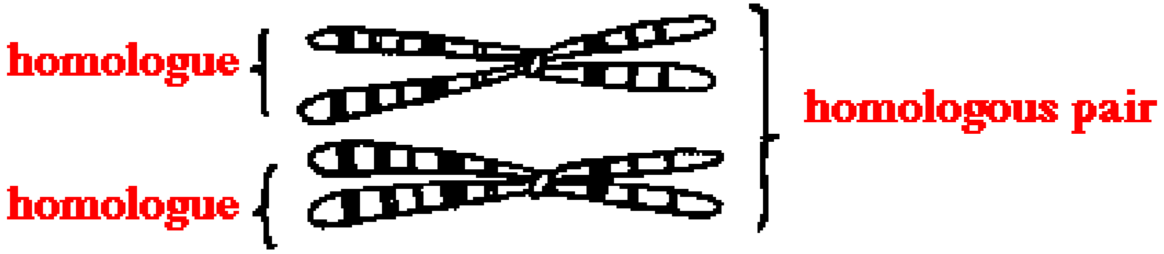
Haploid Number (n): The number of chromosomes comprising one set.

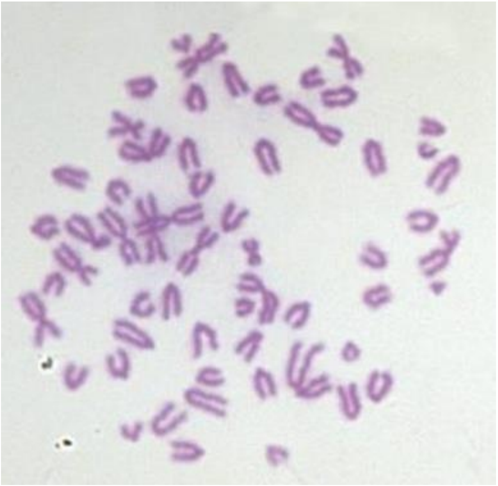
Diploid Number (2n): The number of chromosomes in a cell containing two sets.

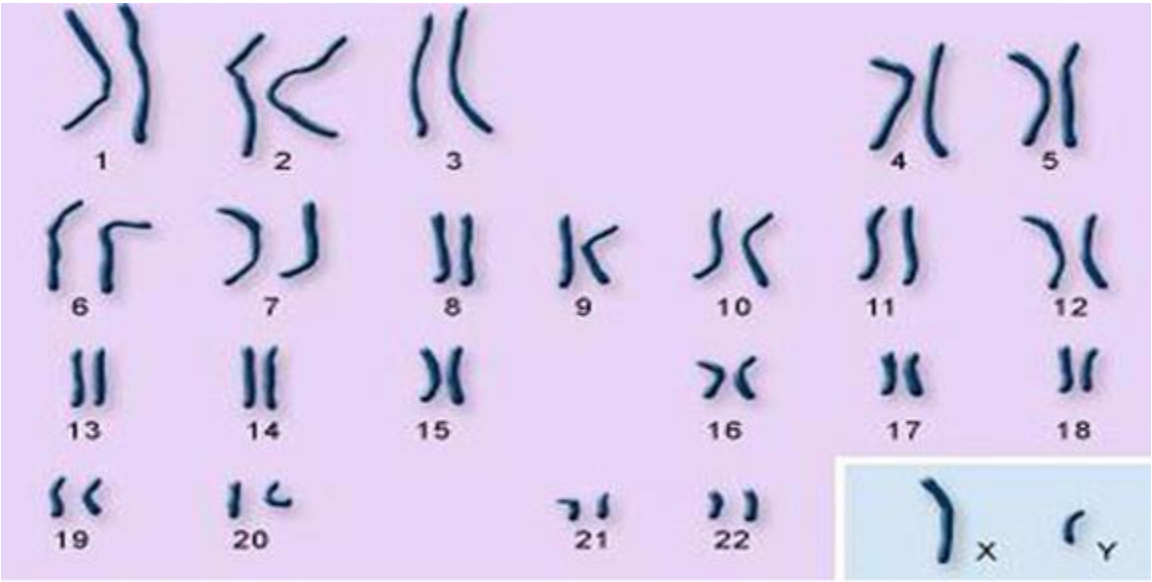
Human	**Haploid (n)= 23** **Diploid (2n)=46**
Dates	**Haploid (n)= 14** **Diploid (2n)=28**

Homologues chromosomes

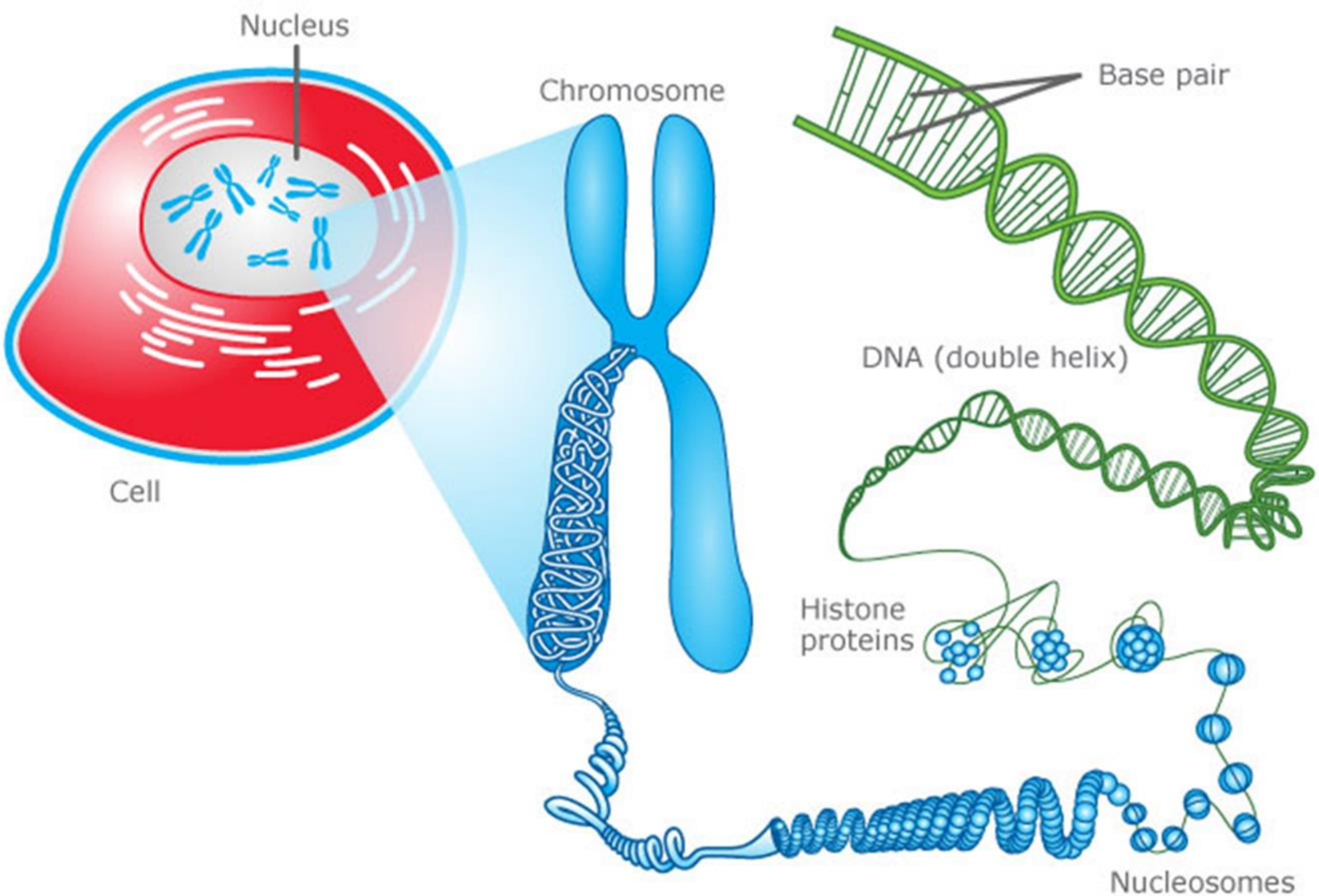
- Chromosomes exist in homologous pairs in diploid cells.



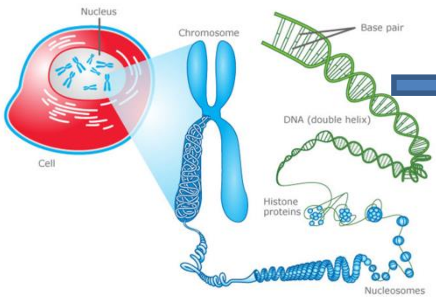


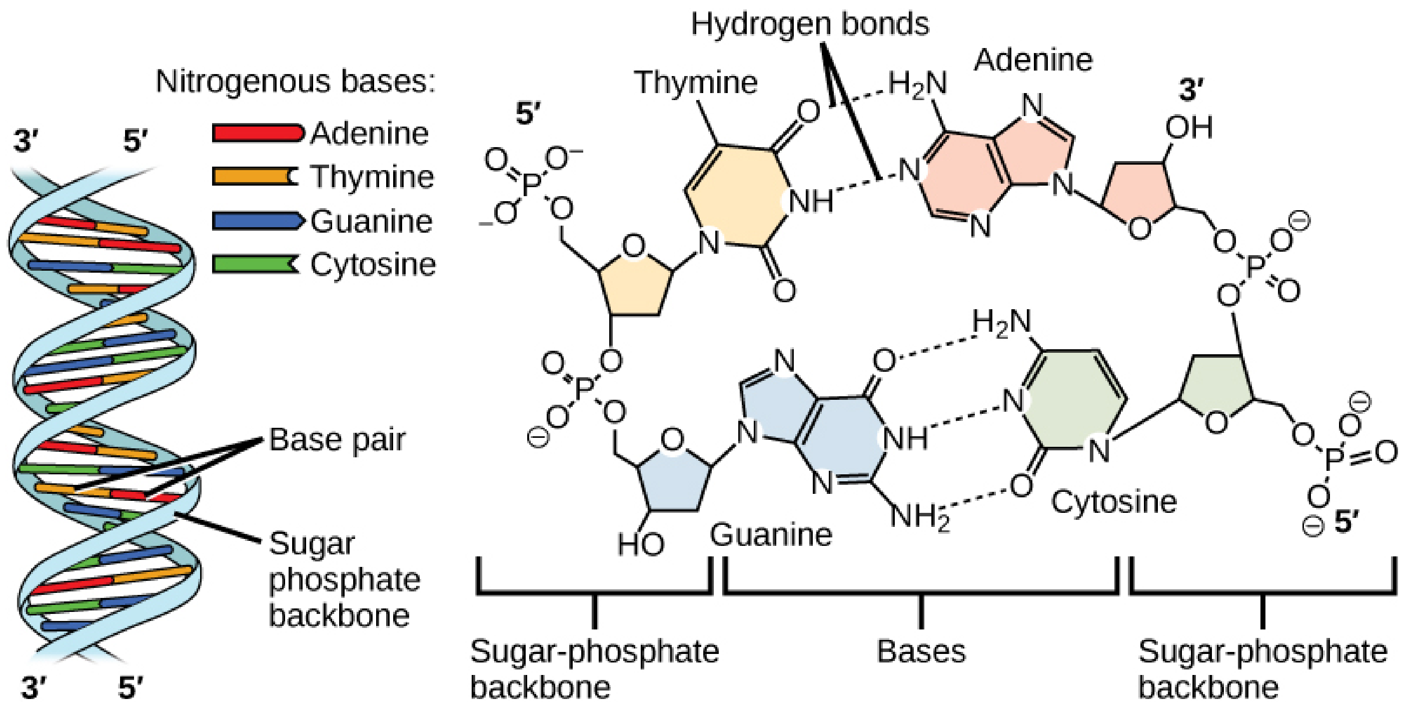


DNA
(DEOXYRIBONUCLEIC ACID)



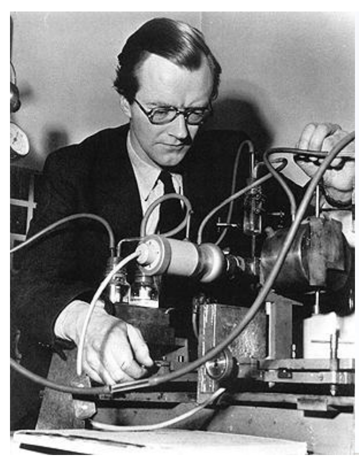
Watson and Crick's DNA double helical model





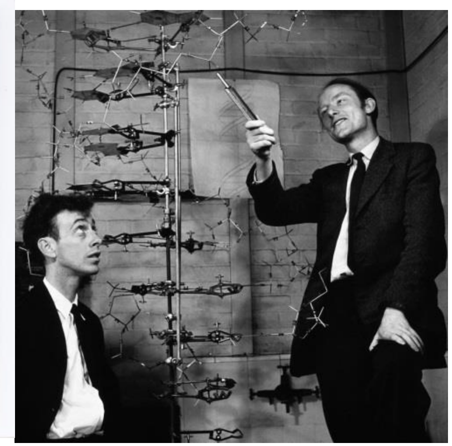
(a) (b)

In 1962 Nobel prize for medicine



Wilkins

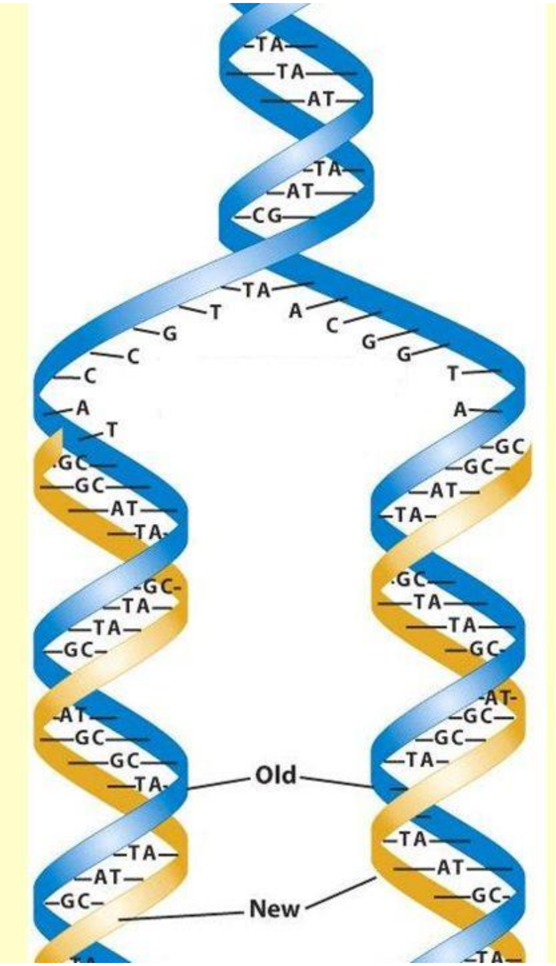
Franklin



James Watson and Francis Crick

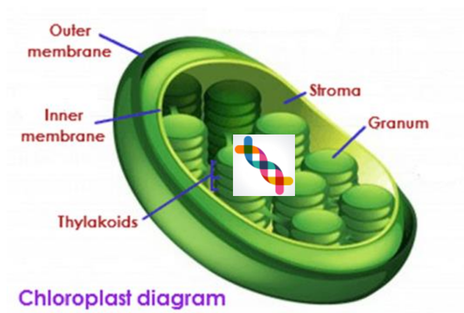
DNA Replication

- The process of the producing two identical DNA from one original DNA
- DNA replication occurs during cell division

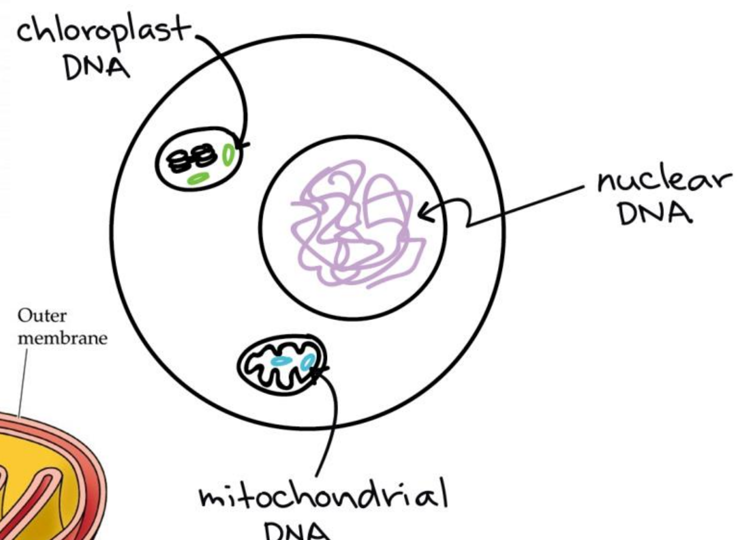


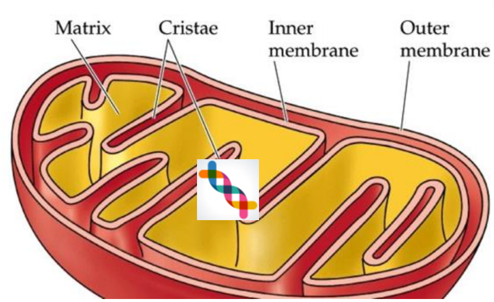
Self-Replicating cell Organelles

- **Mitochondria and plastid contains their own DNA and capable of self replication in the cells.**



Chloroplast diagram





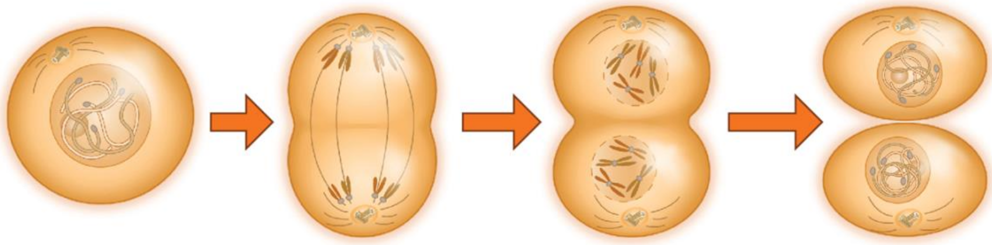
Cell Division

Cell Replication

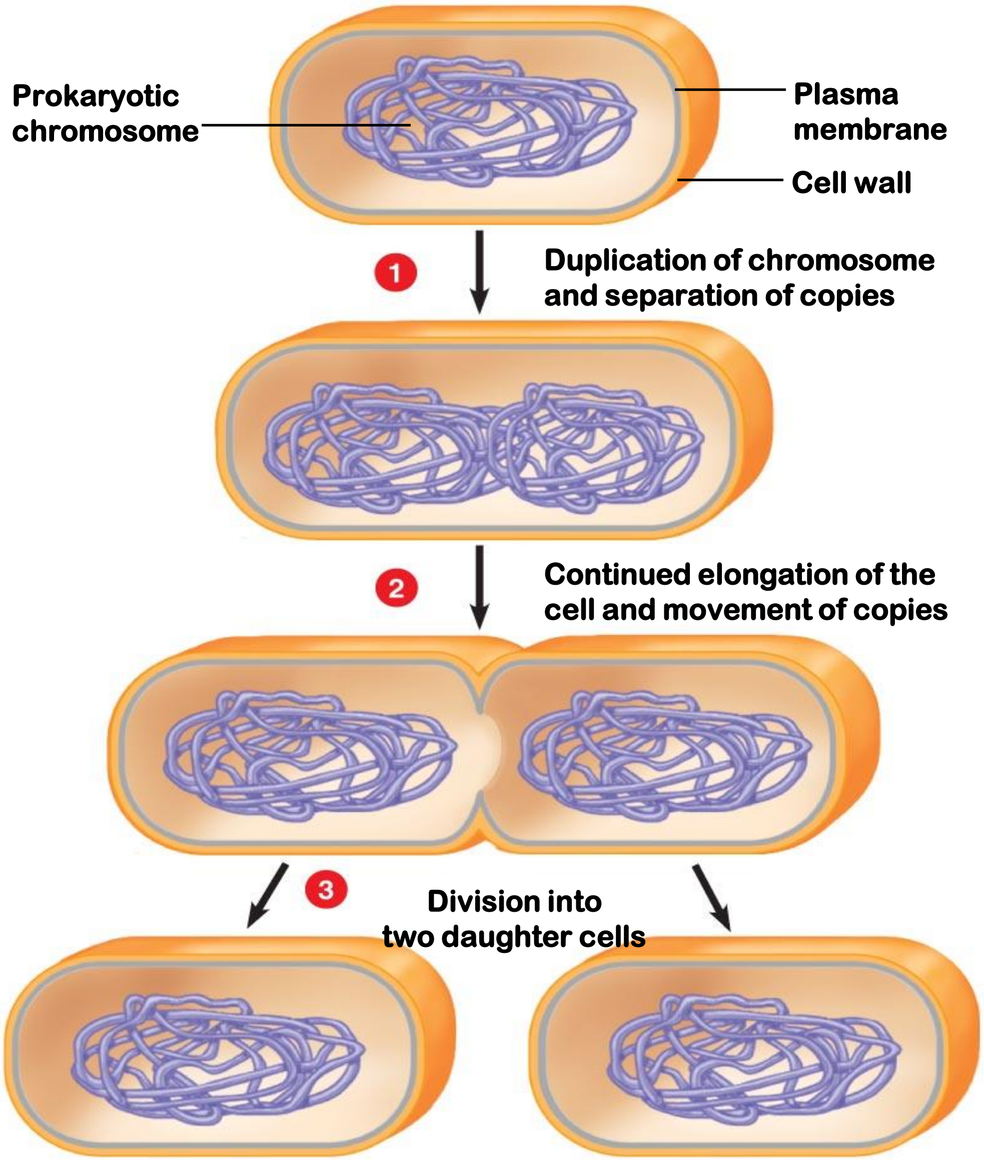
CELL DIVISION / CELL REPLICATION

Cell Division

- Production of new cells
- Completes in two steps:
  - Karyokinesis – nuclear division
  - Cytokinesis – cytoplasm division



Binary Fission

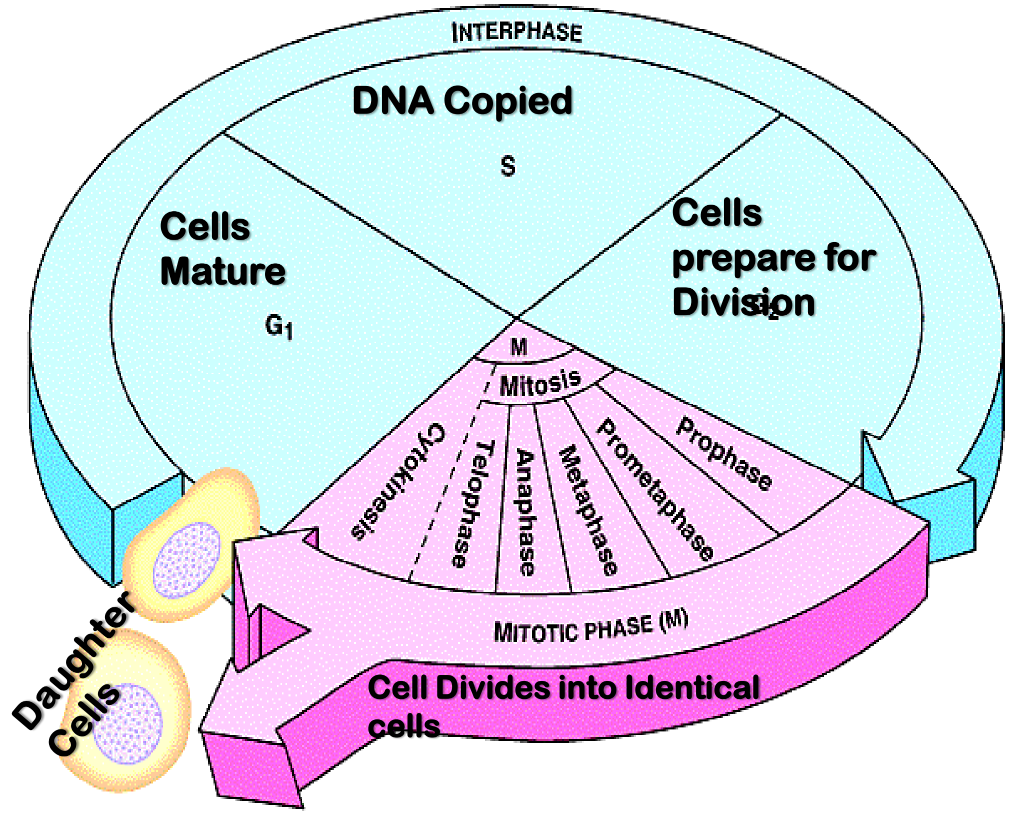


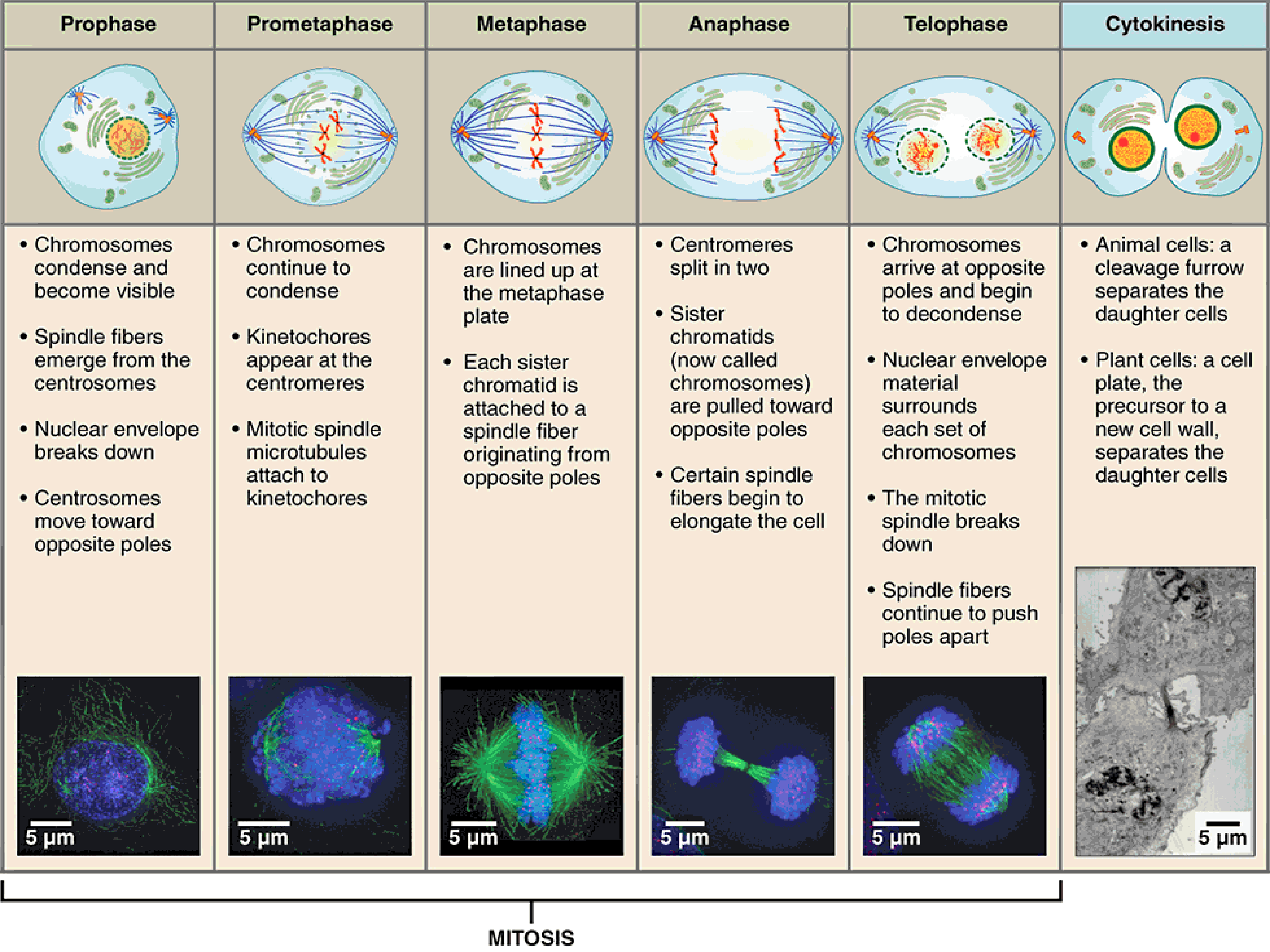
Mitosis cell division

- Eukaryotes divide by a process called as Mitosis

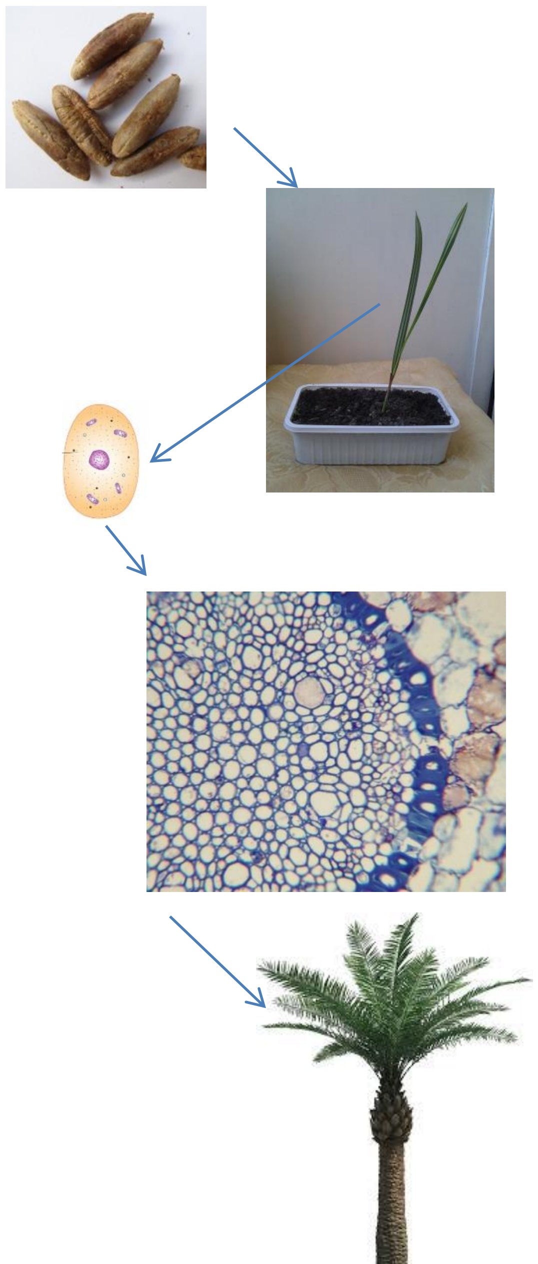
The cell cycle:

- Cells divide along own time frame called its Cell Cycle.
- The Cell cycle consists of the following three steps:
- G1 (Gap 1) Phase - Cell performs its normal function, cells which do not divide, resting phase
- S (Synthesis) Phase - Here the cell actively duplicates its DNA in preparation for division
- G2 (Gap 2) Phase – the amount of cytoplasm and cell organelles increases in preparation for division.
- Mitosis - Actual division occurs (Prophase, Metaphase, Anaphase, Telophase)




Prophase
Prometaphase
Metaphase
Anaphase
Telophase
Cytokinesis
• Chromosomes condense and become visible
• Spindle fibers emerge from the centrosomes
• Nuclear envelope breaks down
• Centrosomes move toward opposite poles
• Chromosomes continue to condense
• Kinetochores appear at the centromeres
• Mitotic spindle microtubules attach to kinetochores
• Chromosomes are lined up at the metaphase plate
• Each sister chromatid is attached to a spindle fiber originating from opposite poles
• Centromeres split in two
• Sister chromatids (now called chromosomes) are pulled toward opposite poles
• Certain spindle fibers begin to elongate the cell
• Chromosomes arrive at opposite poles and begin to decondense
• Nuclear envelope material surrounds each set of chromosomes
• The mitotic spindle breaks down
• Spindle fibers continue to push poles apart
• Animal cells: a cleavage furrow separates the daughter cells
• Plant cells: a cell plate, the precursor to a new cell wall, separates the daughter cells
5 μm
5 μm
5 μm
5 μm
5 μm
5 μm
MITOSIS

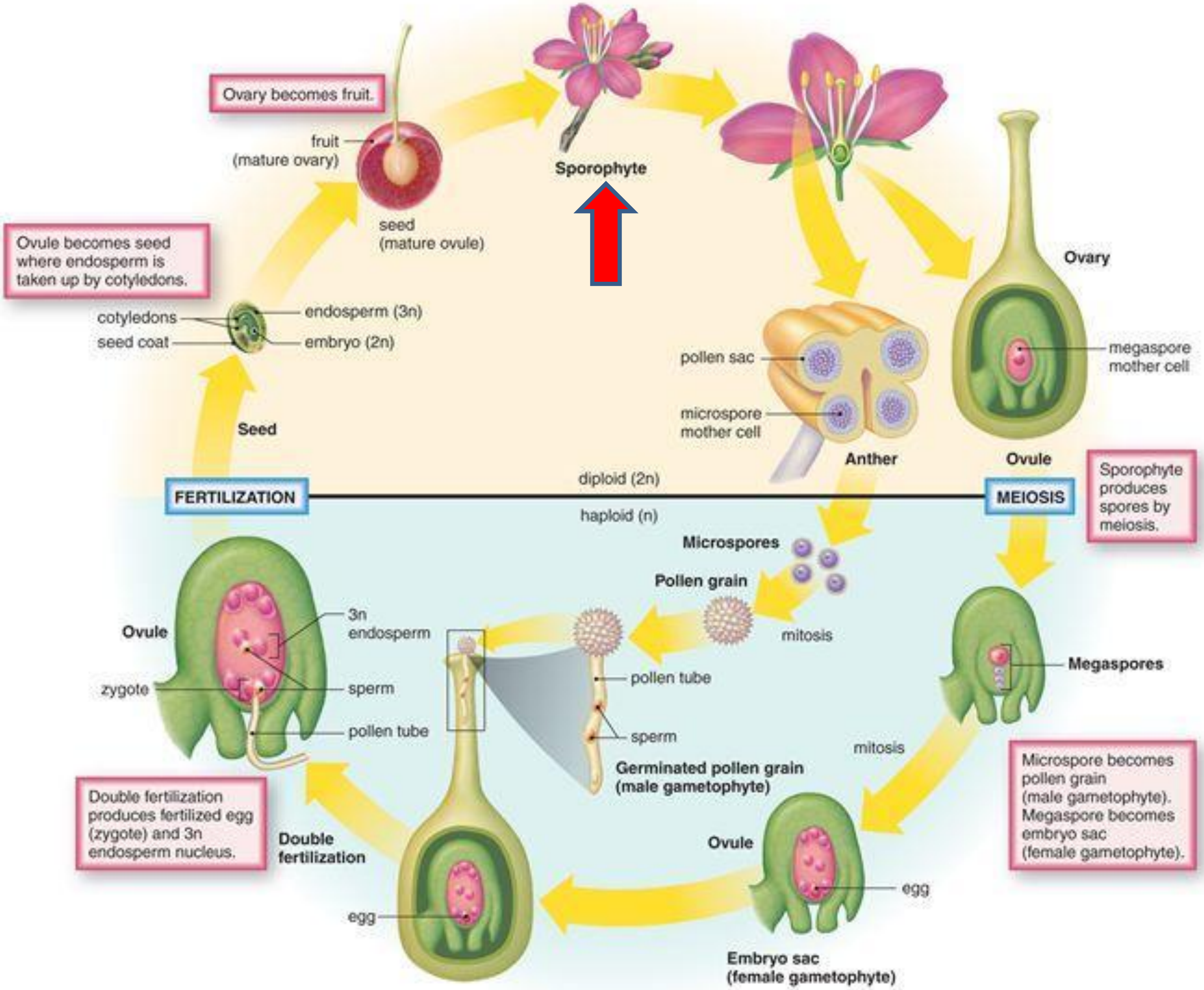
Mitosis



- Requires for growth of the organism
- Occurs in somatic / body cells
- 1 cell after mitosis division gives 2 cells (called daughter cells)
- The division of replicated chromosomes in one nucleus to form two genetically identical daughter nuclei.
- Each “daughter” nucleus has the same number or set of chromosomes that the “parent” nucleus had
- Daughter cells are genetically identical
- Chromosome number does not change after mitosis division

MEIOSIS
CELL DIVISION

How a flowering plant reproduce?

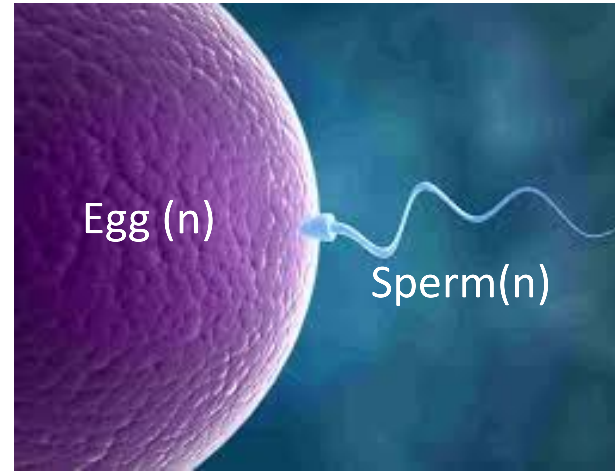


How a flowering plant reproduce?

(Diploid / 2n)

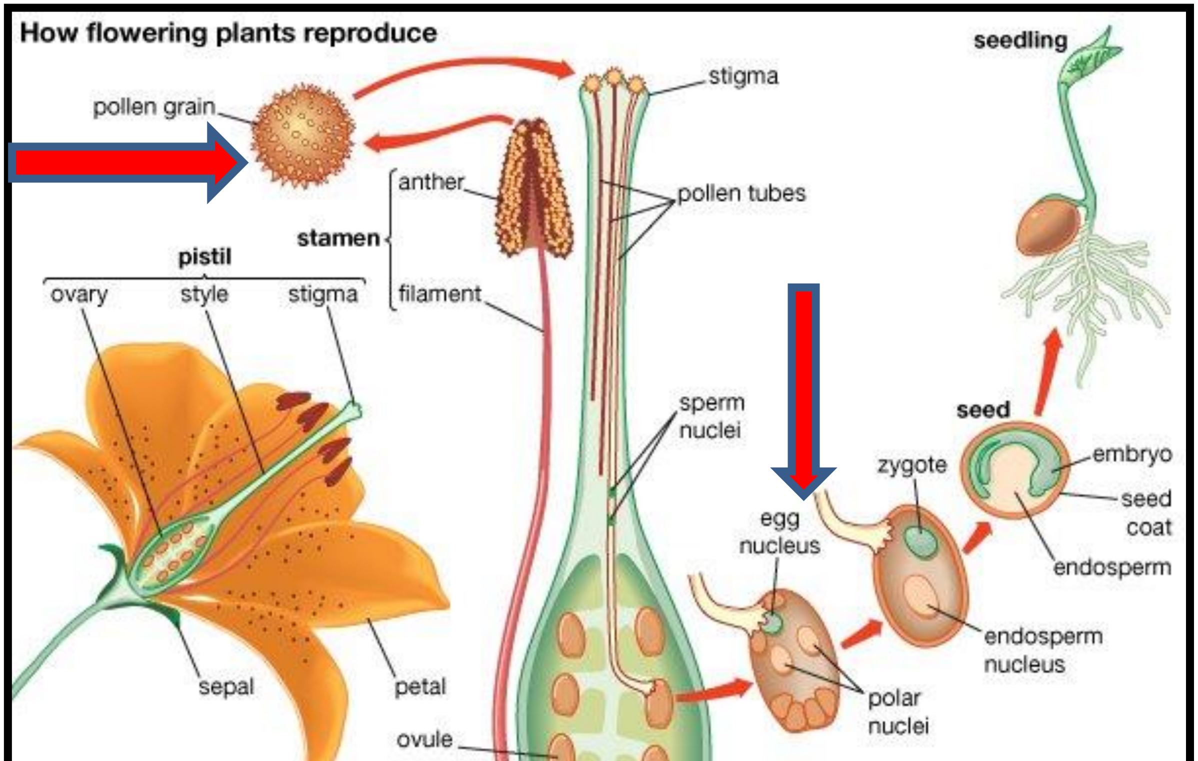
Plant reproductive cells
(Diploid / 2n)

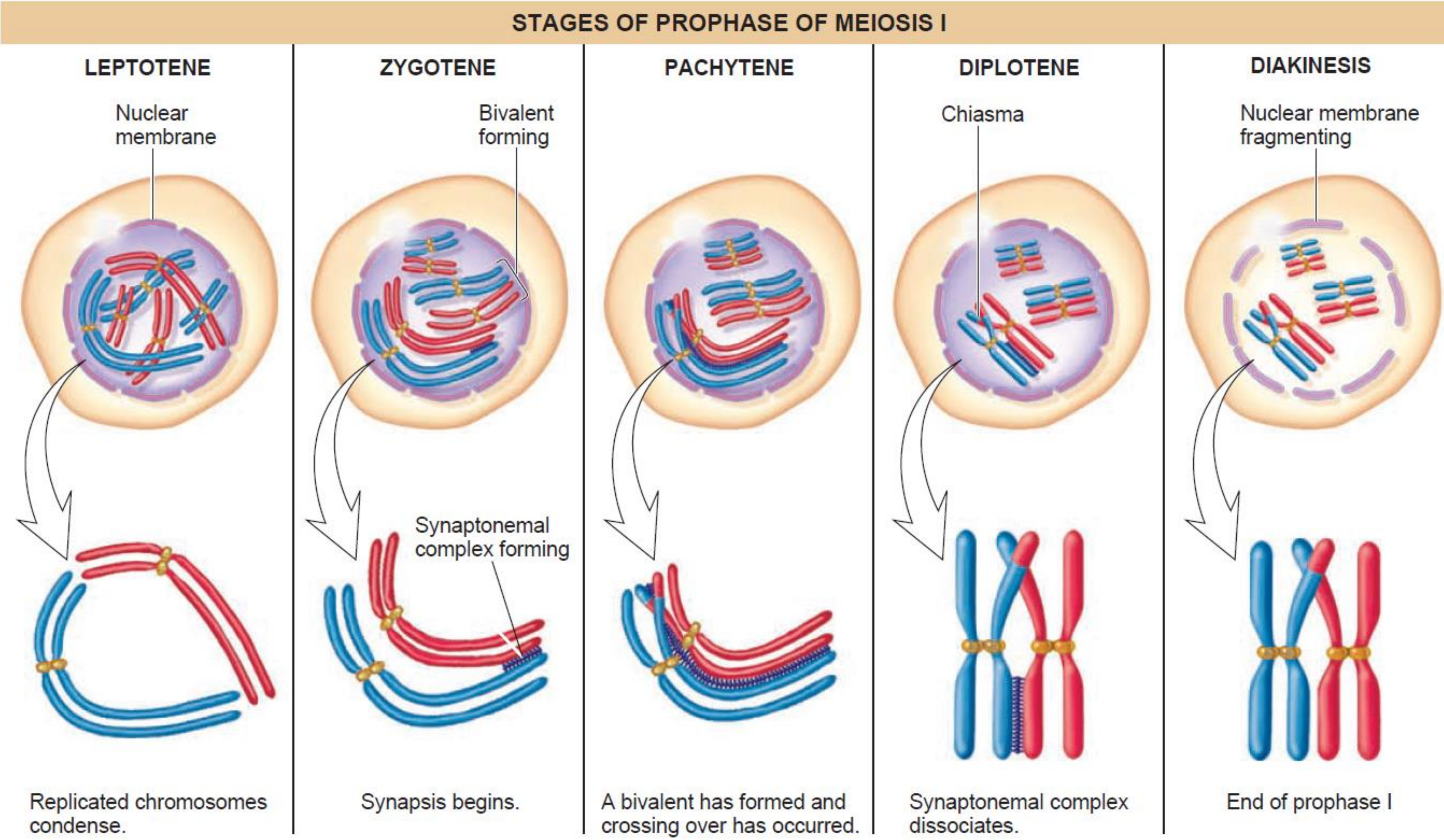
Meiosis



Zygote (2n)

(Diploid / 2n)



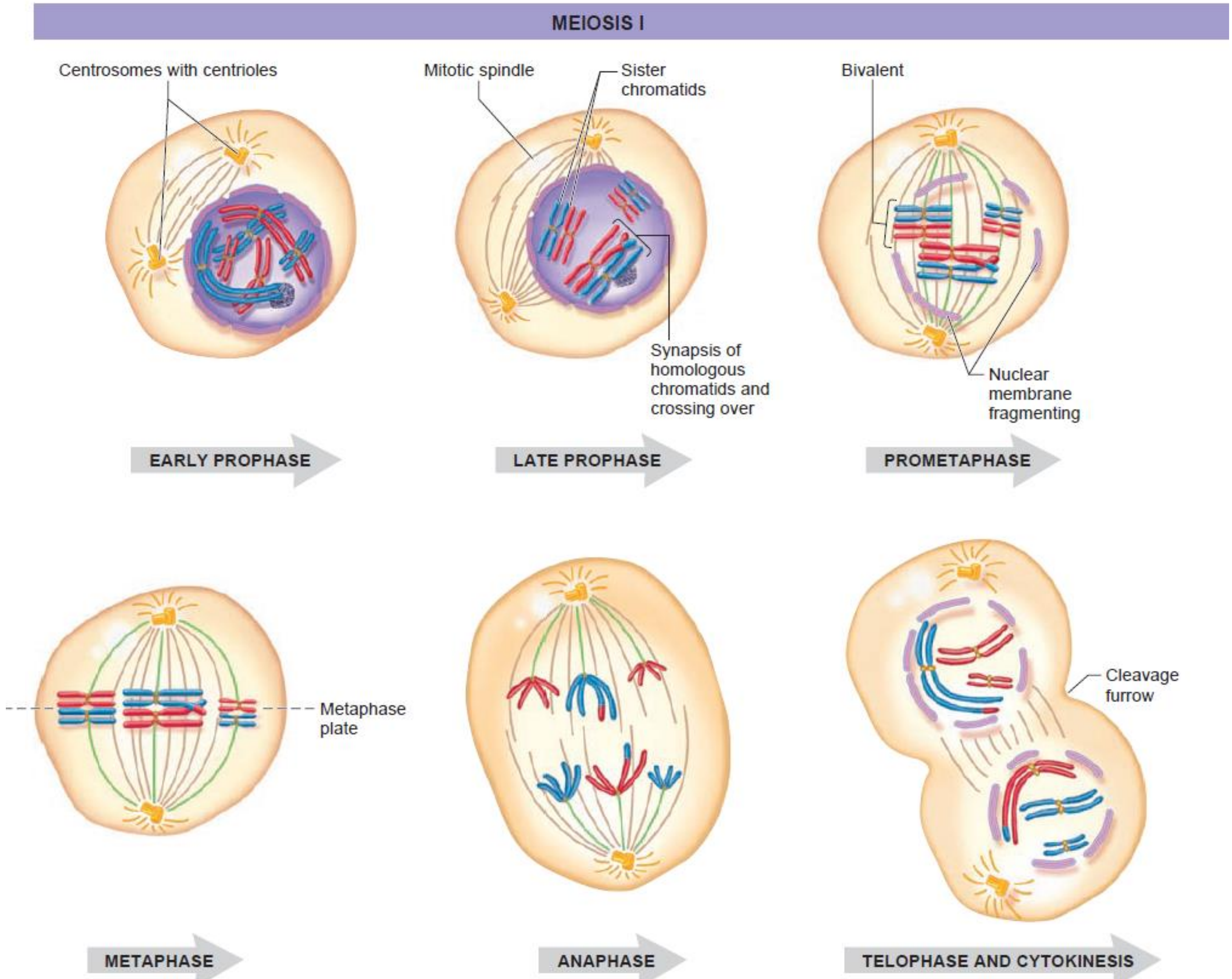


Synapsis = the pairing of two homologous chromosomes

The synaptonemal complex is a protein that forms between homologous chromosomes (two pairs of sister chromatids) during meiosis and is thought to mediate chromosome pairing, synapsis, and recombination

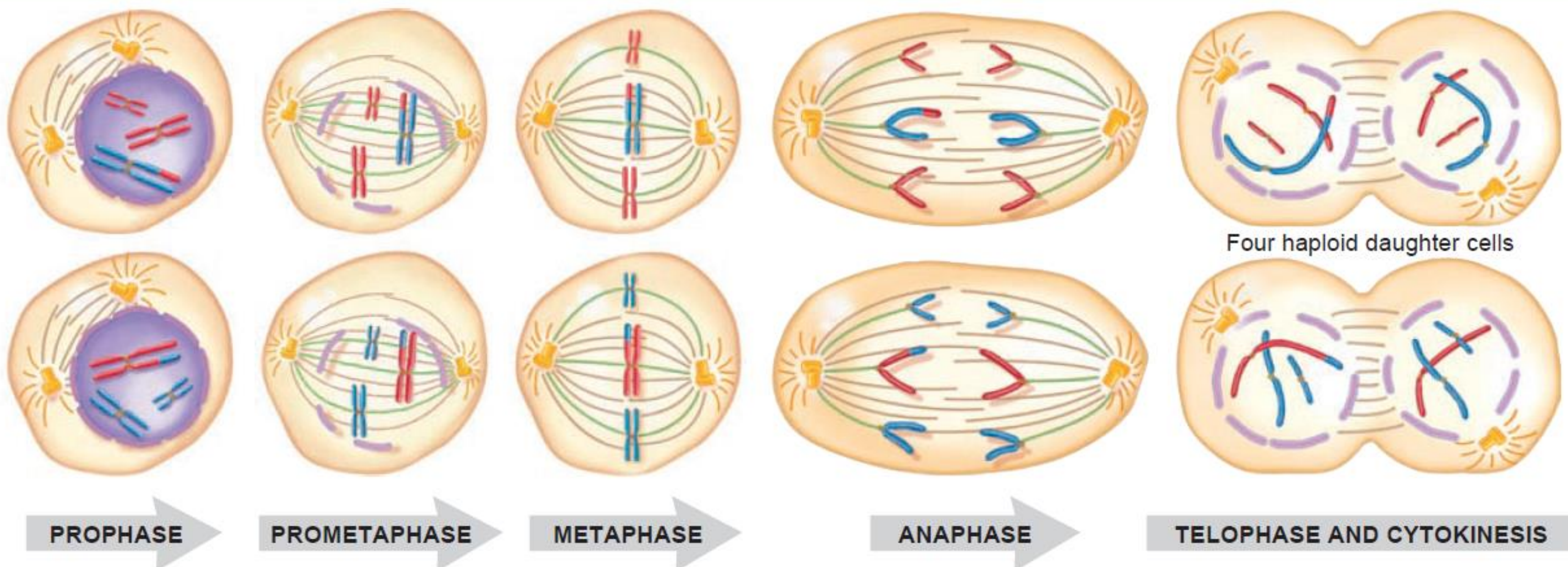
Bivalent= the structure formed after completion of pairing of two homologous chromosomes

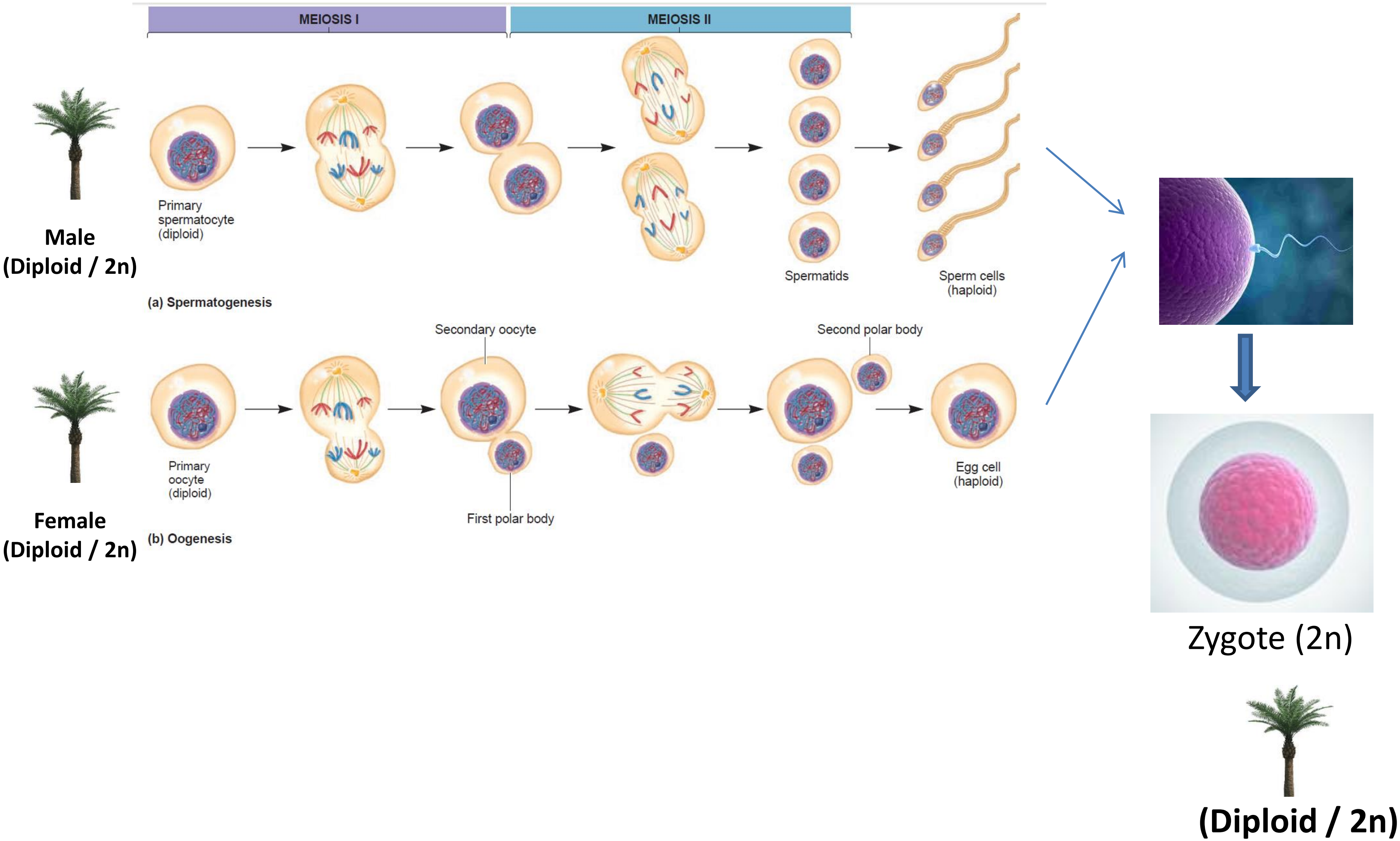
Chaismata= the point where two homologous non-sister chromatids exchange genetic material during chromosomal crossover in meiosis



MEIOSIS I
Centrosomes with centrioles
Mitotic spindle
Sister chromatids
Bivalent
Synapsis of homologous chromatids and crossing over
Nuclear membrane fragmenting
EARLY PROPHASE
LATE PROPHASE
PROMETAPHASE
Metaphase plate
Cleavage furrow
METAPHASE
ANAPHASE
TELOPHASE AND CYTOKINESIS

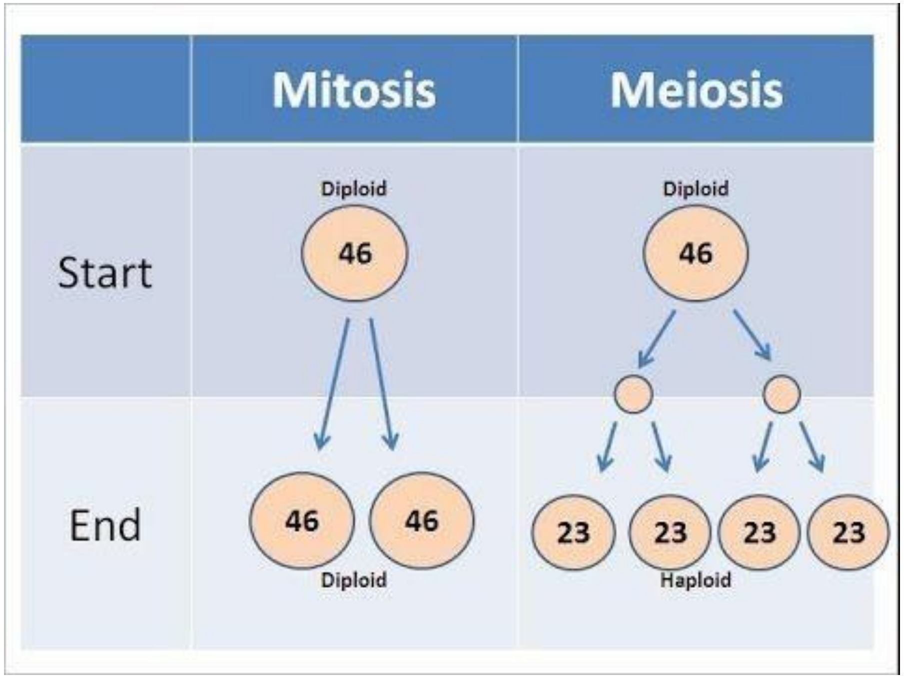
MEIOSIS II (Similar to Mitosis cell division)




MEIOSIS I
MEIOSIS II
Male
(Diploid / 2n)
Primary
spermatocyte
(diploid)
Spermatids
Sperm cells
(haploid)
(a) Spermatogenesis
Secondary oocyte
Second polar body
Female
(Diploid / 2n)
Primary
oocyte
(diploid)
First polar body
Egg cell
(haploid)
(b) Oogenesis
Zygote (2n)
(Diploid / 2n)

Differences in between Mitosis and Meiosis cell division

- Meiosis cell division is similar in many ways to mitosis cell division.
- There are several differences in between Mitosis and Meiosis cell division.
- There are two cell divisions (Meiosis I and Meiosis II) involves in meiosis cell division.
- As a results of Meiosis cell division, one parent cell gives 4 daughter cells.
- The chromosomes number reduced to half in the daughter cells
- Reduction of Chromosome number occurs in Meiosis I division
- Meiosis II is just similar to Mitosis cell division.
- Mitosis cell division occurs in somatic cell but meiosis cell division occurs in reproductive cells



GENETICS

The study of hereditary and variations is called as Genetics

Classical / Mendelian Genetics

- Genetics is the scientific study of heredity and variation.

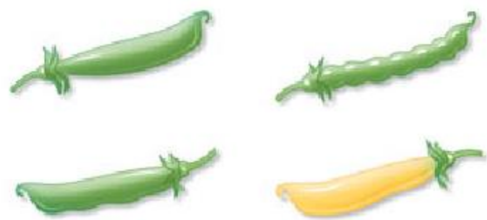
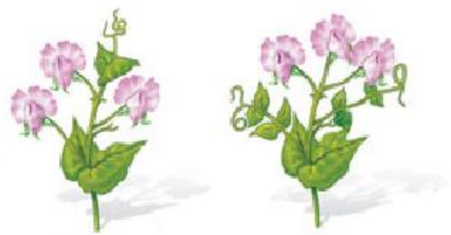
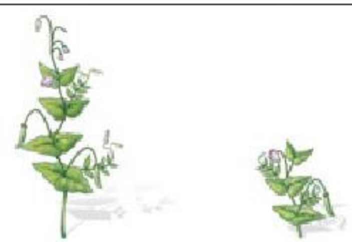
- Gregor Mendel (1860’s) an Austrian Monk, was interested in figuring out how heredity was determined in plants and animals.

- Gregor Mendel selected pea plants for his experiment

- Quantitative (mathematical) approach to collect data.

Gregor Mendel
(Father of Genetics)

MONOHYBRID CROSSES

Character	Contrasting traits	
Seed shape	round/wrinkled	
Seed color	yellow/green	
Pod shape	full/constricted	
Pod color	green/yellow	
Flower color	violet/white	
Flower position	axial/terminal	
Stem height	tall/dwarf	

Seven pairs of contrasting traits selected by Mendle

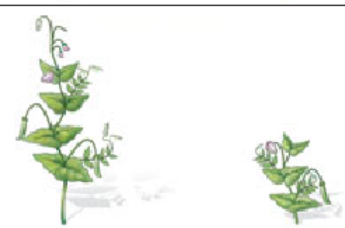
TRAIT = A trait is a specific characteristic, such as seed color or plant height, that varies from one individual to another.

Monohybrid cross is a cross between two individual having single contrasting traits.

Dihybrid cross is a cross between two individual having two different traits.

Seven pairs of contrasting traits and the results of Mendel's seven monohybrid crosses of the garden pea

- **The pea plants were cross pollinated.**
- **Cross pollination (=The transfer of pollen from an anther of a flower of one plant to a stigma of a flower of another plant)**
- **Offspring were called as F1, or "first filial," generation.**
- **Quantitative (mathematical) approach to collect data.**

Character	Contrasting traits		F_1 results	F_2 results	F_2 ratio
Seed shape	round/wrinkled		all round	5474 round 1850 wrinkled	2.96:1
Seed color	yellow/green		all yellow	6022 yellow 2001 green	3.01:1
Pod shape	full/constricted		all full	882 full 299 constricted	2.95:1
Pod color	green/yellow		all green	428 green 152 yellow	2.82:1
Flower color	violet/white		all violet	705 violet 224 white	3.15:1
Flower position	axial/terminal		all axial	651 axial 207 terminal	3.14:1
Stem height	tall/dwarf		all tall	787 tall 277 dwarf	2.84:1

Results of Mendel's F1 Crosses:
When Mendel crossed plants with contrasting characters for the same trait (for example All round), the resulting offspring had only one of the characters in F1 generation.

But the population of F1 generation self pollinated, the resulting offspring had characters of two different traits 3: 1.

Character	Contrasting traits	F_1 results	F_2 results	F_2 ratio
Seed shape	round/wrinkled	all round	5474 round 1850 wrinkled	2.96:1
Seed color	yellow/green	all yellow	6022 yellow 2001 green	3.01:1
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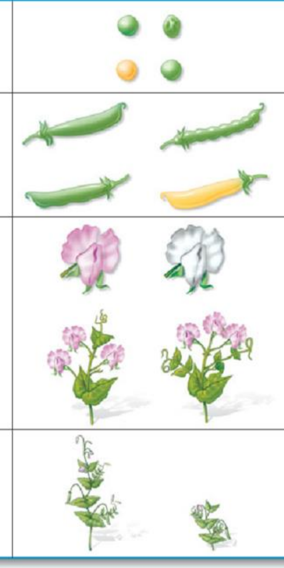
Flower color	violet/white	all violet	705 violet 224 white	3.15:1
Flower position	axial/terminal	all axial	651 axial 207 terminal	3.14:1
Stem height	tall/dwarf	all tall	787 tall 277 dwarf	2.84:1

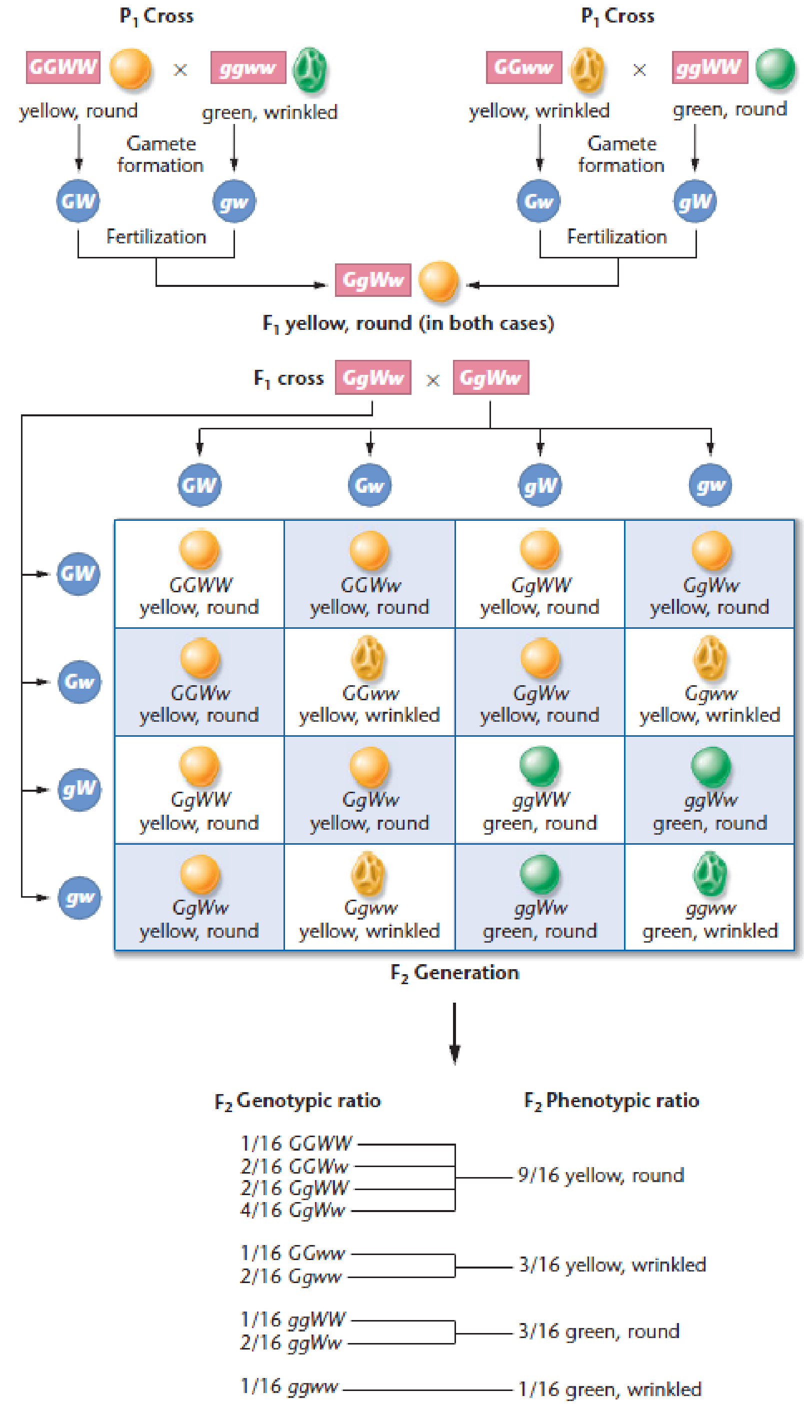


From these, Mendel concluded that:

- Each Phenotype (traits or morphological characters to which we can see) of an organism is governed by a specific Factor
- Each organism has 2 factors for each of traits (Factors = Allelles = Genes), one trait is dominant and other trait is recessive . Or it may be said that one factor Is dominant and other factor is recessive.
- The two factors segregates at the time of gamete formation

DIHYBRID CROSSES:

(The Law of segregation or Independent Assortment)



F_1 generation produced all round yellow seeds

F_2 generation produced :

9 round yellow
3 round green
3 wrinkled yellow
1 wrinkled green

Factors for different traits are inherited independently

MONOHYBRID CROSSES:

Conclusions/ Rules:

The principles of Dominance and Segregation

From these, Mendel concluded that:

- Each Phenotype (traits or morphological characters to which we can see) of an organism is governed by a specific Factor
- Each organism has 2 factors for each of traits (Factors = Allelles = Genes), one trait is dominant and other trait is recessive . Or it may be said that one factor Is dominant and other factor is recessive.

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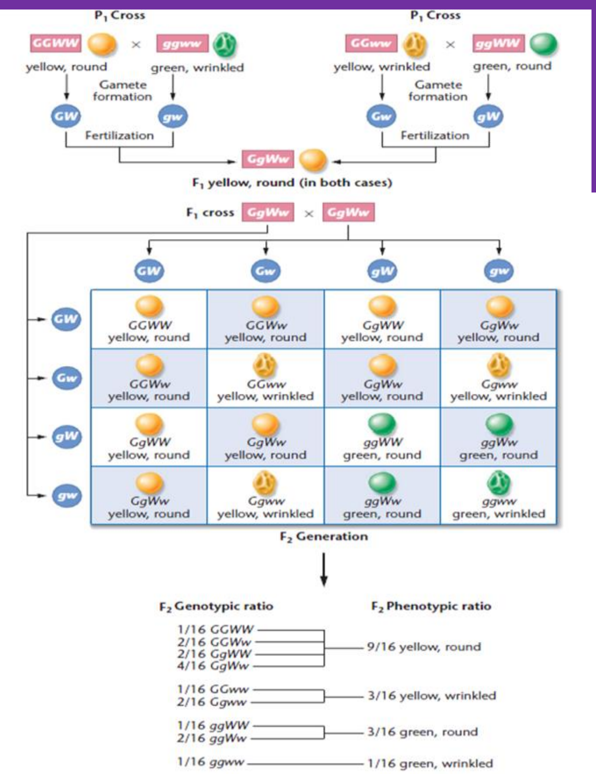
Flower position	axial/terminal	all axial	651 axial 207 terminal	3.14:1
Stem height	tall/dwarf	all tall	787 tall 277 dwarf	2.84:1

DIHYBRID CROSSES:



Conclusions/ Rules:

The Law of segregation or Independent Assortment

- The two dominant and recessive factors remains in a pair but segregates at the time of gamete formation

SECTION 3

PLANT STRUCTURE (MORPHOLOGY AND ANATOMY)

PLANT MORPHOLOGY

Study of external structure of a plant

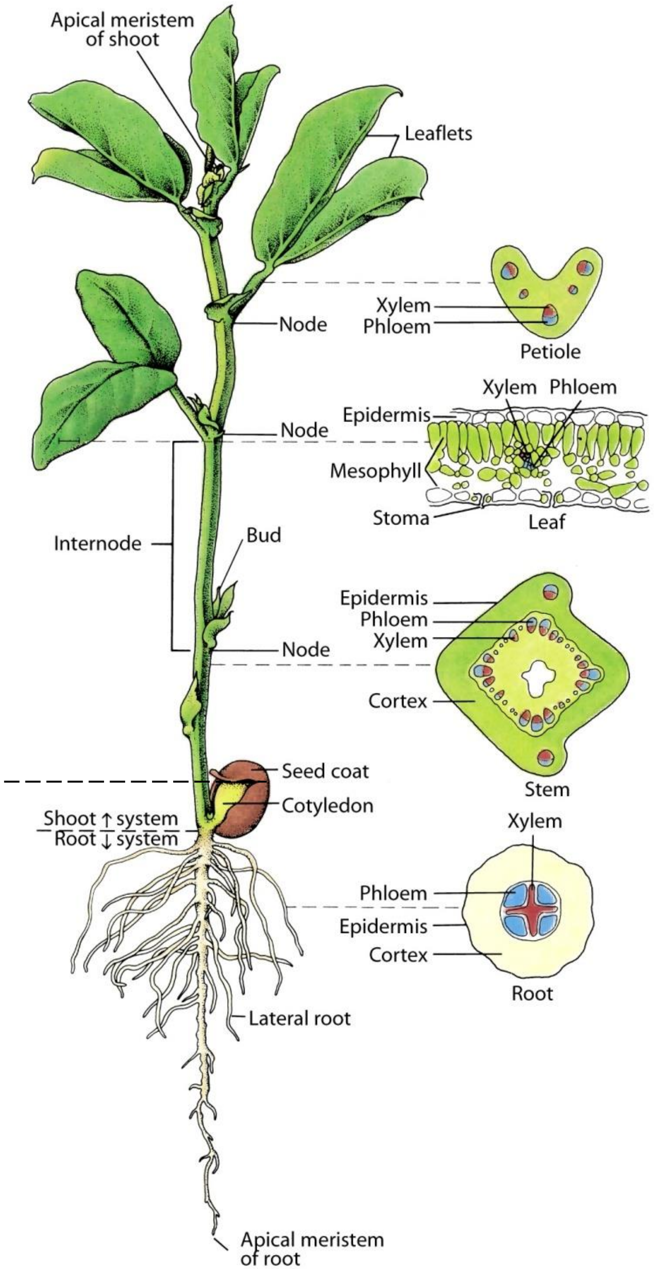
Plant Morphology

Shoot system

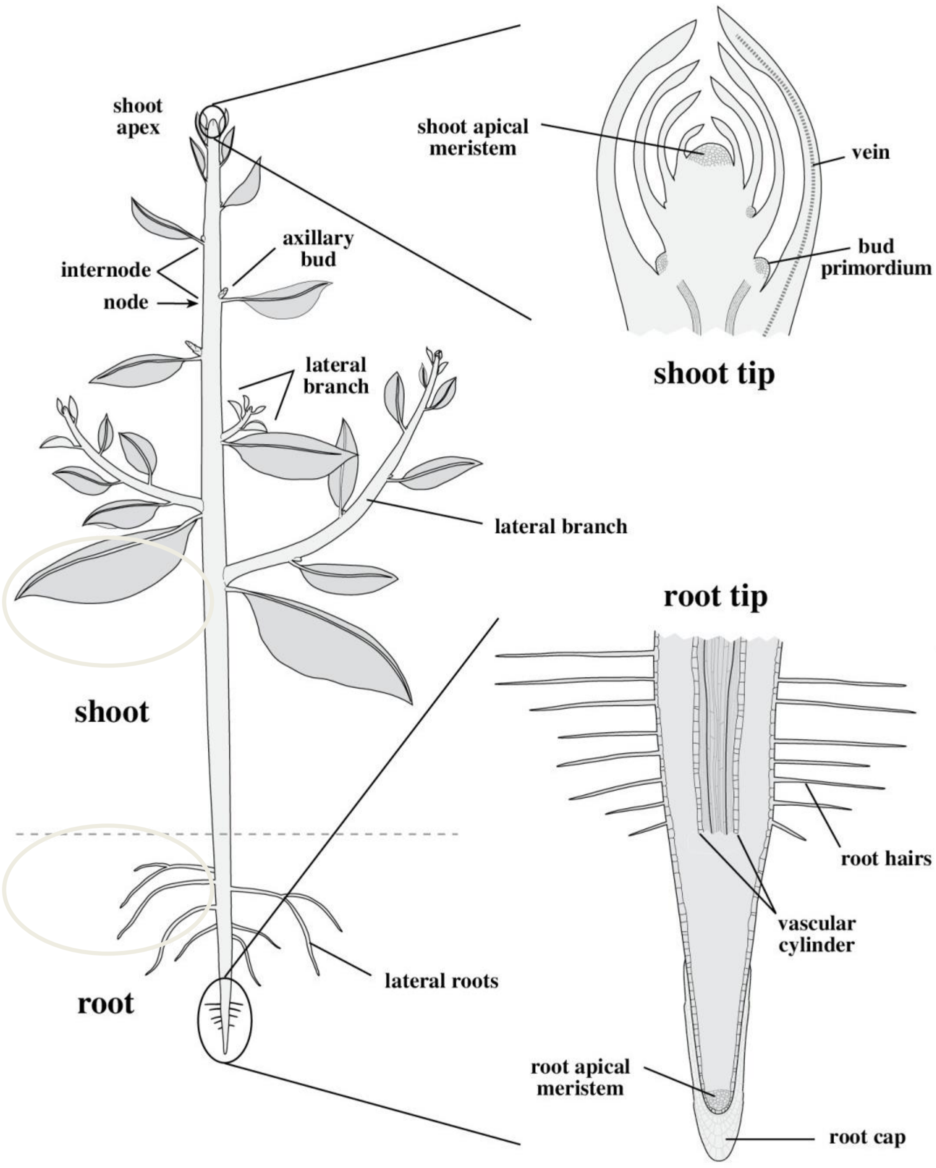
- **Stem**
  - Supports and places leaves
  - Transports H_2O and nutrients
- **Leaves**
  - Photosynthesis
- **Reproductive structures - Flowers**

Root system

- Anchors the plant
- Absorbs water and minerals
- Storage (CHO) & synthesis of some hormones
- Propagation



Root and Shoot Tips

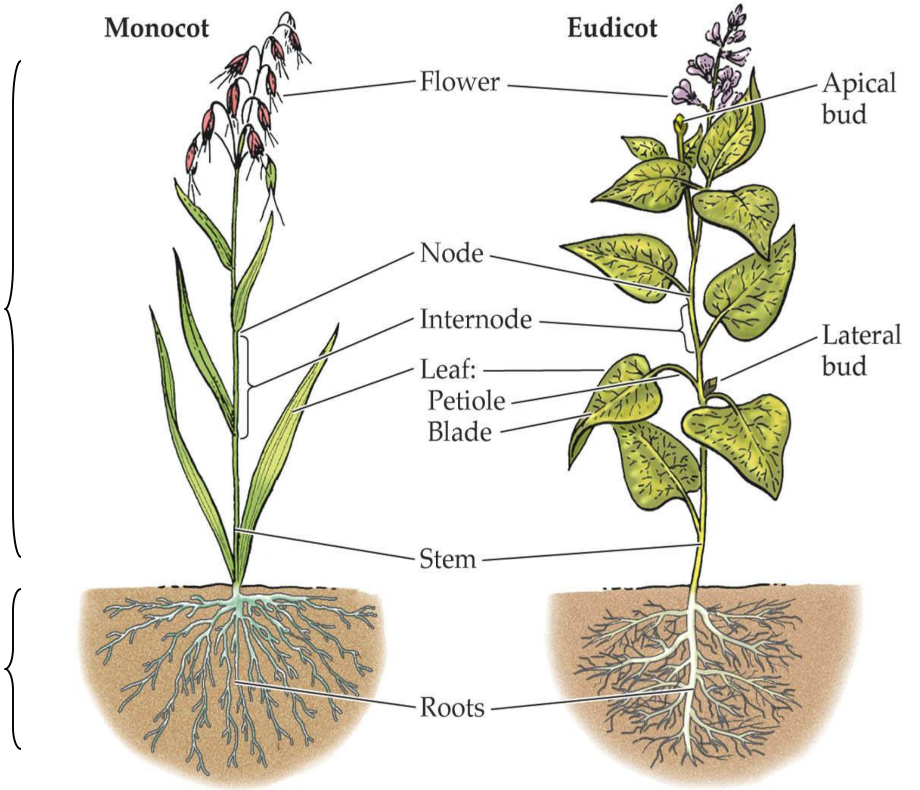


Dicots and Monocots plants

Flowering plants possess three kinds of vegetative (non-reproductive) organs:
Roots, Stems, and Leaves

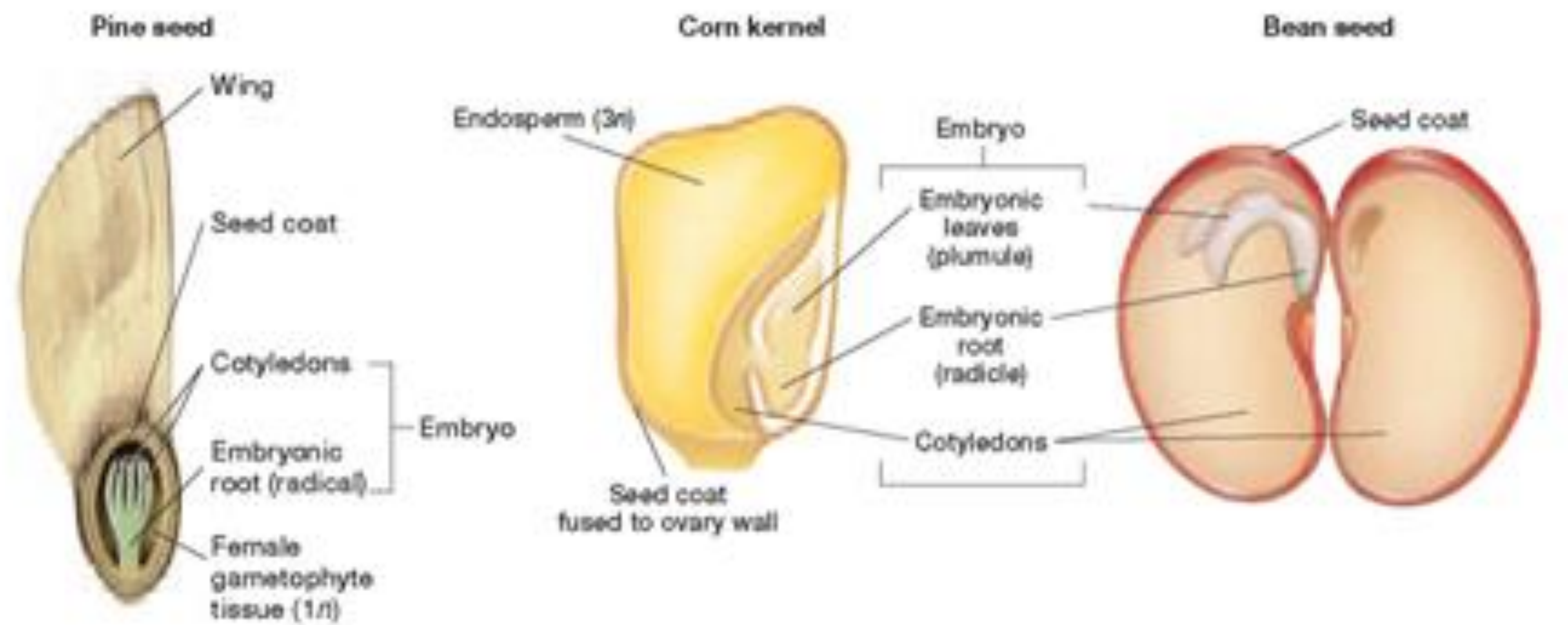
The flower is the reproductive organ of the Angiosperms.

- **Shoots system consist of Stems and leaves.**
- **Functions of Shoots system: Photosynthesis, Support, Reproduction, Storage and Transport**
- **Functions of Roots system: Anchorage, absorption of water and Minerals, provides nutrients for the shoot, storage for food**



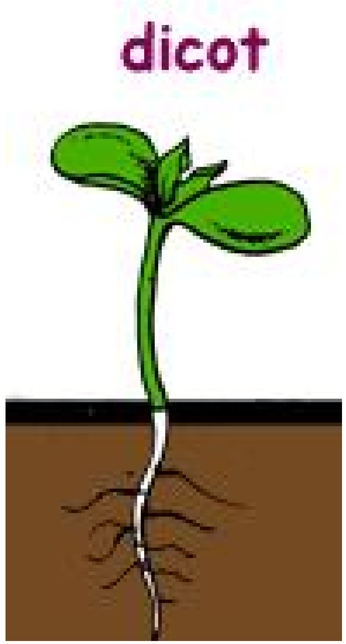
LIFE: THE SCIENCE OF BIOLOGY, Seventh Edition, Figure 35.2 Vegetative Organs and Systems

Seed Structure



- A seed is a sporophyte embryo with its own food supply in a protective coat
- Seed plants (gymnosperms and angiosperms) retain their spores

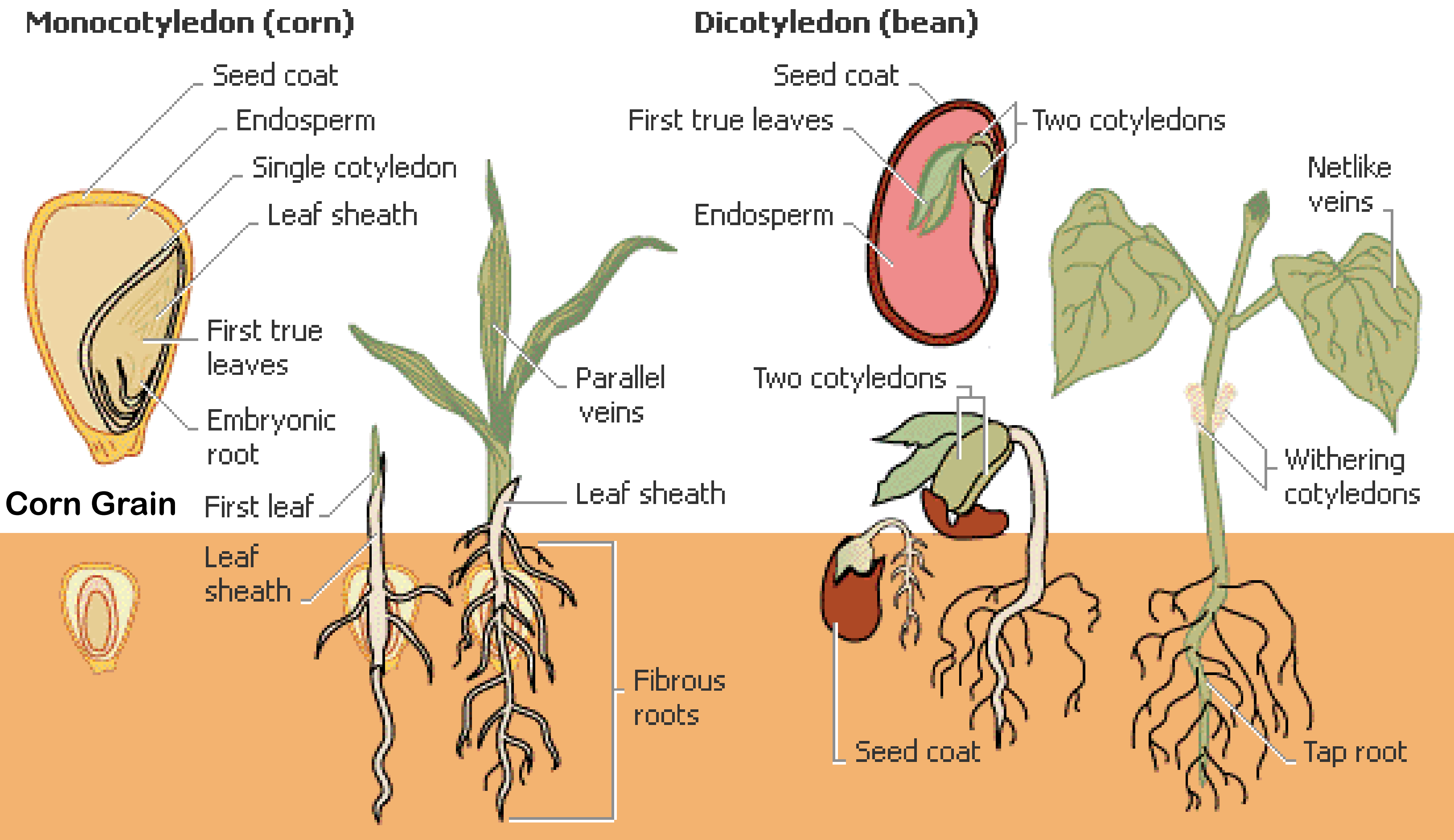
Plant Seedling



– **Monocotyledons (Monocots)-** have a single seed leaf

- **Dicotyledons (Dicots)- have double seed leaves**

Seed Germination



Roots

Function - absorption, anchorage

Structure – root cap, root hairs, endodermis

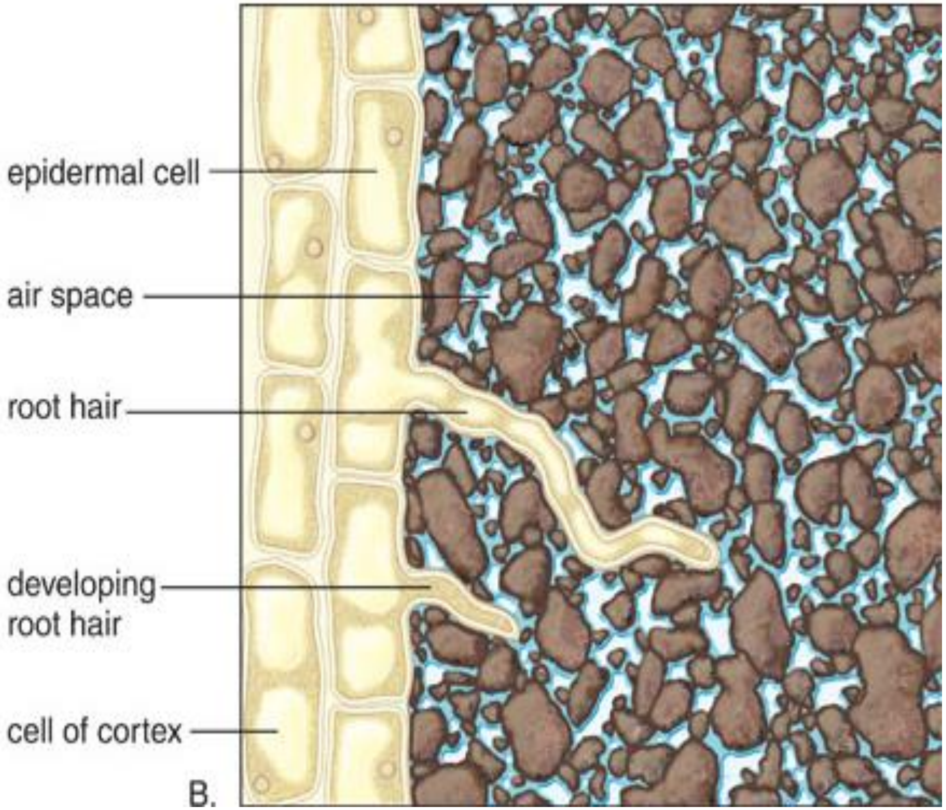
Adventitious roots - A root growing from a location other than the underground rootsas from a stem or leaf

Lateral roots - arise from another root (1˚, 2˚, etc.)

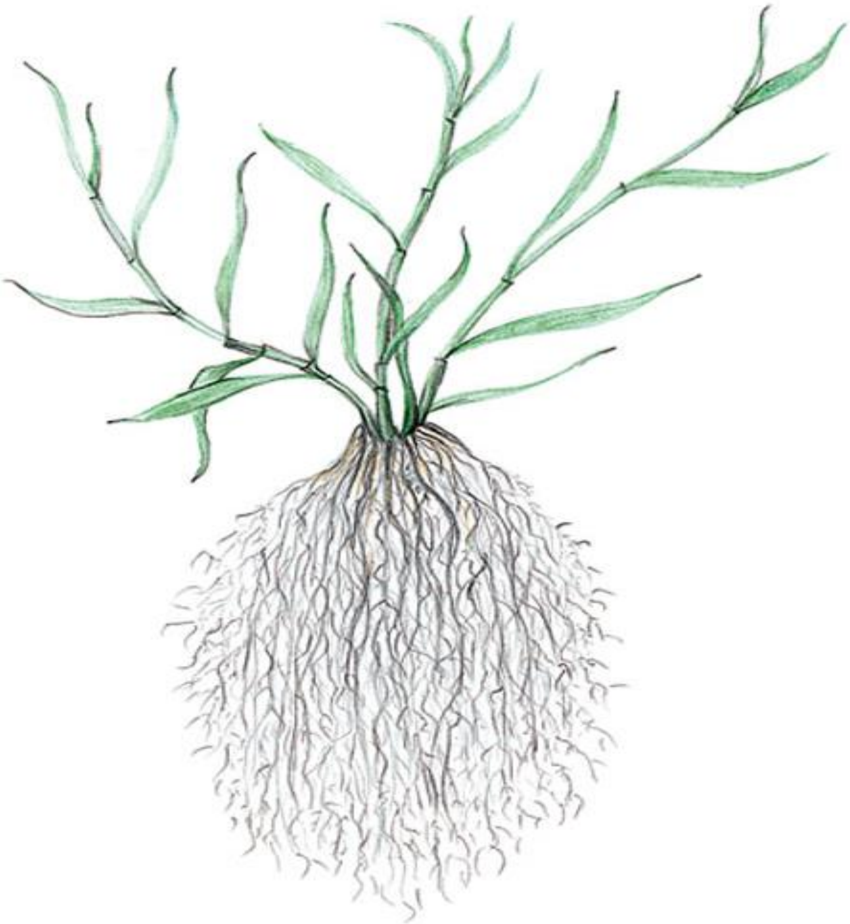
Roots: Specialized for H_2O and Nutrient Absorption

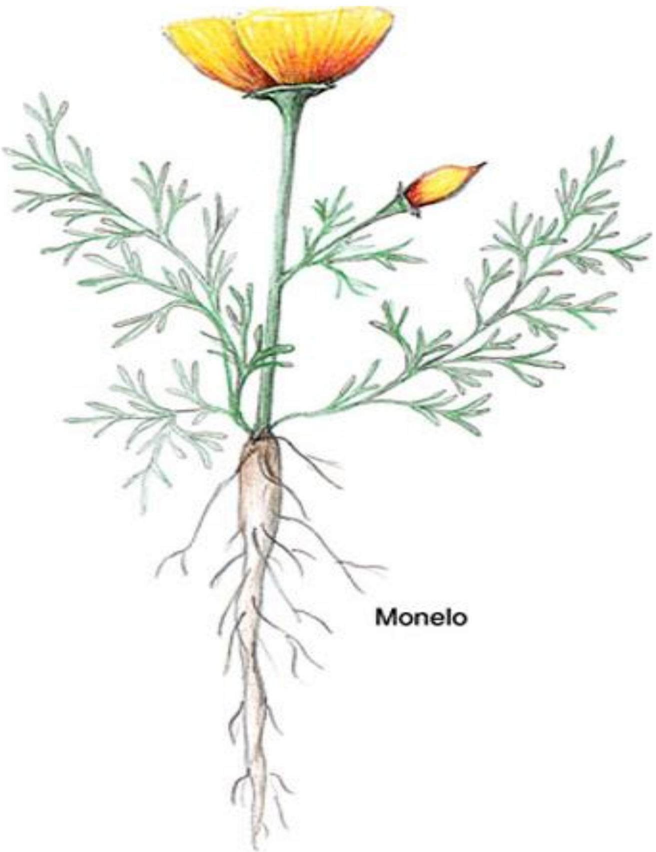
A.

B.



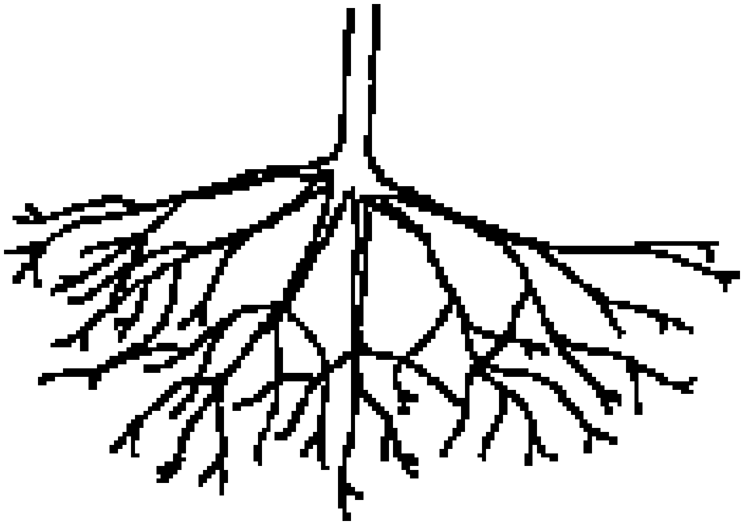
Root Types: Adventitious & Tap Root System





Fibrous Root System

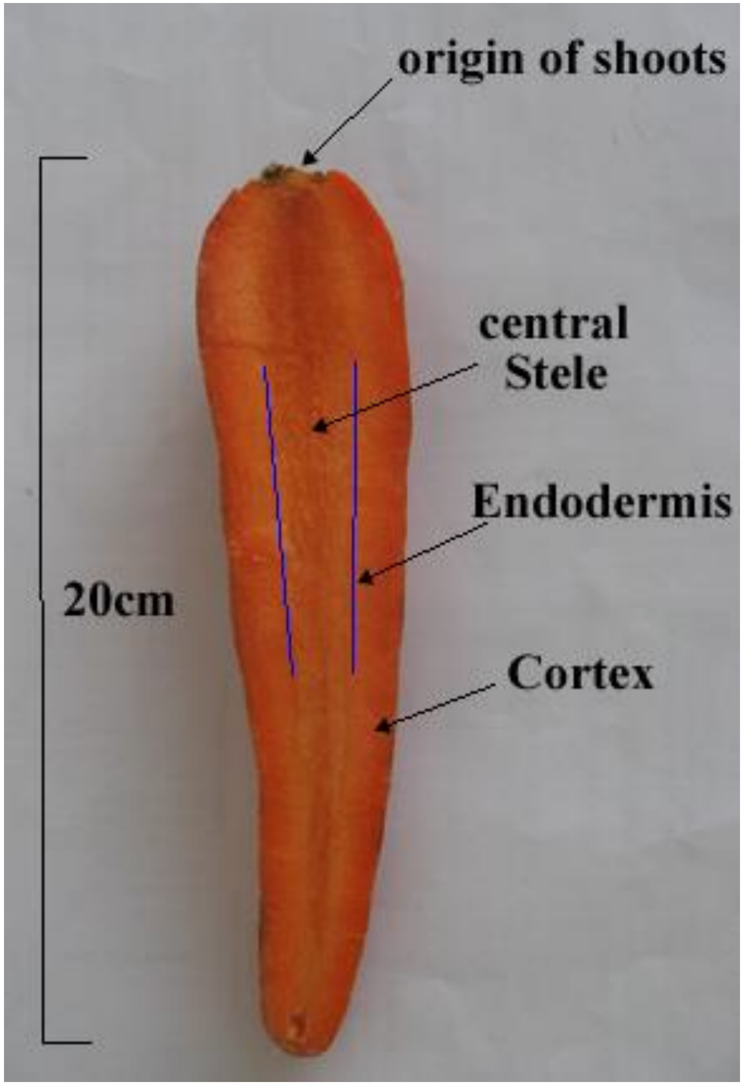
- Develops when the secondary roots become the main roots.
- Shallow roots but spread over a broad area.
- Helps prevent erosion.



FIBROUS

Tap Root System

- Develops from the primary root.
- Reaches deep into the ground
- Helps the plant during periods of drought.

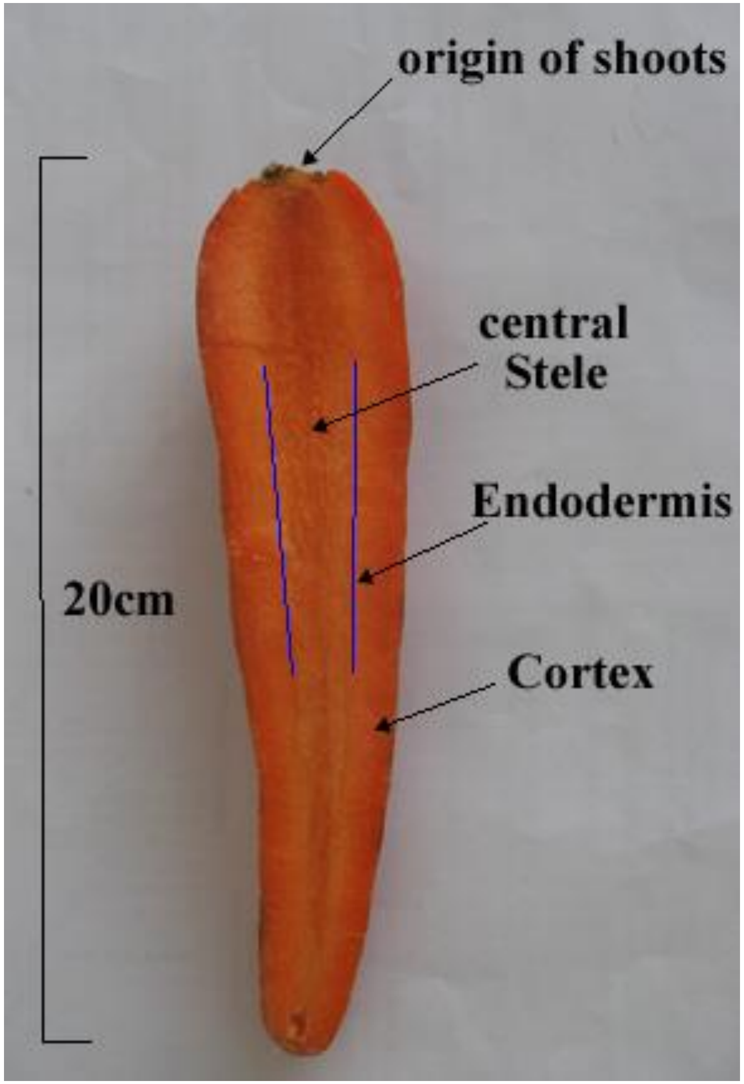


Root Modifications:
Storage Roots

Storage roots
Raphanus sativus, Radish

Storage roots, Sweet potato

Carrot: Tap Root modification



- Function: Storage of water.
- Carrot plants are often associated with very sandy soils.
- The root modification allows the storage of water in the cortex and central stele.
- The mass of the root stabilizes the plant in the loose sandy soils.

Buttress Roots

Buttress roots, Rusty-leaved fig

Respiratory roots

Pneumatophores (respiratory roots)
Avicennia marina, black mangrove

Prop roots

Prop roots (also adventitious)

Haustoria – Parasitic Roots

Root Adaptations ……??


(a)

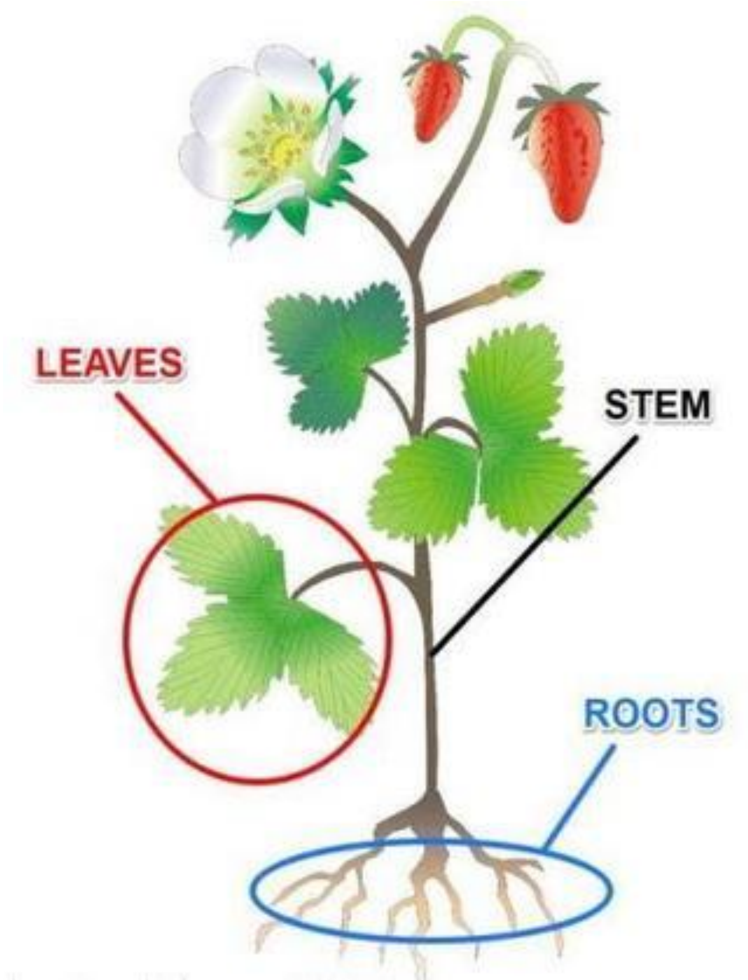

(b)


(c)


(d)


(e)

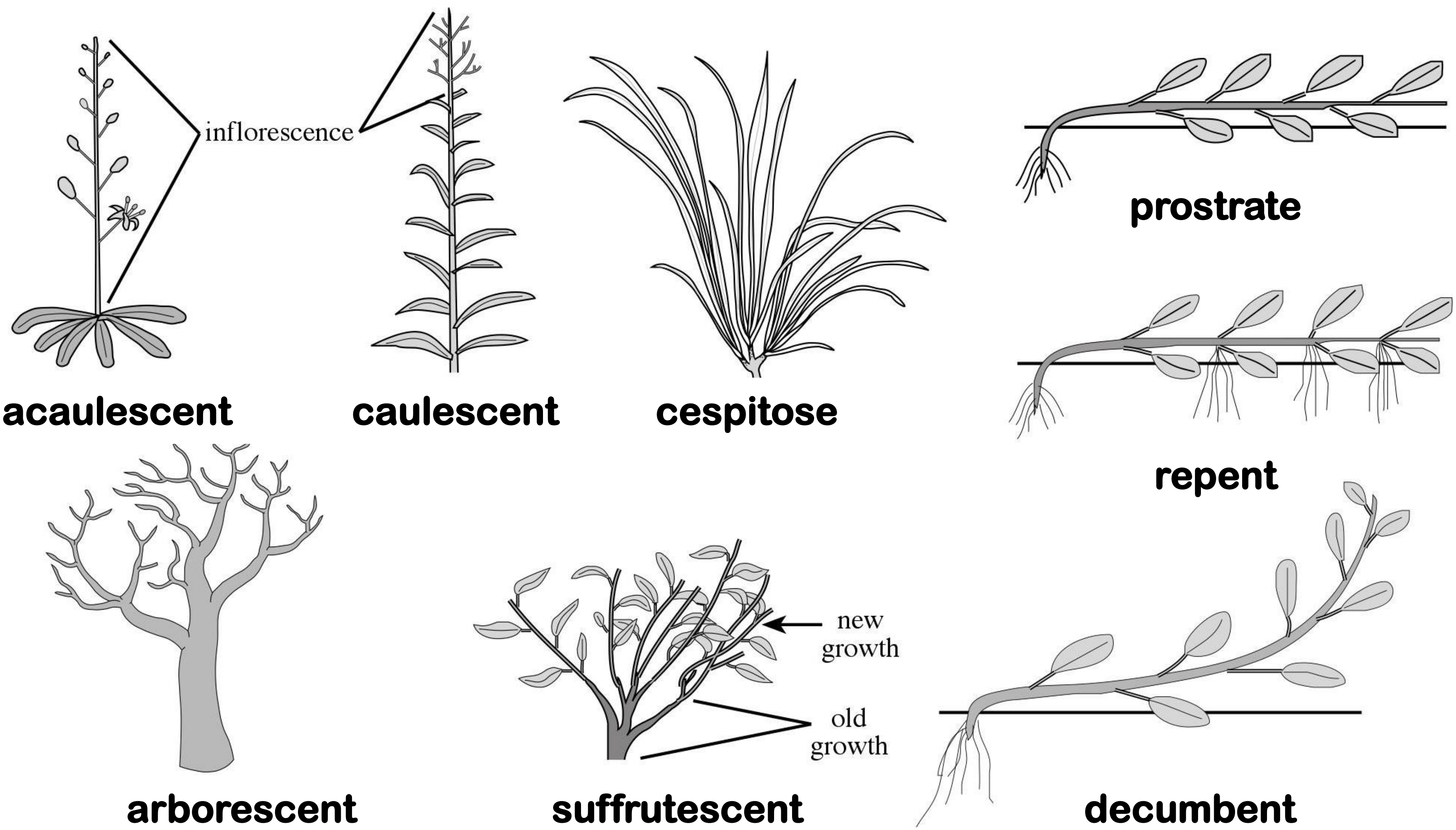
Shoot system (Stem + Associated Leaves)



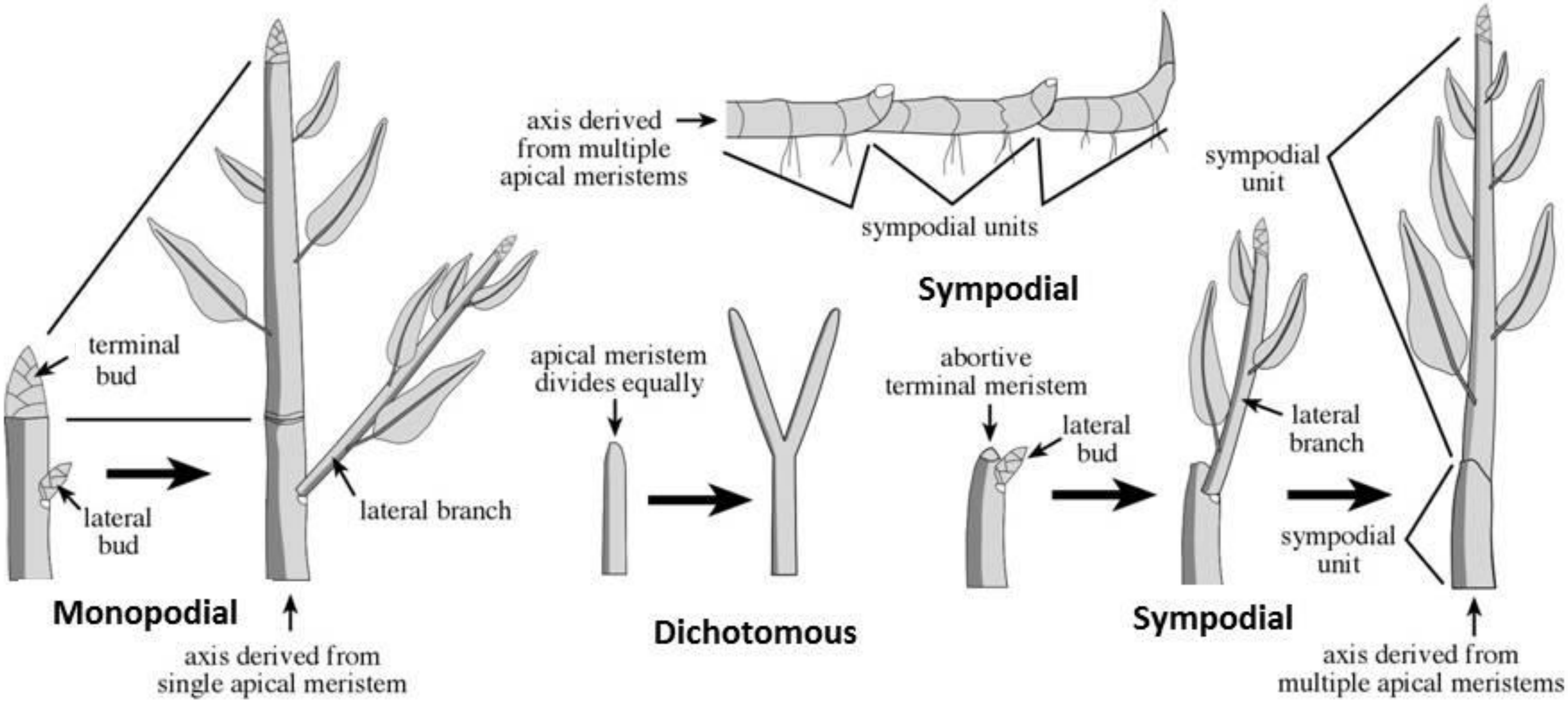
Functions:

- **Support for and the elevation of leaves, flowers and fruits.**
- **The stems keep the leaves in the light and provide a place for the plant to keep its flowers and fruits.**
- **Transport of fluids between the roots and the shoots in the xylem and phloem**

Stem Habit
= Relative position of stem (+ growth, structure)



Stem Branching

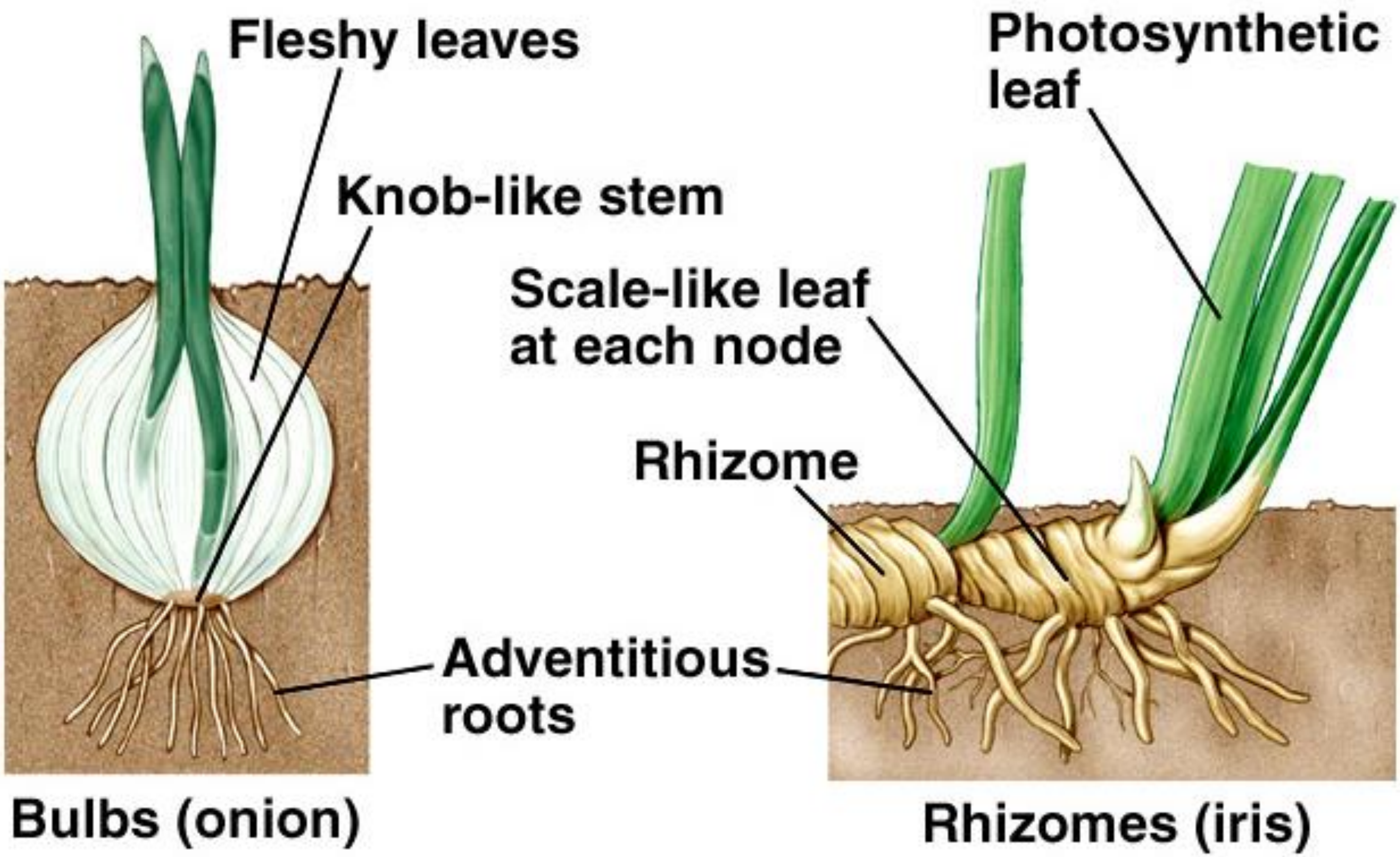


Apical Dominance

Apical dominance is the phenomenon whereby the main, central stem of the plant grows more than other side stems.

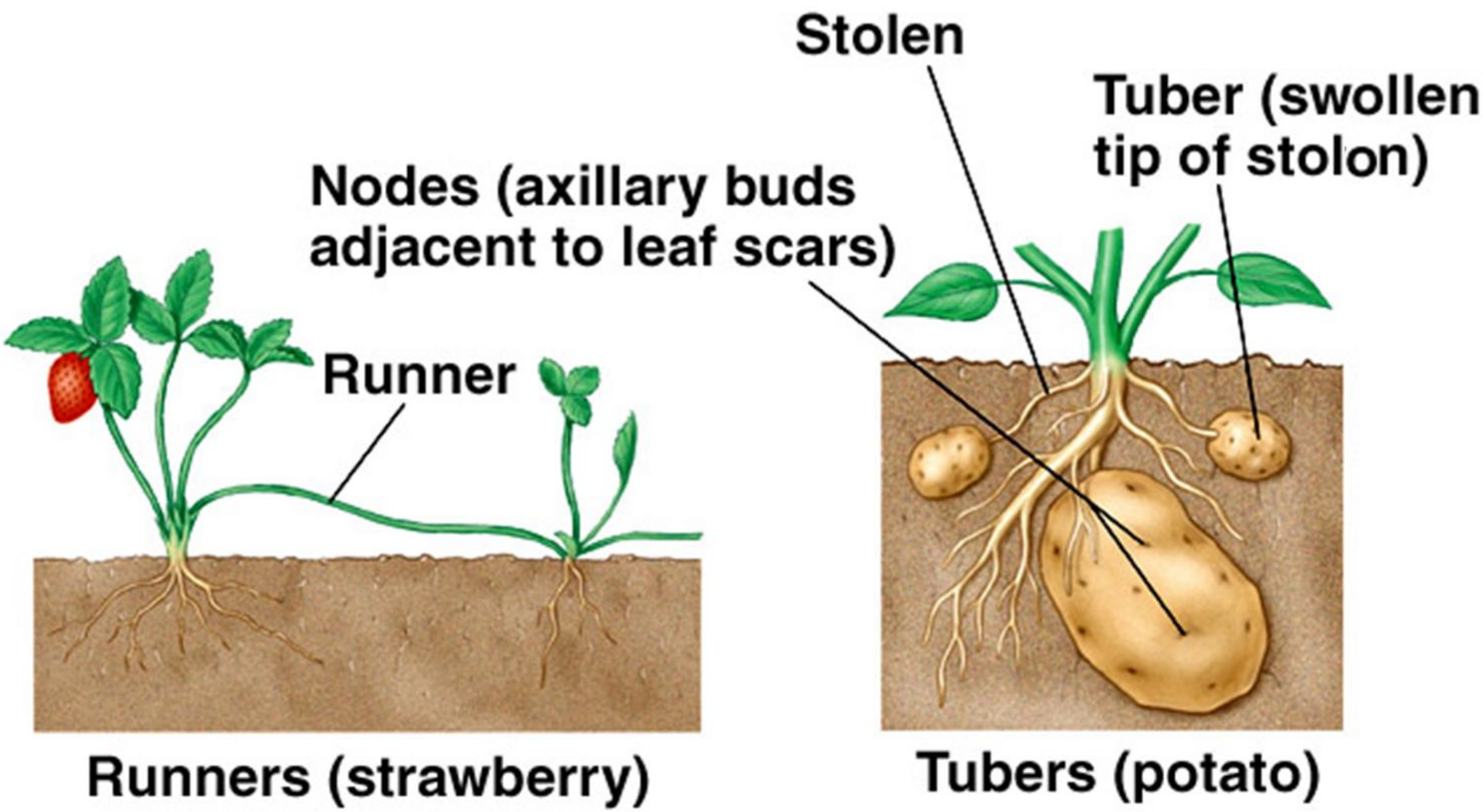
Stem (Shoot)
Types and Modifications

Types of Modified Stems (1)



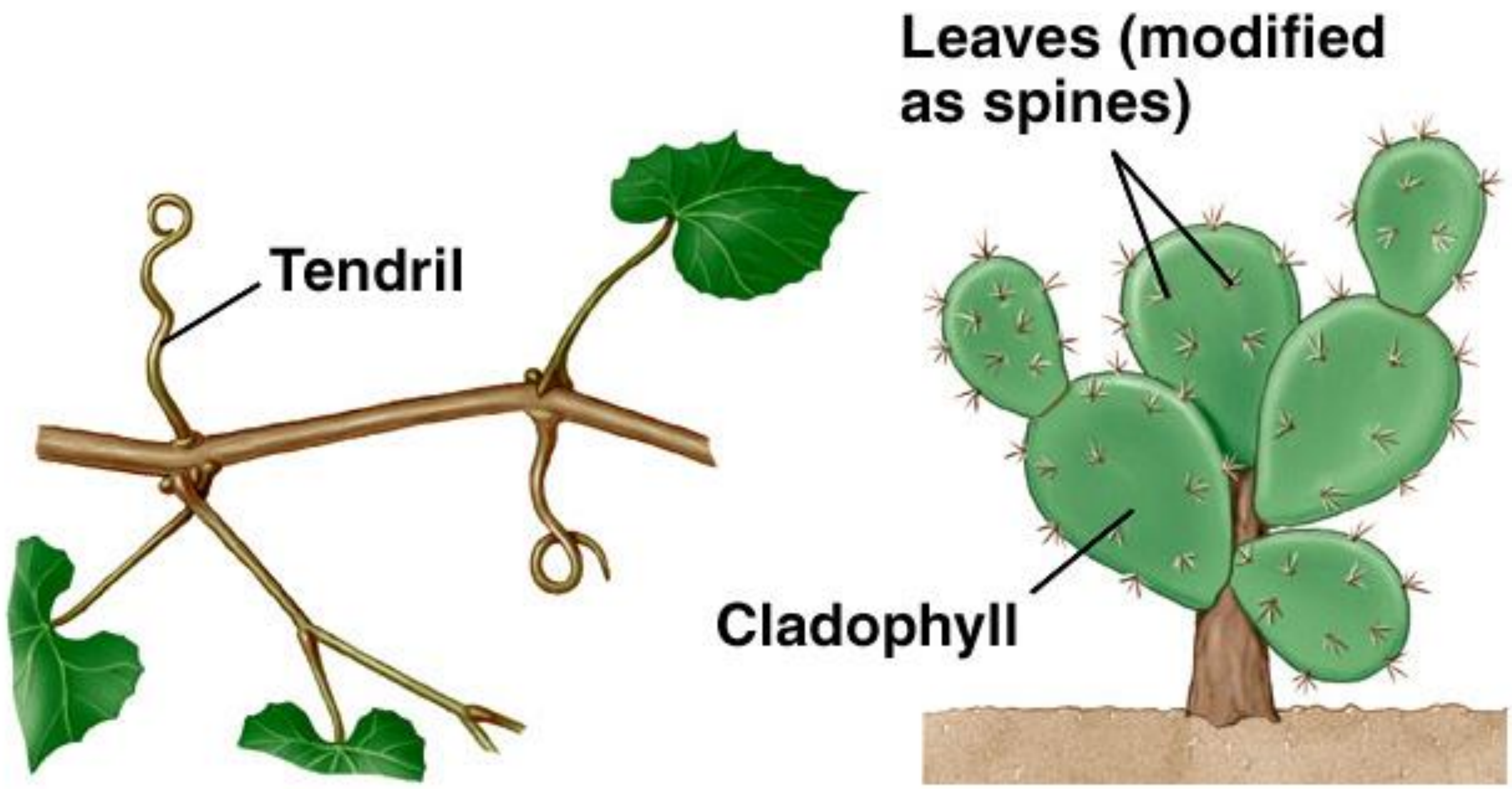
Stem (Shoot)
Types and Modifications

Types of Modified Stems (2)



Stem (Shoot)
Types and Modifications

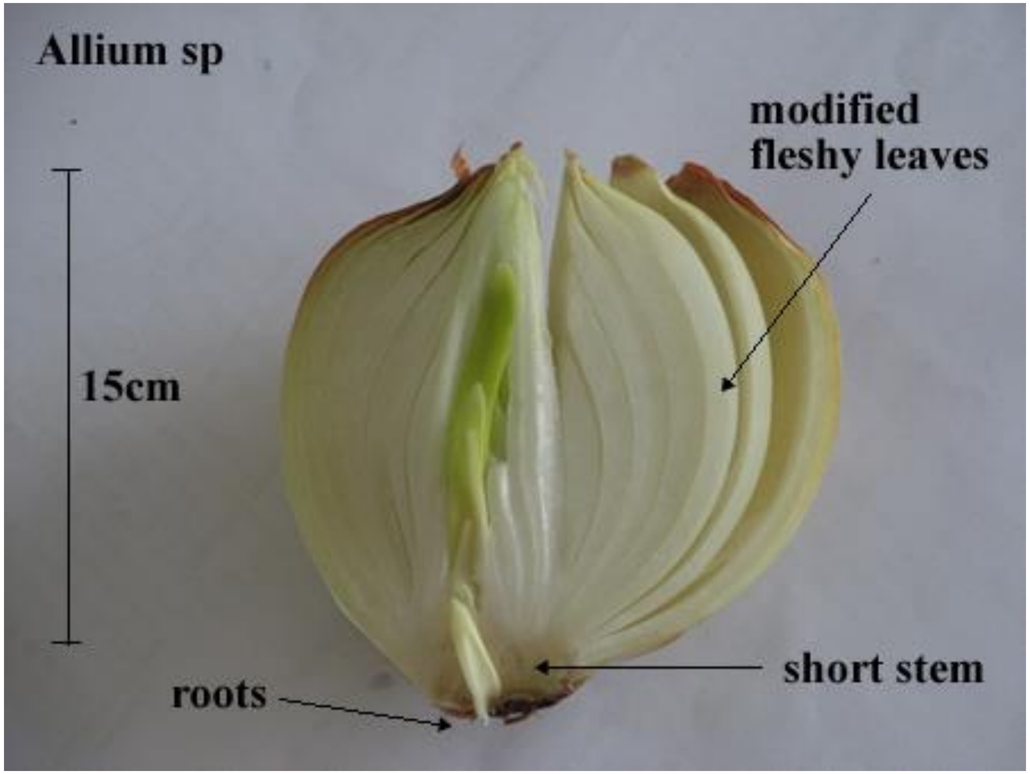
Types of Modified Stems (3)



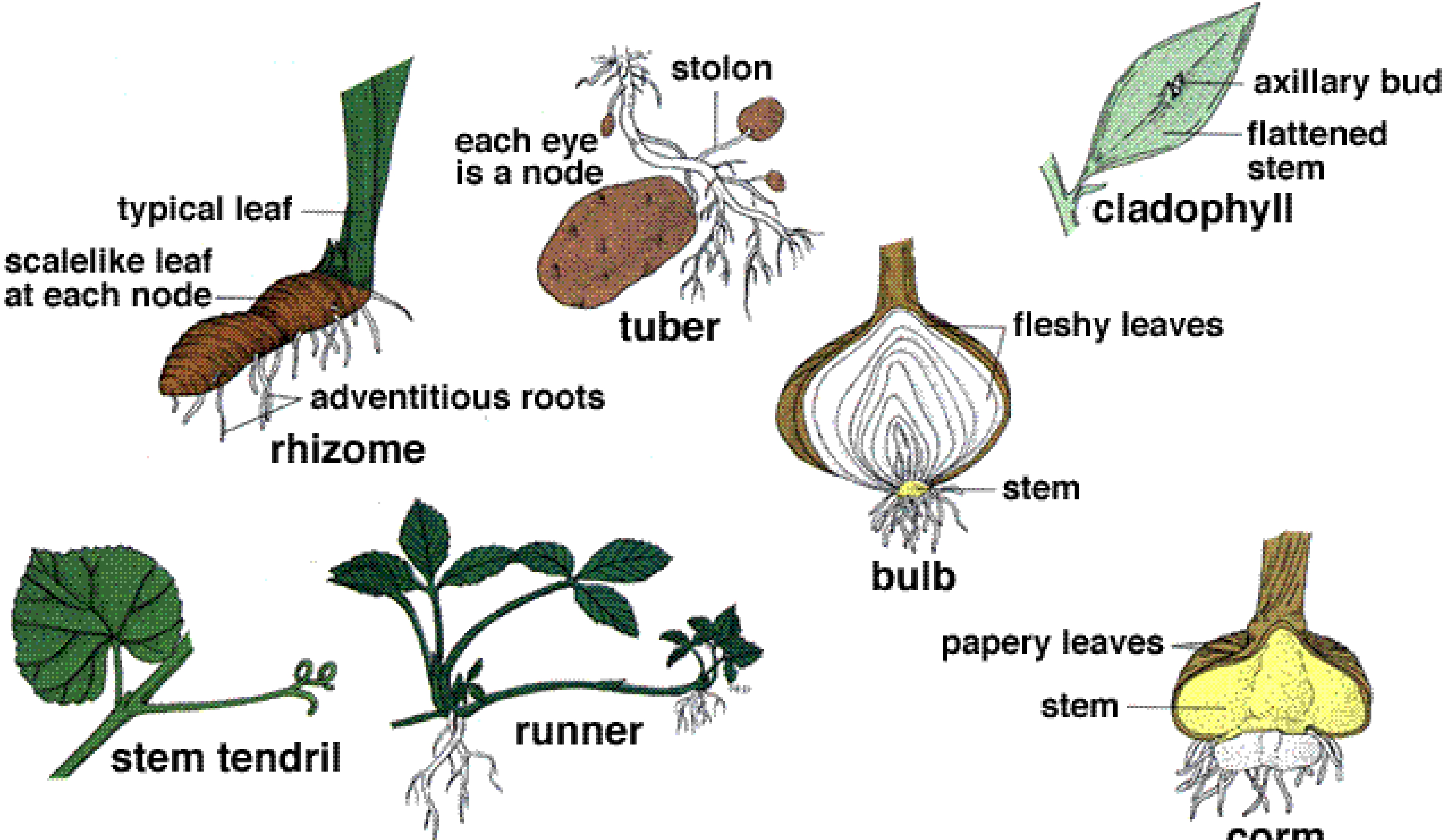
Tendrils (grape)

Cladophylls
(prickly pear)

Onion Bulb



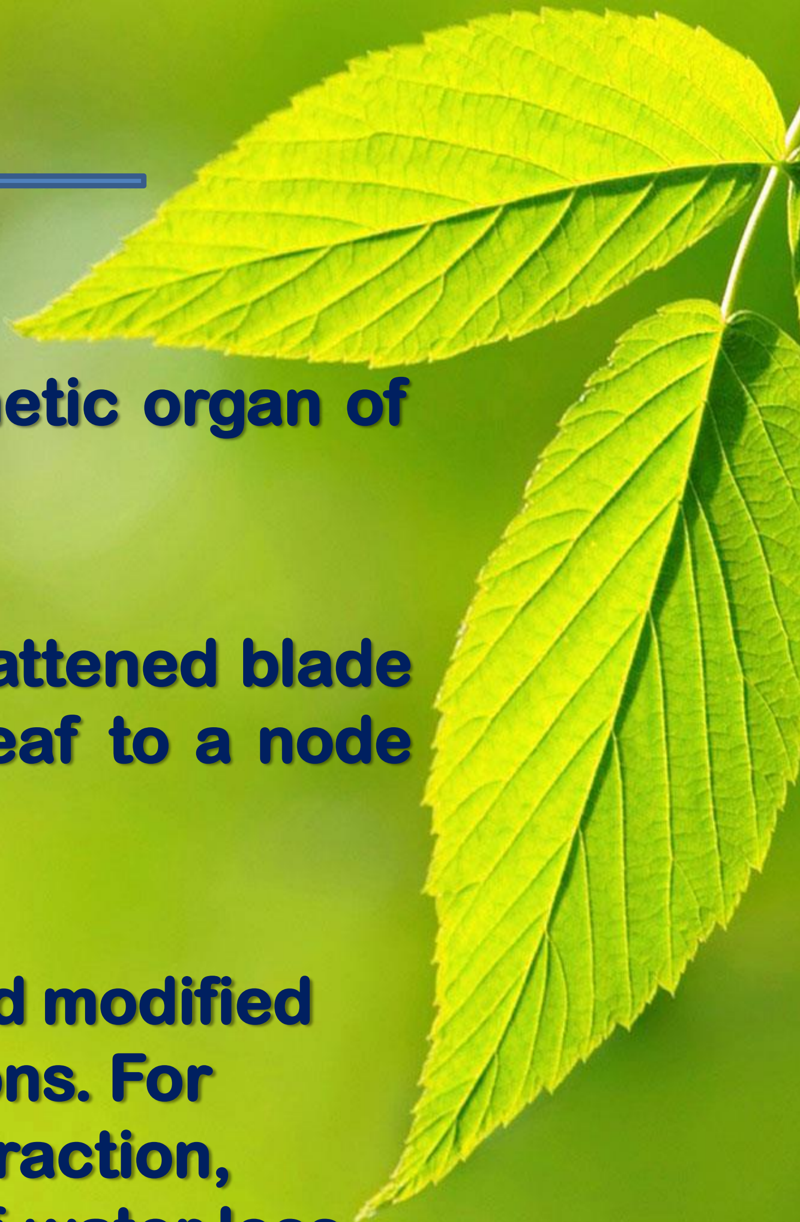
Types of Specialized Stems




LEAVES

LEAVES

Leaves



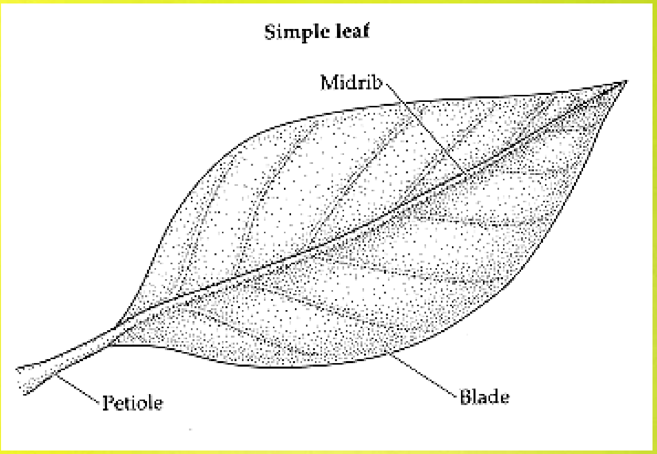
- The leaf is the main photosynthetic organ of most vascular plants

- Leaves generally consist of a flattened blade and a petiole, which joins the leaf to a node of the stem

- Some plant species have evolved modified leaves that serve various functions. For example: climbing, pollinator attraction, storage, digestion, prevention of water loss, etc.

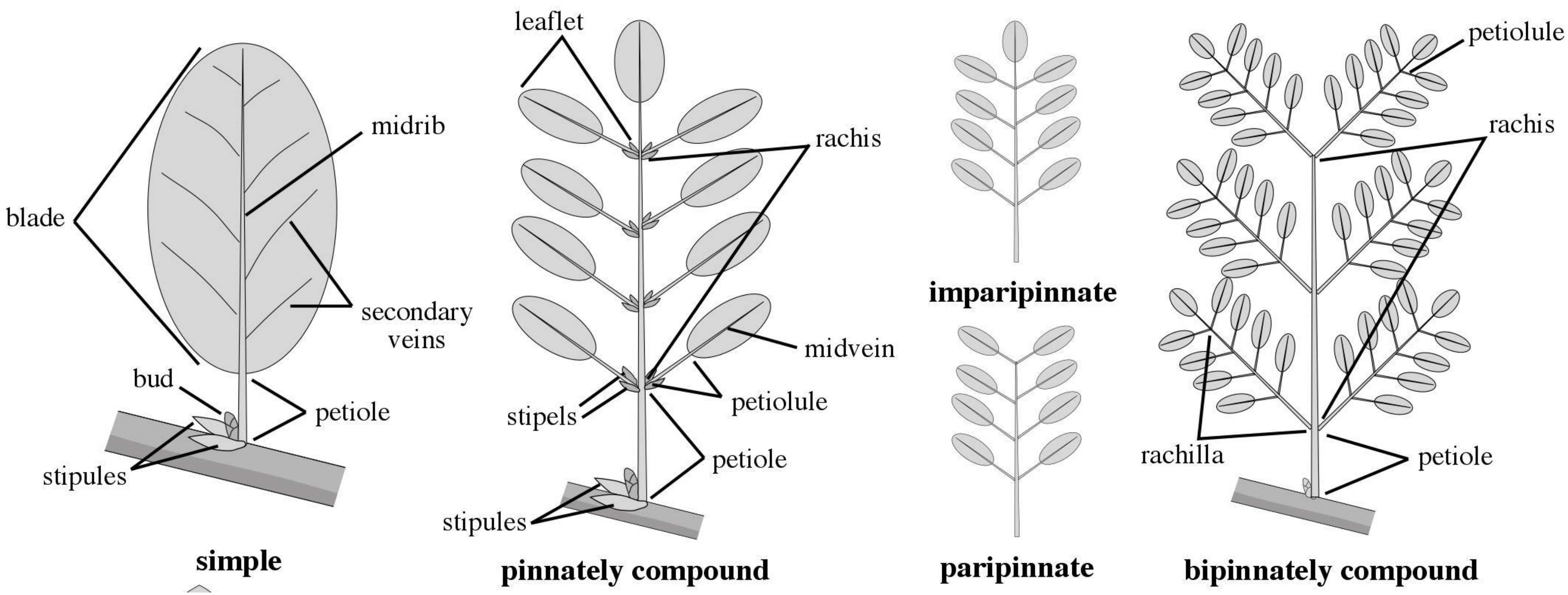
Leaves

External Parts of the Leaf:



- **<u>Petiole عنق</u>**
  - Leaf stalk or part that connects the leaf to the stem.
- **<u>Blade نصل</u>**
  - The large, flat part of a leaf.
- **<u>Midrib عرق وسطي</u>**
  - The large center vein.

Leaf Types

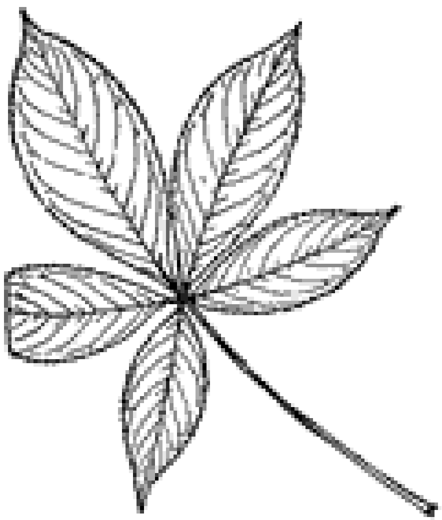


(a) Simple leaf. ورقة بسيطة A simple leaf is a single, undivided blade.

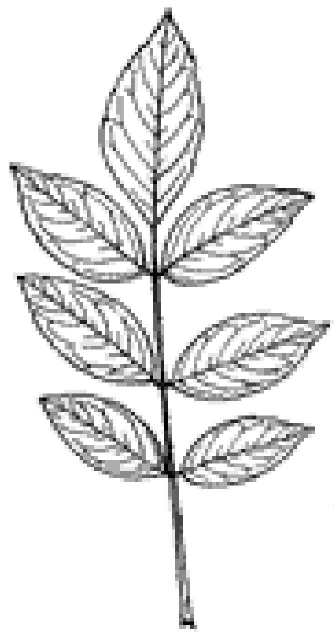
(b) Compound leaf (Pinnate). مركبة ريشية In a compound leaf, the blade consists of multiple leaflets. Note that a leaflet has no axillary bud at its base.

(c) Doubly compound leaf (Bipinnate). مركبة ريشية مزدوجة In a doubly compound leaf, each leaflet is divided into smaller leaflets.

Compound Leaves



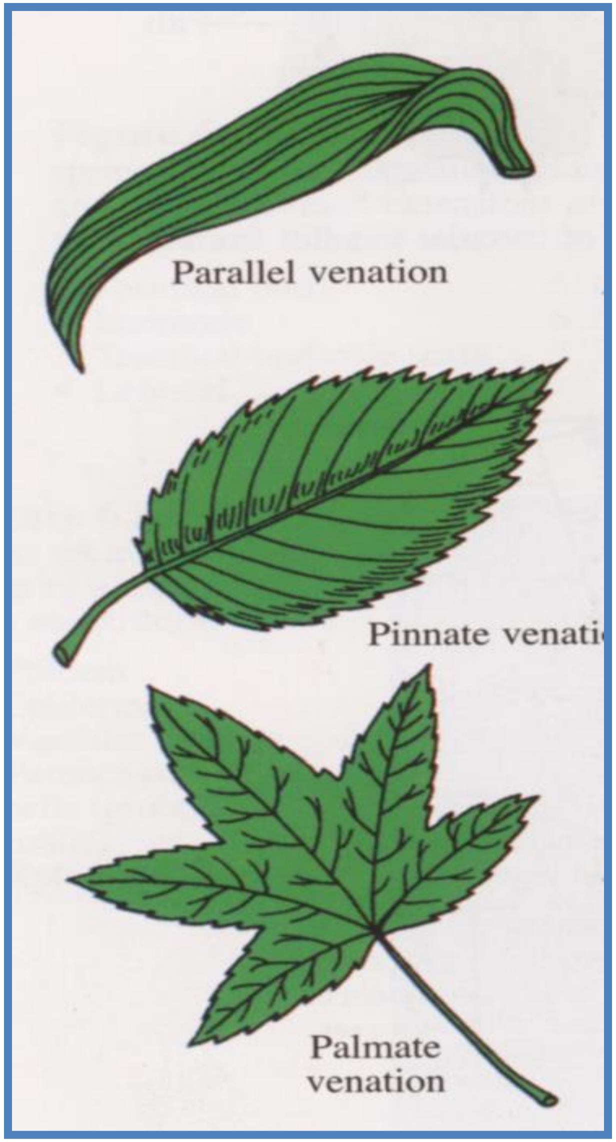
palmately compound



pinnately compound

Bi-Pinnately Compound Leaf

Leaf Venation



- **Parallel-** متوازي veins extend the entire length of the leaf with little or no cross-linking
- **Pinnate-** ريشي leaves have one major vein from which others branch
- **Palmate-** راحي leaves have several veins which branch

Dicot and Monocot Leaves

Reticulate
شبكي

Parallel
متوازي

Leaf Adaptations/ Modifications

Some plant species have evolved modified leaves to serve various functions.

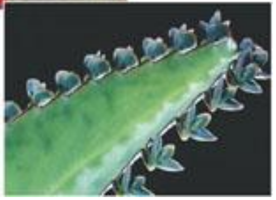
(a) **Tendrils.** The tendrils by which this pea plant clings to a support are modified leaves. After it has "lassoed" a support, a tendril forms a coil that brings the plant closer to the support. Tendrils are typically modified leaves, but some tendrils are modified stems, as in grapevines.

(b) **Spines.** The spines of cacti, such as this prickly pear, are actually leaves, and photosynthesis is carried out mainly by the fleshy green stems.

(c) **Storage leaves.** Most succulents, such as this ice plant, have leaves modified for storing water.

(d) **Bracts.** Red parts of the poinsettia are often mistaken for petals but are actually modified leaves called bracts that surround a group of flowers. Such brightly colored leaves attract pollinators.

(e) **Reproductive leaves.** The leaves of some succulents, such as *Kalanchoe daigremontiana,* produce adventitious plantlets, which fall off the leaf and take root in the soil.



Leaf Adaptations/ Modifications

Some plant species have evolved modified leaves to serve various functions.

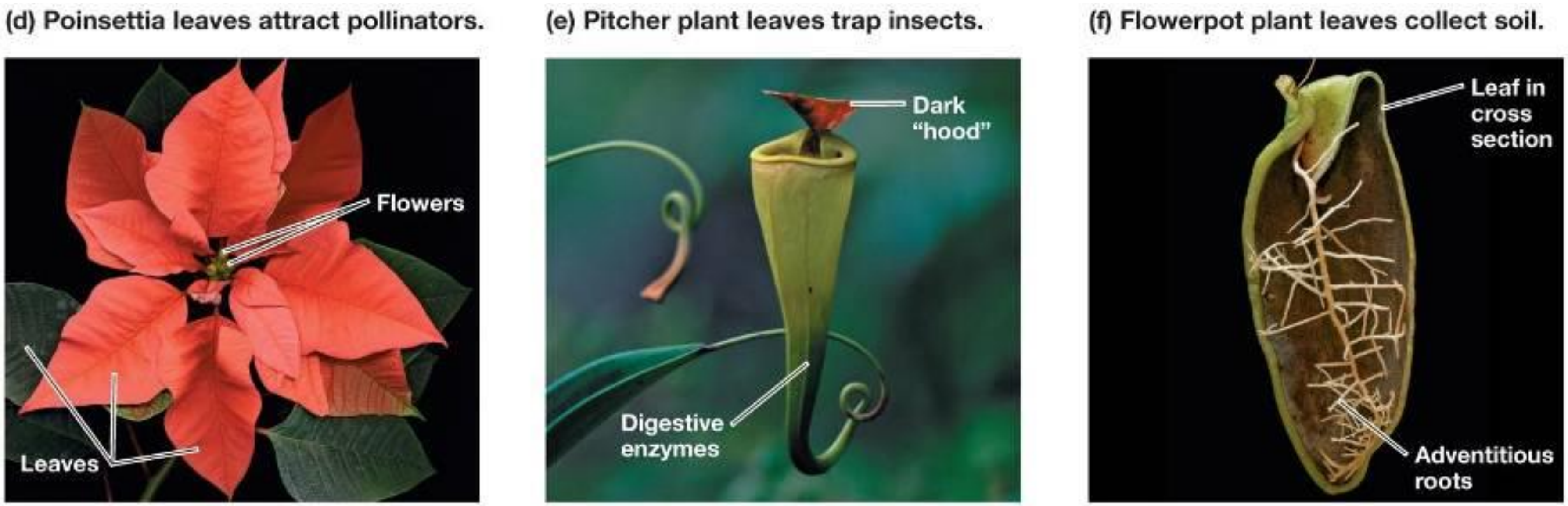
Tendril

Spiny leaf- Cacti spines

Succulent leaves

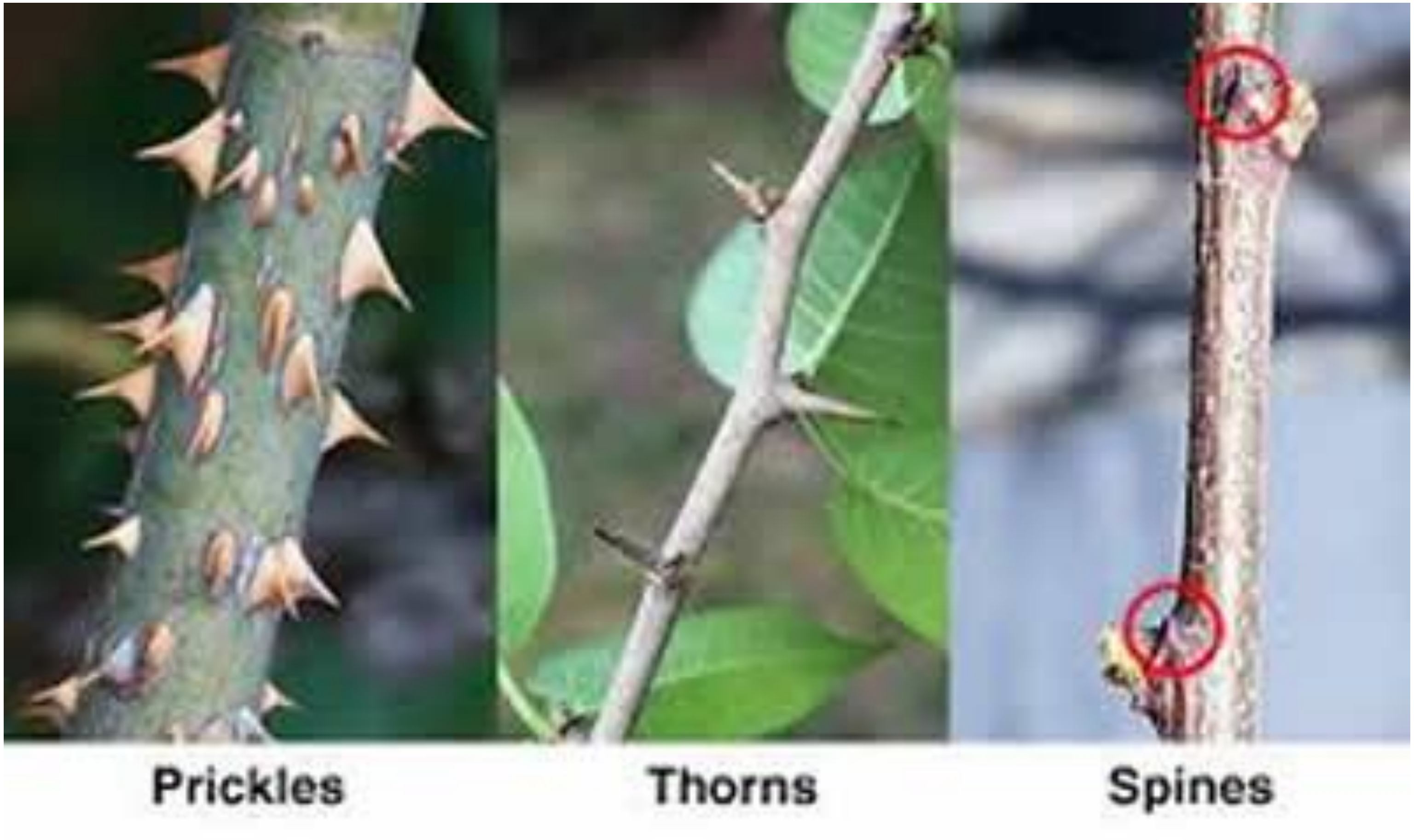
Brightly-colored leaves- to attract pollinators

Leaf Modifications



Modified into Sharp structure for protection

- **Thorn – Hard, long, sharp-pointed**
- **Spine - Hard, rigid extensions of leaves**
- **Prickle – Hard, sharp pointed**



Tentacular Leaf

A leaf bearing numerous, sticky, glandular hairs or bristles that function in capturing and digesting small animals, e.g. Drosera

Tentacular Leaf - *Drosera* spp (Droseraceae)

Carnivorus plants

- **Insect-Trapping Leaves in areas with low soil Nitrogen**
- **Insect digested by enzymes to release Nitrogen from proteins**

Trap Leaf of *Dionaea muscipula* capturing fly

Leaf modification

(Pitcher plant leaf)

Modification of leaves:

Reproductive Leaves - development of a new plants at tip of the leaf.

Sun and Shade Leaves

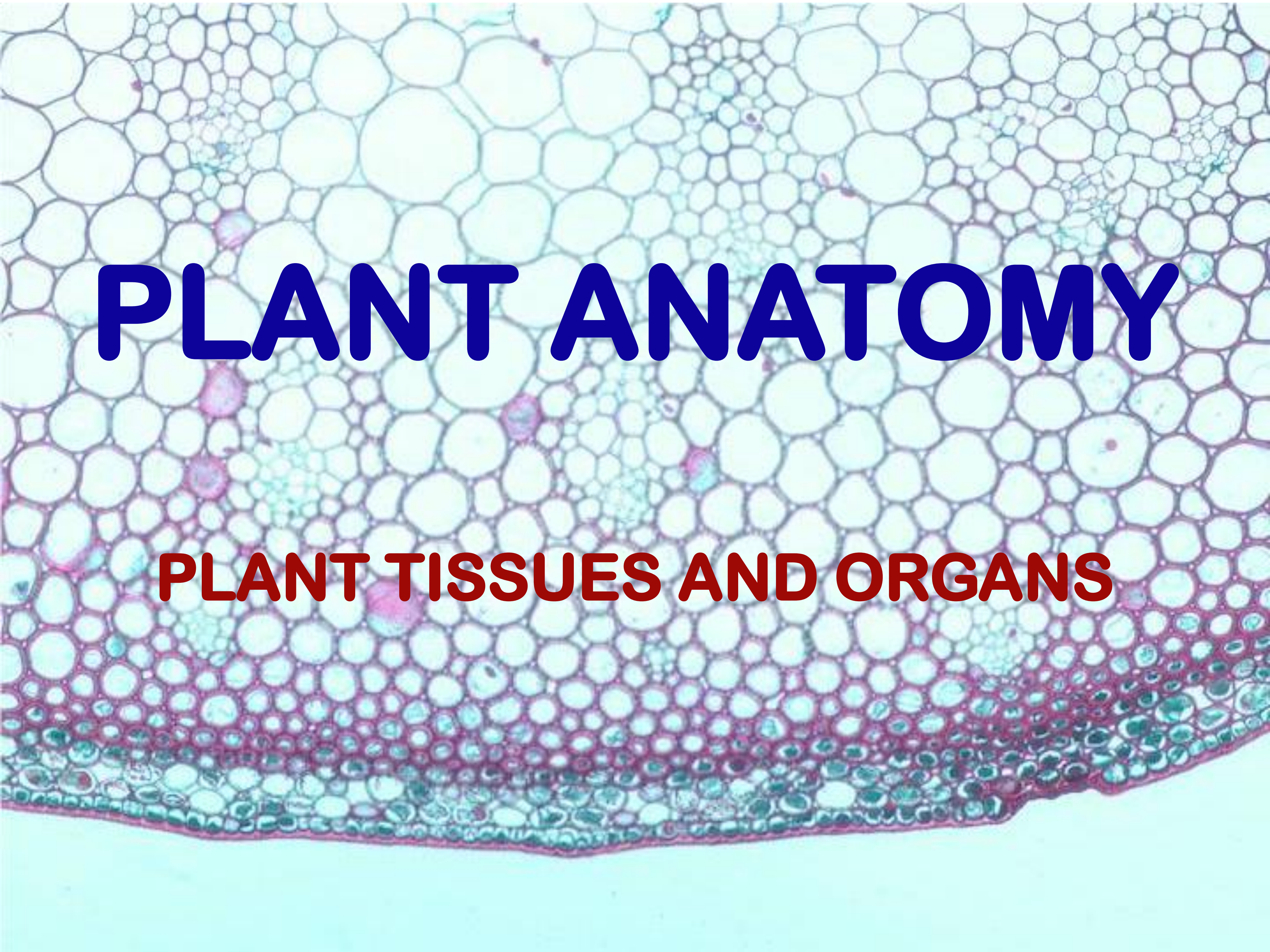
Shade Leaves　　　　Sun Leaves

Grown in shade　　Grown in sun

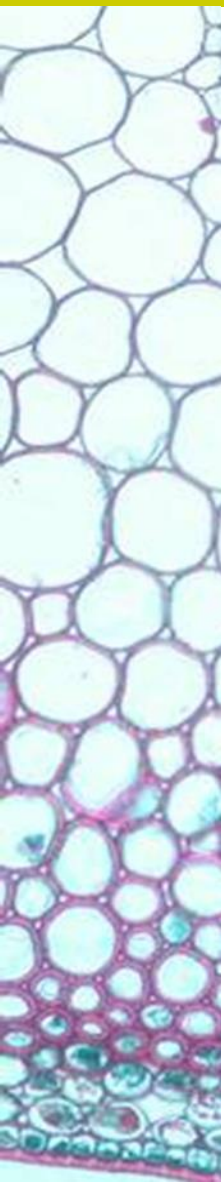
Continue…….

PLANT ANATOMY

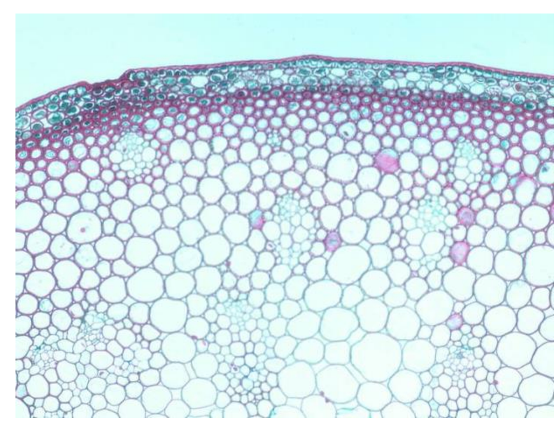
PLANT TISSUES AND ORGANS



PLANT ANATOMY
(Study of internal structure of plant)

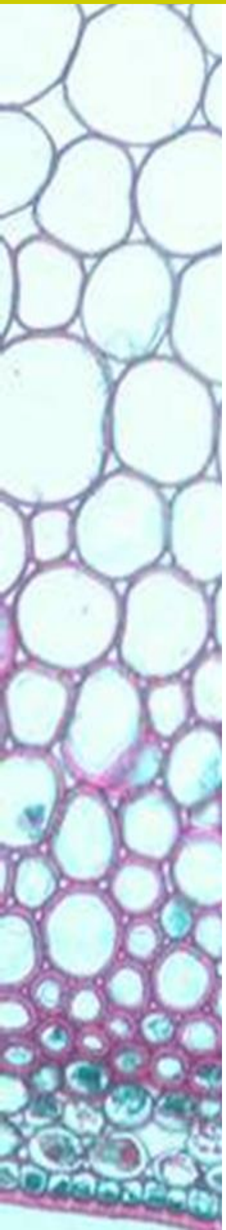


L.S ----Longitudinal section .
T.S ------ Transverse section .



Plant Tissue

(Group of cells having similar structure and function is called as tissue)

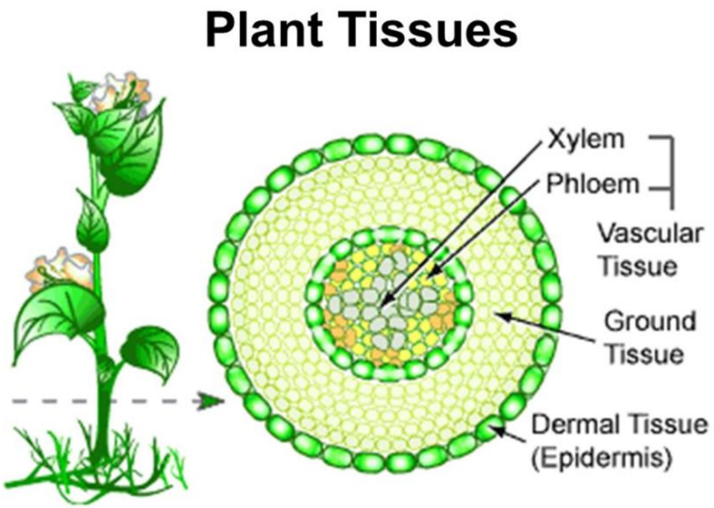


Tissue Systems

There are four plant tissue systems:

1. Ground tissue system :

-Parenchyma tissue
-Collenchyma tissue
-Sclerenchyma tissue



2. Vascular tissue includes:

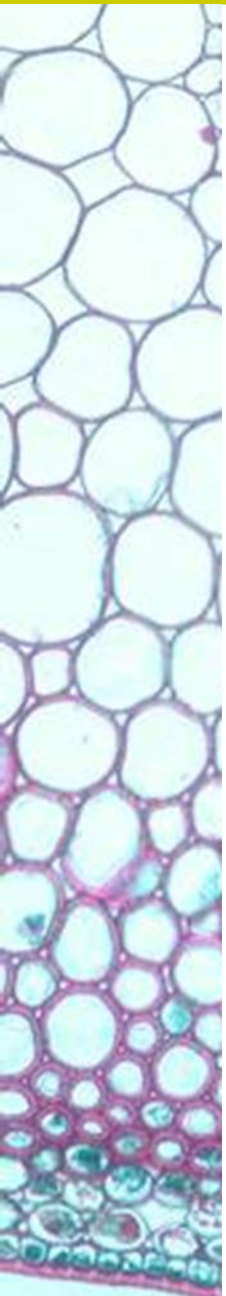
-Xylem tissue
-Phloem tissue

3. Dermal tissue:

-Epidermis

4. Meristematic tissue: (dividing tissue)

Types of plant tissues



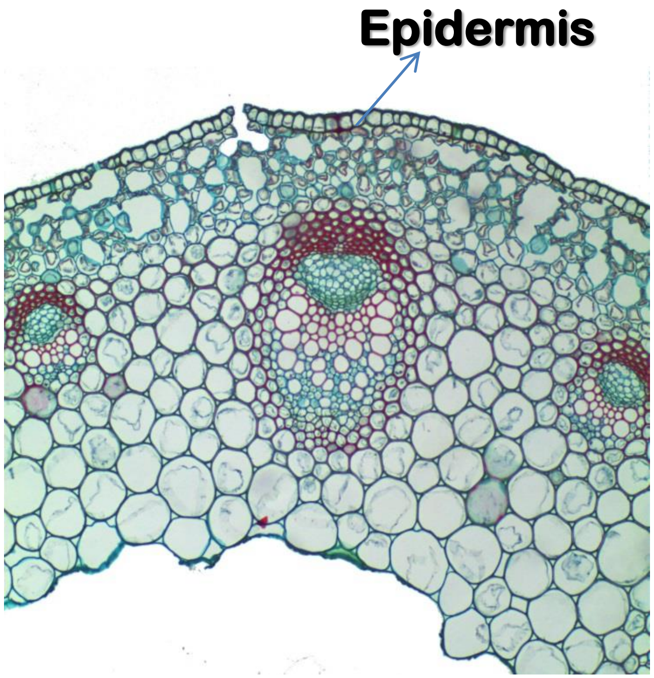
Plant Tissues

include

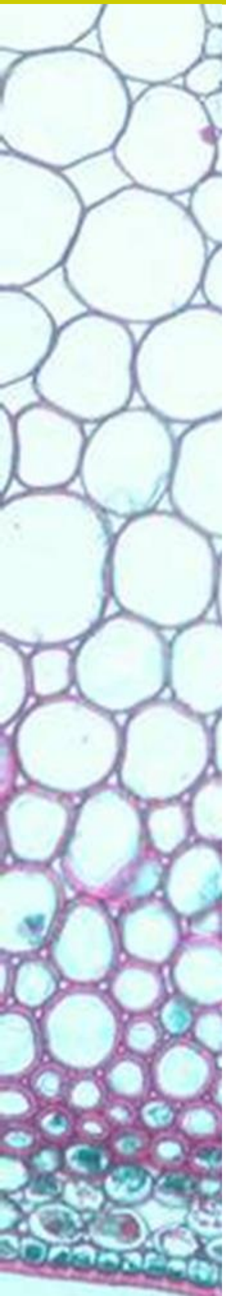
- **Dermal tissue**
  - includes
    - Epidermal cells
- **Meristematic tissue**
- **Vascular tissue**
  - includes
    - Xylem
      - includes
        - Tracheids
        - Vessel elements
    - Phloem
      - includes
        - Sieve tube elements
        - Companion cells
- **Ground tissue**
  - includes
    - Parenchyma cells
    - Collenchyma cells
    - Schlerenchyma cells

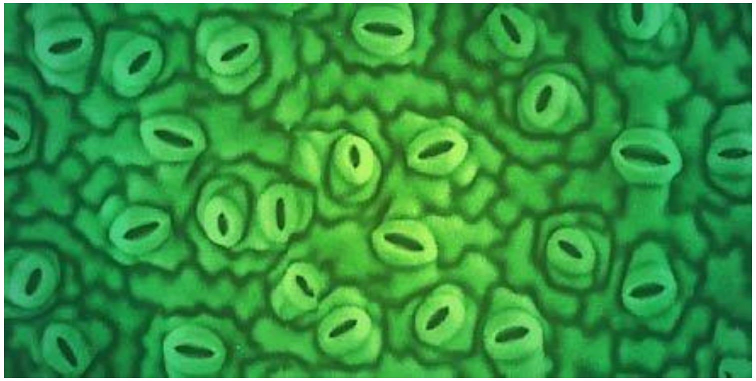
Dermal Tissue

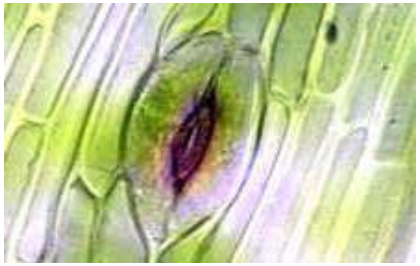
- Dermal tissue covers the plant body.
- Dermal tissue consists of epidermis
- Epidermis is made of parenchyma cells in a single layer
- Epidermis on stem and leaves prevents water loss by transpiration
- Epidermis produces a waxy material called cuticle



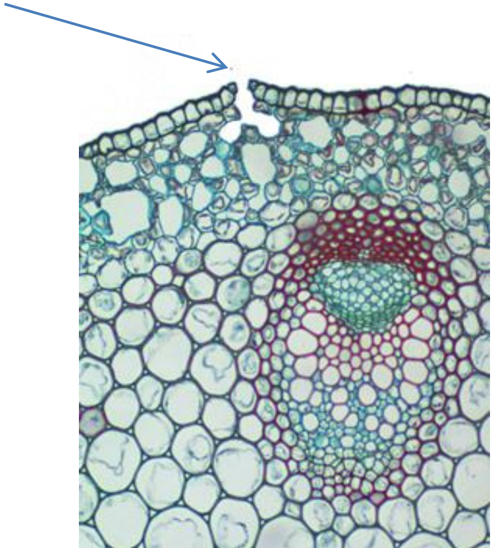
Dermal Tissue - Stomata



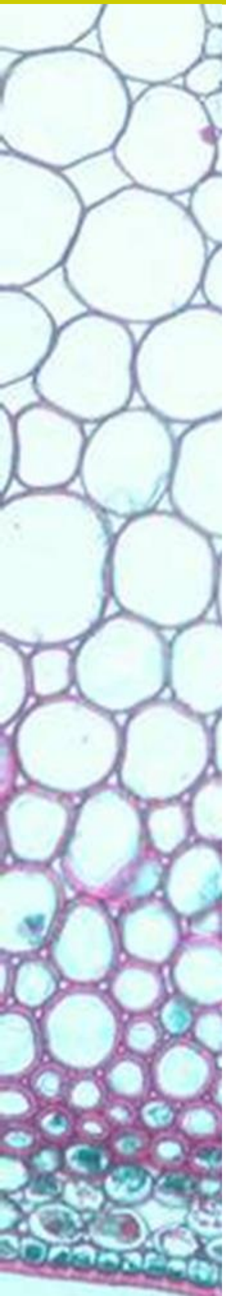


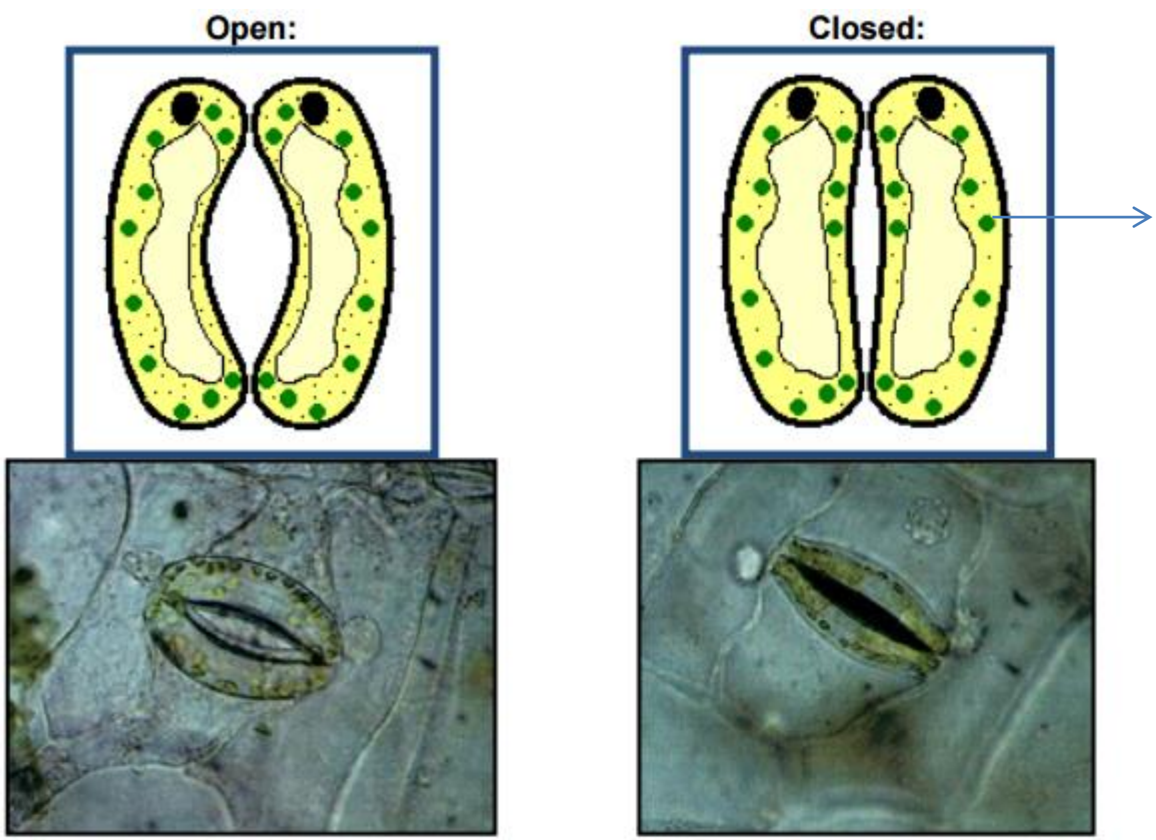


- **Openings in the epidermis on the underside of a leaf where gases are exchanged are called stomata.**



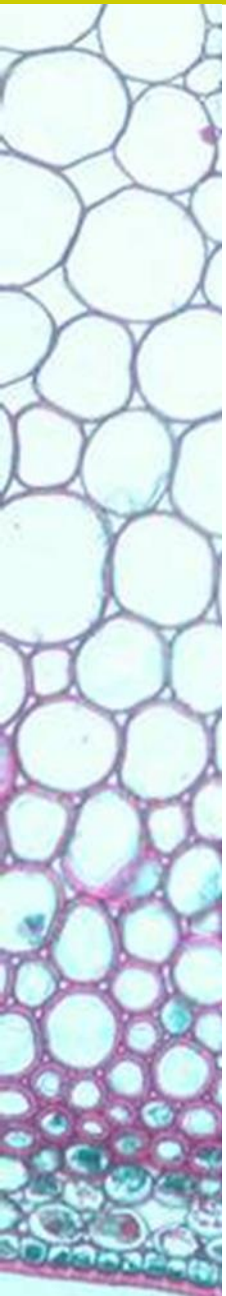
Dermal Tissue - Stomata





Sausage-shaped guard cells are found on each side of the stoma to help open and close the pore to prevent water loss

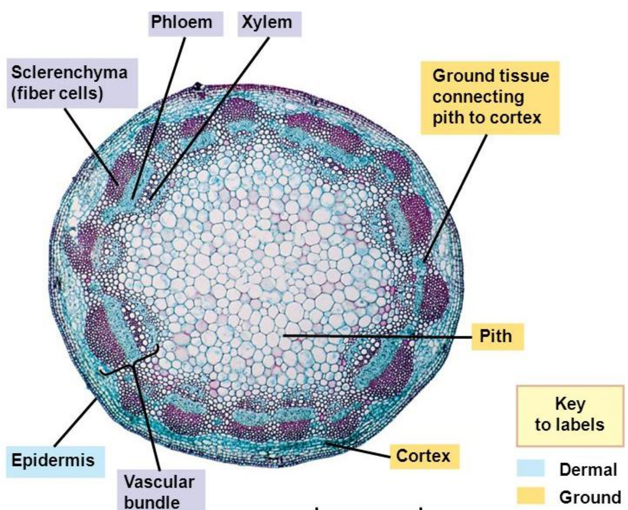
Ground Tissue



The ground tissue of plants includes all tissues that are neither dermal nor vascular.

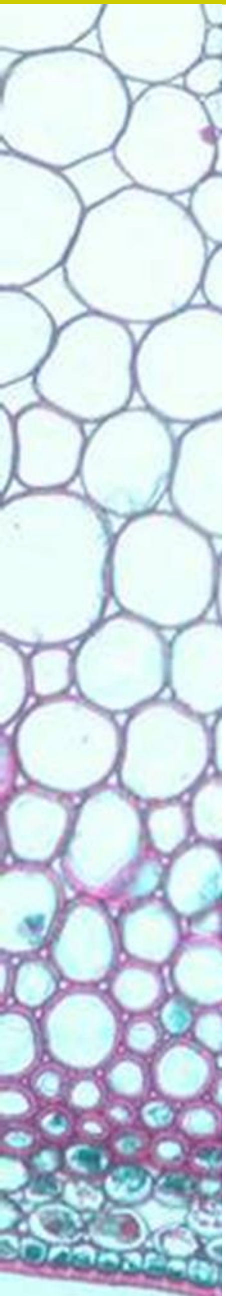
Ground tissue functions primarily in storage, support, photosynthesis, and the production of defensive and attractant substances (oils and toxins).

There are three types of ground tissue:
Parenchyma cells
Collenchyma cells
Sclerenchyma cells

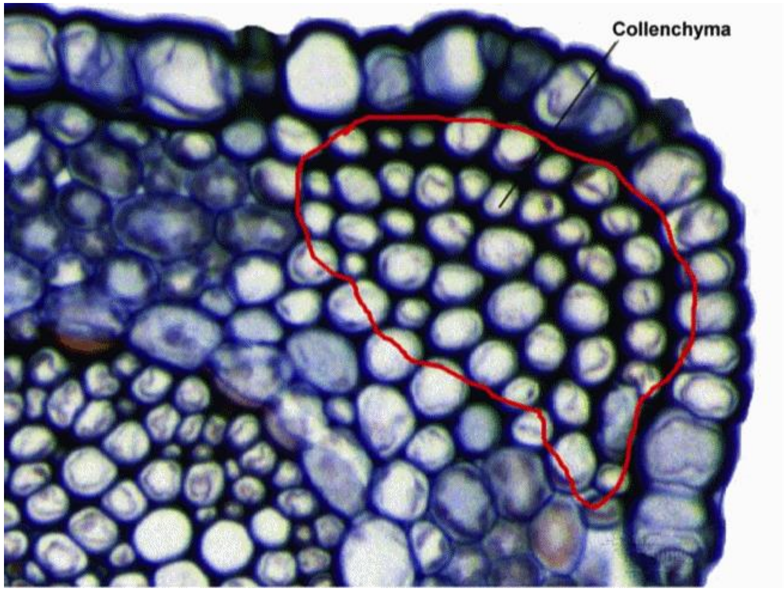


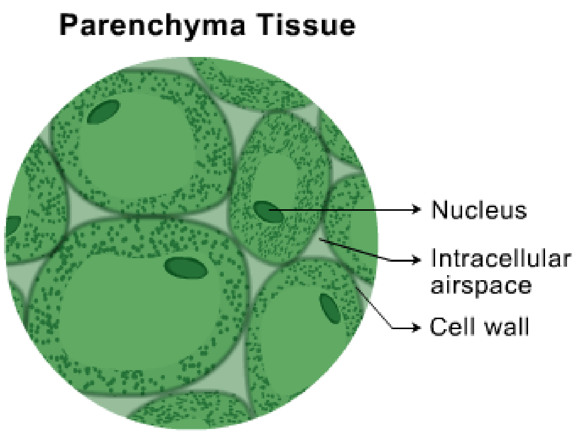
(a) Cross section of stem with vascular bundles forming a ring (typical of eudicots)

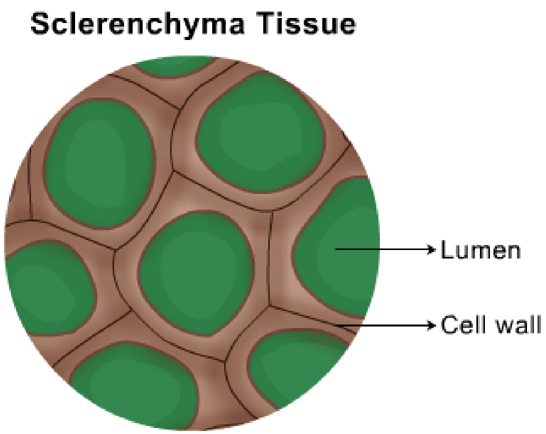
Types of Ground Tissue



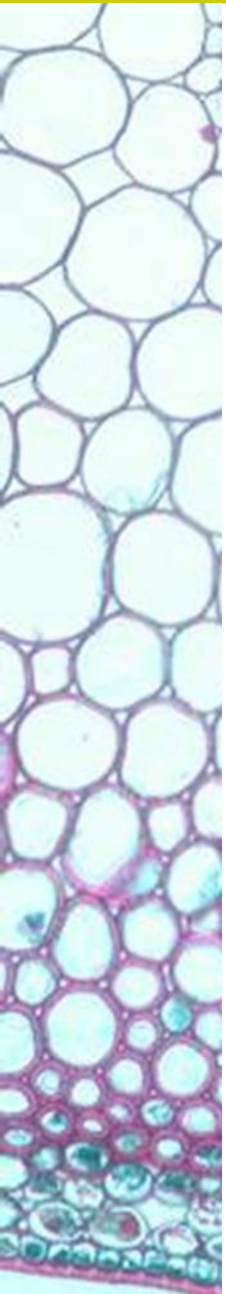
- Parenchyma cells have thin primary walls. Parenchyma forms the "filler" tissue in the soft parts of plants.
- Collenchyma cells have thin primary walls with secondary thickening. Collenchyma provides extra structural support.
- Sclerenchyma cells have thick lignified secondary walls. Sclerenchyma provides the main structural support to a plant.



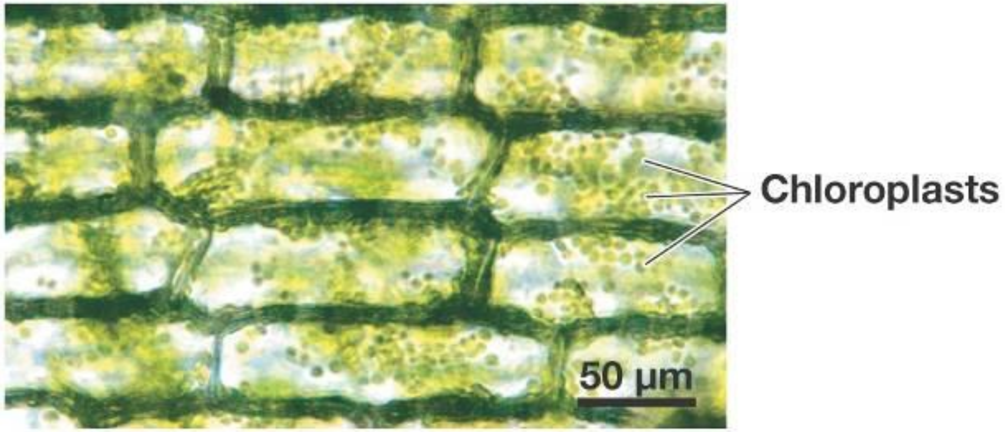




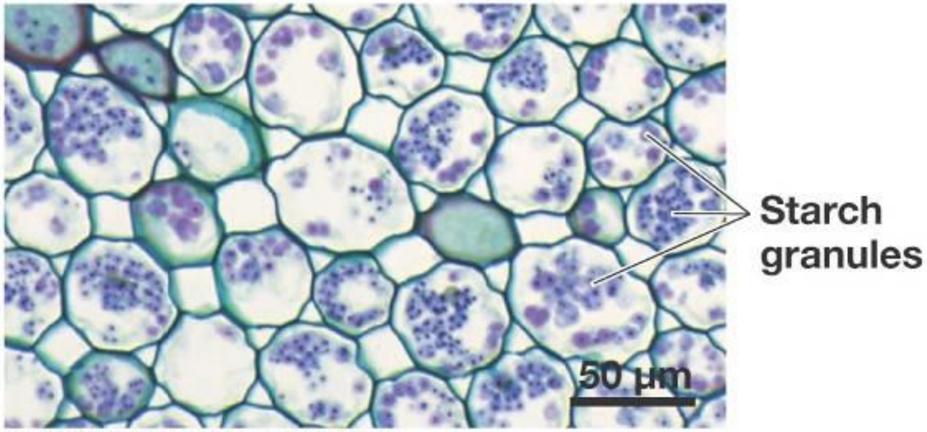
Types of Ground Tissue



(a) In leaves, parenchyma cells function in photosynthesis and gas exchange.



(b) In roots, parenchyma cells function in carbohydrate storage.

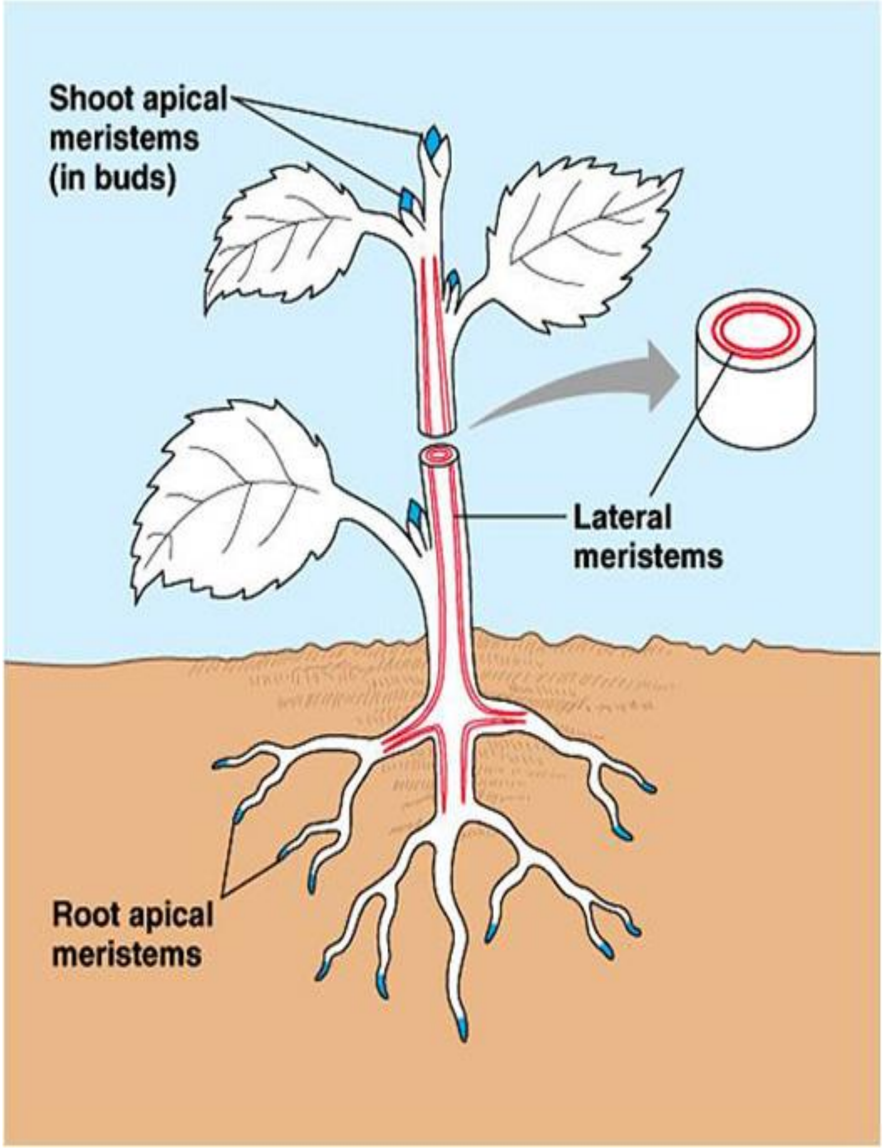


Meristems

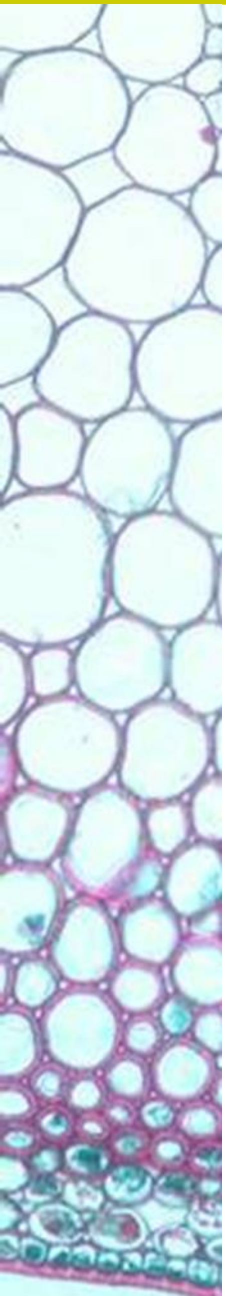
- The Meristems or Meristamatic cells are dividing cell.

- The Meristems are found in zones of the plant where growth take place.

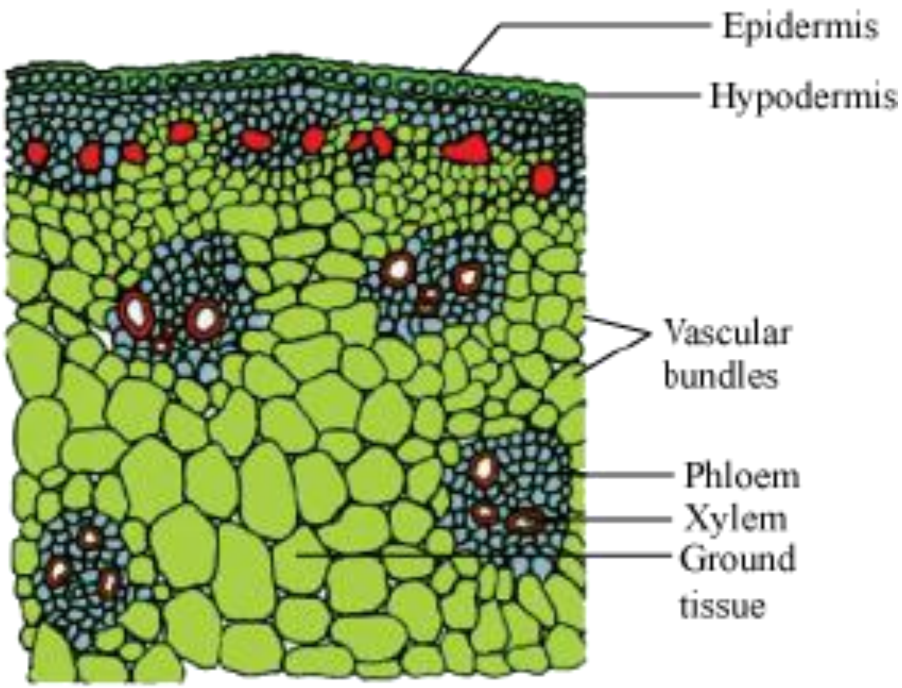
- **There are 3 main types of meristematic tissue in angiosperms:**
- **Apical meristem**
- **Intercalary meristem**
- **Lateral meristems**



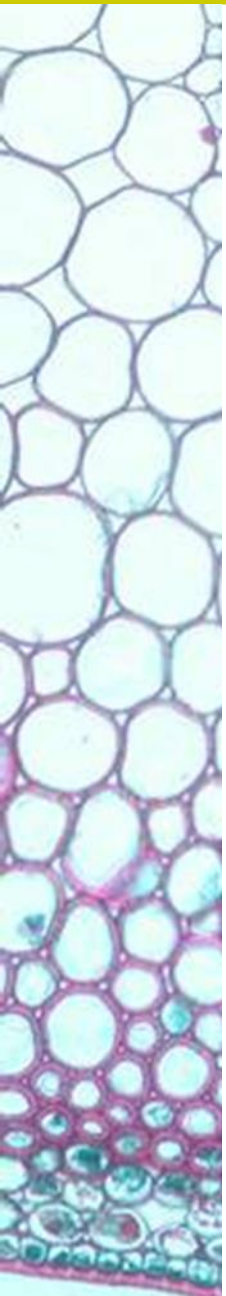
Vascular Tissue



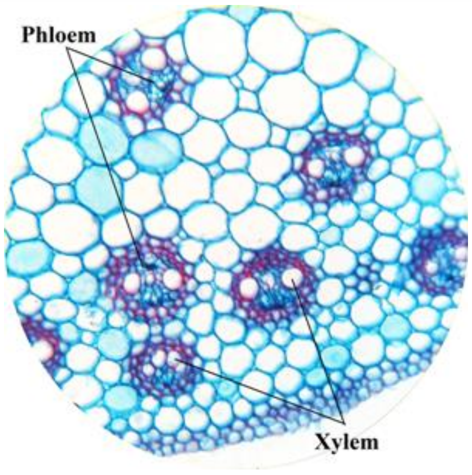
- The vascular tissue system includes the xylem and phloem.
- The vascular tissue system is the conductive or "plumbing" system of the plant.
- The phloem transports carbohydrates from leaves to other parts of the plant.
- The xylem distributes water and mineral ions taken up by the roots to the stem and leaves.



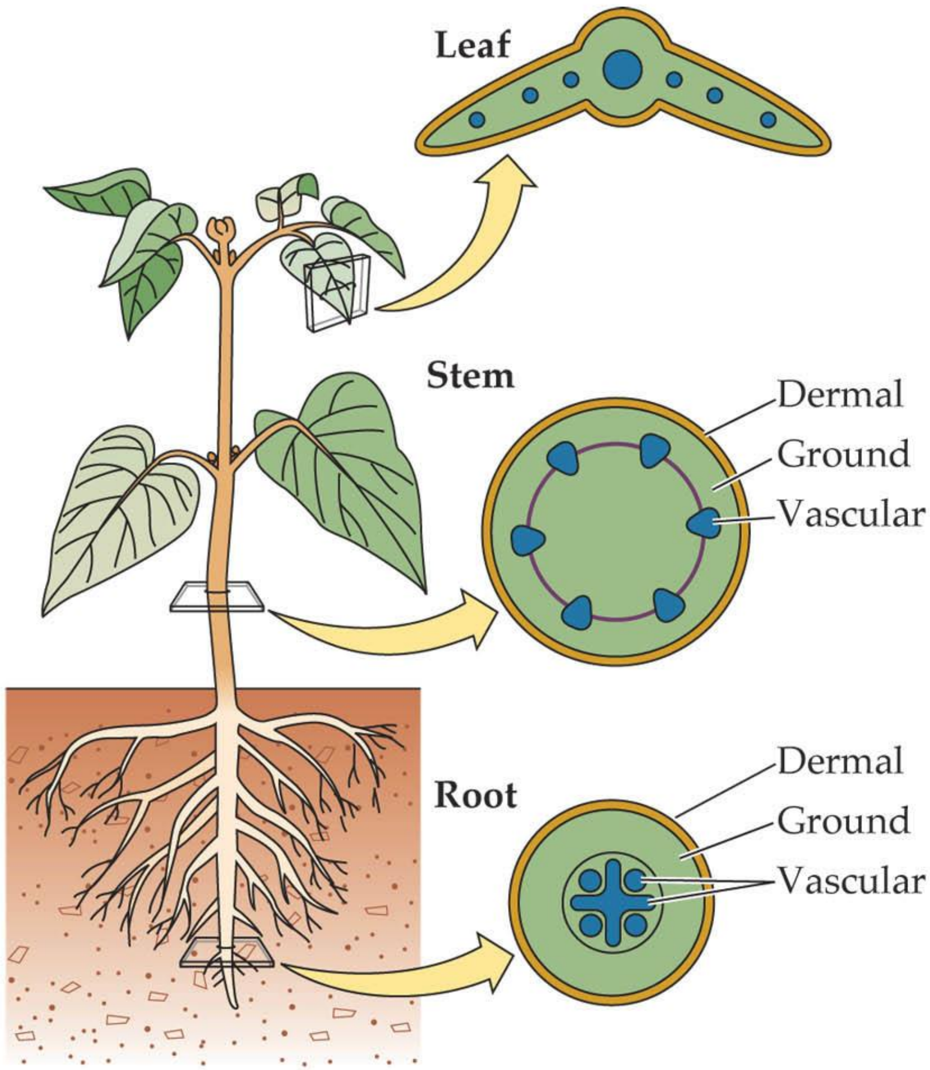
Vascular Tissue



Xylem	Phloem
• Composed of dead cells • Cells are made of thick cell walls • Found in wood • Carries water and nutrients • Transports materials up the stem…capillary action (like a straw) • Helps support the stem	• Composed of living cells • Cells don't have thick cell walls • Found in bark • Carries food (sugar-sap) • Transports materials up and down the stem (like an elevator) • Does not support the stem



PLANT ORGANS



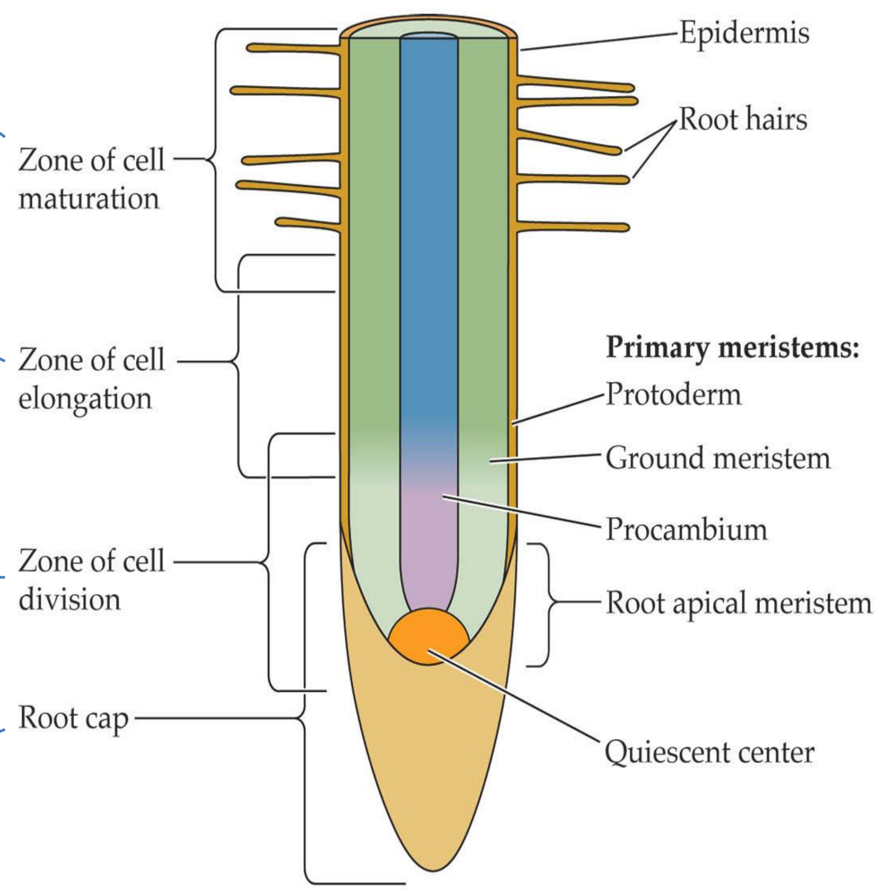
Plant organ: Root

In the Zone of maturation
The cells complete maturation, and become fully functional

In the Zone of elongation, the root cells elongate, pushes root tip further into soil

Zone of cell division is a actively dividing region, produces root cap cells

The root tip is covered by a root cap, which protects the delicate apical meristem as the root pushes through soil during primary growth

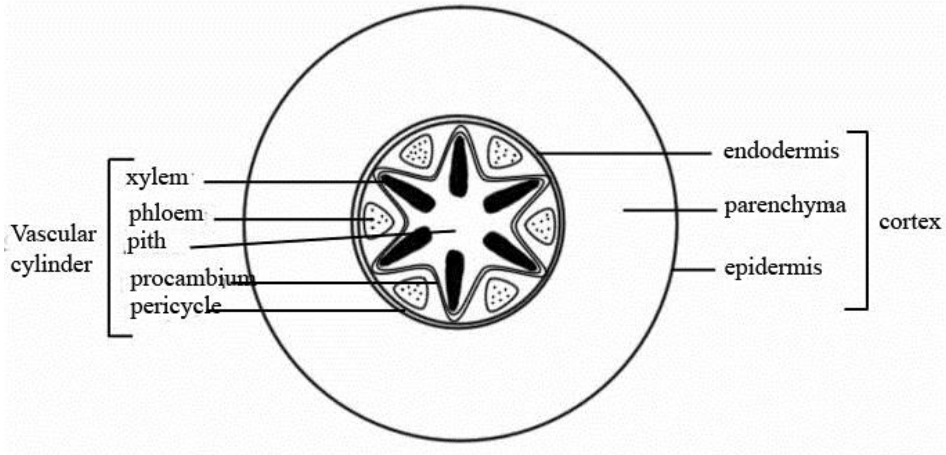


Plant organ: Root

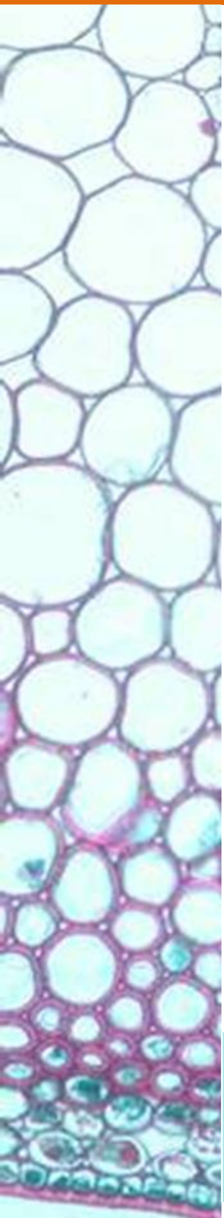
- The outermost cell is called as epidermis

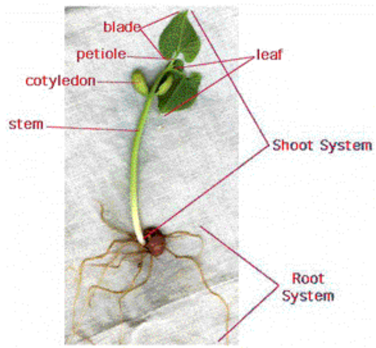
- The tissues in the central region is called the vascular cylinder, contains xylem & phloem

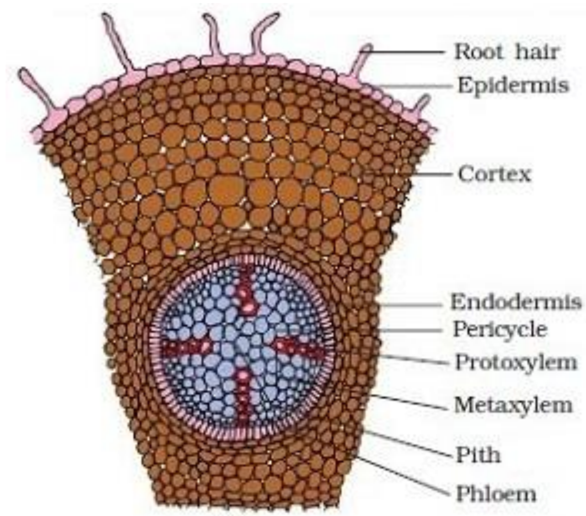
- A ground tissue called cortex surrounds the vascular cylinder
-
- A single cell layer called endodermis separates the cortex & vascular tissue



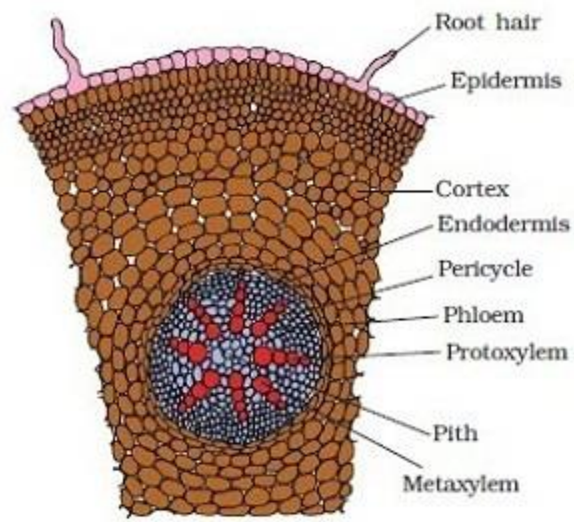
Plant organ: Root
Internal structure of Dicot and Monocot Root







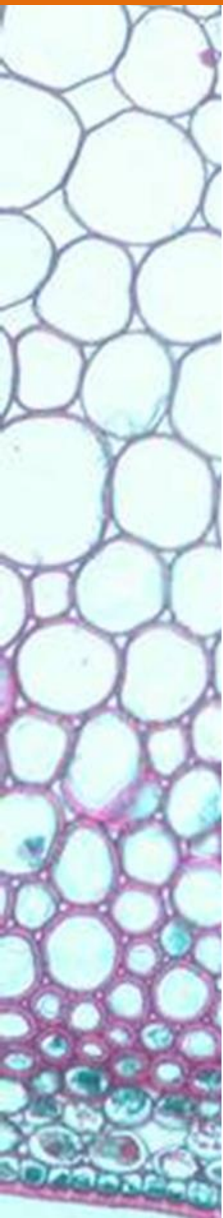
(a)



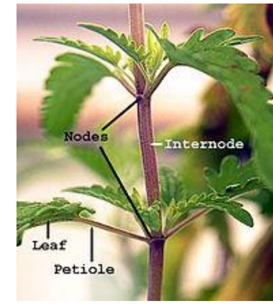
(b)

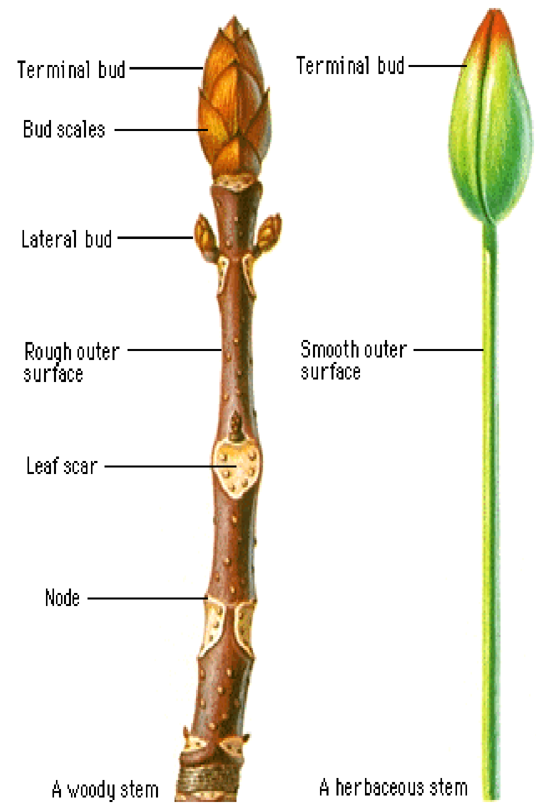
Vascular bundles	2-6 alternate bundles of xylem and phloem.	8 or more alternate bundles of xylem and phloem.

Plant organ: Stem
Internal structure of Dicot and Monocot Root

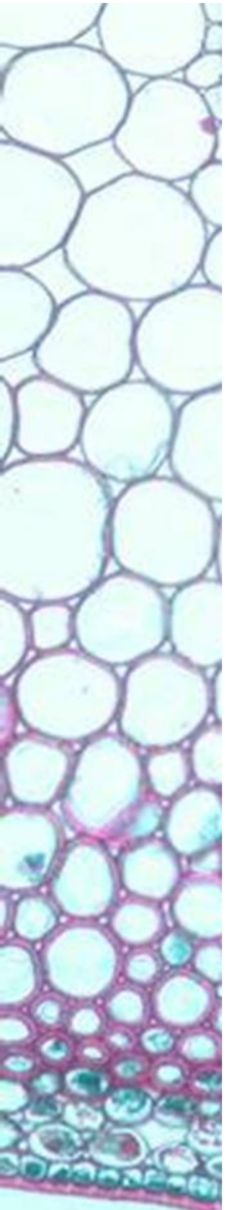


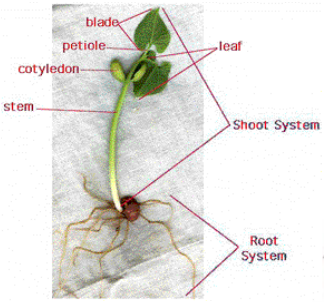
- Adapted to support leaves
- Transport water and minerals from root to leaves
- Transport sugars from leaves to roots
- Stems grow from the tip or apical meristem
- Internode is space between nodes on a stem
- Stems increase in circumference by lateral meristems
- Leaves are attached to stems at nodes
- Vascular Tissue is arranged in bundles with xylem toward the inside and phloem toward the outside

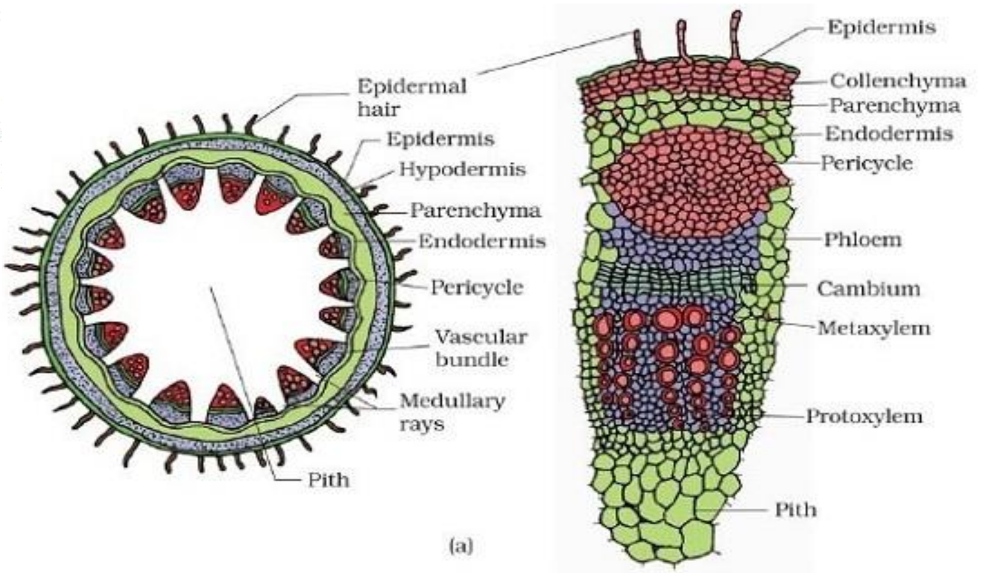




Plant organ: Stem
Internal structure of Dicot and Monocot Stem



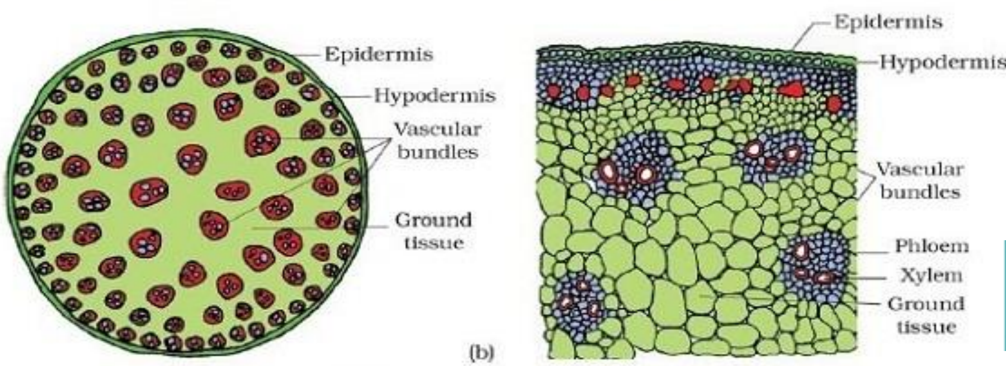




(a)

Vascular bundles

Wedge shaped.
Arranged in a ring.



(b)

Oval in shape.
Numerous and scattered.

Plant organ: Leaf

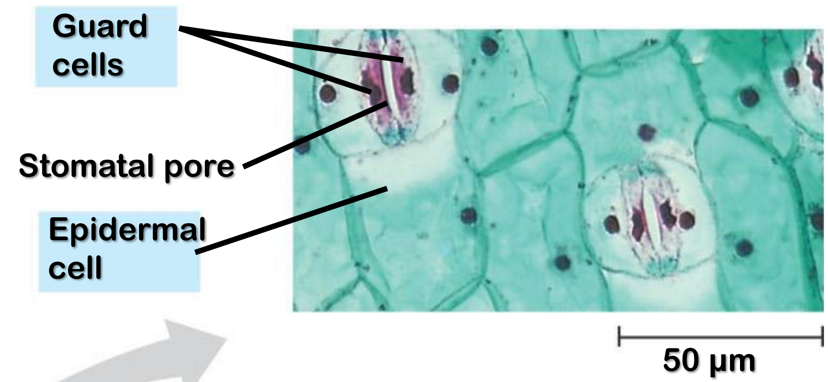
The main function of leaf is photosynthesis.

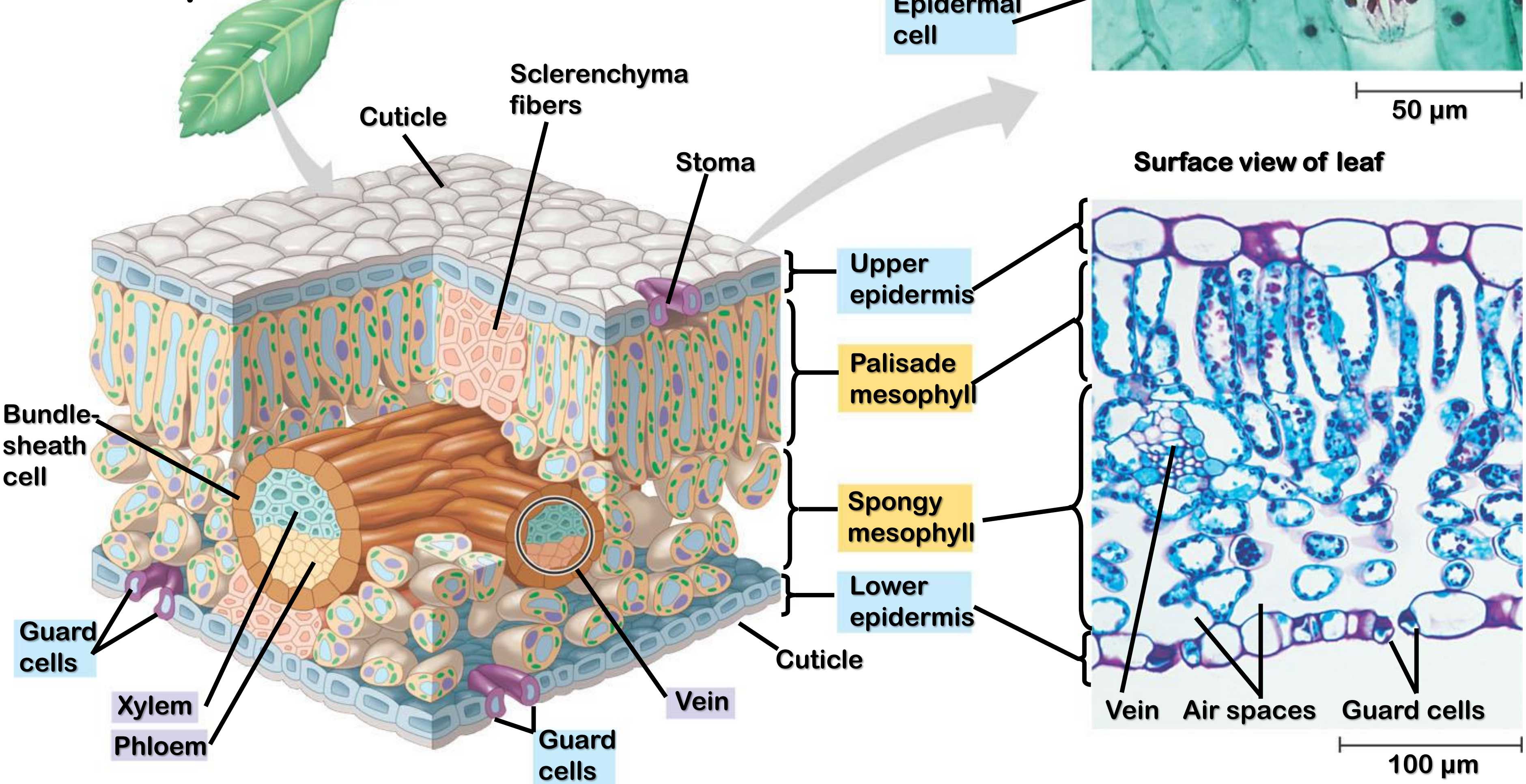
Photosynthesis is the process by which plants use the energy from sunlight to produce glucose from carbon dioxide and water.

Plant organ: Leaf

- The mesophyll contains air space through which CO_2 can diffuse to the photosynthesizing cells.

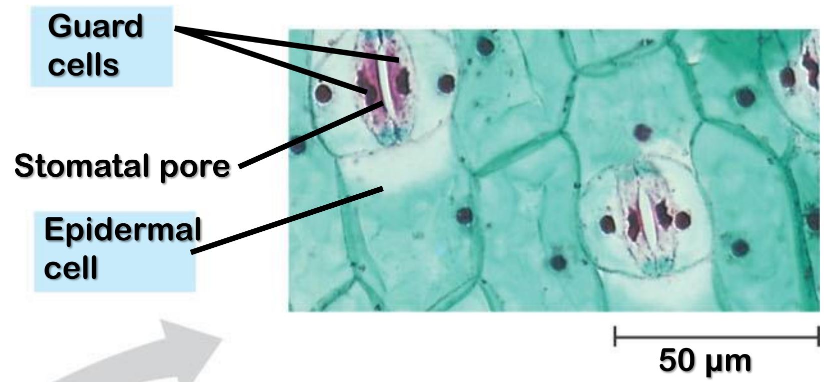
- Veins (vascular bundles) supply mesophyll cells with water and minerals, and they transport the products of photosynthesis to the rest of the plant.

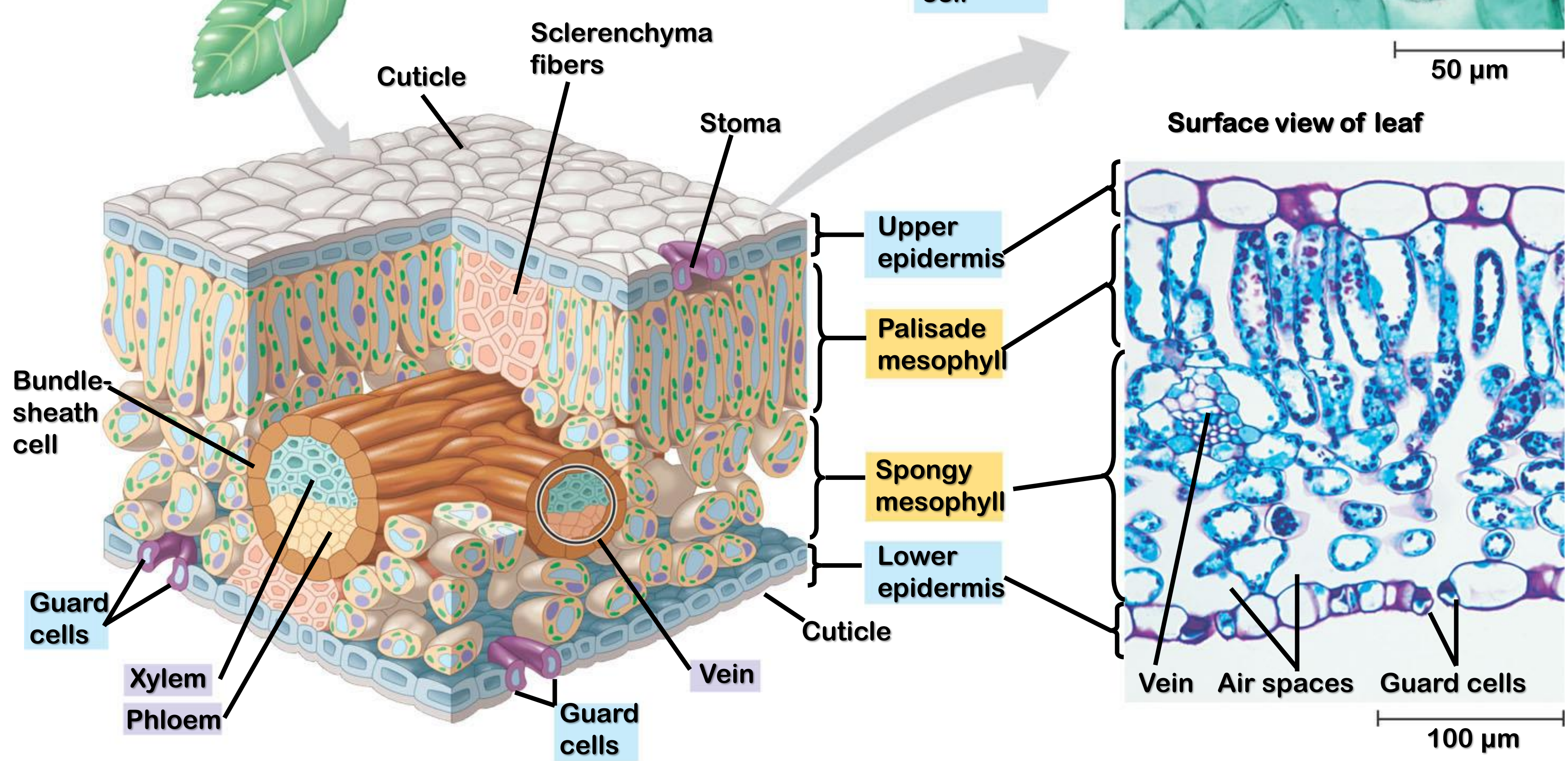




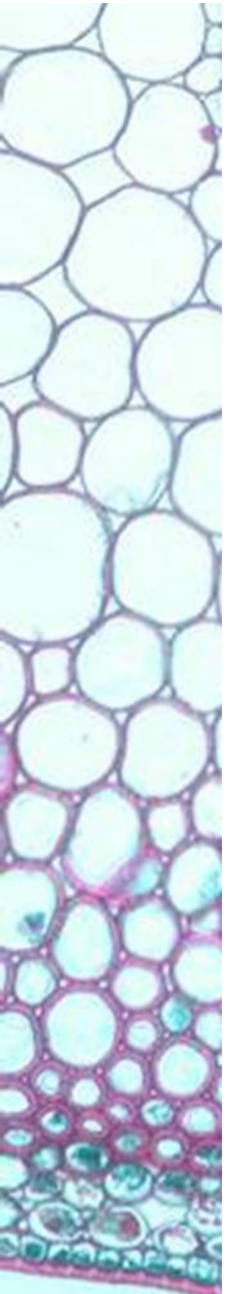
Plant organ: Leaf

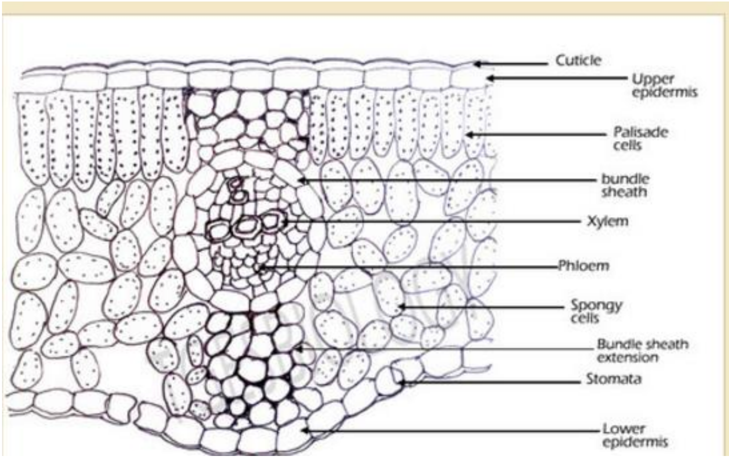
- **The epidermis of the leaf is the outermost cell layer, which is covered by a waxy cuticle.**
- **Guard cells allow controlled gas exchange through pores in the leaf (the stomata).**

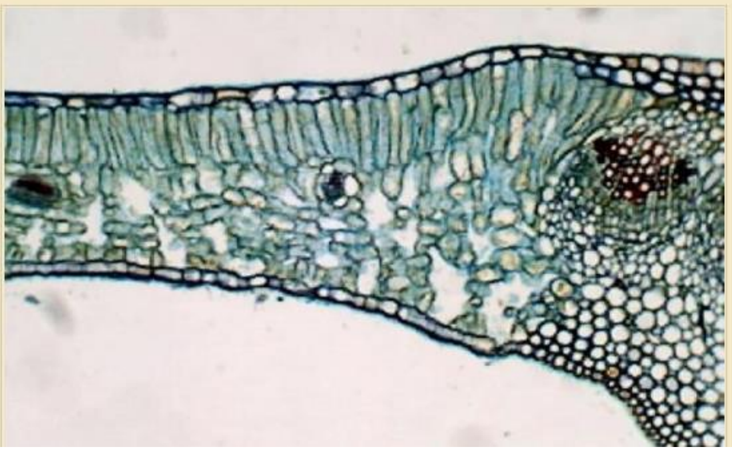


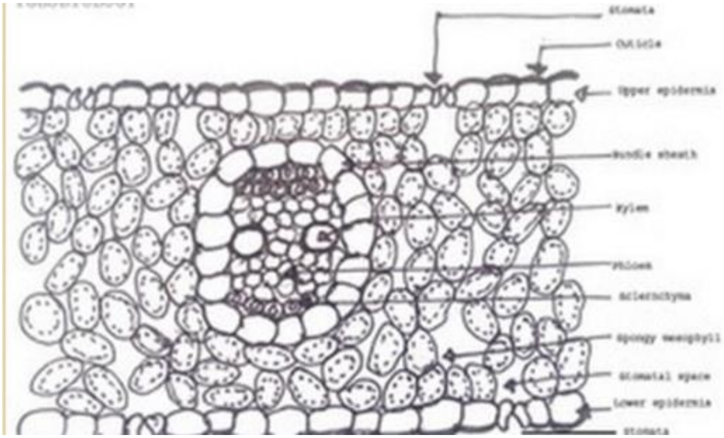


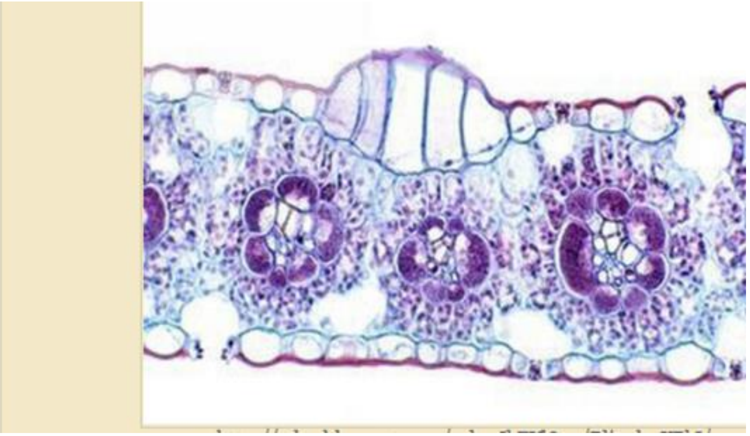
Internal structure of Dicot and Monocot leaves









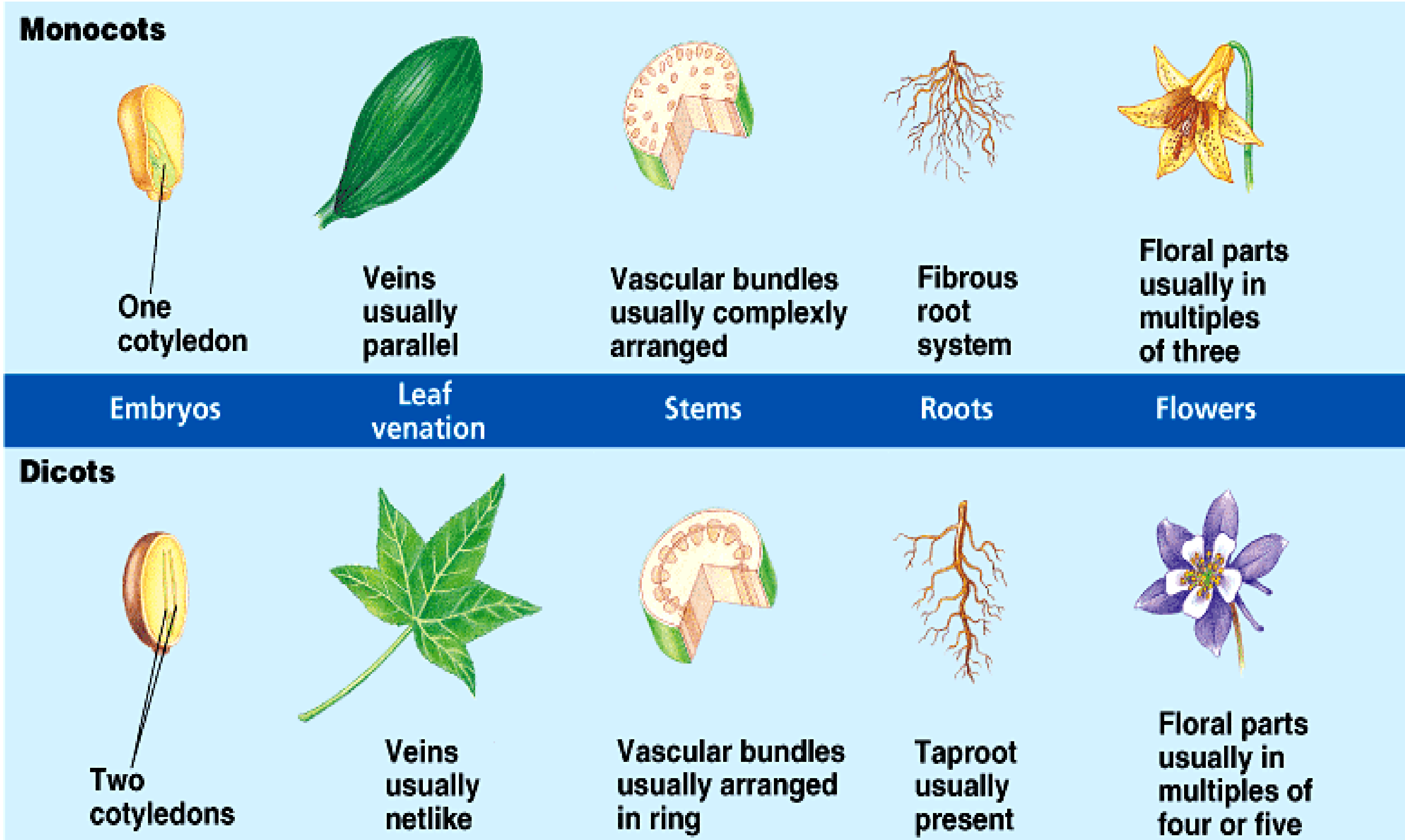


	Dicot leaf	Monocot leaf
1.	Cuticle thick at upper epidermis and thin at lower epidermis	Uniform cuticle on both the surface
2.	Stomata are more on lower surface	Equal number of stomata on either side
3.	Mesophyll is differentiated into palisade parenchyma and spongy parenchyma	Mesophyll is not differentiated into palisade and spongy parenchyma

Different types of plant tissues

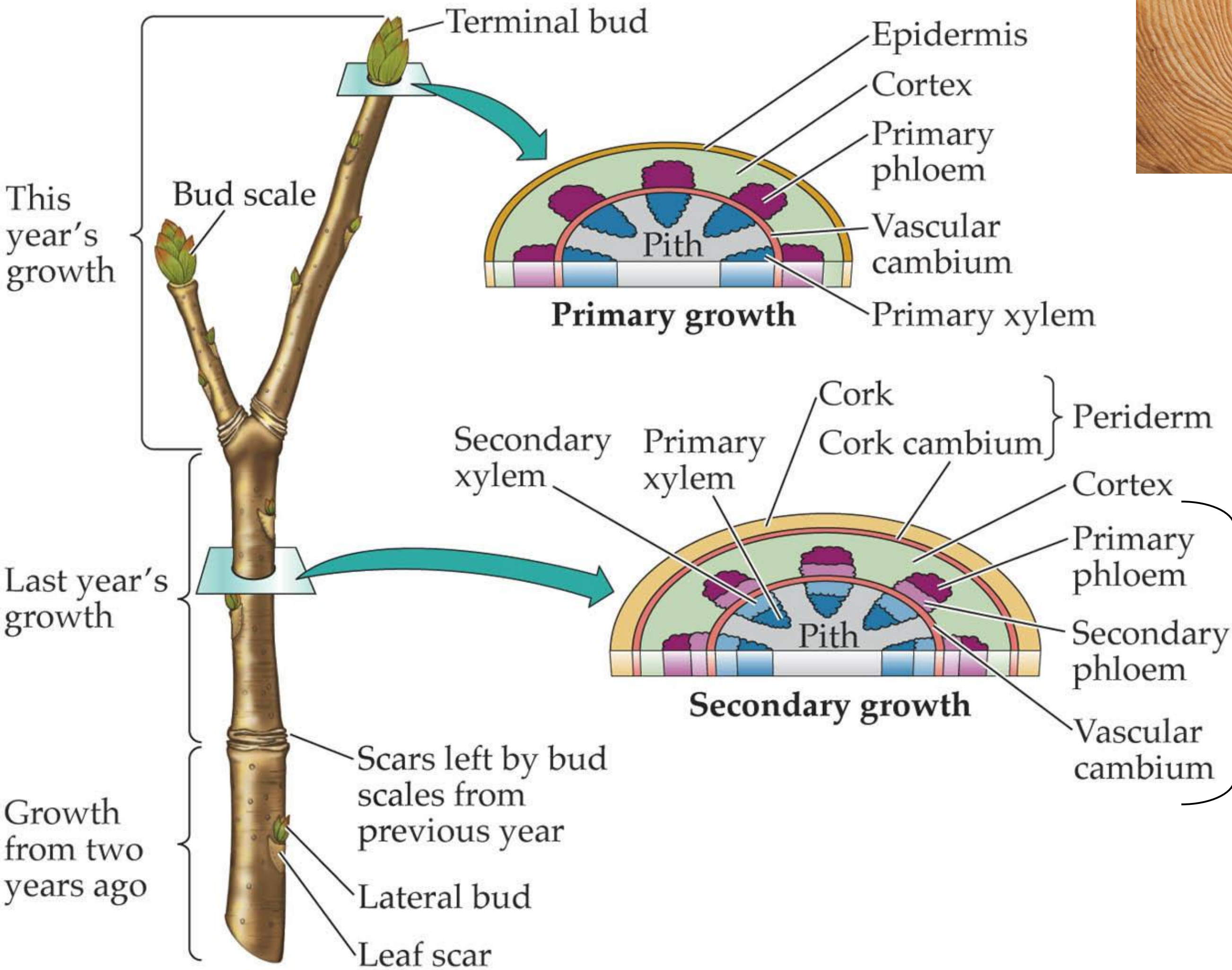
Plant tissue	Cell type	Site
Epidermis	Ground cells; guard cells; cells forming trichomes; Sclerenchyma cells	Outer layer of plant body
Periderm	Cork cells; cork cambium cells; parenchyma cells of phelloderm; Sclerenchyma cells	Outer layer; mainly stems
Xylem	Tracheids; vessel members; Sclerenchyma cells; Parenchyma cells	All organs
Phloem	Sieve cells or sieve-tube members; albuminous cells or companion cells; other parenchyma cells; Sclerenchyma cells	All organs
Parenchyma	Parenchyma cells	Cortex, pith
Collenchyma	Collenchyma cells	Mainly stems
Sclerenchyma	Sclerenchyma cells	All organs

Monocots vs. Dicots



Plant Secondary Growth

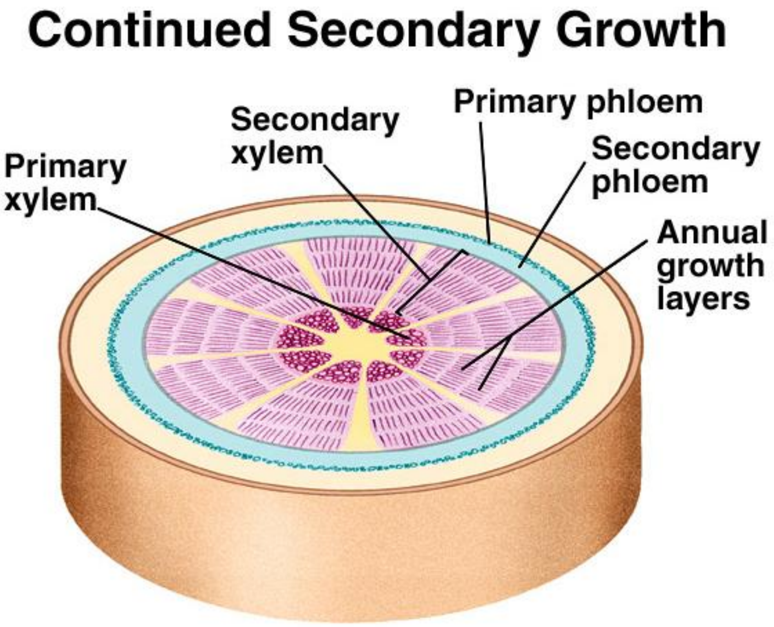
The vascular cambium is a plant tissue located between the xylem and the phloem in the stems and roots of vascular plants.



These tissues form a vascular bundle. In woody plants they grow together and fuse to form a continuous ring creating annual growth rings.

Plant Secondary Growth: Annual Ring

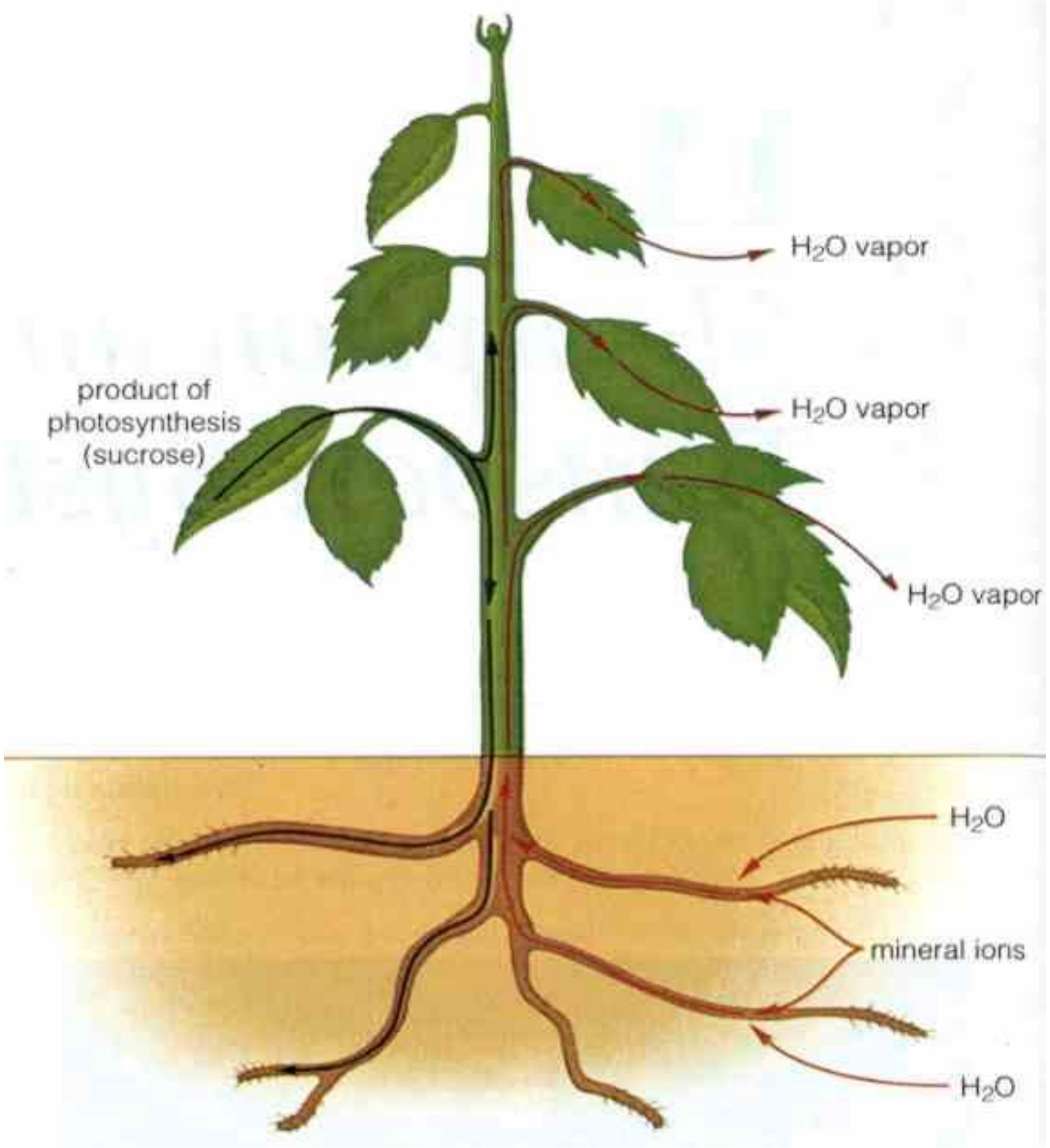
- Secondary growth increases the diameter of stems and roots.
- Annual rings can be seen by the cross sections of most tree trunks
- Annual rings form due to differential rates of growth in spring (when water is plentiful) and in summer.
- Wood that is no longer conducting water is known as heartwood.



SECTION 4

Plant Physiology

Plant physiology is a discipline of botany concerned with the functioning of plants.

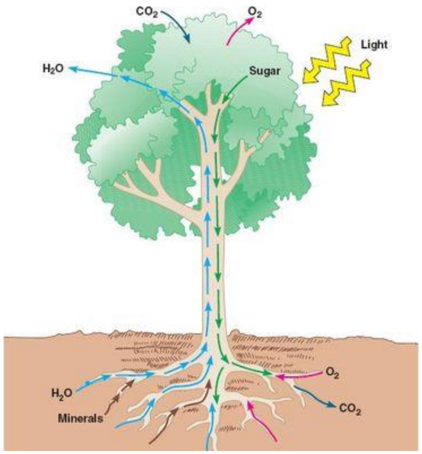


Plant Water Relations

TRANSPORT IN PLANTS

There is no circulatory system in plants, but water and minerals moves from root to leaves, and nutrients moves from leaves to roots.

- Each levels of structural organization participate in the physiology / functions

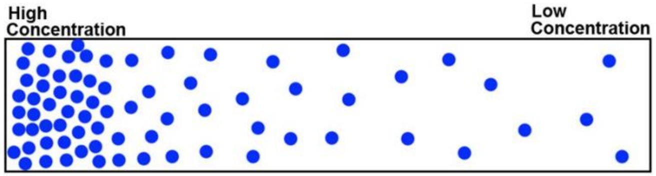


Different levels of structural organization are:

- **Cell** - unit of structure of all living organisms
- **Tissue** - composed of groups of similar cells
- **Organs** - composed of groups of tissues functioning together
- **Organ Systems** - composed of groups of organs functioning together
- **Organism** - an individual animal, plant, or single-celled life form

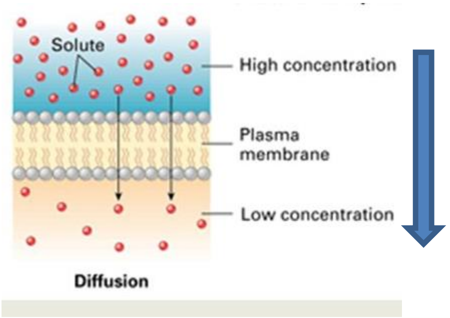
Types of transport in Cells

Concentration - the amount of a particular substance in a contained area compared with the amount of the same substance in another area



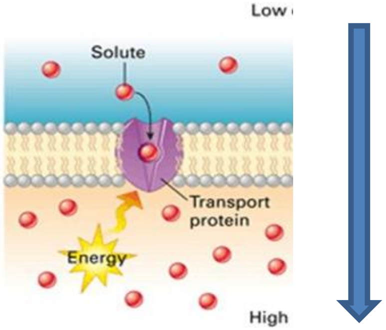
PASSIVE TRANSPORT –

- The movement of substances through a membrane from a region of high to a region of low concentration –
- No energy needed (ATP)
- Example: diffusion and osmosis



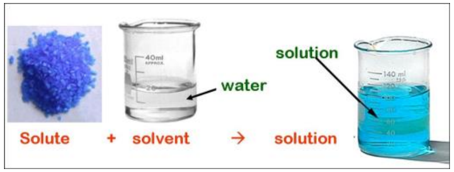
ACTIVE TRANSPORT –

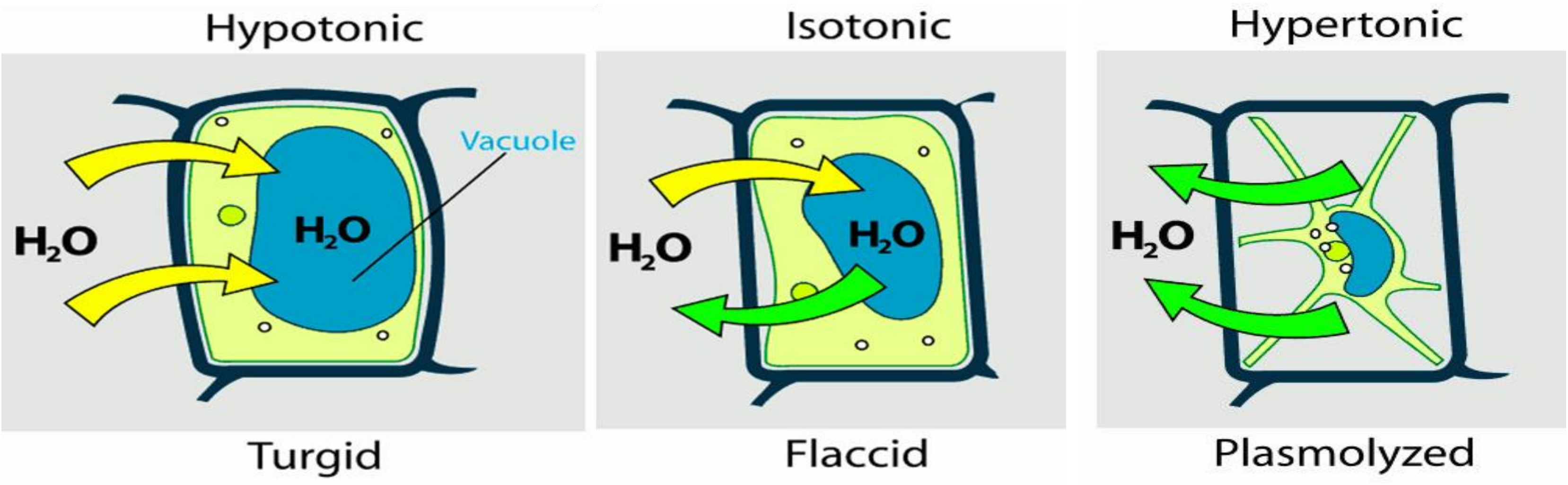
- The movement of substances through a membrane from a region of low concentration to a region of high concentration –
- Requires cellular energy (ATP)



Plant-Water Relations

SOLUTION: A liquid mixture in which the minor component (the solute) is uniformly distributed within the major component (the solvent).





Hypotonic-

A solution that causes a cell to swell because of osmosis meaning water rushes into the cell

Isotonic-

A solution that causes no change in cell size. Meaning there is no movement of water.

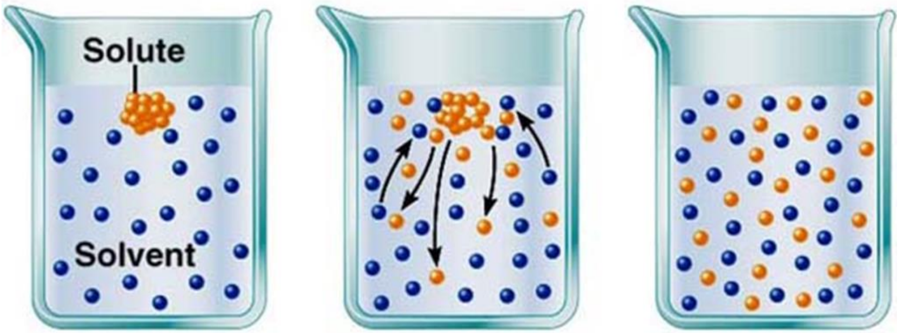
Hypertonic-

A solution that causes a cell to shrink because of osmosis. Meaning water leaves the cell.

Processes of transport in the living system

There are two types of process of transport in the living system:

1. Diffusion: the tendency of molecules to move from an area of higher concentration to an area of lower concentration



- **The goal of both diffusion and osmosis is to reach EQUILIBRIUM within the cell.**
- **EQUILIBRIUM is a condition in which the movement in one direction is equal to the movement in another direction.**

2. Osmosis: movement of water through a membrane from a region of higher to lower concentration

-Solute - substance being dissolved in a liquid (e.g. salt)

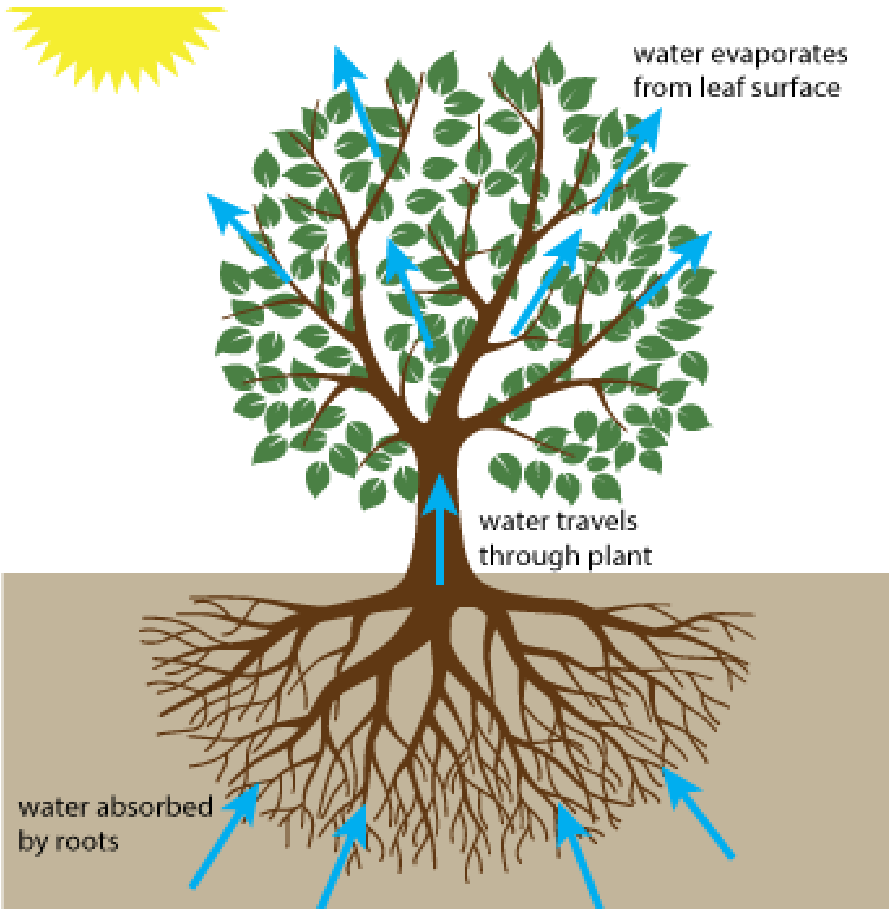
-Solvent - substance doing the dissolving (e.g. water)

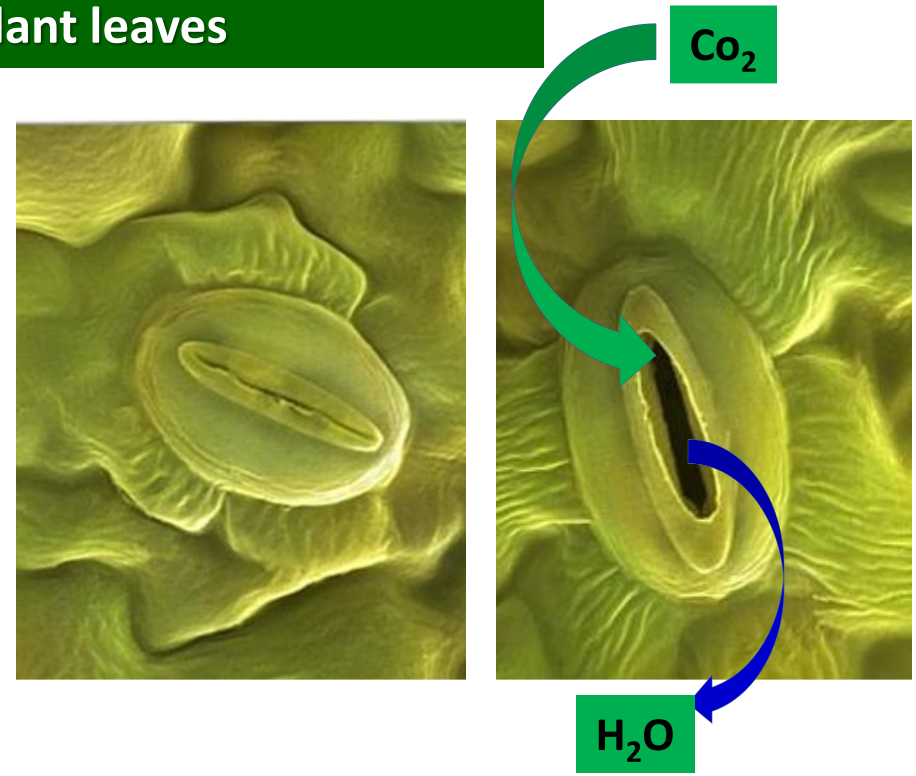
-Permeability - the extent to which a membrane will allow particular sized molecules to pass

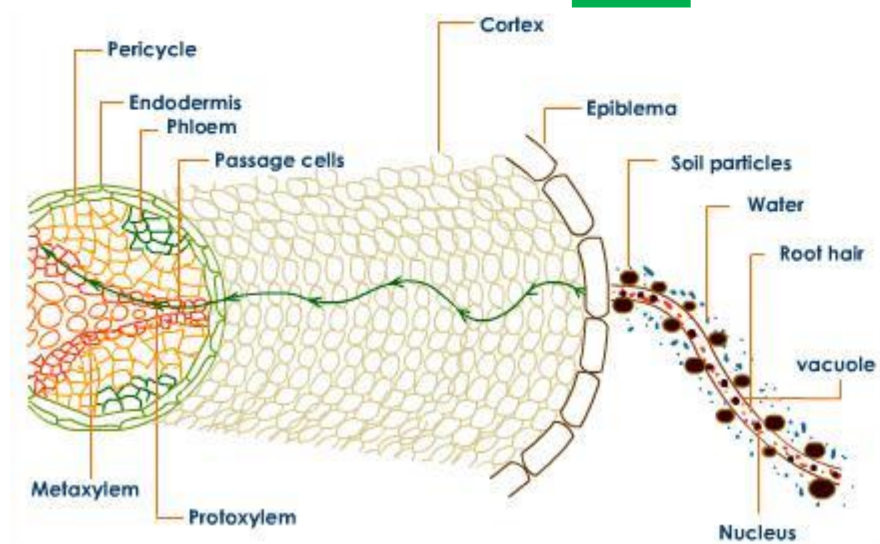
-Semi-permeable membrane (selectively permeable)-allows some molecules to pass but not others

TRANSPIRATION

It is mainly the evaporation of water from plant leaves

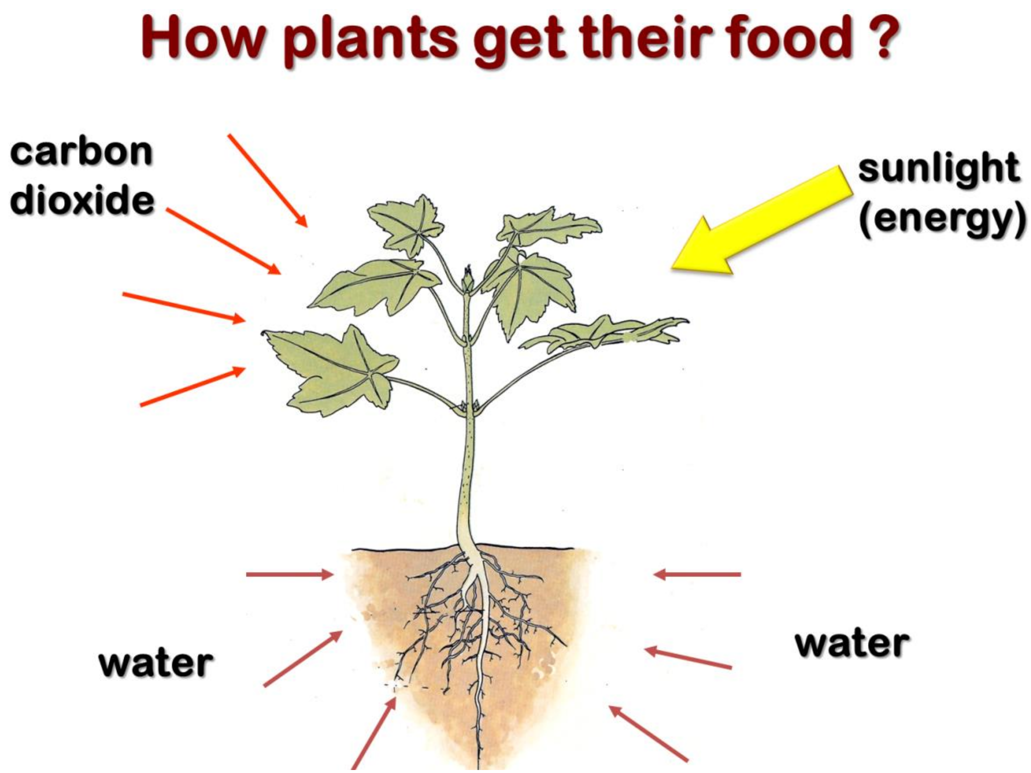






Transpiration is the process by which water is carried through plants from roots to small pores on the underside of leaves, where it changes to vapor and is released to the atmosphere.

PHOTOSYNTHESIS



Photosynthesis

- **Green plants takes carbon dioxide (CO_2) from the air, and water (H_2O) from the soil. The plants combine the CO_2 with the H_2O to make the sugar (Glucose ($C_6H_{12}O_6$)**

- Photosynthesis is the conversion of light energy to chemical energy by chlorophyll in chloroplasts

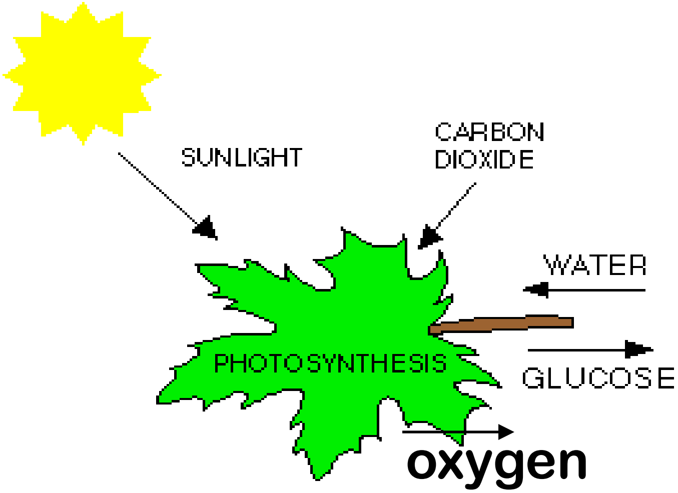
- Overall Net equation for photosynthesis:
  - 6 Water + 6 Carbon dioxide gives glucose + 6 oxygen (when catalyzed by chlorophyll in the presence of sunlight)

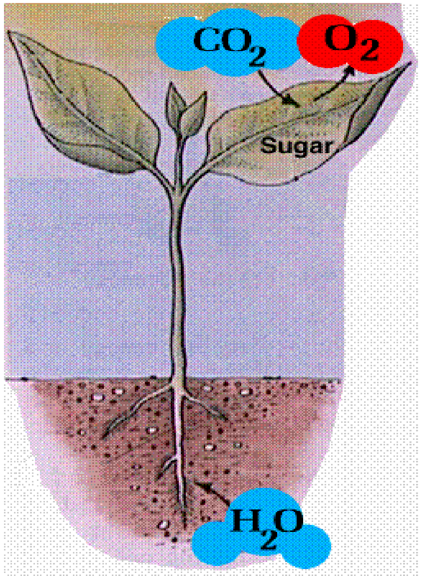
$6CO_2 + 6H_2O = C_6H_{12}O_6 + 6O_2$

Photosynthesis

- **Photosynthesis** is the major path through which carbon re-enters the biosphere (from CO_2).

- **Photosynthesis** is also the major source of oxygen (O_2) in the earth's atmosphere





Photosynthesis

- Photosynthesis completes in two phase-

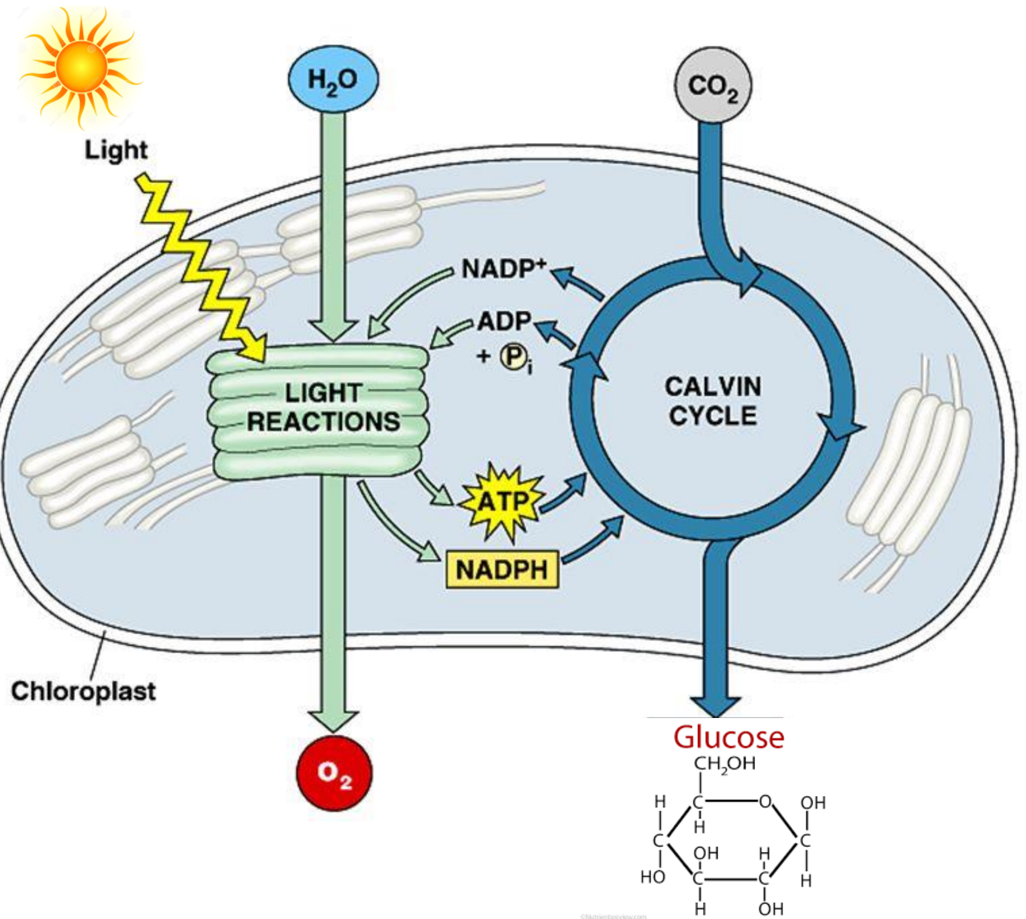
-Photochemcial phase (Light reaction)
-Biosynthetic phase (Calvin cycle)

- In the Photochemical phase (light reaction), the water molecular breakdown into Hydrogen and Oxygen.

- The released Hydrogen molecules helps in the conversion Adenosine diphosphate (ADP) into Adenosine triphosphate (ATP),

- The released Hydrogen molecules also help in the conversion of Nicotinamide adenine dinucleotide phosphate (NADPH) into reduced Nicotinamide adenine dinucleotide phosphate ($NADP^+$)

- ATP and Nicotinamide adenine dinucleotide phosphate ($NADP^+$)
- used in Biosynthetic phase called as Calvin cycle in which CO_2 molecules convert into Glucose.

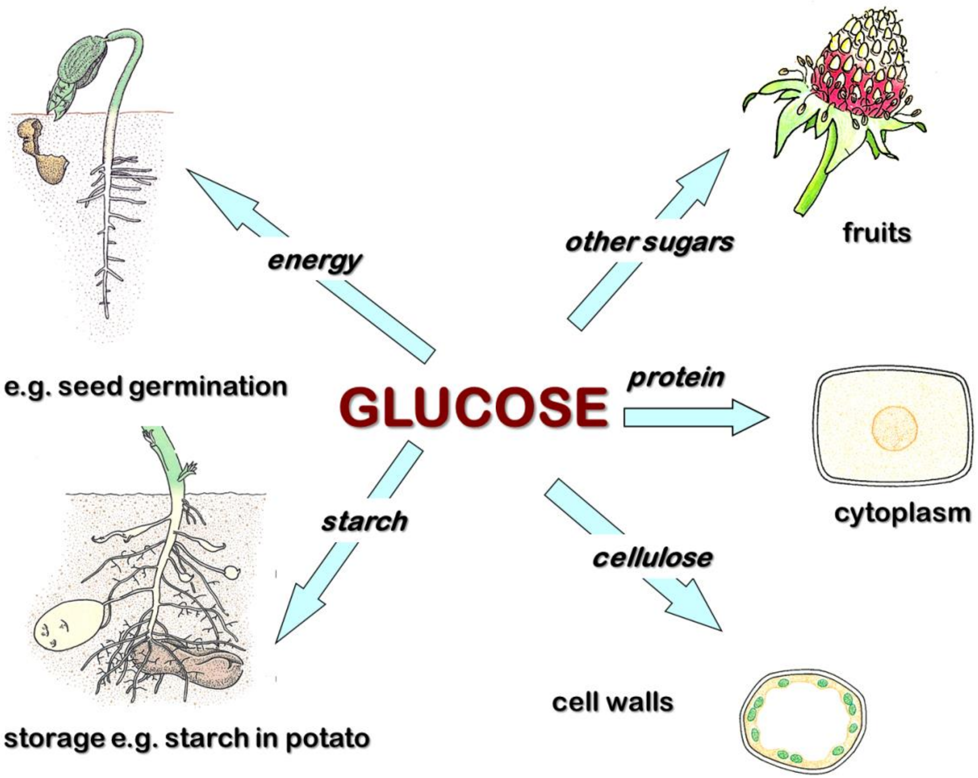


RESPIRATION

- **The breakdown of food materials within the cell to release energy in the form of ATP (Adenosine Tri Phosphate).**

- **$C_6H_{12}O_6 + 6O_2 = 6CO_2 + 6H_2O$ + ATP (Energy)**

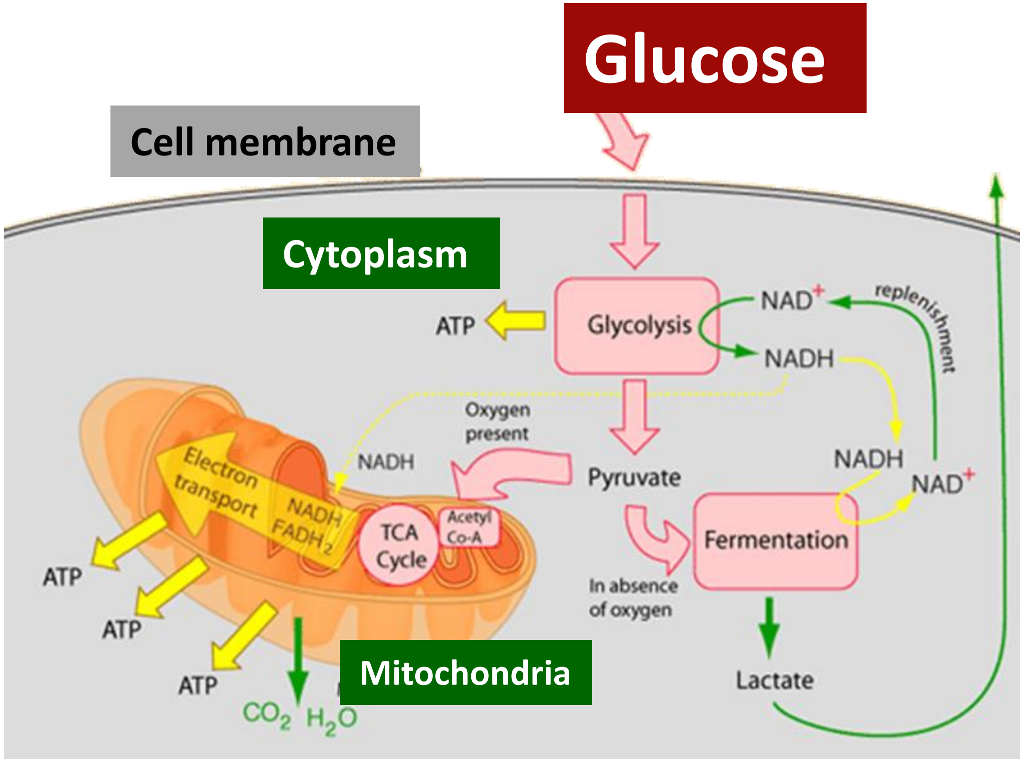
- **It involves Cytoplasm and Mitochondria**



Respiration

Glycolysis:

- Glucose enters into cytoplasm.
- Glucose passed thru series of enzymatic reaction in which glucose converted in to pyruvic acid.
- The process is called as Glycolysis.
- Glycolysis occurs in cytoplasm



The citric acid cycle – also known as Tricarboxylic acid (TCA) cycle or Krebs cycle:

In this cycle, in presence of oxygen, pyruvic acid resulted from the process of glycolysis enters into mitochondria, and passed thru a cyclic enzymatic reaction, and finally gives ATP.

ATP is used in the cell as a energy for various reactions.

The ATP produced in the Mitochondria; hence, the mitochnodria is called as power house of the cell

PLANT GROWTH HORMONES

Plant hormones (also known as phytohormones) are chemicals that regulate plant growth

Hormone	Where Produced or Found in Plant	Major Functions
Auxin (IAA)	Embryo of seed, meristems of apical buds, young leaves	Stimulates stem elongation (low concentration only), root growth, cell differentiation, and branching; regulates development of fruit; enhances apical dominance; functions in phototropism and gravitropism; promotes xylem differentiation; retards leaf abscission
Cytokinins	Synthesized in roots and transported to other organs	Affect root growth and differentiation; stimulate cell division and growth; stimulate germination; delay senescence
Gibberellins	Meristems of apical buds and roots, young leaves, embryo	Promote seed and bud germination, stem elongation, and leaf growth; stimulate flowering and development of fruit; affect root growth and differentiation

SECTION 5

CLASSIFICATION OF ORGANISMS

Taxonomy / Systematics

The branch of biology that deals with classification and nomenclature.

Nomenclature deals with the application of a correct name to a plant or a taxonomic group.

Kingdom:	**Plantae**
Class:	**Angiosperms**
Order:	**Arecales**
Family:	**Arecaceae**
Genus:	***Phoenix***
Species:	***P. dactylifera***

Taxonomic Hierarchy

Species:

- **Organisms sharing a set of biological traits and reproducing only their exact kind.**

- **Species is the fundamental unit in taxonomy**

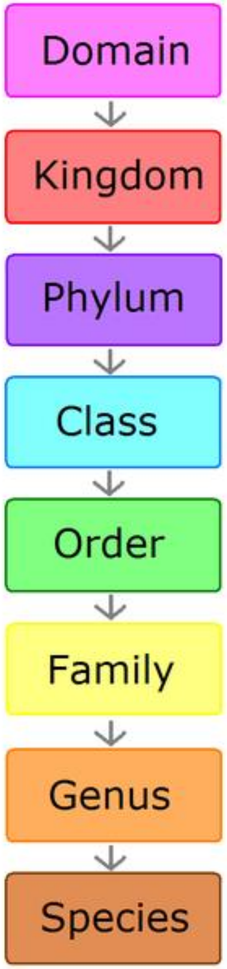
Genus: Closely related species

Family : Closely related genera

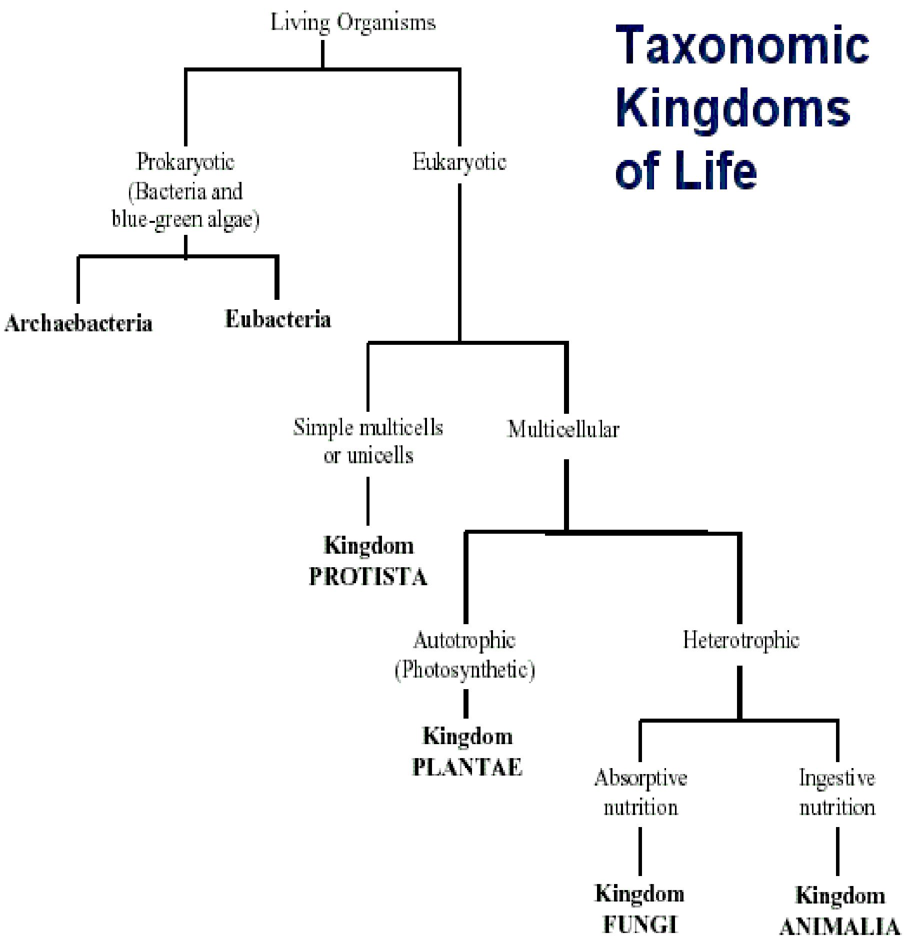
Order : Closely related families

Class : Closely related order

Division : Related classes



Classification of Organisms



Taxonomic Kingdoms of Life

- **The most basic category of organisms is called a *kingdom*.**
- **Most scientists divide organisms into five major kingdoms.**

Microorganisms

1. Viruses
2. Bacteria
3. Cyanobacteria
4. Algae
5. Fungi
6. Protozoa

Biological Kingdoms

- 2 Kingdoms

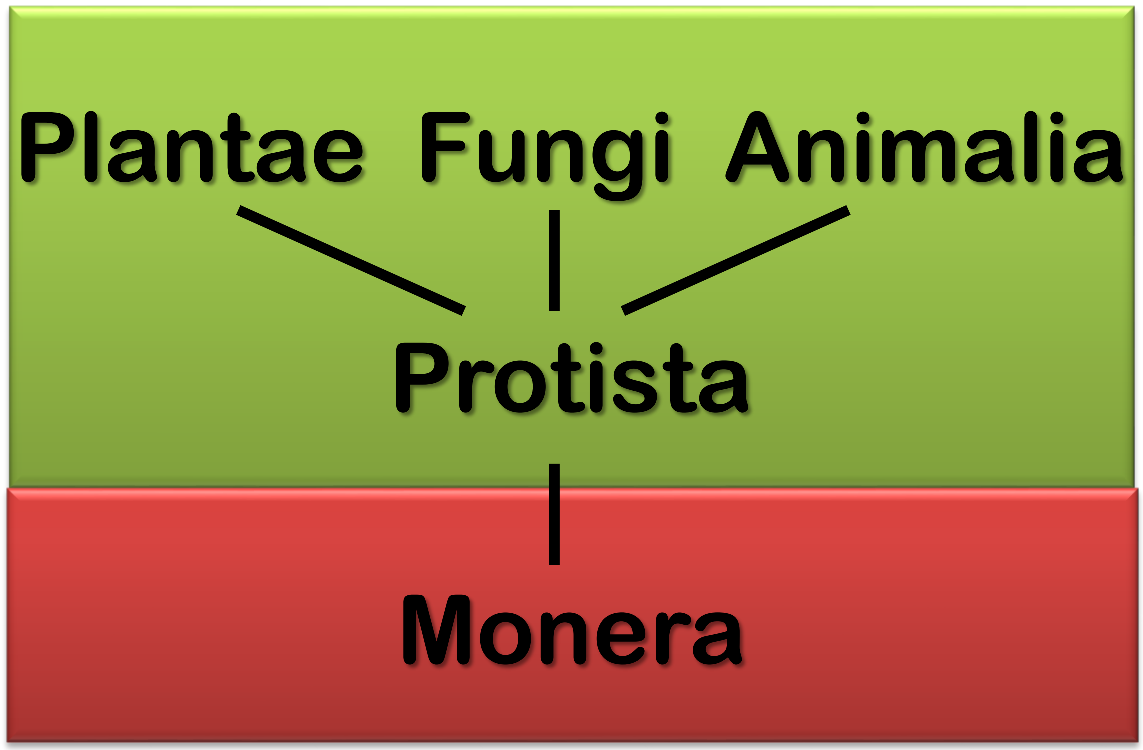
  Traditional view

plants	animals

Biological Kingdoms

5 Kingdoms

Whittaker, 1969



Protist is an informal term for eukaryotic organism that is not an animal, plant or fungus.

Monera = bacteria

Biological Kingdoms

Five kingdom system:

Monera | Protista | Plantae | Fungi | Animalia

Six kingdom system:

Eu-bacteria | Archae-bacteria | Protista | Plantae | Fungi | Animalia

Three domain system:

Eu-bacteria | Archae-bacteria | E U K A R Y A

Eight kingdom system:

Eu-bacteria | Archae-bacteria | Archezoa | Chromista | Protista | Plantae | Fungi | Animalia

Six-Kingdom System

Kingdom Archaebacteria

Kingdom Eubacteria

Kingdom Fungi

Kingdom Protista

Kingdom Plantae

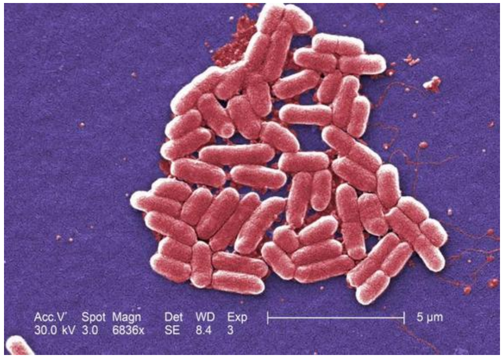
Kingdom Animalia

KINGDOM: ARCHAEBACTERIA

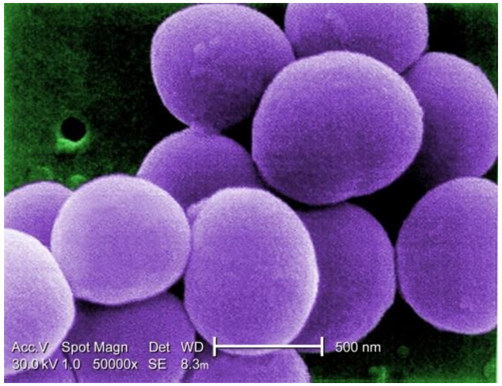
- Archaebacteria are unicellular prokaryotes with distinctive Cell Membranes.
- Some are autotrophic, producing food by chemosynthesis.
- Most of the Archaebacteria are heterotrophic.
- A heterotroph is an organism that cannot fix carbon from inorganic sources (such as carbon dioxide) but uses organic carbon for growth.
- Many Archaebacteria live in harsh environments such as Sulfurous Hot Springs, very salty lakes, and in anaerobic environments, such as the intestines of mammals.

KINGDOM EUBACTERIA

- **Eubacteria are unicellular prokaryotes.**
- **Most of the bacteria causing disease in human.**
- **Eubacteria are both autotrophic and heterotrophic.**
- **Normally reproduce by binary fission**



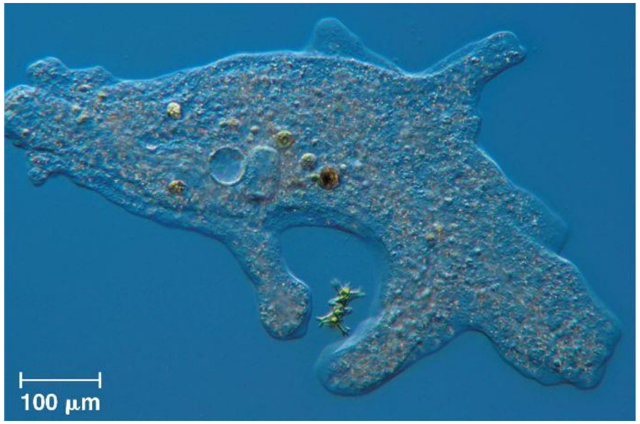
Escherichia coli



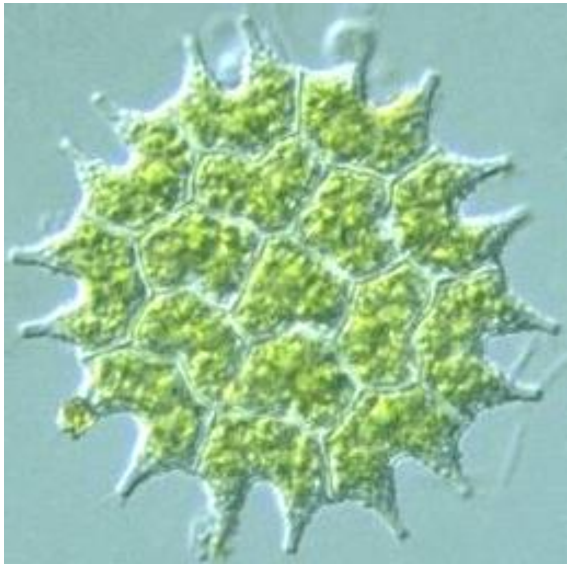
Staphylococcus

KINGDOM PROTISTA

- Kingdom Protista contains all eukaryotes that are NOT Plants, Animal, or Fungi,
- There are more than 50,000 species in Protista.
- Kingdom Protista includes unicellular and a few simple multicellular EUKARYOTES.
- The cells of multicellular protists are not specialized to perform specific functions in the organisms.



Amoeba



Pediastrum

KINGDOM FUNGI

- Fungi are eukaryotes, and most are multicellular.
- The cell wall of fungi are made up of chemical chitin.
- Fungi are heterotrophic and obtain their nutrients by releasing digestive enzymes into a food source.
- Fungi act either as decomposers or as parasites in nature.

Mushroom

KINGDOM PLANTAE

- Plants are eukaryotic, multicellular and carry out photosynthesis.
- The cells of plants have cell walls, that contain the polysaccharide cellulose.
- Plant cells are specialized for different functions.
- Kingdom Plantae includes mosses, ferns, cone-bearing plants (gymnosperms), and flowering plants (angiosperms).

fern

Flowering plant

KINGDOM ANIMALIA

- Animals are multicellular, eukaryotic, and heterotrophic.
- Animal cells have NO CELL WALLS.
- Most members of the Animal Kingdom can move from place to place.
- Fish, Birds, Reptiles, Amphibians, and mammals-including humans belong to the Kingdom Animalia.
- This Kingdom also includes sponges, jellyfish, worms, sea stars, and insects.

jellyfish

elephant

Six-Kingdom System

Kingdom	Cell type	Number of cells	Nutrition
Archaebacteria	prokaryotic	unicellular	autotrophy and heterotrophy
Eubacteria	prokaryotic	unicellular	autotrophy and heterotrophy
Protista	eukaryotic	unicellular and multicellular	autotrophy and heterotrophy
Fungi	eukaryotic	unicellular and multicellular	heterotrophy
Plantae	eukaryotic	multicellular	autotrophy and (rarely) heterotrophy
Animalia	eukaryotic	multicellular	heterotrophy

PROKARYOTIC
EUKARYOTIC

UNICELLULAR
MULTICELLULAR

AUTOTROPHIC
HETEROTROPHIC

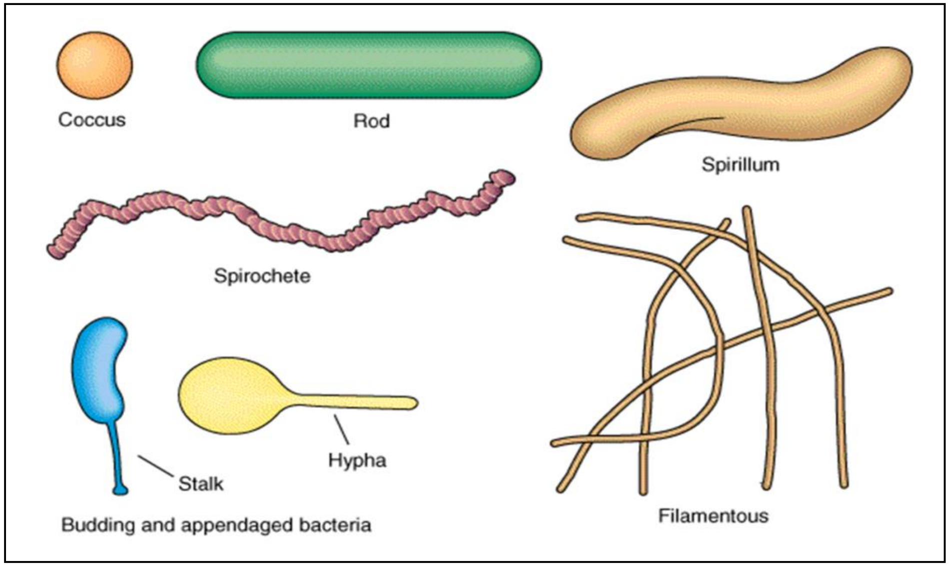
Morphology of Bacteria

- Bacterial are prokaryotes.
- Three are different shapes of bacteria:

Cocci (spherical, ovoid, or generally round shape)

Bacilli (a rod-shaped bacterium)

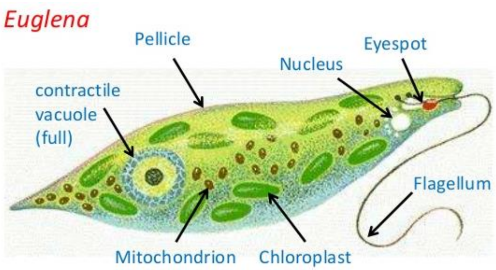
Spiral (Bacteria of spiral / helical shape)



ALGAE

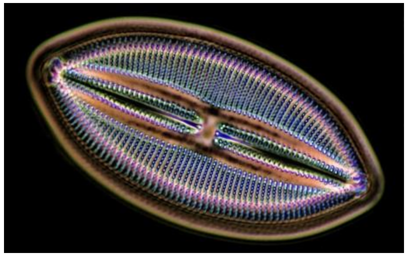
(Chlorophyll bearing thallophyta, Number: 30,000 to over 1 million species)

1. **Euglenoids**
   eg. Euglena
   food storage - lipoid polysaccharide – paramylum



2. **Green algae**
   eg. Spirogyra
   food storage – starch

3. **Golden Brown algae**
   eg. Diatoms
   food storage – oil and leucosin (a polysaccharide)
   have fucoxanthin, a brownish pigment



4. **Brown Algae**
   Mainly marine water algae
   food storage – laminarin, a polysaccharide and mannitol, a sugar alcohol

FUNGI

The fungi are **not true plants because** they do not contain chlorophyll.

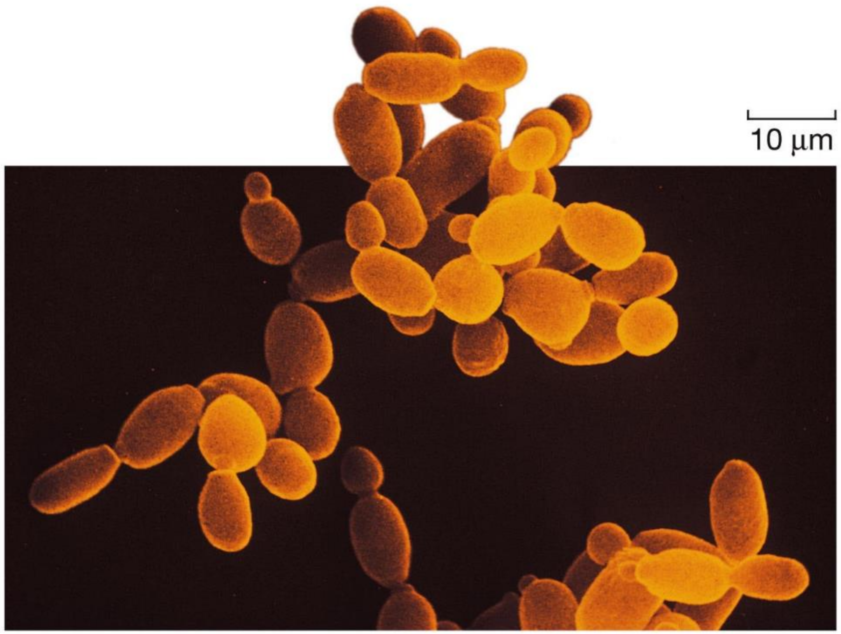
Indeed many scientists today place fungi as more closely related to animals than plants

Unicellular fungi

The members of the fungal family the zygomycetes, ascomycetes and basidiomycetes are Unicellular.

Unicelluar (=single cell)

e.g. , Yeasts: Budding: mitosis followed by asymmetrical cell division.



Saccharomyces sp.

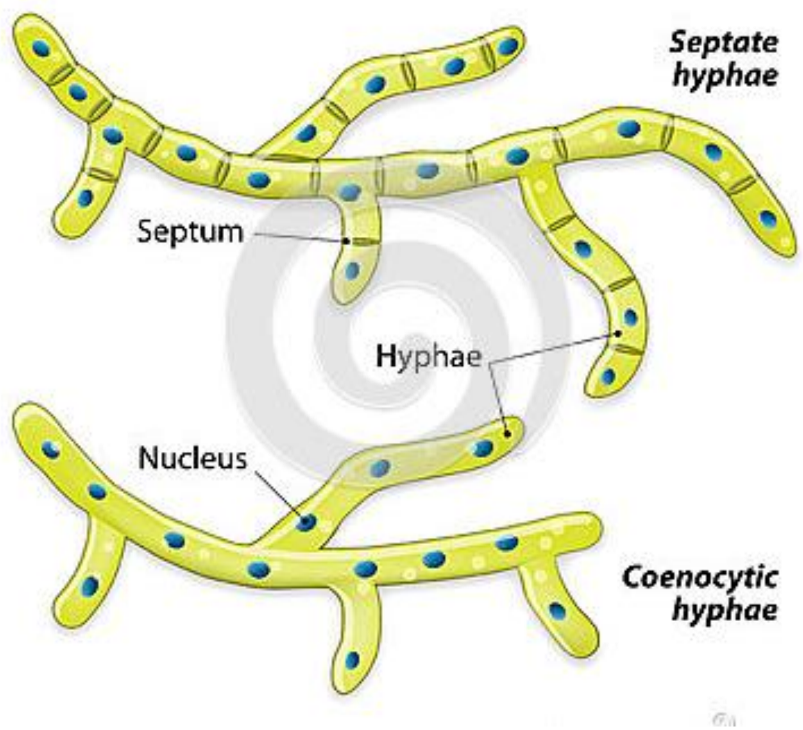
Multicellular fungi

Multicellular fungi:

- Body is a **mycelium**—composed of tubular filaments called **hyphae.** (singular hypha)
- Hyphae cell walls have **chitin**.
- Some hyphae have incomplete cross walls or **septa**, and are called **septate**.
- Hyphae without septa are called **coenocytic**.

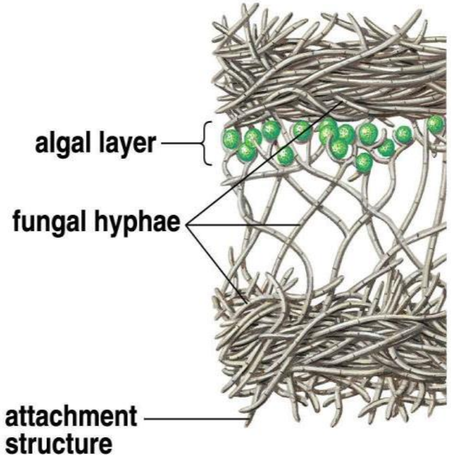
Multicellular fungi

- Some hyphae have incomplete cross walls or **septa**, and are called **septate**.
- Hyphae without septa are called **coenocytic**.



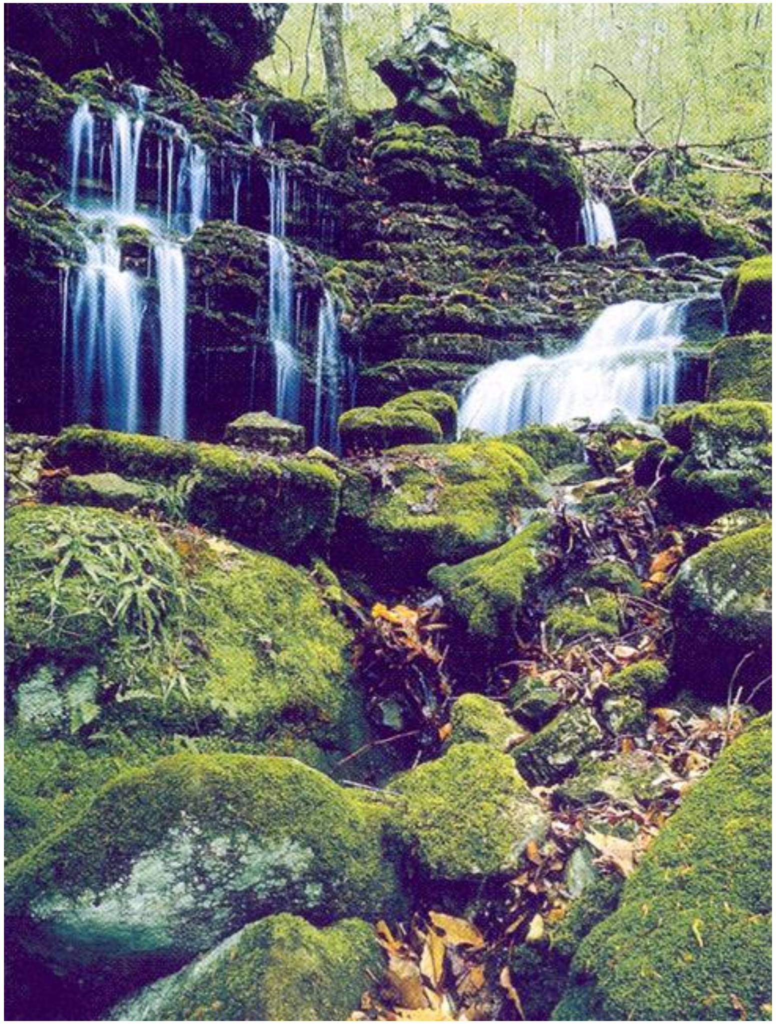
LICHENS:
Symbiotic Association
Nature's Perfect Marriage

- **Lichens is the association of algae and fungi**
- **Lichens is association of fungus and photosynthetic organism**
- **Mostly ascomycetes fungi associated with lichens**
- **The members of the algal class cyanophyceae or chlorophyceae associated in the lichens.**
- **Can survive the harshest environmental condition.**
- **Lichens are very sensitive to toxic compounds—good indicators of air pollution.**
- **Lichens are great ecological markers**
- **Many Lichens have medicinal properties**



BRYOPHYTES

- Do not have vascular tissue for support or conduction of water & mineral and food.
- Require a constantly moist environment
- Cells must be in direct contact with moisture
- Sperm must swim to egg through water droplets

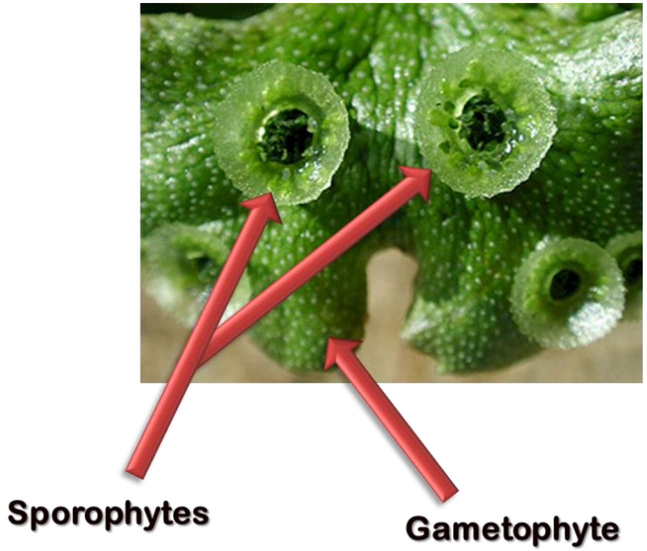


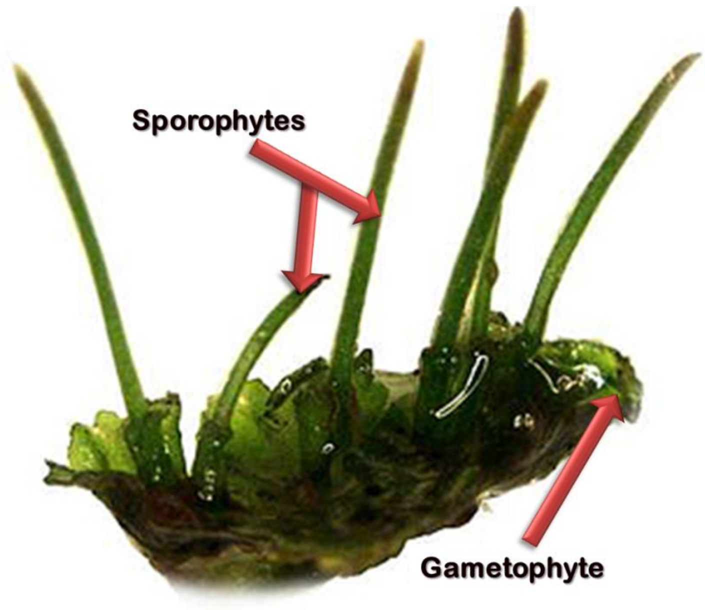
Classes of Bryophytes

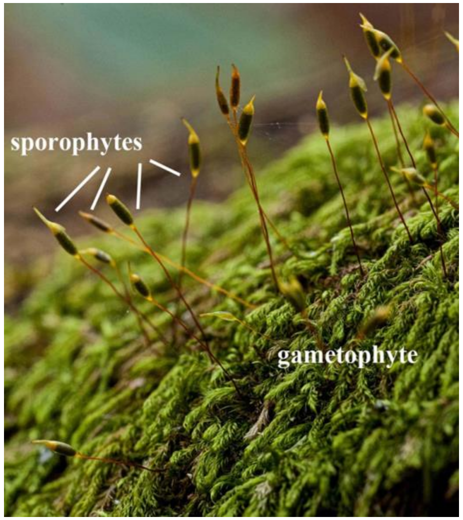
(1) Hepatophyta (liverwort)
(2) Anthocerophyta (Hornworts)
(3) Moss (Hornworts)

- Gametophyte (n) is dominant phase of life cycle

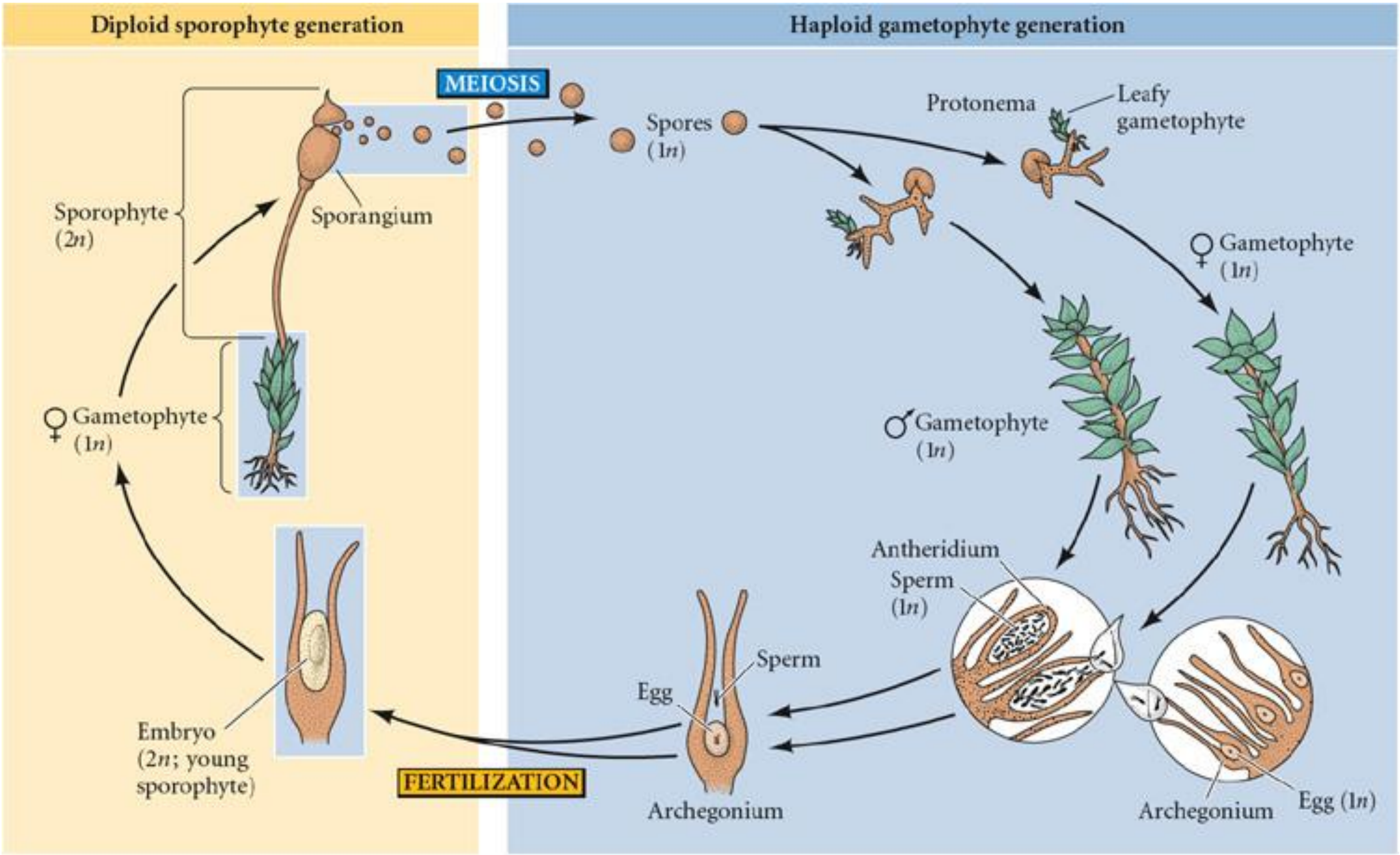
- Sporophyte (2n) phase of life cycle is small







Simplified Lifecycle of a Moss (Bryophytes)



PTERIDOPHYTA

- **Broad leaves called fronds**
- **Leaflets called pinnae**
- **Sporangium are formed on the underside of the fronds.**
- **Unfolding fronds are called fiddleheads.**
- **Spores are dispersed by the wind.**
- **Sporangium produces spores.**
- **Spores germinate to produce gametophyte phase.**

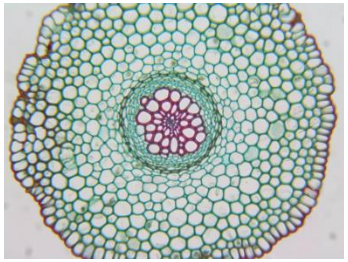
Pteris

Fiddleheads

- **Four main classes based on reproductive characters:**

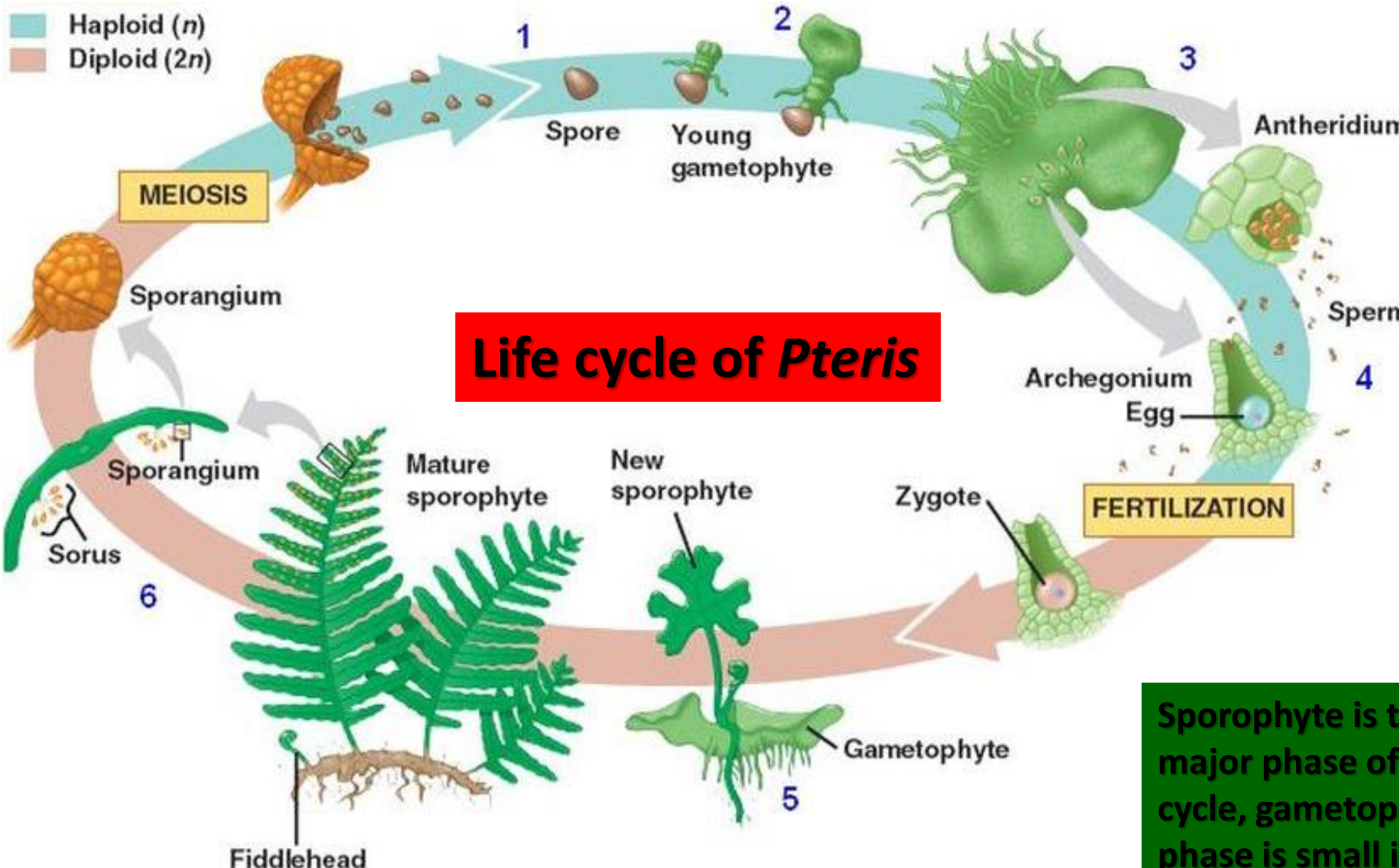
(1) Psilophyta (Whisk Ferns)
(2) Lycophyta (Spike Mosses)
(3) Sphenophyta (Horsetails)
(4) Pterophyta (True Ferns)

Frond containing spores at lower surface



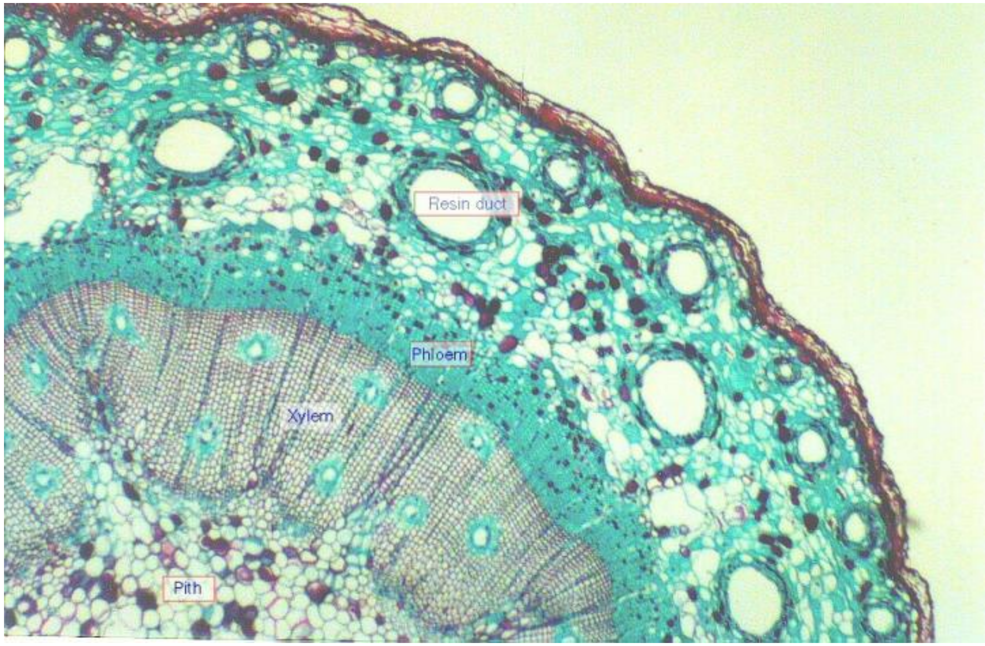
T.S of Rachis showing vascular tissue (xylem and Phloem)

Simplified Lifecycle of a Pteris (Pteridophyta)



Sporophyte is the major phase of life cycle, gametophyte phase is small in pteridophyte.

GYMNOSPERMS



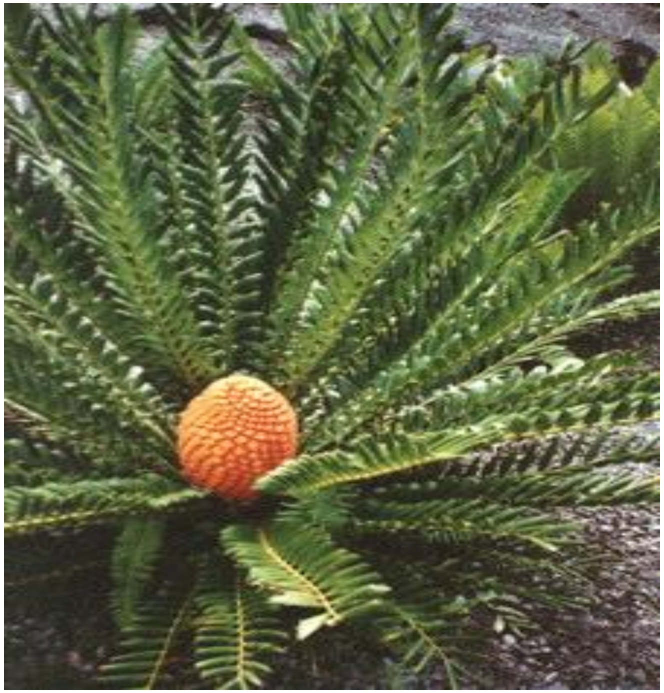
- **Root, stem, leaf: present**
- **Well developed vascular tissue**
- **No true flower and fruits**
- **Reproductive structures called as Cones**
- **Example: *Cycas, Pinus, Taxys, Gnetum***

Gymnosperms

- *Gymnos* means naked, *sperm* means seed: gymnosperm = naked seeds
- Gymnosperms have seeds with no covering (ie: a fruit or a seed coat). They bear woody cones that hold the seeds.
- There are 700 living species placed into four divisions: Conifers, Cycads, Ginkgos, and Gnetales

GYMNOPSERMS
Cycadophyta (Cycads)

- Large fernlike leaves
- Plants are either males or females
- Plants produce gametes in large strobilus



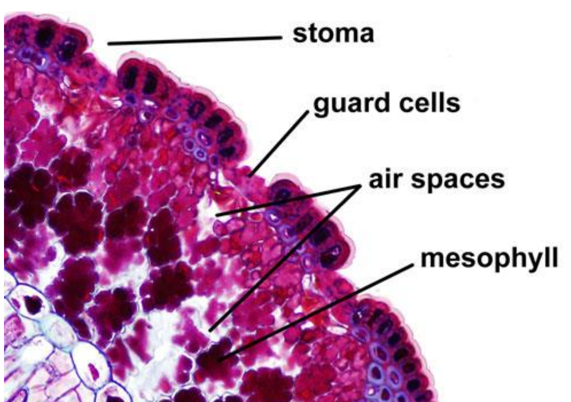
GYMNOPSERMS
GINKGOPHYTA (*Ginkgo biloba)*

- Only one species in present day
- Bear male and female cones on separate plants.
- Male produces pollen in strobilus-like cones.
- Female bears seed which develop a fleshy outer covering
- Plants are resistant to air pollution

GYMNOPSERMS

Coniferophyta
(Cone-bearing trees)

- **Cone bearing**
- **needles with thick waxy covering**
- **Stomata in cavities below surface**
- **Seeds are carried on the surfaces of cones**
- **Evergreen and adapted to cold and dry habitats**



Pine needle cross section

Male & Female cones

Gnetum

GYMNOPSERMS

Gnetophyta

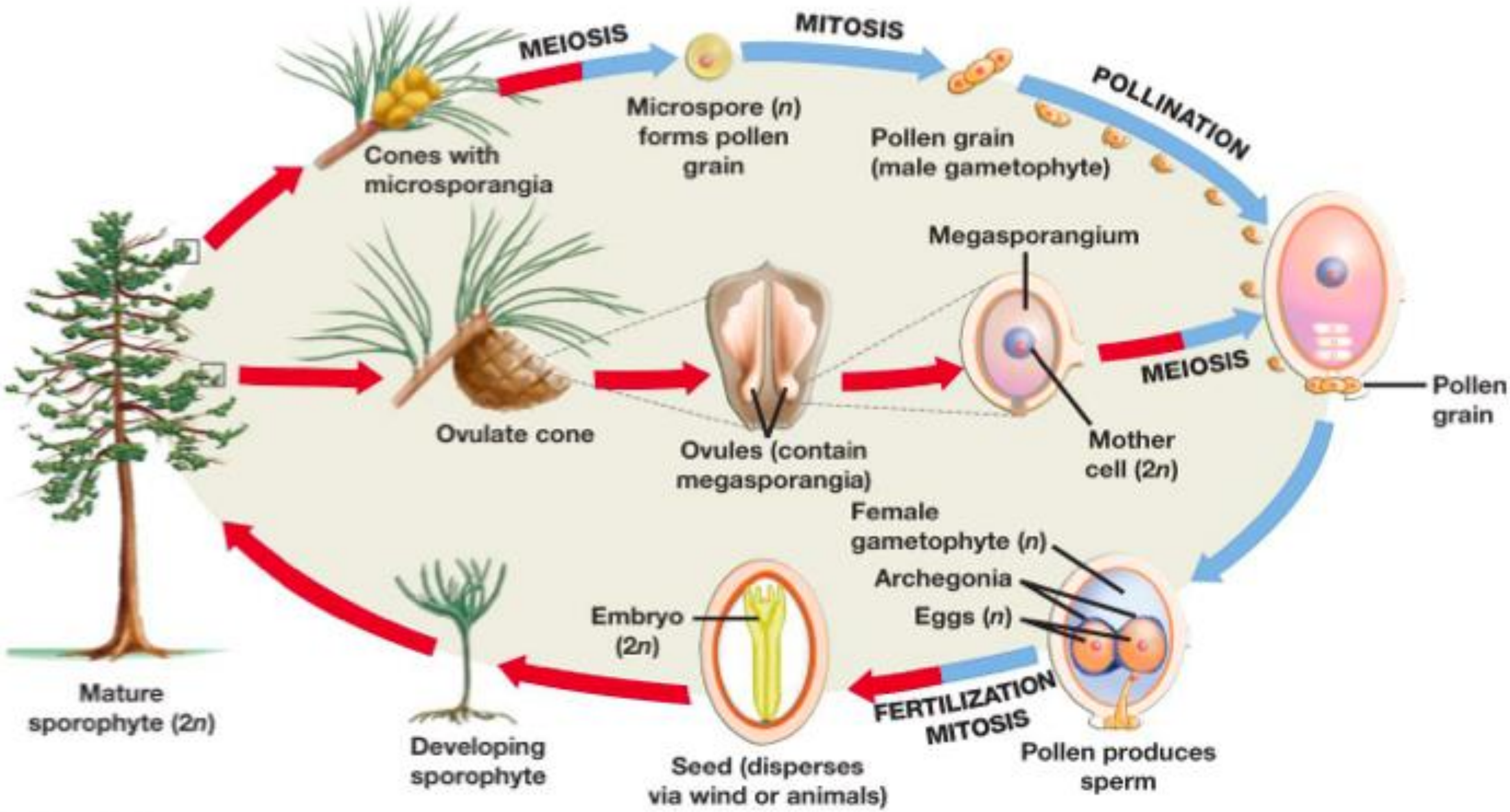
There are three genera:

1. *Gnetum* : A tropical climbing plant
2. *Ephedra* (Shrub-like plants)
3. *Welwitschia* (Desert dweller with large tuberous root). Has only two leaves and may live 1000 yr.

Ephedra

Welwitschia

Alternation of Generations in Gymnosperms

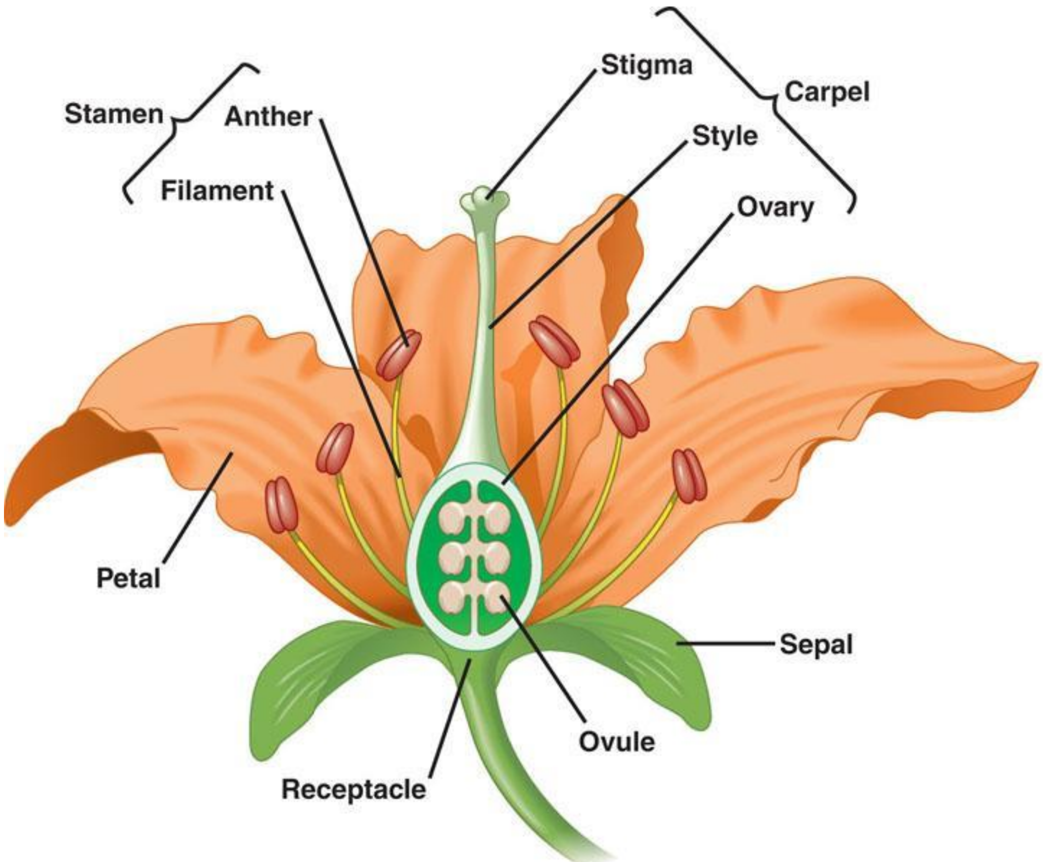


Angiospermae (Anthophyta – flowering plants)

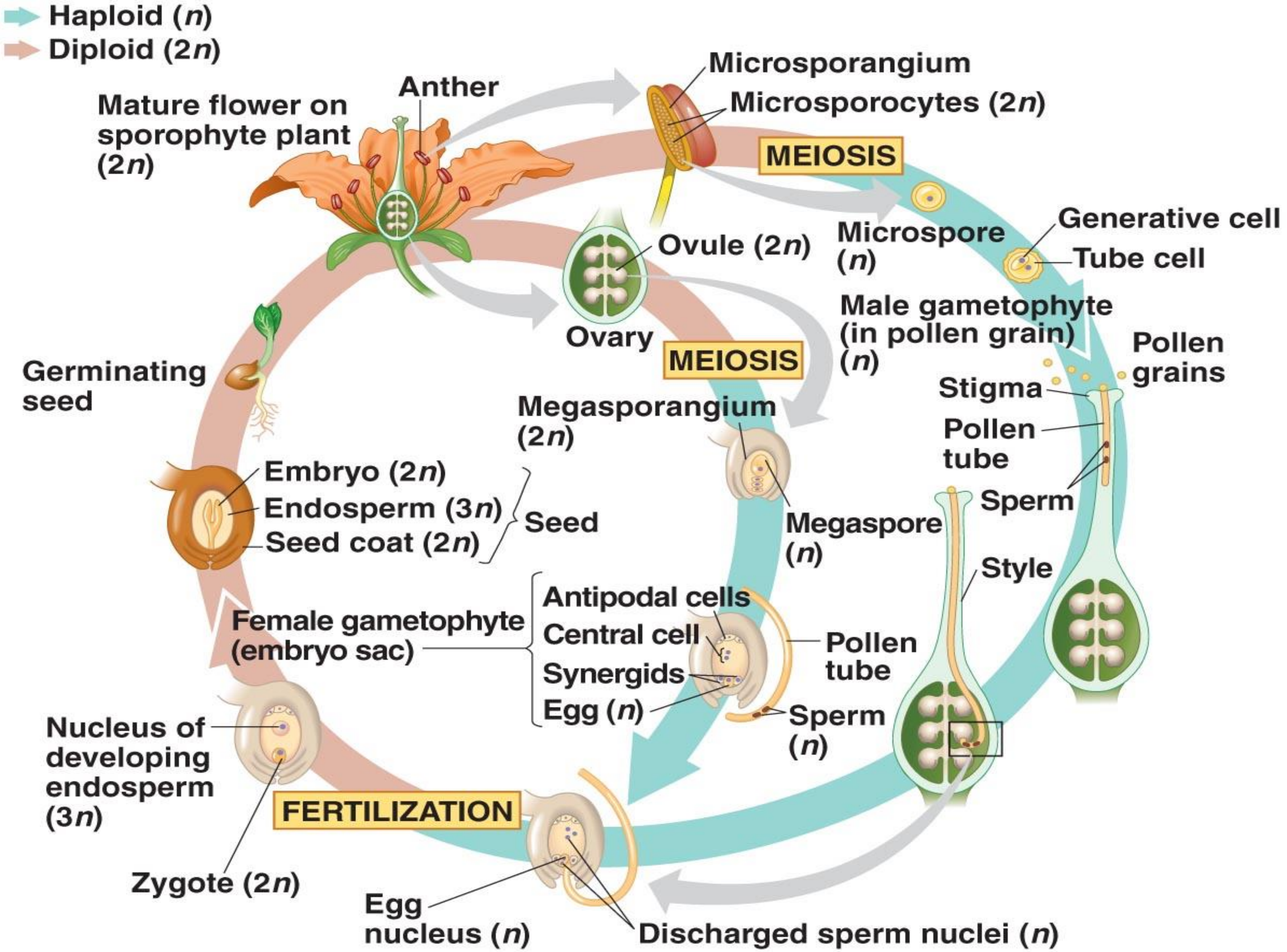
- Angiosperms all produce flowers containing the sexual reproduction structures.
- The angiosperms (*angios*=covered, *sperm* = seed) produce fruits and seeds.
- There are presently 235,000 known living flowering plants species.

What are the ANTHOPHYTA?

- Flowering plants
- Seeds are within a layer of protective tissue
- Flowers, ovaries, pollinators (insects, etc.)



Life cycle (Alternation of Generations) of Angiosperms



PLANT SYSTEMATICS

PLANT SYSTEMATICS

The four main groups of plants contains millions of species:

- **Mosses** (nonvascular plants) – Bryophytes (15,600 species)
- **Ferns** (vascular and seed less plants, spore bearing plants) – Pteridophytes (11,000 species)
- **Gymnosperms** (vascular and naked seeds, cone-bearing Plants (760 species)
- **Angiosperms** (vascular and covered seeds) - Flowering Plants (235,000 species)

Need of scientific name of an organism and classification

- Taxonomy: The science of classification.
- Plant taxonomy: The science of classification of plants.
- Scientific names are necessary because the same common name is used for different plants in different areas of the world.

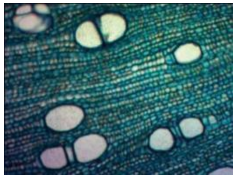
PLANT SYSTEMATICS

Karl von Linne (1707-1778)

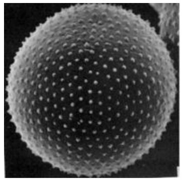
- Swedish botanist Carolus Linnaeus introduced **Binomial Nomenclature**.
- **Binomial nomenclature =** Uses two Latin words to indicate the genus and the species. The first word is the genus and the second word is the species.
- Example- the botanical name of dates is *Phoenix dactylifera*
- Published the book '**Species Plantarum**' in 1753.
- Classified the plants based on the plant's method of reproduction and structure of reproductive parts.

Morphology to Molecules

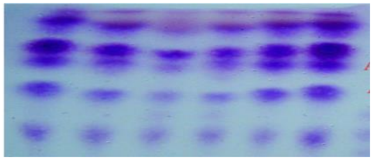
Morphology



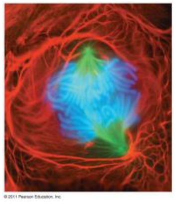
Anatomy



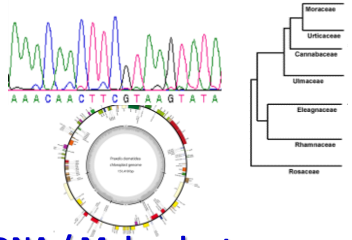
Pollen



Chemistry



Chromosomes



DNA / Molecular taxonomy

Species concept

- **Species is the basic unit of classification.**
- **Plants in the same species consistently produce plants of the same types.**

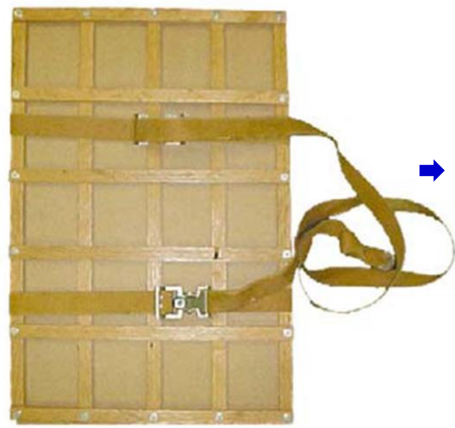
TAXONOMIC RANKS OF LAND PLANTS	ENDING	EXAMPLE TAXON
Kingdom	(various)	**Plantae**
Phylum [Division]	**-phyta**	**Magnoliophyta**
Subphylum [Subdivision]	-phytina	Magnoliophytina
Class	**-opsida**	**Asteropsida**
Subclass	-idae	Asteridae
Order	**-ales**	**Asterales**
Suborder	-ineae	Asterineae
Family	**-aceae**	**Asteraceae**
Subfamily	-oideae	Asteroideae
Tribe	-eae	Heliantheae
Subtribe	-inae	Helianthinae
Genus	(various)	***Helianthus***
Subgenus	(various)	*Helianthus*
Section	(various)	*Helianthus*
Series	(various)	*Helianthus*
Species [abbr. sp. (sing.), spp. (pl.)]	(various)	***Helianthus annuus***
Subspecies [abbr. subsp. or ssp. (sing.), subspp. or sspp. (pl.)]	(various)	*Helianthus annuus* ssp. *annuus*
Variety [abbr. var. (sing.), vars. (pl.)]	(various)	*Helianthus annuus* var. *annuus*
Form [abbr. f.]	(various)	*Helianthus annuus* f. *annuus*

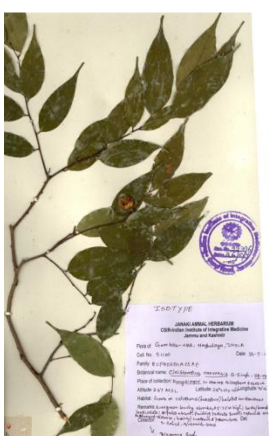
The name of the plants must should be written in italics. For example *Phoenix dactylifera*

Plant collecting and Documentation

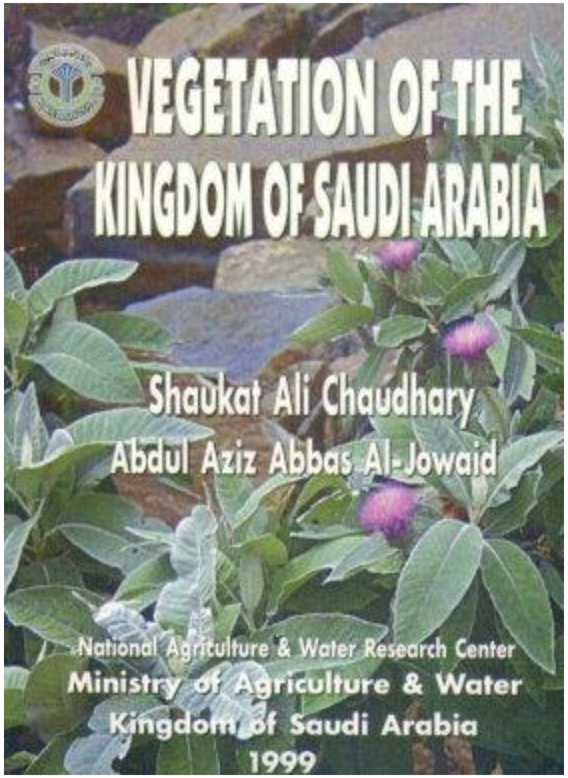
- **A HERBARIUM is a collection of dried plants systematically named and arranged for ready reference and study.**

- **To make a herbarium specimen, the plant is collected, and notes are made about it. The plant is then pressed until dry between blotters that absorb moisture and mounted onto a herbarium sheet with a suitable label.**

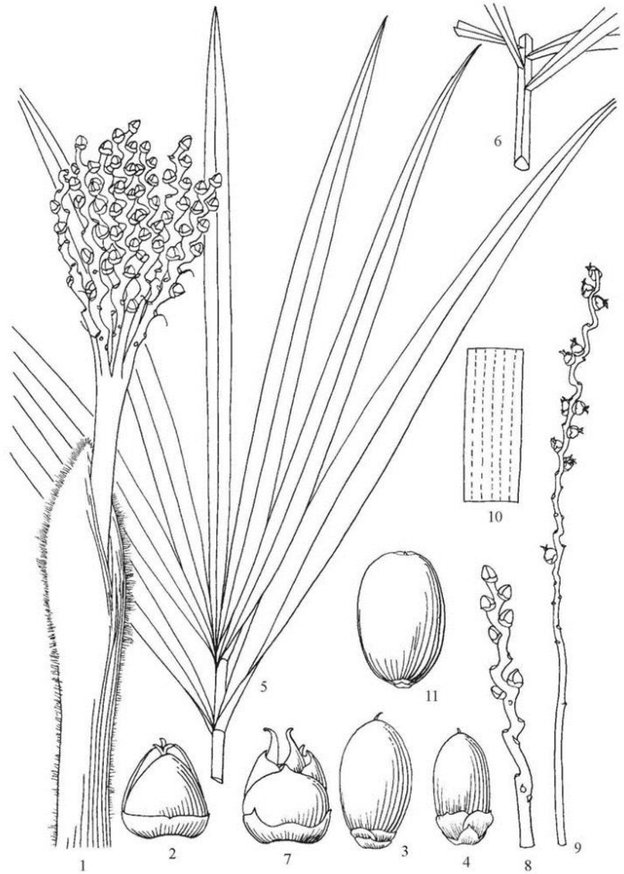




The FLORA is the main Resources of Taxonomic Information



Flora = it is the documentation of plants occurring in a particular region.

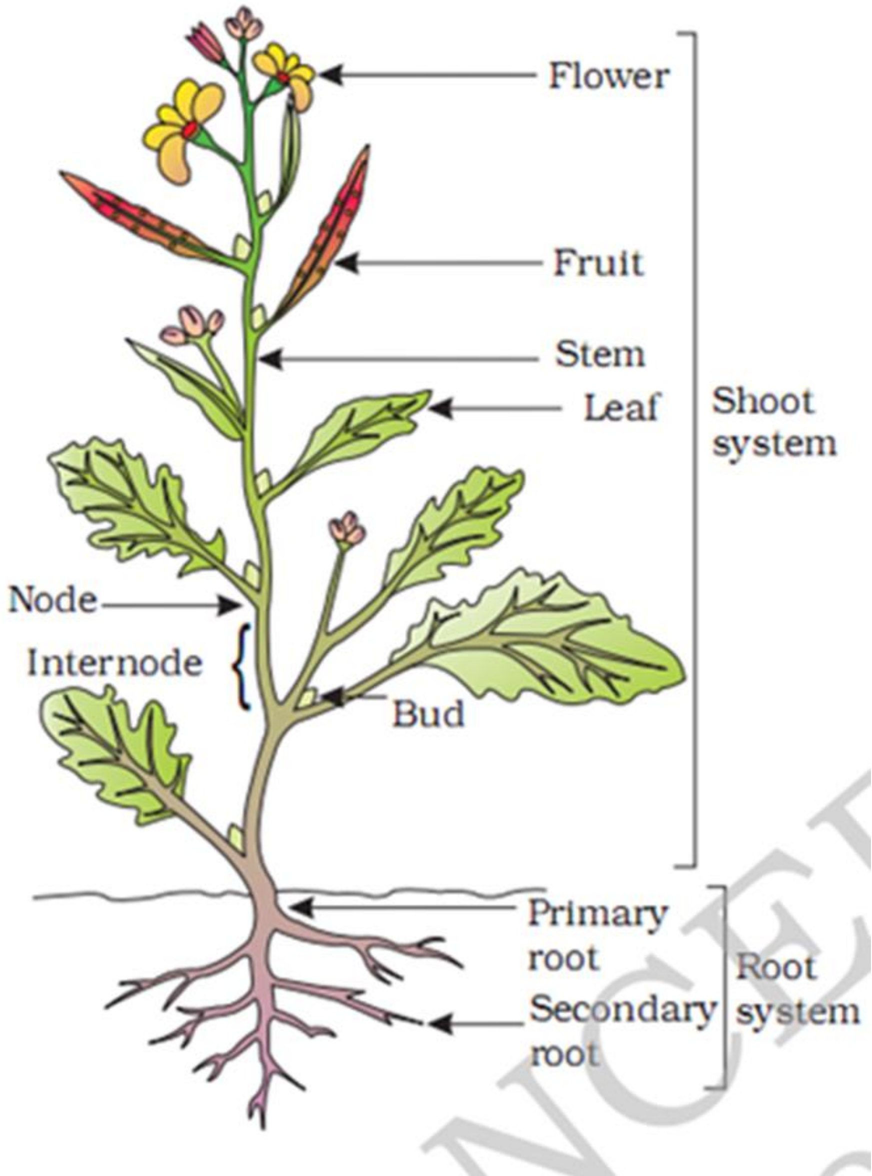


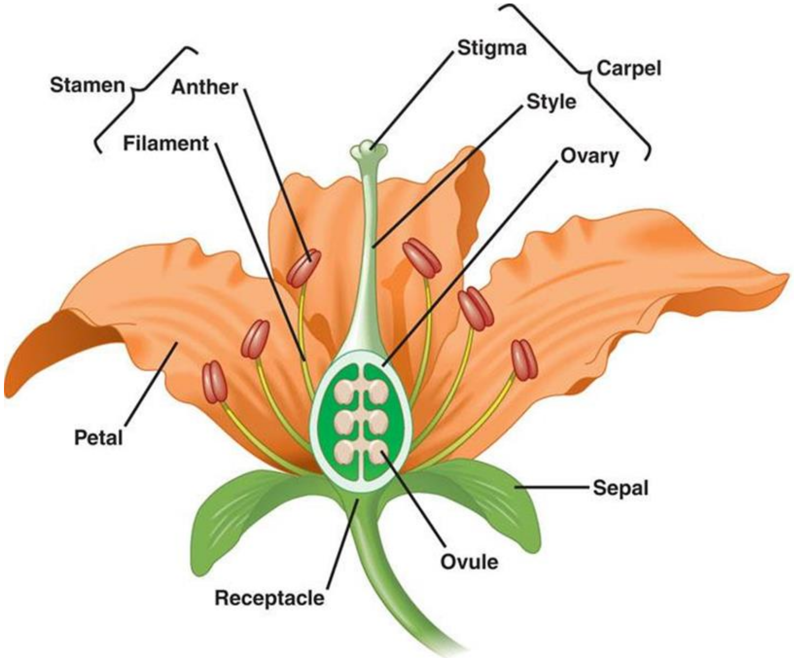
Description of plant need taxonomic terminology

Phoenix dactylifera Linnaeus, Sp. Pl. 2: 1188. 1753.

Stems solitary or clustered and then with few shoots, to 30 m tall, to 50 cm in diam., rough with persistent, diamond-shaped leaf bases. Leaves 3-5 m; sheath and petiole to 1 m; rachis 1-2 m; acanthophylls many per side of rachis; pinnae to 200 per side of rachis, linear, irregularly arranged and spreading in different planes; middle pinnae to 40 × 2 cm. Male inflorescences erect, to 1 m, with many rachillae, these ca. 30 cm; female inflorescences erect, becoming pendulous, to 2 m, with to 150 rachillae, these to 40 cm. Fruits variable in shape, usually oblong, to 7 × 3 cm, brown or black; endosperm homogeneous.

TAXONOMIC TERMINOLOGY





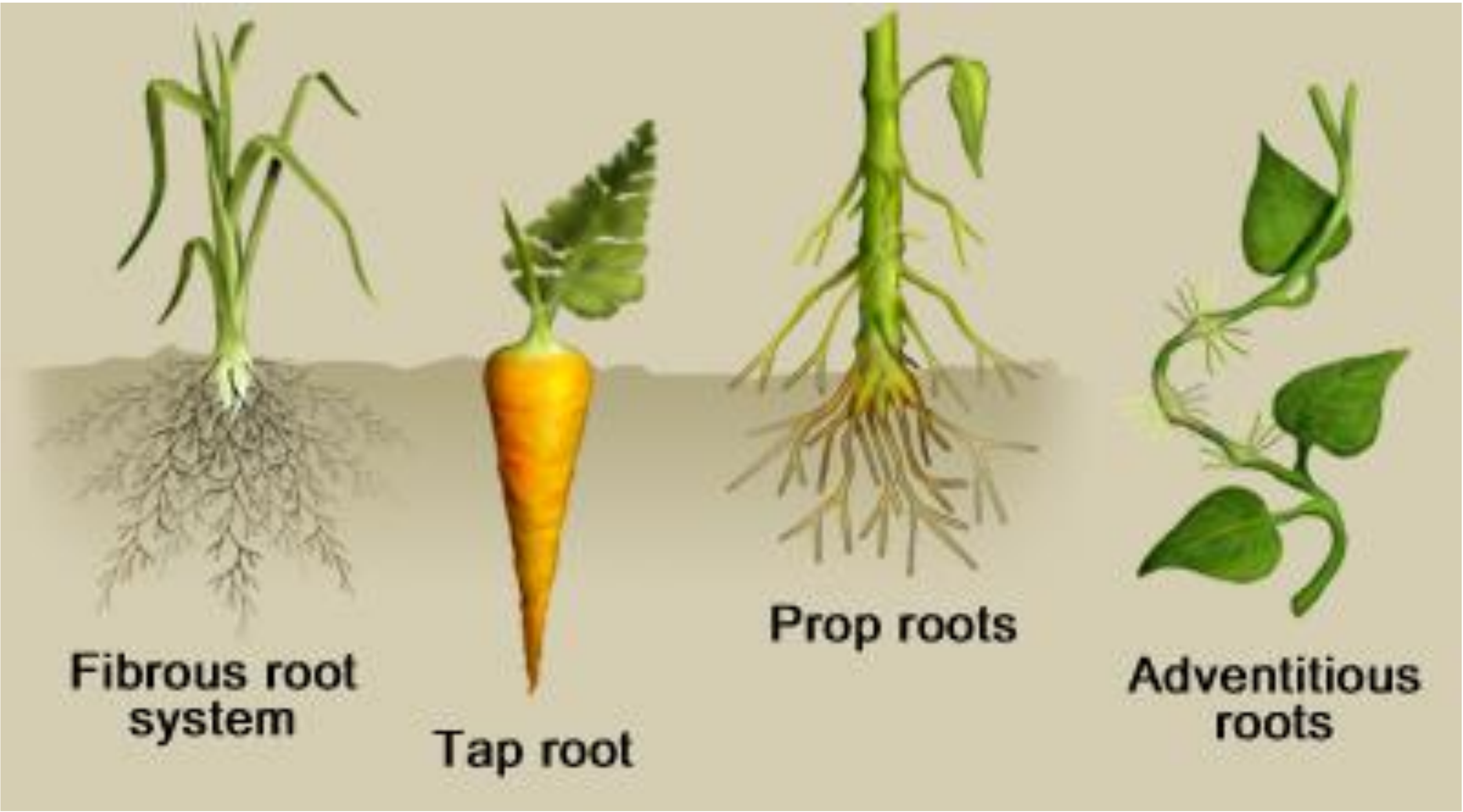
Plant parts

Habit of plant

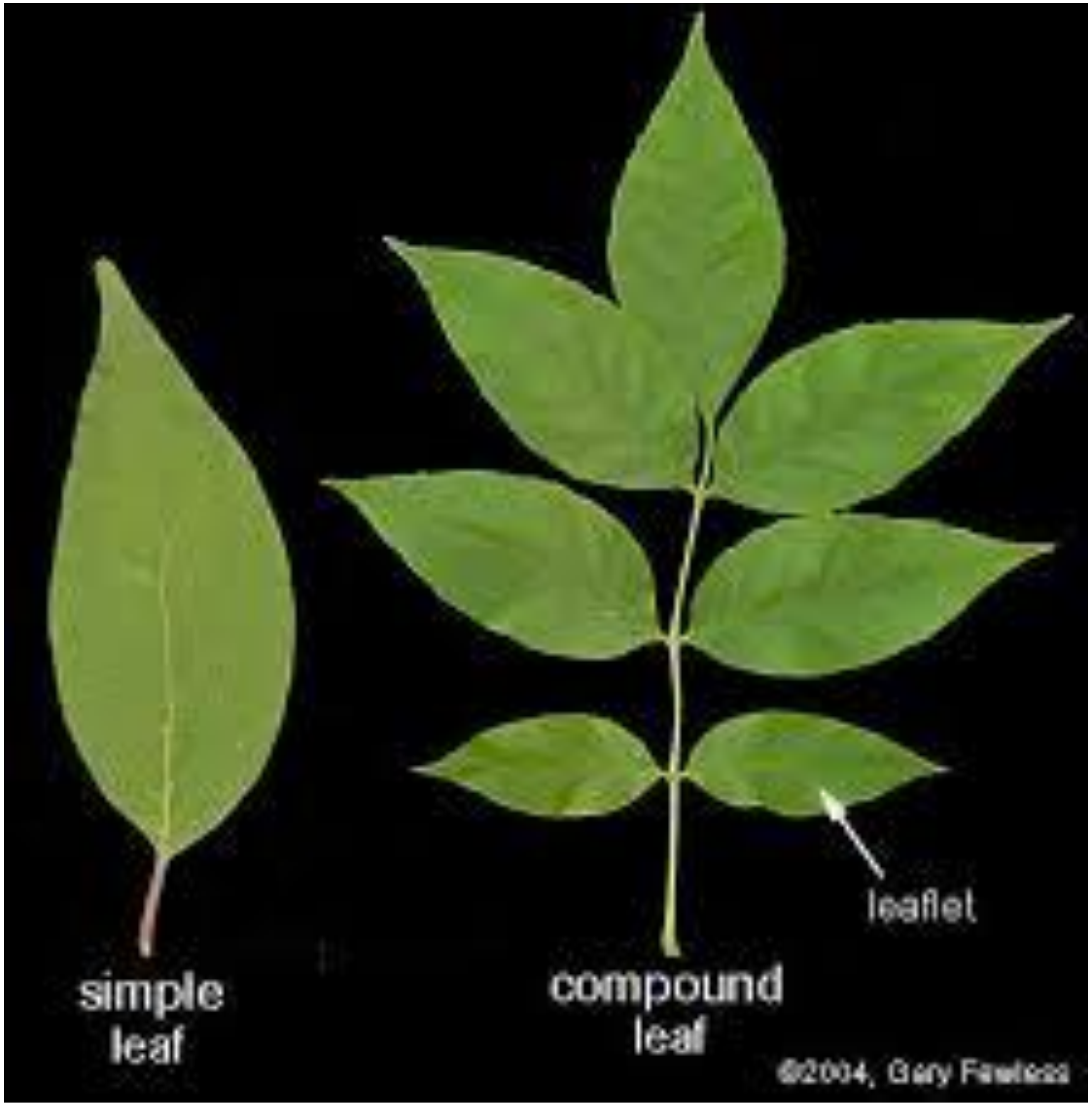
Herb. A usually low, soft or coarse plant with annual aboveground stems.
Shrub. A much-branched woody perennial plant usually without a single trunk.
Tree. A tall, woody perennial plant usually with a single trunk.
Vine *or* Liana. An elongate, weak-stemmed, often climbing annual or perennial plant, with herbaceous or woody texture.

shrubs

Types of Roots



LEAF

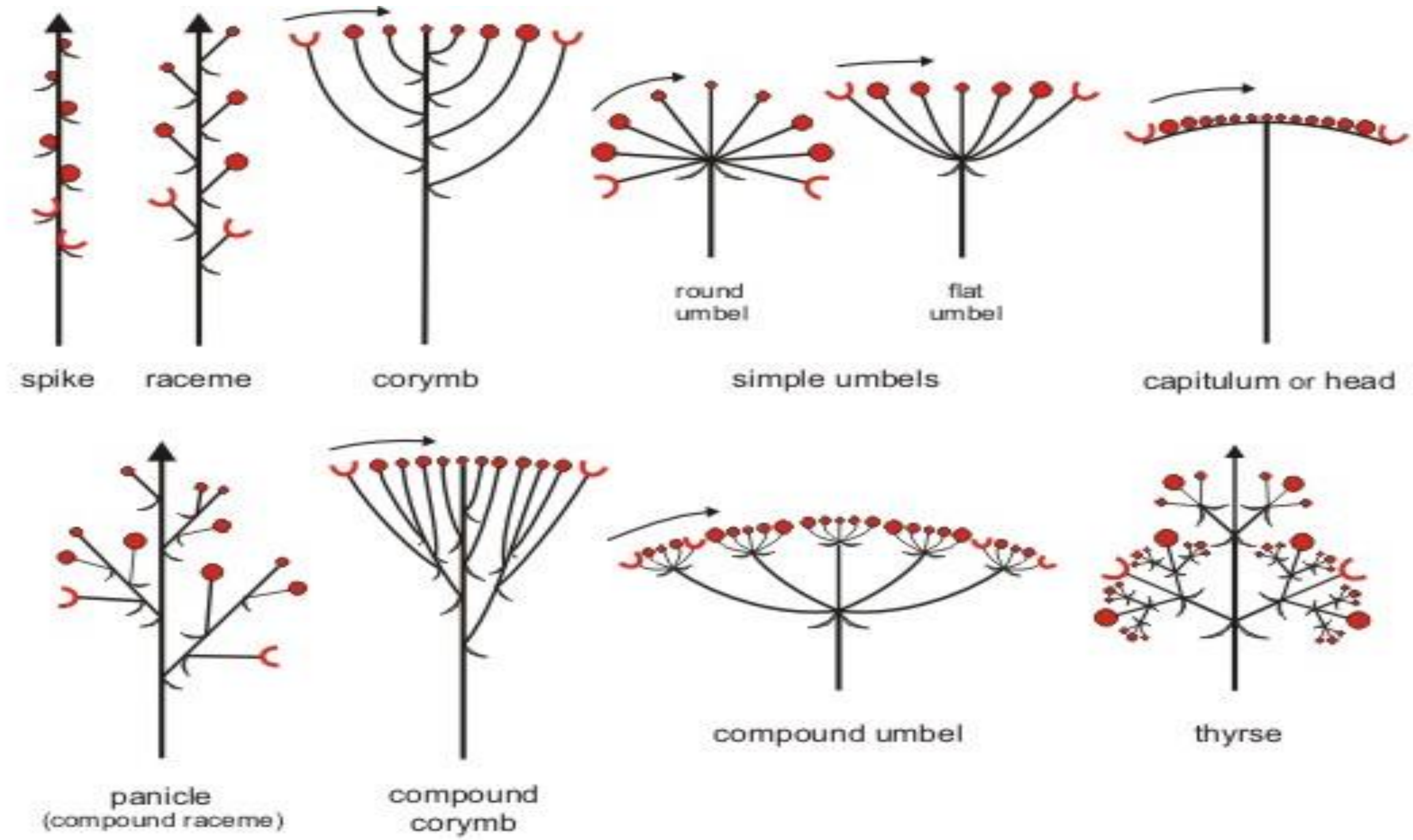


There are large number of terminology leaf based on:

- Margin
- Apex
- Base
- Venation
- Arrangement
- Petiole
- Modifications

Inflorescence types

- **An inflorescence is an arrangement of one or more flowers on a floral axis**



Inflorescence types

- **Inflorescence type determined by:**
  - Number of flowers
  - Positional relationships
  - Degree of the development of their pedicels
  - Nature of their branching pattern

Simple Inflorescences

- Terminal: flower at the tip of a stem.
- Example: ***Hibiscus coccineus***

Scarlet rose-mallow (*Hibiscus coccineus)*

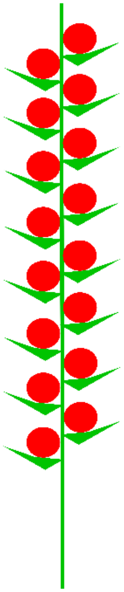
Compound Inflorescences

- Two or more flowers in every inflorescence

- Example: Sunflower

Compound Inflorescences

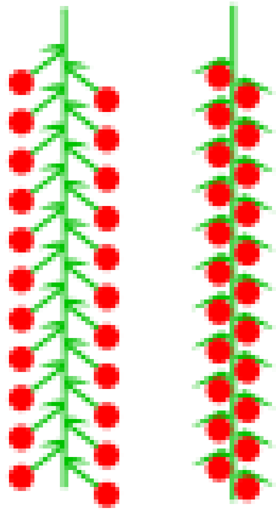
- **Spike**: elongate inflorescence; flowers are sessile, dense, or remote from one another



Spiked blazing star (*Liatris spicata*)

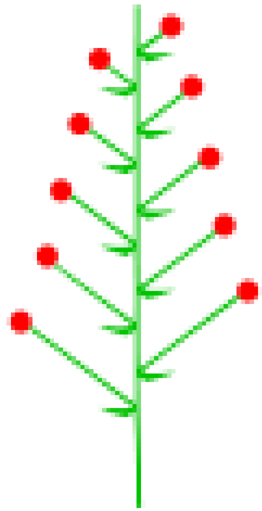
Compound Inflorescences

- **Catkin**: A spike like inflorescence of unisexual flowers; found only in woody plants.



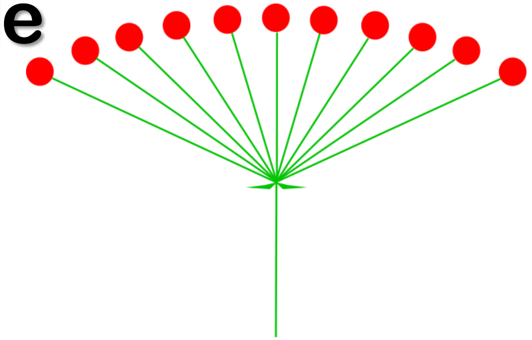
Compound Inflorescences

- **Raceme**: an elongate inflorescence of pedicellate flowers on an unbranched rachis



Compound Inflorescences

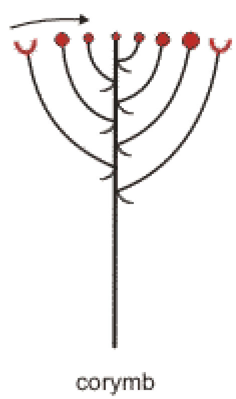
- **Umbel**: a flat-topped or somewhat rounded inflorescence in which all of the pedicels arise from a common point at the tip of the peduncle



Butterfly weed (*Asclepias* sp.)

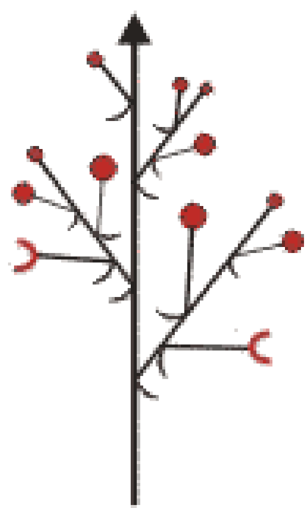
Compound Inflorescences

- **Corymb**: a flat-topped or somewhat rounded inflorescence in which the pedicels of varying length are inserted along the rachis



Compound Inflorescences

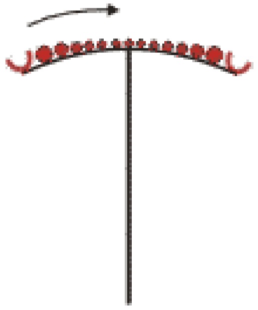
- **Panicle**: a much-branched inflorescence with a central rachis which bears branches which are themselves branched



panicle
(compound raceme)

Compound Inflorescences

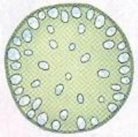
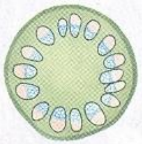
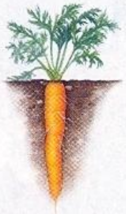
- **Head, (Capitulum) :** is a short dense spike in which the flowers are borne directly on a broad, flat peduncle, giving the inflorescence the appearance of a single flower.



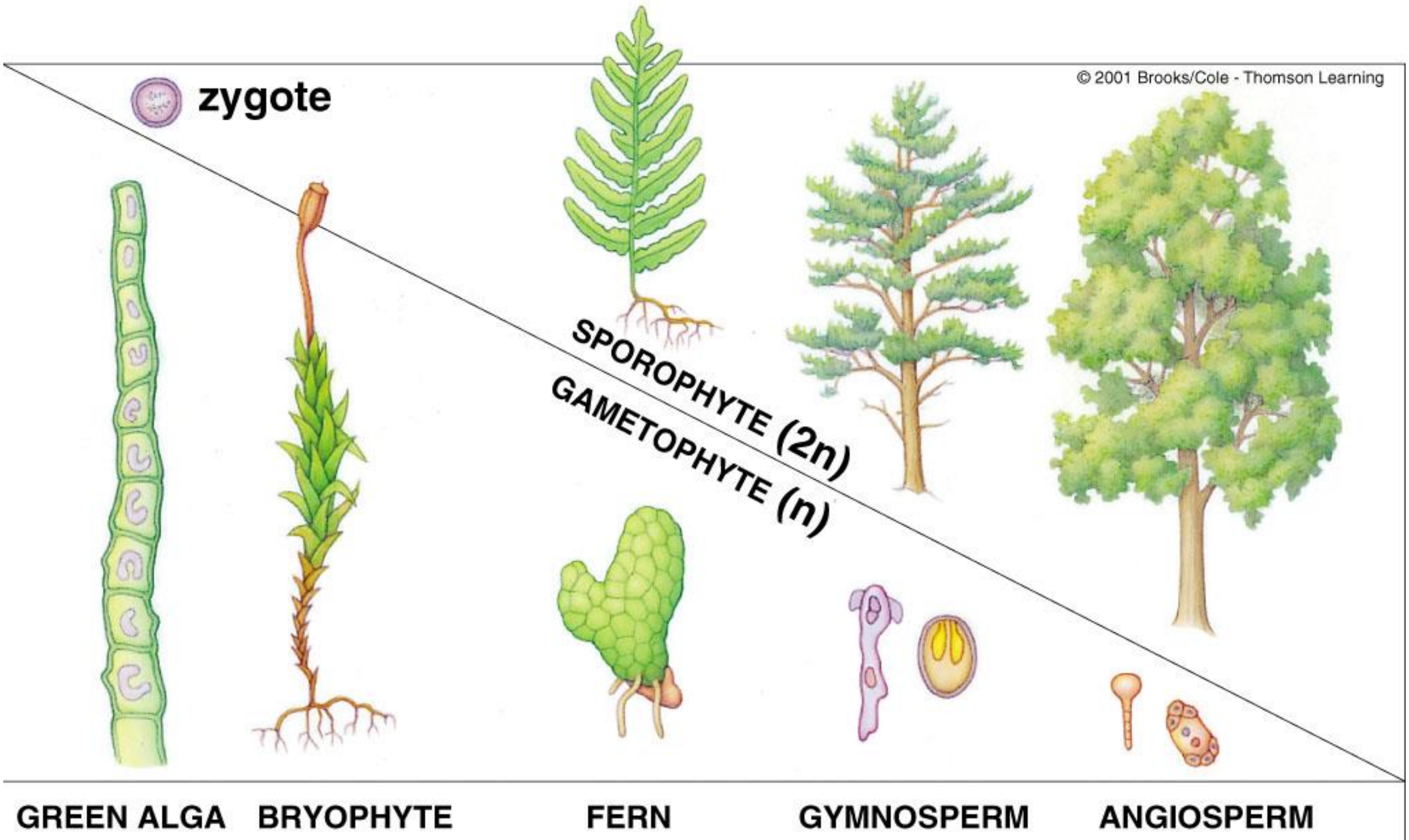
capitulum or head

Differences between dicot and monocot plants

Characteristics of Monocots and Dicots

	Monocots	Dicots
Seeds	Single cotyledon 	Two cotyledons 
Leaves	Parallel veins 	Branched veins 
Flowers	Floral parts often in multiples of 3 	Floral parts often in multiples of 4 or 5 
Stems	Vascular bundles scattered throughout stem 	Vascular bundles arranged in a ring 
Roots	Fibrous roots 	Taproot 

Switch to Sporophyte Dominance



ECOLOGY
&
ENVIRONMENTAL BIOLOGY

Ecology is the study of living organisms in relation to their habits and habitats.

HABITAT

The zone in which the organism (plants and animals) lives and where it can find food, shelter, protection and mates for reproduction.

HABIT:

Aspects of behavior or structure

ECOLOGY

The study of living organisms in relation to their habits and habitats.

HABITAT
The zone in which the organism (plants and animals) lives and where it can find food, shelter, protection and mates for reproduction.



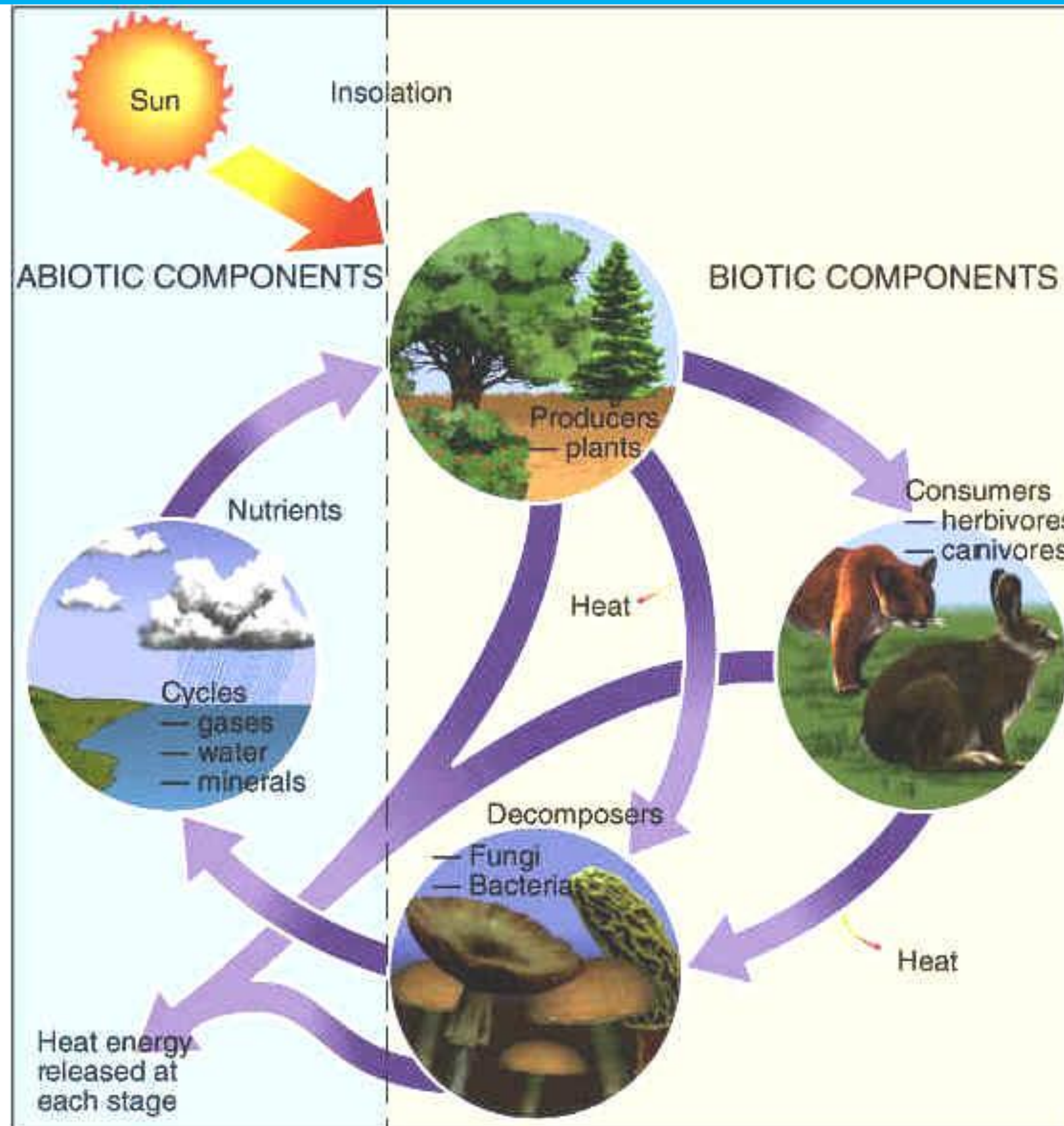



HABIT:
Aspects of behavior or structure

ENVIRONMENT

Environment is the interactions among the abiotic (physical and chemical) and biological component

- **Environmental science is an interdisciplinary academic field that integrates physical, biological and information sciences (including ecology, biology, physics, chemistry, zoology, mineralogy, oceanology, soil science, geology, atmospheric science) to the study of the environment, and the solution of environmental problems.**



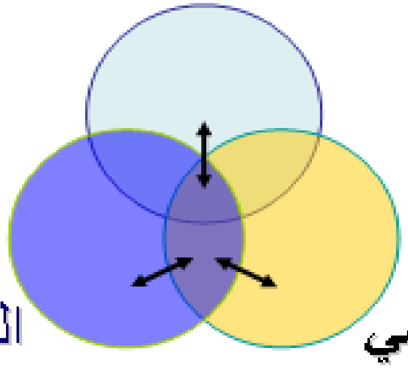
Biosphere (sphere of life)

Total portion of lithosphere, hydrosphere and atmosphere that supports the life of organisms.

مكونات المحيط الحيوي

Atmosphere

الغلاف الجوي



الغلاف المائي

الغلاف الأرضي

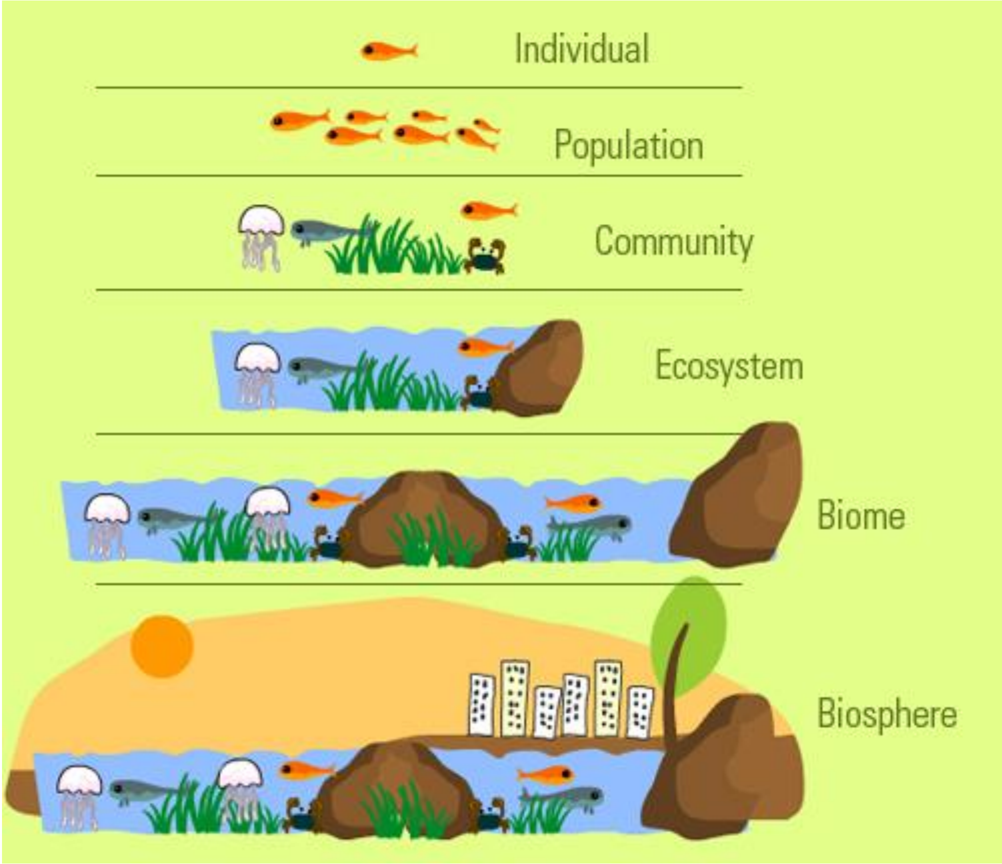
Hydrosphere

Lithosphere

Levels of organization in Ecology

In ecology, the levels of organization include:

- **Individuals** - the fundamental functional units.
- **Populations** - members of the same species co-occurring in space and time and sharing the same resources.
- **Communities** - populations of organisms living together in the same environment.
- **Ecosystems** – Dynamic systems of organisms interacting with each other and their environment.
- **Biomes** - regional ecosystem types with similar communities.



ECOSYSTEM

- **All organisms along with physical environment in a single location.**

- **Various ecosystems make up the largest life unit called biosphere.**

Structure of Ecosystem

1. Abiotic components

- **Energy** - solar energy
- **Physical factors** - temperature, light, wind, etc.
- **Chemicals** - inorganic substances (oxygen, carbon, etc.) and organic substances (carbohydrates, proteins, etc.)

2. Biotic components

- **Producers** - green plants (autotrophs)
- **Consumers** - animals (heterotrophs)

  -**Herbivores** (primary consumers)

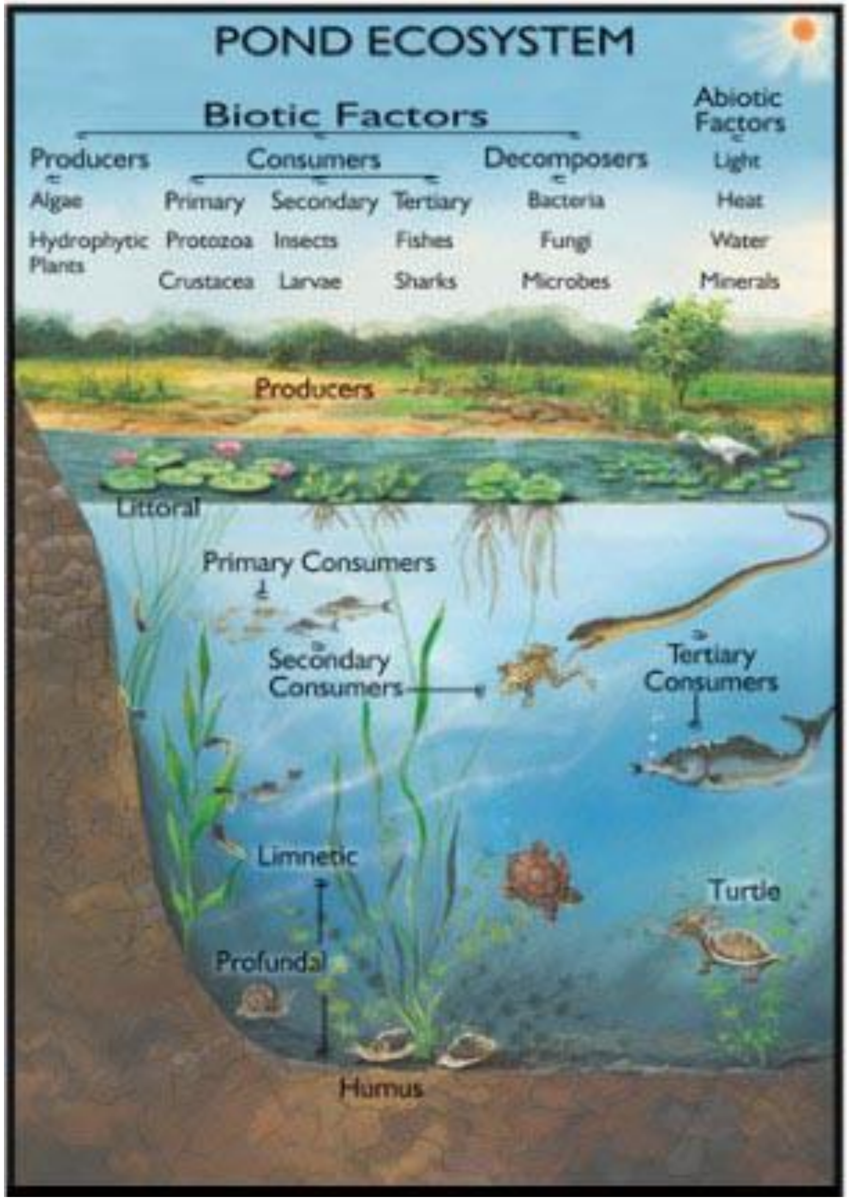
  -**Carnivores** (primary, secondary, tertiary, etc. consumers)

  -**Omnivores** (generalists)-can feed on both plants and animals.

  -**Scavengers** (top carnivores)-utilize the dead remains of animals

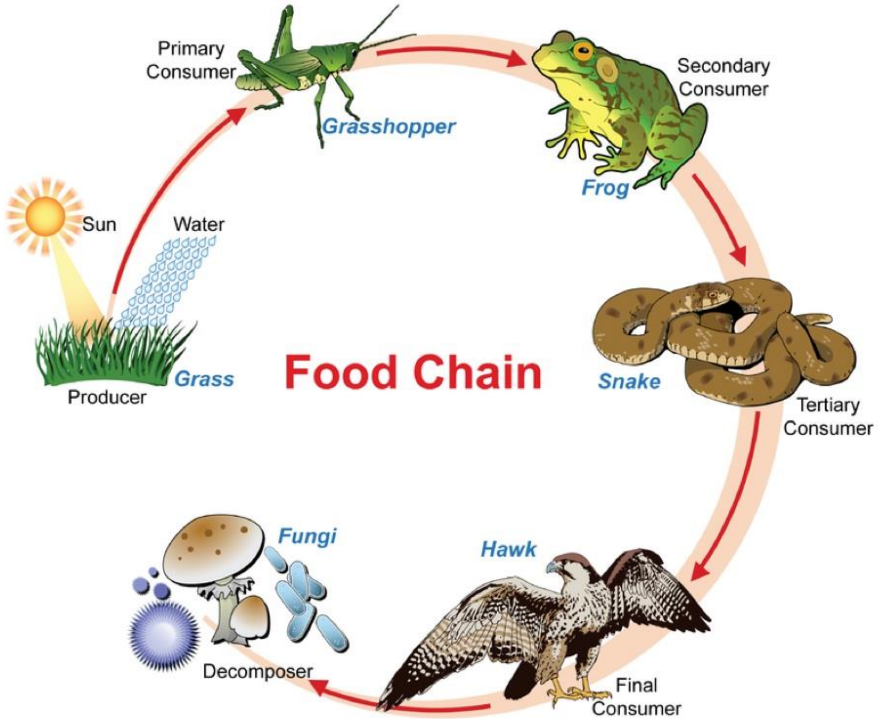
3. Decomposers (saprotrophs)

bacteria and fungi



Food Chain

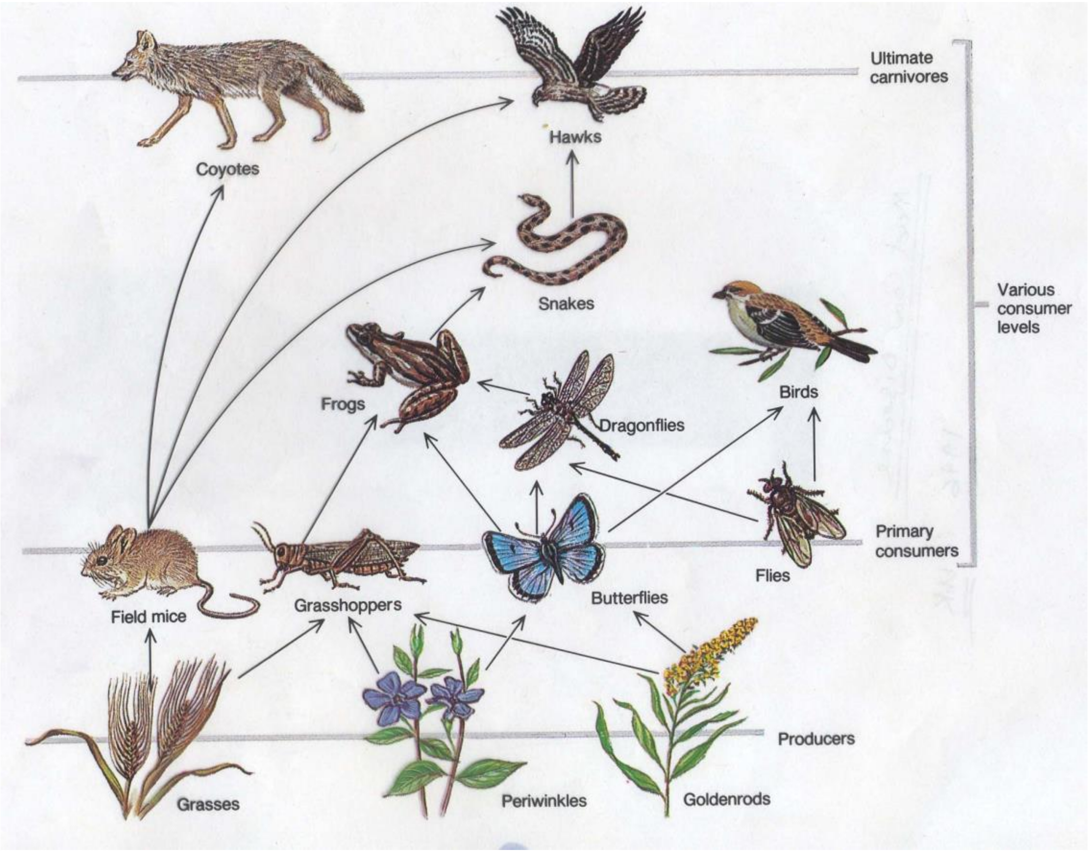
- A linear energy and chemical flow through organisms.
- In food chain, there is transfer of food from one trophic (feeding) level reaches to the other trophic level (who eats whom?).
- In the classical food chain: Plants are eaten only by primary consumers primary consumers are eaten by secondary consumers, secondary consumers are eaten by tertiary consumers, and so forth.



Food Web

- The natural interconnection of food chains is called as food web

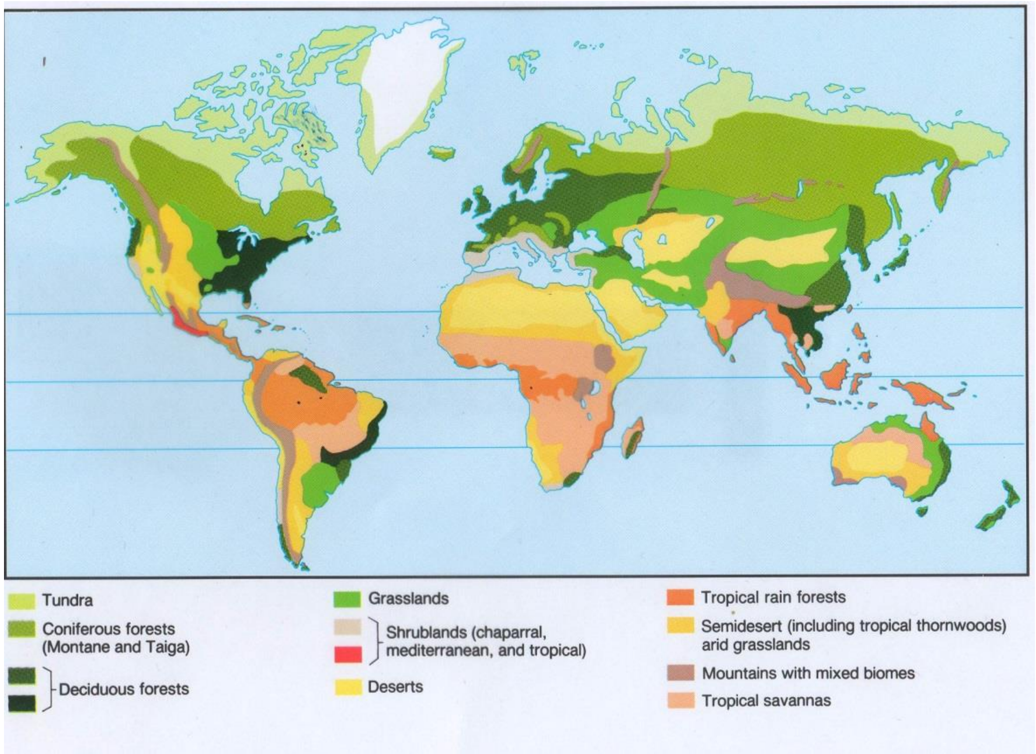
- A given organism may obtain nourishment from many different trophic levels and thus gives rise to a complex and interconnected series of energy transfers.



Zonobiomes (Biomes)

1.	Equatorial diurnal climate	المناطق المدارية اليومية
2.	Tropical	المناطق الاستوائية
3.	Subtropical (Desert)	المناطق تحت الاستوائية (الصحراء)
4.	Mediterranean	مناطق البحر المتوسط
5.	Warm temperate	المناطق المعتدلة الدافئة
6.	Temperate	المناطق المعتدلة
7.	Arid temperate (Continental)	المناطق المعتدلة الجافة (المناخ القاري)
8.	Cold temperate	المناطق المعتدلة الباردة
9.	Arctic (Tundra)	المناطق القطبية (التندرا)

Regional ecosystem types with similar communities



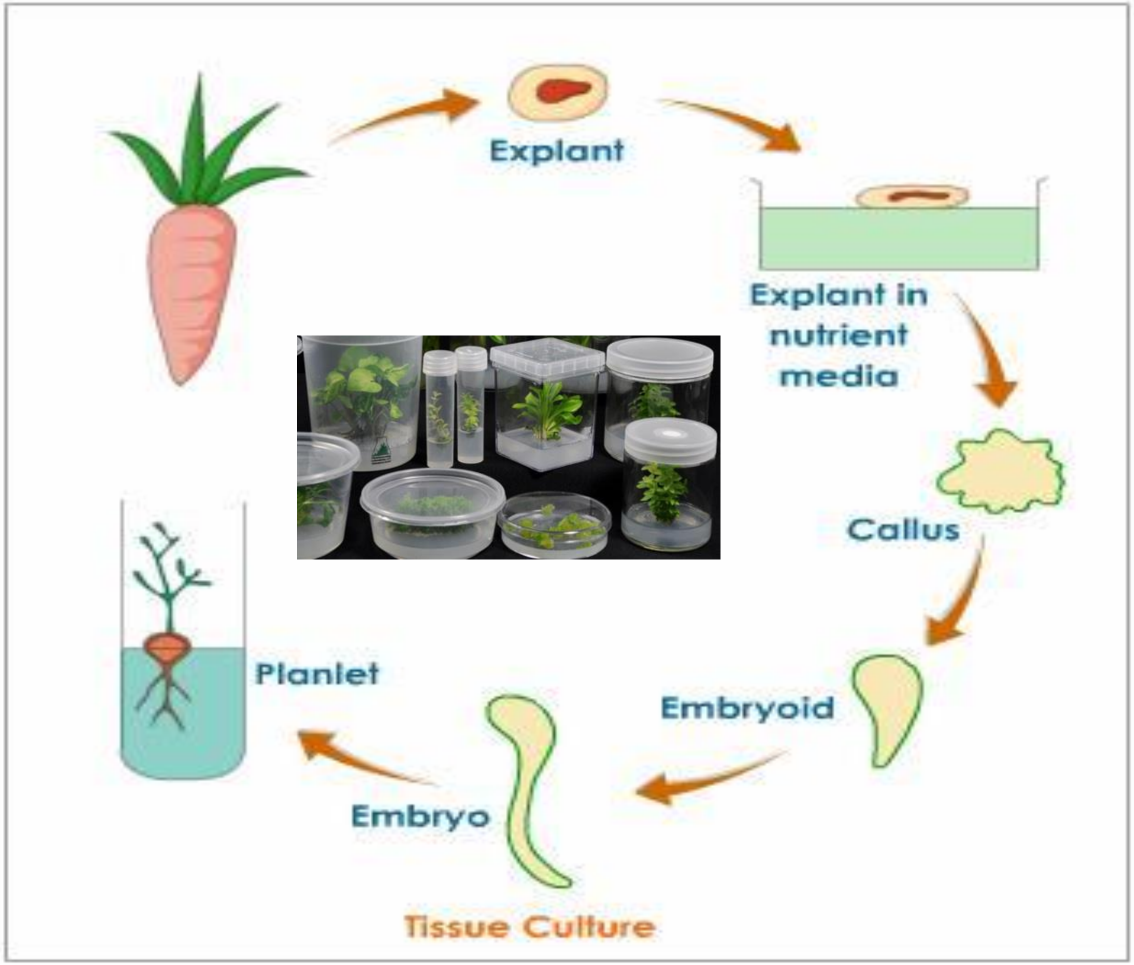
SECTION 8

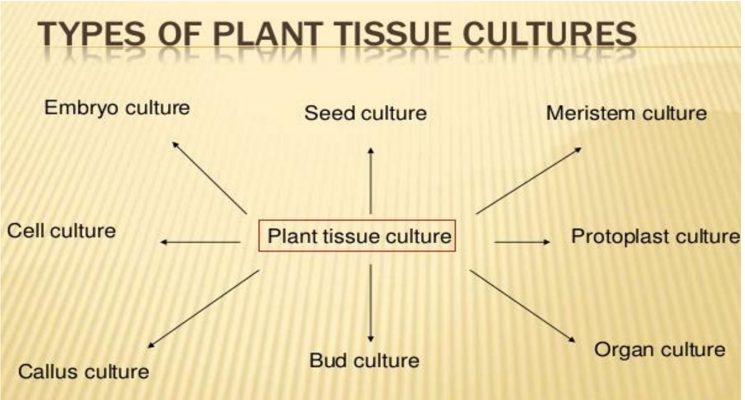
BIOTECHNOLOGY

Biotechnology is a field that entails applying technology on life (plants)

Plant Biotechnology

- Plant biotechnology is a field that entails applying technology on plants.
- Micropropagation or plant tissue culture is a collection of techniques used to grow plant cells, tissues or organs under sterile conditions on a nutrient culture medium of known composition.





Advantages of micropropagation

- Produces large numbers of genetically identical plants very quickly.
- Produces species that are hard to grow in other ways.
- Genetic modifications can be made in a small number of plants which then give thousands of plants carrying the desired change.
- Helps in plant conservation

THE END ...

Lecture Notes

General Botany (Bot 102)

عرض محاضرات

علم النبات العام (١٠٢ نبت)

قسم النبات والأحياء الدقيقة ـ كلية العلوم

Course specification- an overview
عرض توصيف المقرر

A. Basic information:

-Lecture: 2hour

-Labs: 2 (1x2) hours

Total credit hours: 3

B. Professional information:

(1) Goals & Objectives

- The course provides background material for students who have not previously been exposed thoroughly to basic Botany at university level.
- Knowledge of the fundamental and applied aspects of different botany fields of study, considering the levels of organization, plant structure and function, classification of the plant kingdom and interactions between plants and their environment.

(2) Intended Learning Outcomes (ILO'o)
المخرجات التعليمية المستهدفة

a. Knowledge and understanding:

- Knowledge of fundamental and concepts of Botany.
- Demonstrate the ability of how to utilize the theoretical concepts in applicable form.
- Knowledge of the major fields of Botany.
- What characters link plants to each other and to their environment? How flexible are these links? And how intricate or intermeshed? How do plants evolve and function in their environment? ….their reproduction? …acquisition of energy and nutrients? ………?

b. Intellectual skills:

- Knowledge integration and evaluation of Botanical processes at different levels of organization and classification from molecules to biomes (zonobiomes).
- Testing hypothesis and solve problems with self-direction and originality.
- What can organisms tell us about the past, present and future course of their existence?

c. Professional and practical skills:

- Ability to work in laboratory and field either independently or as a member of a team.
- Ability to do research and report on many areas of Botanical and biological sciences

d. General and transferable skills:

- Problem analysis and solving at theoretical and practical levels.
- Learn in familiar and unfamiliar situation with open mentality and in the spirit of critical enquiry
- Know how to cope with situations (bad or good) and accept to live with others.

(3) Course content

Course content covers the basic principles of Botany that deal with:

- **levels of organization from molecules to biomes**
- **Plant cell structure and division**
- **Basics of Mendel's Genetics**
- **Plant structure (Morphological & Anatomical perspectives) and function (basics of plant physiology)**
- **Classification of plant kingdom**
- **Plant environment and interactions among plants.**

(4) Teaching and Learning Methods

- Lectures
- Laboratory studies
- Student group assignment
- Class discussion and reading materials
- Term papers (internet search)

(5) Student Assessment Methods

- **Written exams and quizzes:** to assess the ability to manage and present the understanding in appropriate manner.
- **Practical exams and assignments:** to assess the skills and abilities and evaluate the outreach of used methodology.
- **Feedback questionnaires:** to assess the student satisfaction, efficiency of instructors and suitability of course contents.
- **Oral exam or group discussion (optional):** to assess the ability to present knowledge and understanding.

❖ Assessment schedule:

-Monthly exams and assignments+ class attendance	30
-Laboratory exam and assignment	30
-Final written exam	40
Total Marks	100

List of references

(A) Course notes:

Lecture and laboratory hand outs and assigned reading materials

(2) Text books

1-Plant Biology in brief. Mohammed H. Al-whaibi (2011). King Saud University, Academic publishing & Press.

2- Biology of plants 5th Ed. by Raven, P.H., Evert, R.F. and Eichhorn, S.E.(1992) W.H. Freeman and company, Worth Publishers. New York

Supporting books:

3-Biology of Plants 5th ed. by Raven et al. 1992 Worth Publishers. (Translation into Arabic by Al-Whaibi, M. H. and A. S. Al-Khalil, 2002., (2005 second Ed.) Scientific Publications, King Saud University Press, Riyadh, Saudi Arabia. (In Arabic).

4-Manual of Biology of Plants.2002. (2005 second Ed.) Arif, I. A., A. S. Al-Khalil, Al-Whaibi, M. H., R. M. Al-Summ and K. M. Zayed. Scientific Publications, King Saud University Press, Riyadh, Saudi Arabia. (In Arabic).

5- Study Guide to Plant Biology (In Brief). 2008. Al-Whaibi, M. H. and A. S. Al-Khalil) Scientific Publications, King Saud University Press, Riyadh, Saudi Arabia. (In Arabic).

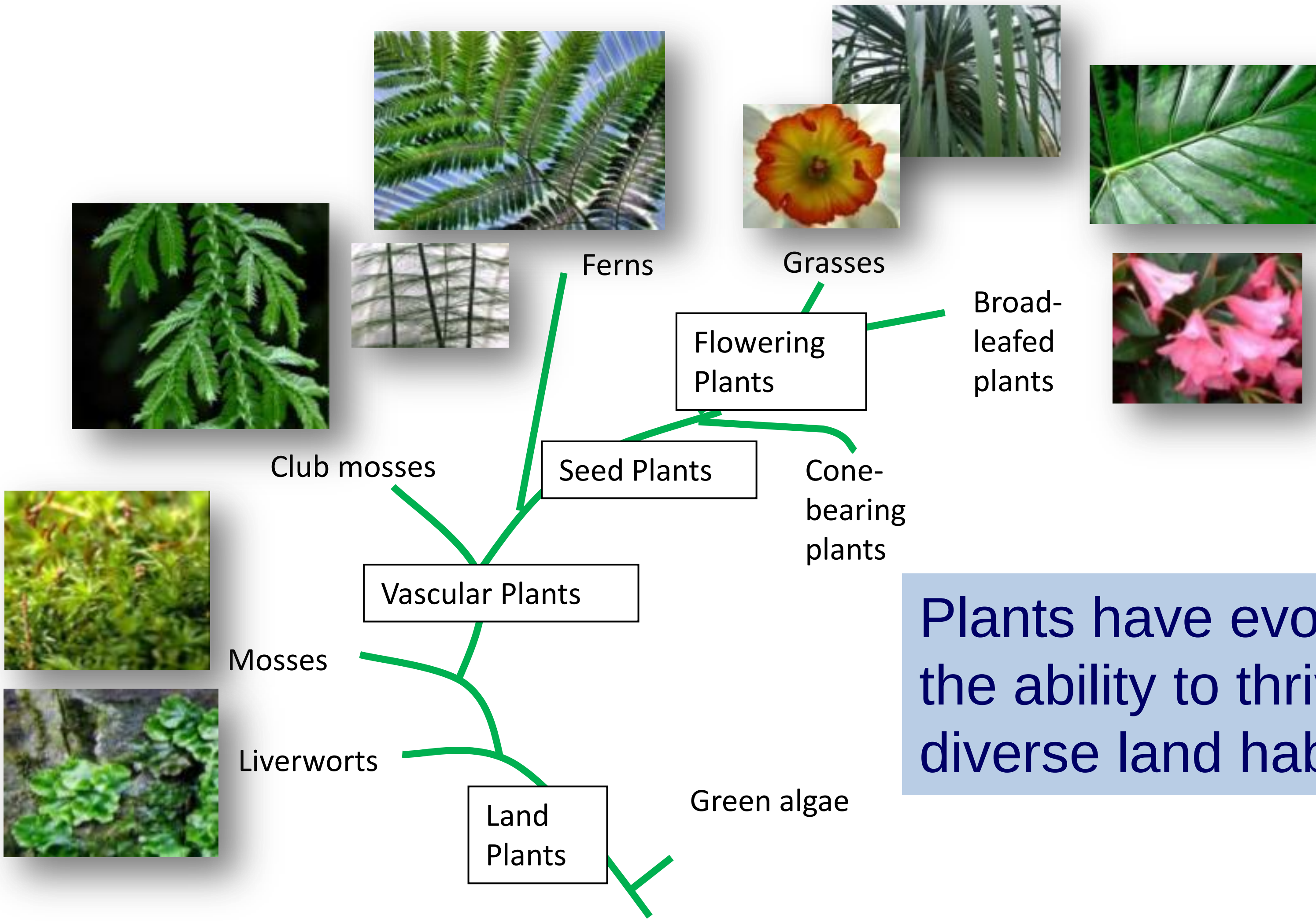
6- Raven, P.H., Evert, R.F. and Eichhorn, S.E.(1999). Biology of plants 6th. E. W.H. Freeman and company, Worth Publishers. New York.

7. Raven, P.H., Evert, R.F. and Eichhorn, S.E.(2005). Biology of plants 7th. E. W.H. Freeman and company, Worth Publishers. New York

(C) Periodicals & Websites: To be listed and handed out during lecture time.

Why study plants?

Plants are diverse



Plants have evolved the ability to thrive in diverse land habitats.

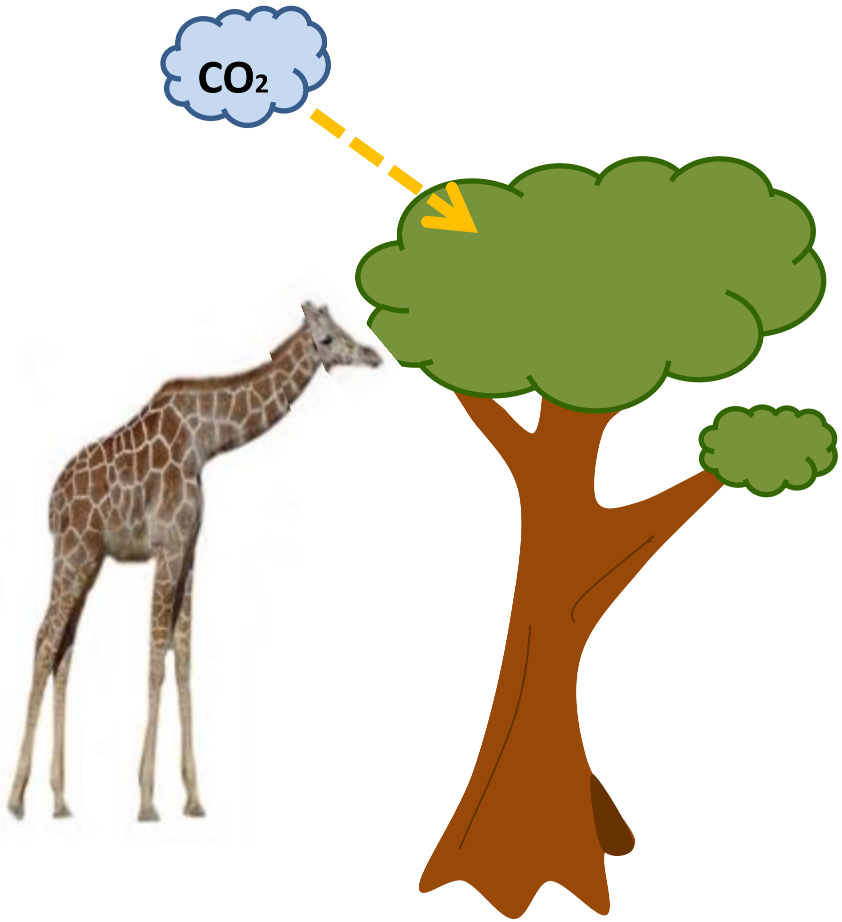
We could not live without plants

- Plants produce most of the oxygen we breathe.

- Plants produce most of the chemically stored energy we consume as food and burn for fuel.

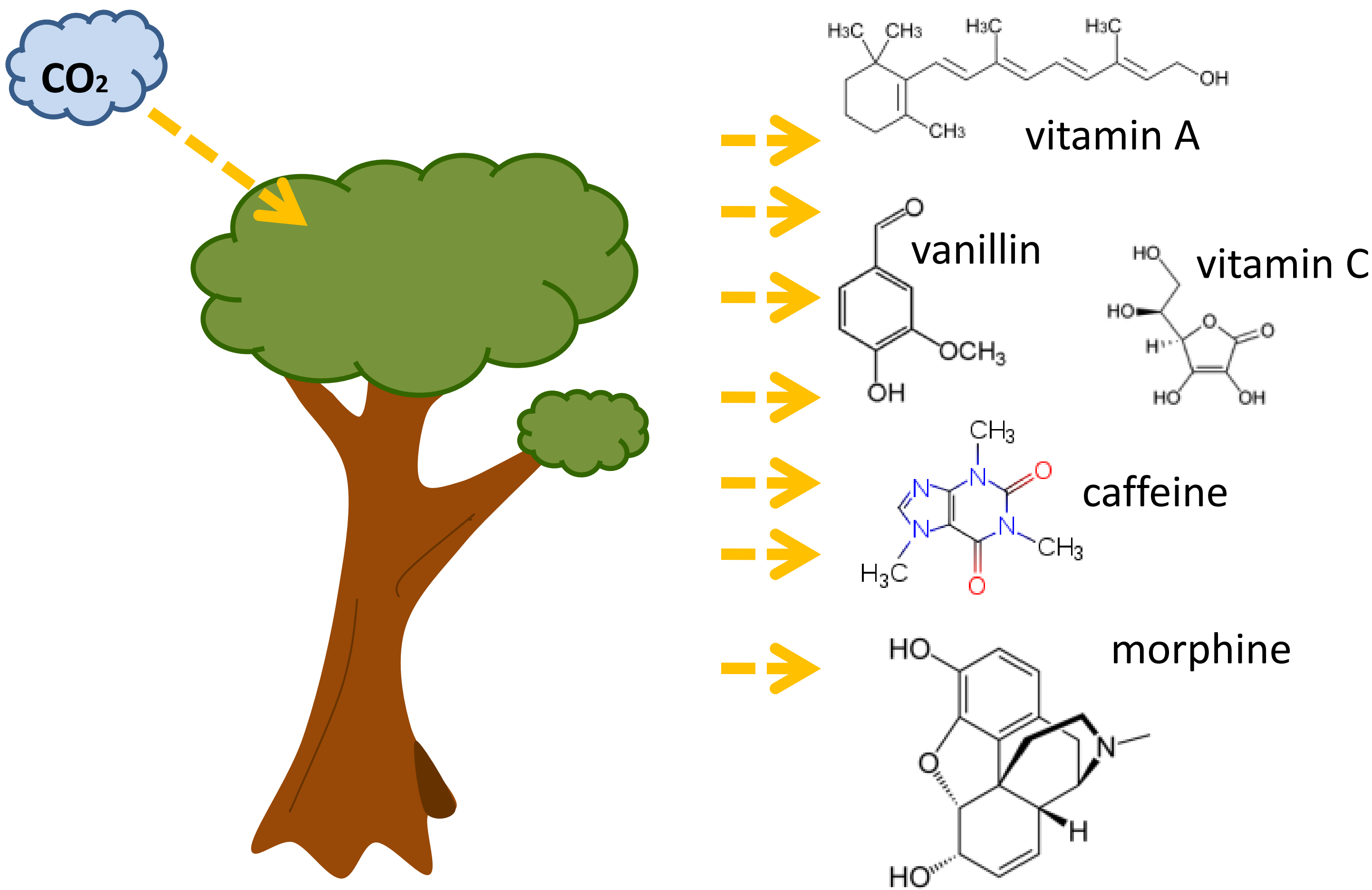
- Plants produce an assortment of useful chemicals.

Plants fix carbon dioxide into energy-rich molecules where human & animals can use as food



Plants convert CO_2 gas into sugars through the process of photosynthesis.

Plants can produce an amazing assortment of chemicals



More reasons ....?

- To help conserve endangered plants and threatened environments
- To learn more about the natural world
- To enhance the abilities of plants to provide us with food, medicines, and energy

Mendel's studies of peas revealed the laws of inheritance

Plant scientists can contribute to the alleviation of hunger

By developing plants that

- are drought or stress tolerant
- require less fertilizer or water
- are resistant to pathogens
- are more nutritious

Identification of resistance genes

Geneticists have identified the gene conferring resistance and are introducing it into edible varieties.

Inoculated with fungus

Not inoculated

Resistant

Susceptible

The plant on the left carries the resistance gene and is free from disease symptoms.

Plant biologists study ways to keep plants fresh after harvesting

After harvesting, fruits soften, ripen, and eventually rot.

These processes make the fruit less appealing and affect the nutritional qualities.

Genetically biofortified foods

Iron-enriched rice

()

Vitamin A–enriched rice

Wild-type (top) and antioxidant-enriched tomatoes

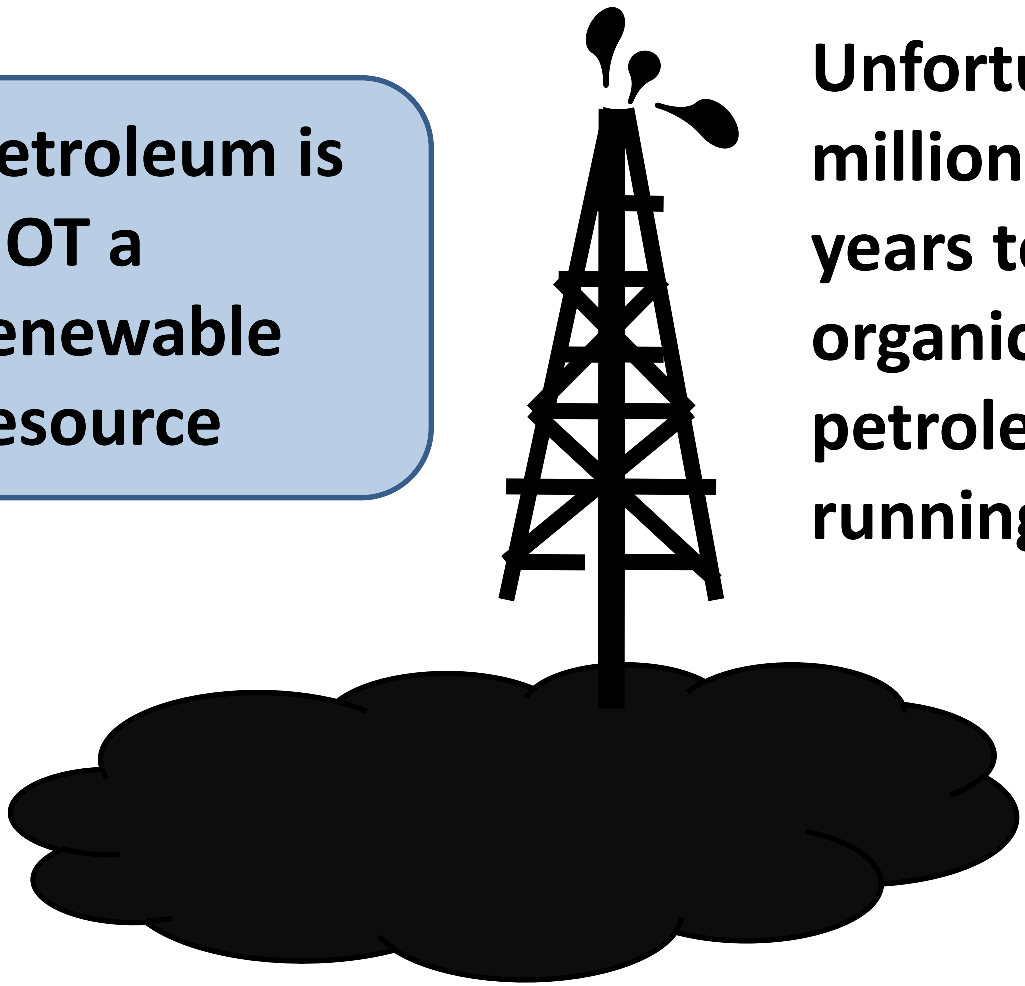
Plants provide us with more than food

Plants:

- are sources of novel therapeutic drugs
- provide better fibers for paper or fabric
- are sources of biorenewable products
- provide renewable energy sources

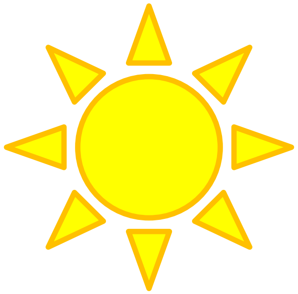
Plants can replace petroleum for many products and purposes

Petroleum is NOT a renewable resource

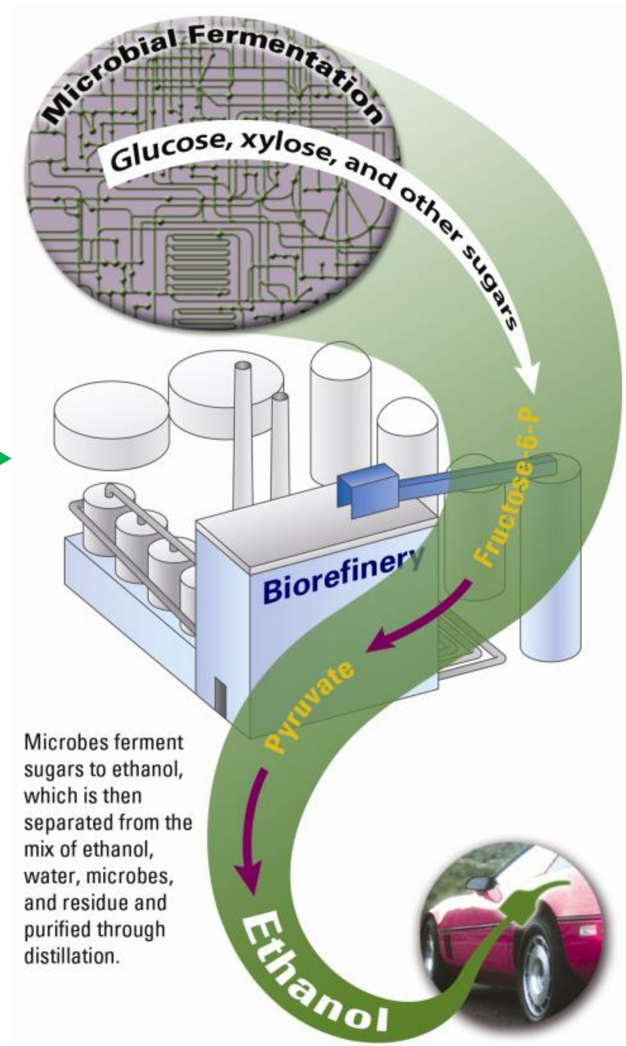


Unfortunately, it takes millions and millions of years to convert dead organic material into petroleum...and we are running out of it.

Plants can be a source of biofuels



Energy from sunlight



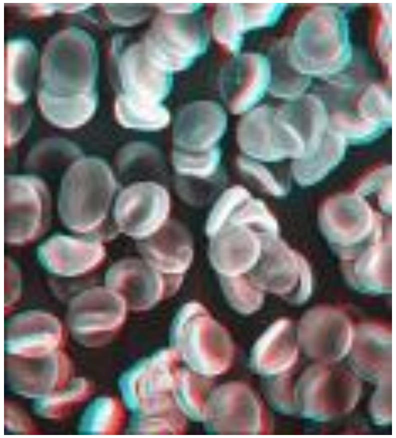
Sugars, starches and cellulose can be fermented into ethanol

What is Life?
Properties of life …..

- Cellular structure (unit of life)
- Metabolism (perform function)
- Growth (enlargement)
- Movement (intracellular)
- Reproduction (avoid extinction)
- Behaviour (response to stimuli)
- Evolution (long term adaptation)
- Pass on their traits to offsprings (heredity)

PLANT CELL

CELLULAR COMPONENTS & PROCESES



Red Blood Cells

The cell theory states:

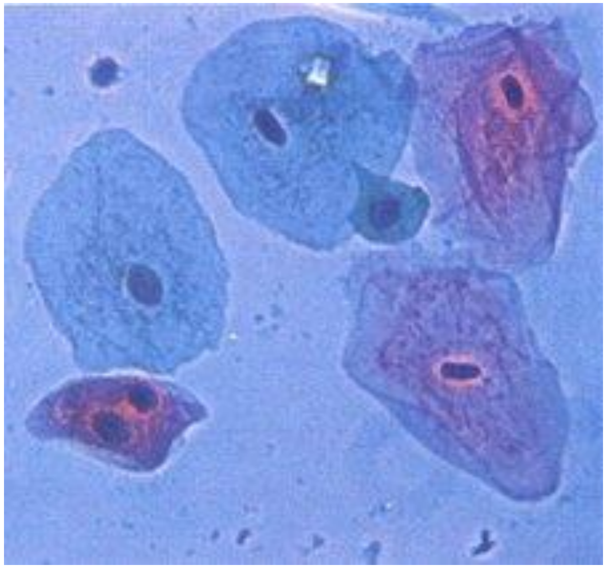
1. The cell is the basic unit of structure and function of all living things.
2. All living things are composed of one or more cells.
3. All cells come from pre-existing cells.
4. The cells of all living things carry on similar chemical activities.
5. All cells carry on their metabolic activities in organelles.

A virus and a prion are not considered cellular nor living organisms because of their simplicity (only Nucleic acid surrounded by a protein coat in the case of a virus or only a single strand of protein in the case of a prion). Neither exhibit characteristics of life unless they are in a host cell and cannot replicate outside the host cell.

There are two types of cells:

1. **Prokaryotic**- cells that DO NOT have a well-defined NUCLEUS or other cell ORGANELLES
2. **Eukaryotic**- cells have a NUCLEUS with nuclear membrane & cell ORGANELLES

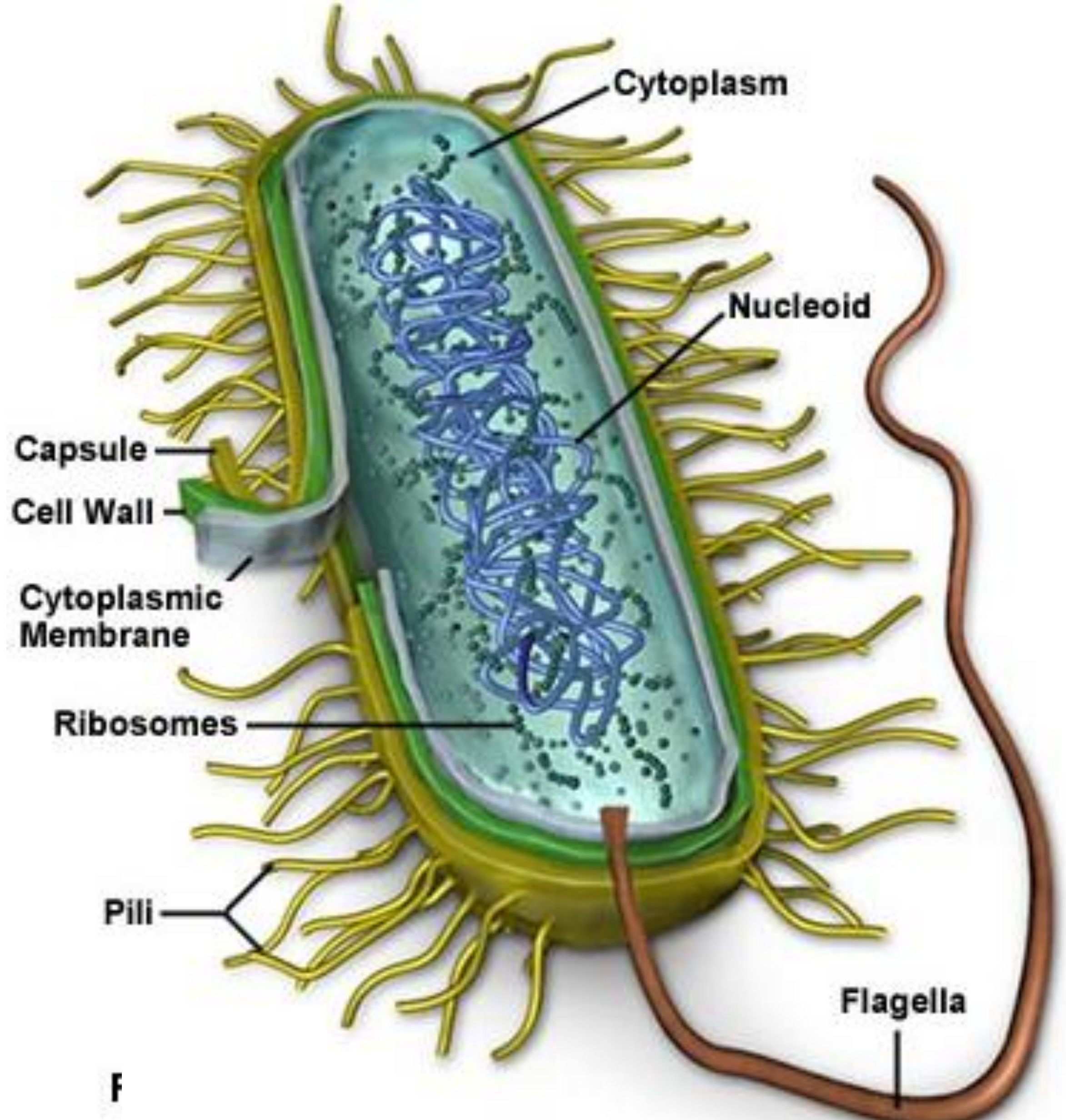
- Which is more complicated?



Prokaryote cells

1. **Oldest of cell types, first appeared 3.5 billion years ago.**
2. **Cells that do not contain a nucleus.**
3. **DNA is not contained in an internal structure.**
4. **Have a cell membrane.**
5. **Do not have membrane-bound organelles.**
6. **Generally smaller and simpler than eukaryotic cells.**
7. **Can live in hostile environments. Halophiles and thermophiles that are archeabacteria.**
8. **Very diverse in their metabolic process: obligate aerobes (require O_2), obligate anaerobes (killed by O_2), and facultative anaerobes (can survive with or without O_2).**
9. **Example: Bacteria**

Prokaryotic Cell Structure

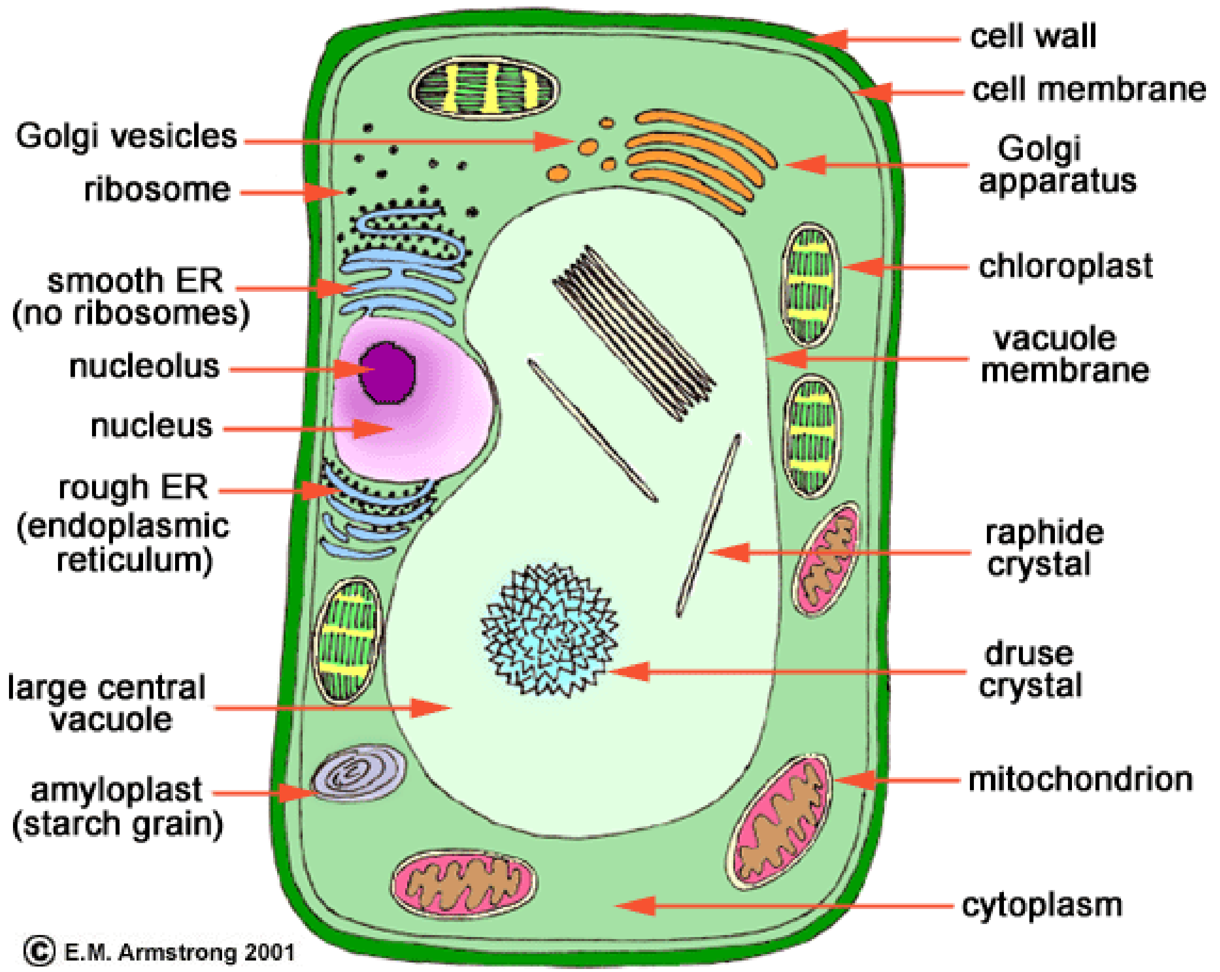


Eukaryote cells

1. **First appeared in the fossil record 1.5 billion years ago.**
2. **Eukaryotes are organisms that have a nucleus in each cell.**
3. **The nucleus contains that cell's DNA.**
4. **Have a cell membrane.**
5. **Generally larger and more complex than prokaryotic cells.**
6. **Have complex membrane bound organelles (mitochondrion, chloroplast, Golgi apparatus, etc.)**
7. **Many eukaryotic cells are highly specialized.**
8. **Examples: Plants, animals, fungi, and protists.**

Eukaryotic Cell Structure and Function

- Plasma Membrane
- Nucleus
- Ribosomes
- Nucleolus
- Endoplasmic Reticulum
- Golgi Bodies
- Lysosomes
- Plastids
- Chloroplasts
- Mitochondria
- Vacuoles
- Microtubules
- Cytoplasm



Cell wall consists of:

(1) Middle lamella – mostly pectin, cements adjacent cells together

(2) Primary cell wall

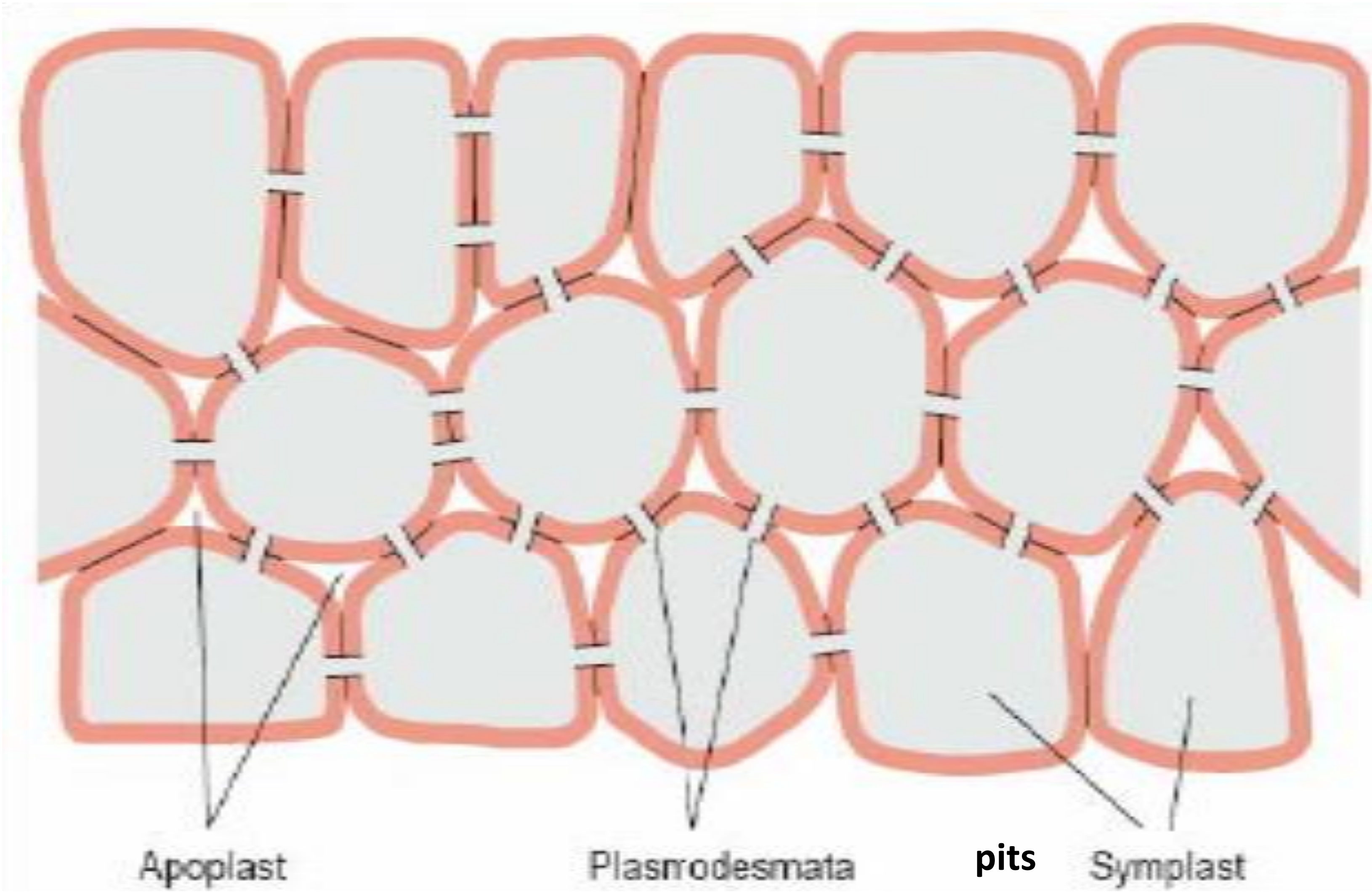
- Found in all plant cells
- Cellulose matrix with hemicellulose, proteins, pectin, lignin, cutin, and wax
- Characteristic of undifferentiated cells or ones that still are growing

(3) Secondary cell wall

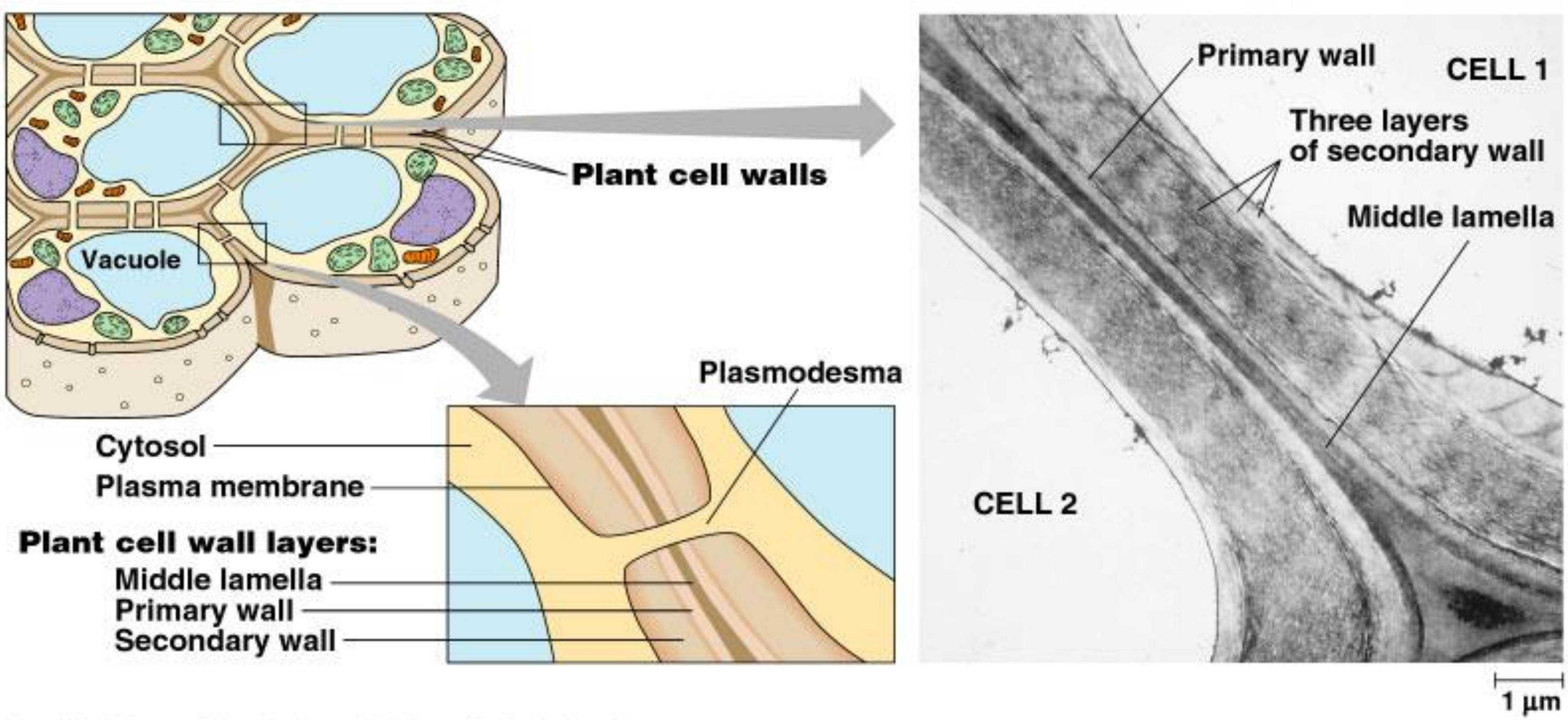
- Just inside primary cell wall
- Characteristic of mature cells
- Comprised of hemicellulose and lignin

Connections between Cells:

Plasmodesmata



Cell Wall



Plant cell walls
Vacuole
Plasmodesma
Cytosol
Plasma membrane
Plant cell wall layers:
Middle lamella
Primary wall
Secondary wall
Primary wall
CELL 1
Three layers
of secondary wall
Middle lamella
CELL 2
1 µm

Cell or Plasma Membrane

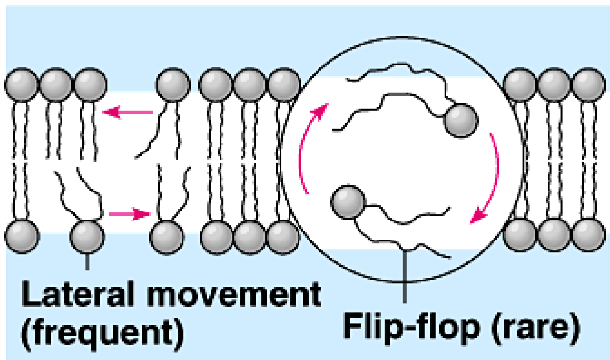
- The cell membrane’s function is to form a barrier between the cell’s inner and outer environment. It is selectively permeable meaning that it allows certain materials to pass through and prevents the movement of other through it.

- It is composed of a phospholipid bilayer with protein molecules (integral proteins) embedded within in the bilayer. Some of these proteins pass completely through both layers of phospholipids. There are also other types of molecules such as cholesterol and carbohydrates that are associated with the cell membrane’s outer surface.

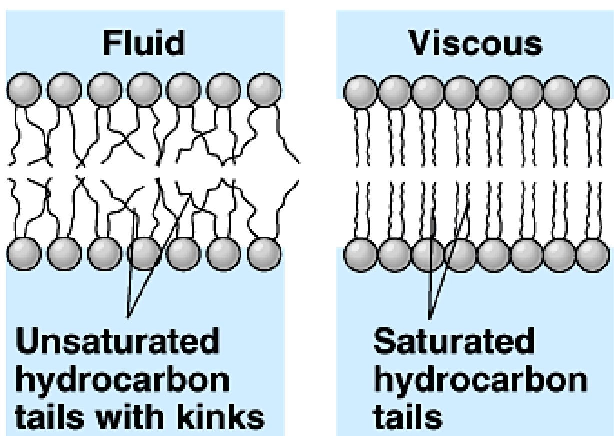
- The phospholipids and proteins are not in a static state, but have the ability to move from one location to another or change positions within the bilayer. Therefore the molecules which make up the membrane are described as being in a fluid state. The structure of the membrane is called the ”fluid-mosaic model.” The membrane is literally a mosaic of molecules that have the ability to move from area to area on the surface of the membrane.

Cell or Plasma Membrane Structure
Fluid Mosaic Model

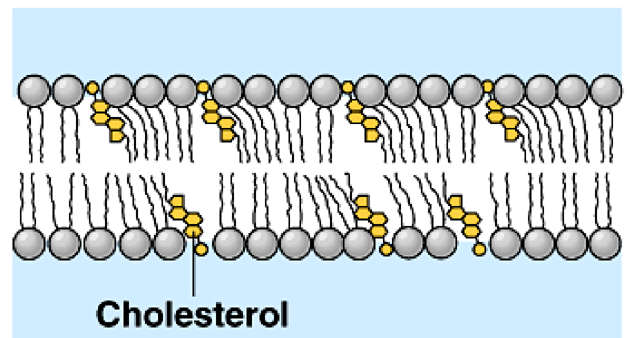
Phospholipid bilayer & protein molecules



(a) Movement of phospholipids



(b) Membrane fluidity

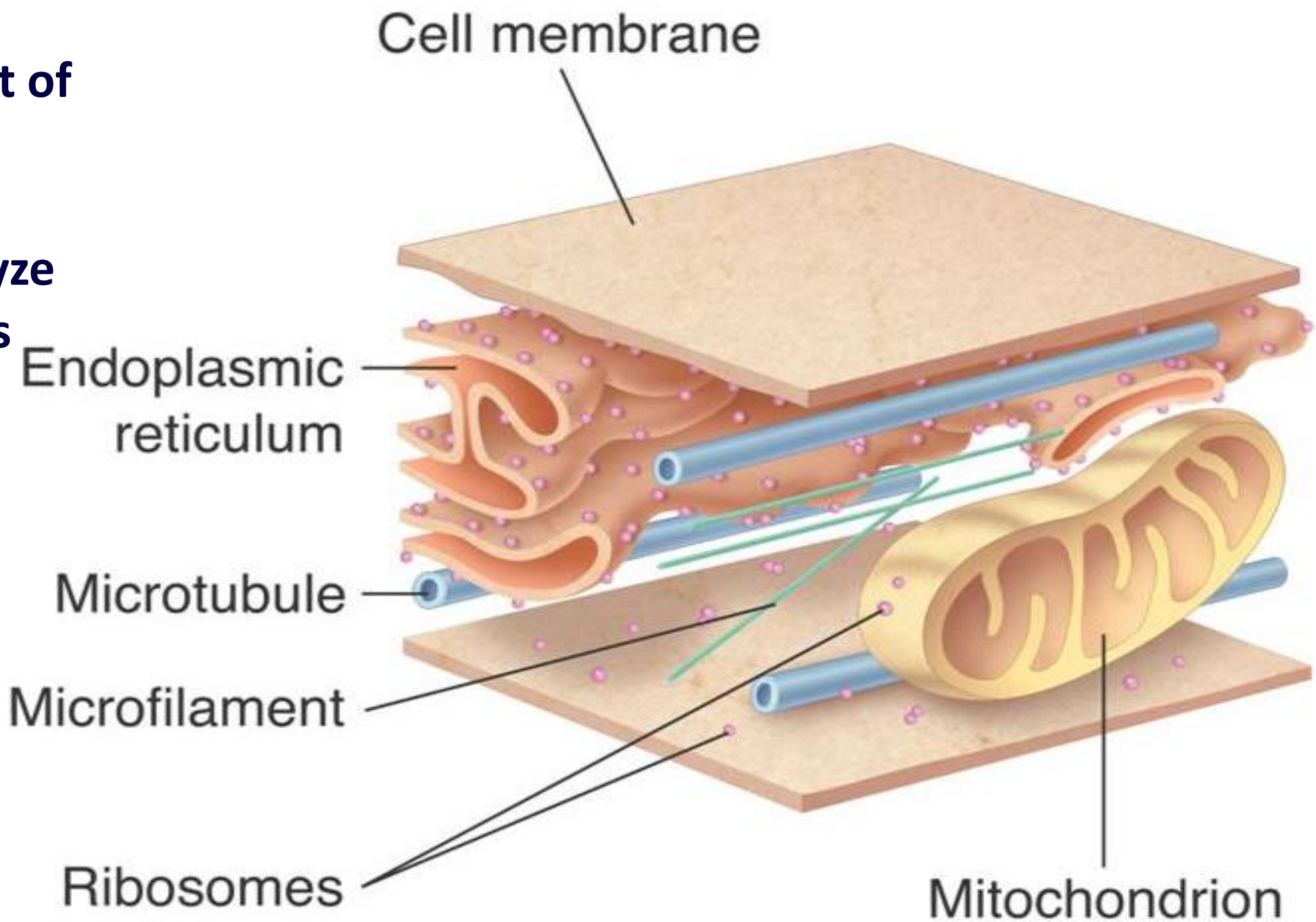


(c) Cholesterol within the membrane

Cytoplasm

A watery solution made of cytosol that contains the cell organelles. Cytoplasm includes salts, an assortment of organic molecules, including many enzymes that catalyze reactions, as well as water

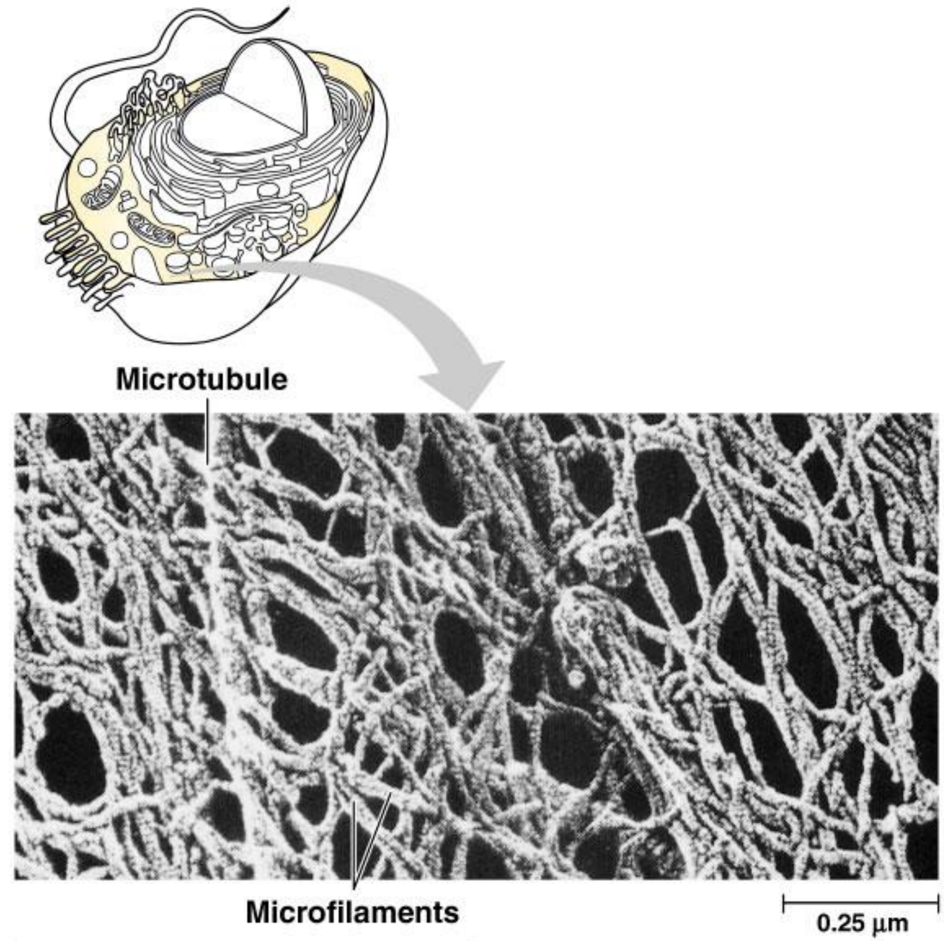
Cytoskeleton



Cytoskeleton

Cytoskeleton:

The cytoskeleton is a "framework" that supports the cell membrane and other cell structures within the cytoplasm.



Cytoskeleton

- Eukaryotic cells are given their shape and internal organization by the cytoskeleton.
- The cytoskeleton is made up of:
  Microfilaments and microtubules

Microfilaments

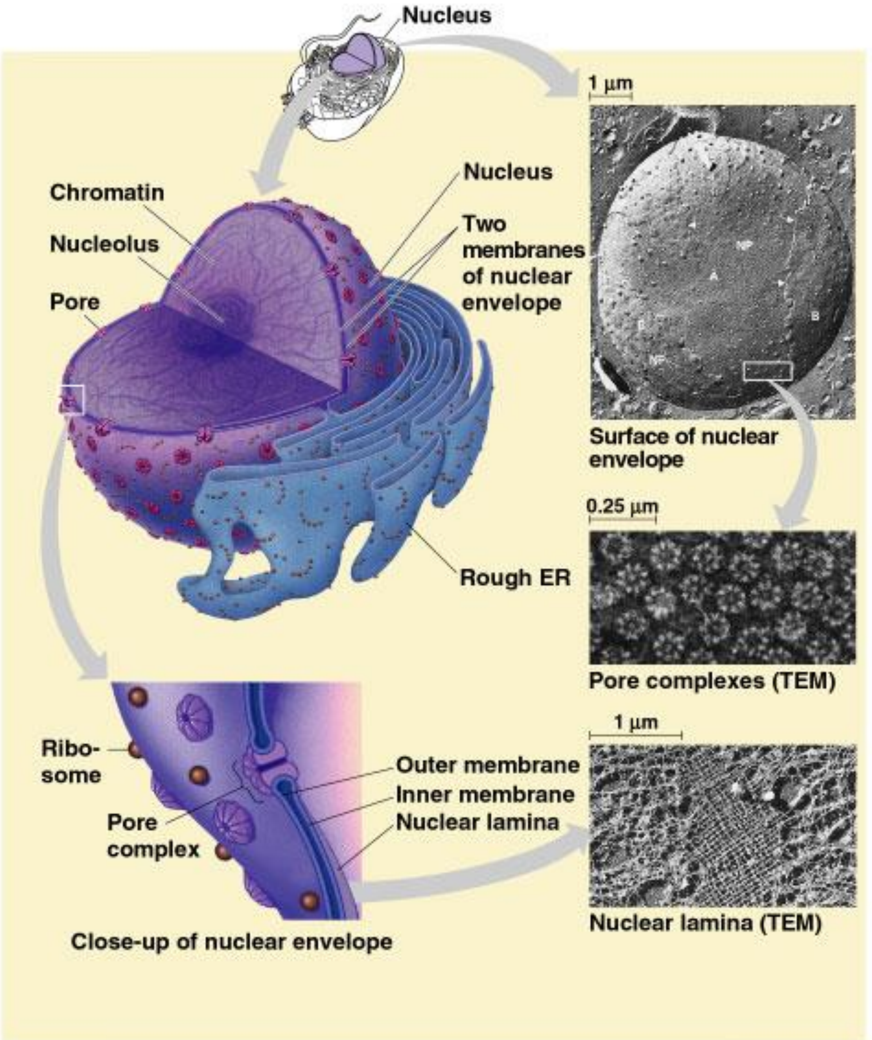
- are threadlike structures made up of the protein actin.
- form extensive networks in some cells.
- produce a tough, flexible framework that supports the cell.
- help some cells move.

Microtubules

- are hollow structures made up of proteins known as tubulins. maintain cell shape.
- are important in cell division.
- build projections from the cell surface—cilia and flagella—that enable some cells to swim rapidly through liquids.

Nucleus

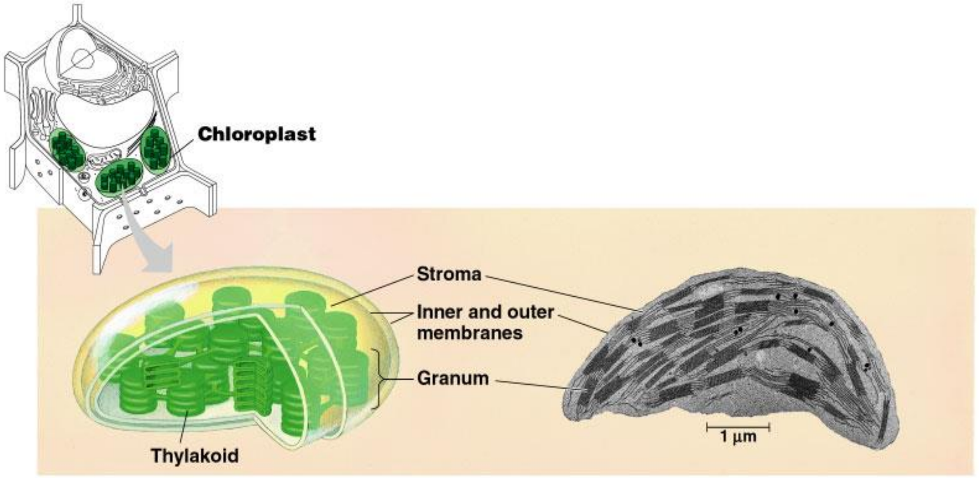
The Nucleus is enclosed in an envelope which is a double membrane structure. It has pore complexes in the membranes which allow the movement of materials in and out of the structure. It contains DNA and proteins in the form of loose threads called chromatin. During mitosis or meiosis the chromatin super coils to form chromosomes. Self duplicating structure -divides when the cell divides. The nucleolus is a structure composed of RNA located in the nucleoplasm. There maybe be more than one present and it functions in the production of ribosomes. The overall function of the nucleus is the regulation of cellular activities.



Cell Organelles

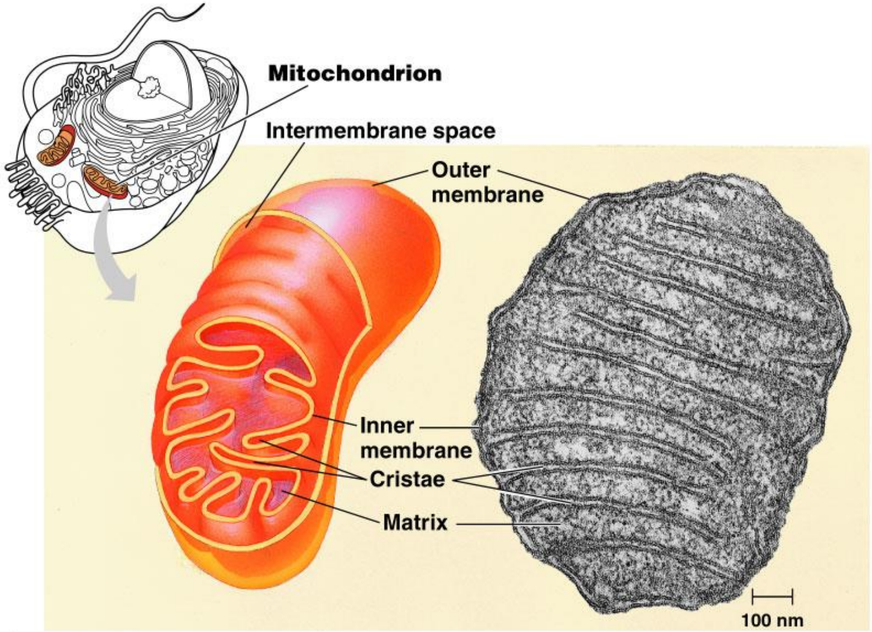
Plastids

Plastids are structures that function in storage and photosynthesis according to their type. Amyloplasts (Leucoplastides) are large white structure where starch is stored. They are responsible for the color of an Irish potato. Chromoplasts contain pigments and are responsible for the orange and yellow colors of fruits and flowers. Chloroplasts are double membrane structures where the process of photosynthesis occurs. The inner membrane is arranged in flattened sacs called thylakoids. The thylakoids are stacked one on top of another. A stack of thylakoids is called a granum or grana (pl). The space in between the grana is called the stroma.



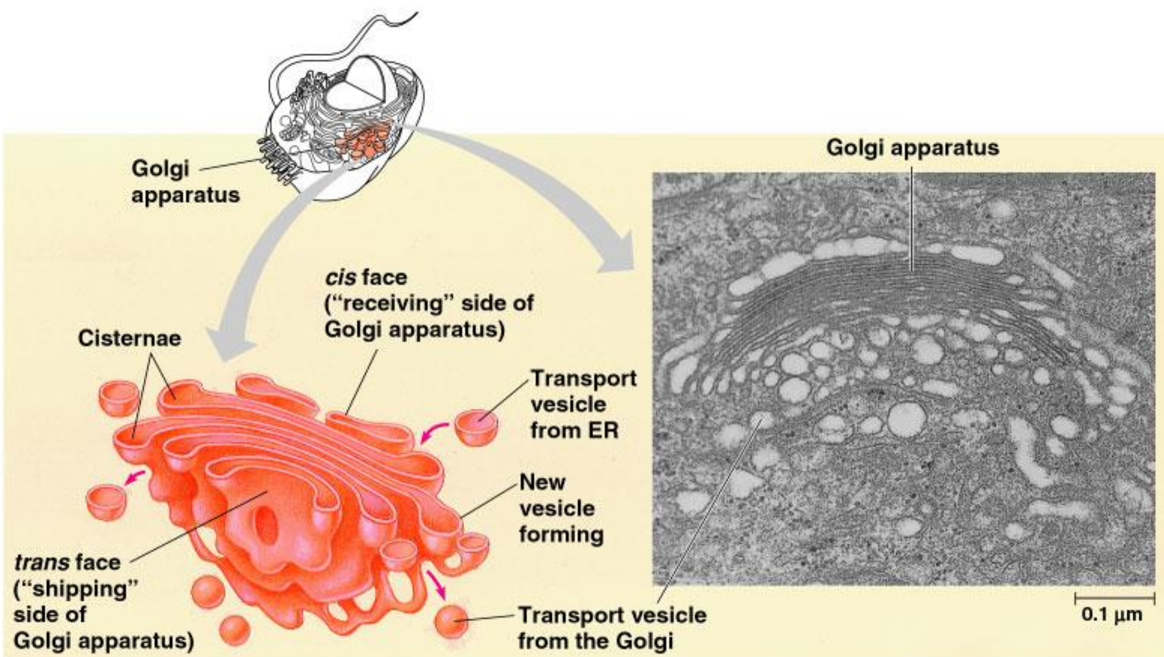
Mitochondria

The mitochondria is a double membrane structure with an outer membrane which surrounds a highly folded inner membrane. It is the site of aerobic cellular respiration in which ATP is produced. The inner membrane has finger like projection called cristae which increase the surface area. The inner space within the mitochondrion is called the matrix and contains cytoplasm, ribosomes, and DNA. Mitochondrion are self replicating. They are found in both plant and animal cells and are sometimes called "the powerhouse of the cell".



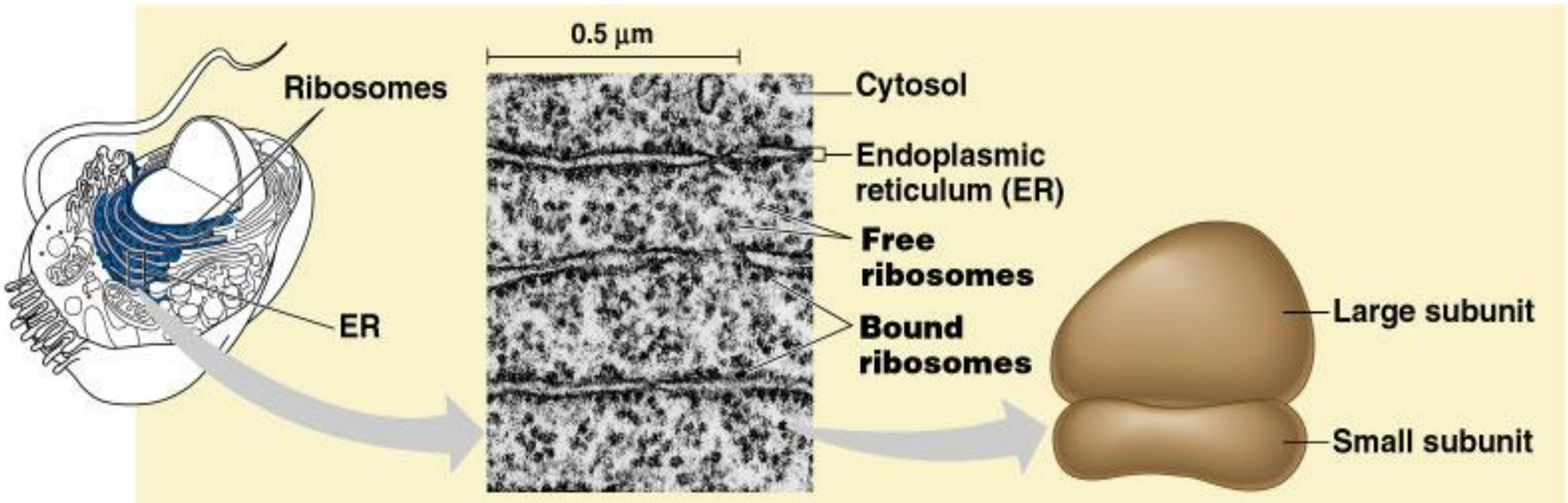
Golgi Apparatus (Dictyosome)

The Golgi apparatus appears as a series of flattened, stacked, membrane sacs. The Golgi apparatus is the center for manufacturing, modifying, and packaging of materials for transport. It receives secretory proteins from the RER and modifies and packages the materials in small secretory vesicles. It is found in both animal and plant cells. In plant cells it maybe referred to as Dictyosome.



Ribosomes

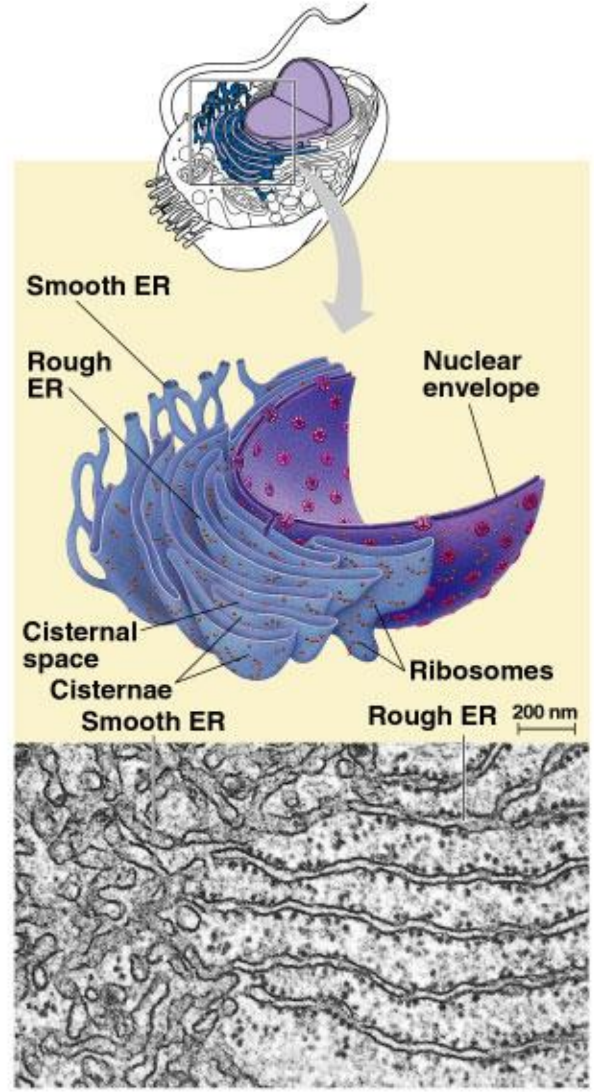
Ribosomes are the structures within the cell which read m-RNA and assembles amino acids into polypeptide chains. They are found free floating in the cytoplasm or attached to the nuclear envelope or the rough endoplasmic reticulum. They are found in all prokaryotic and eukaryotic cell types. They are composed of two subunits. Prokaryotic cells have smaller ribosomes (70s) and eukaryotic cells have the larger (80s) form.



(a) TEM showing ribosomes (b) Diagram of a ribosome

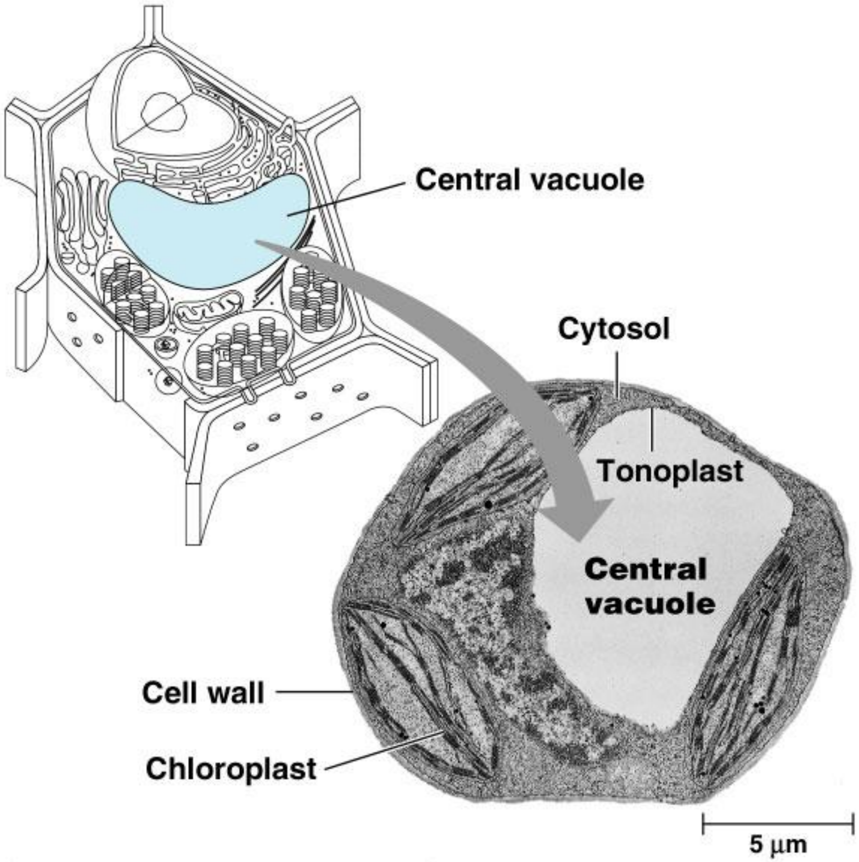
Endoplasmic Reticulum

The endoplasmic reticulum (ER) is a series of single membrane channels which run throughout the cytoplasm of the cell. The smooth endoplasmic reticulum (SER) is free of ribosomes and functions in lipid synthesis, metabolism of carbohydrates, and as a detoxification center of the cell. The rough endoplasmic reticulum (RER) has ribosomes bound to its outer membrane layer and is the active site of protein synthesis. These are secretory proteins which will be released by the cell. Both forms of endoplasmic reticulum are found in plant and animal cells.



Vacuoles

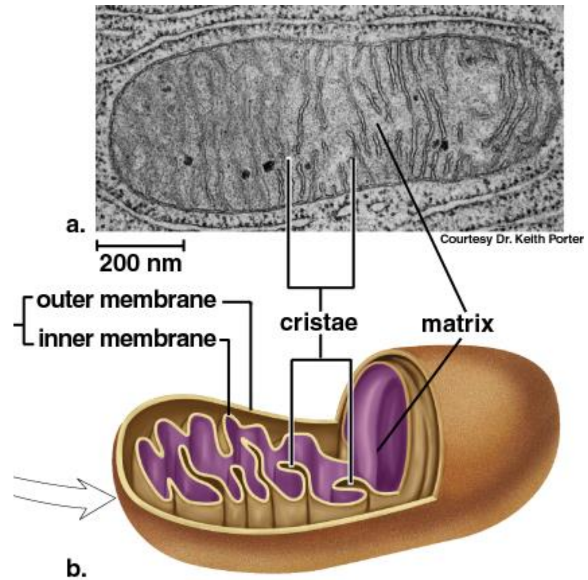
Vacuoles are storage areas and can also serve as the site of chemical digestion within the cell itself. Vacuoles in animal cells are often small. However, plant cells often have a large centrally located vacuole which contains water and dissolved solutes, surrounded by a membrane called the tonoplast. Freshwater Protists contain specialized vacuoles which act as "water pumps" to remove excess water that enters their cytoplasm. These specialized vacuoles are called contractile vacuoles.

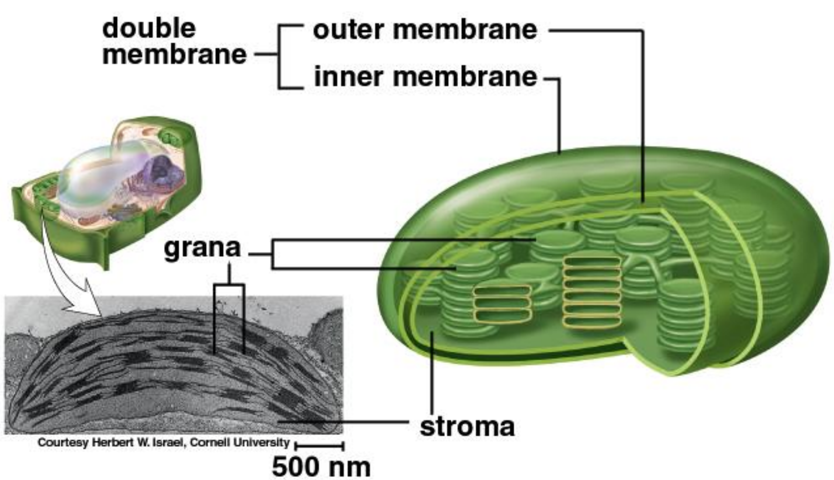


Self-Replicating Organelles

- **Mitochondria**
  - Involved in energy release

- **Plastids**
  - Involved in energy capture and storage.
  - –Chloroplasts
  - –Amyloplasts
  - –Chromoplasts





The Cellular Basis of Reproduction and Inheritance

Cell Reproduction

I. The Cell Cycle

A. **Growth**

- Increase in cell size.

B. **Division**

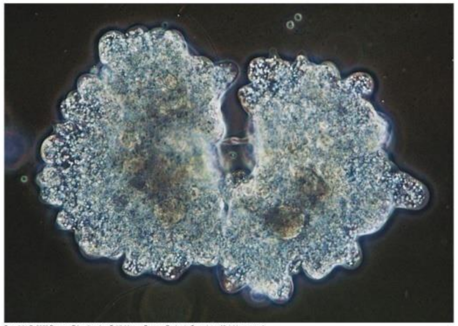
- Production of new cells
- Two overlapping processes
  - Karyokinesis – nuclear division
  - Cytokinesis – cytoplasm division

Methods of Reproduction

Asexual reproduction

- **Chromosomes are duplicated and cell divides**
- **One copy of each chromosome is placed in each cell**
- **Each “daughter” cell is genetically identical to the parent and the other daughter**
  - **Type of Cellular Division required: mitosis**

Advantage = fast and convenient
Disadvantage = very little genetic variation

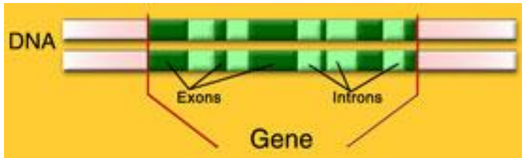


Sexual reproduction

- **Offspring inherit DNA from both of their parents**
  - **Type of Cellular Division required: meiosis**
- **Offspring can show great variation**
  - **Advantage = lots of genetic variation**
  - **Disadvantage = metabolically expensive**

Related Terms

- **Chromatin**
  - Material in an active nucleus.
    - Submicroscopic "threads" consisting of 50% DNA and 50% supporting proteins.
    - Abundant water and dissolved chemicals.
- **Gene**
  - a unit of heredity information determining the nature of a specific trait and have specific places on chromosomes.
  - a section of DNA that codes for a protein, tRNA or rRNA molecule

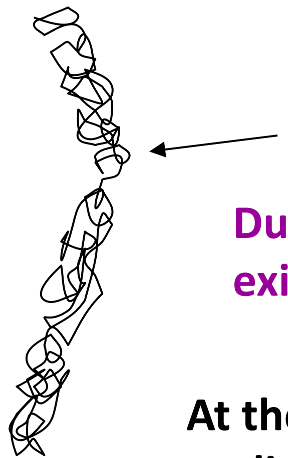


- **DNA Replication**
  - Conversion of one strand/piece of DNA into two identical strands/pieces.

- **Chromosome Set**
  - One copy of each of the different chromosomes in the nucleus containing one copy of each different gene.
- **Haploid Number** (n)
  - The number of chromosomes comprising one set.
    - For humans, n=23
    - For some ferns, n=250
  - A haploid individual has one set of chromosomes per cell.
- **Diploid Number** (2n)
  - The number of chromosomes in a cell containing two sets.
  - A diploid individual has 2 sets per cell.
  - (Triploid is 3 sets, Tetraploid is 4 sets, etc.)

Structure of the Chromosome

Chromosome – a package of hereditary material with supporting proteins visible in condensed form during cell division.



Chromatid – a single strand of DNA

During most of the life of a cell the chromosomes exist as a single strand called a "monad".

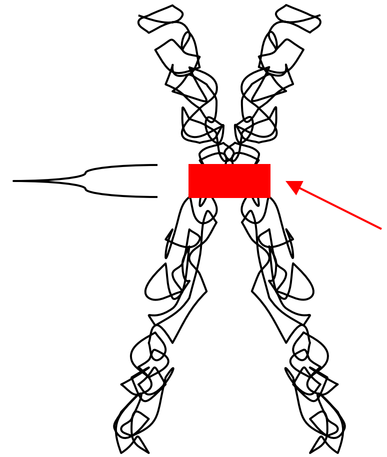
At the beginning of karyokinesis the single strand is replicated forming two identical chromatids attached to one another, a "dyad".

Sister chromatids have identical DNA

Centromere

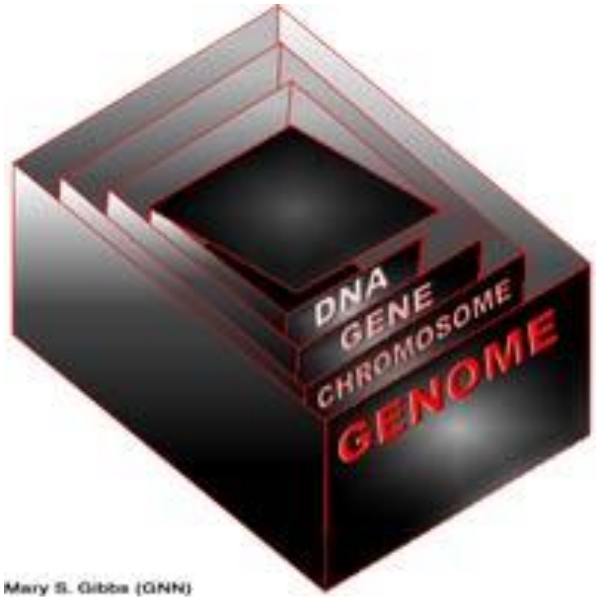
- **Kinetechore on centromere provides binding site for microtubules**

Centromere



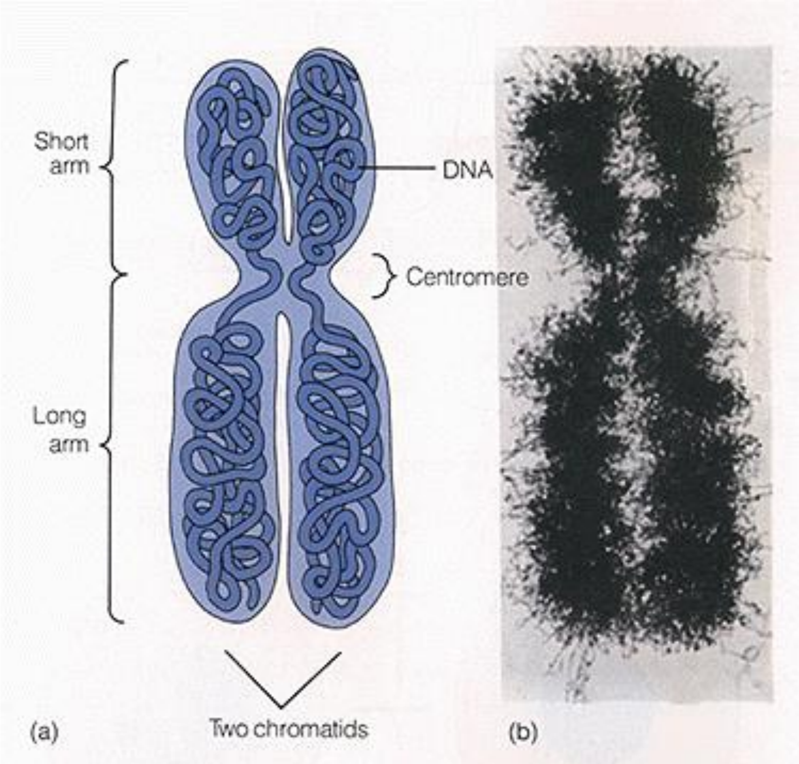
Kinetochore

- **Genome**: Complete complement of an organism's DNA.
  - Includes **genes** (control traits) and non-coding DNA organized in **chromosomes**.



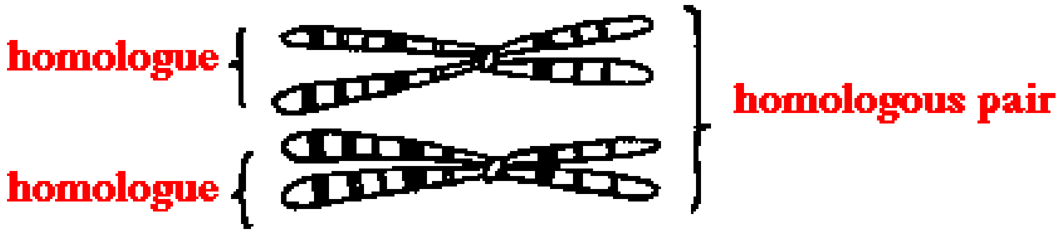
- **Eukaryotes & DNA:**

- Many eukaryotes have 1000 times as much DNA as prokaryotes.
- DNA is located in the nucleus in the form of chromosomes.
- Chromosomes are DNA wound tightly around proteins called histones.



•Homologues

- Chromosomes exist in homologous pairs in diploid cells.



Exception: **Sex chromosomes in human** (X, Y).

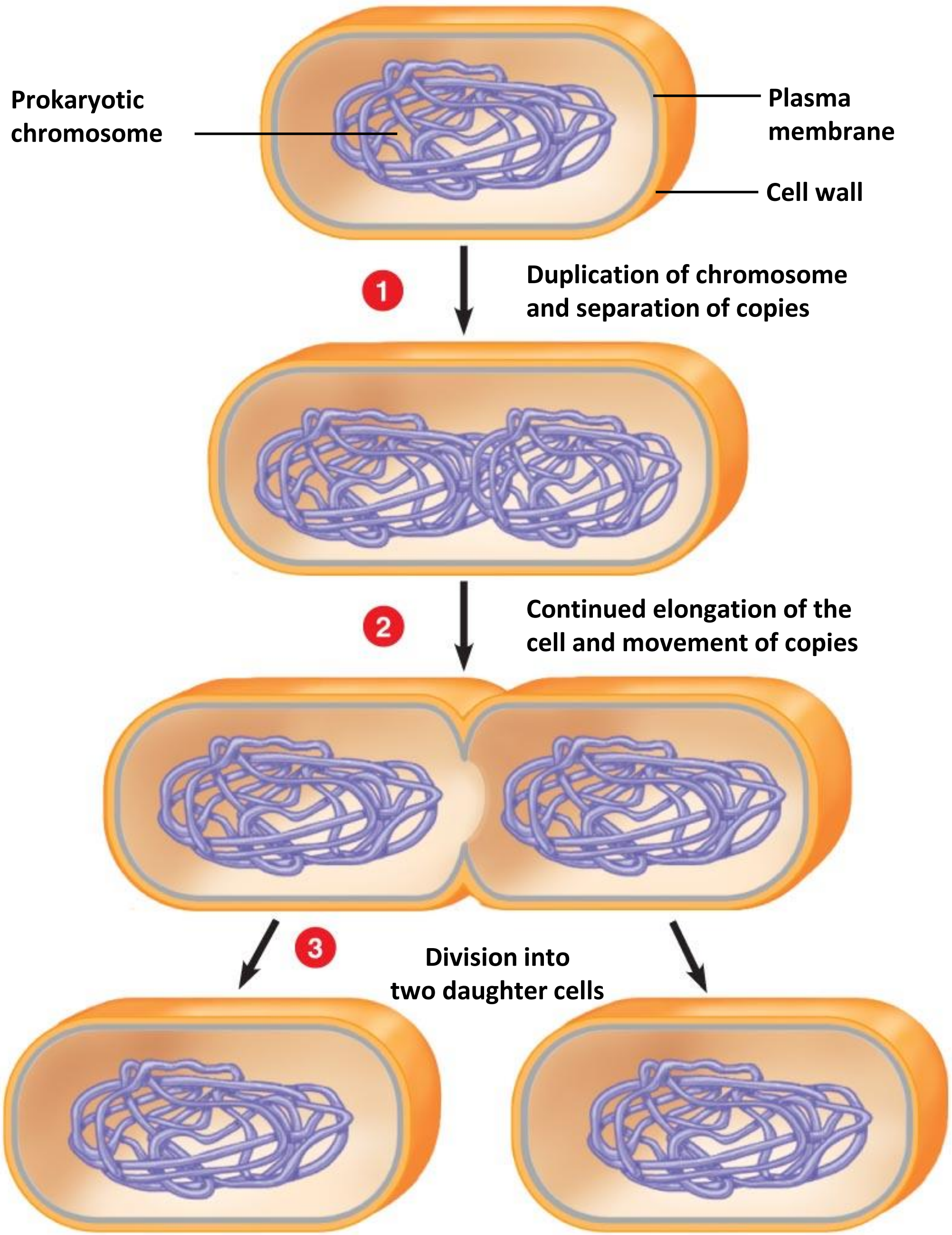
Other chromosomes are known as **autosomes**, they have homologues.

Cell Division

Binary Fission, Mitosis & Meiosis

Prokaryotic cells reproduce asexually by a type of cell division called binary fission

- The circular DNA molecule replicates to form 2 chromosomes
- The chromosome copies move apart
- The cell elongates
- The plasma membrane grows inward, dividing the parent into two daughter cells



binary fission

- The circular DNA molecule replicates to form 2 chromosomes
- The chromosome copies move apart
- The cell elongates
- The plasma membrane grows inward, dividing the parent into two daughter cells

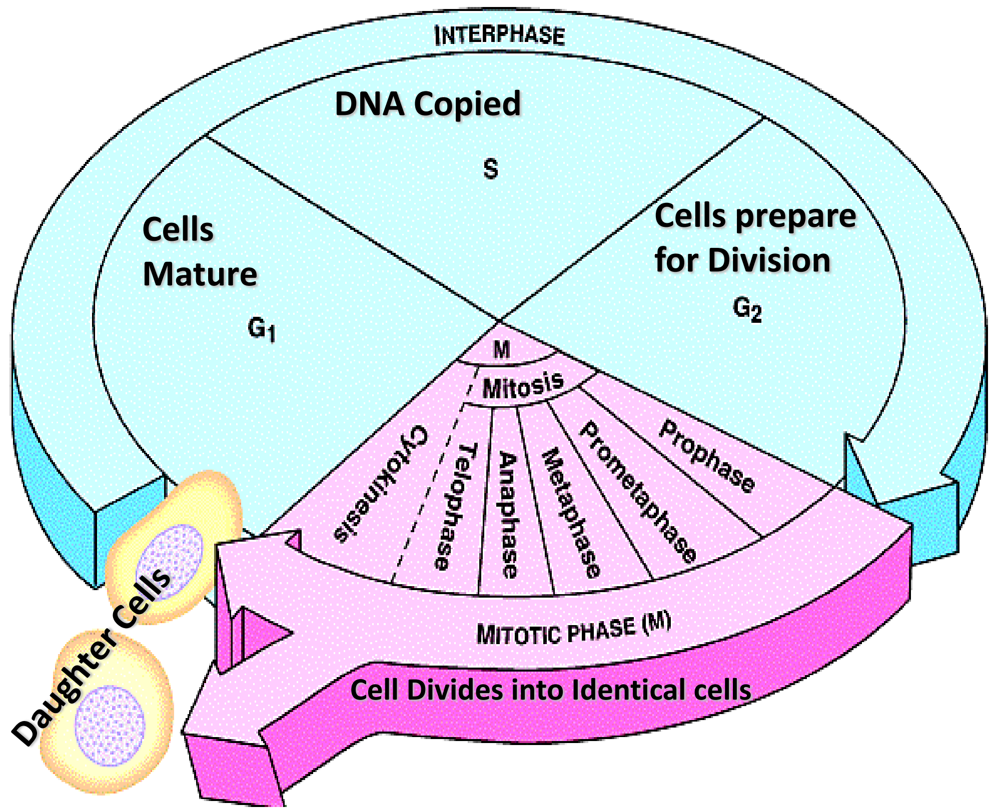
Mitosis

- Eukaryotes divide by a more complicated system called Mitosis
- This is because:

1. They have a nucleus which must be broken up and then reformed
2. They have their DNA “packaged” in the form of Chromosomes
3. Chromosomes are composed of Chromatin
4. Also contain Nucleosomes containing Histones - Proteins the DNA is wrapped around Name for the DNA/Protein complex is Chromatin
5. They usually have more than 1 chromosome (Humans have 23 pairs)
6. They have numerous organelles to equally share

The Cell Cycle

- Most of the cell's life is spent doing its regular function.
- Cells divide along a rough time frame called its Cell Cycle.
- The Cell cycle consists of the following steps:
- G1 (Gap 1) Phase - Cell performs its normal function (cells which do not divide stay in this stage for their entire life span)
- S (Synthesis) Phase - Here the cell actively duplicates its DNA in preparation for division
- G2 (Gap 2) Phase - Amount of cytoplasm (including organelles) increases in preparation for division.
- Mitosis - Actual division occurs

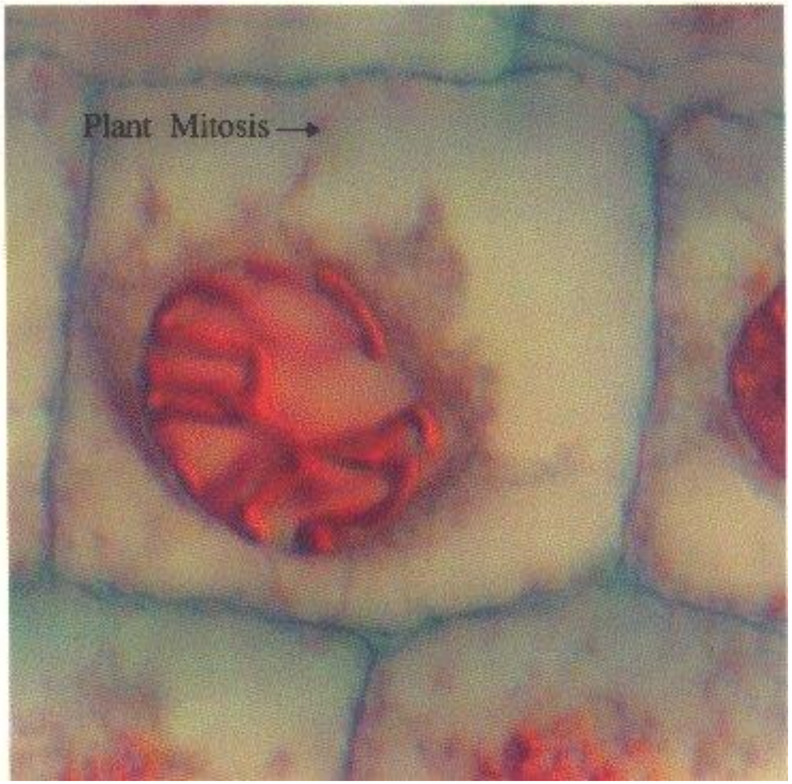


Interphase

- Cell Replicates its DNA/Chromosomes in preparation of upcoming division

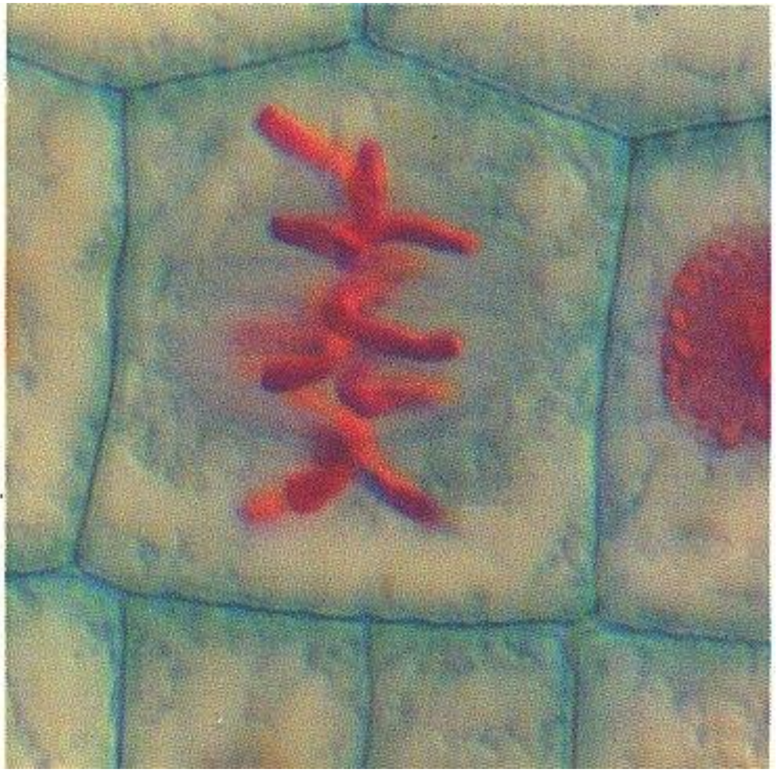
Prophase

1. Chromosomes Shorten and become visible.
2. Centrioles move to opposite sides of the cell
3. Nuclear envelope disappears
4. Spindle Fibers & Astral Fibers both together are known as the Spindle Apparatus begin to form



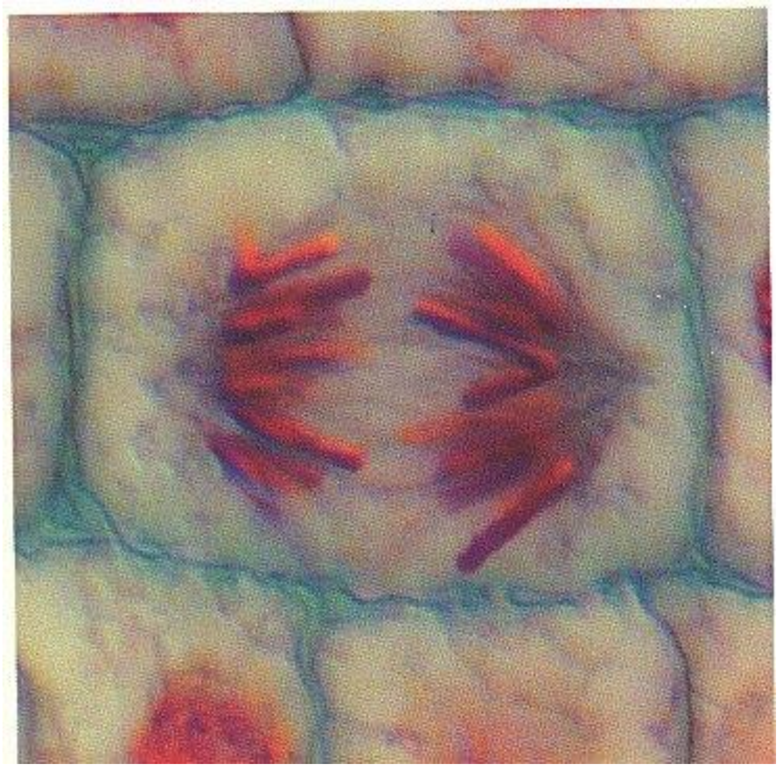
Metaphase

- Chromosomes line up along center of cell called the [Metaphase Plate]
- Chromosomes attach to spindle fibers
- Spindle & Astral fibers are now clearly visible



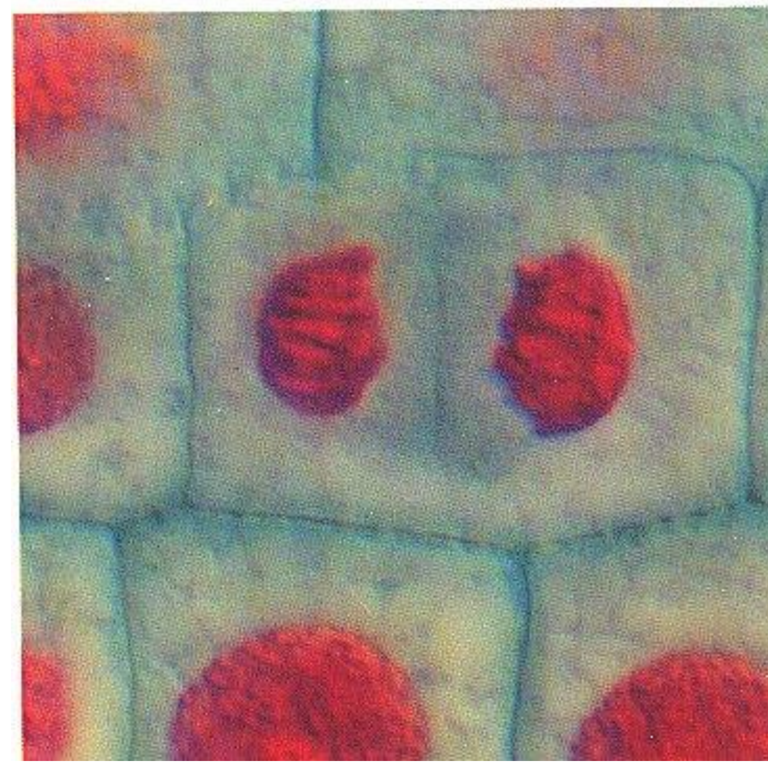
Anaphase

- Centromeres break up separating chromosome copies
- Chromosomes are pulled apart to opposite sides of cell
- Spindle & Astral fibers begin to break down



Telophase (cytokinesis)

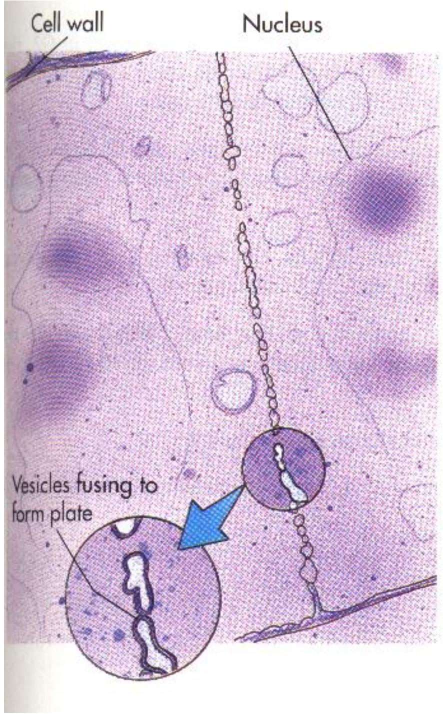
- Nuclear envelope forms around both sets of chromosomes
- DNA uncoils
- Spindle & Astral fibers completely disappear
  - Cytokenesis happens with most (but not all) cells
  - Cytoplasm & organelles move (mostly equally) to either side of the cell.Cell Membrane "pinches" to form 2 separate cells

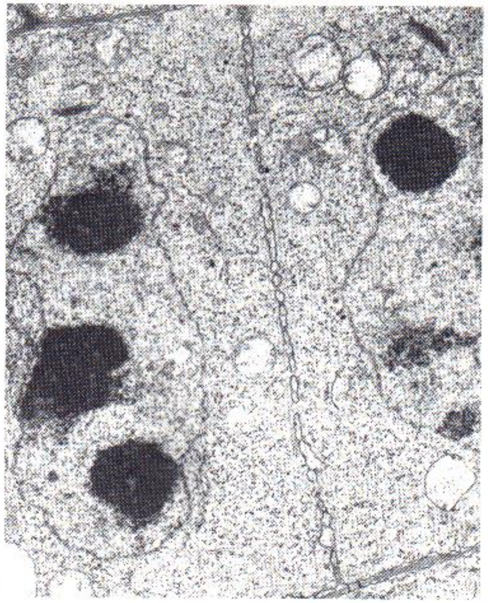


Plant Cytokinesis- division of the cytoplasm

- **With Plants, a cell wall must be formed between the 2 daughter cells.**
- **Vessicles containing Cellulose form and fuse between the tow daughter cells, eventually forming a complete cell wall.**

❑Vesicles containing cell wall material line up across middle of cell
❑Vesicles merge and form cell plate
❑Cell plate grows until it divides the cell in 2



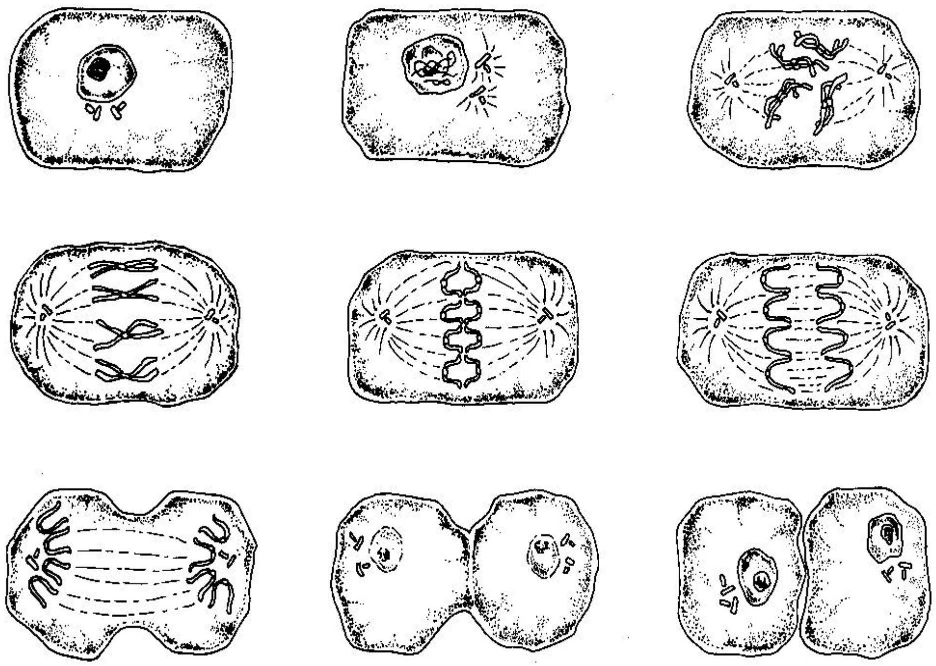


Overview of Mitosis

- Occurs in <u>somatic cells</u>
- Longitudinal division of replicated chromosomes in one nucleus to form two genetically identical daughter nuclei.

- Each "daughter" nucleus has the same number of chromosomes (and sets) that the "parent" nucleus had.

- Mitosis requires One division.
  - 1 cell → 2 cells *(called daughter cells)*
  - Daughter cells are genetically identical Chromosome number does not change.



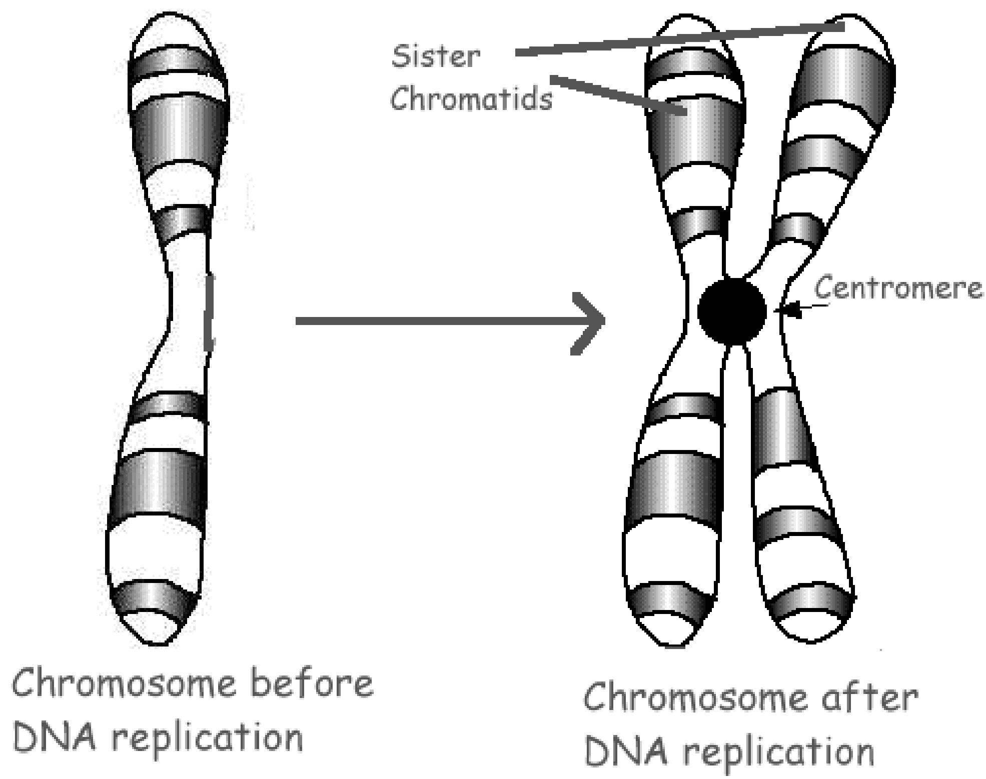
Meiosis

- Similar in many ways to mitosis
- Several differences
- Involves 2 cell divisions
- Results in 4 cells with 1/2 the normal genetic information

Meiosis Phases

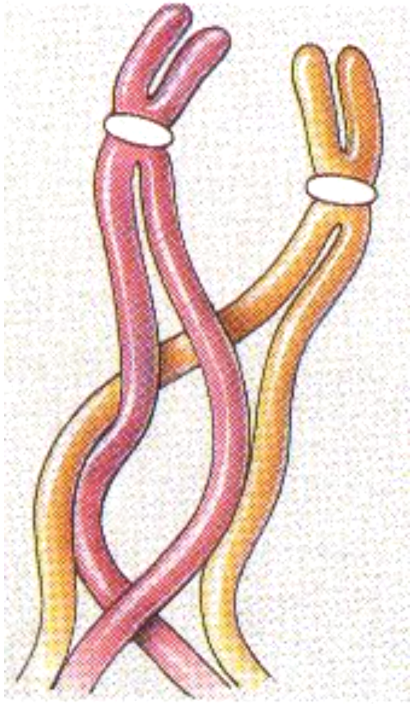
- Meiosis occurs in 2 phases; Meiosis I, & Meiosis II.

- Meiosis I.
  - Prior to division, amount of DNA doubles

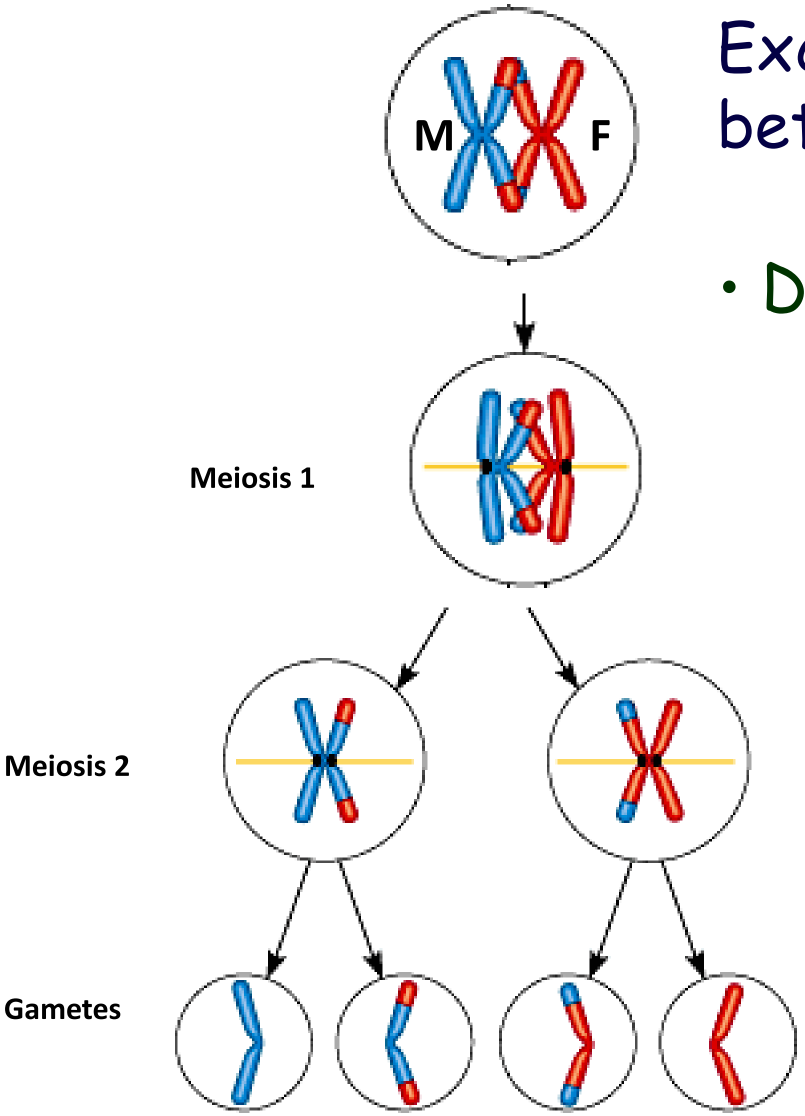


Crossing Over

- **During metaphase 1 homologous chromosomes line-up along the metaphase plate**
- **Areas of homologous chromosomes connect at areas called [chiasmata]**



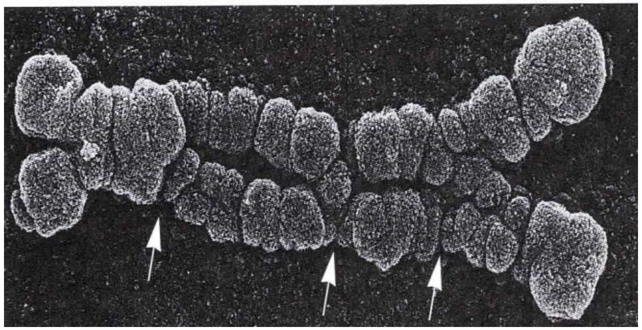
Crossing over (contd.)



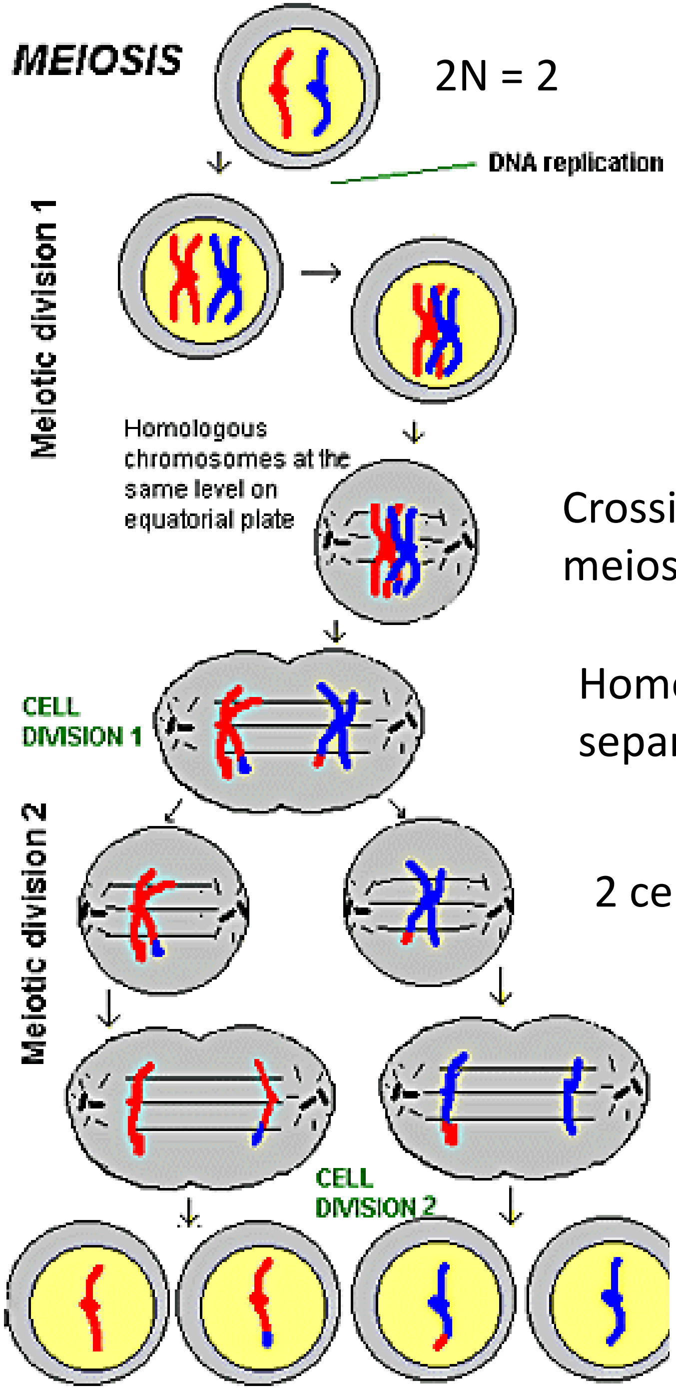
Exchange of genetic material between Homologous Chromosomes

- During Prophase I

occurs at CHIASMA



Produces <u>new genetic combinations</u>
--Chromosomes with both
<u>Maternal</u> & <u>Paternal</u> components



2N = 2

Crossing over occurs in meiosis I

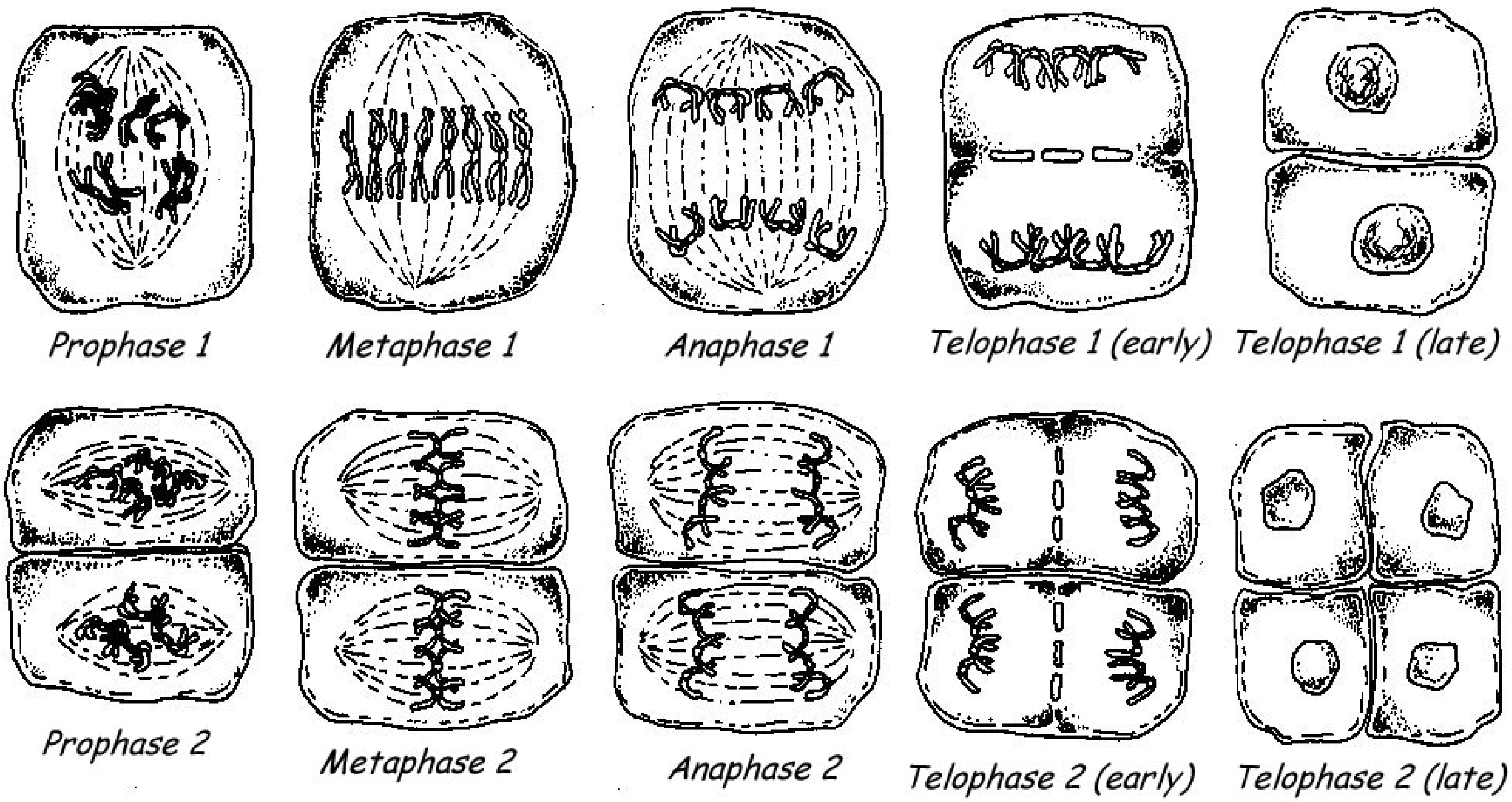
Homologous chromosomes separate in meiosis I

2 cells, N = 1 for each

Sister chromatids separate in meiosis II

4 cells, N = 1 for each. Chromosomes are different due to crossing over

Overview of Meiosis



Classic (Mendel) Genetics

Gregor Mendel: Father of Genetics

- Genetics is the scientific study of **heredity**.
- Gregor Mendel (1860's) an Austrian Monk, was interested in figuring out how heredity was determined in plants and animals.
  - used pea plants
  - **quantitative** approach to collect data.
- Mendel studied seven different pea plant traits.
  - Seed shape & color, pod shape & color, plant height, flower color and seed coat color
- A **trait** is a specific characteristic, such as seed color or plant height, that varies from one individual to another.

Gregor Mendel's Experiment

- He called the offspring of the P-generation, the F1, or "first filial," generation. *Filius* is the Latin word for "son."
  - These pea plants were cross pollinated.
  - In cross-pollination, male sex cells in pollen from the flower on one plant fertilize the egg cells of a flower on another plant.

- The offspring of crosses between parents with different traits are called hybrids.

- The F2 generation was allowed to self-pollinate (on the same plant).

- Out of 929 F2 Generation plants, 705 were purple and 224 were white.
  - Ratio of 3 purple to 1 white flowers

Mendel's Seven F_1 Crosses on Pea Plants							
	Seed Shape	**Seed Color**	**Seed Coat Color**	**Pod Shape**	**Pod Color**	**Flower Position**	**Plant Height**
P	Round x Wrinkled	Yellow x Green	Gray x White	Smooth x Constricted	Green x Yellow	Axial x Terminal	Tall x Short
F_1	Round	Yellow	Gray	Smooth	Green	Axial	Tall

Mendel's F_1 Crosses When Mendel crossed plants with contrasting characters for the same trait, the resulting offspring had only one of the characters. **From these experiments, Mendel concluded that some alleles are dominant and others are recessive.**

Mendel's conclusions: Rules

1. **Rule of Unit Factors**

   Each organism has 2 factors for each of its traits (alleles: gene alternatives)

2. **Rule of Dominance**

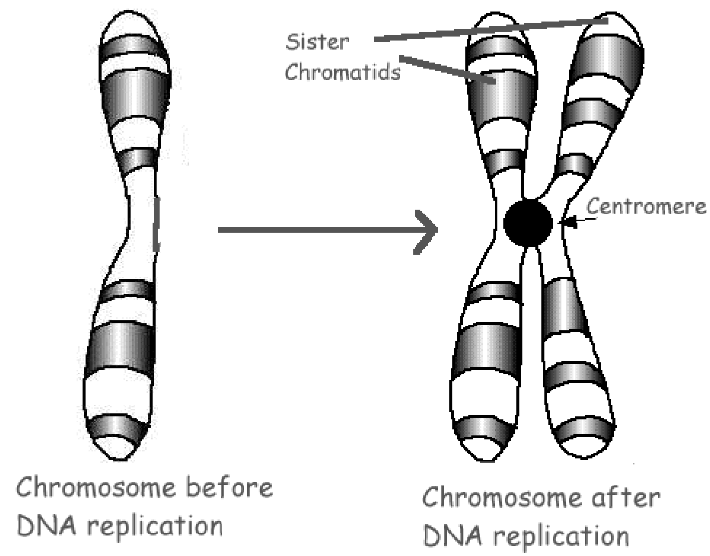
   For each trait there exists 2 possible factors that are expressed in physical characters, one that may be dominant, and the other recessive.

3. **Law of Segregation**

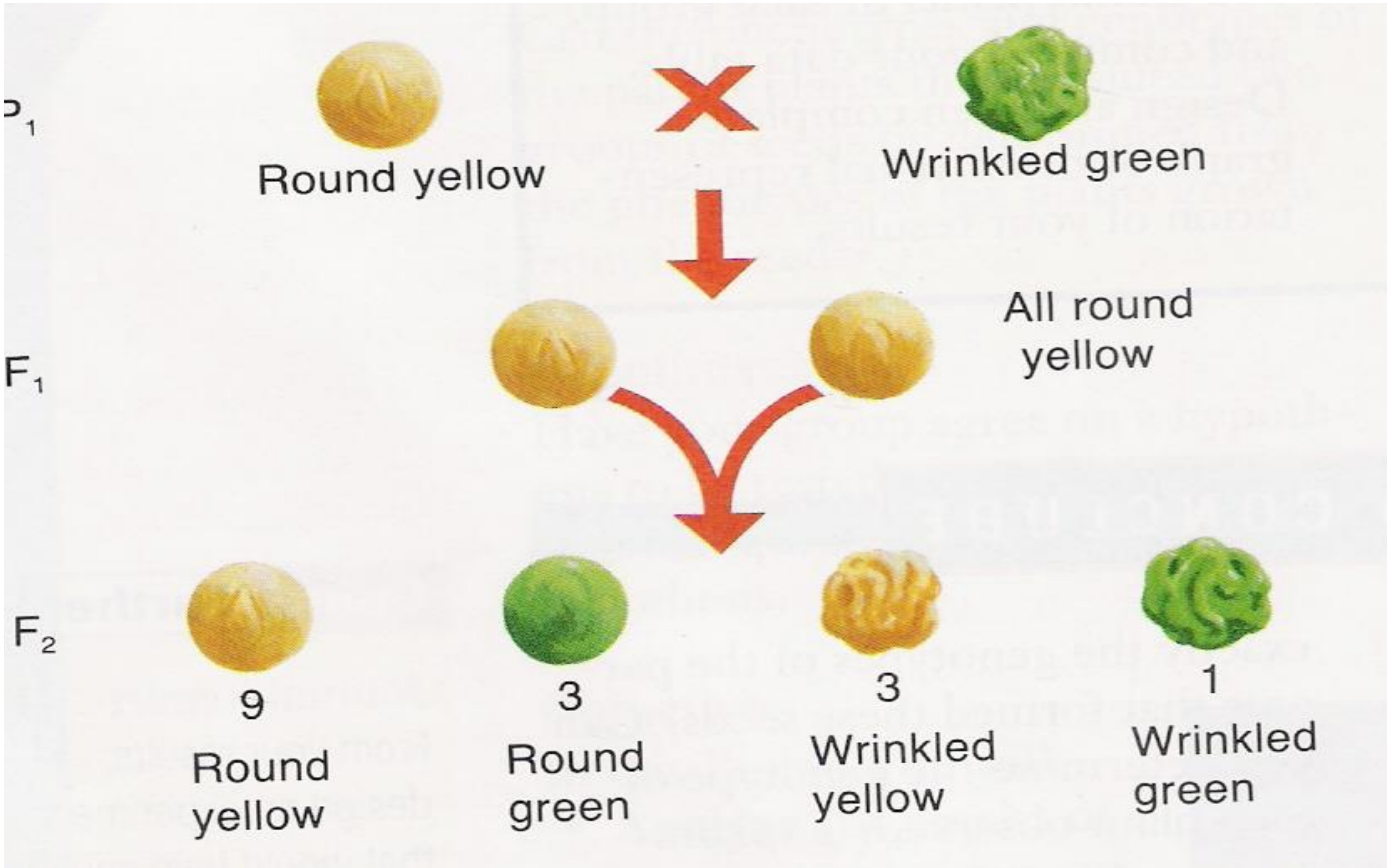
   The two alleles for each trait must separate when gametes form.

Expression of Traits

1. **phenotype**: physical expression of a gene
2. **genotype**: a make of genes on a chromosome
3. **homozygous**: alleles for a trait are the same
4. **heterozygous**: alleles for a trait are opposite



Dihybrid cross



Punnett Square for Dihybrid Cross

(Cross between 2 parents that are Heterozygous for two traits)

Law of Independent assortment – different traits are passed independently of each other. All possible combinations of gametes with the two traits must be considered possible.

Round Yellow Seeds X Round Yellow Seeds

RrYy X RrYy

Did this mean that the two dominant alleles would always stay together?

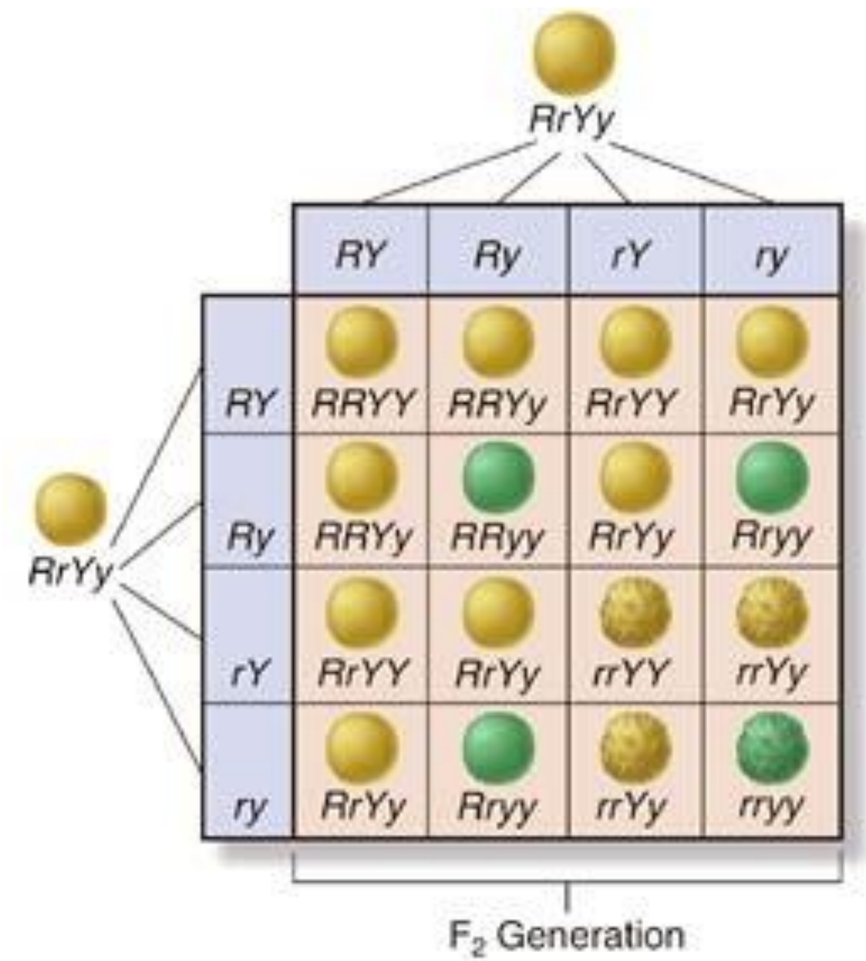
When Mendel let the F_1 self pollinate, he got a definite ratio of visible phenotypes:

9 with both dominant (RY)-Round Yellow

3 one dominant and one recessive (Ry)-round green

3 one recessive and one dominant (rY)–wrinkled yellow

1 both recessive (rryy)-wrinkled green



B. F_1 generation produced all round yellow seeds

C. F_2 generation produced

9 round yellow
3 round green
3 wrinkled yellow
1 wrinkled green

D. **The Law of Independent Assortment**

Genes for different traits are inherited independently of each other.

Plant Structure
(Morphology & Anatomy)

Plant Morphology

Shoot system

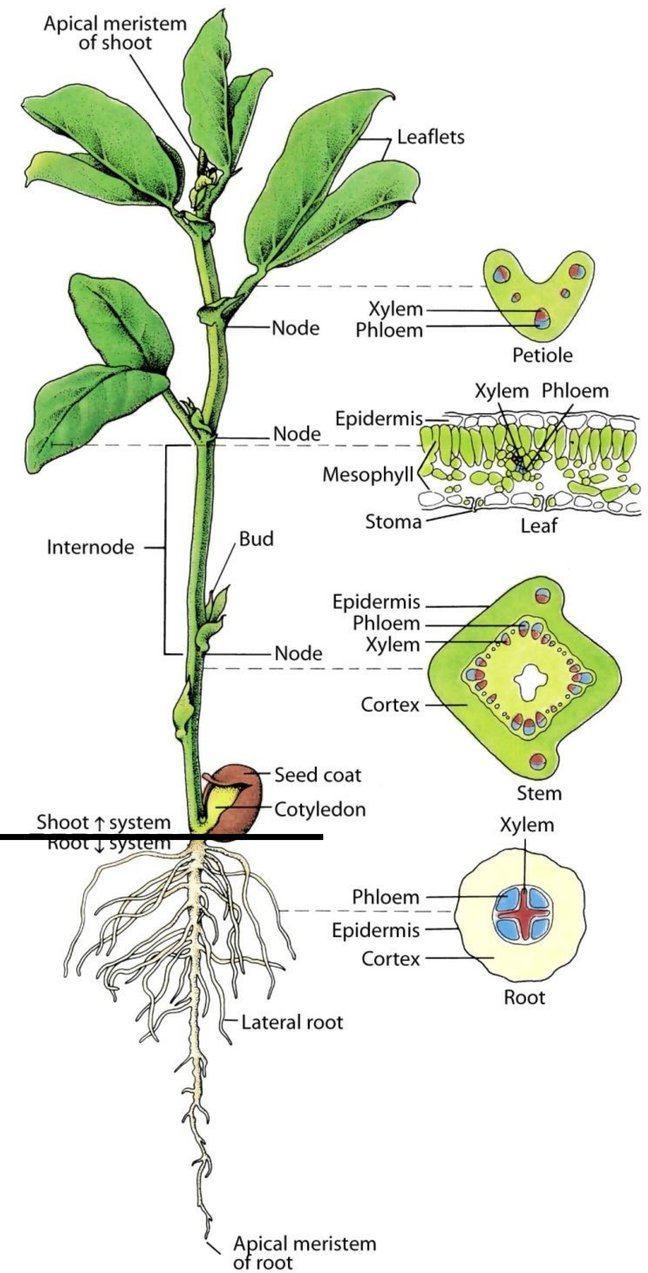
- **Stem**
  - **Supports and places leaves**
  - **Transports H_2O and nutrients**

- **Leaves**
  - **Photosynthesis**

- **Reproductive structures - Flowers**

Root system

- **Anchors the plant**
- **Absorbs water and minerals**
- **Storage (CHO) & synthesis of some hormones**
- **Propagation**

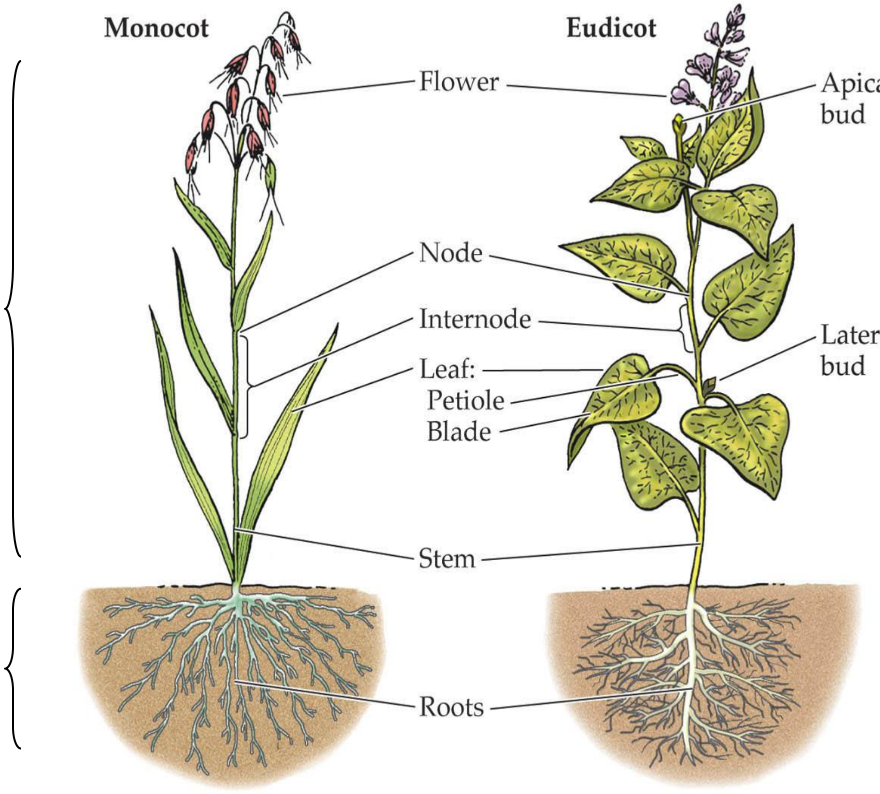


Dicots & Monocots

Flowering plants possess three kinds of vegetative (non-reproductive) organs: roots, stems, and leaves. The flower is the reproductive organ of the Angiosperms.

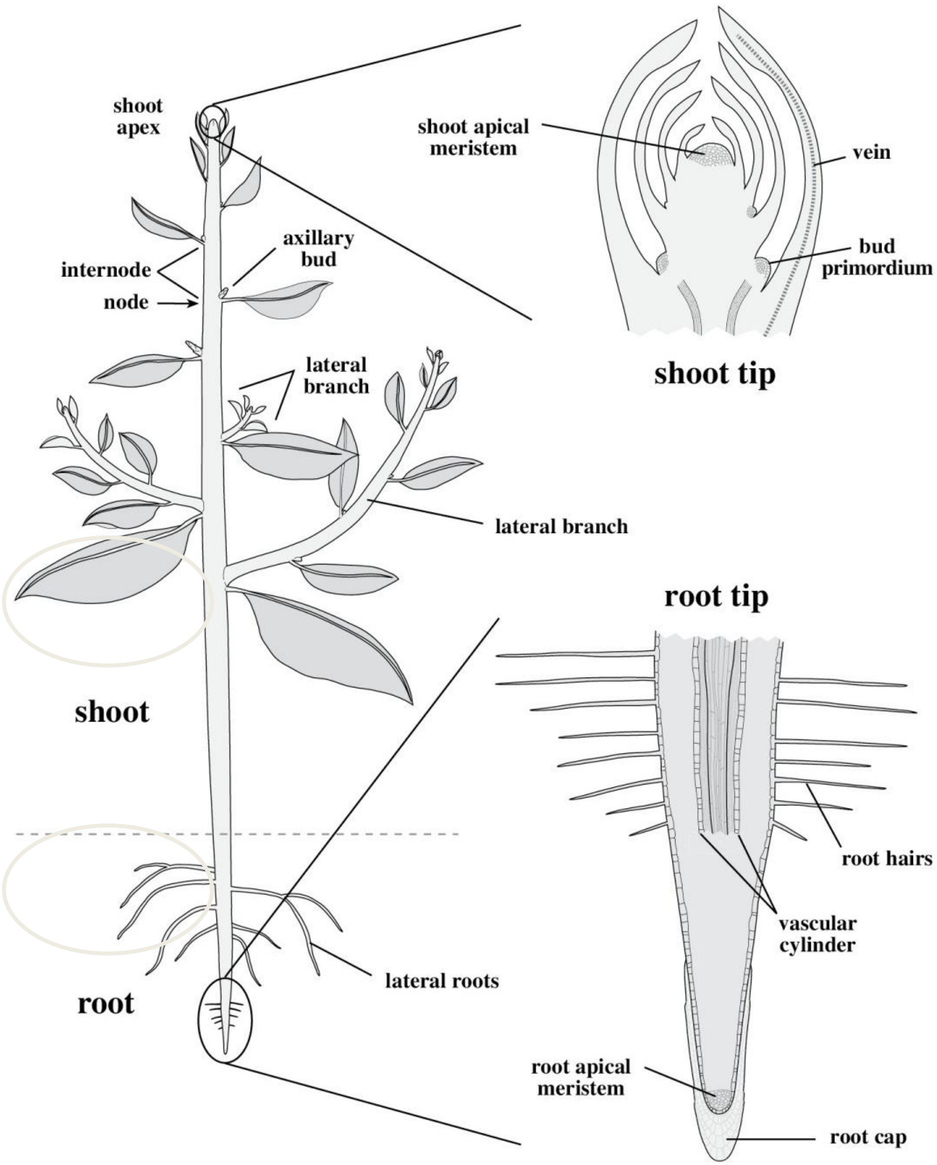
Shoots consist of:
<u>Stems</u> and <u>leaves</u>;
Functions are photosynthesis, support, reproduction, storage and transport

<u>Roots</u> Functions are anchorage, and absorption of water and Minerals, provides nutrients for the shoot and can be an area of storage

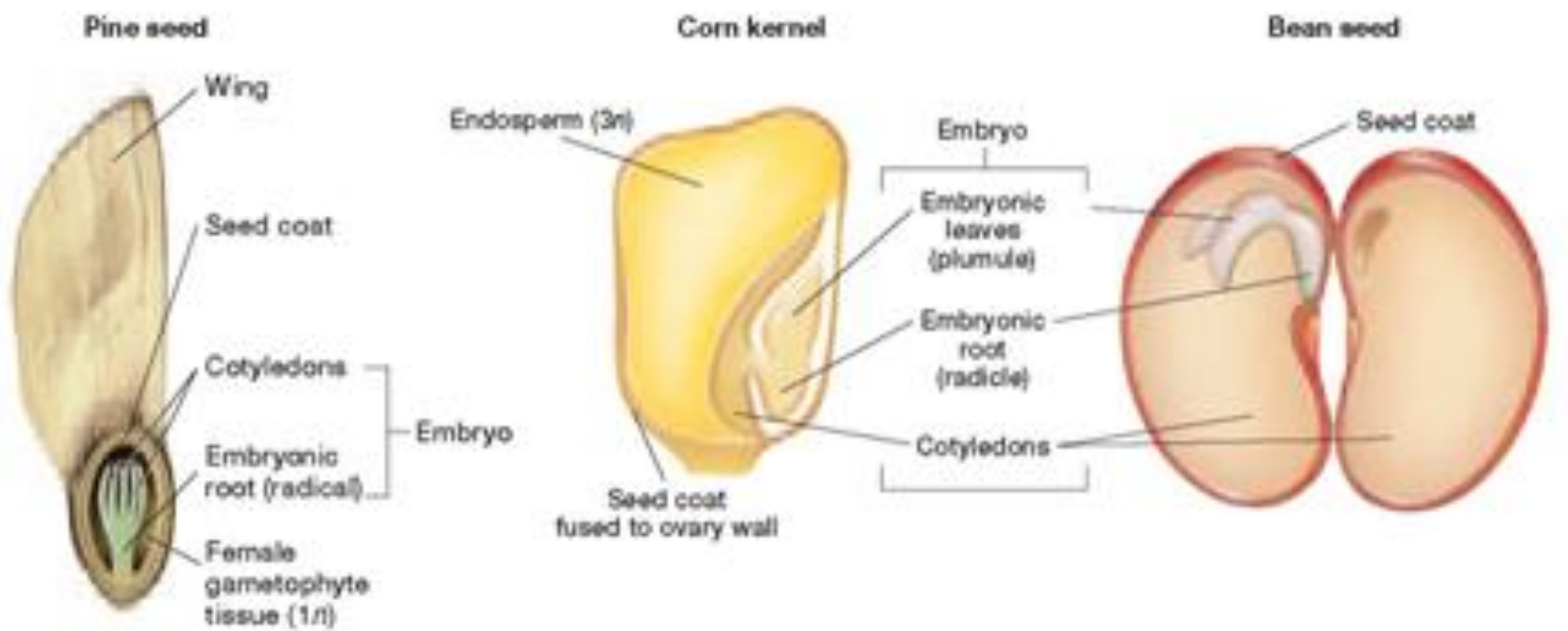


LIFE: THE SCIENCE OF BIOLOGY, Seventh Edition, Figure 35.2 Vegetative Organs and Systems

Root & Shoot Tips

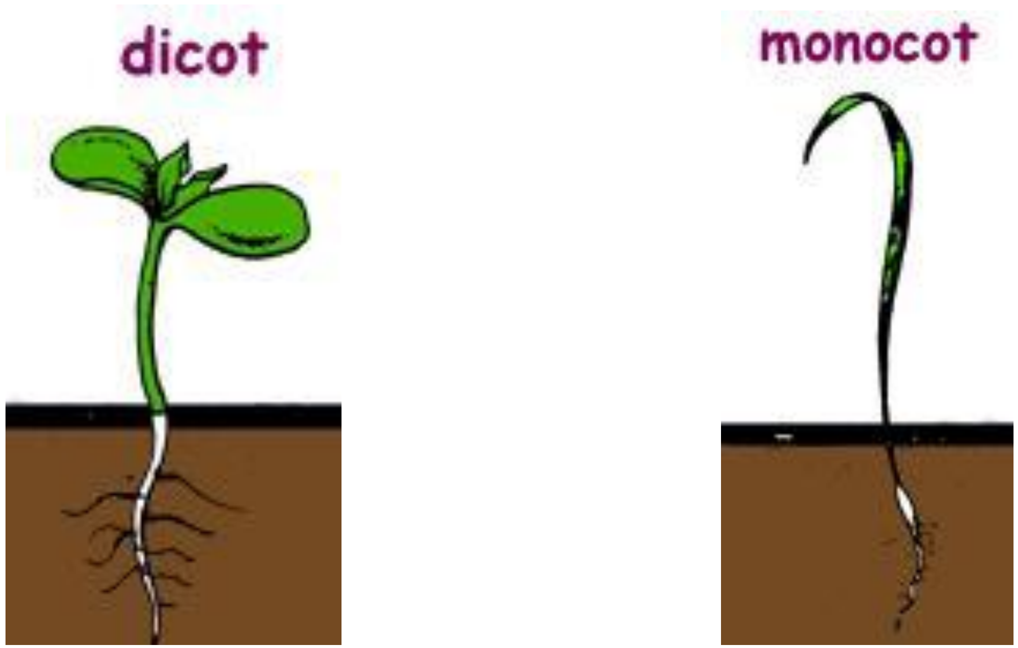


Seed Structure



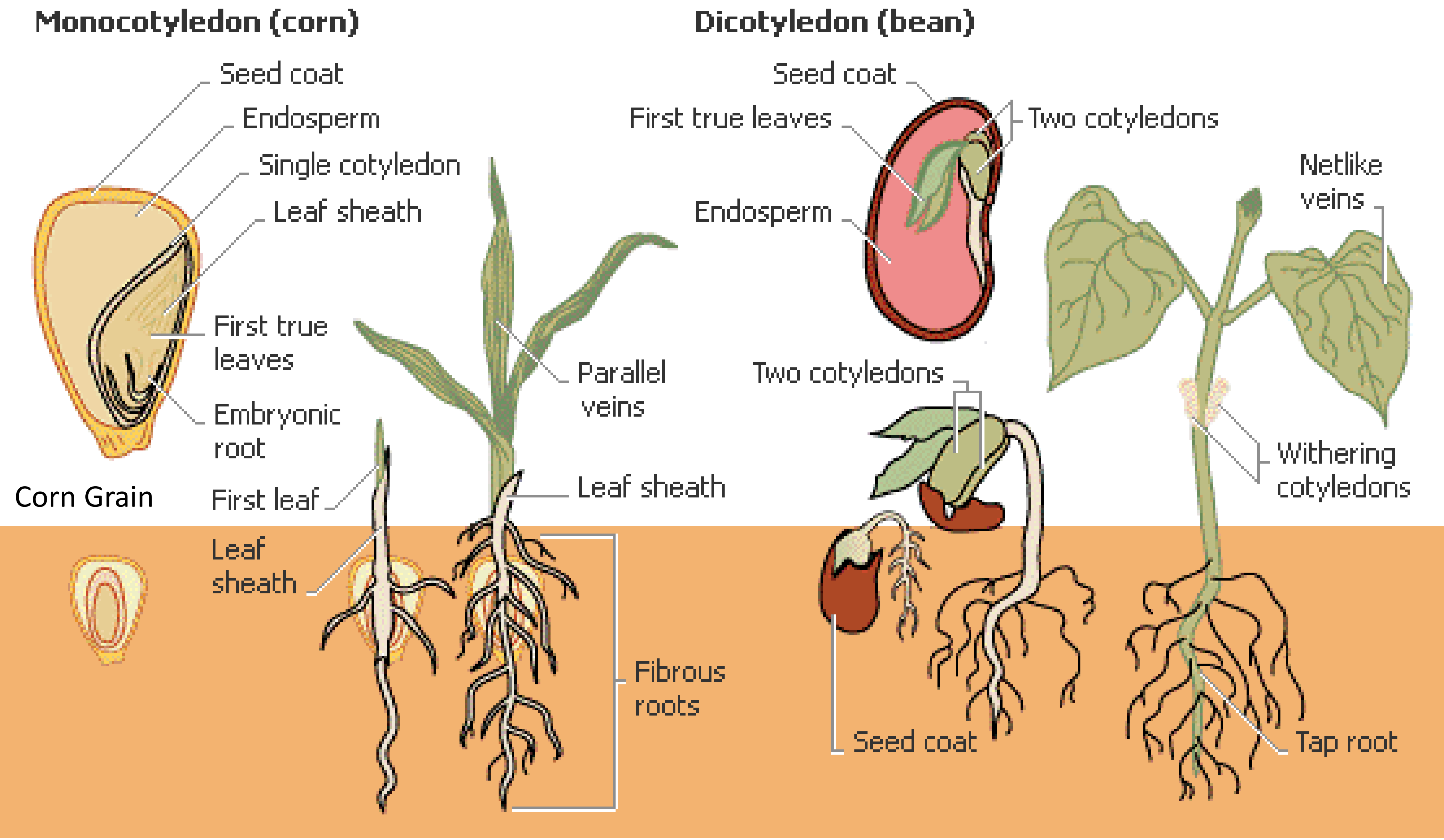
- A seed is a sporophyte embryo with its own food supply in a protective coat
  - Seed plants (gymnosperms and angiosperms) retain their spores

Plant Seedling



- **Monocotyledons (Monocots)-** have a single seed leaf
- **Dicotyledons (Dicots)- have double seed leaves**

Seed Germination



Roots

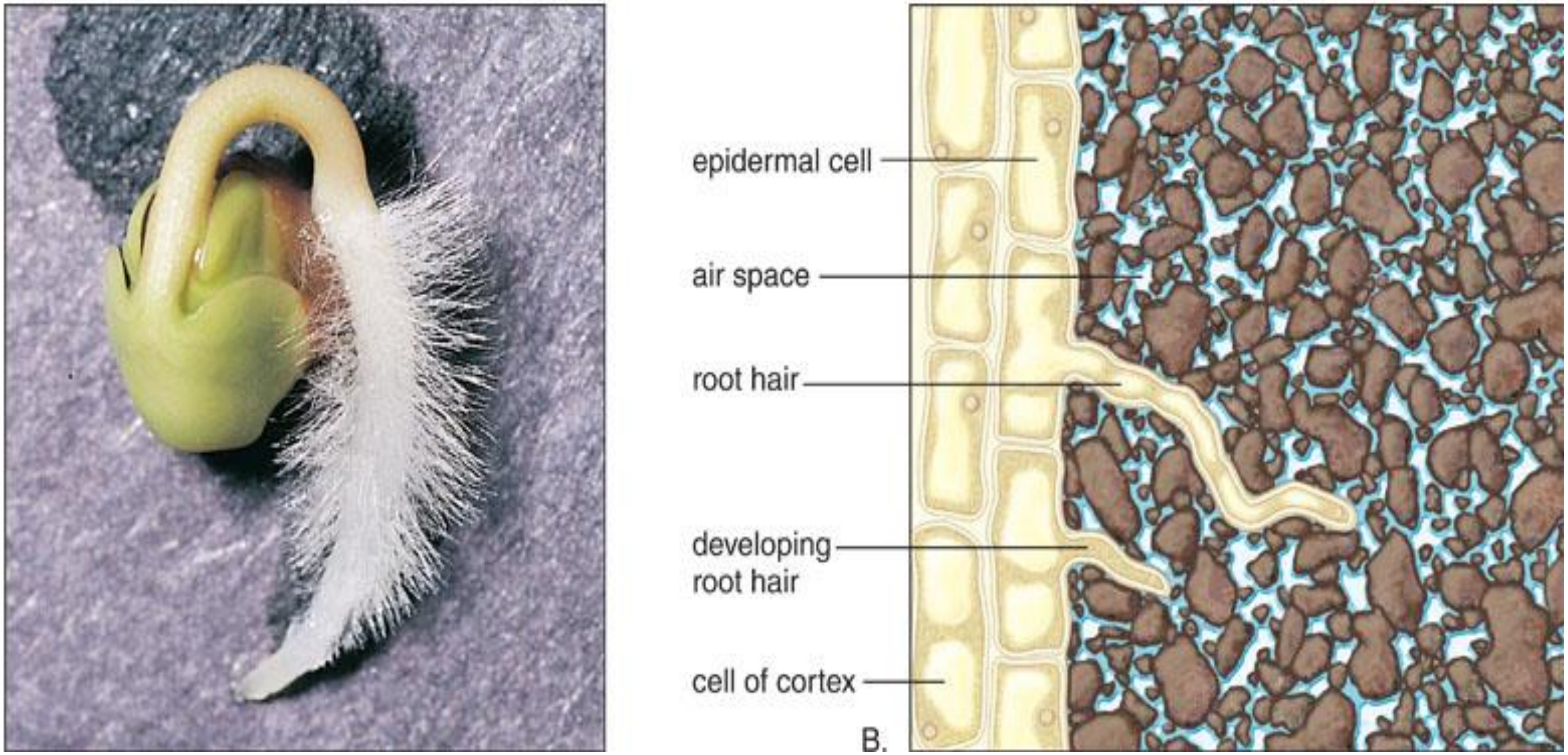
Function - absorption, anchorage

Structure – root cap, root hairs, endodermis

Adventitious roots - arise from non-root organ to perform specific function

Lateral roots - arise from another root (1˚, 2˚, etc.)

Roots: Specialized for H2O & Nutrient Absorption

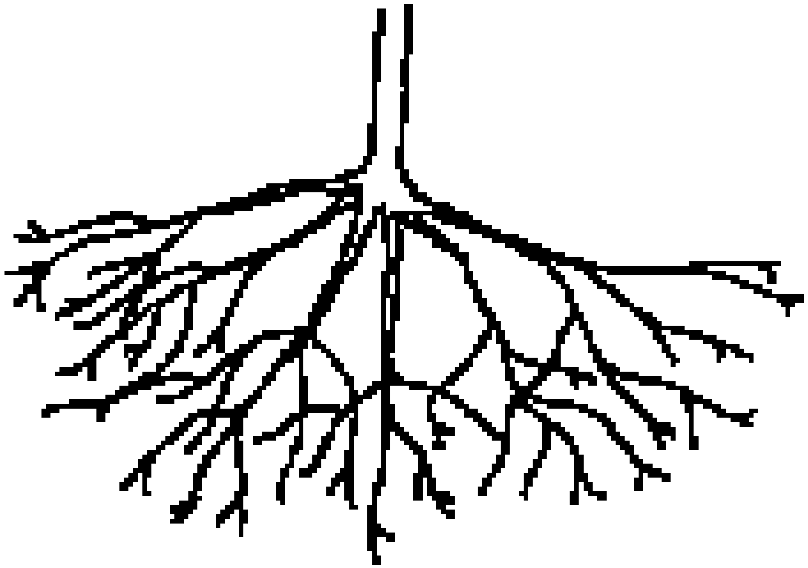


A. B.

Root Types: Adventitious & Tap Root System

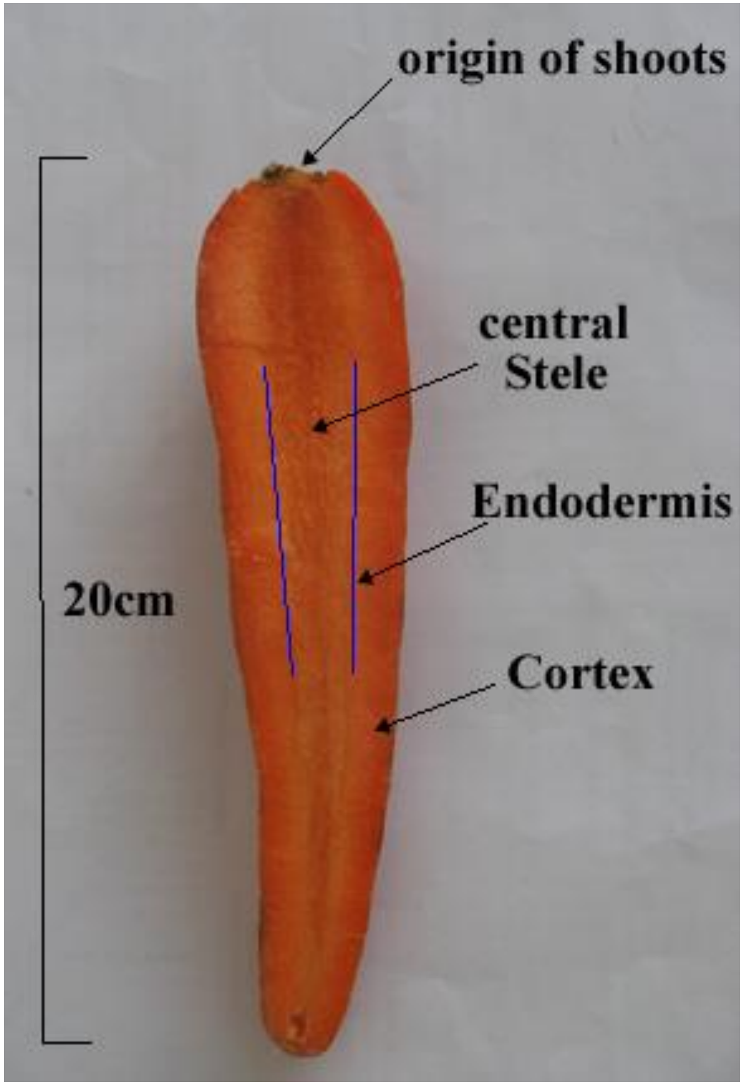
Fibrous Root System

- Develops when the secondary roots become the main roots.
- Shallow roots but spread over a broad area.
- Helps prevent erosion.



Tap Root System

- Develops from the primary root.
- Reaches deep into the ground
- Helps the plant during periods of drought.



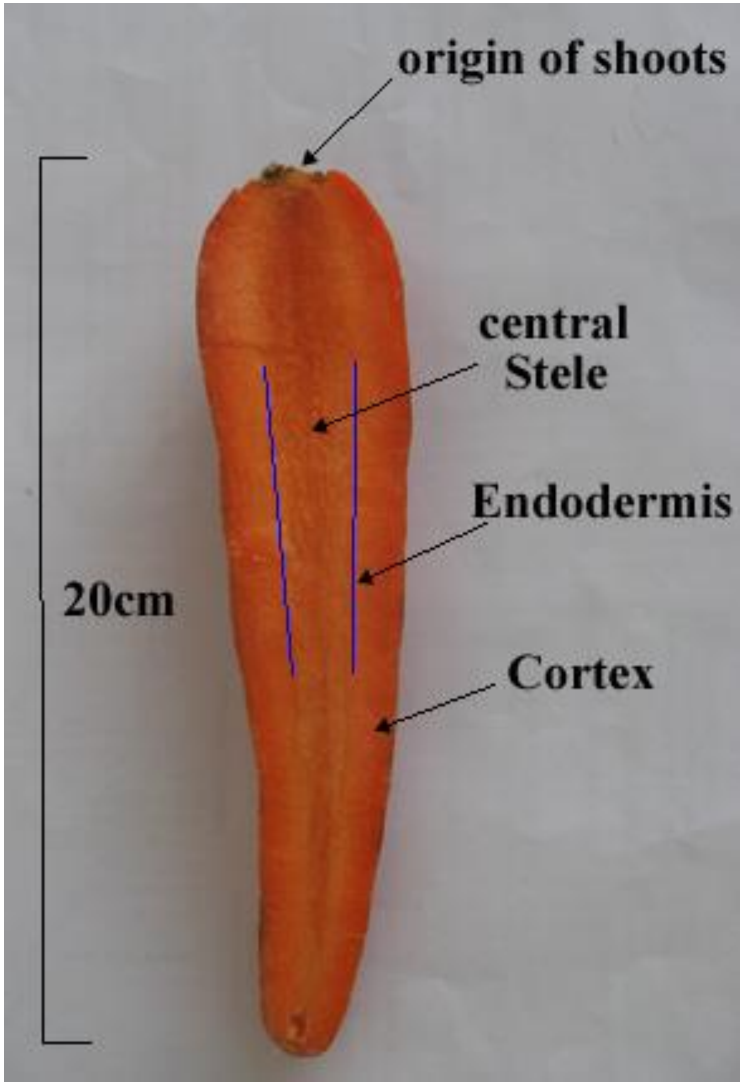
Root Modifications:

Storage Roots

Storage roots *Raphanus sativus*, radish

Storage roots, Sweet potato

Carrot: Tap Root modification



Function: Storage of water.

Carrot plants are often associated with very sandy soils.

The enlarged root is familiar to those who have eaten the vegetable.

The root modification allows the storage of water in the cortex and central stele.

The mass of the root stabilizes the plant in the loose sandy soils.

buttress roots

buttress roots, rusty-leaved fig

Respiratory roots

Pneumatophores (respiratory roots)
Avicennia marina, black mangrove

Prop roots

Prop roots (also adventitious)

Haustoria – parasitic roots

Root Adaptations ……??


(a)


(b)


(c)


(d)


(e)

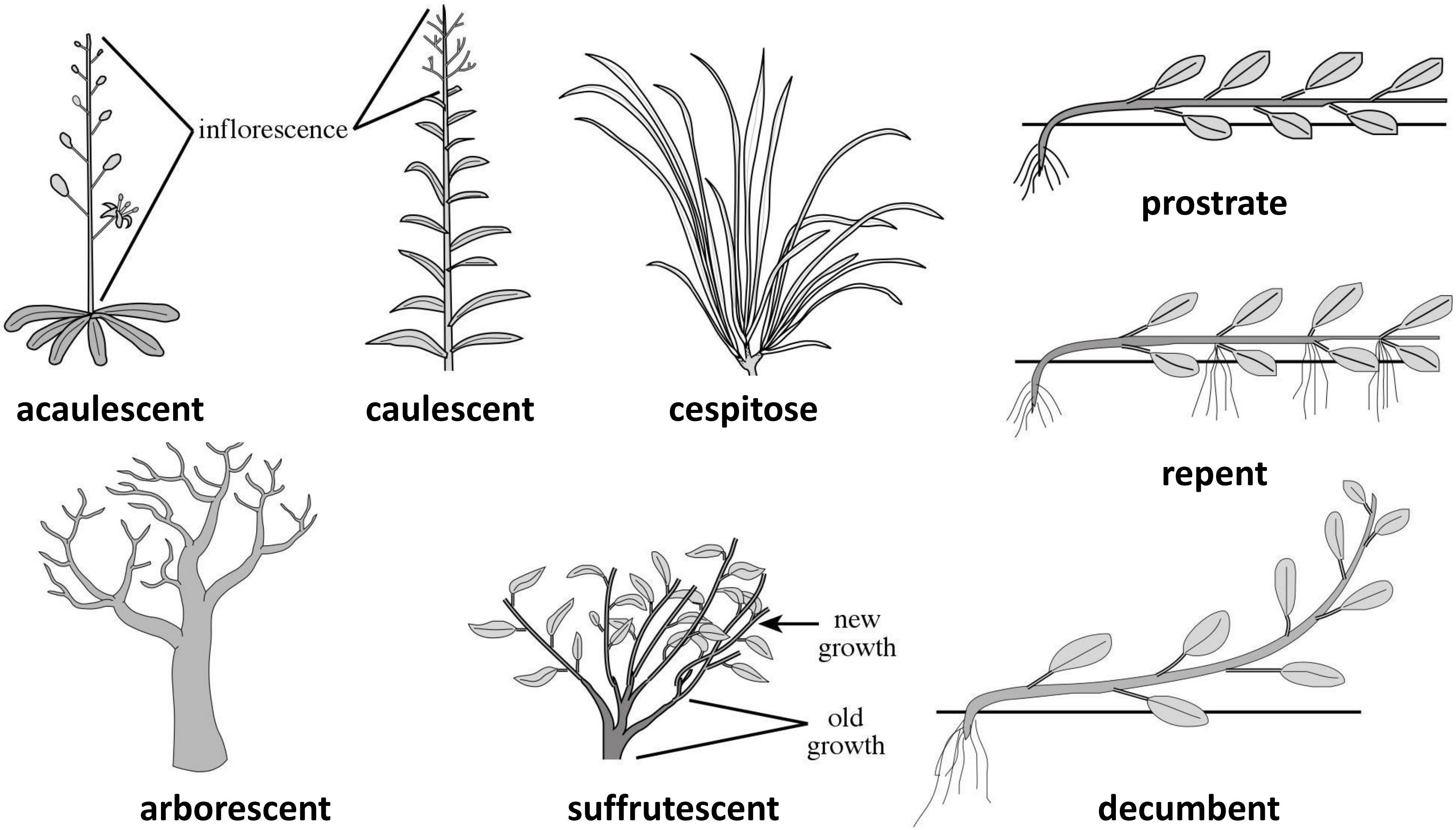
Shoot
(Stem + Associated Leaves)

Stems

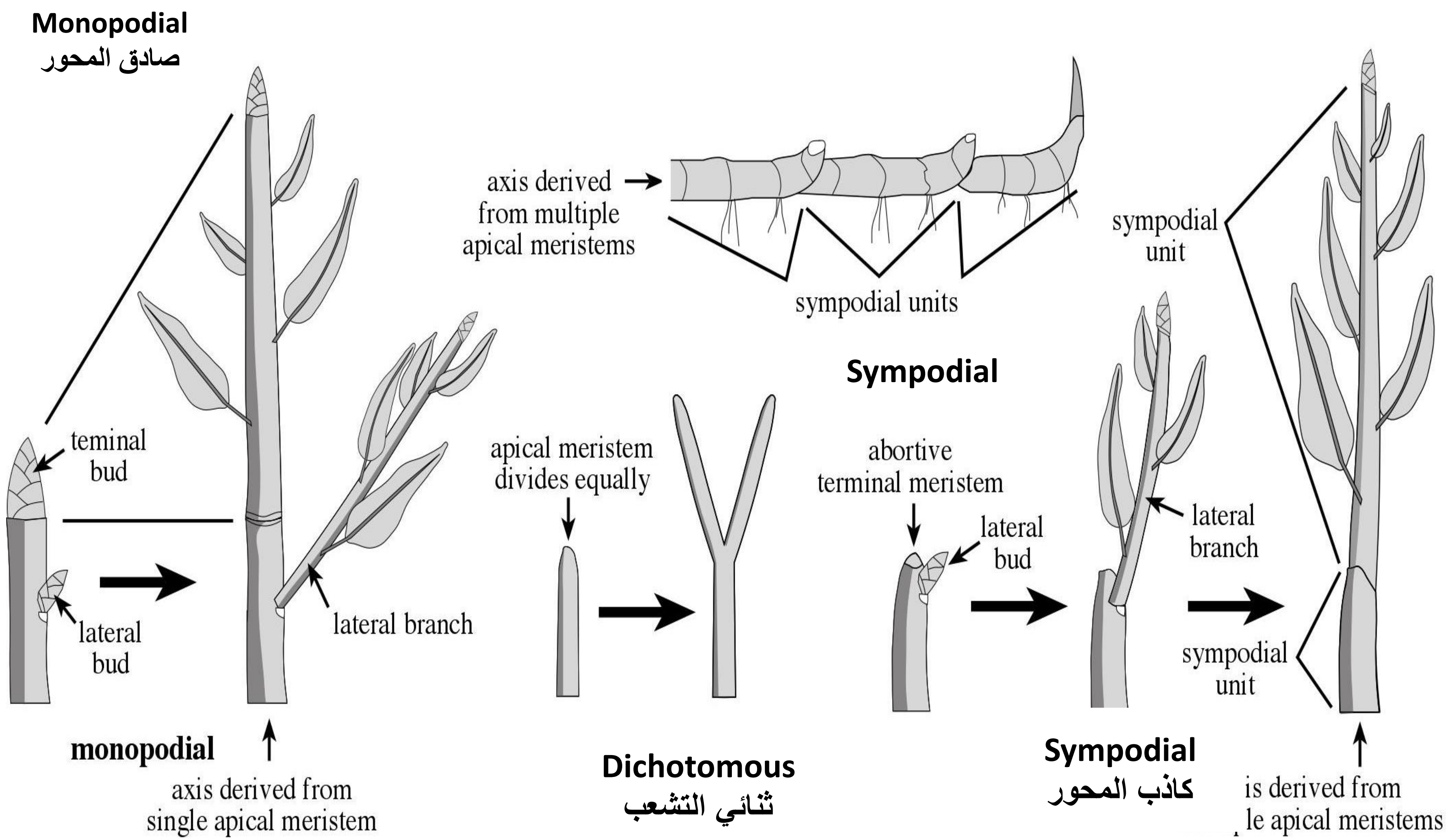
The two main functions of the stems are conduction and support

- Conduction involves moving substances manufactured in the leaves through the phloem to other parts of the plant including developing leaves, stems, roots, developing flowers, seeds and fruits and the xylem carries water from the roots to the leaves, where water is transpired
- Support involves holding the plant off the ground - supporting the principal photosynthetic organs of the plant (the leaves) as well as flowers, seeds and fruits

Stem Habit
=relative position of stem (+ growth, structure)

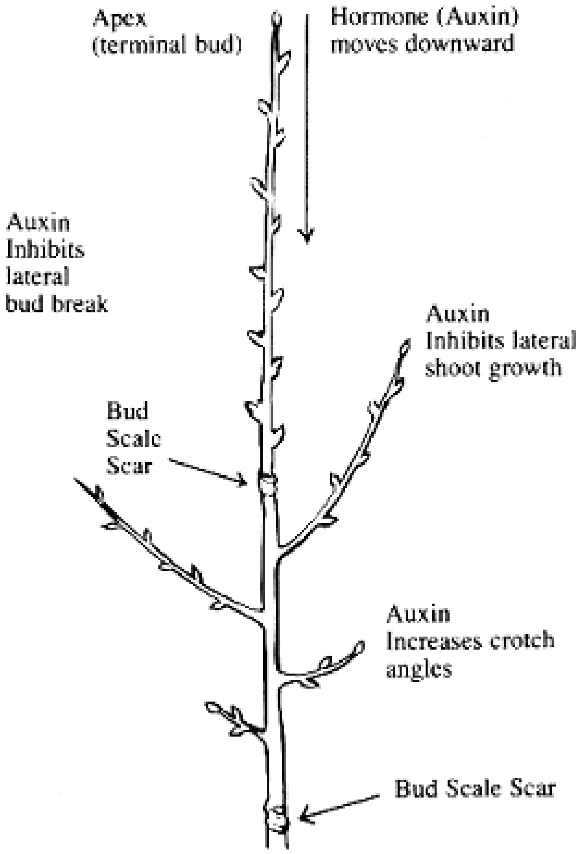


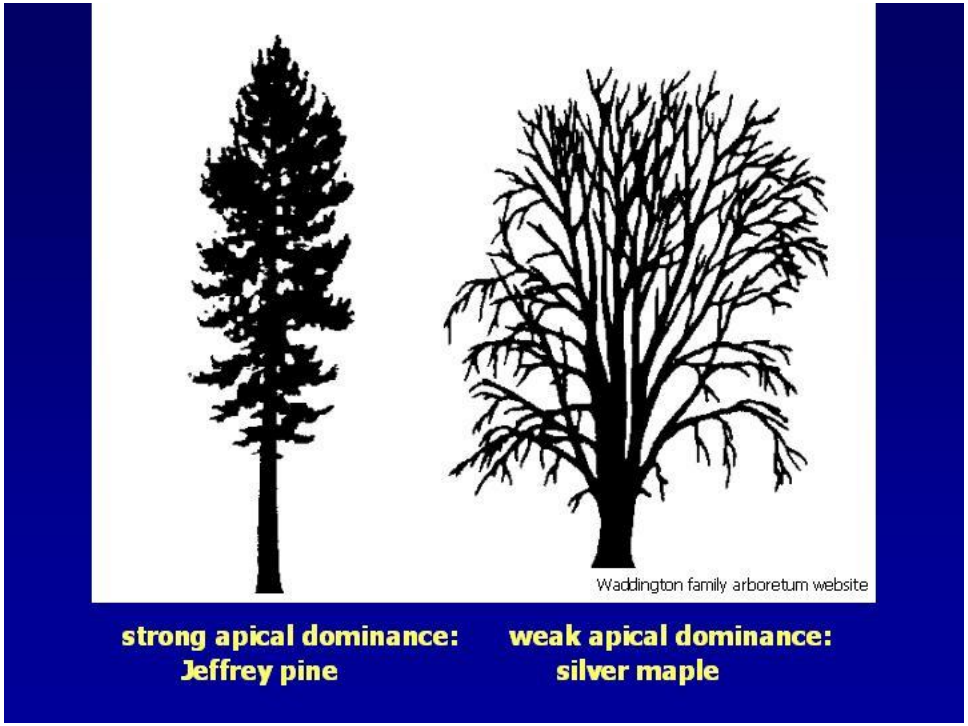
Stem Branching تفرع الساق



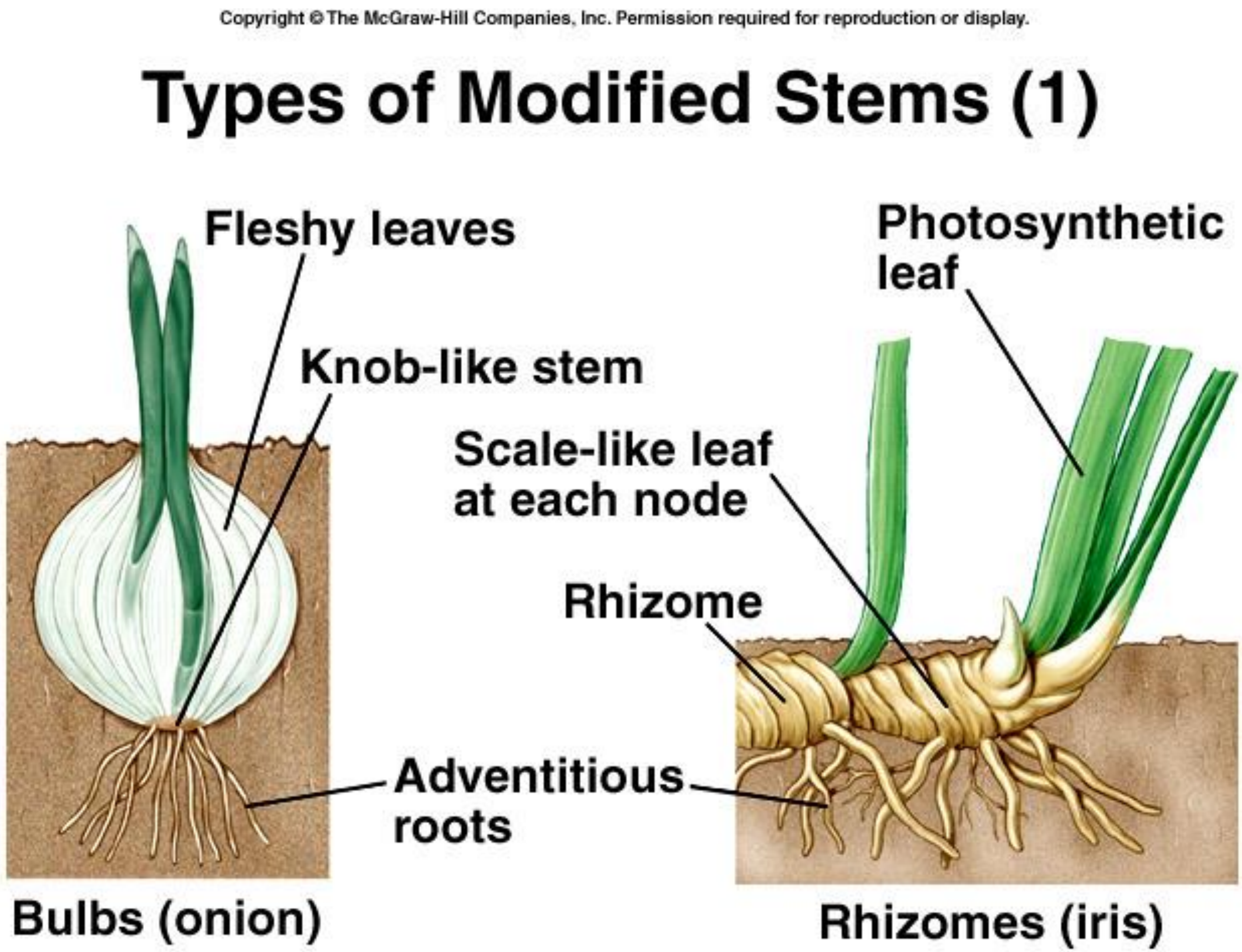
Apical Dominance السيادة القمية

Usually the growing terminal bud inhibits the development of the lateral buds, a phenomenon known as apical dominance – as the influence of the apical meristem lessens the growth of the lateral buds which proceed with their development.

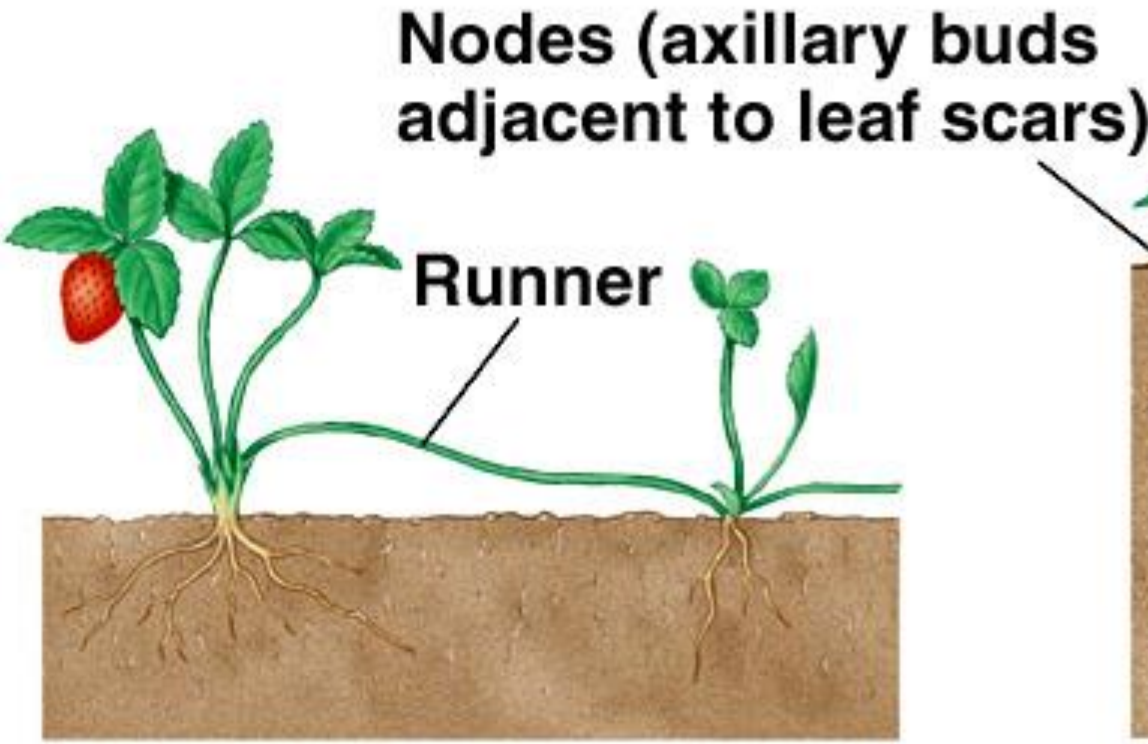




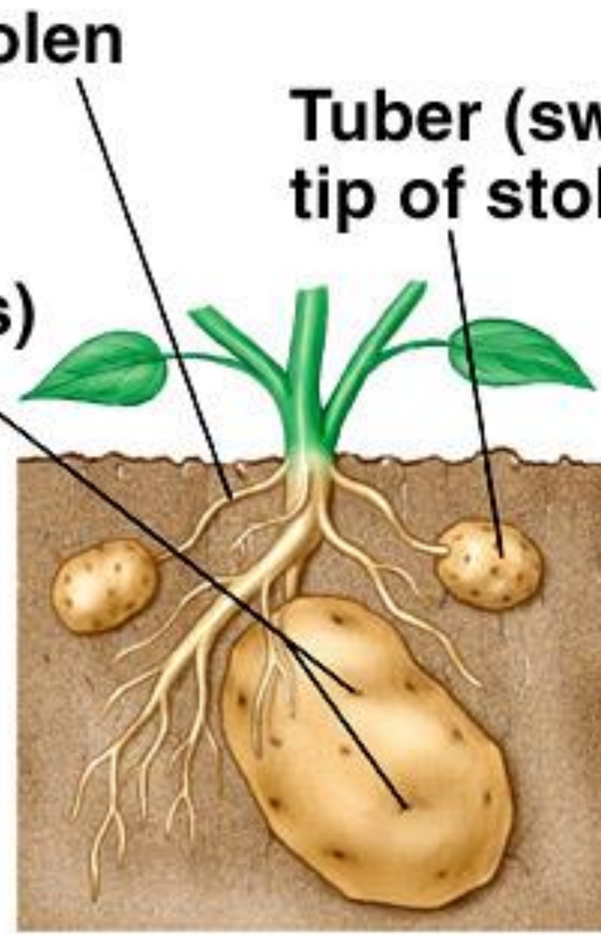
Stem (Shoot) Types & Modifications أنواع وتحور السيقان



Types of Modified Stems (2)

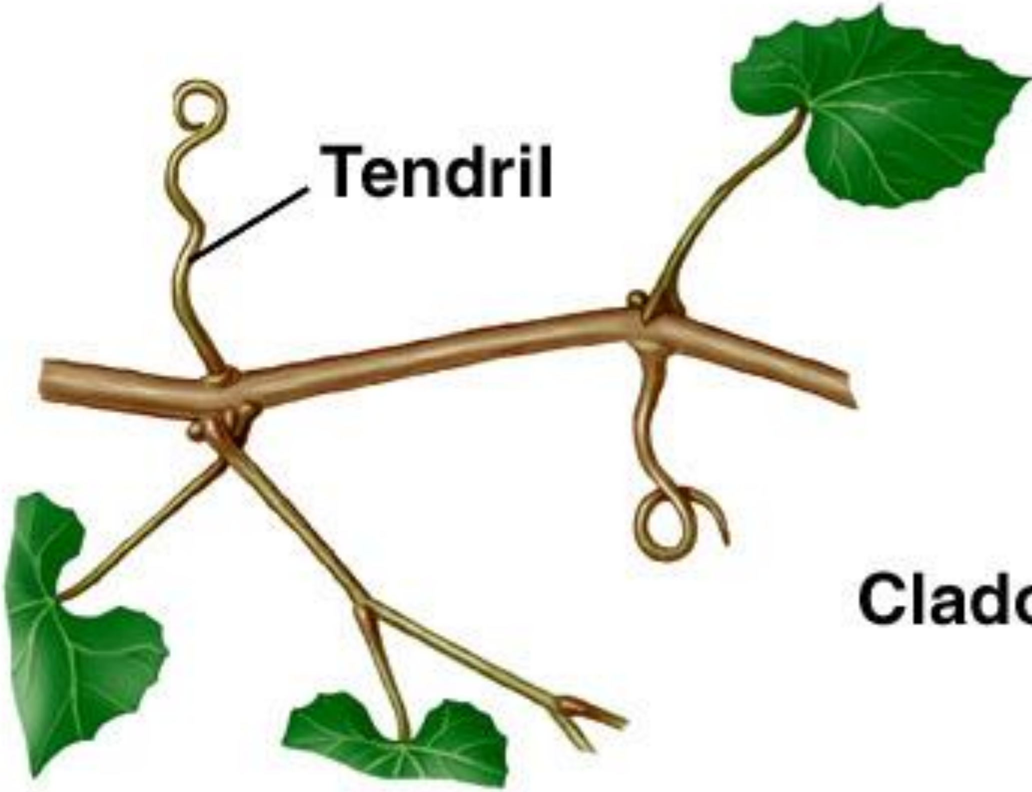


Runners (strawberry)

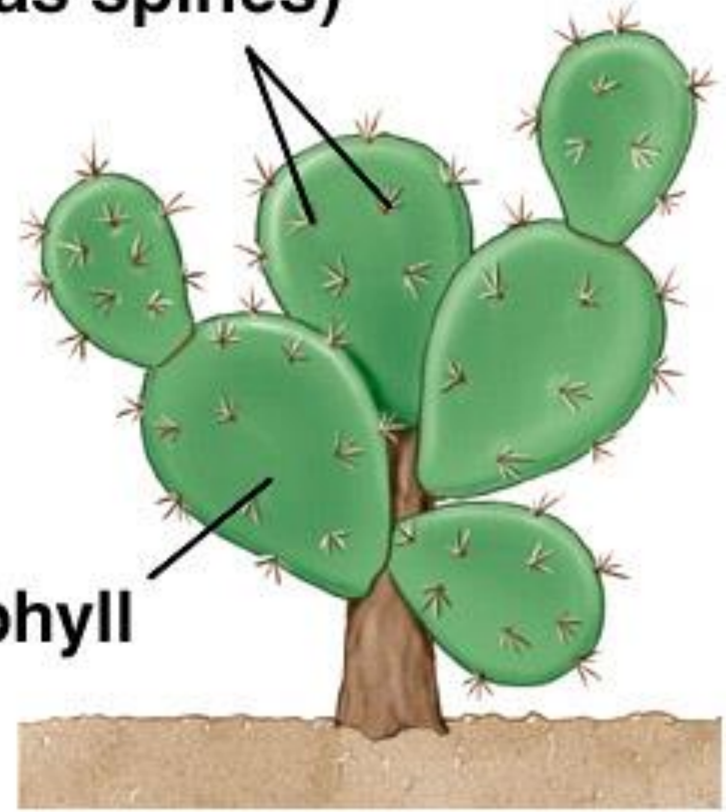


Tubers (potato)

Types of Modified Stems (3)

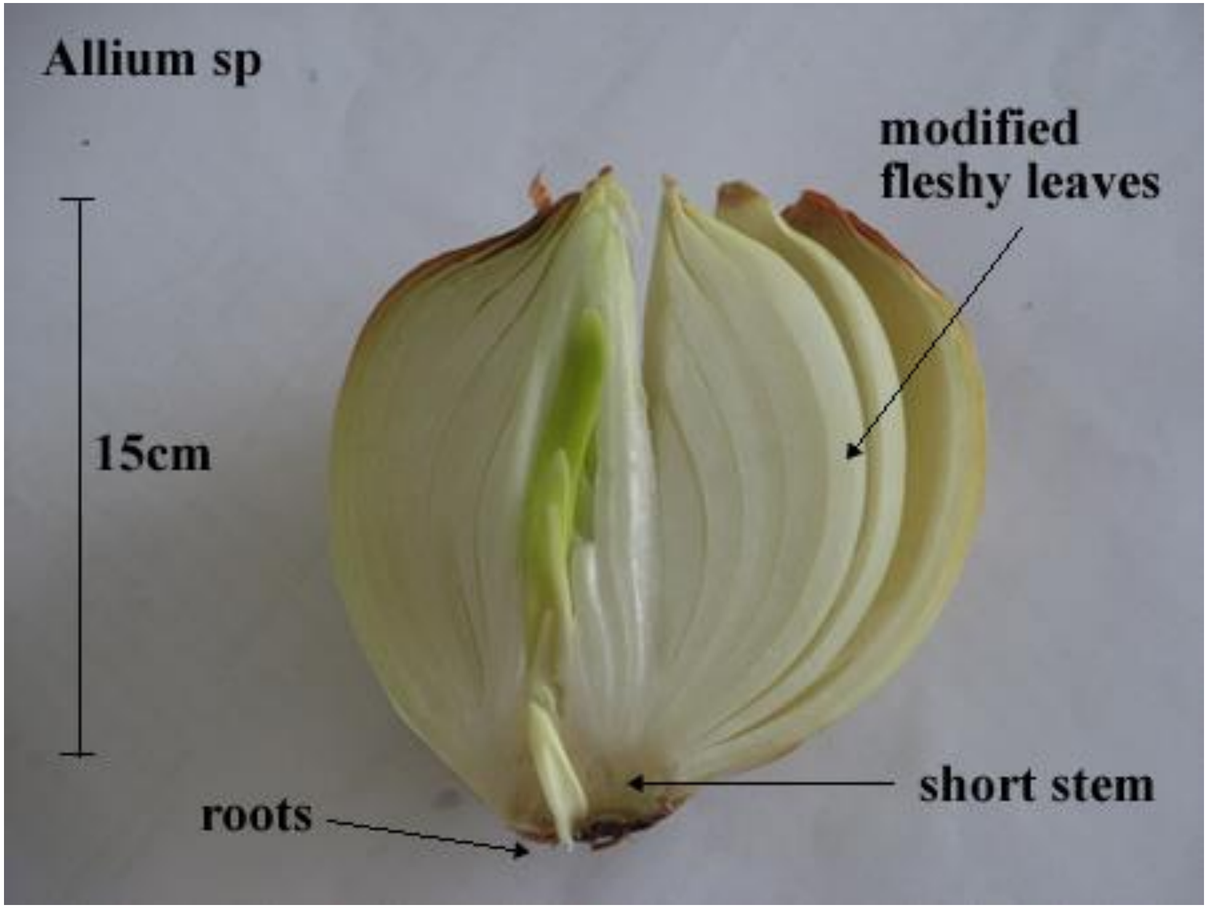


Tendrils (grape)

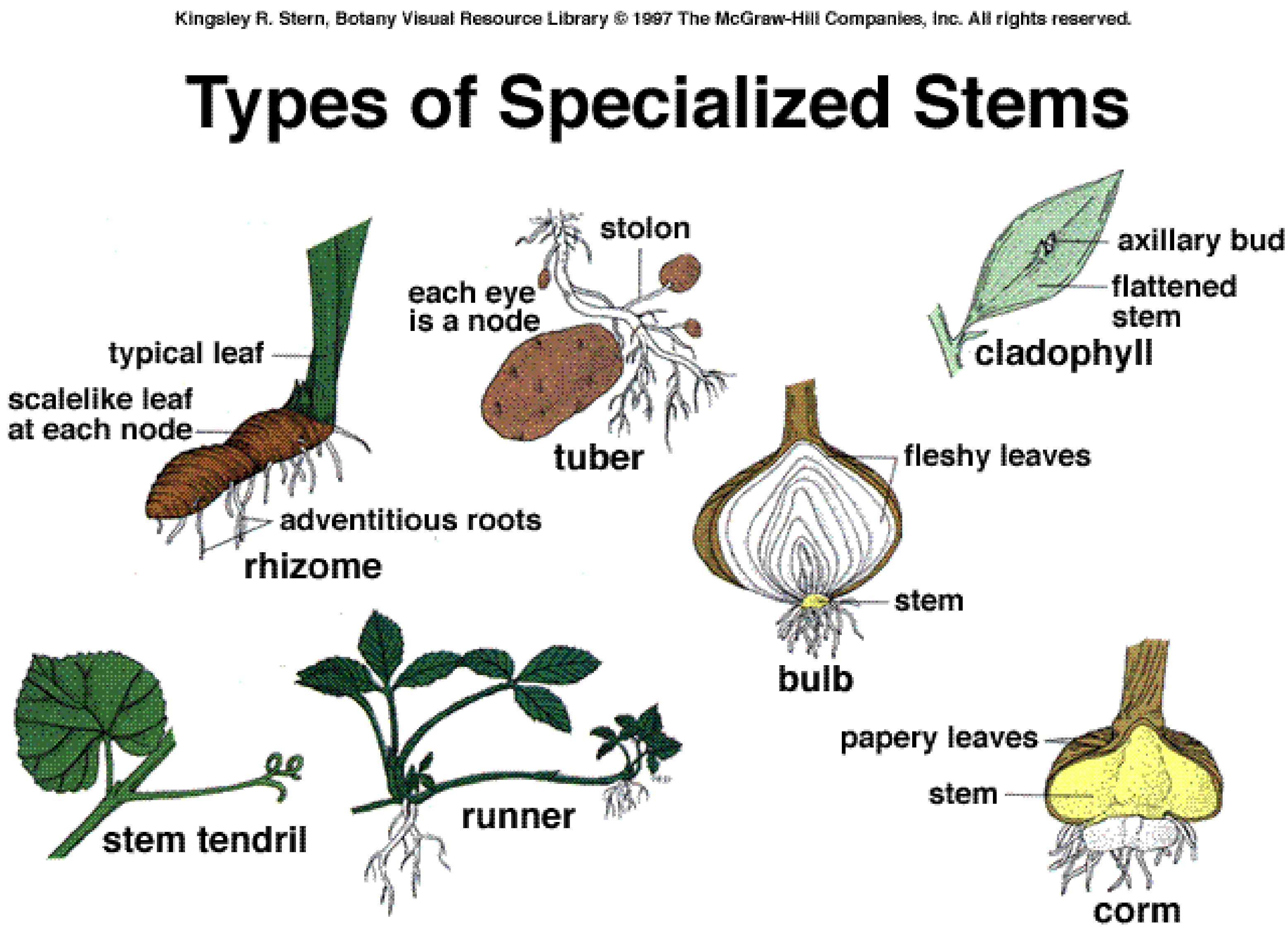


Cladophylls
(prickly pear)

Onion Bulb



Compare ……???



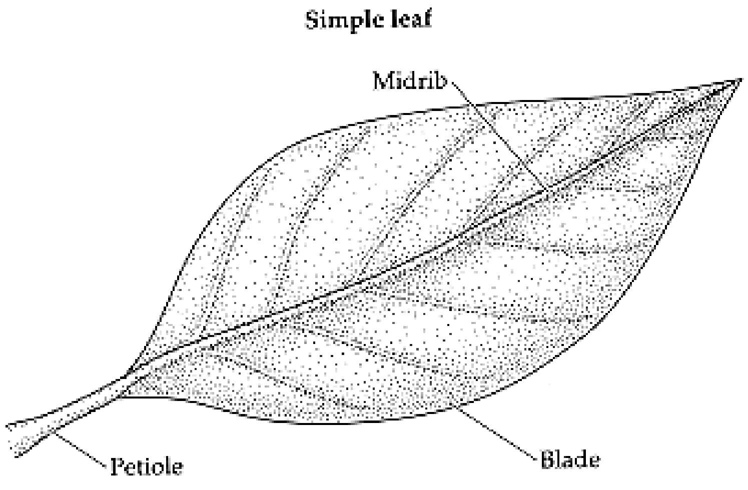
Kingsley R. Stern, Botany Visual Resource Library © 1997 The McGraw-Hill Companies, Inc. All rights reserved.
Types of Specialized Stems
typical leaf
scalelike leaf at each node
adventitious roots
rhizome
stolon
each eye is a node
tuber
axillary bud
flattened stem
cladophyll
fleshy leaves
stem
bulb
stem tendril
runner
papery leaves
stem
corm

Leaves

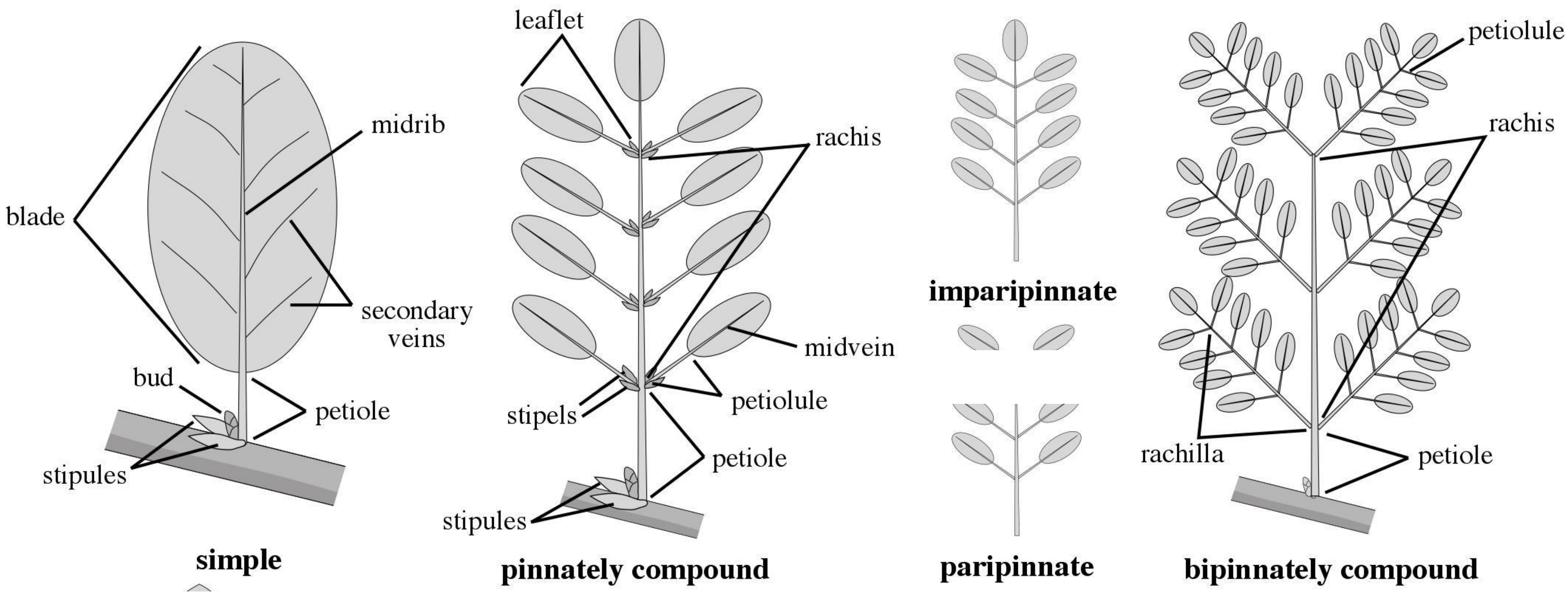
- The leaf- Is the main photosynthetic organ of most vascular plants
- Leaves generally consist of a flattened blade and a petiole, which joins the leaf to a node of the stem
- Leaves may appear different based on whether they grow in shade or full sun
- Some plant species have evolved modified leaves that serve various functions
  - Climbing, pollinator attraction, storage, digestion, prevention of water loss, etc.

External Parts of the Leaf:

- Petiole عنق
  - Leaf stalk or part that connects the leaf to the stem.
- Blade نصل
  - The large, flat part of a leaf.
- Midrib عرق وسطي
  - The large center vein.



Leaf Types

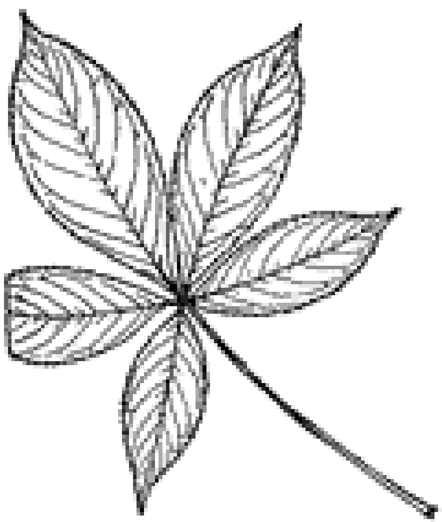


(a) **Simple leaf. ورقة بسيطة** A simple leaf is a single, undivided blade. Some simple leaves are deeply lobed.

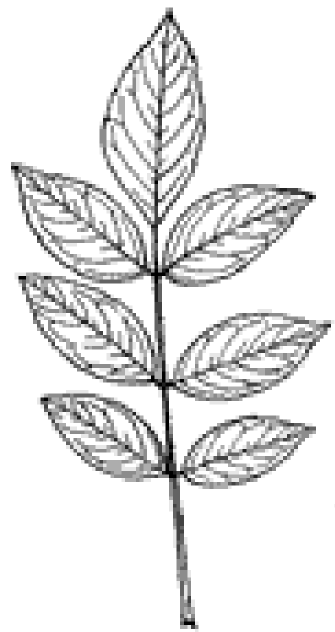
(b) **Compound leaf (Pinnate). مركبة ريشية** In a compound leaf, the blade consists of multiple leaflets. Note that a leaflet has no axillary bud at its base.

(c) **Doubly compound leaf (Bipinnate). مركبة ريشية مزدوجة** In a doubly compound leaf, each leaflet is divided into smaller leaflets.

Compound Leaves



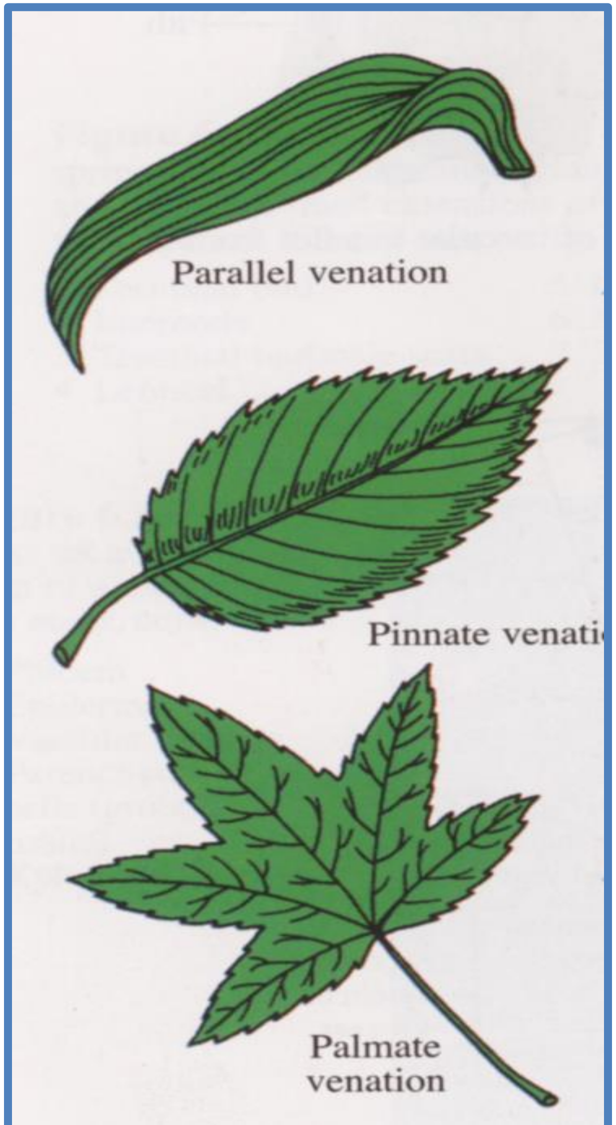
palmately
compound



pinnately
compound

Bi-Pinnately Compound Leaf

Leaf Venation تعرق الورقة



- **Parallel- متوازي** veins extend the entire length of the leaf with little or no cross-linking
- **Pinnate- ريشي** leaves have one major vein from which others branch
- **Palmate- راحي** leaves have several veins which branch

Dicot and Monocot Leaves

Reticulate
شبكي

Parallel
متوازي

Leaf Adaptations/ Modifications

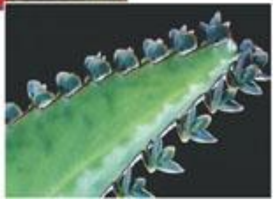
Some plant species have evolved modified leaves to serve various functions.

(a) Tendrils. The tendrils by which this pea plant clings to a support are modified leaves. After it has "lassoed" a support, a tendril forms a coil that brings the plant closer to the support. Tendrils are typically modified leaves, but some tendrils are modified stems, as in grapevines.

(b) Spines. The spines of cacti, such as this prickly pear, are actually leaves, and photosynthesis is carried out mainly by the fleshy green stems.

(c) Storage leaves. Most succulents, such as this ice plant, have leaves modified for storing water.

(d) Bracts. Red parts of the poinsettia are often mistaken for petals but are actually modified leaves called bracts that surround a group of flowers. Such brightly colored leaves attract pollinators.



(e) Reproductive leaves. The leaves of some succulents, such as *Kalanchoe daigremontiana,* produce adventitious plantlets, which fall off the leaf and take root in the soil.

Tendril

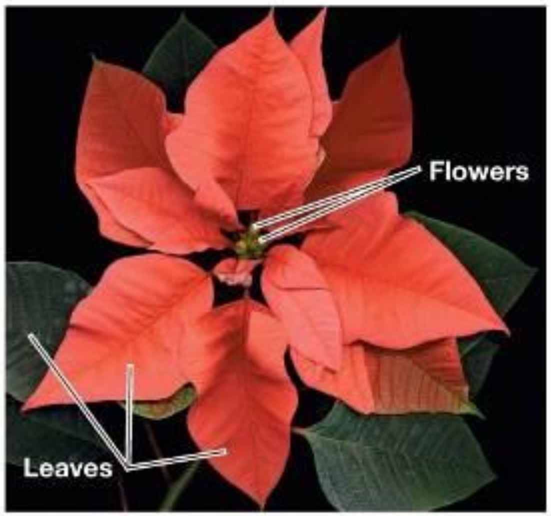
Spiny leaf- Cacti spines

Succulent leaves

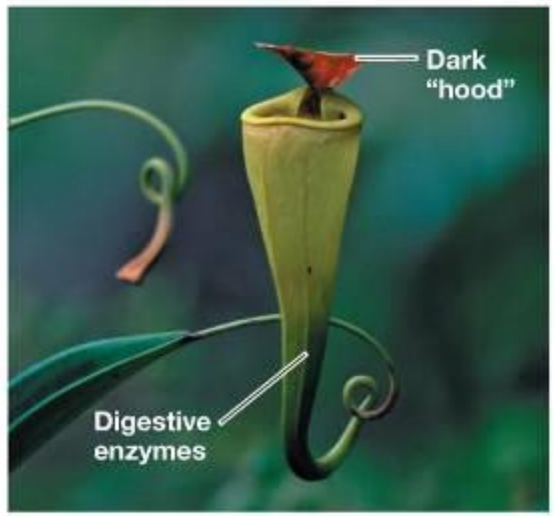
Brightly-colored leaves-
to attract pollinators

Leaf Modifications

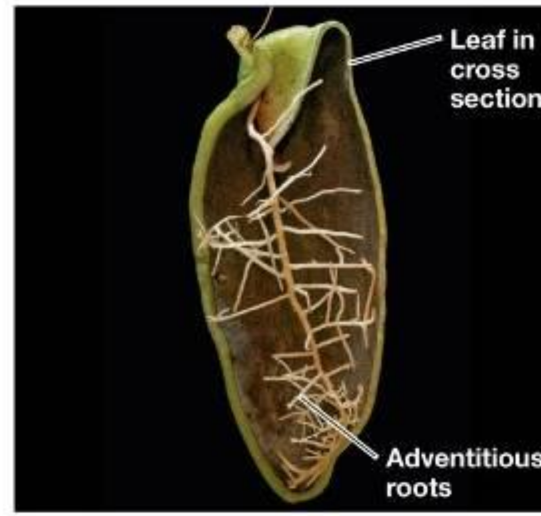
(d) Poinsettia leaves attract pollinators.



(e) Pitcher plant leaves trap insects.



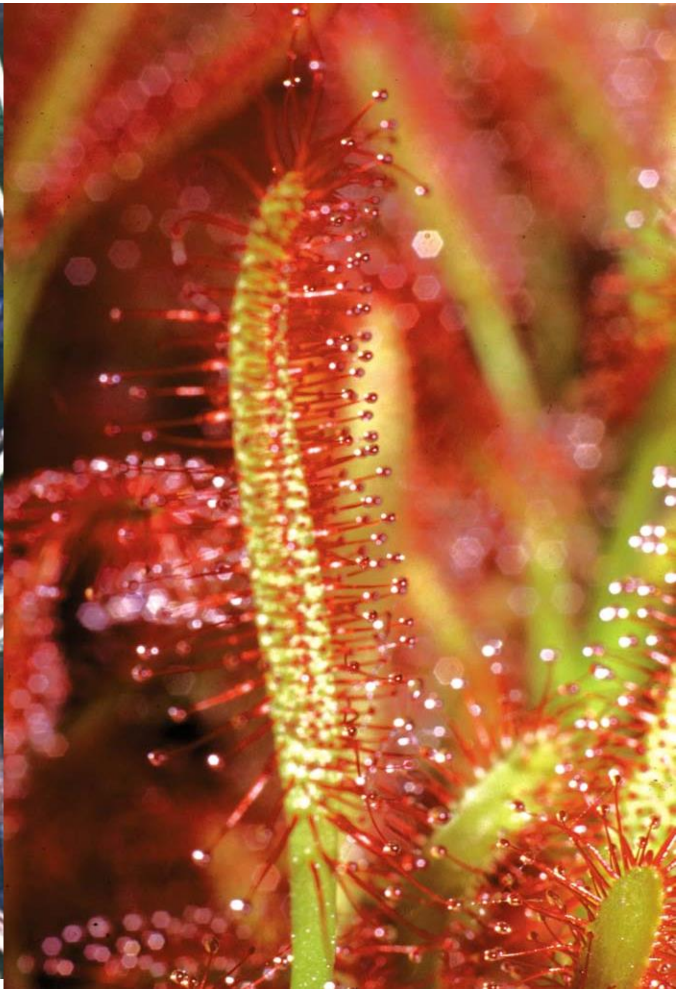
(f) Flowerpot plant leaves collect soil.



Sharp things

- **Thorn** - sharp-pointed stem/shoot (fr. axillary bud)
- **Spine** - sharp-pointed leaf or leaf part
  - **leaf spine** (also leaflet spine)
  - **stipular spine**
  - **petiolar spine**
- **Prickle** - sharp pointed epidermal appendage

Leaf Structural/ Functional Types



Tentacular Leaf - *Drosera* spp Sundew (Droseraceae)

Carnivorus plants

- Insect-Trapping Leaves in areas with low soil N

- Insect digested by enzymes to release N from proteins

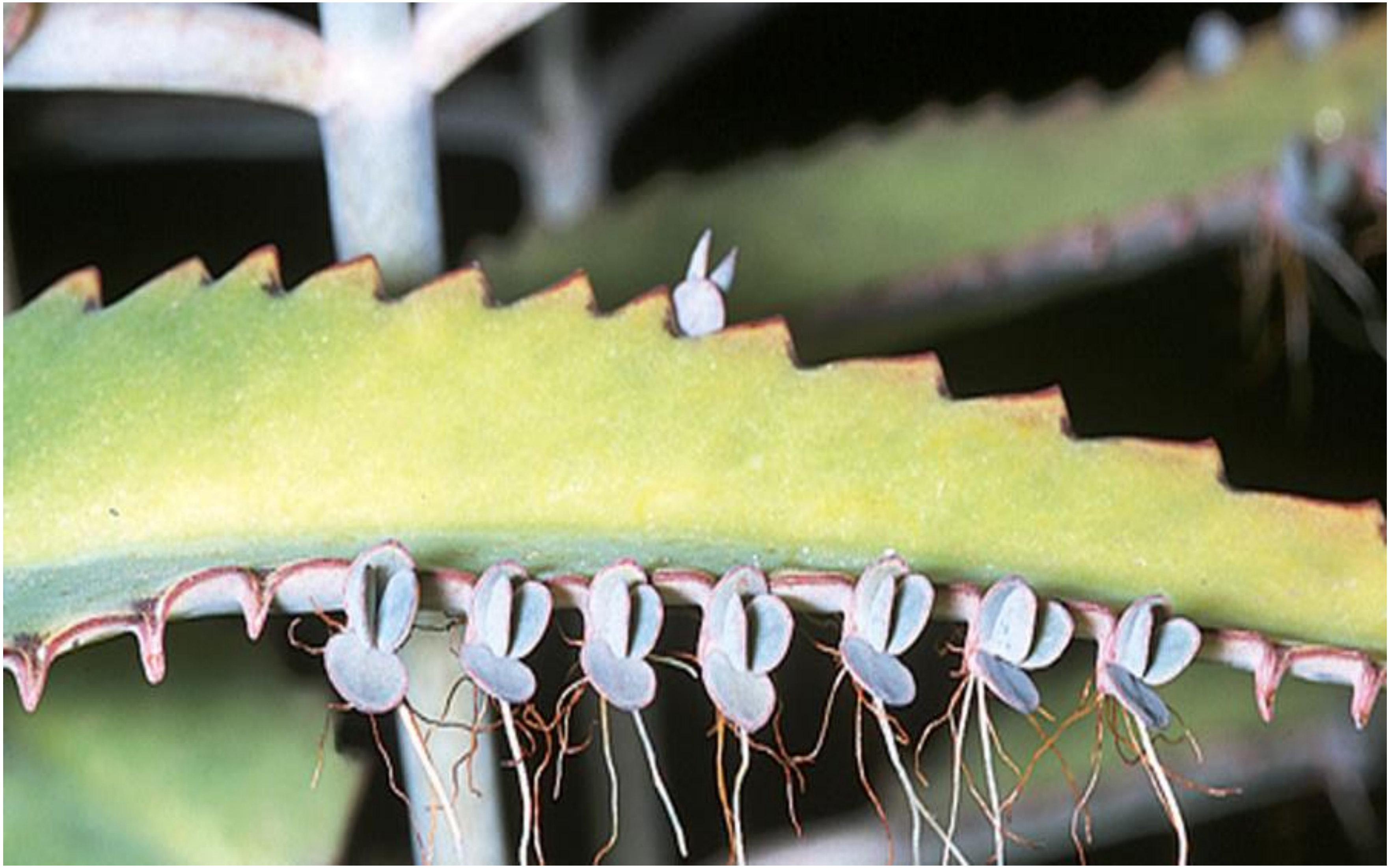
Trap Leaf - *Dionaea muscipula*
Venus Fly Trap

Fig. 39.5

A Carnivorous Plant

Pitcher plant leaf

Reproductive Leaves - New plants at tips.

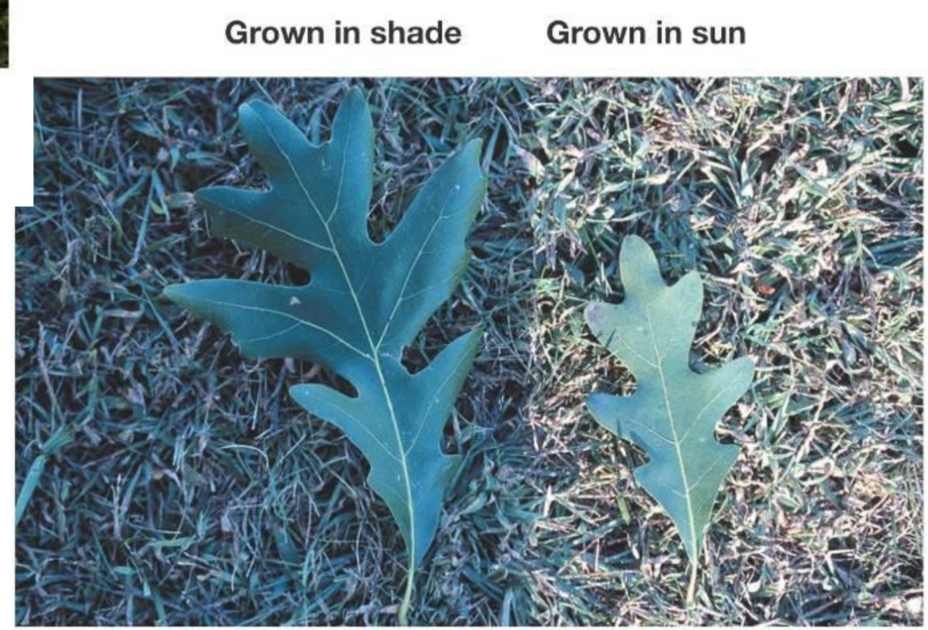


Sun & Shade Leaves

Sun and Shade Leaves

Shade Leaves

Sun Leaves



Plant Tissues & organs

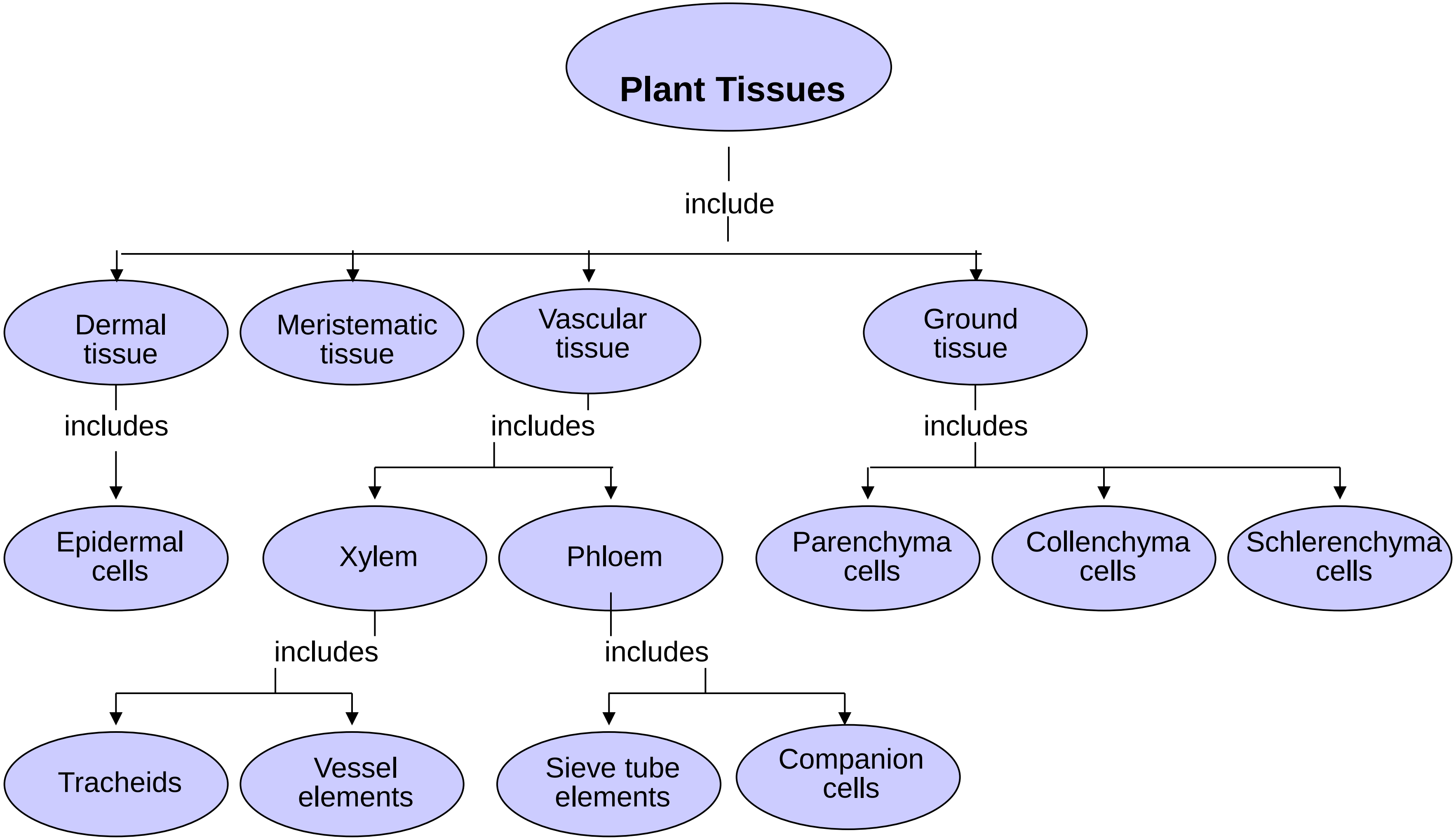
Plant Tissues

- **A tissue is an organization of cells that work together as a functional unit.**
- **Parenchyma cells make up parenchyma tissue, which is a simple tissue.**
- **Xylem and phloem are complex tissues; they are composed of a number of different cell types.**
- **Tissues are grouped into tissue systems that extend throughout the body of the plant from to form the various organs of the plant.**
- **There are three plant tissue systems: *vascular, dermal, and ground*.**

Tissue Systems

Tissue Systems:

1. **Ground tissue includes:**
    - **Parenchyma tissue**
    - **Collenchyma tissue**
    - **Sclerenchyma tissue**
2. **Vascular tissue includes:**
    - **Xylem tissue**
    - **Phloem tissue**
3. **Dermal tissue:**
    - **Epidermis**
4. **Meristematic tissue**

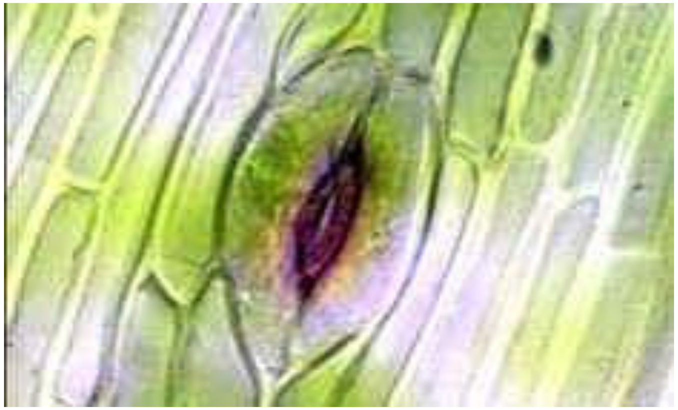


Plant Tissues
include
Dermal tissue
Meristematic tissue
Vascular tissue
Ground tissue
includes
includes
includes
Epidermal cells
Xylem
Phloem
Parenchyma cells
Collenchyma cells
Schlerenchyma cells
includes
includes
Tracheids
Vessel elements
Sieve tube elements
Companion cells

Dermal Tissue:

- **Covers the plant body and consists of epidermis in young plants & non-woody plants that is replaced later by periderm in woody plant**
- **Epidermis is made of parenchyma cells in a single layer**
- **Epidermis on stem and leaves prevents water loss by transpiration & produces a waxy material called cuticle**

Dermal Tissue:



Guard Cells surrounding stoma

- **Openings in the epidermis on the underside of a leaf where gases are exchanged are called stomata (stoma, singular)**
- **Sausage-shaped guard cells are found on each side of the stoma to help open and close the pore to prevent water loss**
- **Dead cork cells replace epidermis in woody stems & roots**

Ground Tissue

- **The ground tissue system makes up the rest of a plant and consists primarily of parenchyma tissue.**
- **Ground tissue functions primarily in storage, support, photosynthesis, and the production of defensive and attractant substances (oils and toxins).**

Vascular Tissue

- **The *vascular tissue system includes the xylem and phloem*; it is the conductive or "plumbing" system of the plant.**
- **The *phloem transports carbohydrates from sites of production (sources such as leaves) to sites of utilization for energy or where it is being stored (sinks) elsewhere in the plant.***
- **The *xylem distributes water and mineral ions taken up by the roots to the stem and leaves*.**

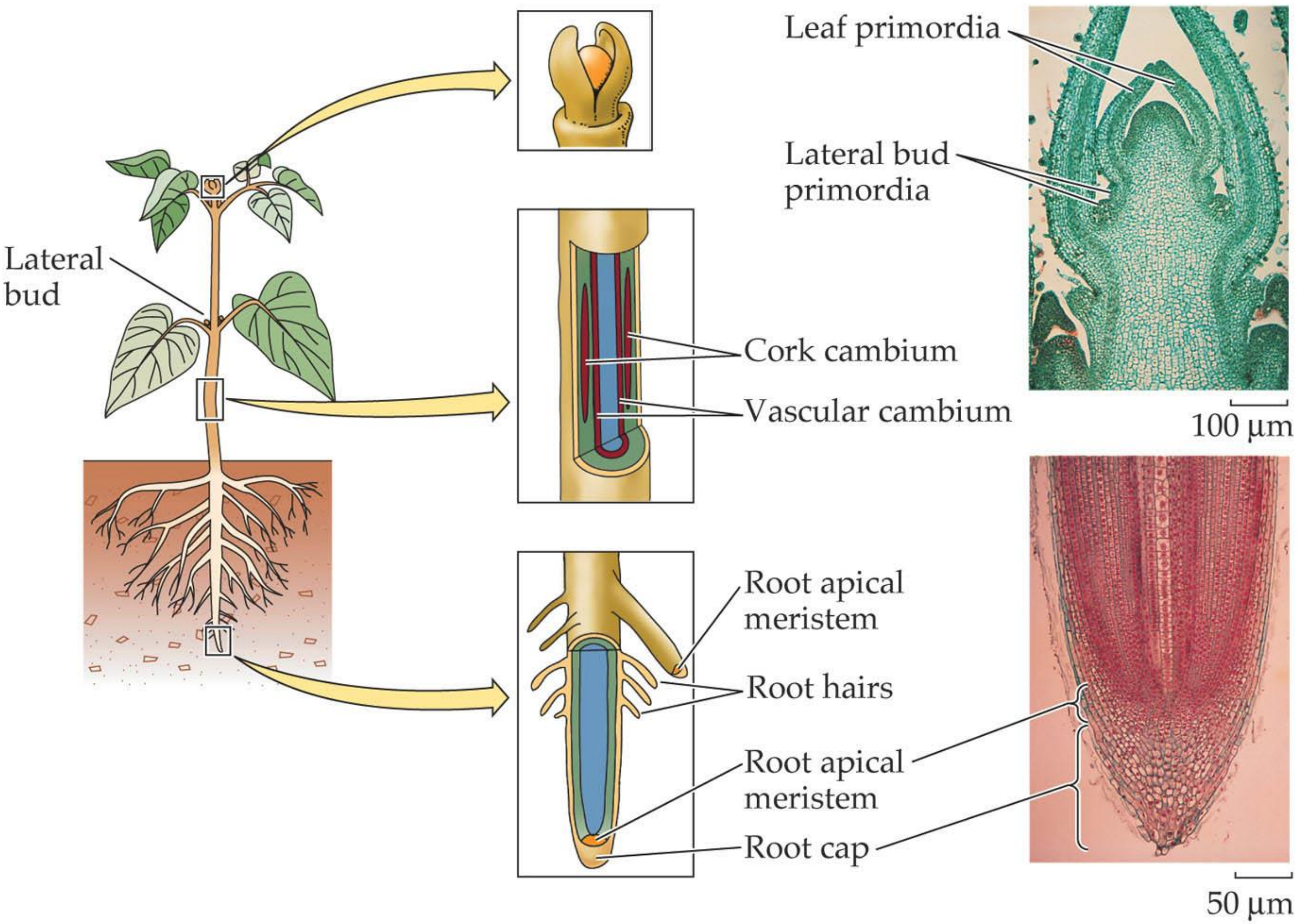
Meristems (Plant Stem Cells)

- **There are 3 main types of meristematic tissue in vascular seed plants ---- apical, intercalary, & lateral meristems**

TABLE 31-2 *Types of Meristems*

Type	Location	Function
Apical meristem	tips of stems and roots	growth; increase length at tips
Intercalary meristem	between the tip and base of stems and leaves	growth; increase length between nodes
Lateral meristem	sides of stems and roots	growth; increase diameter

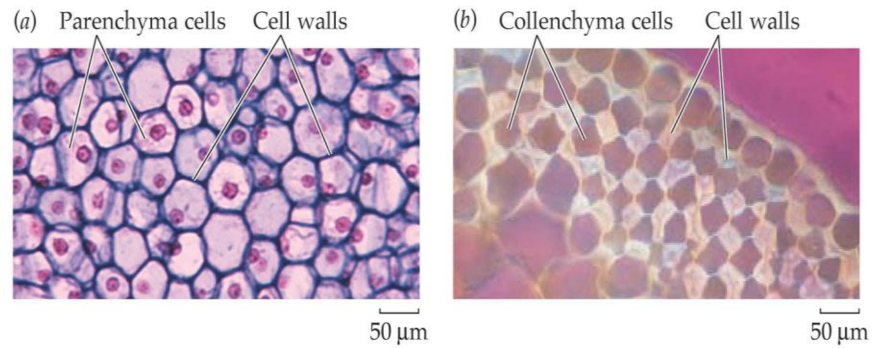
Location of Meristematic Tissues

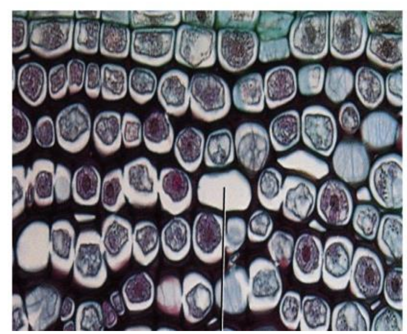


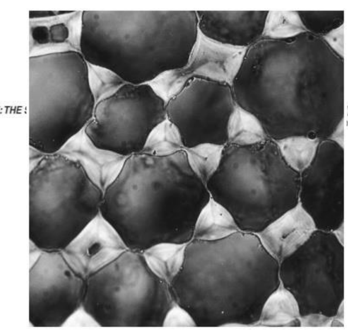
LIFE: THE SCIENCE OF BIOLOGY, Seventh Edition, Figure 35.13 Apical and Lateral Meristems

Plant Cell Types (Support and Storage)

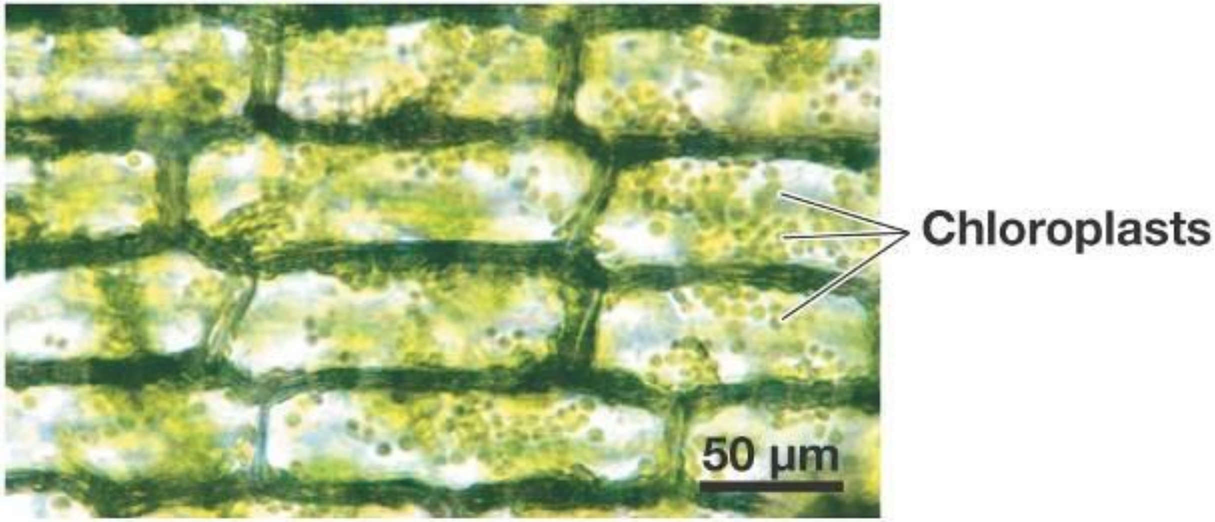
- ***Parenchyma cells*** are the most numerous type of cell in young plants.
- Parenchyma cells usually have thin walls and large central vacuoles.
- The photosynthetic cells in leaves or stems are parenchyma cells filled with chloroplasts. These cells are called ***chlorenchyma*** cells.
- Some parenchyma cells store lipids or starch (potatoes).
- Other parenchyma cells serve as "packing material" and play a vital role in supporting the stem especially in nonwoody stems.
- ***Collenchyma cells*** are supporting cells that lay down primary cell walls that are thick in the corners.
- Collenchyma cells provide support to leaf petioles, nonwoody stems, and growing organs.
- These cell types compose the cortex and pith tissues of the root and stems.



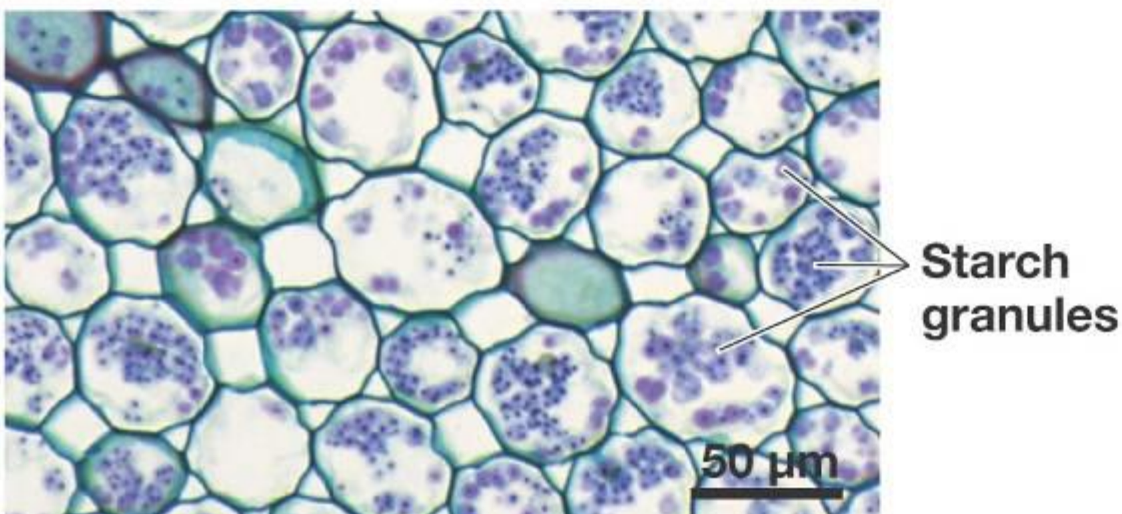


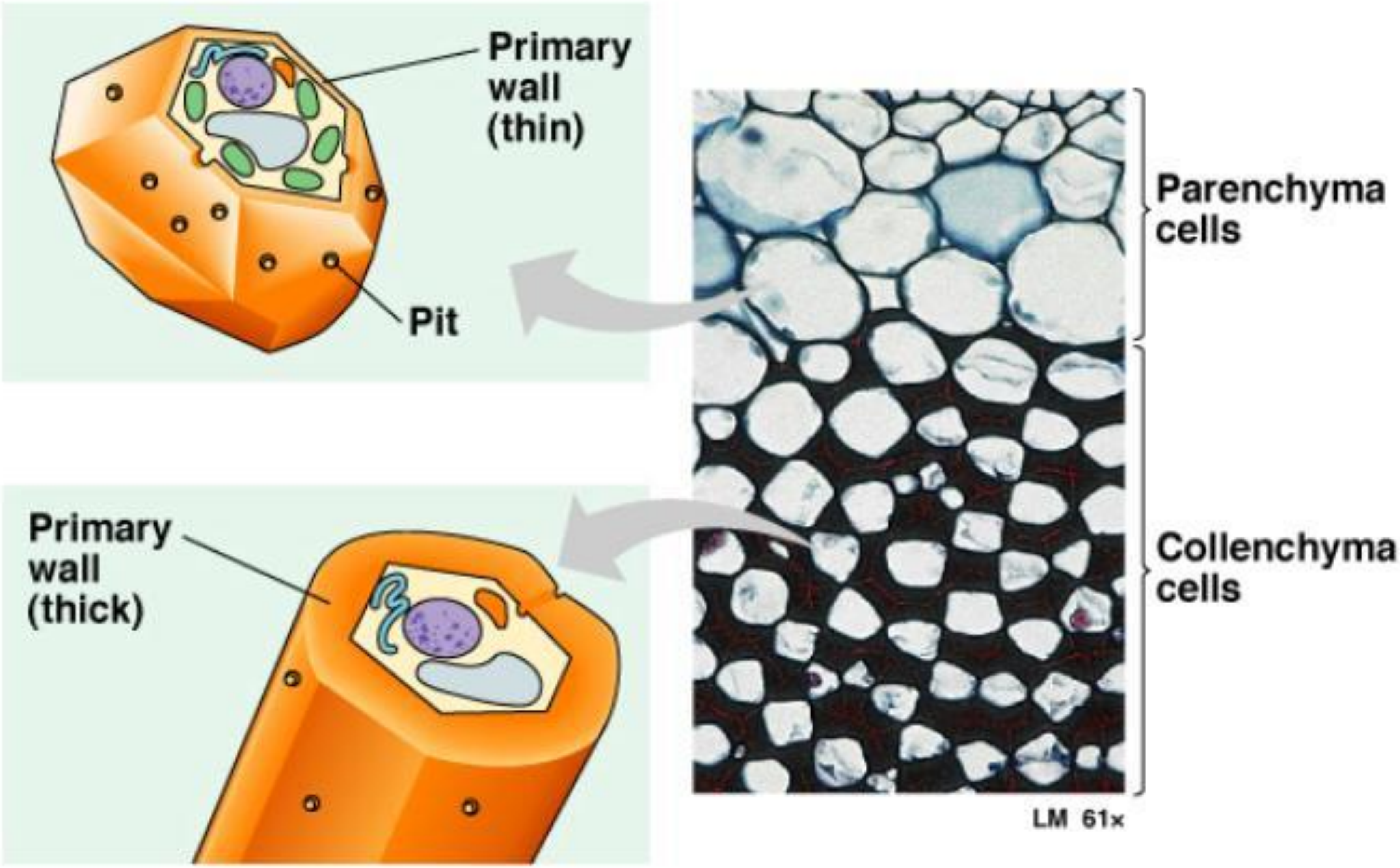


(a) In leaves, parenchyma cells function in photosynthesis and gas exchange.



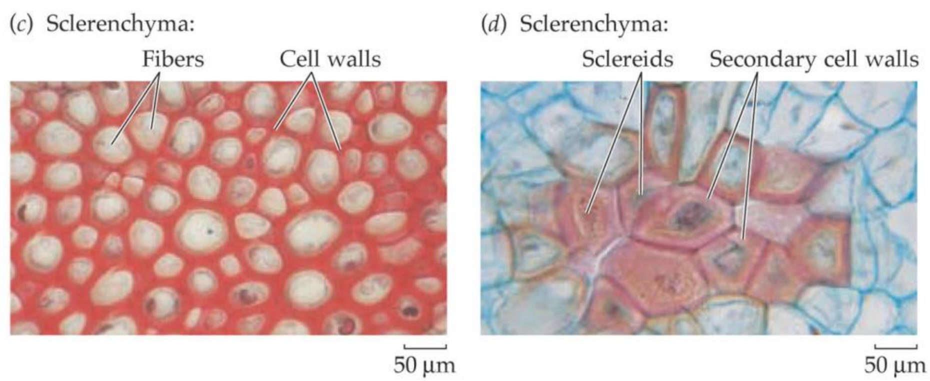
(b) In roots, parenchyma cells function in carbohydrate storage.

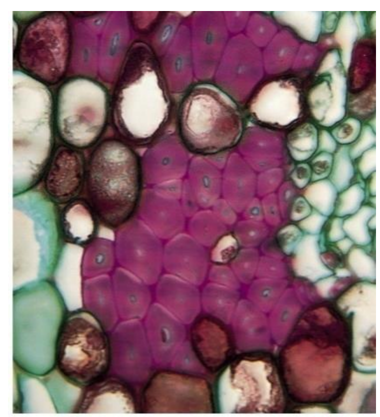


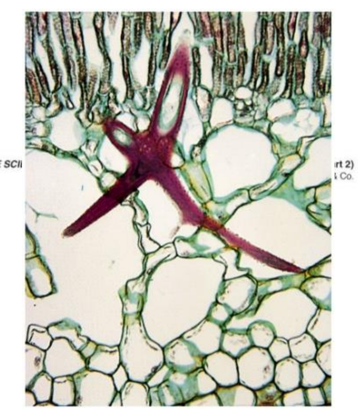

Primary
wall
(thin)
Pit
Primary
wall
(thick)
Parenchyma
cells
Collenchyma
cells
LM 61x

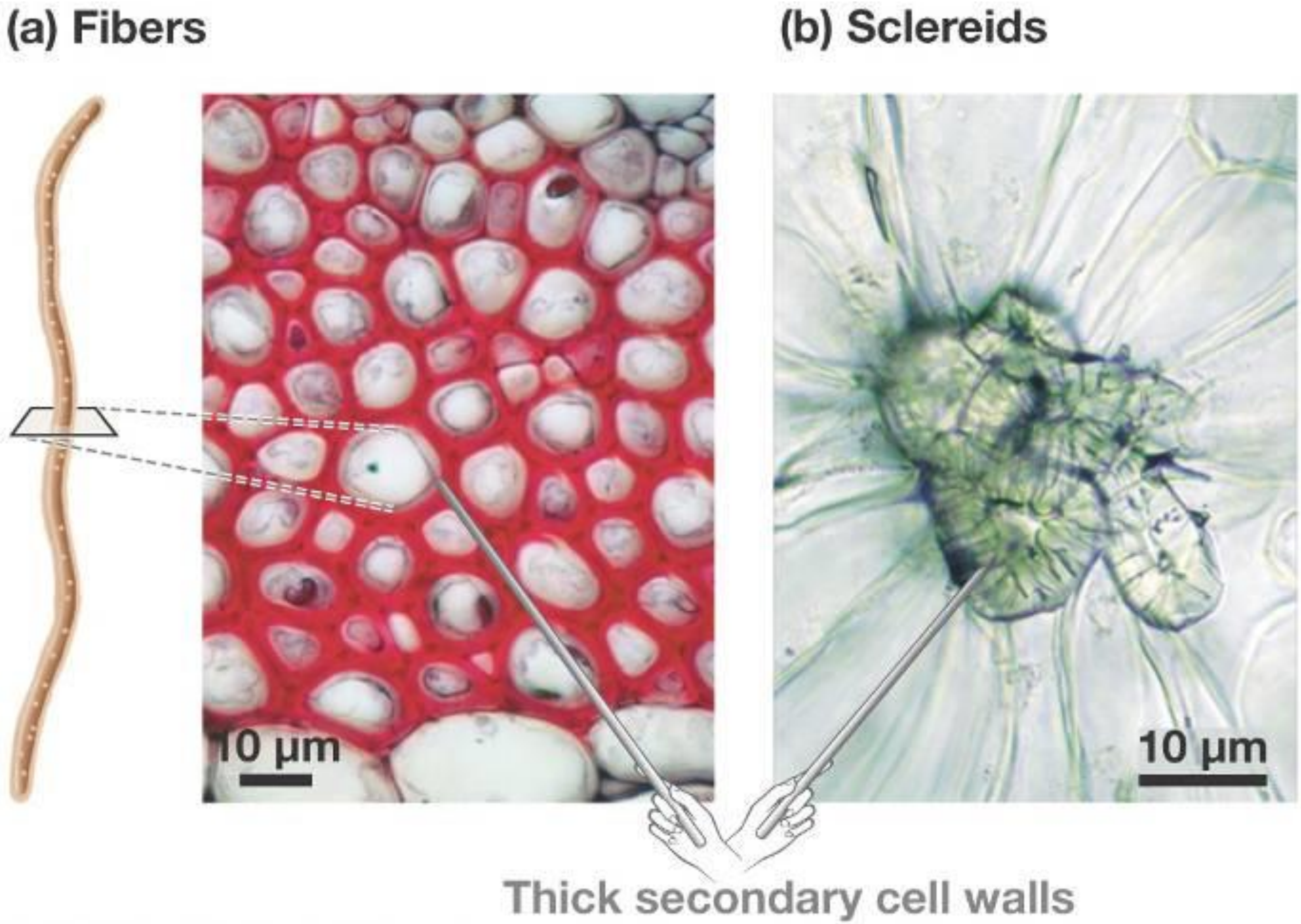
Plant Cell Types (Support)

- *Sclerenchyma* cells are the main supporting cells of a plant. They have a thick secondary cell wall that contains a substance called lignin, a component of wood. Therefore they are found in woody plants.
- There are two types of sclerenchyma cells: elongated fibers and variously shaped sclereids.
- Fibers often organize into bundles. (They are common components of xylem.)
- Sclereids may pack together very densely. (Sclereids are found in fruits such as pears and are what given them their gritty texture.) They are often referred to as "stone cells".

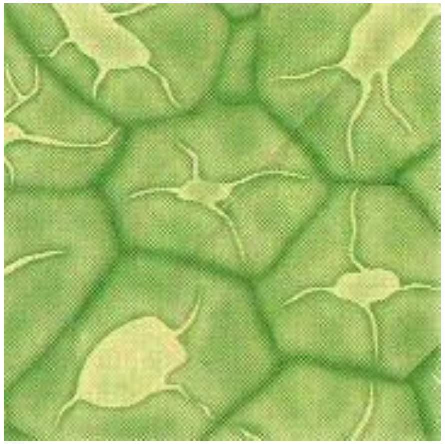






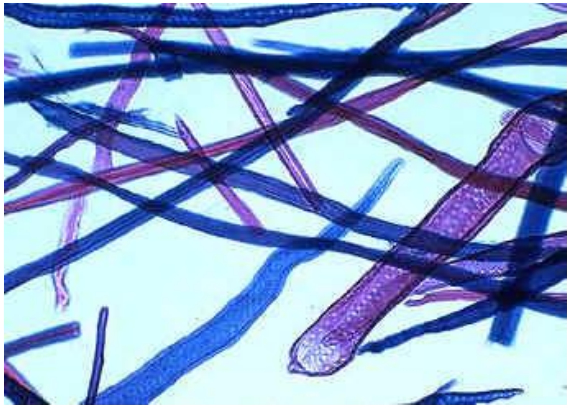

(a) Fibers
(b) Sclereids
10 µm
10 µm
Thick secondary cell walls

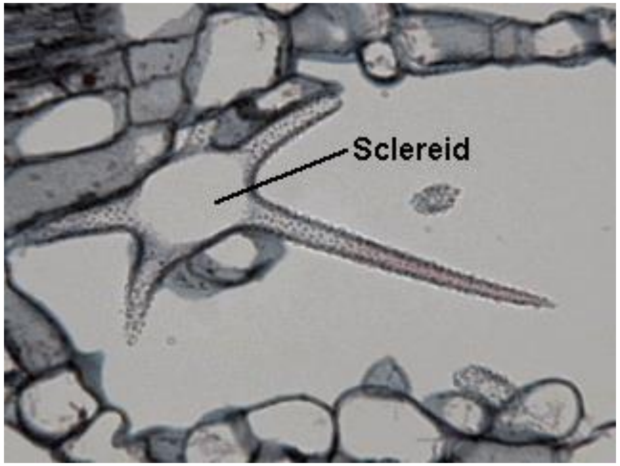
Sclerenchyma & Sclereids



Sclerynchyma

Sclerynchyma Fibers





Sclereid Fibers

Plant Cell Types: Vascular Tissue (Transport)

Xylem

- The xylem conducts water from roots to above ground plant parts. It contains conducting cells called *tracheary elements*.
- Tracheids are evolutionarily more ancient tracheary elements found in gymnosperms.
- Both tracheary elements: *Vessel elements* and *tracheids* undergo apoptosis (die) and do their jobs as empty cells (only the cell walls remain).
- *Vessel elements* are the water "pipeline" system in flowering plants, also formed from dead cells. Flowering plants have both tracheids and vessel elements.
- Vessel elements are generally larger in diameter than tracheids and are laid down end-to-end to form hollow tubes.

Phloem

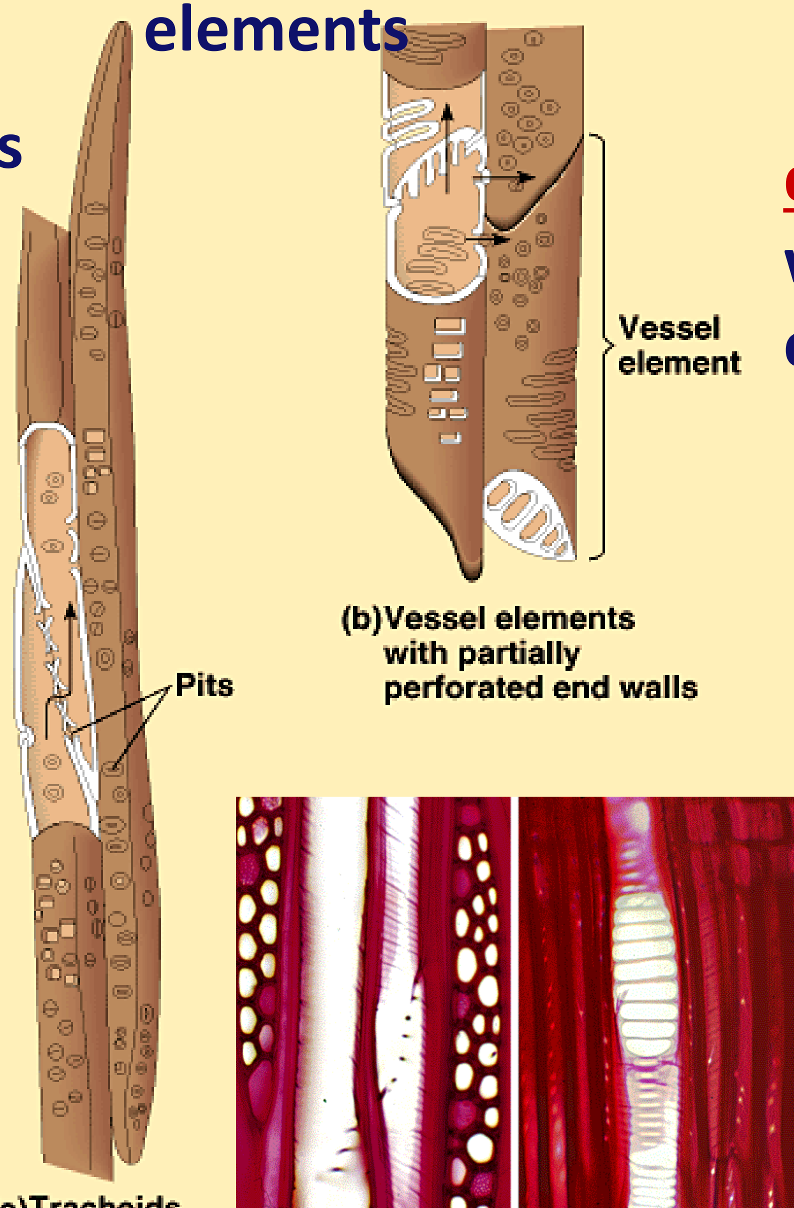
- Cells of the phloem are alive when they do their job, unlike those of the xylem.
- The characteristic cell of the phloem is the *sieve tube member* in flowering plants.
- Cells of the phloem are arranged end-to-end and form long sieve tubes, which transport carbohydrates and other materials.
- The plasmodesmata in sieve tube members enlarge as they mature, resulting in end walls that look like sieves. called sieve plate
- At functional maturity, a sieve tube is filled with sieve tube sap (water, sugars, and other solutes).
- The sieve tube members have adjacent companion cells.
- *Companion cells* retain all their organelles and may regulate the performance of and support the sieve tube members.

Xylem

tracheids

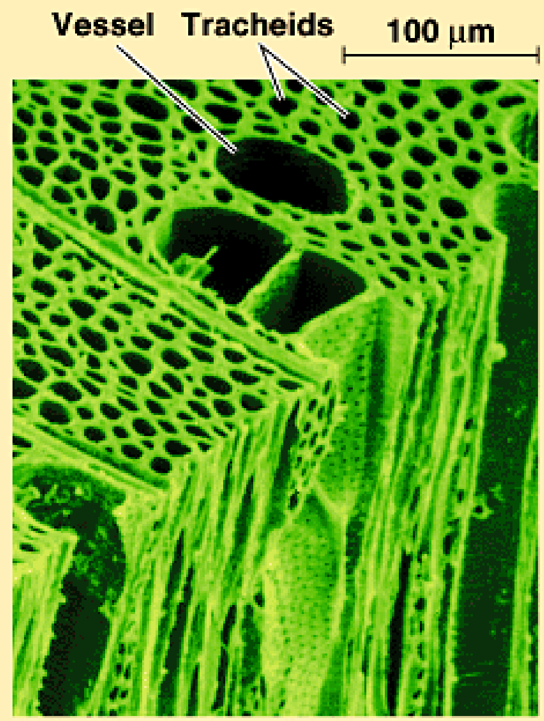
vessel elements

<u>dead cells</u> → water-conducting cells of xylem



(a)Tracheids

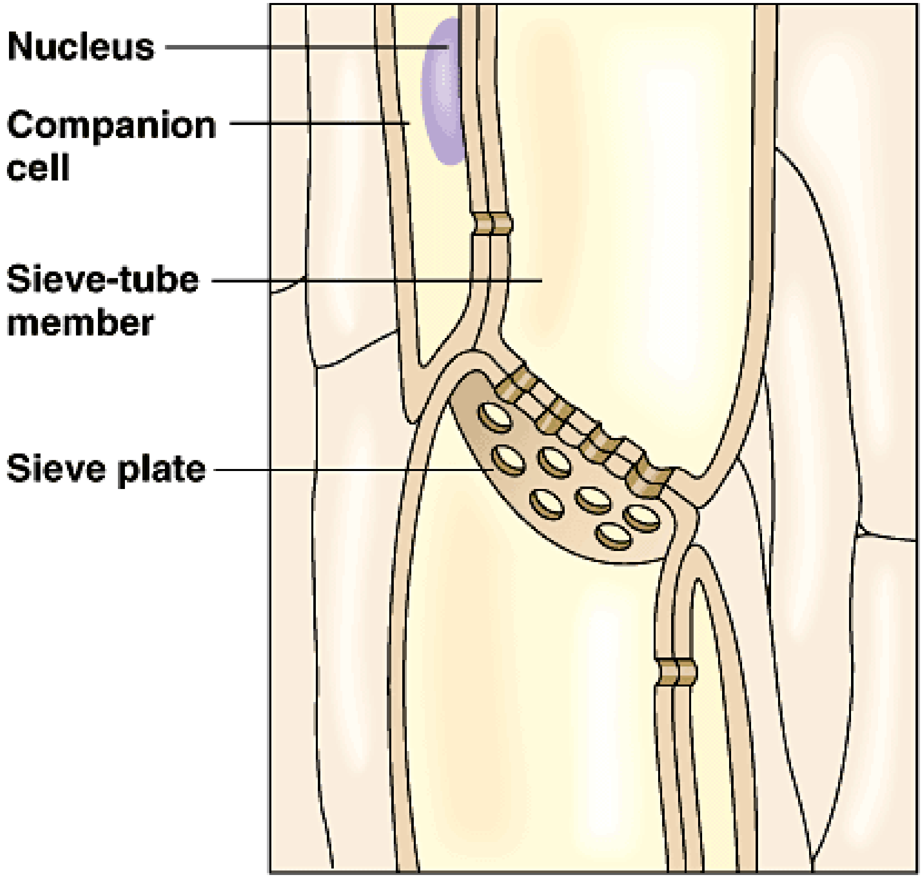
(b)Vessel elements with partially perforated end walls



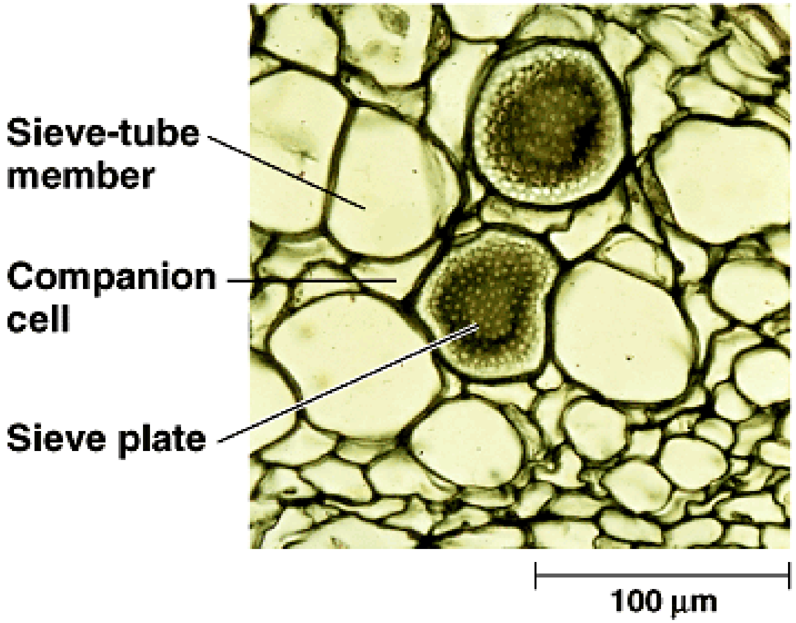
(c)Tracheids and vessels (colorized SEM)

Phloem

- sieve tube elements & companion cells

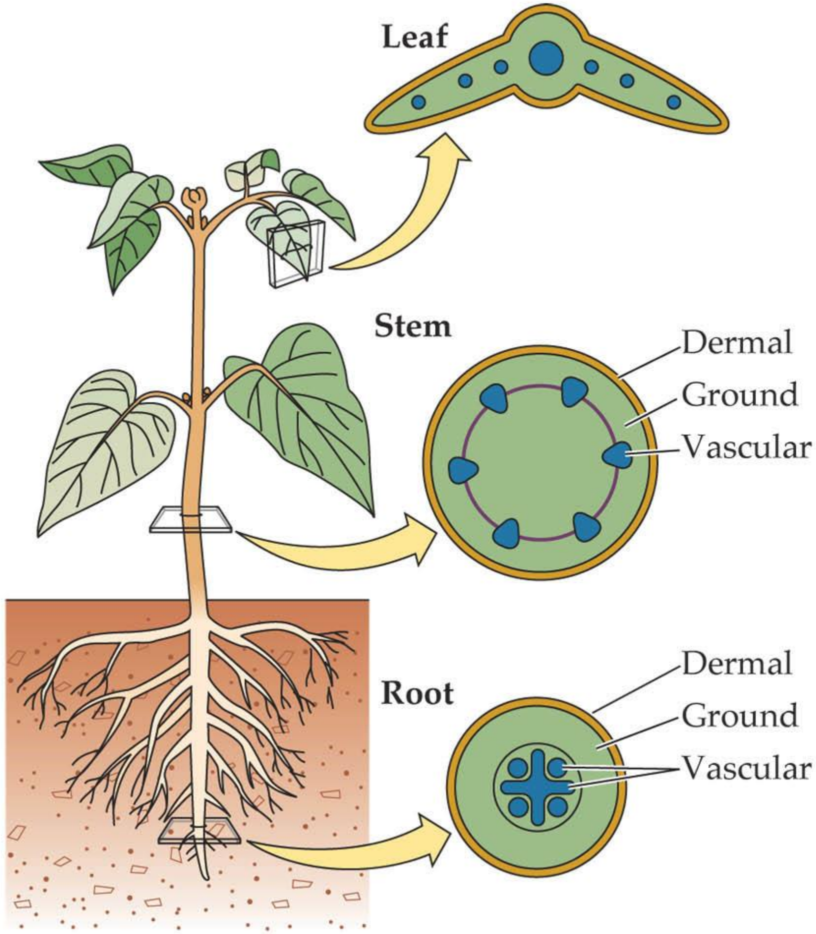


(a) Longitudinal view



(b) Transverse section (LM)

Plant Organs

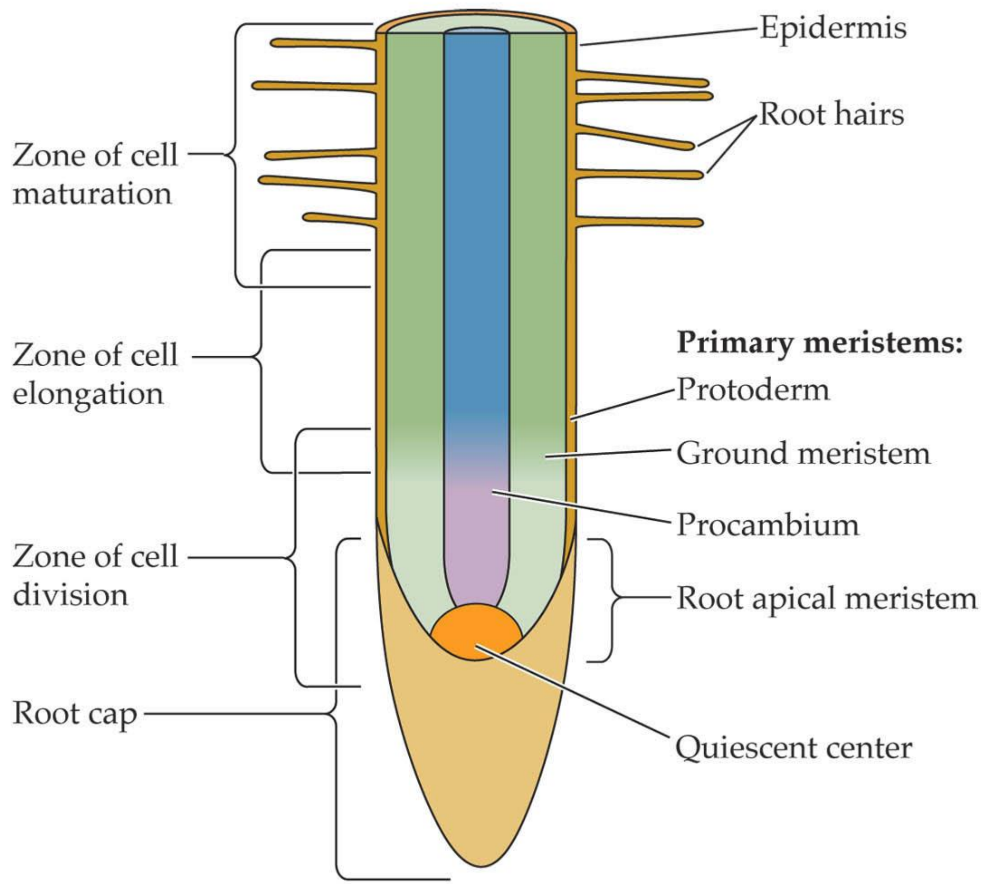


LIFE: THE SCIENCE OF BIOLOGY, Seventh Edition, Figure 35.12 Three Tissue Systems Extend throughout the Plant Body

Structure of Primary Plant Organs

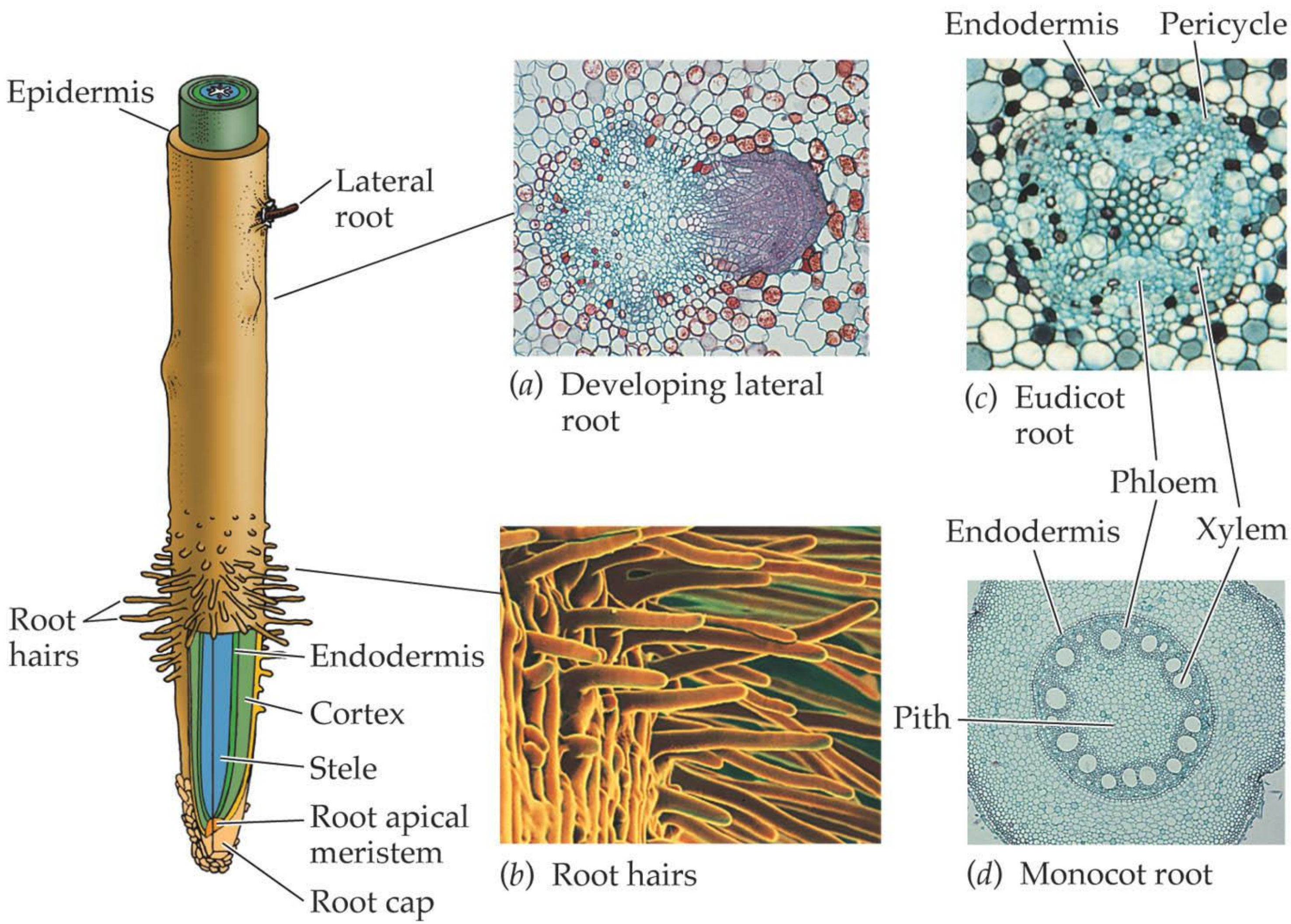
Root Tip Zones

- **The root tip is covered by a root cap, which protects the delicate apical meristem as the root pushes through soil during primary growth**
- **Zone of cell division**
  - **Actively dividing, including root apical meristem, produces root cap cells**
- **Zone of elongation**
  - **Root cells elongate, pushes root tip further into soil**
- **Zone of maturation**
  - **Cells complete maturation, become fully functional**



LIFE: THE SCIENCE OF BIOLOGY, Seventh Edition, Figure 35.15 Tissues and Regions of the Root Tip

Root Structure (Monocot vs Eudicot)



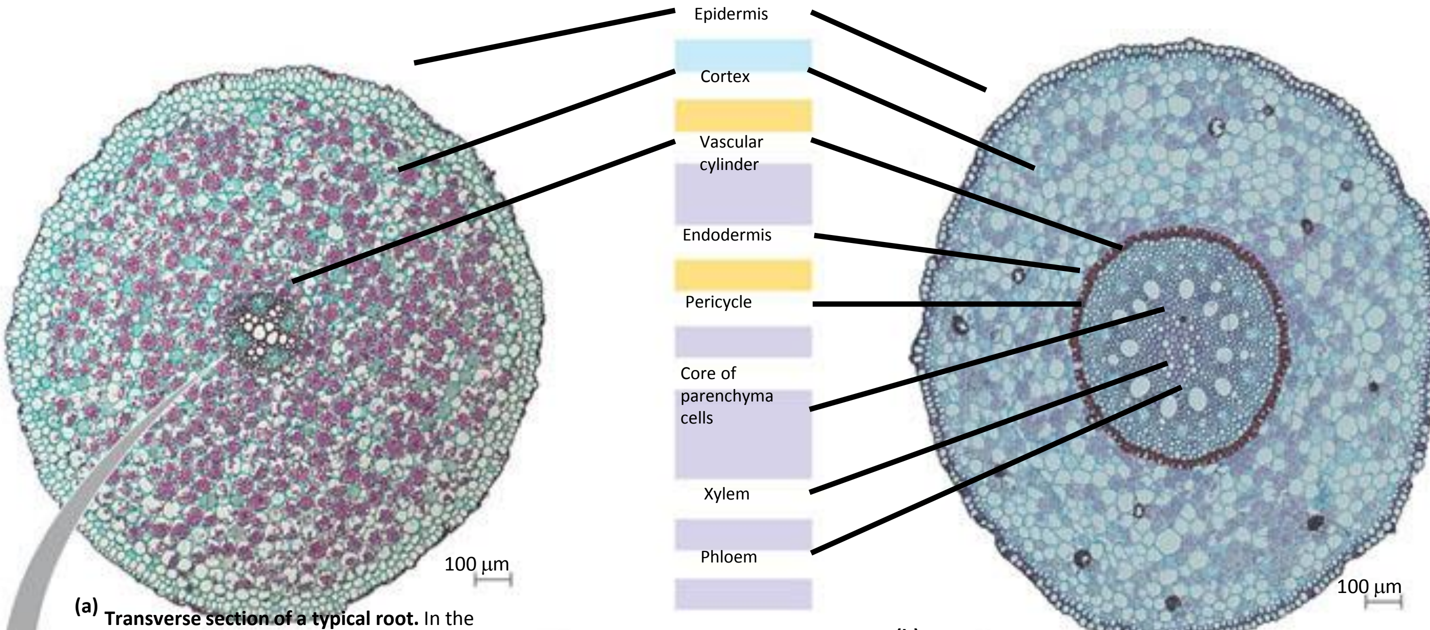
LIFE: THE SCIENCE OF BIOLOGY, Seventh Edition, Figure 35.16 Root Anatomy

Structure of the Root:

- **Root cap covers the apical meristem (growth tissue) at the tip of the root & produces a slimy substance so roots can more easily grow through the ground**
- **Apical meristem replaces cells of the root cap as they are damaged**
- **Epidermis covers the outside of the root & has extensions called root hairs that absorb water & minerals and increase the surface area of the root**

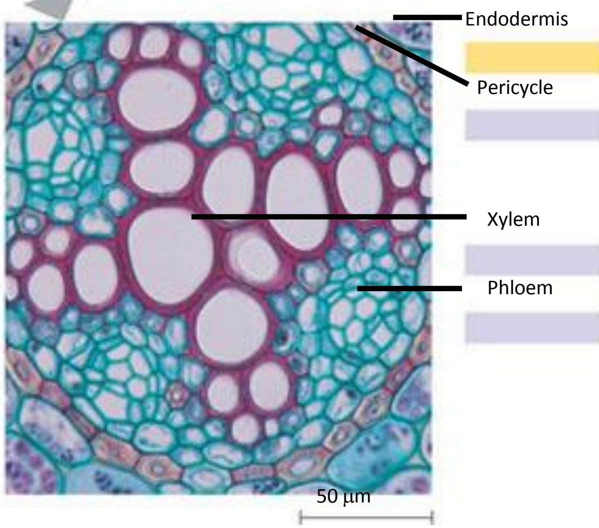
Structure of the Root:

- **The core of the root is called the vascular cylinder, contains xylem & phloem**
- **A band of ground tissue called cortex surrounds the vascular cylinder**
- **A single cell layer called endodermis separates the cortex & vascular tissue**
- **Endodermal cells are coated with a waxy layer called the Casparian strip so water is channeled into the vascular tissue**
- **The Pericycle is the outermost layer of central vascular tissue & forms lateral roots**



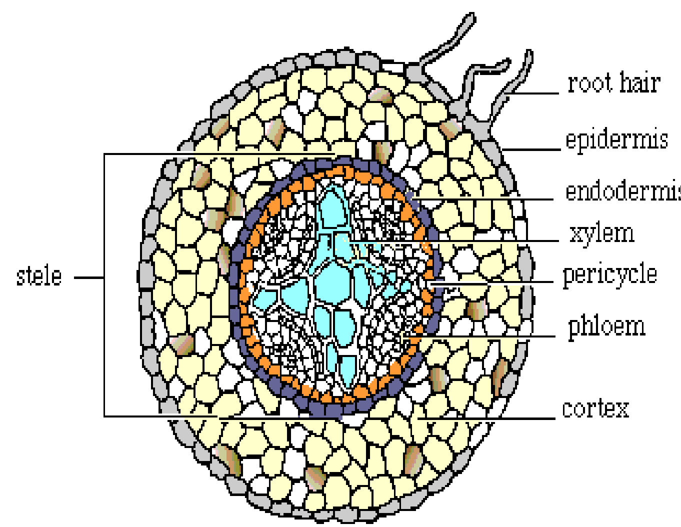
(a) **Transverse section of a typical root.** In the roots of typical gymnosperms and eudicots, as well as some monocots, the stele is a vascular cylinder consisting of a lobed core of xylem with phloem between the lobes.

(b) **Transverse section of a root with parenchyma in the center.** The stele of many monocot roots is a vascular cylinder with a core of parenchyma surrounded by a ring of alternating xylem and phloem.



Key

Dermal
Ground
Vascular



Stem Structure & Function:

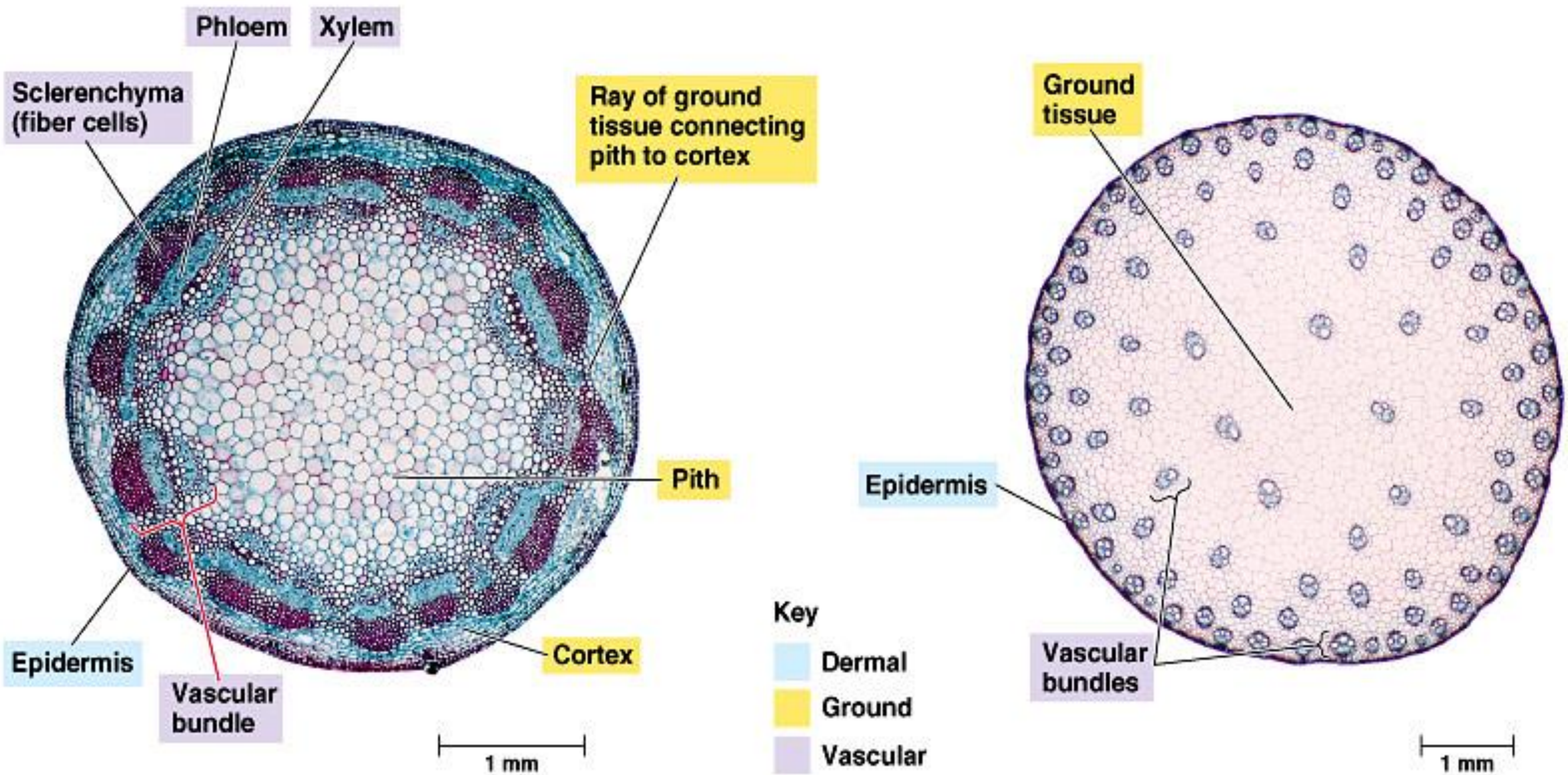
- **Adapted to support leaves**
- **Transport water & minerals**
- **Transport sugars (usually sucrose) from Source (where they're made) to Sink (where they're stored)**
- **Movement of sugars is called translocation**
- **Store food and/or water**
- **Tubers (potatoes) underground food storage stems**
- **Stems grow from the tip or apical meristem**
- **Stems increase in circumference by lateral meristems**
- **Leaves are attached to stems at nodes & have lateral buds that can develop into new stems or branches**
- **Internode is space between nodes on a stem**

- **The tip of each stem usually has a Terminal Bud enclosed by specialized leaves called Bud Scales**
- **Vascular Tissue is arranged in bundles with xylem toward the inside & phloem toward the outside**
- **Vascular bundles are scattered throughout monocot stems**
- **Vascular bundles are arranged in rings in dicot stems**

Stem Structure

Dicot (woody plants)

Monocot (grasses)



(a) Dicot

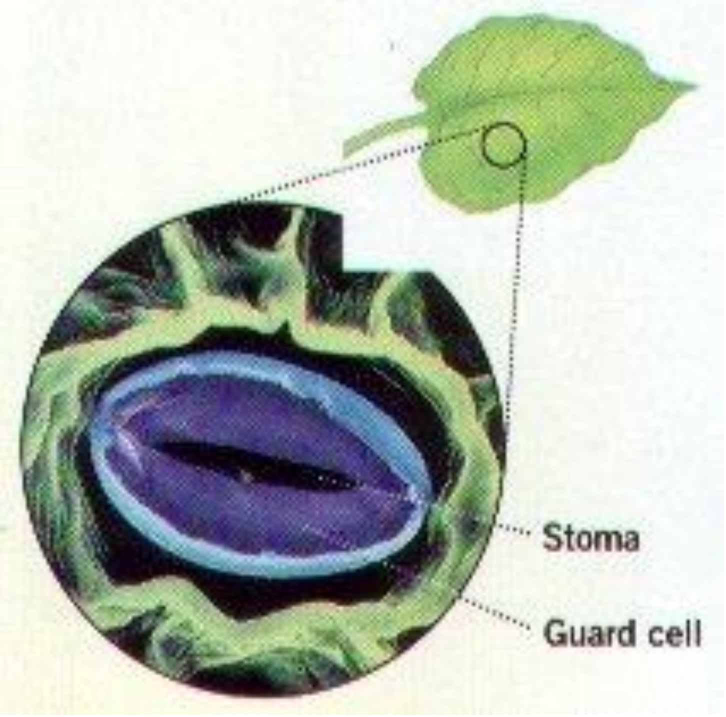
(b) Monocot

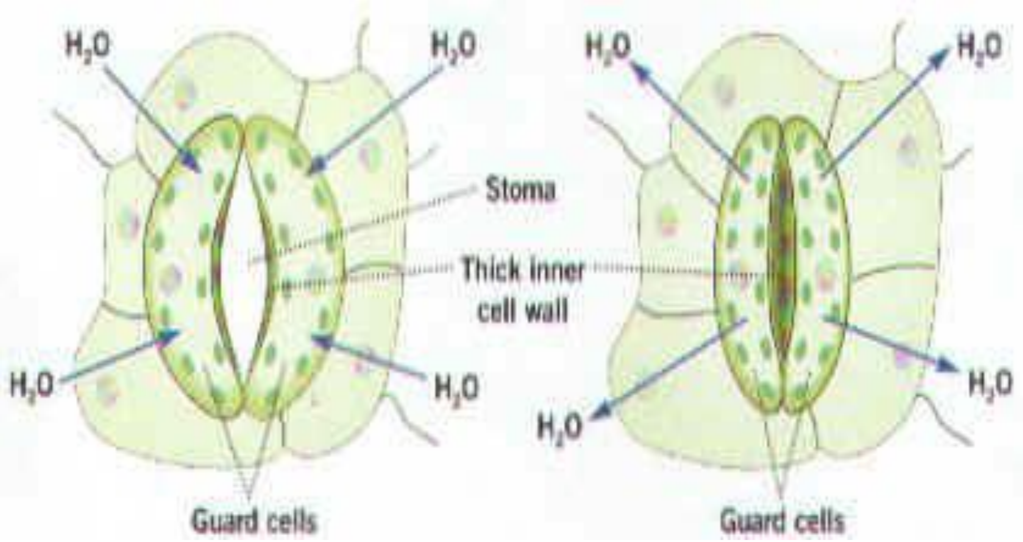
Leaf Structure

- Leaf anatomy is adapted to carry out photosynthesis, limit evaporative water loss, and transport the products of photosynthesis to the rest of the plant.
- The two zones in leaf parenchyma that photosynthesize are the palisade mesophyll and the spongy mesophyll.
- Within the mesophyll is air space through which CO_2 can diffuse to the photosynthesizing cells.
- Veins (vascular bundles) supply mesophyll cells with water and minerals, and they transport the products of photosynthesis to the rest of the plant.
- The epidermis of the leaf is the outermost cell layer, which is covered by a waxy cuticle. The epidermis functions to keep water and photosynthetic products in the leaf.
- Guard cells allow controlled gas exchange through pores in the leaf (the stomata).

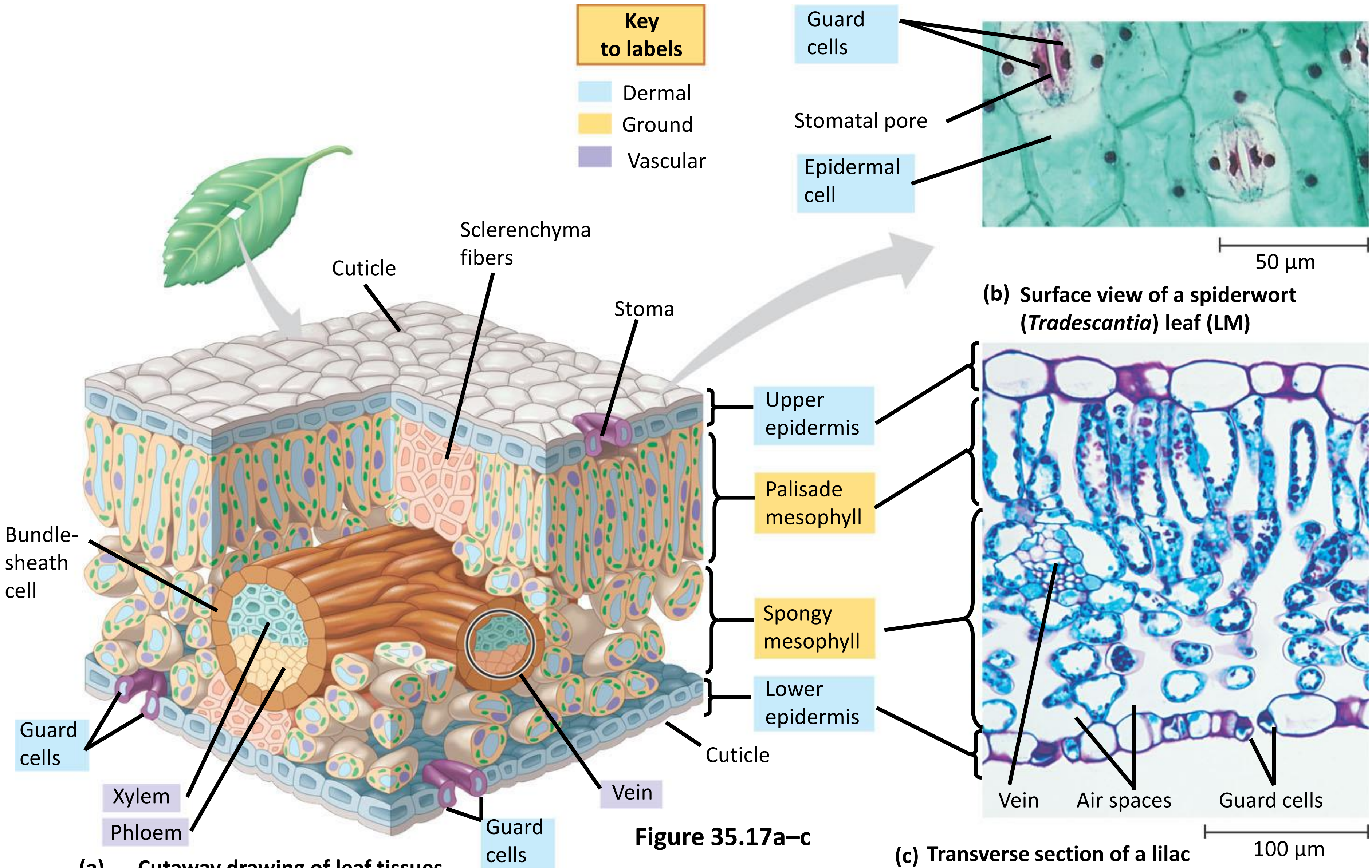
Stomata:

- Openings called stomata on the underside of leaves for gas exchange (CO2 & O2)
- Two guard cells on either side of the stomata open & close the openings
- When guard cells LOSE water, the stoma CLOSE, while the stoma OPEN when guard cells gain water & swell





Leaf Structure



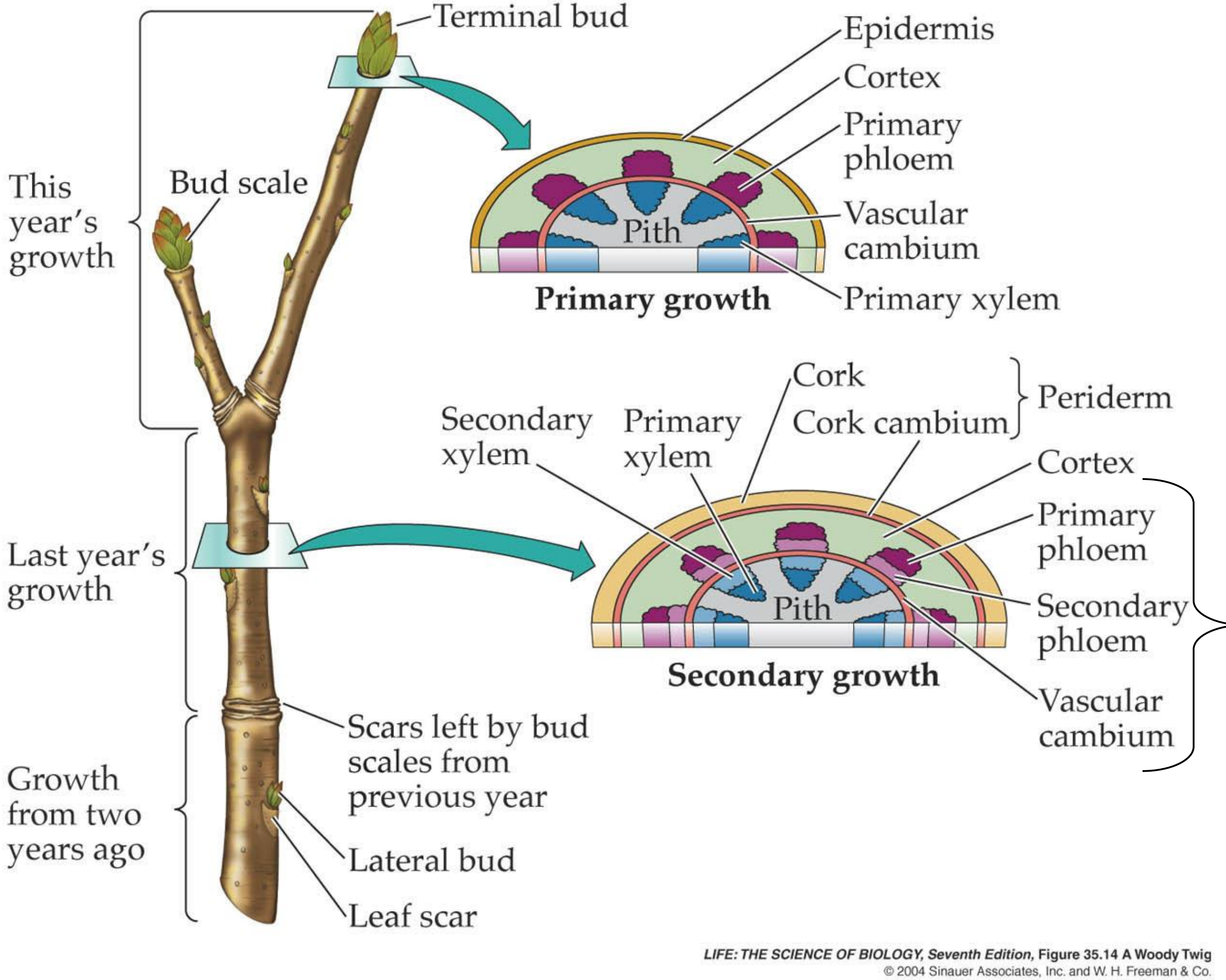
(b) Surface view of a spiderwort (*Tradescantia*) leaf (LM)

(a) Cutaway drawing of leaf tissues

Figure 35.17a–c

(c) Transverse section of a lilac (*Syringa*) leaf (LM)

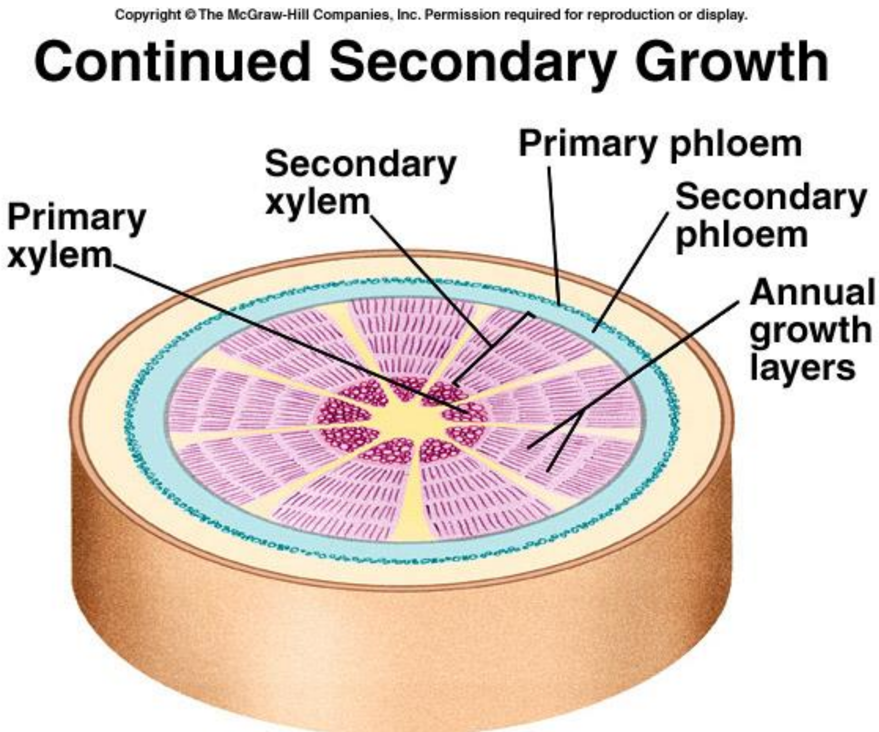
Plant Secondary Growth



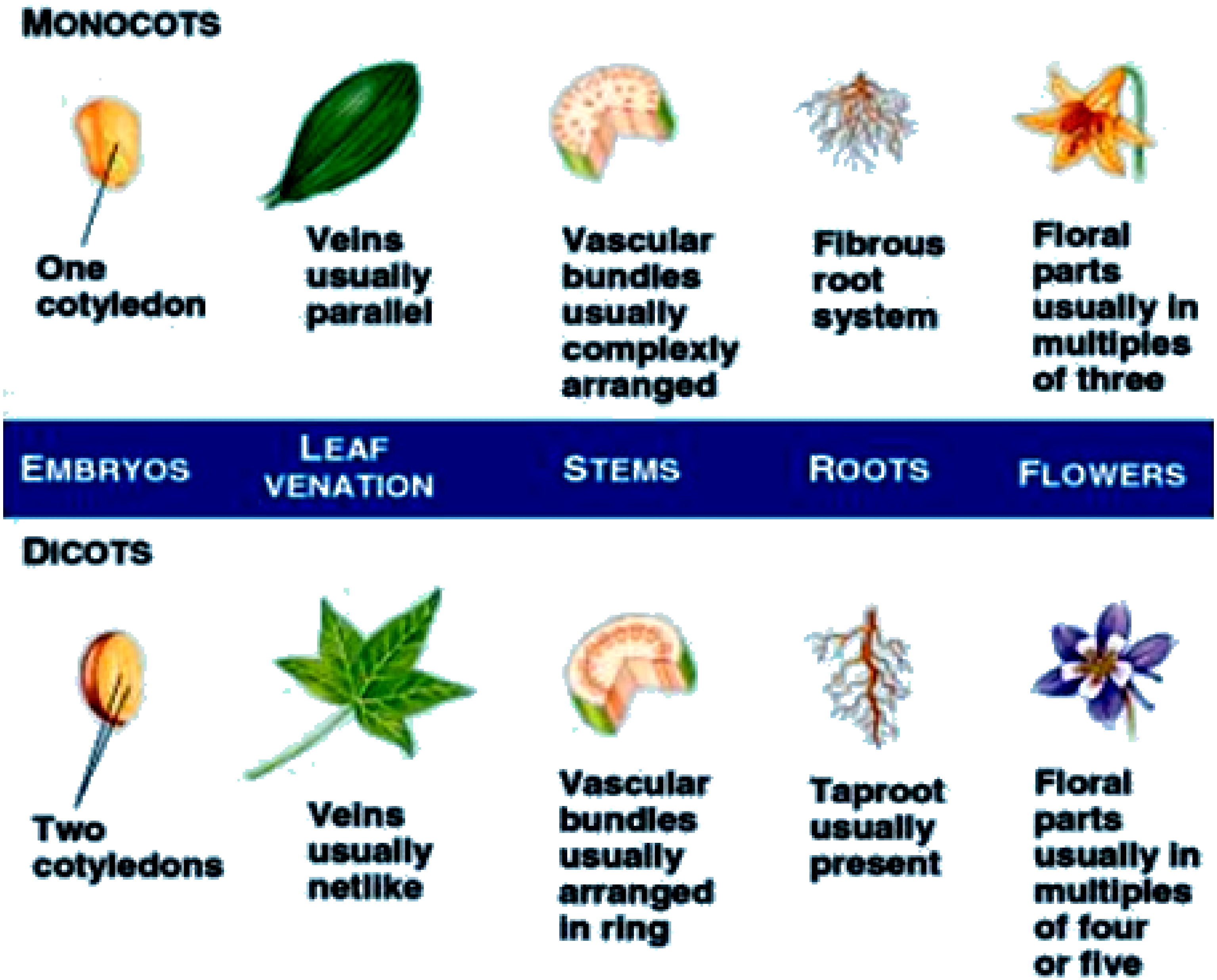
These tissues form a vascular bundle. In woody plants they grow together and fuse to form a continuous ring creating annual growth rings.

Mature Dicot Stem

- Secondary growth increases the diameter of stems and roots.
- Secondary growth results from the activity of vascular and cork cambia.
- Vascular rays connect storage parenchyma to the sieve tubes of the phloem.
- Only eudicots have a vascular cambium and a cork cambium and thus undergo secondary growth.
- Cross sections of most tree trunks in temperate zone forests have annual rings.
- Annual rings form due to differential rates of growth in spring (when water is plentiful) and in summer.
- Wood that is no longer conducting water is known as heartwood.
- Sapwood is wood that is actively conducting water and minerals in the tree.



Monocots vs. Dicots



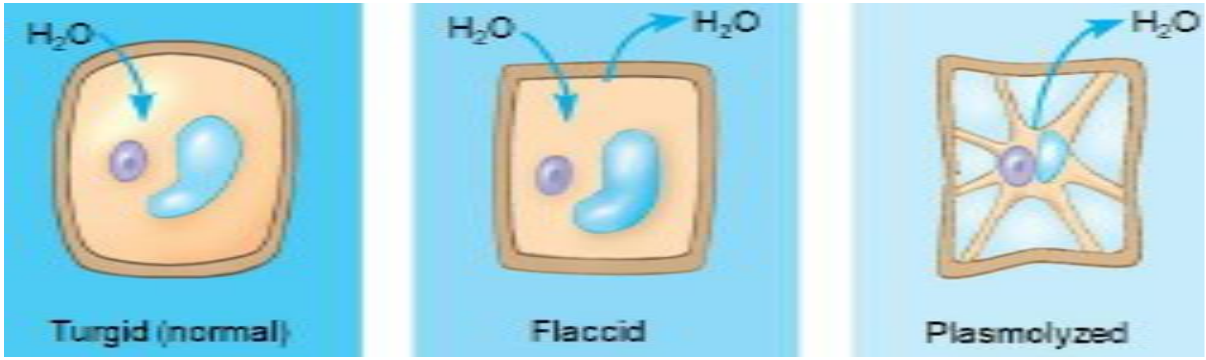
Plant Physiology

Levels of Tissue Organization

- cell - unit of structure of all live organisms
- tissue - composed of groups of similar cells
- organs - composed of groups of tissues functioning together
- organ systems - composed of groups of organs functioning together

Cell wall and Turgor

- Cell walls is made of neutral and charged polysaccharides → absorbs H2O because it has a hypotonic environment.
- Increased H2O in the cell → Turgor Pressure
- If a plant cell is turgid, It is very firm, a healthy state in most plants
- If a plant cell is flaccid, It is in an isotonic or hypertonic environment



- When comparing two solutions there are three possible relationships, We Identify the relationships by determining what would happen if a cell were placed in the solution.
- **Hypertonic**- A solution that causes a cell to **shrink** because of osmosis. Meaning water leaves the cell.
- **Hypotonic**- A solution that causes a cell to **swell** because of osmosis meaning water rushes into the cell.
- **Isotonic**- A solution that causes **no change** in cell size. Meaning there is no movement of water.

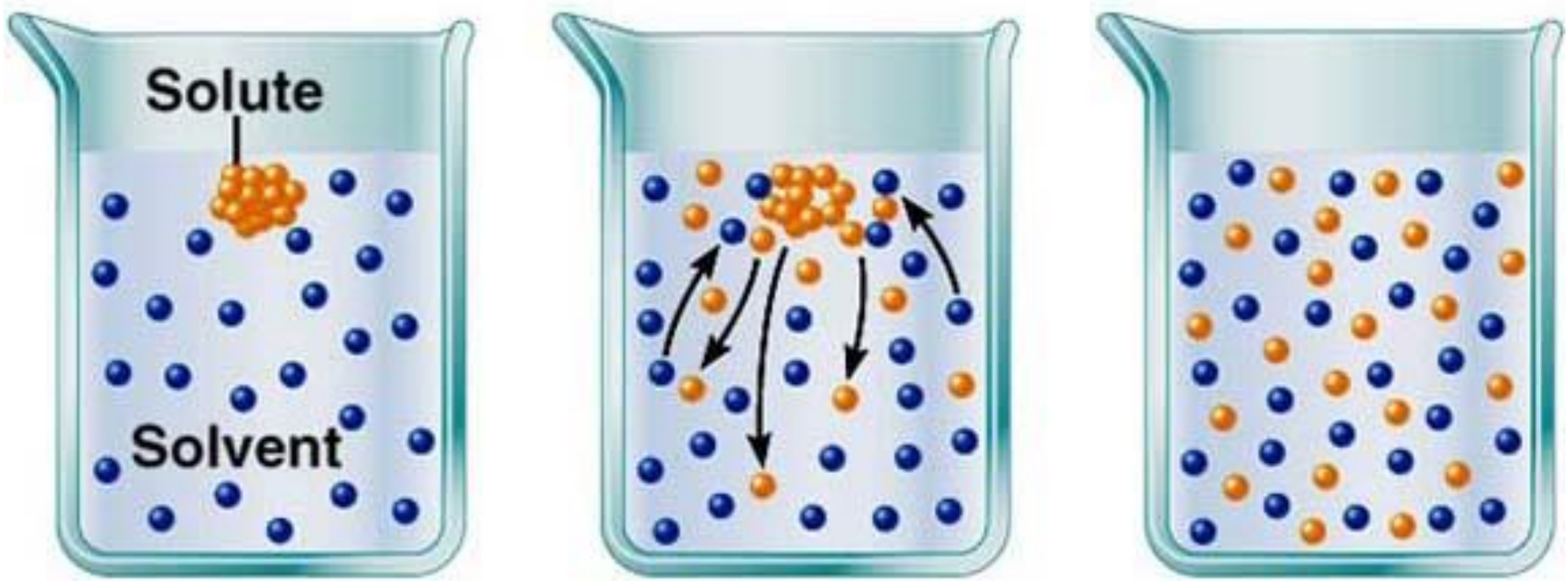
PROCESSES OF THE PLASMA MEMBRANE

- There are two types of **passive transport**: Diffusion and Osmosis
- The goal of both diffusion and osmosis is to reach EQUILIBRIUM within the cell
- Equilibrium is a condition in which the movement in one direction is equal to the movement in another direction

Diffusion

- the tendency of molecules to move from an area of higher concentration to an area of lower concentration
- (concentration gradient- difference in concentration between two regions)

Diffusion



Osmosis

- movement of water through a membrane from a region of higher to lower con.
- Solute - substance being dissolved in a liquid (ex. salt)
- Solvent - substance doing the dissolving (ex. water)
- Permeability - the extent to which a membrane will allow particular sized molecules to pass
- Semi-permeable membrane (selectively permeable)- allows some molecules to pass but not others

Types of transport in Cells

- Passive transport - movement of substances through a membrane from a region of high to a region of low concentration - no energy needed (ATP) - diffusion and osmosis are examples of this
- Active transport - movement of substances through a membrane from a region of low concentration to a region of high concentration - requires cellular energy (ATP)

- Whether passive or active transport is needed depends on the CONCENTRATION GRADIENT
- The concentration gradient is the difference in the concentration of a substance in two different spaces
- Concentration - the amount of a particular substance in a contained area compared with the amount of the same substance in another area

Active Transport

- the movement of a substance against the concentration gradient. (uphill)
- Active transport requires cell to USE ENERGY
- **Sodium pump** - transports three sodium ions out of the cell and two potassium ions into the cell
- Both are against the concentration gradient
- The energy needed to perform this activity is supplied by ATP (adenosine tri-phosphate)
- ATP is a unit of energy made by the cell

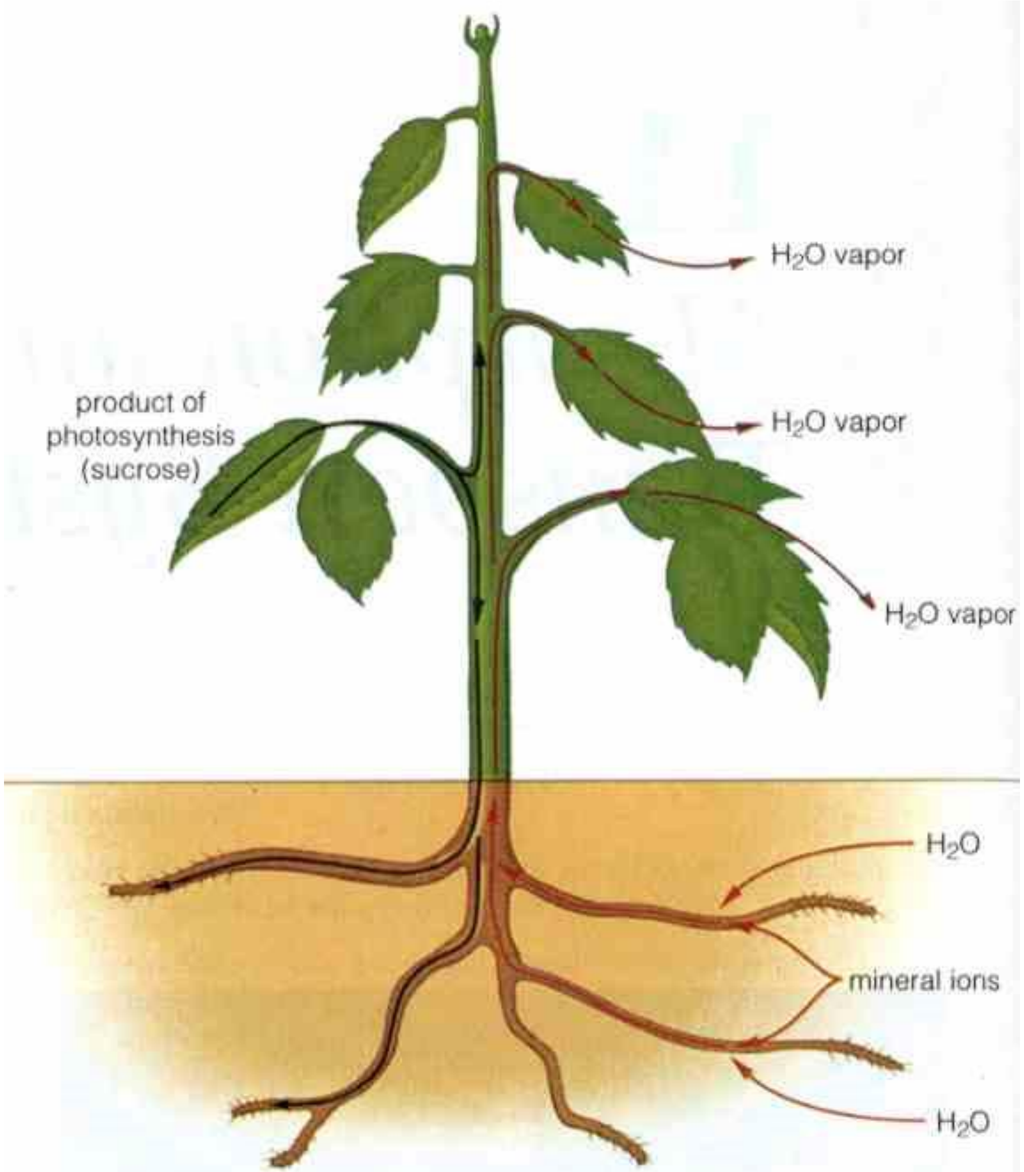
photosynthesis

- the conversion of light energy to chemical energy by chlorophyll in chloroplasts

- Overall Net equation for photosynthesis:
  - 6 Water + 6 Carbon dioxide yields glucose + 6 oxygen (when catalyzed by chlorophyll in the presence of sunlight)

Respiration

$$C_6H_{12}O_6 + 6O_2 = 6CO_2 + 6H_2O + Energy$$



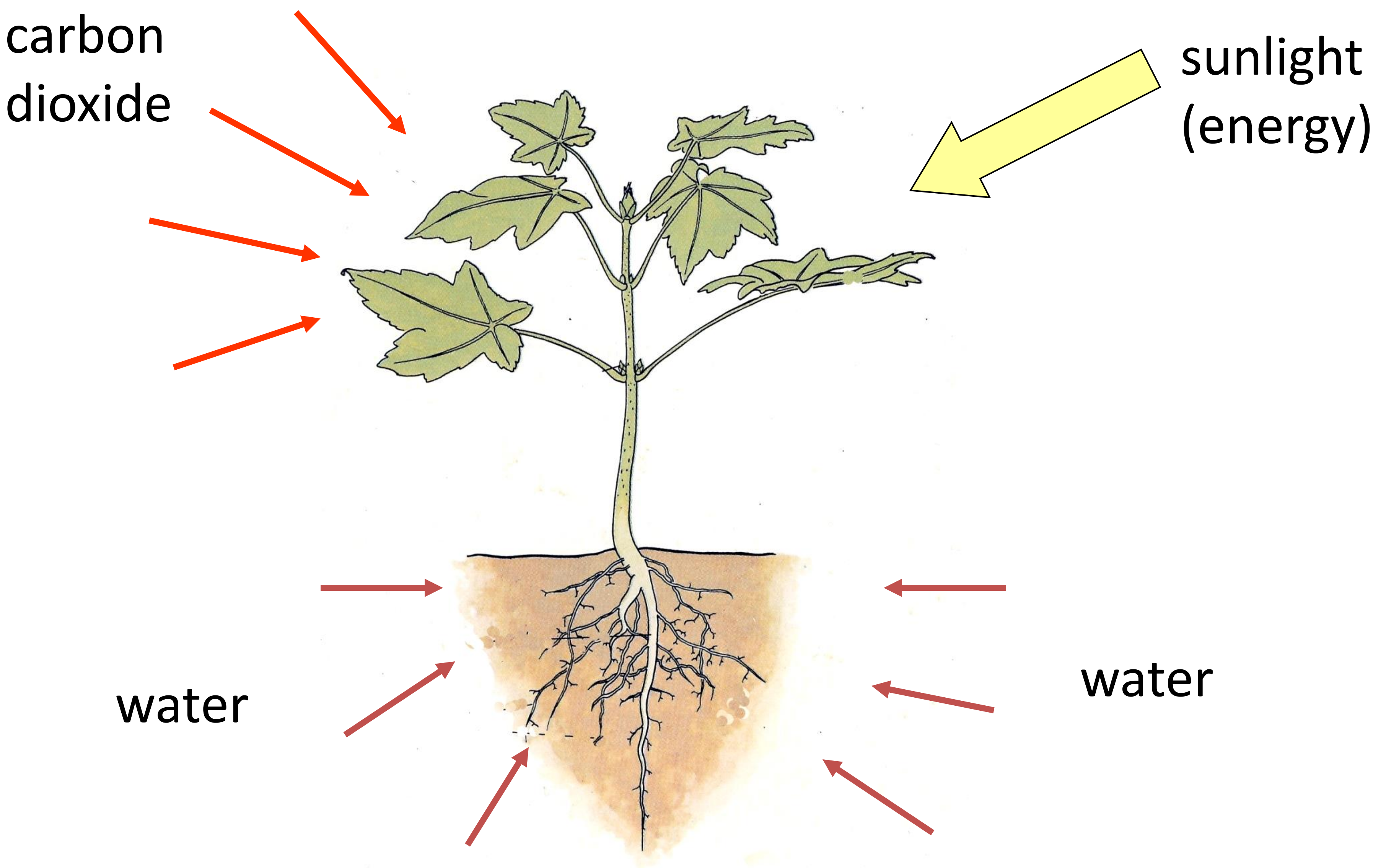
PlantWater Relations

Why is water important to (plant) cells?

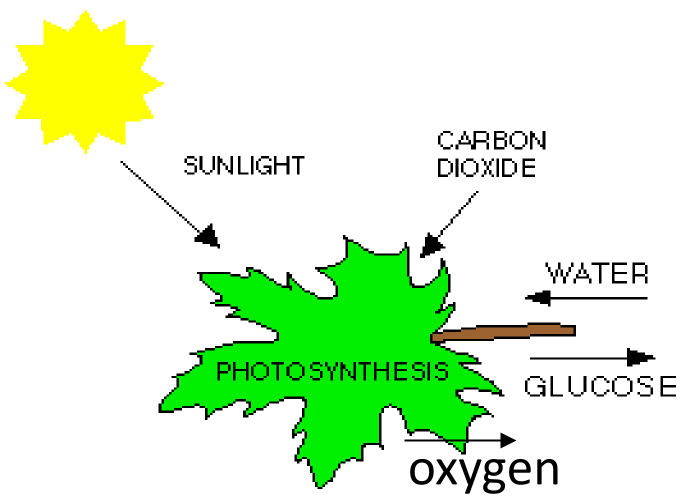
- Water constitutes about **70% by weight** of annual plants
- Water has **multiple roles** in plant cells

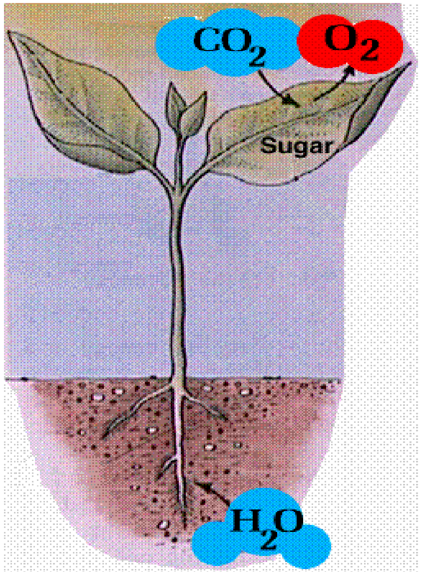
1. Thermal property: a liquid!
    - High heat potential: can absorb energy changes without large temperature changes (slows heating and cooling)
2. "Universal" solvent required for mineral uptake and transport
3. It is a requirement for biochemical reactions to proceed
    - Most enzymes are water soluble

How Plants Get Their Food



- **Photosynthesis** is a chemical process that energy from light is harvested to provide carbohydrates.
- It is the major path through which carbon reenters the biosphere (from CO2).
- **Photosynthesis** is also the major source of oxygen in the earth's atmosphere





Photosynthesis:

Green plants take in **carbon dioxide** (CO_2) from the air

They take up **water** (H_2O) from the soil

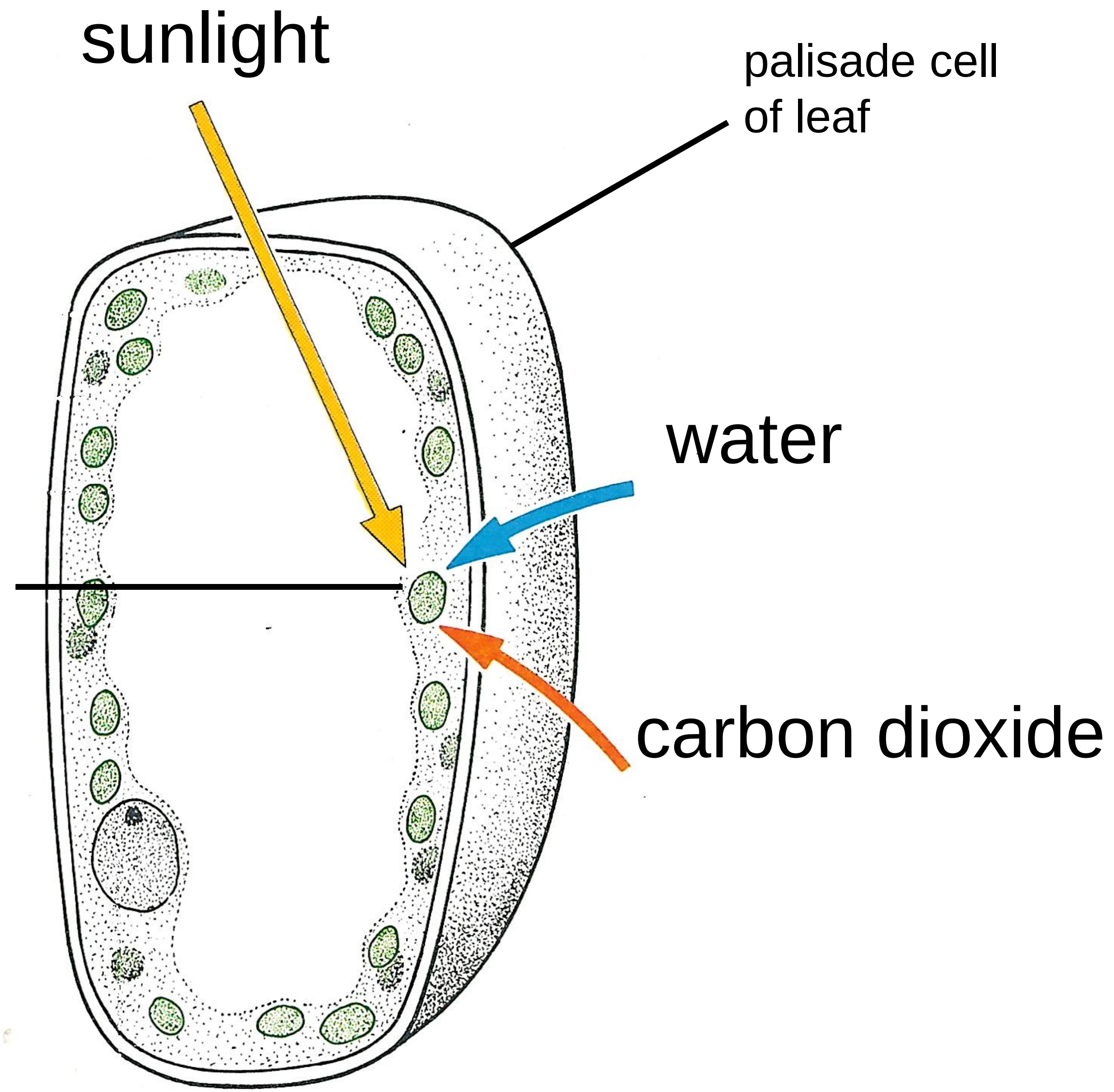
The plants combine the CO_2 with the H_2O to make the sugar, glucose ($C_6H_{12}O_6$)

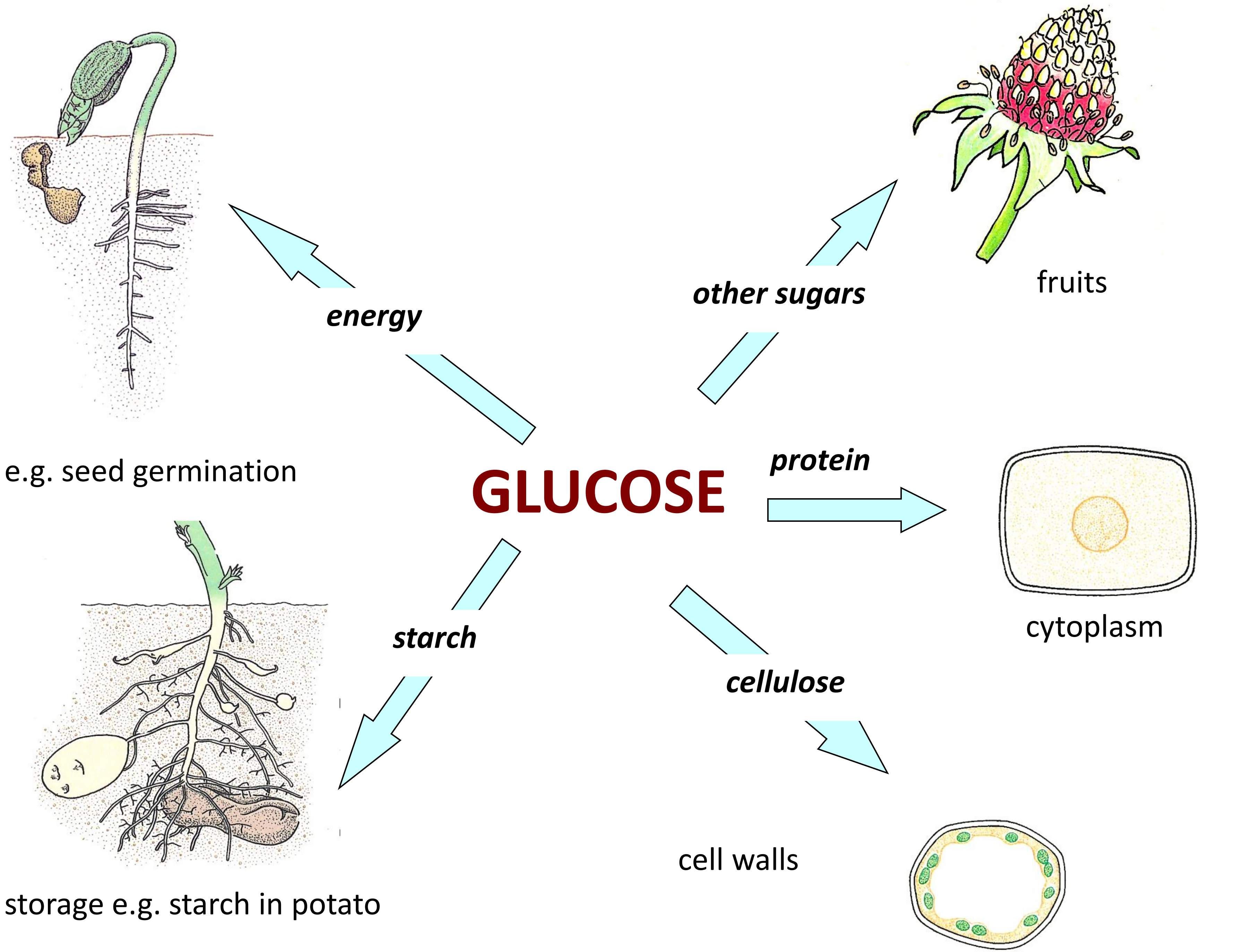
$$6CO_2 + 6H_2O = C_6H_{12}O_6 + 6O_2$$

Oxygen (O_2) is a by-product of this reaction

All the reactions to combine CO_2 and H_2O take place in the chloroplast

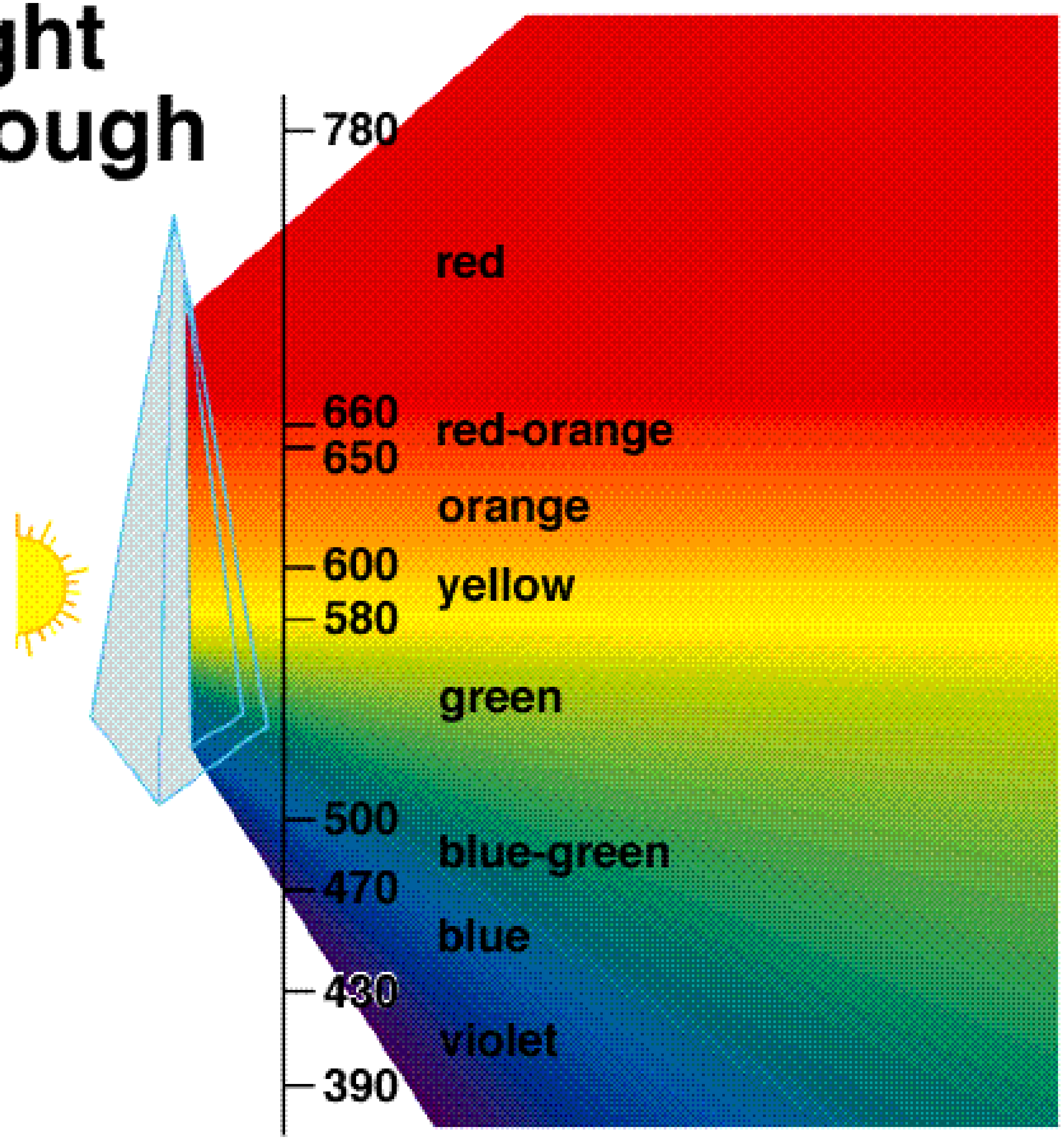
in the chloroplast, carbon dioxide and water combine to make sugar

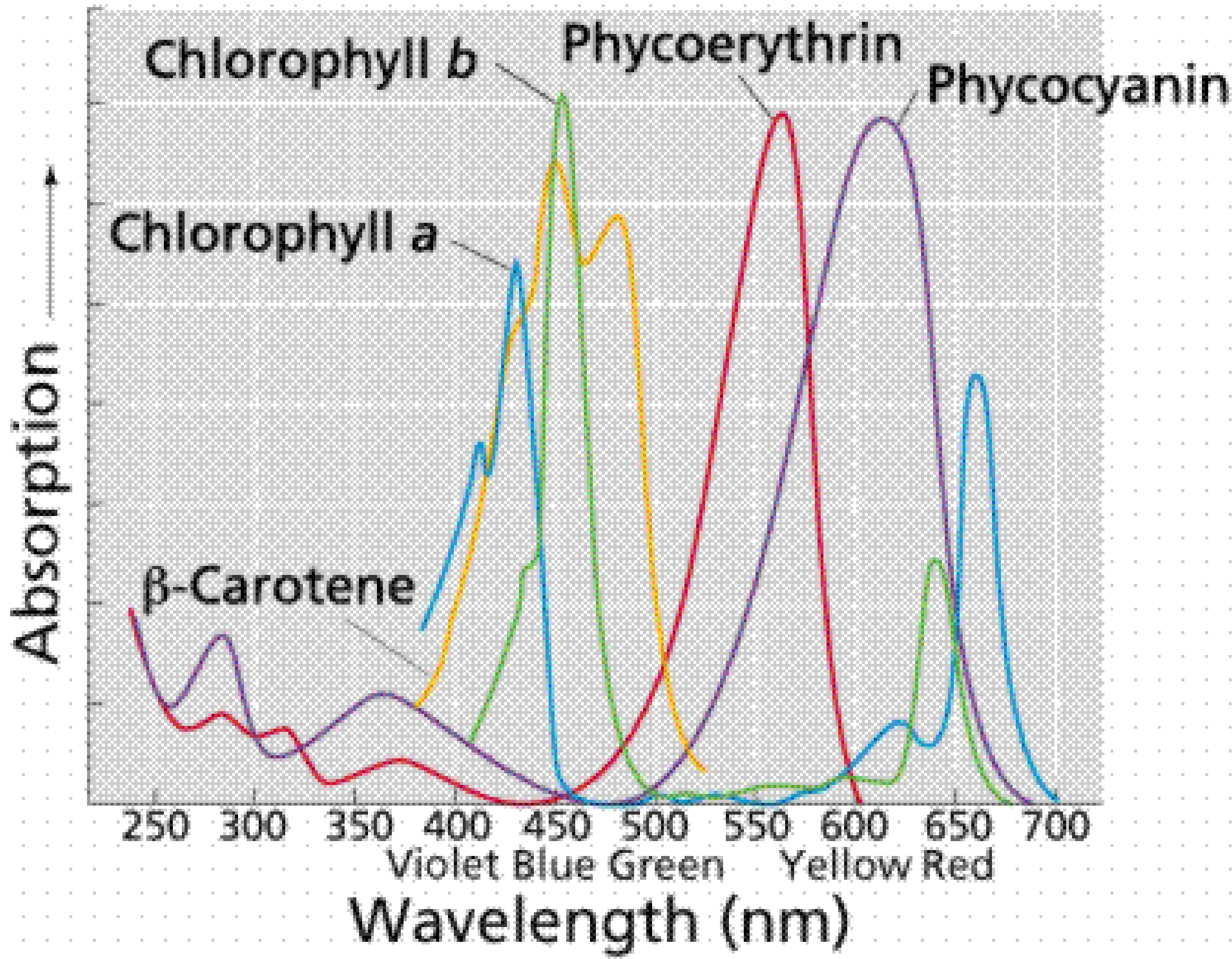




GLUCOSE
energy
e.g. seed germination
other sugars
fruits
protein
cytoplasm
starch
storage e.g. starch in potato
cellulose
cell walls

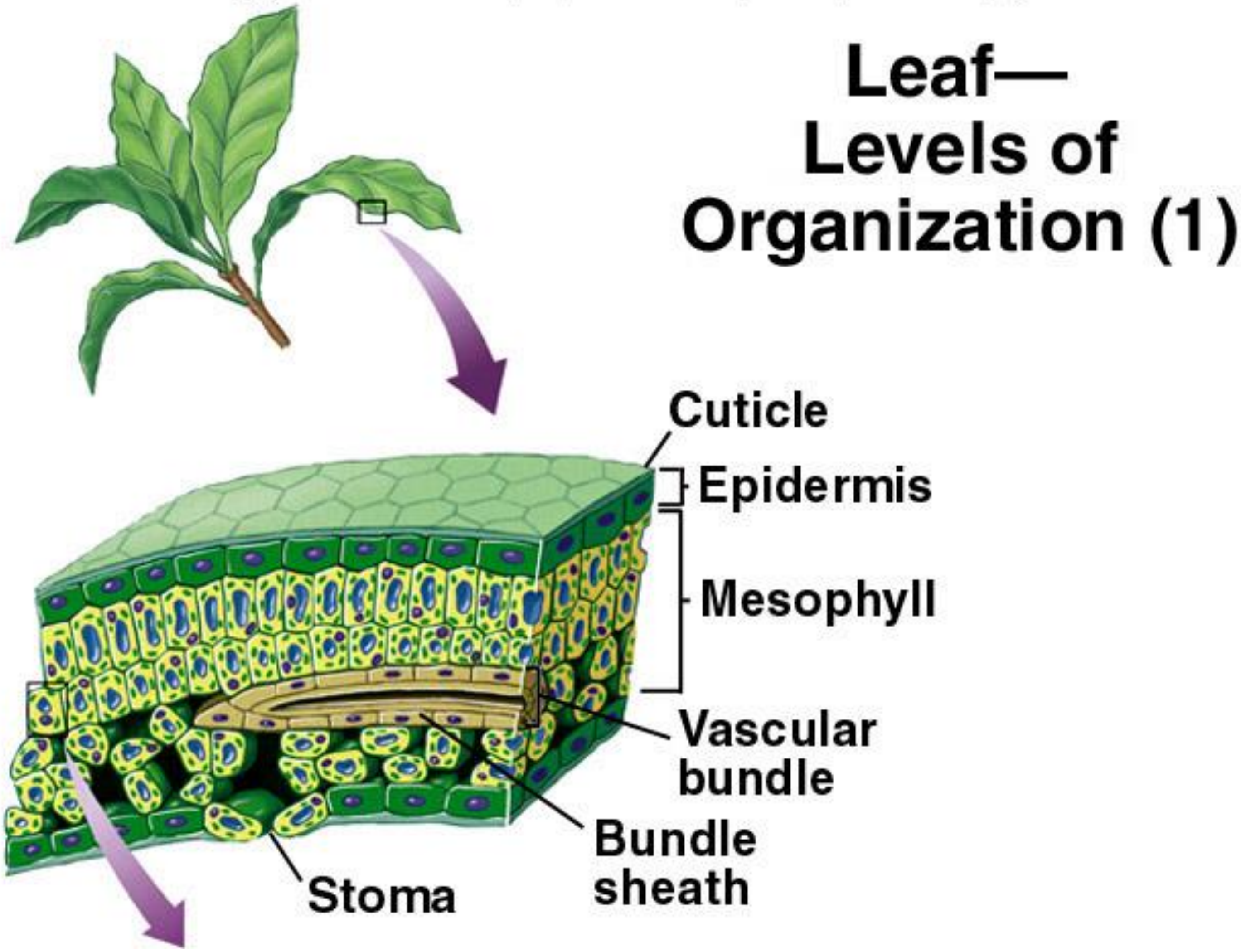
Visible Light Passing Through a Prism





Chlorophyll b
Phycoerythrin
Phycocyanin
Chlorophyll a
β-Carotene
Absorption
250 300 350 400 450 500 550 600 650 700
Violet Blue Green Yellow Red
Wavelength (nm)

Capturing Energy
أقتناص الطاقة



Types of photosynthesis

- **C3**
  - **The majority of plants** In the case of C3 photosynthesis, the first organic product of carbon fixation is a three-carbon compound, 3-phosphoglycerate, which is the reason these plants are termed the C3 plants.
- **C4**
  - **CO_2 temporarily stored as 4-C organic acids resulting in more efficient C exchange rate**
  - **Advantage in high light, high temperature, low CO_2**
  - **Many grasses and crops (e.g., corn, sorghum, millet, sugar cane)**
- **CAM**
  - **Stomata open during night**
  - **Advantage in arid climates**
  - **Many succulents (e.g., cacti, euphorbs, bromeliades, agaves)**

TO SUM UP ....

Plants combine carbon dioxide from the air, and water from the soil to make glucose.

The energy needed for this process comes from sunlight

The sunlight is absorbed by chlorophyll contained in the chloroplasts of the leaf.

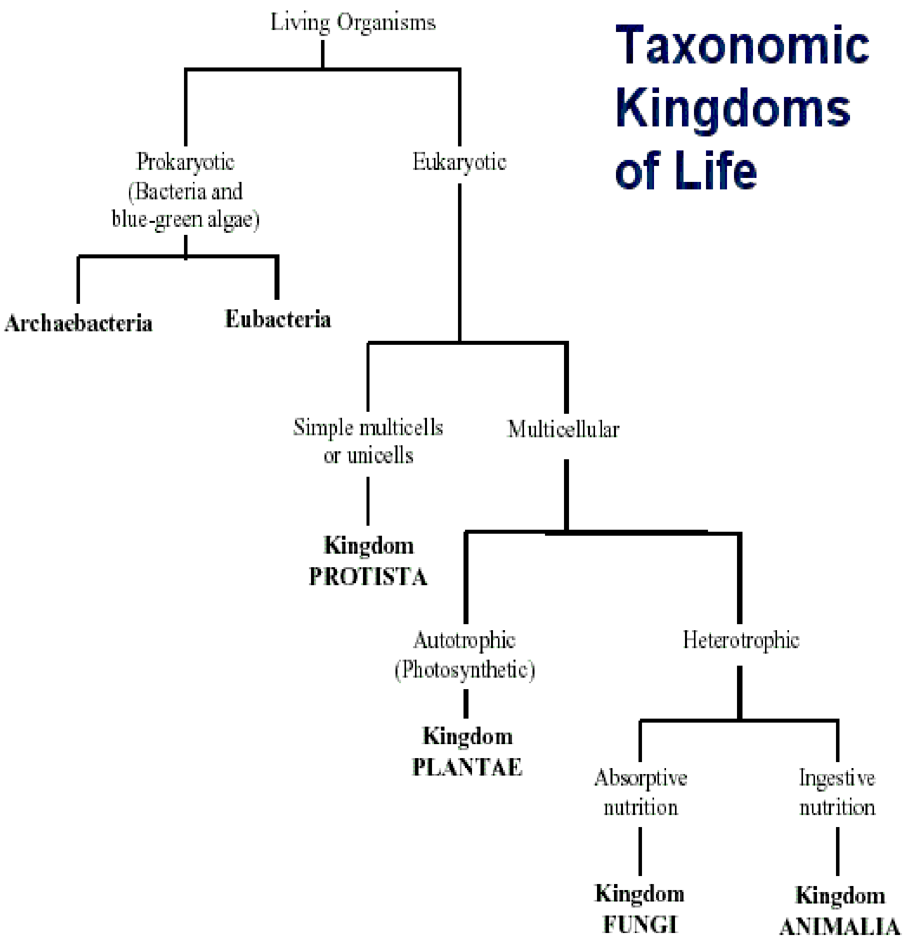
The glucose can be used for energy or to make other substances.

To make other substances, the glucose must be combined with other chemical elements such as nitrogen and potassium.

These chemical elements are present as ions in the soil and are taken up in solution by the roots.

Classification of Organisms

Classification of Organisms



- **The most basic category of organisms is called a *kingdom.***
- **Most scientists divide organisms into five major kingdoms.**

Systematics

- 1. Species: Organisms sharing a set of biological traits and reproducing only their exact kind. (Species is the fundamental unit in taxonomy)

  a. strains: organisms within the species varying in a given quality

  b. types: organisms within the species varying immunologically.

  2. Genus: closely related species

  3. Family : closely related genera

Systematics (contd.)

- 4. Order: closely related families
- 5. Class : closely related order
- 6. Phylum: related classes

Use nutritional patterns, as well as structure ones and biochemical properties, provide guidelines for classification of microorganisms. E.g.. Autotrophy, heterotopy, oxygen requirement etc.

Survey of Microorganisms

1. Viruses
2. Bacteria
3. Cyanobacteria
4. Algae
5. Fungi
6. protozoa

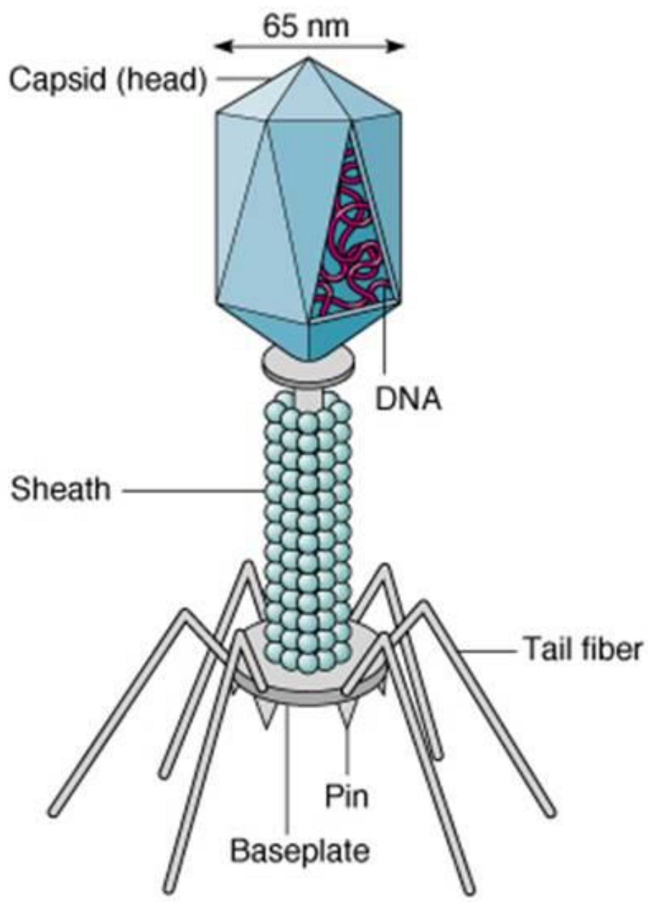
VIRUSES

- Obligated intracellular parasite.
- host specific:
  - bacteriophage
  - animal virus
  - plant virus
- according to its genetic material
  - DNA virus
  - RNA virus
- Shape:

  Most common shape is icosahedral , some are helical shape
- Structure:

  Protein capsid and genetic material some animal virus have envelope with glycoprotein spikes
- Life cycle: lytic infection lysogenic infection
- Some animal viruses are closely associated with certain cancers

Virus structure

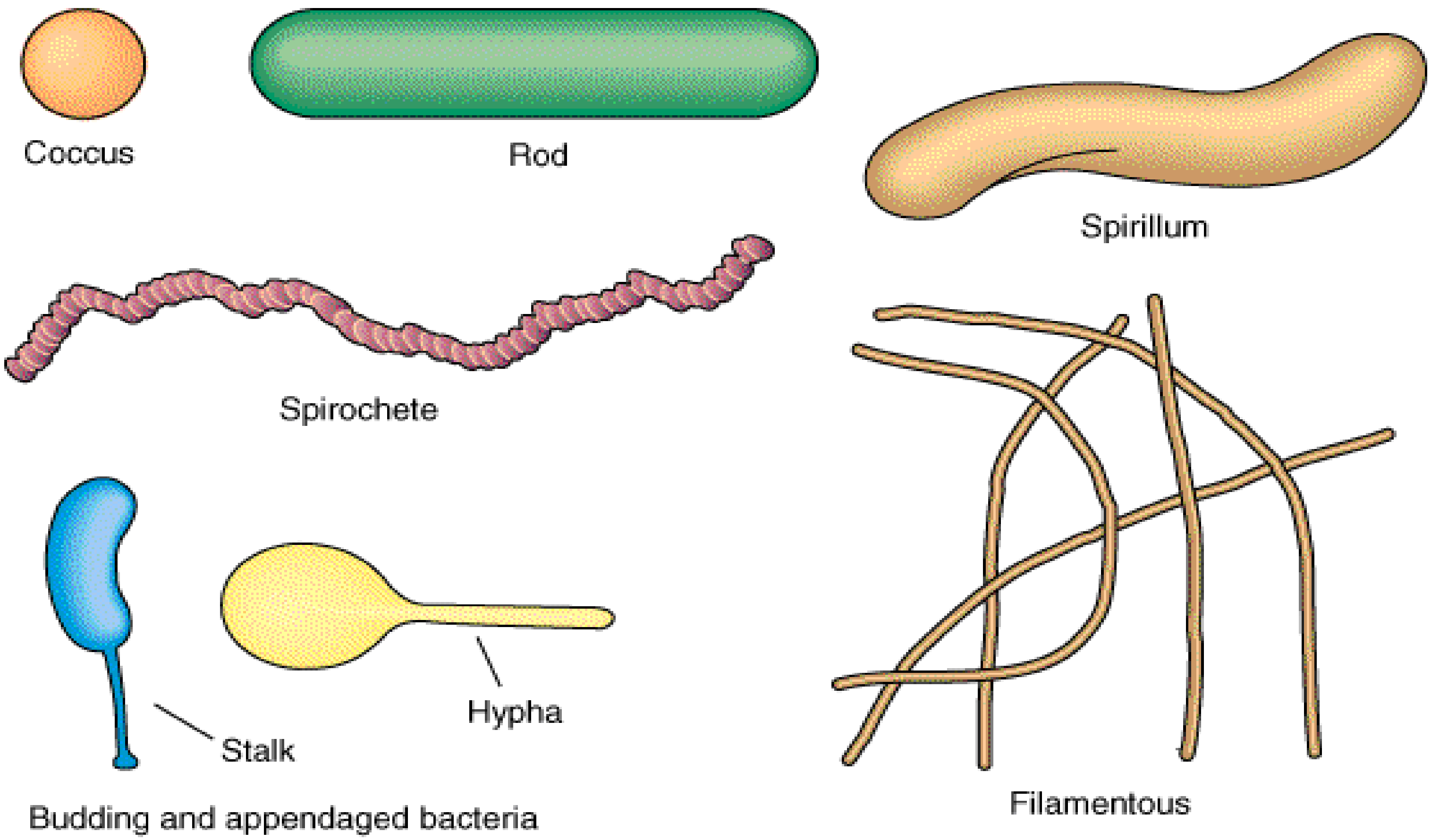


(a) A T-even bacteriophage

BACTERIA

- **Typical prokaryotes.**
  - **Three shapes: cocci, bacilli and spiral**
  - **Can be autotroph or heterotroph**
  - **Autotroph: photoautotroph or chemoautotroph**
- **Heterotroph: parasite or saprophyte**
  - **Type of reproduction: binary fission**
  - **Some genetic material transfer:**
  - **transformation, transduction and conjugation**

Bacterial morphology



Algae

1. Euglenoids
   eg. Euglena
   food storage - lipoid polysaccharide - paramylum
2. Green algae
   eg. Chlamydomonas
   food storage - starch
3. Golden Brown algae
   eg. Diatoms
   food storage – oil and leucosin (a polysaccharide)
   have fucoxanthin, a brownish pigment
4. Brown Algae
   Mainly marine water algae
   food storage – laminarin, a polysaccharide and mannitol, a sugar alcohol
5. Fire Algae
   Dinoflagellate
   eg. Peridinium
   food storage – starch, fat, oils

Fungi

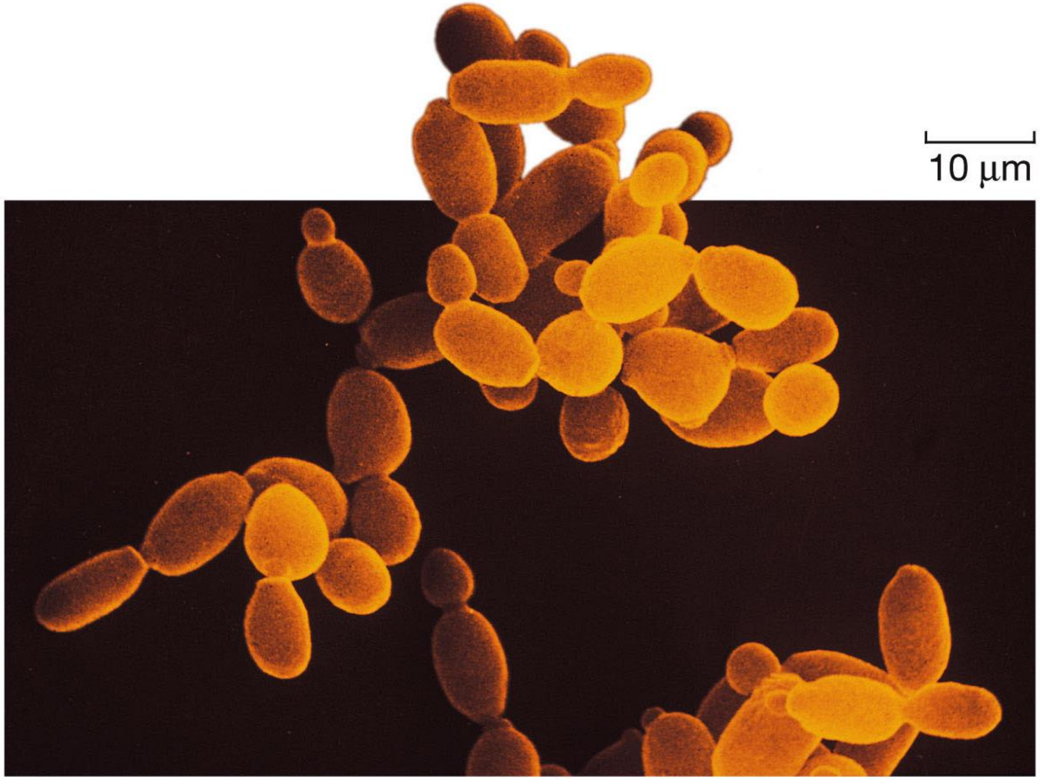
The fungi are **not true plants …!!** you see they do not contain chlorophyll! Indeed many scientists today place fungi as more closely related to animals than plants (**chitin** – which also forms the arthropod exoskeleton - is the main component of fungal cell wall).

Fungi and animals are descended from a common ancestor: A unicellular eukaryote with a flagellum.

Unicellular

Unicellular members of the zygomycetes, ascomycetes, and basidiomycetes.

e.g. , Yeasts:
Budding: mitosis followed by asymmetrical cell division.



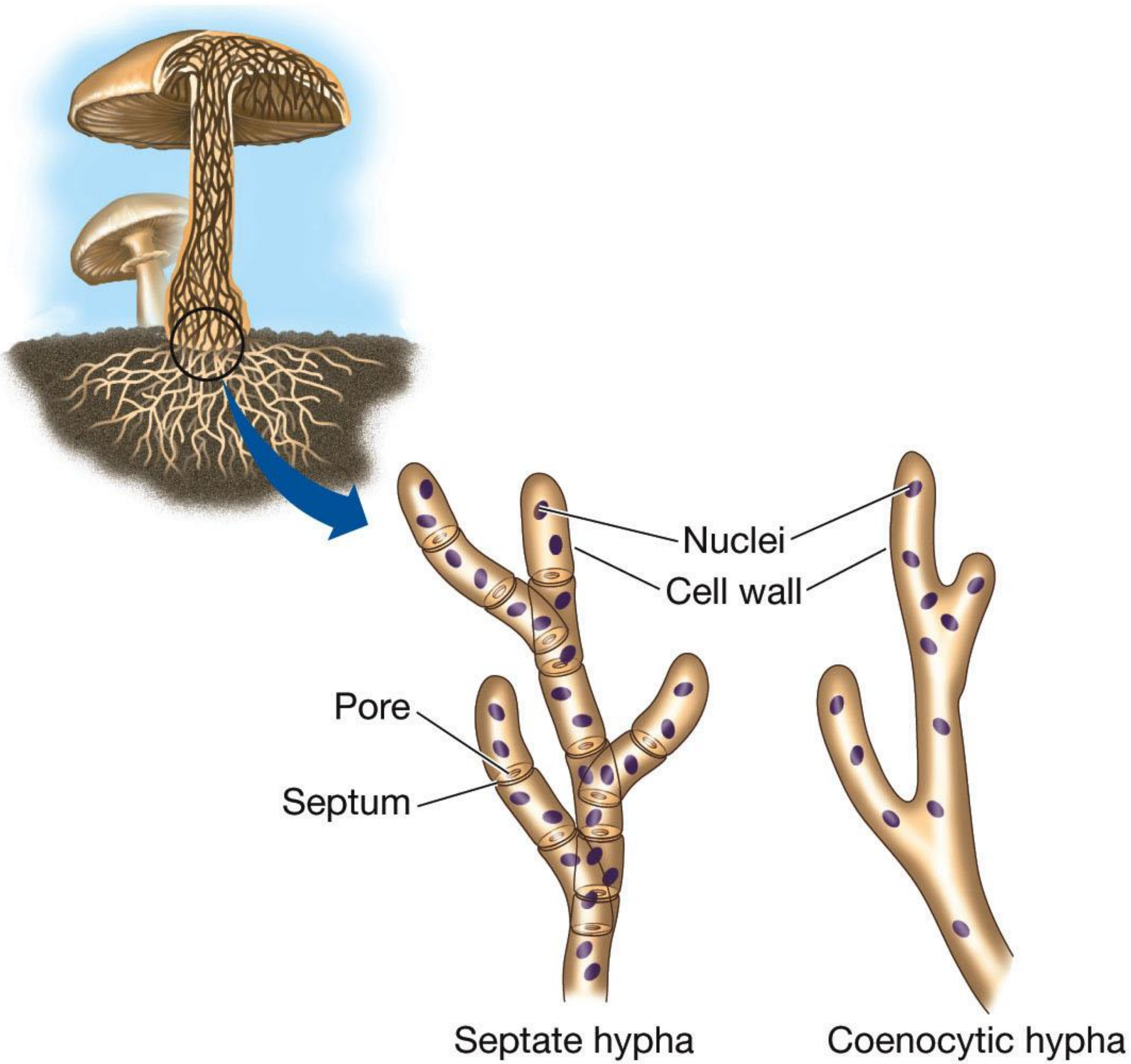
Saccharomyces sp.

Multicellular

Multicellular fungi:

- Body is a **mycelium**—composed of tubular filaments called **hyphae.** (singular hypha)
- Hyphae cell walls have **chitin**.
- Some hyphae have incomplete cross walls or **septa,** and are called **septate.**
- Hyphae without septa are called **coenocytic.**

Most Hyphae Are Incompletely Divided into Separate Cells

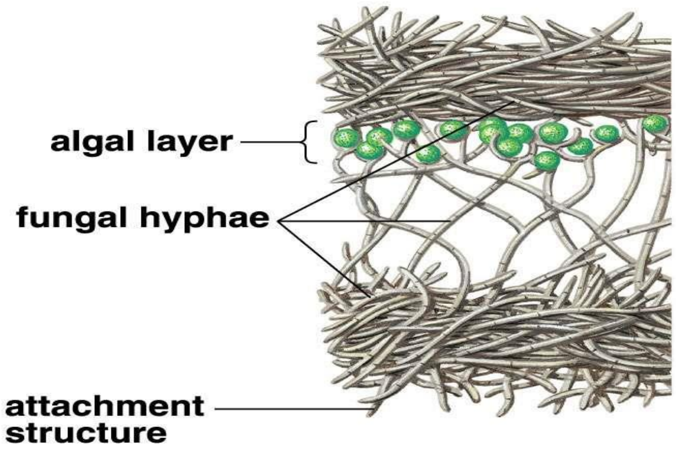


LIFE 8e, Figure 30.4

Lichens: Nature's perfect marriage

Lichens: fungus + photosynthetic organism

- Fungi—mostly ascomycetes
- Photosynthetic partner—cyanobacterium or alga, or both.
- Species are named for fungal component.
- Can survive the harshest environments on Earth.
- Very sensitive to toxic compounds—good indicators of air pollution.
- Lichens are great ecological markers
- Early medicinal remedy



Plant systematics

WHAT'S THE FLOWERING PLANT ?

- **Plants are members of the kingdom plantae. Plants are photosynthetic multicellular eukaryotes - or PHOTOAUTOTROPHS.**

- **Cell walls are made of CELLULOSE - the material that bacteria and protists in our small intestine digest for us. Cellulose is a kind of complex sugar or polysaccharide.**

- **Although cellulose plays an important role in structural support in the cell walls of plants, cellulose is found in other forms - such as cotton.**

- **The green of plants comes from their photosynthetic pigments (chlorophyll a & b)**

What are characteristics of plants?

- Sessile
- Multicellular & cell specialization
- Eukaryotic
- cellulose cell walls
- autotrophic (photosynthetic)
- Chlorophylls *a* and *b* in thylakoid membranes
- Store reserve food as amylose (starch)
- Alternation of Generations
  - Sporophyte
  - gametophyte

What do plants need to survive?

- **Sunlight** - energy of sun captured by chlorophyll and used to join CO_2 and H_2O to form glucose ($C_6H_{12}O_6$); plants need broad leaves to maximize light absorption
- **Water and minerals** - roots to absorb these
- **Gas Exchange** – stomata in leaves
- **Protective structures** - were required to protect the developing embryos.
- **Movement of water and nutrients**
  - Most plants have tubes – phloem (nutrients down) and xylem (water up)
  - Some small plants use diffusion

Plant Adaptations to Land

Problems:

- Need minerals
- Gravity
- Increase in Height for Light
- Adaptations for Drier environment
- Reproduction

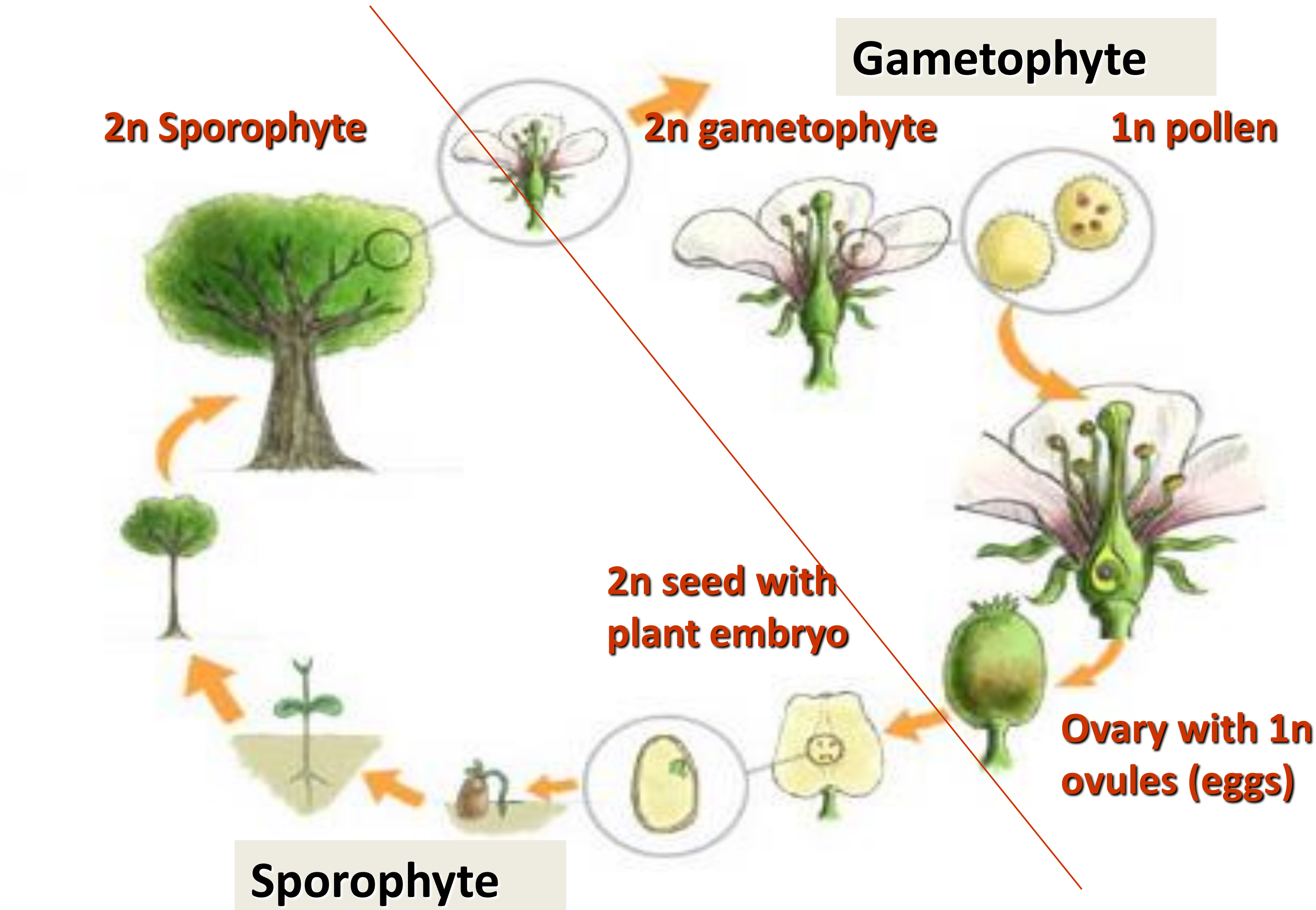
Solutions:

- Roots absorb H_2O & minerals
- Lignin & cellulose in cell walls
- Vascular Transport System
- Waxy cuticle & stomata with guard cells
- Pollen containing sperm

GENERAL LIFE CYCLE OF PLANTS

- The life cycle of plants has two different phases. This is called; ALTERATION OF GENERATIONS. In this alteration of generations, the plant takes turns undergoing mitosis and meiosis to produce haploid (n) gametes and diploid (2n) phase.
- The diploid (2n) phase is called the sporophyte - or spore producing plant. The haploid (n) phase is called the gametophyte - or gamete producing plant.
- The spores are haploid (n) and produced through meiosis in the sporophyte plant - each spore can grow into a new plant; the gametophyte!
- A gamete is a reproductive cell produced by mitosis and fuses during fertilization with another gamete to produce a new individual - the diploid sporophyte.

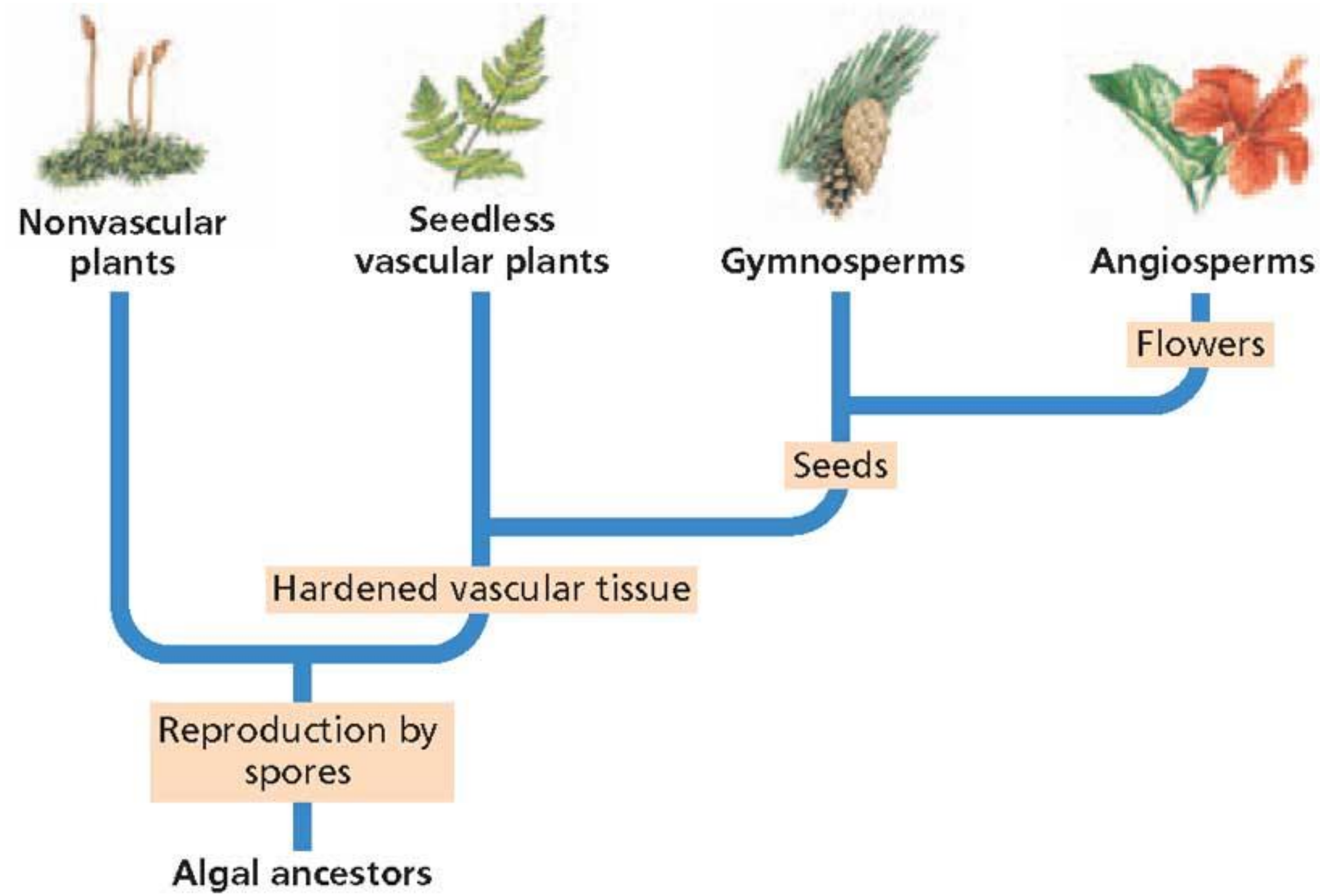
Alternation of Generations



- **Alternation of generations:**
  - <u>Sporophyte</u> – 2n – Diploid – produce haploid spores by meiosis
  - <u>Gametophyte</u> - (1n) – haploid undergoes mitosis to produce eggs and sperm – the eggs and sperm (gametes)
  - <u>Zygote</u> - merge to grow into a 2n sporophyte (cycle continues)

Plant Cladogram

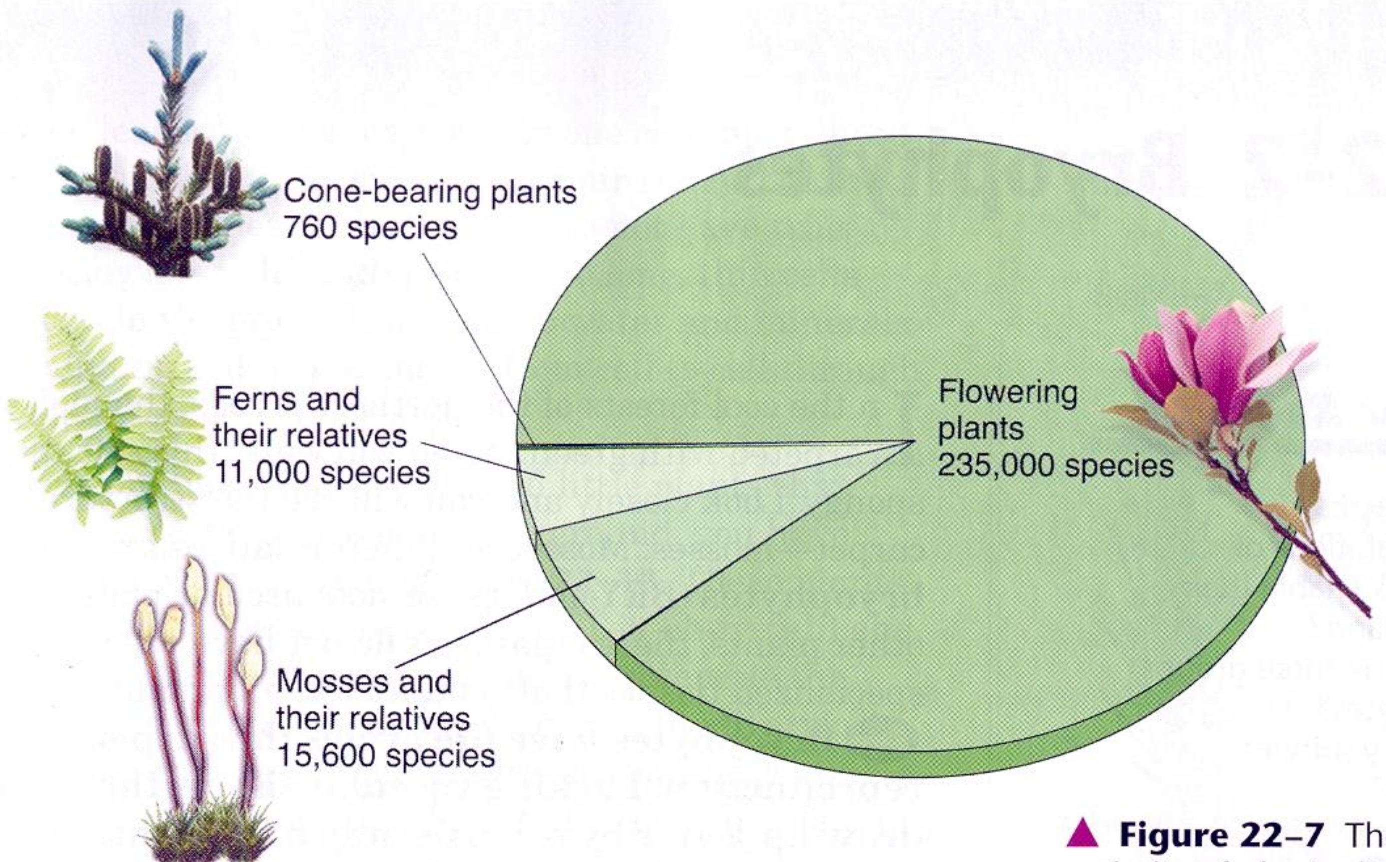
Relationships among the various groups of plants



The four main groups of plants?

- <u>Mosses</u> (nonvascular plants)– Bryophytes (15,600 species)
- <u>Ferns</u> (vascular & seedless plants)– Pterophytes (11,000 species)
- <u>Gymnosperms</u> (vascular & naked seeds)- Cone-bearing Plants (760 species)
- <u>Angiosperms</u> (vascular & covered seeds)- Flowering Plants (245,000 species)

Diversity of plants today



▲ **Figure 22–7** The great majority of plants alive today are angiosperms, which are also known as flowering plants. **Interpreting Graphics** *What is the second largest group of plants?*

Nonvascular Plants

- Do not have vascular tissue for support or conduction of materials
- Require a constantly moist environment
- Plants can't grow as tall

(Contd.)

Moss Gametophytes & Sporophytes

Nonvascular Plants (contd.)

- Cells must be in direct contact with moisture
- Materials move by diffusion cell-to-cell
- Sperm must swim to egg through water droplets
- Called Bryophytes, Hepatophytes & Anthocerophytes

Vascular Plants

Vascular System:

- Xylem tissue carries water and minerals upward from the roots
- Phloem tissue carries sugars made by photosynthesis from the leaves to where they will be stored or used
- Sap is the fluid carried inside the xylem or phloem

Seedless Vascular Plants
(reproduce via spores)

TABLE 30-2 ***Seedless Vascular Plants***

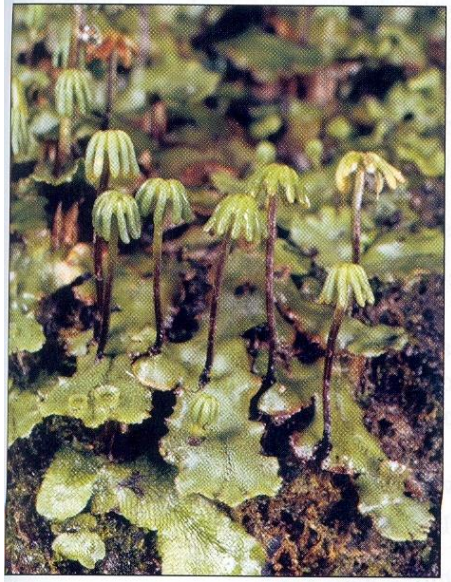
Example plant	Phylum	Features	Size	Location
Whisk ferns	Psilotophyta	• produce reproductive structures on the ends of forked branches • no roots or leaves	• about 30 cm (1 ft) tall	• tropical and temperate regions, as far north as South Carolina
Club mosses	Lycophyta	• evergreens that produce spores in cones • have roots	• about 5 cm (2 in.) tall	• tropical and temperate regions, on forest floors, in swamps, or as epiphytes
Horsetails	Sphenophyta	• jointed stems • outer cells of stems contain silica, the major component of sand	• about 60–90 cm (2–3 ft) tall	• tropical and temperate regions, usually in moist soil
Ferns	Pterophyta	• leaves • most have an underground stem • most produce spores on the underside of their leaves	• range from less than 1 cm (0.4 in.) to 25 m (82 ft) tall	• all climates, on forest floors, as epiphytes, some in full sun, some aquatic

Seed producing plants

- Major adaptations
  - Pollen (male gametophyte)
  - Seeds (embryonic plant)

  (male and female gametophyte are greatly reduced in size)
- Two types
  - Gymnosperms (lack flowers, naked seeds)
  - Angiosperms (flowering plants, seeds enclosed in fruits)

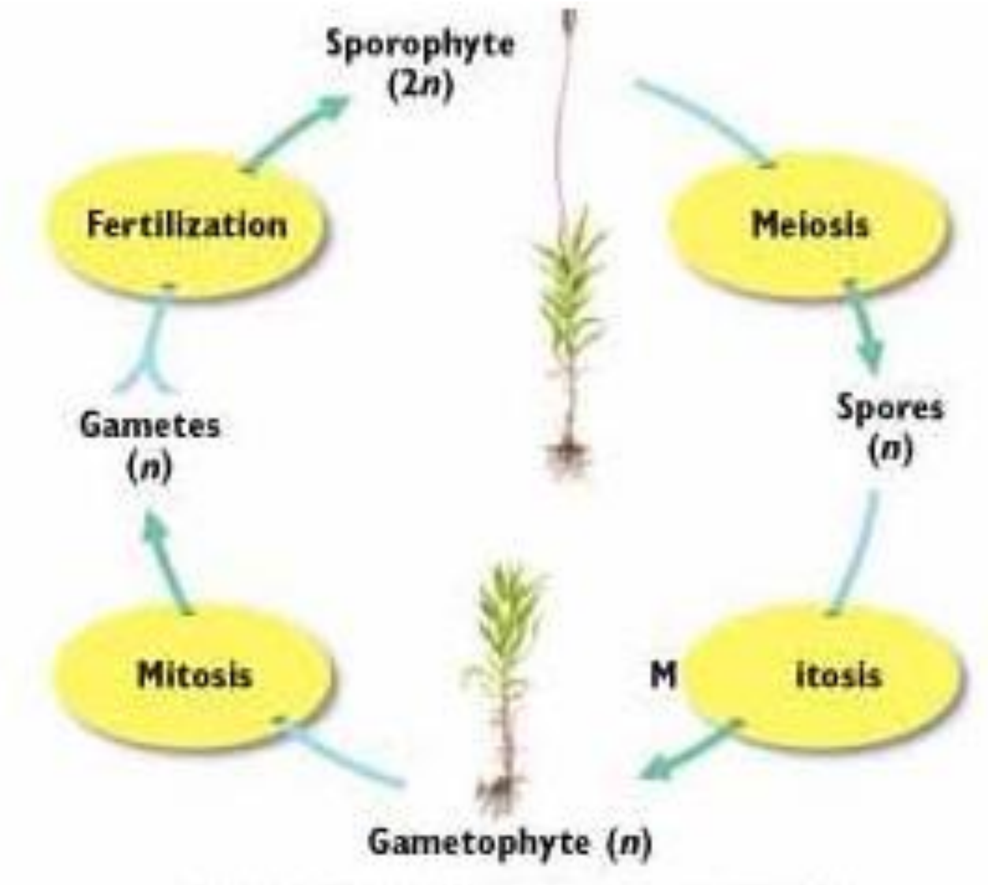
Types of Nonvascular Plants
(1) BRYOPHYTA



(2) Hepatophyta (liverwort)

(3) Anthocerophyta (Hornworts)

Simplified Lifecycle of a Bryophyte



(a) NONVASCULAR PLANT LIFE CYCLE

Types of Seedless Vascular Plants
(1) PSILOPHYTA (whisk ferns)

- Epiphytes
- Rootless and leafless

(2) LYCOPHYTA (club mosses)

- **Produces a sporangia bearing strobilus.**

(3) SPHENOPHYTA (Horsetails)

- **Genus:** ***Equisetum***
- **Large deposits of silica in their leaves.**
- **Jointed stems with whorled leaf arrangement.**

(4) PTEROPHYTA
(True ferns)

PTEROPHYTA (True ferns)

- **Broad leaves called fronds**
- **Leaflets called pinnae**
- **Sporangium (sorus *pl* sori) are formed on the underside of the fronds.**
- **Unfolding fronds are called fiddleheads.**
- **Spores are dispersed by the wind.**

Types of Gymnosperms

(1) CYCADOPHYTA (Cycads)

- Large fernlike leaves
- Plants are either males or females
- Plants produce gametes in large strobilus

(2) GINKGOPHYTA (*Ginkgo biloba)*

- Only one species in present day
- Bear male and female cones on separate plants.
- Male produces pollen in strobilus-like cones.
- Female bears seed which develop a fleshy outer covering
- Plants are resistant to air pollution

(3) CONIFEROPHYTA

(Cone-bearing trees)

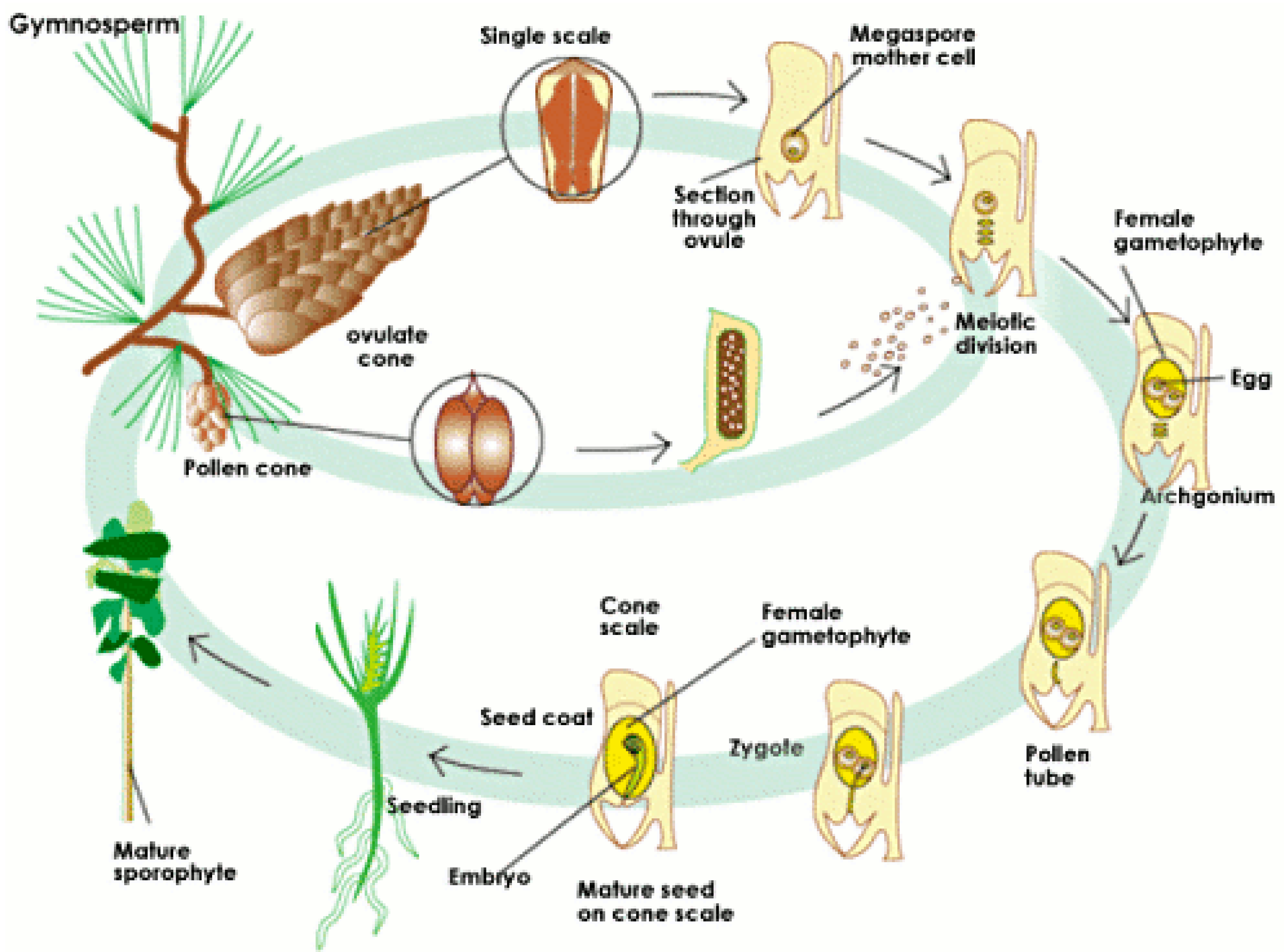
- Cone bearing
- needles with thick waxy covering
- Stomata in cavities below surface
- Seeds are carried on the surfaces of cones
- Evergreen and adapted to cold and dry habitat s

(a) Fir needles and cones

(b) Pine needles and cones

Male & female cones

What is **alternation of generations** in gymnosperms?



(4) GNETOPHYTA

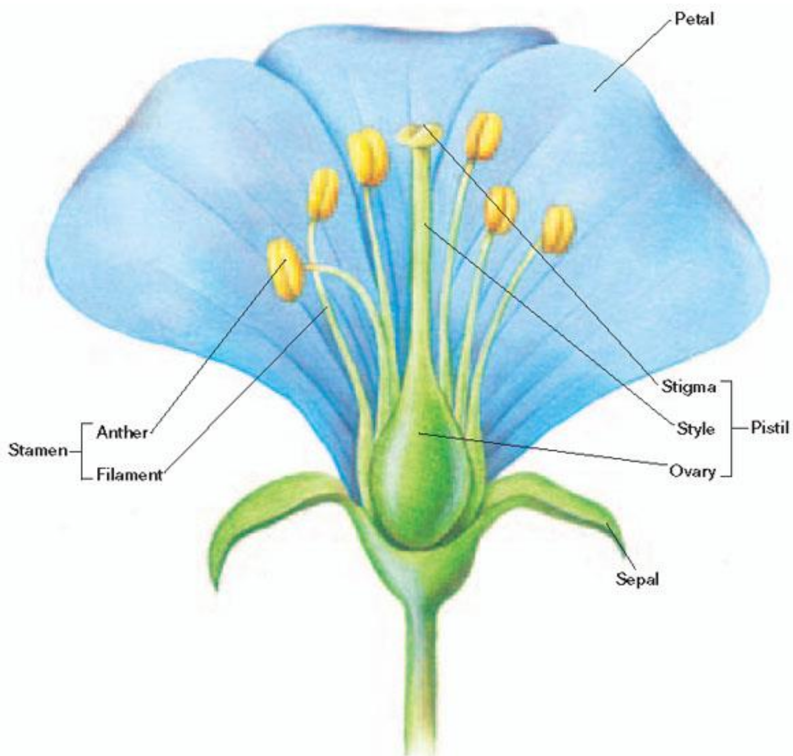
There are three genera:

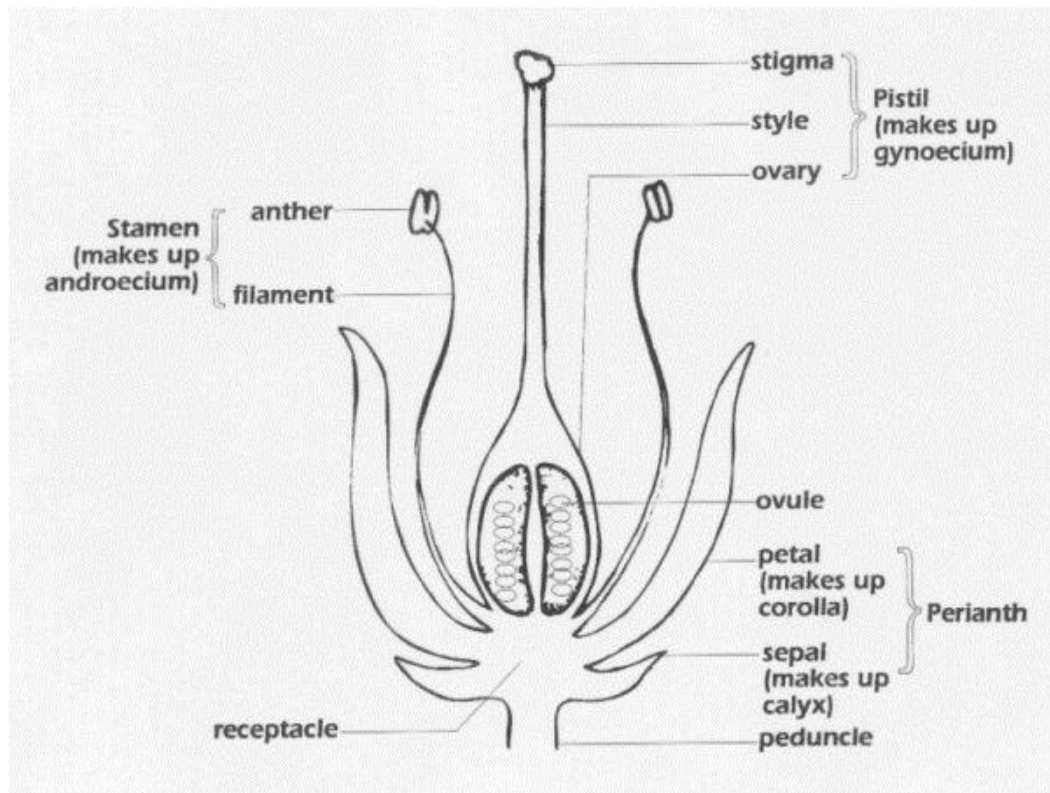
1. *Gnetum* : A tropical climbing plant
2. *Ephedra* (Shrub-like plants)
3. *Welwitschia* (Desert dweller with large tuberous root). Has only two leaves and may live 100 yr.

Angiospermae
(Anthophyta – flowering plants)

What are the ANTHOPHYTA?

- Flowering
- Seeds are within a layer of protective tissue
- Flowers, ovaries, pollinators (insects, etc.)





Types of Inflorescences: Simple/compound

- **1-Raceme:** is an un-branched, with pedicellate flowers
- along the axis.

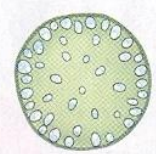
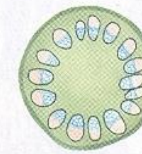
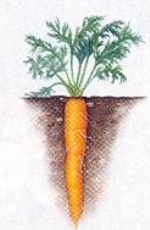
- **2-Panicle:** is a compound raceme

- **3-Spike:** is a simple raceme with sessile flowers

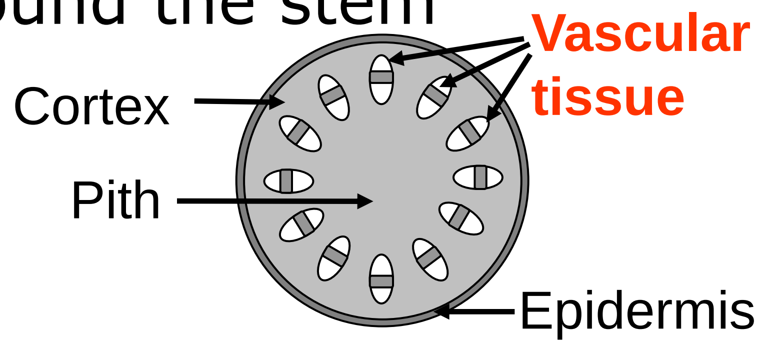
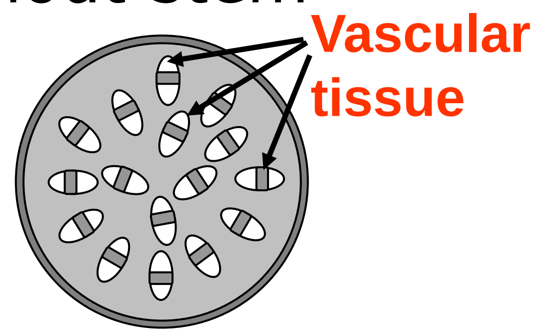
- **4-Umbel:** is a raceme arise from a common point

- **5-Head:** is a contracted raceme with
- sessile flowers are borne on an enlarged head.

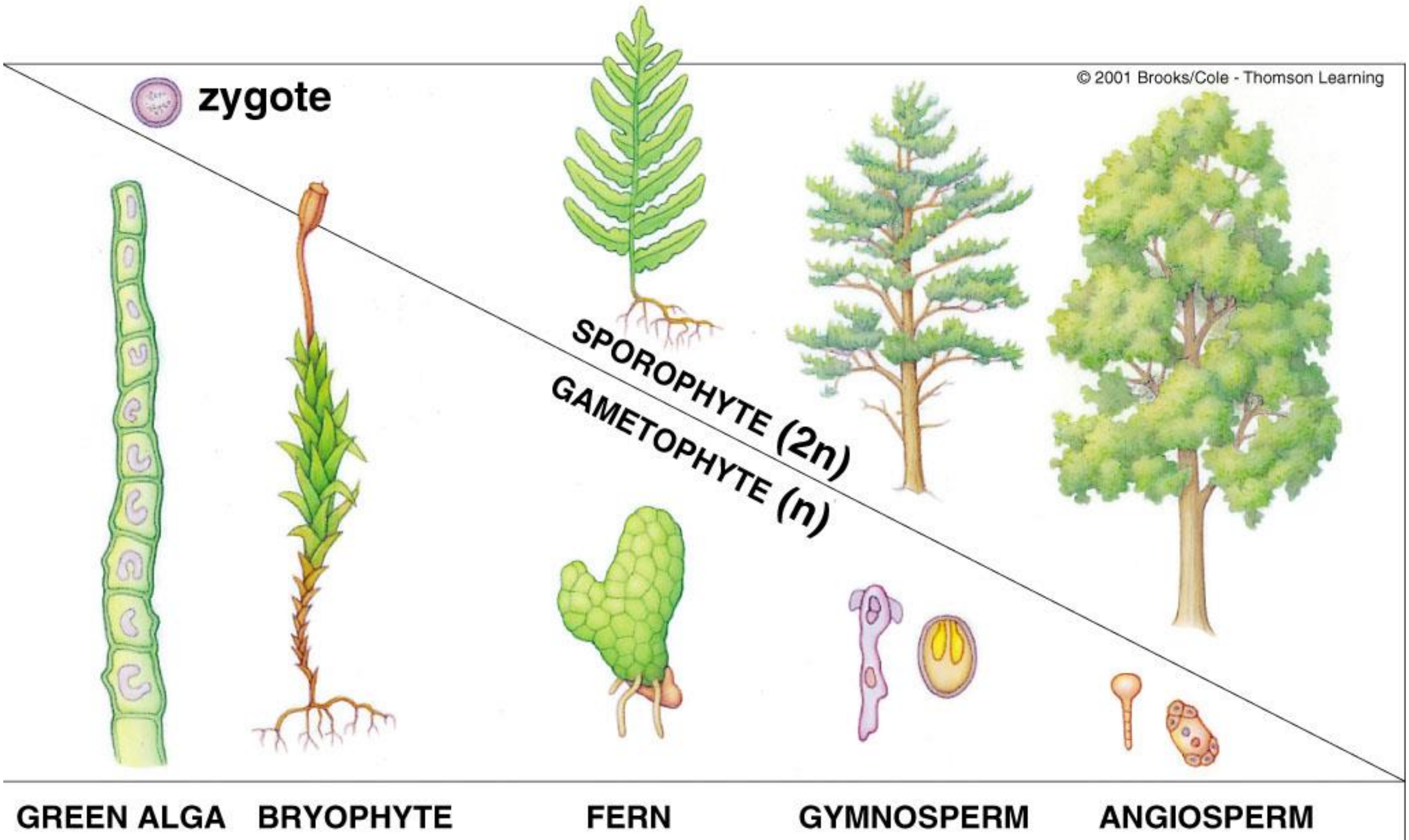
Characteristics of Monocots and Dicots

	Monocots		Dicots	
Seeds	Single cotyledon		Two cotyledons	
Leaves	Parallel veins		Branched veins	
Flowers	Floral parts often in multiples of 3		Floral parts often in multiples of 4 or 5	
Stems	Vascular bundles scattered throughout stem		Vascular bundles arranged in a ring	
Roots	Fibrous roots		Taproot	

Dicots v Monocots – other differences

Dicotyledons	Monocotyledons
Vascular tissue in a ring round the stem 	Vascular tissue scattered throughout stem 
Flowers with multiples of 4 or 5 organs 	Flowers with multiples of 3 organs 

Switch to Sporophyte Dominance

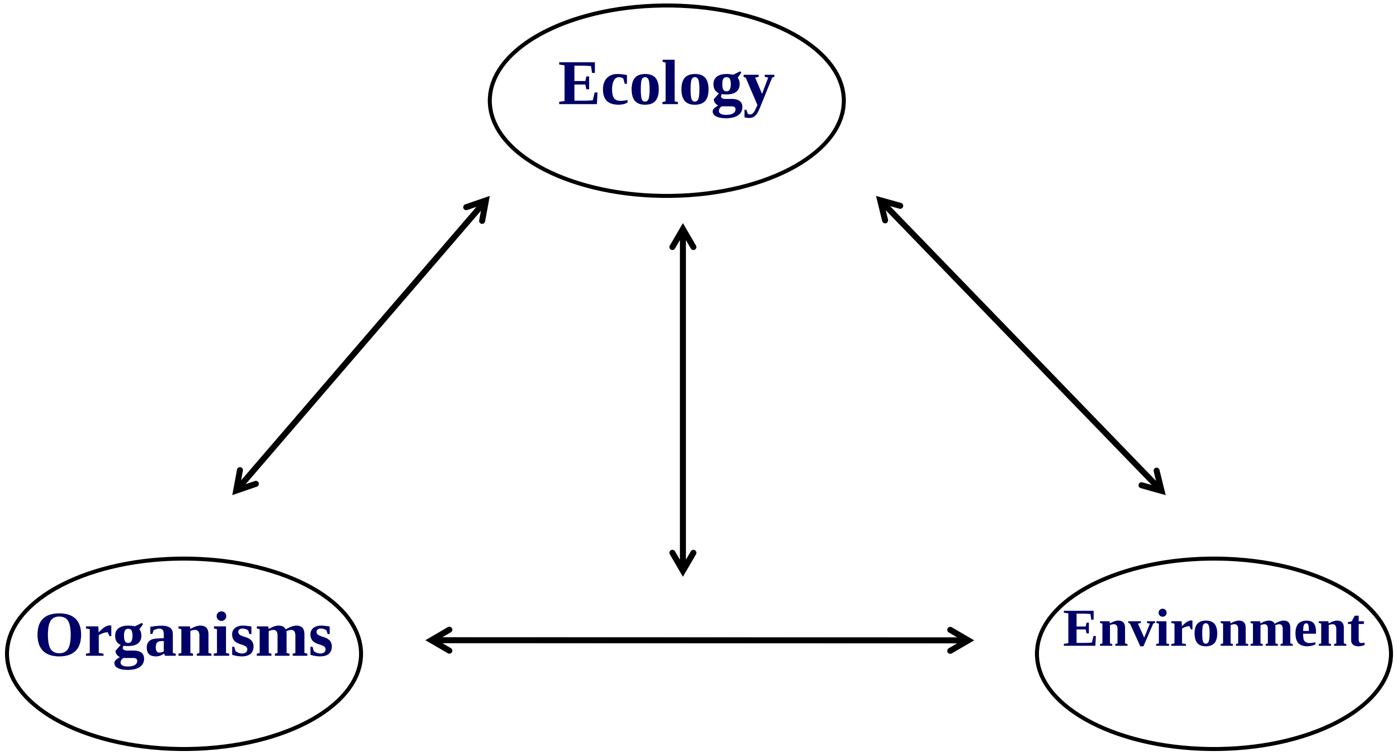


Plant Ecology

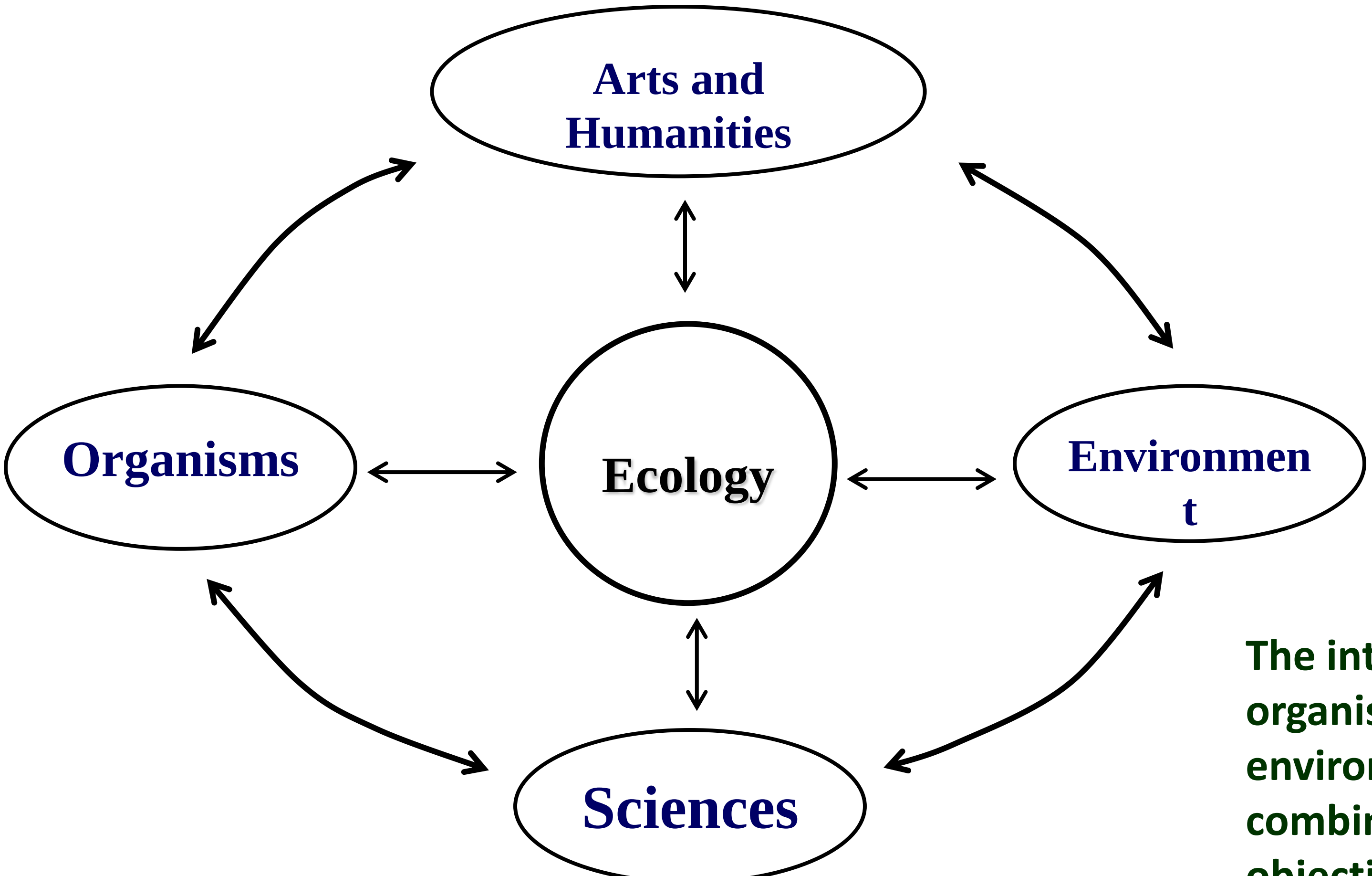
Ecology

The word first coined by E. Haeckel (1869) and H. Reiter (1885) from the Greek words *OIKOS* (habitat or home) and *LOGOS* (the study or knowledge), i.e. the study of living organisms in relation to their habits and habitats. It seeks to explain how many different kinds of organisms can live together in the same place for many generations (share habitats). It deals with the reciprocal relationships between organisms and their environment.

The reciprocal relationships between organisms and their environment



Odum (1971) and Clark (1973) have defined ecology as a science of ecosystems, i.e. study of the structure and function of nature.



The interplay of organisms and environment combines between objectivity of science and subjectivity of art.

The three fundamental ecological questions

- What is there?
- How much is there?
- Why is it there?

Environment

Summation of all biotic (living) and abiotic (non-living) components that surround or potentially influence the organisms and their habitats. It is a complex of factors acting, reacting and interacting with the organism complex, i.e., organisms and their environment are wedded together in state of constant flux.

- **Macro-environment (prevailing regional climate)**
- **Micro-environment (close to an organism to be influenced by it)**

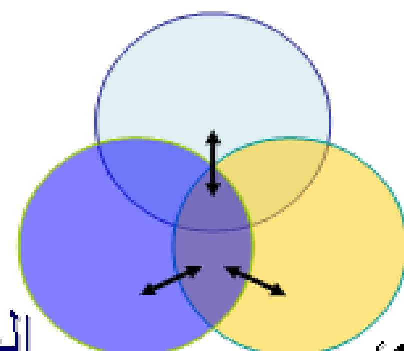
Biosphere (sphere of life)

Total portion of lithosphere, hydrosphere and atmosphere that supports the life of organisms.

مكونات المحيط الحيوي

Atmosphere

الغلاف الجوي



الغلاف المائي

الغلاف الأرضي

Hydrosphere

Lithosphere

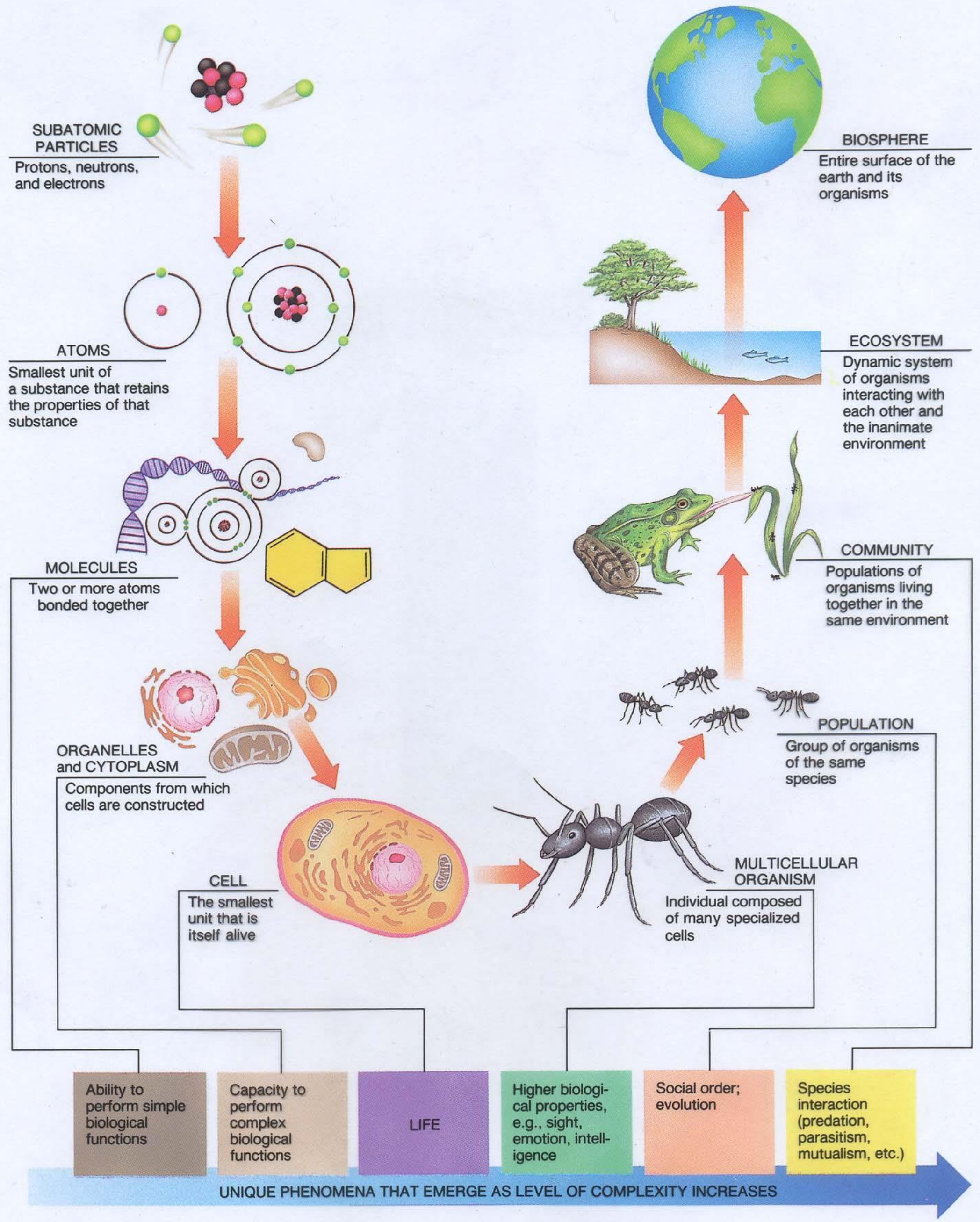
Levels of organization

The biological portion of an interactive organism-environment system. In ecology, the levels of organization include:

- **Individuals - the fundamental functional units.**
- **Populations - members of the same species co-occurring in space and time and sharing the same resources.**
- **Guilds - group of populations of different species exploit the same resources.**
- **Communities - populations of organisms living together in the same environment.**
- **Ecosystems – Dynamic systems of organisms interacting with each other and their environment.**
- **Biomes - regional ecosystem types with similar communities.**

Levels of organization

مستويات التعضي



Ecosystem

All organisms and their physical environment in a single location. Self-sustaining and self-regulating communities of organisms interacting with one another and with their environment. The matter that cycles into and out of the ecosystem is small compared with the quantities that are internally recycled in a continuous exchange of the essentials of life. Various ecosystems make up the largest life unit called biosphere.

Ecosystem structure

1. Abiotic components

- **Energy - solar energy**
- **Physical factors - temperature, light, wind, etc.**
- **Chemicals - inorganic substances (oxygen, carbon, etc.) and organic substances (carbohydrates, proteins, etc.)**

2. Biotic components

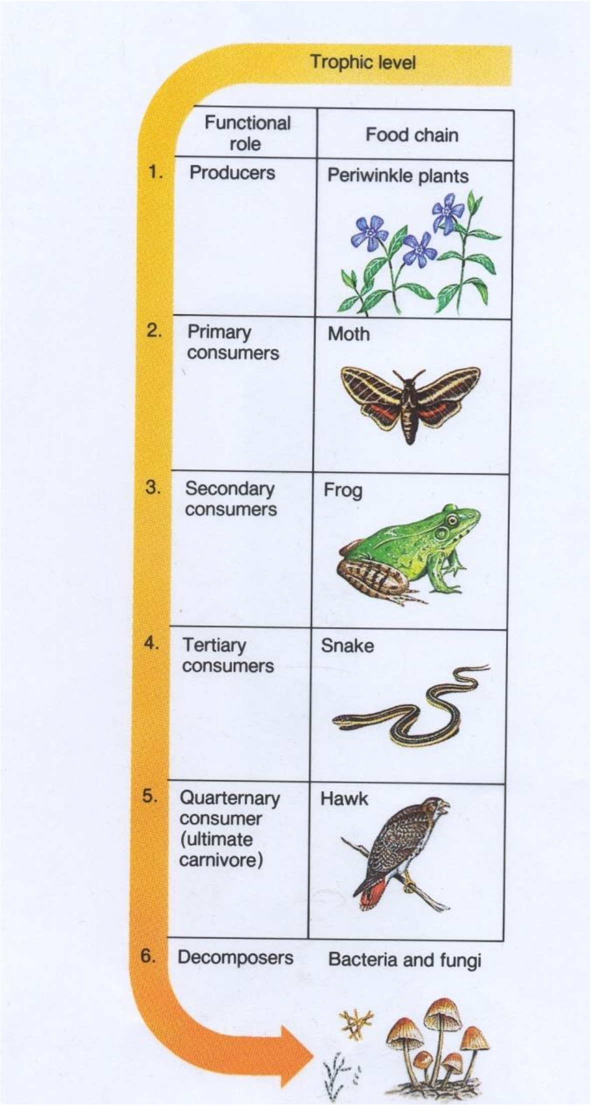
- **Producers - green plants (autotrophs)**
- **Consumers - animals (heterotrophs)**
  - **-Herbivores (primary consumers)**
  - **-Carnivores (primary, secondary, tertiary, etc. consumers)**
  - **-Omnivores (generalists) - can feed on both plants and animals.**
  - **-Scavengers (top carnivores) - utilize the dead remains of animals**

3. Decomposers (saprotrophs) - bacteria and fungi

Food chain

A linear energy and chemical flow through organisms, i.e. food from one trophic (feeding) level reaches to the other trophic level (who eats whom?). In the classical food chain, plants are eaten only by primary consumers, primary consumers are eaten by secondary consumers, secondary consumers are eaten by tertiary consumers, and so forth.

Food Chain

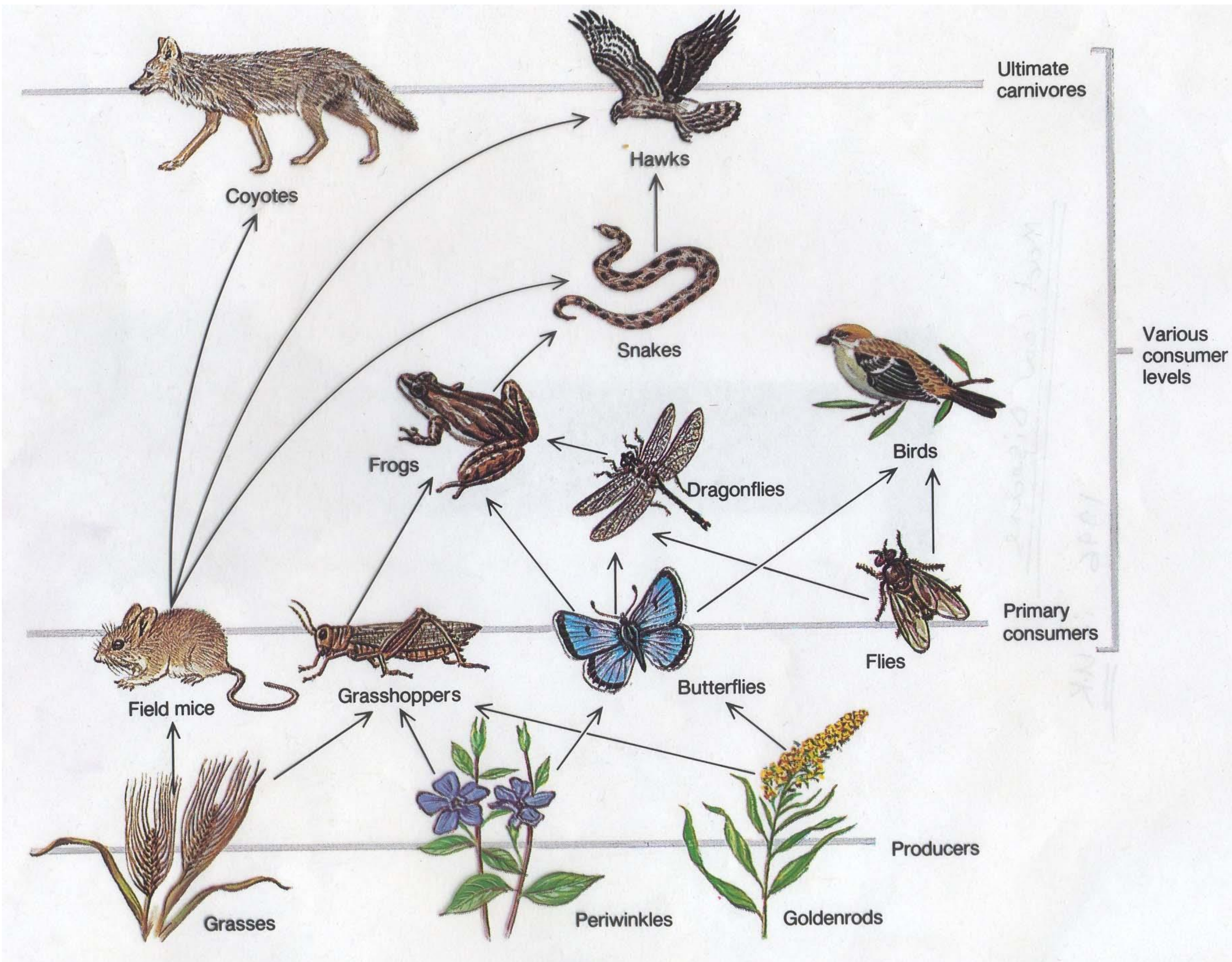


Trophic level
Functional role
Food chain
1. Producers
Periwinkle plants
2. Primary consumers
Moth
3. Secondary consumers
Frog
4. Tertiary consumers
Snake
5. Quarternary consumer (ultimate carnivore)
Hawk
6. Decomposers
Bacteria and fungi

Food web

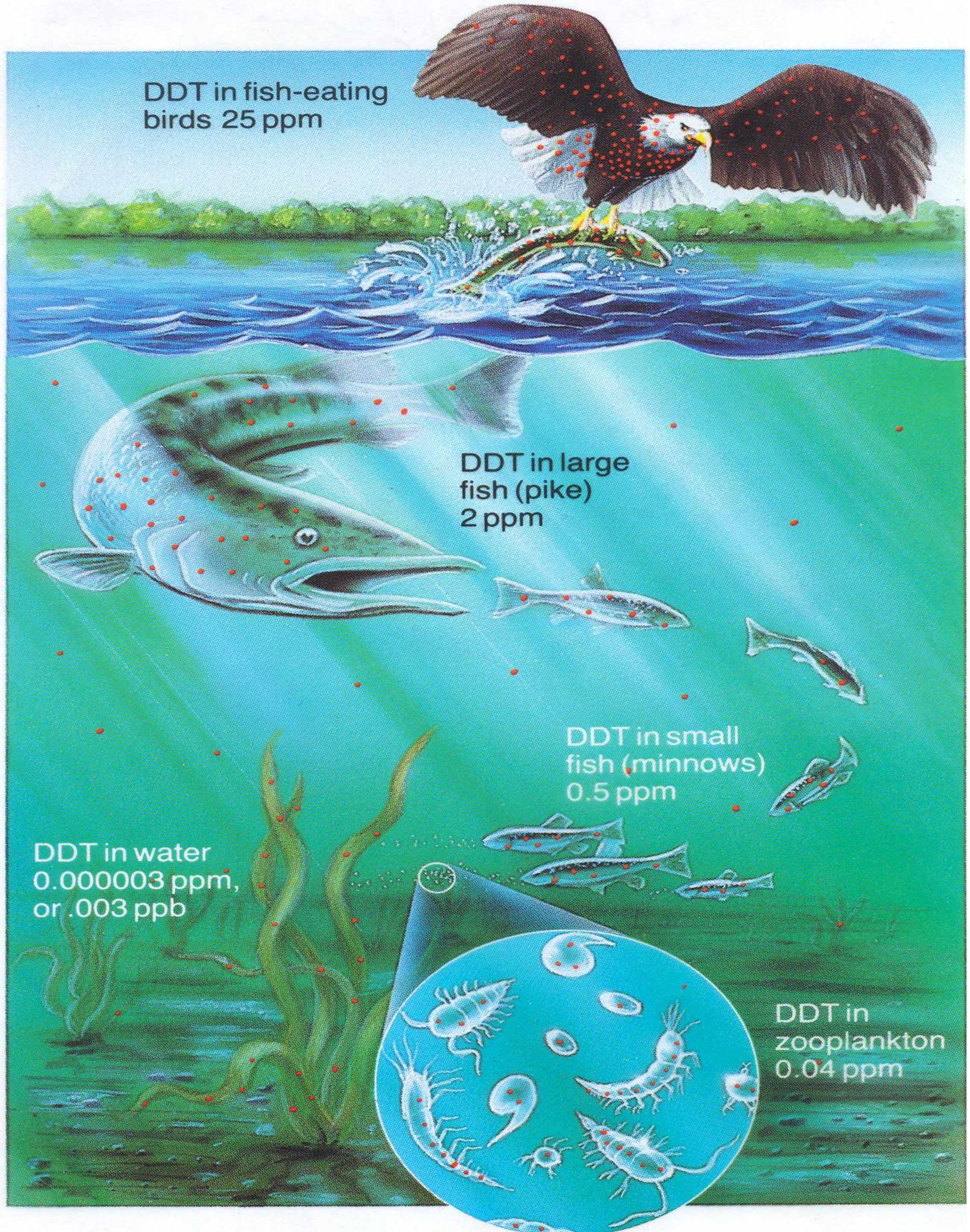
The actual pattern of food consumption in a natural ecosystem. A given organism may obtain nourishment from many different trophic levels and thus gives rise to a complex, interwoven (interconnected) series of energy transfers. The more complex the food web, the more stable the ecosystem.

Food Web



Ultimate carnivores
Hawks
Coyotes
Snakes
Various consumer levels
Birds
Frogs
Dragonflies
Flies
Primary consumers
Butterflies
Field mice
Grasshoppers
Producers
Grasses
Periwinkles
Goldenrods

Food chain and pollutant accumulation



Types of Systems

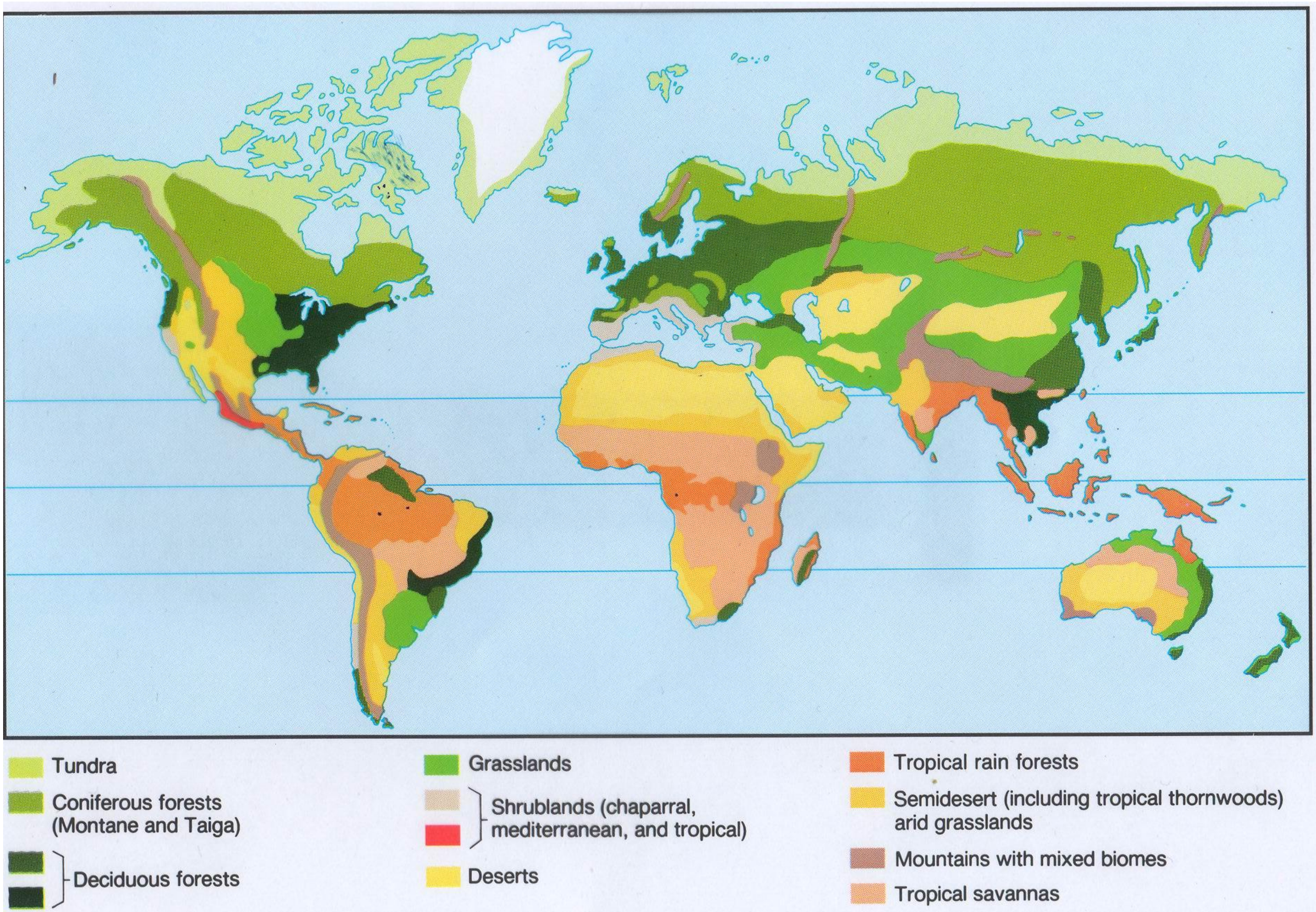
(1) Closed system: Energy <u>but not</u> matter is exchanged between the system and environment, e.g., earth.

(2) Open system: <u>Both</u> energy <u>and</u> matter are exchanged between the system and environment, e.g., lakes or living organisms.

(3) Isolated system: <u>Neither</u> energy <u>nor</u> matter are exchanged between the system and environment, e.g., (examples and comments given as student assignment).

المناطق الحياتية (النطاقات الحياتية)
Zonobiomes (Biomes)

1) المناطق المدارية اليومية — Equatorial diurnal climate
2) المناطق الاستوائية — Tropical
3) المناطق تحت الاستوائية (الصحراء) — Subtropical (Desert)
4) مناطق البحر المتوسط — Mediterranean
5) المناطق المعتدلة الدافئة — Warm temperate
6) المناطق المعتدلة — Temperate
7) المناطق المعتدلة الجافة (المناخ القاري) — Arid temperate (Continental)
8) المناطق المعتدلة الباردة — Cold temperate
9) المناطق القطبية — Arctic (Tundra)



Zonobiomes (المناطق الحياتية (النطاقات البيئية

Allelopathy

- **Allelopathy is a chemical interaction between two or more populations that suppresses one population while the another remains stable through the release of metabolic by-products (allelochemicals) into the environment.**

- **The allelochemicals are selectively toxic, affecting some species but not the others. Many allelopathic species release autotoxic compounds which affect their own growth and development negatively (Autopathy).**

- **To gain a selective advantage, there must be a trade-offs between allelopathy and autopathy through which the source (donor) species inhibits the target (receptor) species more than its self-inhibition.**

- **Amensalism:** An interaction between two populations in which one **is not** affected and the other is **negatively** affected.

- **Commensalism:** An interaction between two populations in which one **is not** affected and the other is **positively** affected.

- **Predation:** An interaction in which one living organism serves as a food source for another organism; one **positively** (predator) affected and the other is **negatively** (prey) affected.

- **Parasitism**: An interaction in which an organism serves as a food source (host) for other organisms (parasites) that commonly are much smaller in size, ultimately results in the death of, or detriment to, the host organism.

- **Symbiosis**: An interaction in which both species are positively influenced as a result of their co-occurrence (happy and strong together).

- **Mutualism**: An interaction in which each member derives a positive benefit and also provides a portion of the cost of the interaction.

THE END ...

Plant Cells

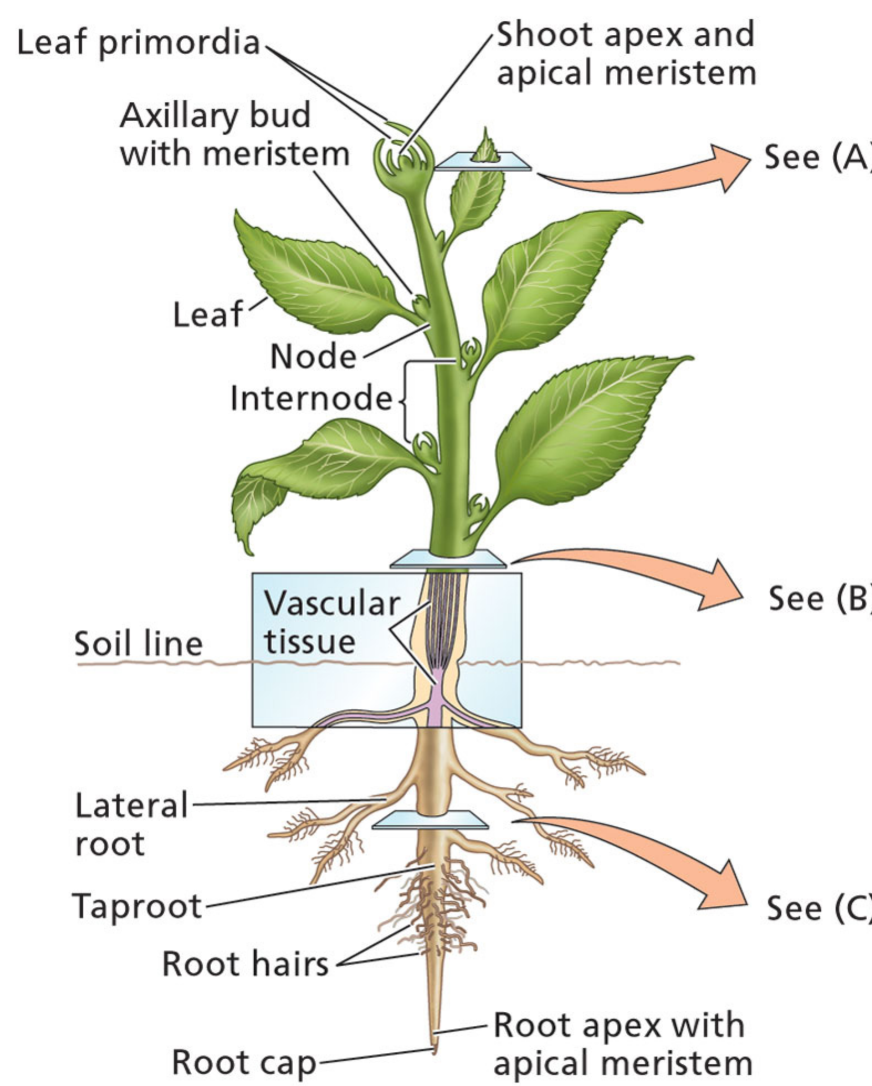
Overview of Plant Structure

- Plants are Earth's Primary Producers
  - Harvest Energy from sunlight by converting ***light*** energy into ***chemical*** energy
- They store this Chemical Energy in bonds formed when the synthesize ***Carbohydrates*** from Carbon Dioxide and Water.

- Non- motile
  - Have evolved to grow towards resources throughout their life span.

Overview of Plant Structure

- The vegetative body consists of:
- **Leaf:** ***Photosynthesis***
- **Stem:** ***Support***
- **Roots:** ***anchorage*** and absorption of ***water*** & ***minerals***.
- **Nodes:** leaf attached to stem.
- **Internode:** Region of stem between two nodes



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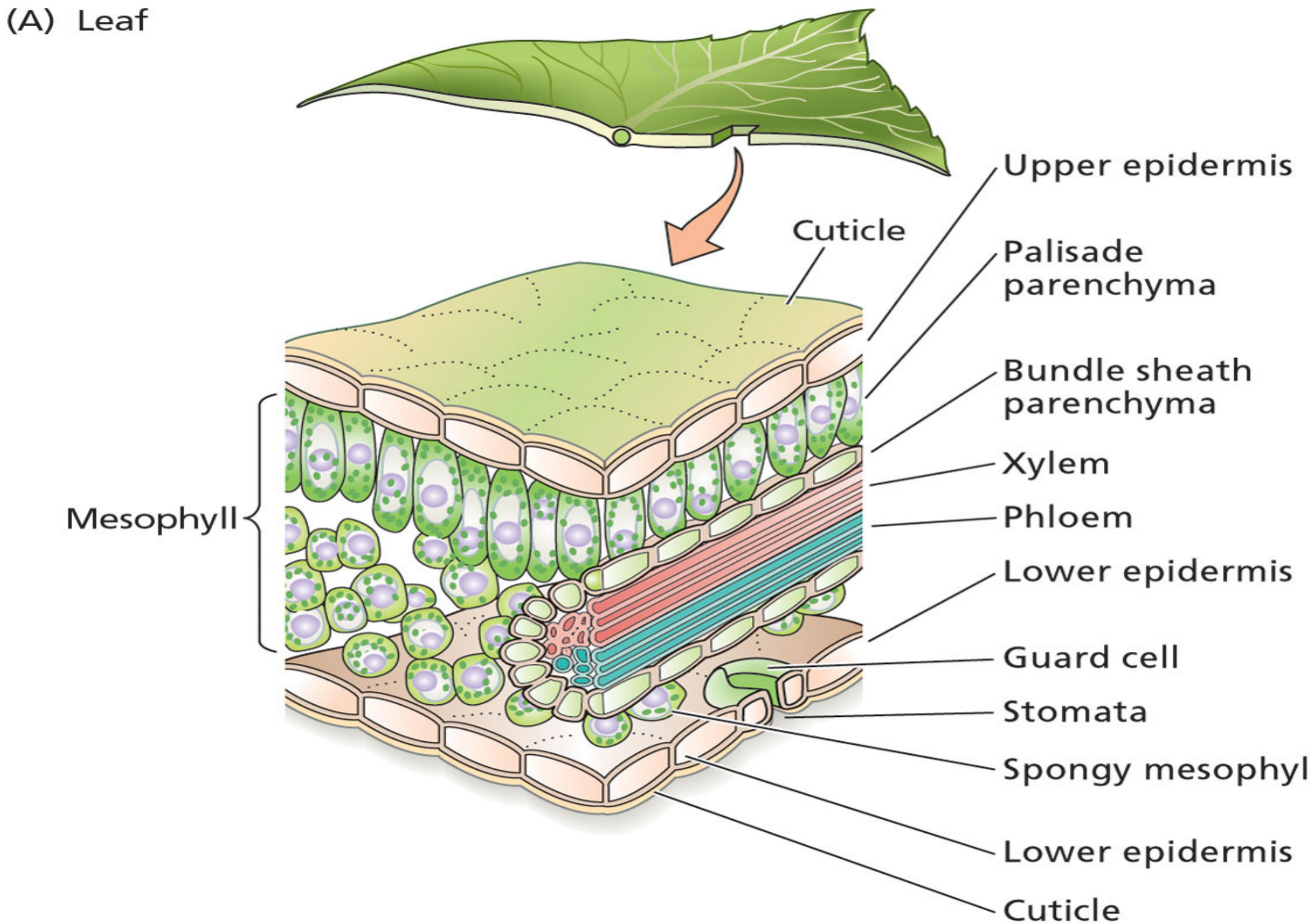
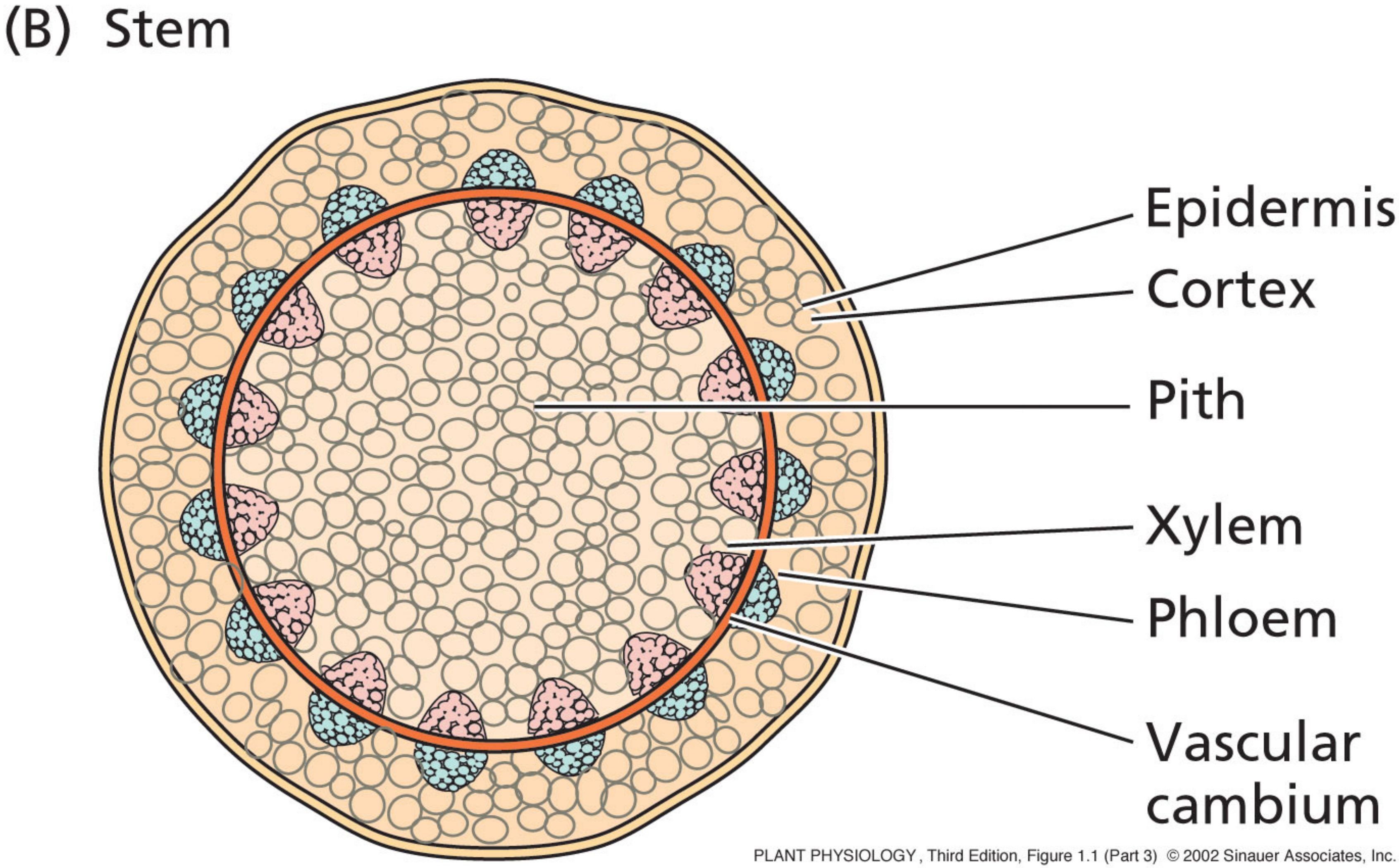
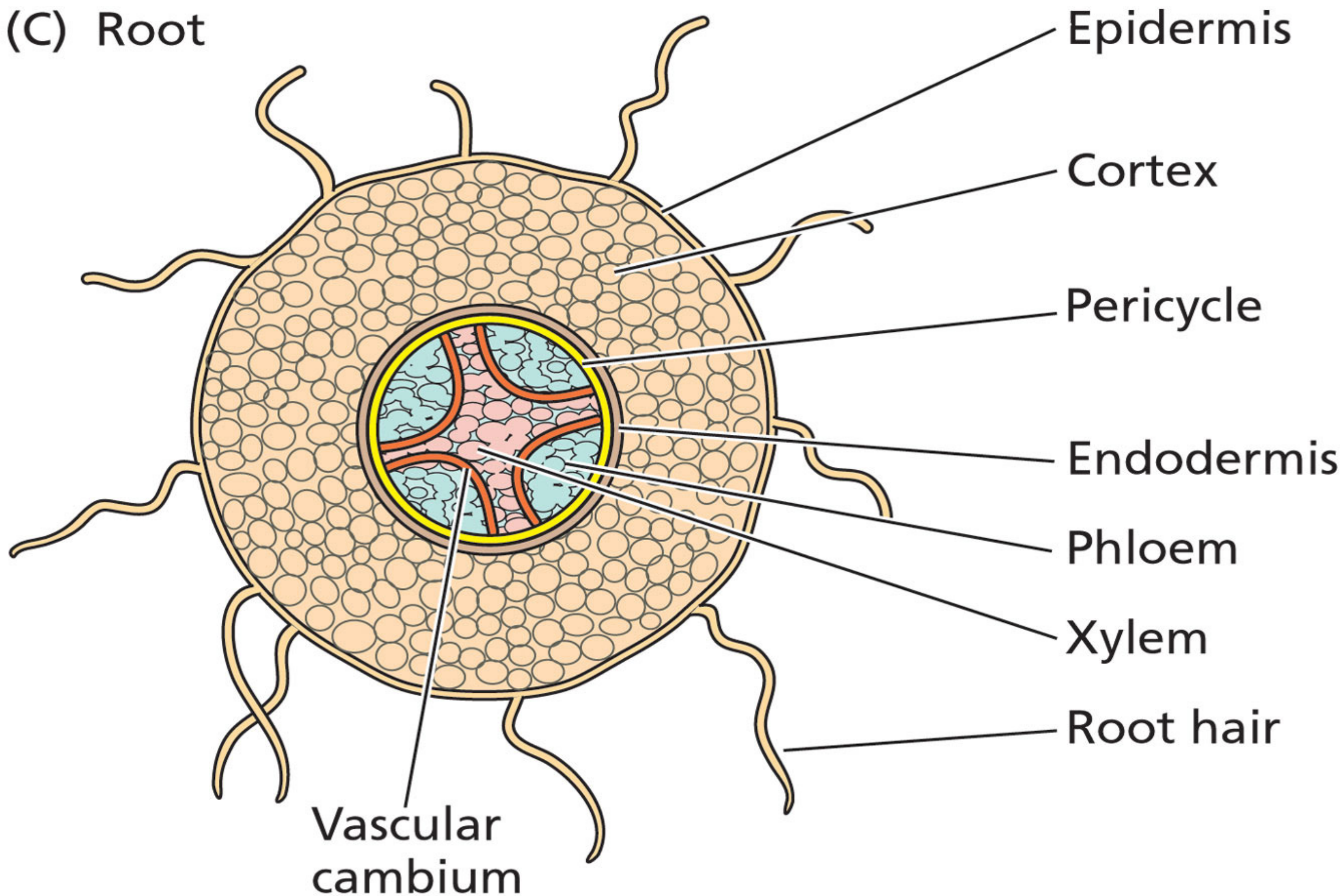
The leaf


(A) Leaf
Cuticle
Upper epidermis
Palisade parenchyma
Bundle sheath parenchyma
Xylem
Phloem
Lower epidermis
Guard cell
Stomata
Spongy mesophyll
Lower epidermis
Cuticle
Mesophyll

The stem


(B) Stem
Epidermis
Cortex
Pith
Xylem
Phloem
Vascular cambium

The Root



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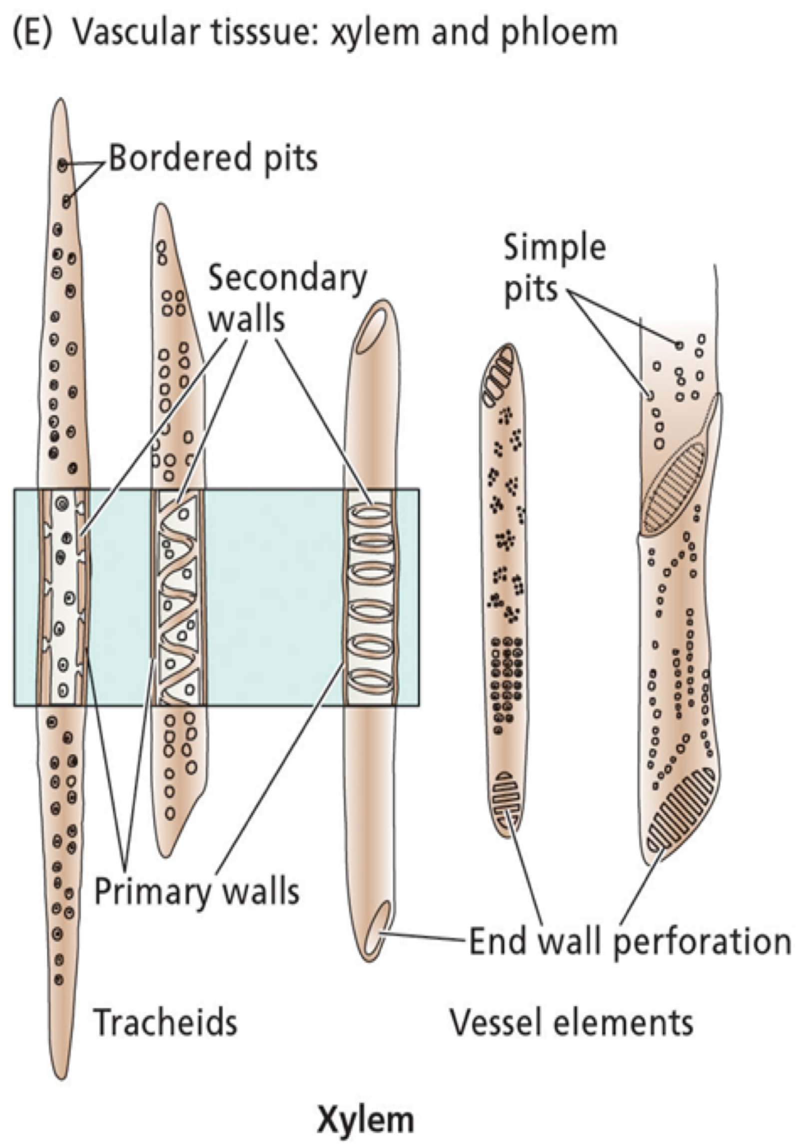
Overview of Plant Structure

- Two general types of plants:
- ***Angiosperms***:
  - More advanced type of plant
    - About 250,000 species known
    - Major innovation is the Flower
      - So these are also known as flowing plants!
- ***Gymnosperms***:
  - Less advanced than angiosperms
    - About 700 species known
    - Largest group is the conifer (cone bearer)
      - ie, pine, fir, spruce, and redwood

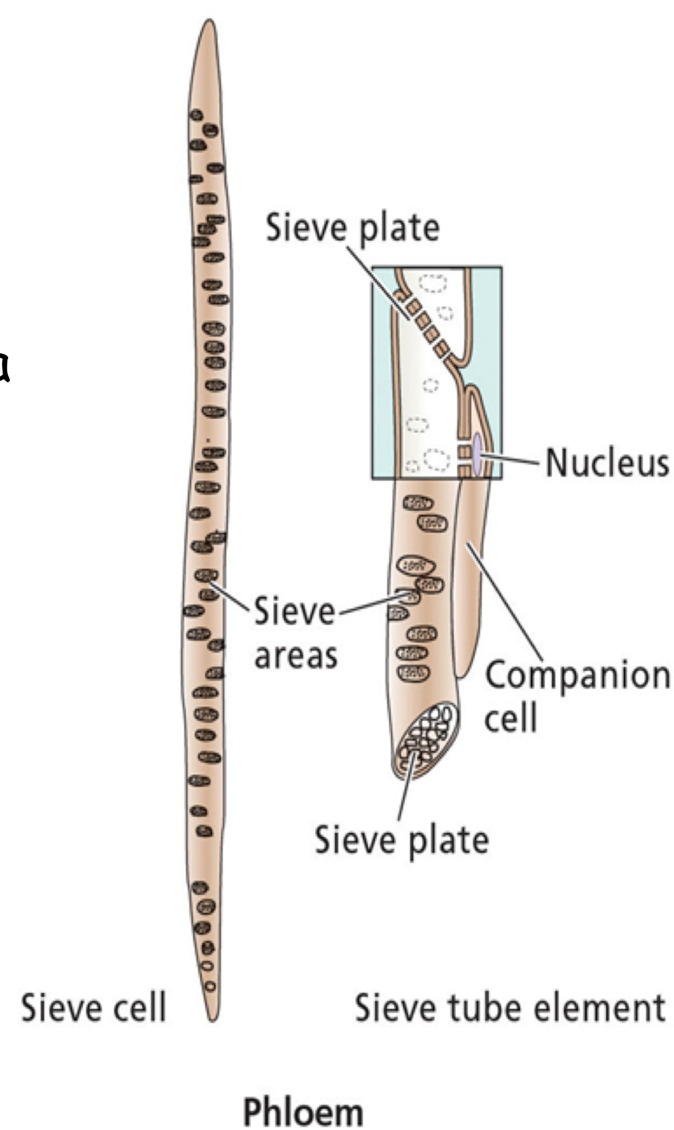
Overview of Plant Structure

- ***Xylem:***
  - Main water-conducting tissue of vascular plants.
  - arise from individual cylindrical cells oriented end to end.
  - At maturity the end walls of these cells dissolve away and the cytoplasmic contents die.
  - ***The result is the xylem vessel, a continuous nonliving duct.***
  - carry water and some dissolved solutes, such as inorganic ions, up the plant

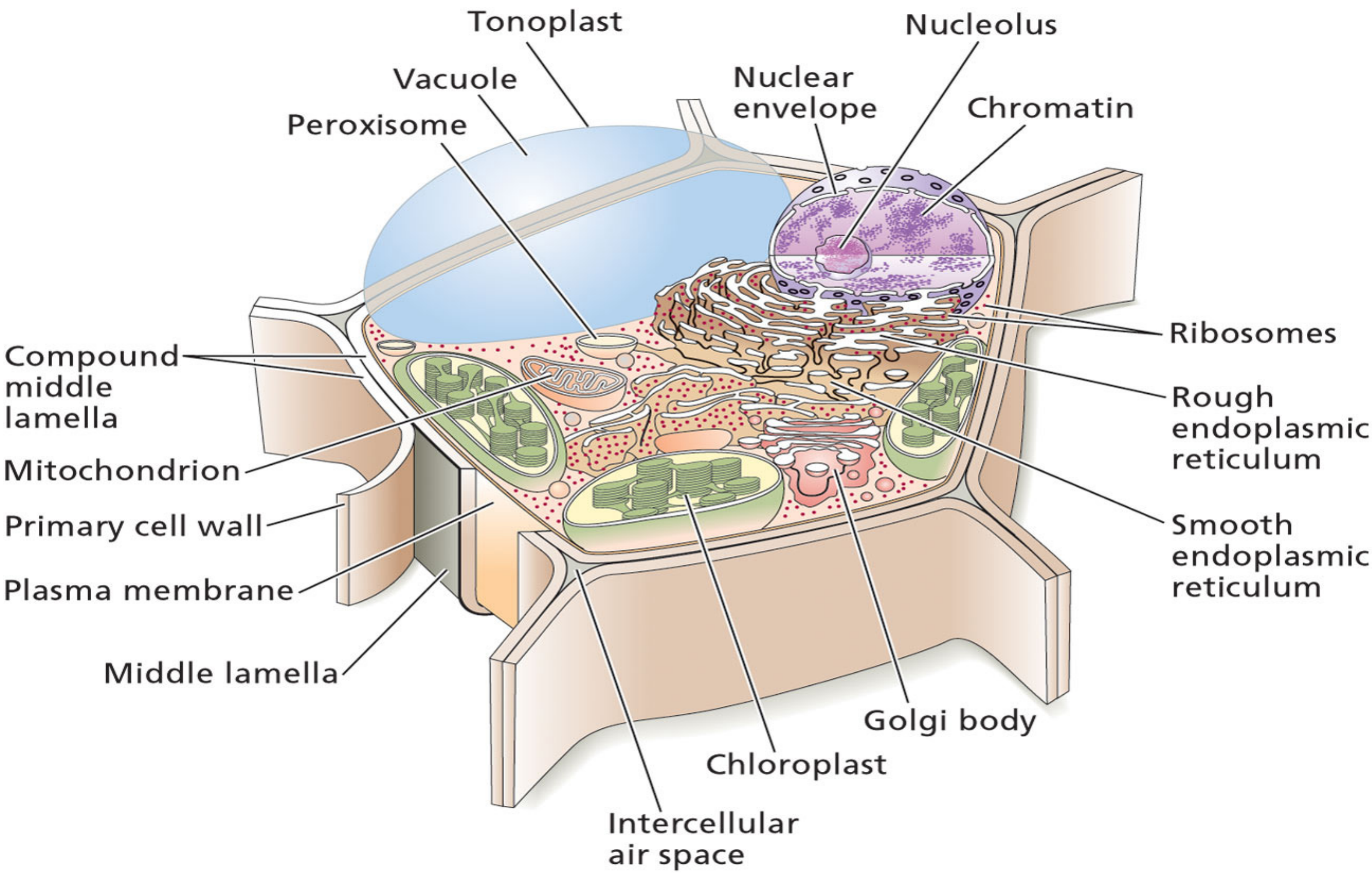


Overview of Plant Structure

- ***Phloem:***
  - The main components of phloem are
    - ***sieve elements***
    - ***companion cells***.
  - Sieve elements have no nucleus and only a sparse collection of other organelles . ***Companion cell provides energy***
  - so-named because end walls are perforated - allows cytoplasmic connections between vertically-stacked cells .
  - conducts sugars and amino acids - from the leaves, to the rest of the plant



The Plant Cell



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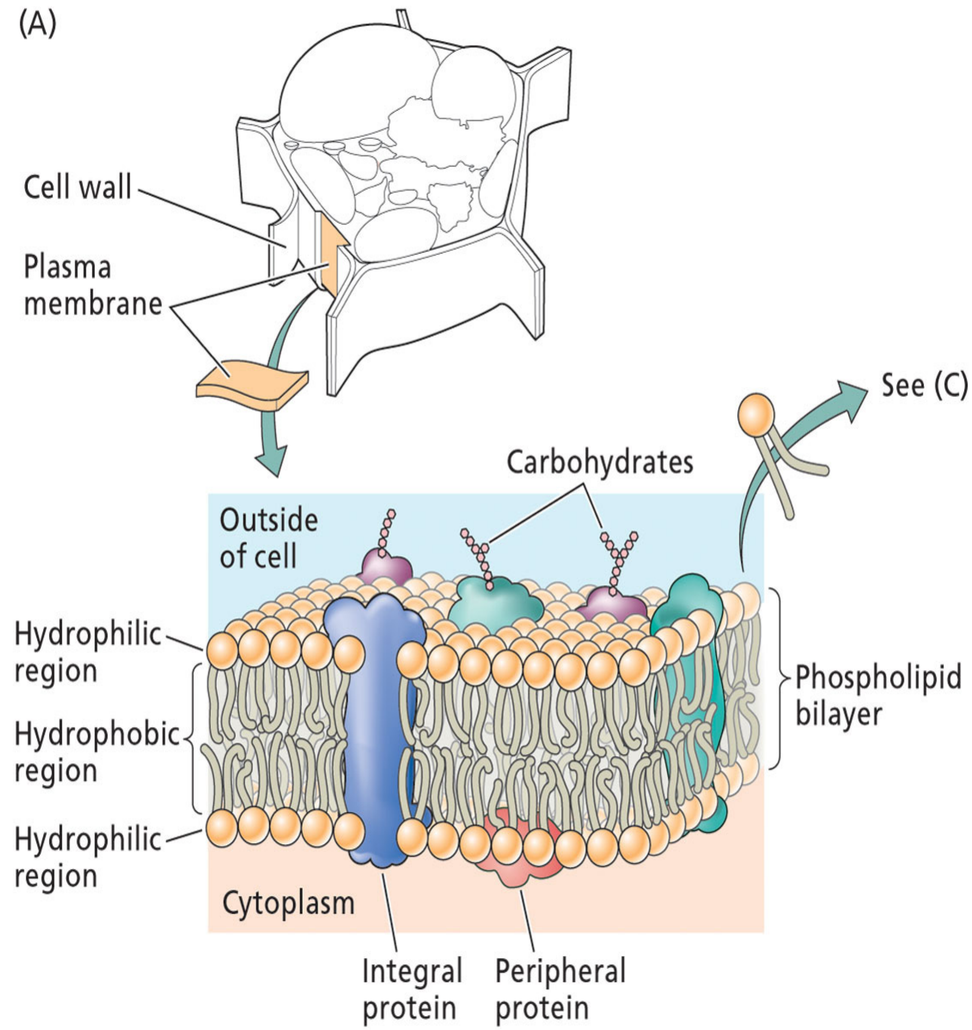
The Plant Cell

- All plant cells have the same basic eukaryotic organization
  - ***However***, at maturity when they become specialized, plant cells may differ greatly from one another in their structures and functions
    - ***Even those physically next to each other.***
    - ***Even the nucleus can be lost in some plant cells***
- Contains many organelles with specific functions
- Enclosed by a membrane which defines their boundaries
- ***Don't Forget the Cell Wall!!!!!!!!!!***

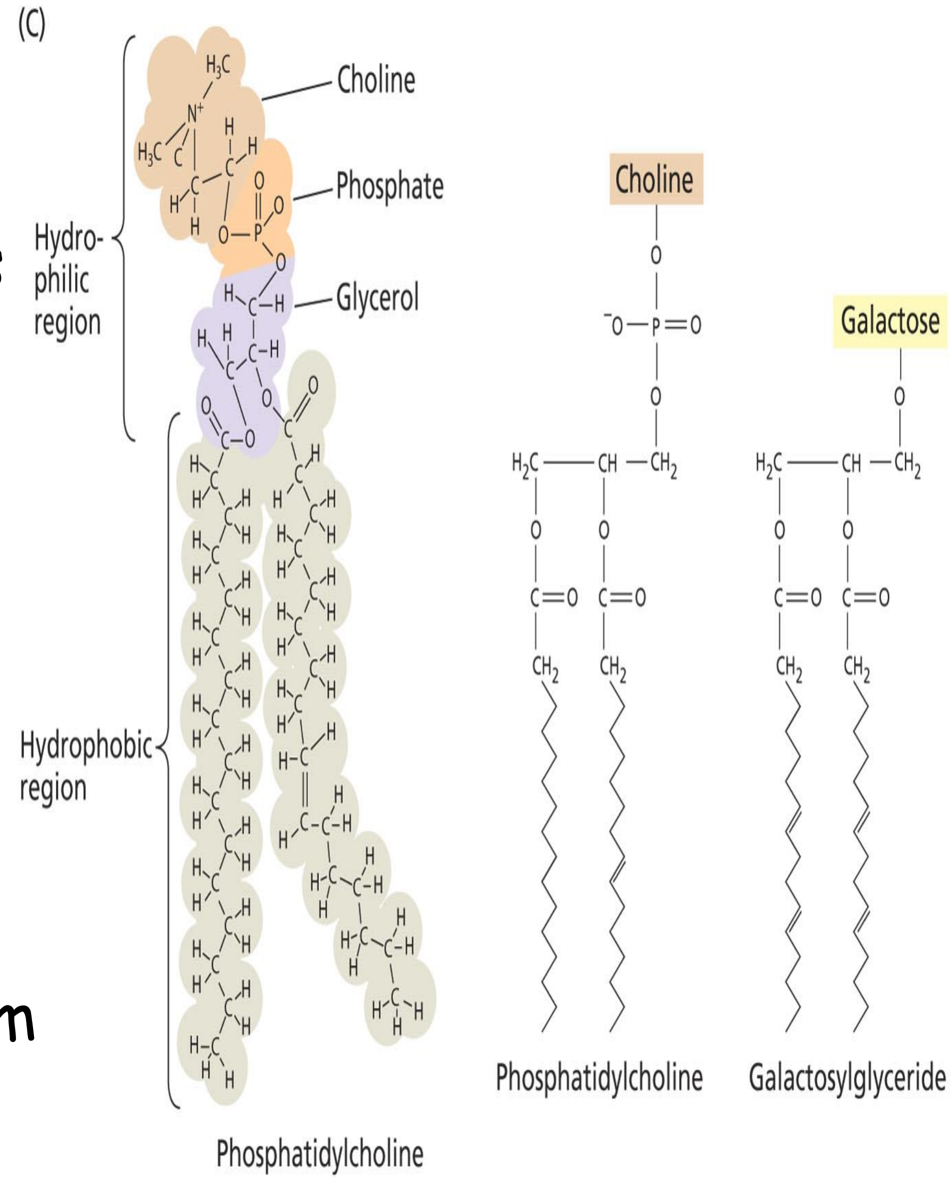
The Plasma Membrane

- Composed of a phospholipid bilayer and proteins.
- The phospholipid sets up the bilayer structure
- Phospholipids have hydrophilic heads and fatty acid tails.
- The plasma membrane is fluid--that is proteins move in a fluid lipid background



The Plasma Membrane

- ***Phospholipids*:**
- Two fatty acids covalently linked to a ***glycerol***, which is linked to a ***phosphate***.
- All attached to a "head group", such as ***choline***, an amino acid.
- Head group POLAR – so ***hydrophilic*** (loves water)
- Tail is non-polar - ***hydrophobic***
- The tail varies in length from 14 to 28 carbons.



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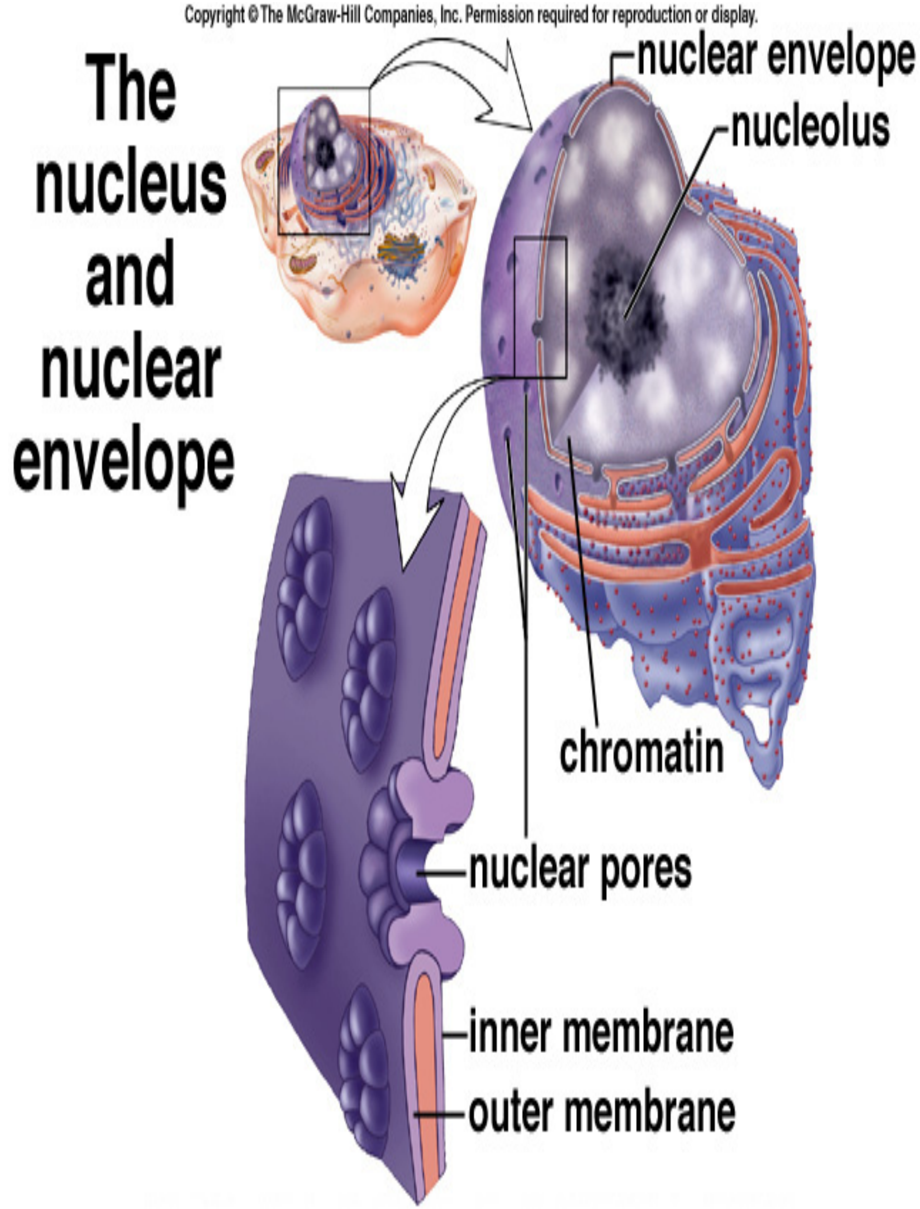
The Plasma Membrane

- ***Proteins***:
- ***Integral proteins***:
  - Embedded in lipid bylayer – serve as "ion pumps"
  - They pump ions across the membrane against their concentration gradient
- ***Peripheral proteins***:
  - Bound to membrane surface by ionic bonds.
  - Interact with components of the cytoskeleton
- ***Anchored proteins***:
  - Bound to surface via lipid molecules

The nucleus

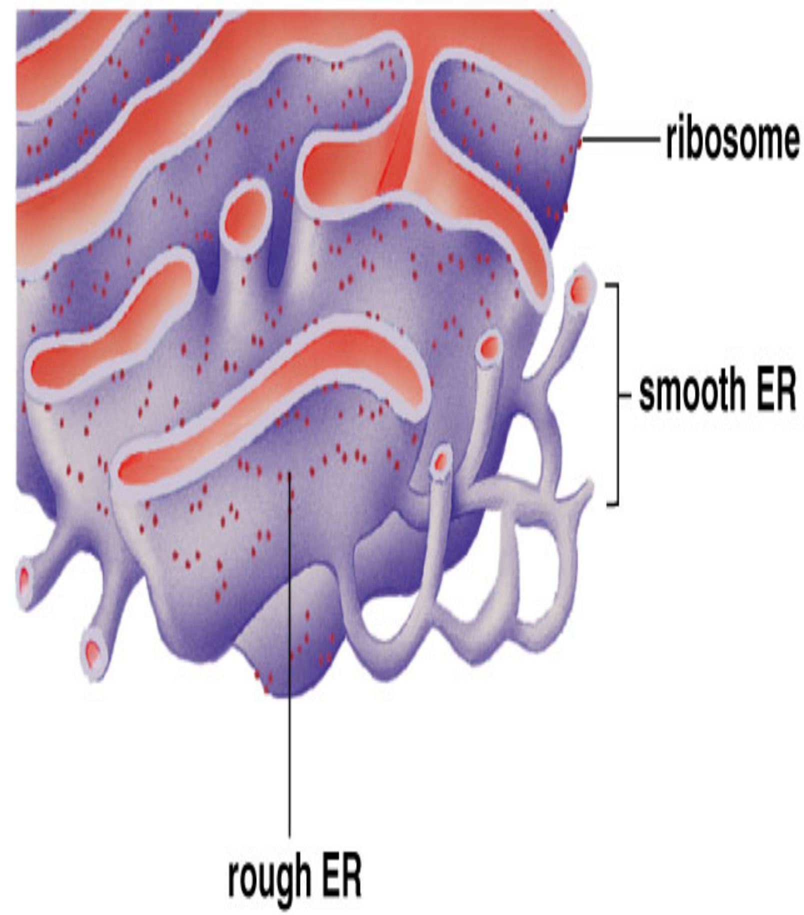
- Contains ***almost all*** of the genetic material
- What it contains is called the ***nuclear genome*** – this varies greatly between plant species.
- Surrounded by ***nuclear envelope***- double membrane - ***same as the plasma membrane***.
- The ***nuclear pores*** allow for the passage of macromolecules and ribosomal subunits in and out of the nucleus.



The Endoplasmic reticulum

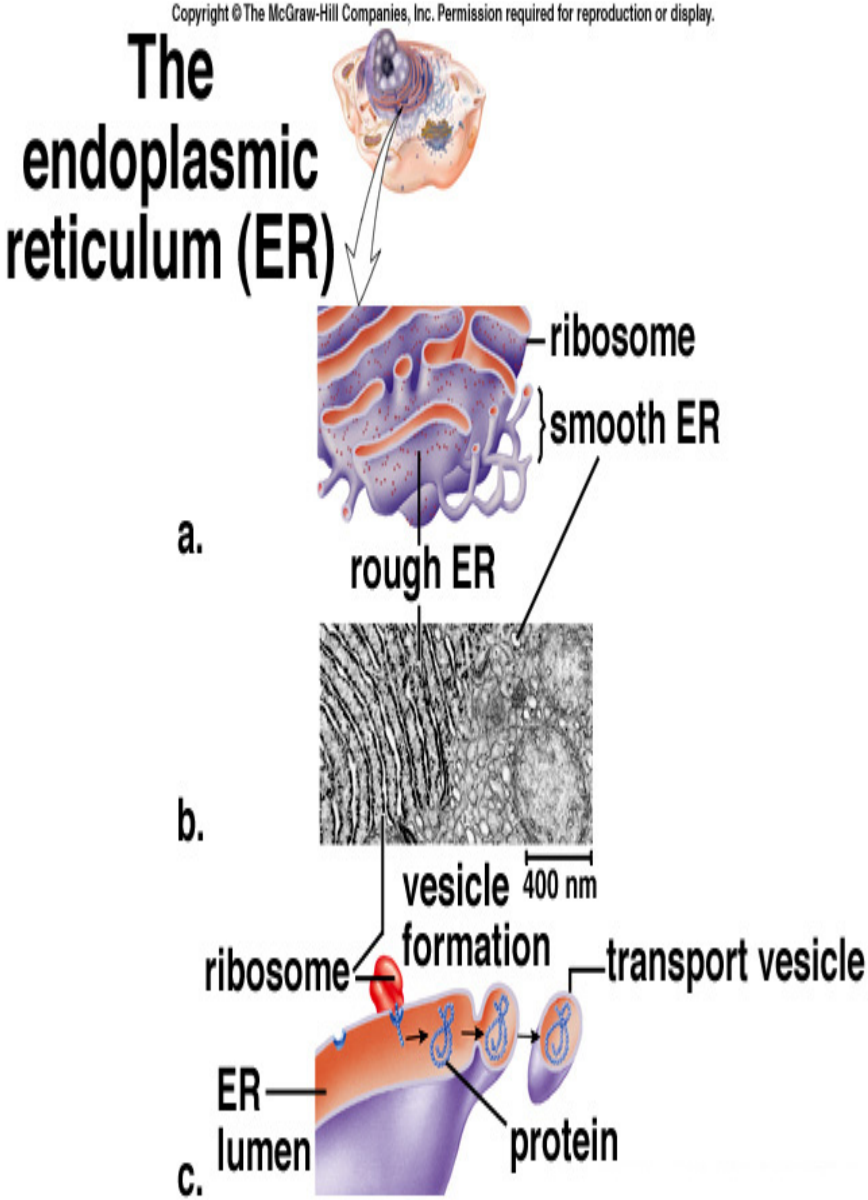
- Connected to the nuclear envelope
- 3D-network of continuous tubules that course through the cytoplasm.

- ***Rough ER***: Synthesize, process, and sort proteins targeted to membranes, vacuoles, or the secretory pathway.
- ***Smooth ER:*** Synthesize lipids and oils.
- Also:
  - Acts as an anchor points for actin filaments
  - Controls cytosolic concentrations of calcium ions



The Endoplasmic reticulum

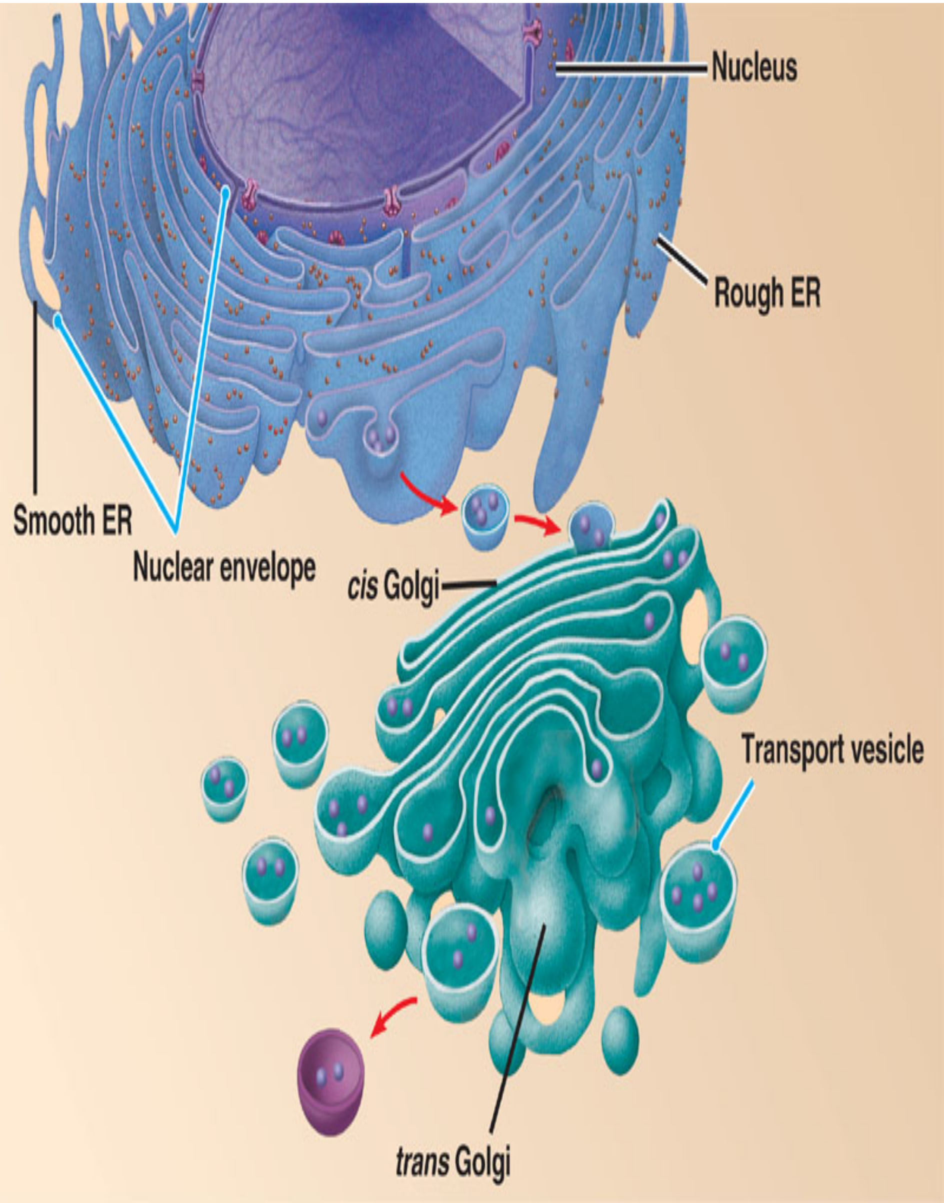
- Proteins are made in the Rough ER lumen by an attached ribosome.
- Protein detaches from the ribosome
- The ER folds in on itself to form a ***transport vesicle***
- This transport vesicle "buds off" and moves to the cytoplasm
- Either:
  - Fuses with plasma membrane
  - Fuses with ***Golgi Apparatus***



The Golgi Network

- Proteins or lipids made in the ER contained in transport vesicles fuse with the Golgi.

- The Golgi modifies proteins and lipids from the ER, sorts them and packages them into ***transport vesicles***.
- This transport vesicle "buds off" and moves to the cytoplasm.
- Fuse with plasma membrane.
-



The Golgi Network

Site of synthesis for:

Cellulose
Callose

Site of synthesis for:

Pectins
- HGA
- RG I
- RG II

Cross-linking glycans
- Xyloglucan
- Glucuronoarabinoxylan
- β-Glucan
- Galactomannan

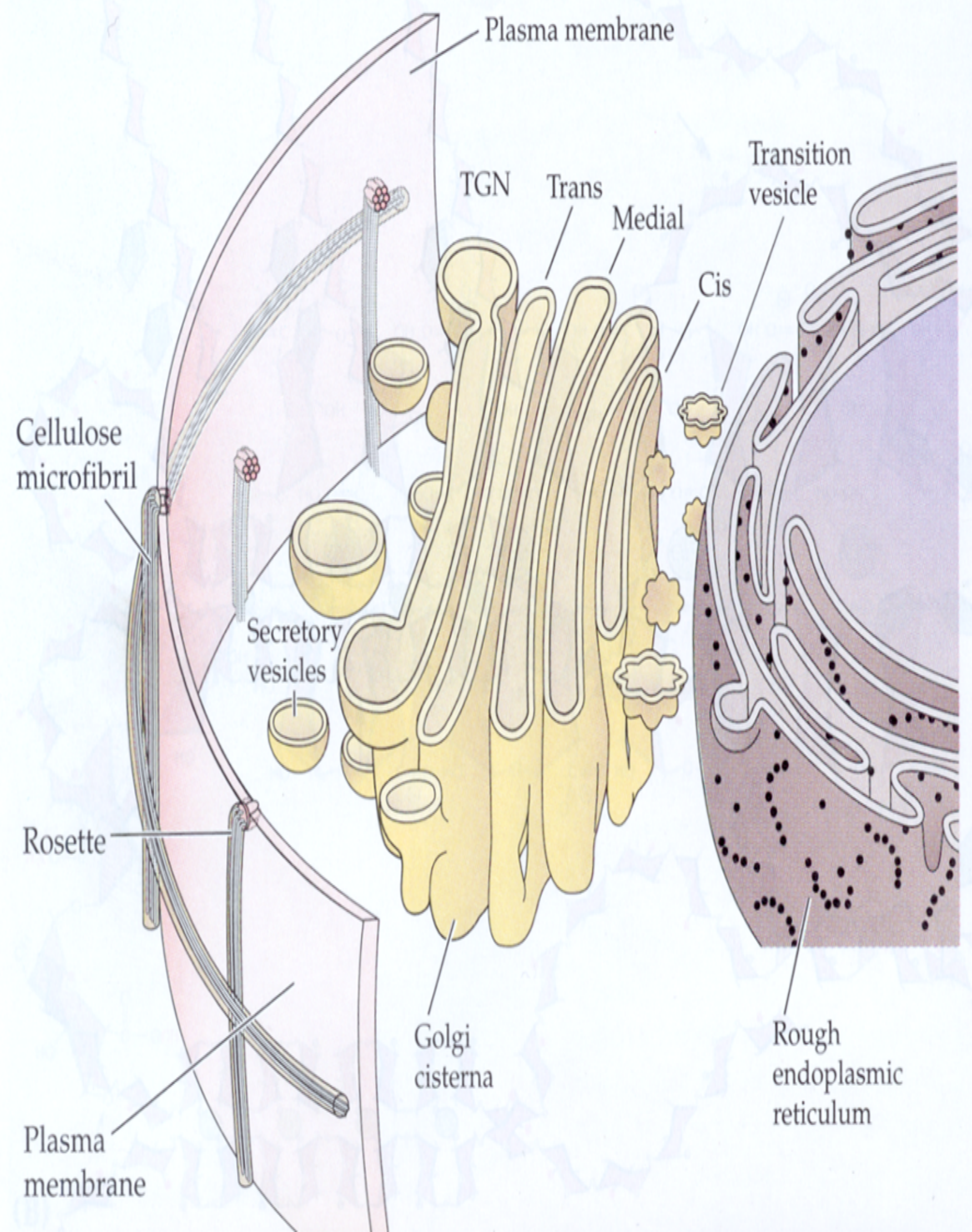
Site of glycosylation of:

HRGPs
AGPs
Modified glycoproteins

Site of synthesis for:

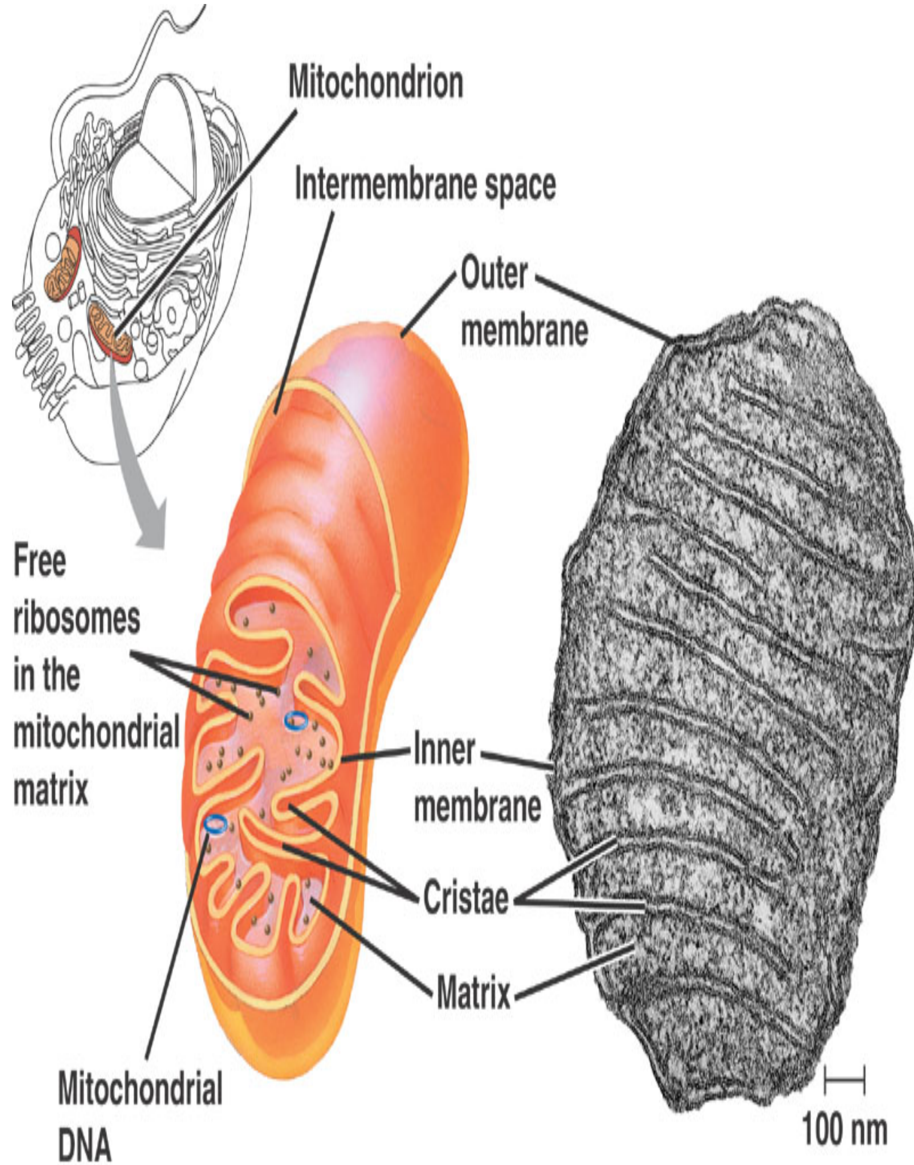
Cell wall proteins
- HRGPs
- PRPs
- GRPs
- AGPs

Enzymes
- Hydrolases
- Esterases
- Peroxidases
- Polysaccharide synthase



The Mitochondria

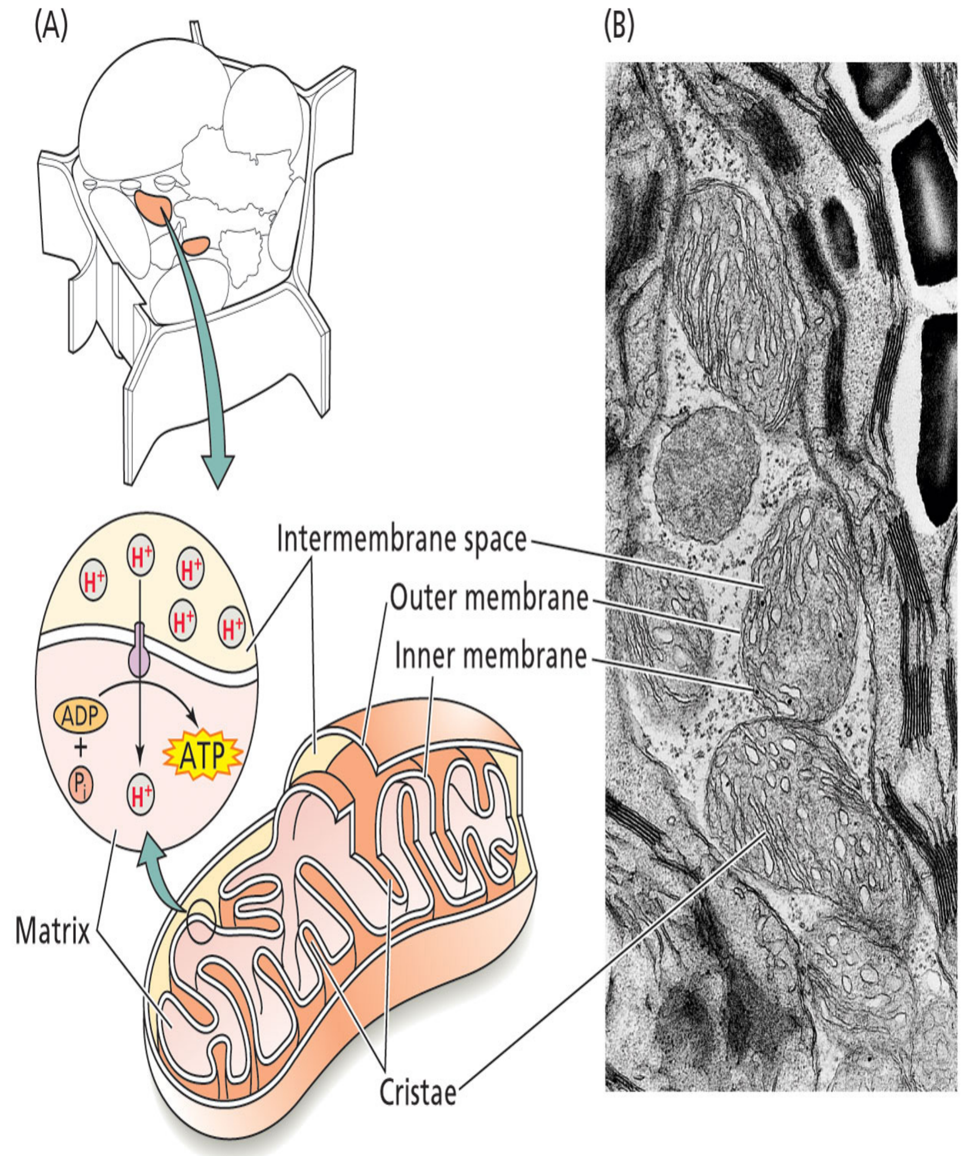
- Contain their own DNA and protein-synthesizing machinery
  - Ribosomes, transfer RNAs, nucleotides.
  - Thought to have evolved from ***endosymbiotic bacteria***.
  - Divide by fusion
  - The DNA is in the form of circular chromosomes, like bacteria
  - DNA replication is independent from DNA replication in the nucleus



The Mitochondria

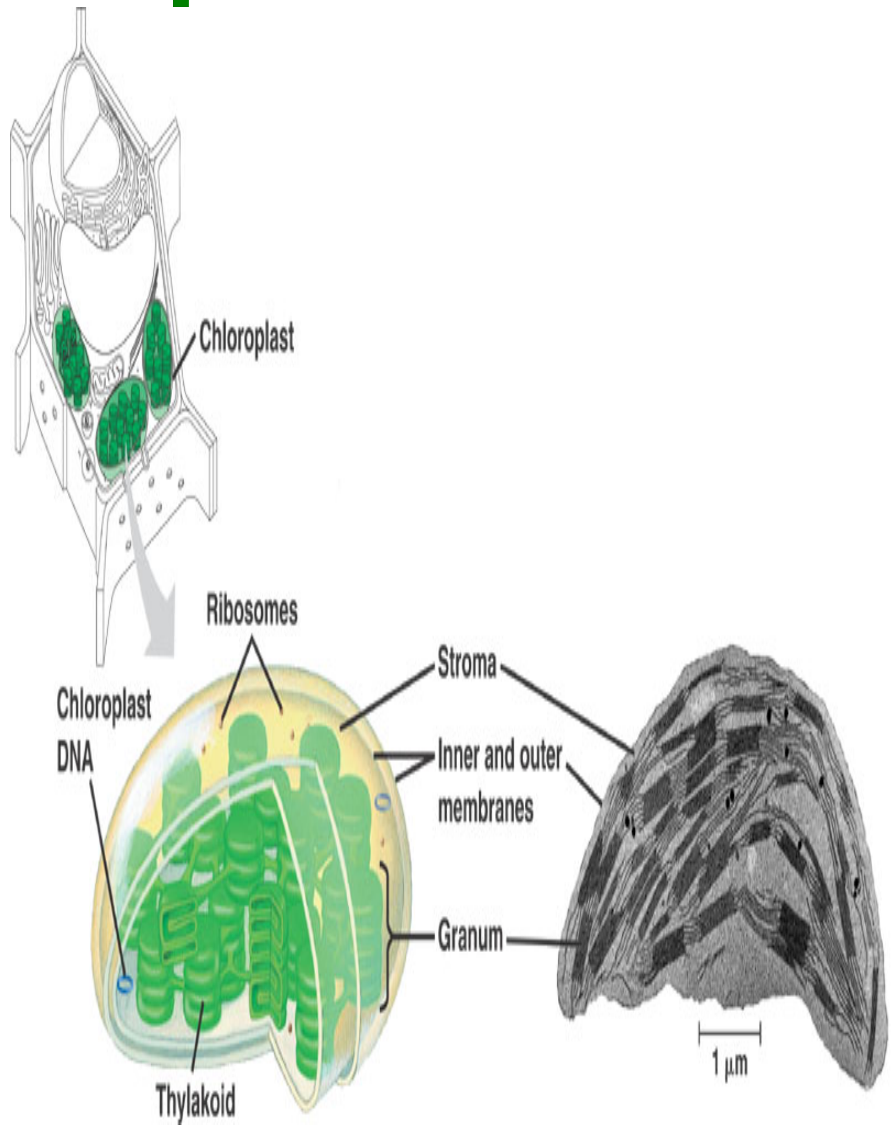
Site of Cellular Respiration

- This process requires oxygen.
- Composed of three stages:
  - *Glycolysis*--glucose splitting, occurs in the cell. Glucose is converted to Pyruvate.
  - *Krebs cycle*--Electrons are removed--carriers are charged and CO2 is produced. This occurs in the mitochondrion.
  - *Electron transport*--electrons are transferred to oxygen. This produces H2O and ATP. Occurs in the mito.



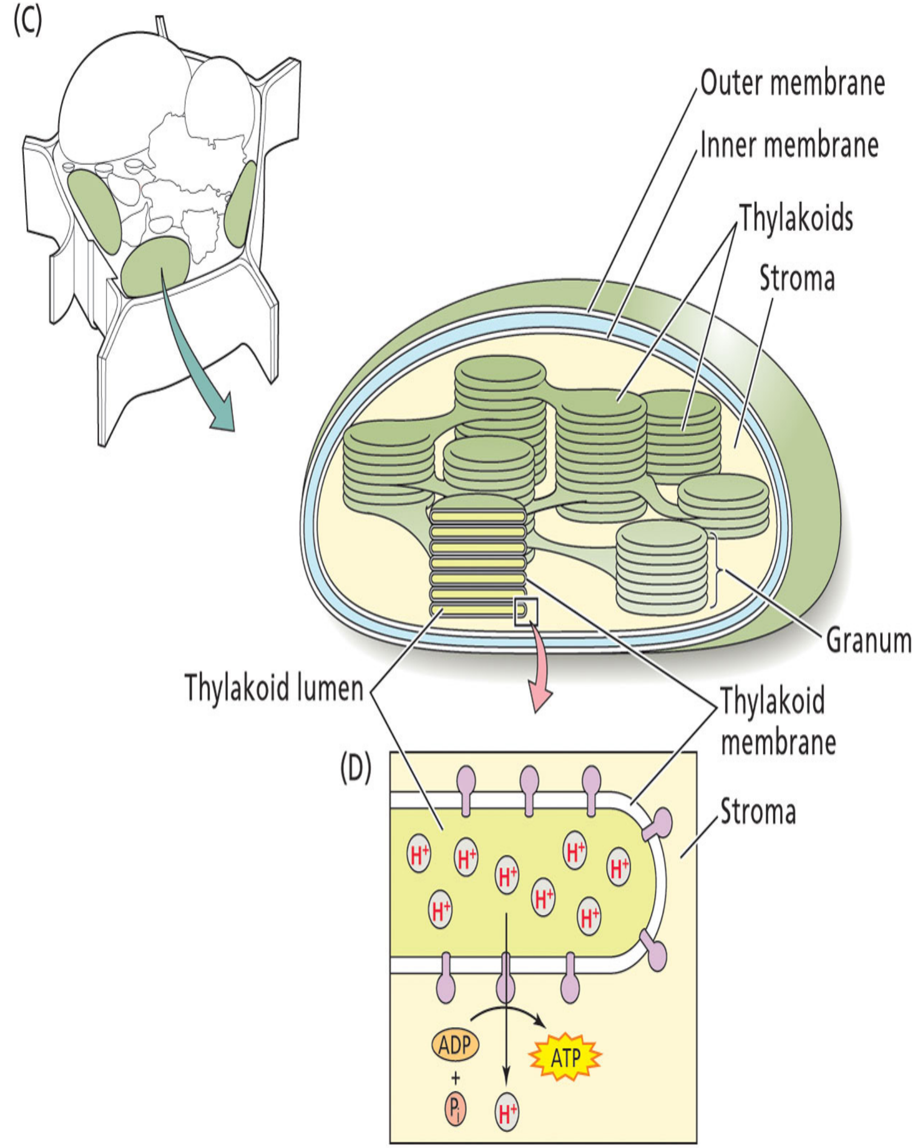
The Chloroplast

- Contain their own DNA and protein-synthesizing machinery
  - Ribosomes, transfer RNAs, nucleotides.
  - Thought to have evolved from ***endosymbiotic bacteria***.
  - Divide by fusion
  - The DNA is in the form of circular chromosomes, like bacteria
  - DNA replication is independent from DNA replication in the nucleus



The Chloroplast

- Membranes contain chlophyll and it's associated proteins
  - *Site of photosynthesis*
- Have inner & outer membranes
- 3rd membrane system
  - *Thylakoids*
- Stack of Thylakoids = *Granum*
- Surrounded by *Stroma*
  - Works like mitochondria
- During photosynthesis, ATP from stroma provide the energy for the production of sugar molecules

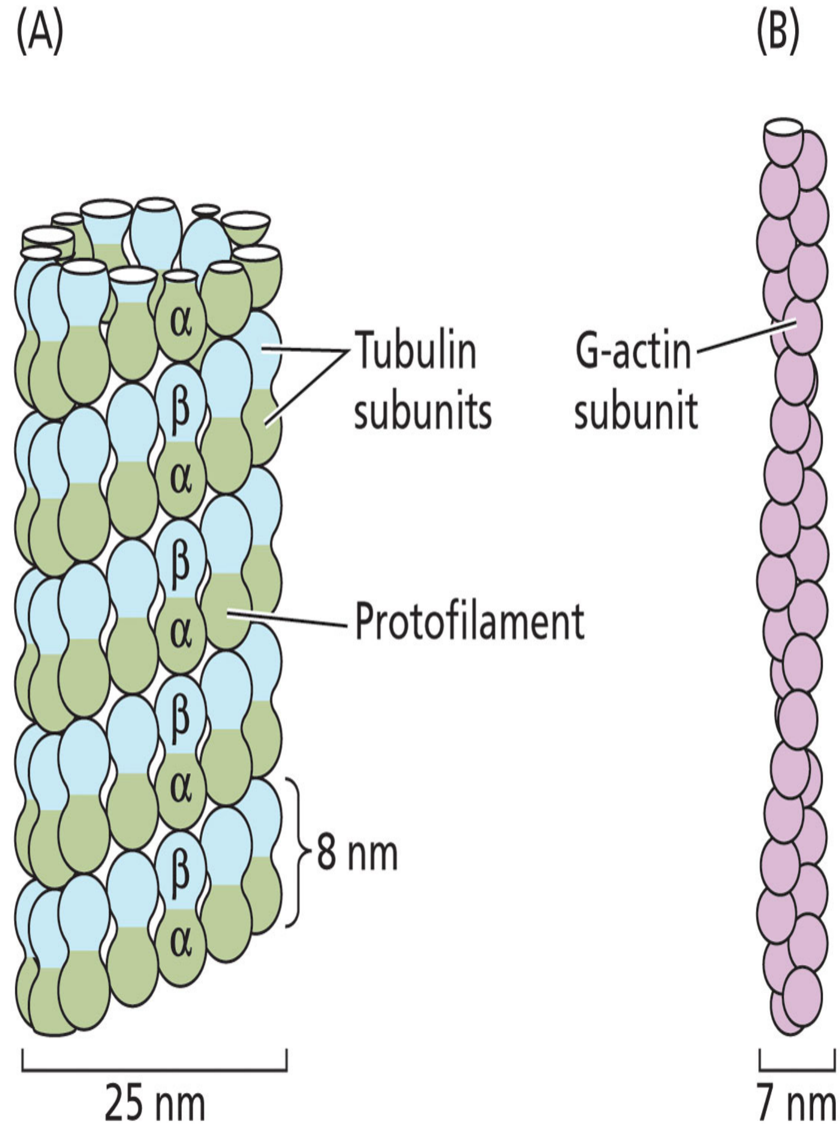


The Vacuole

- Can be 80 – 90% of the plant cell
- Contained within a vacuolar membrane (***Tonoplast***)
- Contains:
  - Water, inorganic ions, organic acids, sugars, enzymes, and secondary metabolites.
- Required for plant cell enlargement
- The turgor pressure generated by vacuoles provides the structural rigidity needed to keep herbaceous plants upright.

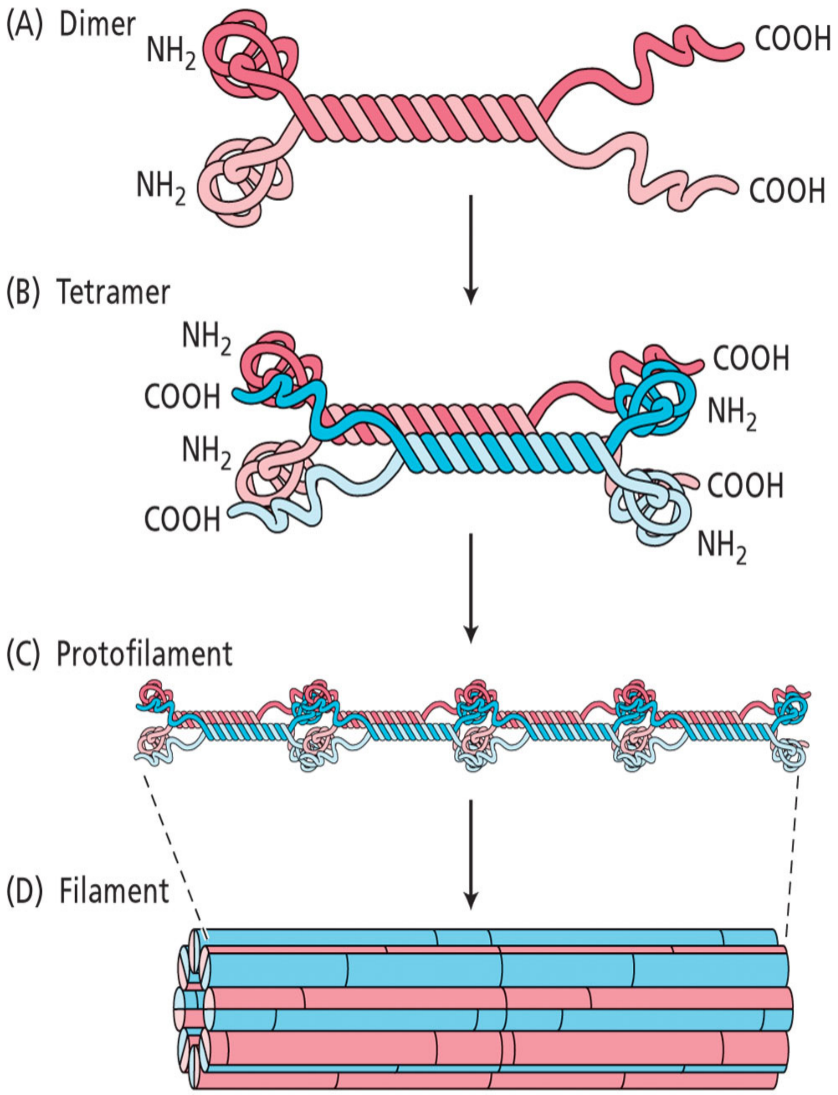
The cytoskeleton

- ***Three main components:***
- ***Microtubules***: are α and β proteins that create scaffolding in a cell. MTs are formed from the protein tubulin. ***13 rows of tubulin =1 microtubule***
- ***Microfilaments***: solid (7 nm) made from ***G-actin*** protein. Consists of 2 chains of actin subunits that intertwine in a helical fashion



The cytoskeleton

- ***Intermediate filaments***: a diverse group of helically wound linear proteins.
- Dimers line up parallel to each other
- These form anti-parallel Tetramers
- These join together to form a filament



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The cytoskeleton

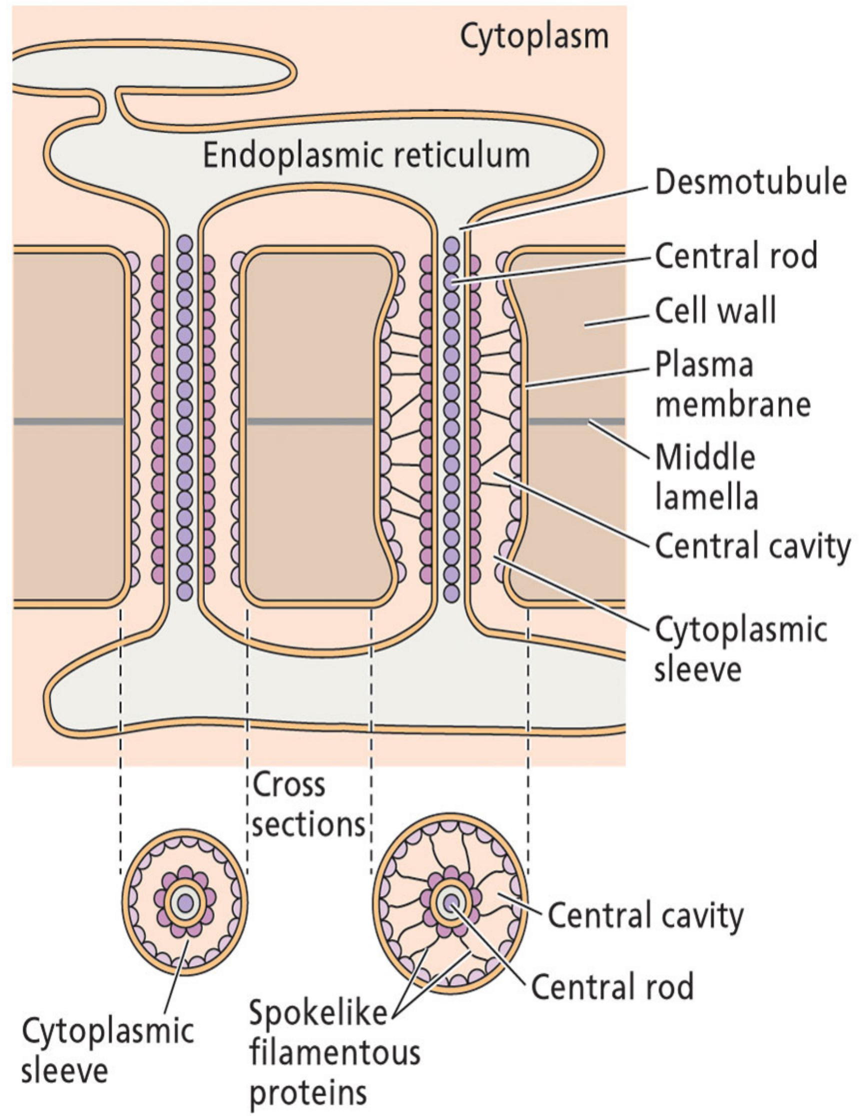
- All these elements can assemble and disassemble

- Involved in plant cell division
  - During mitosis
    - ***Process of division that produces two daughter cells with identical chromosomal content of parent cell***

Plamodesmarta

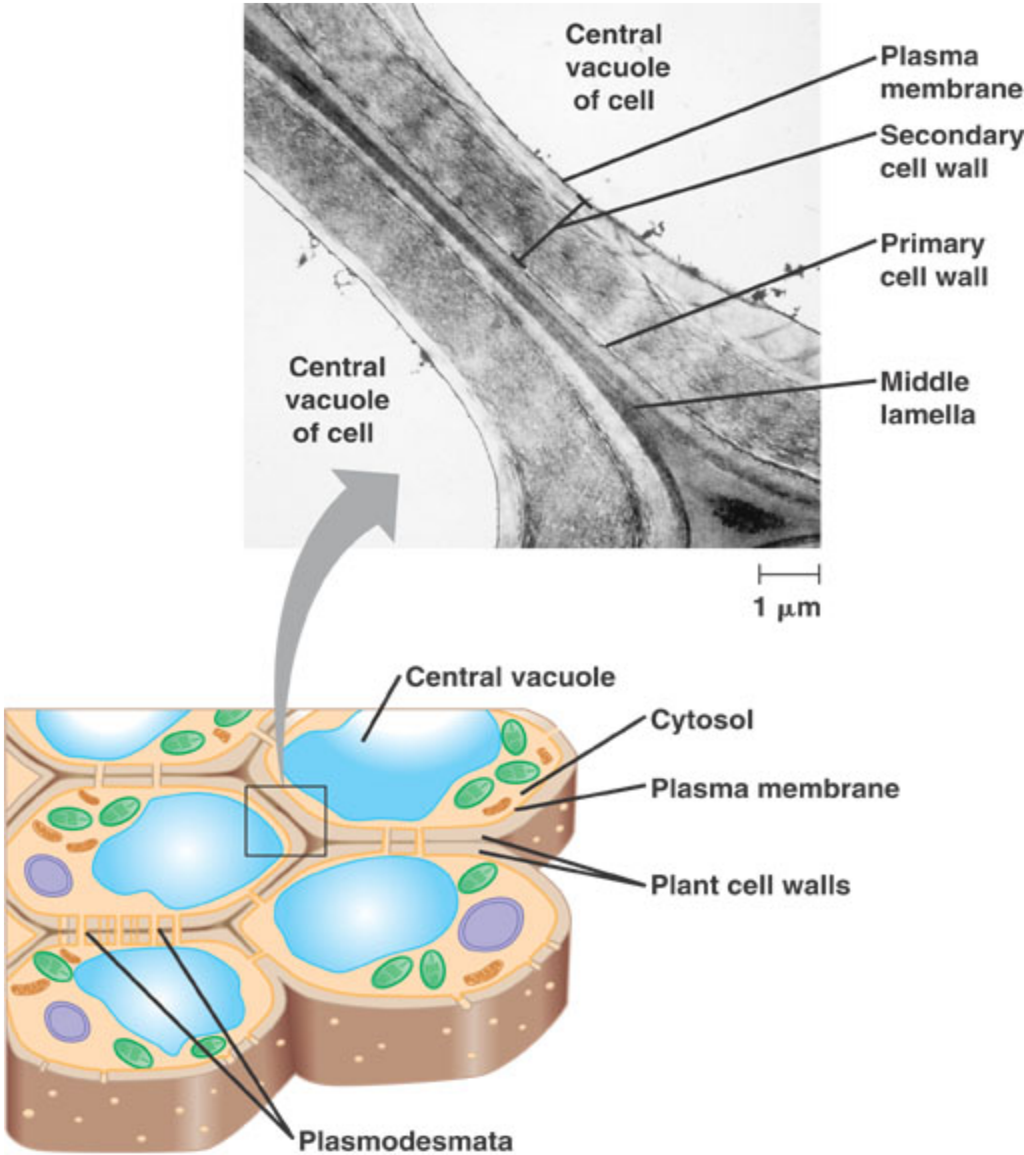
- Each contains a tube called a ***Desmotubule***, which is part of the ER.
- This is what connects adjacent cell and allow chemical communication and transport of material throughout the whole plant.

- The restriction acts to control the size of the molecules which pass through.



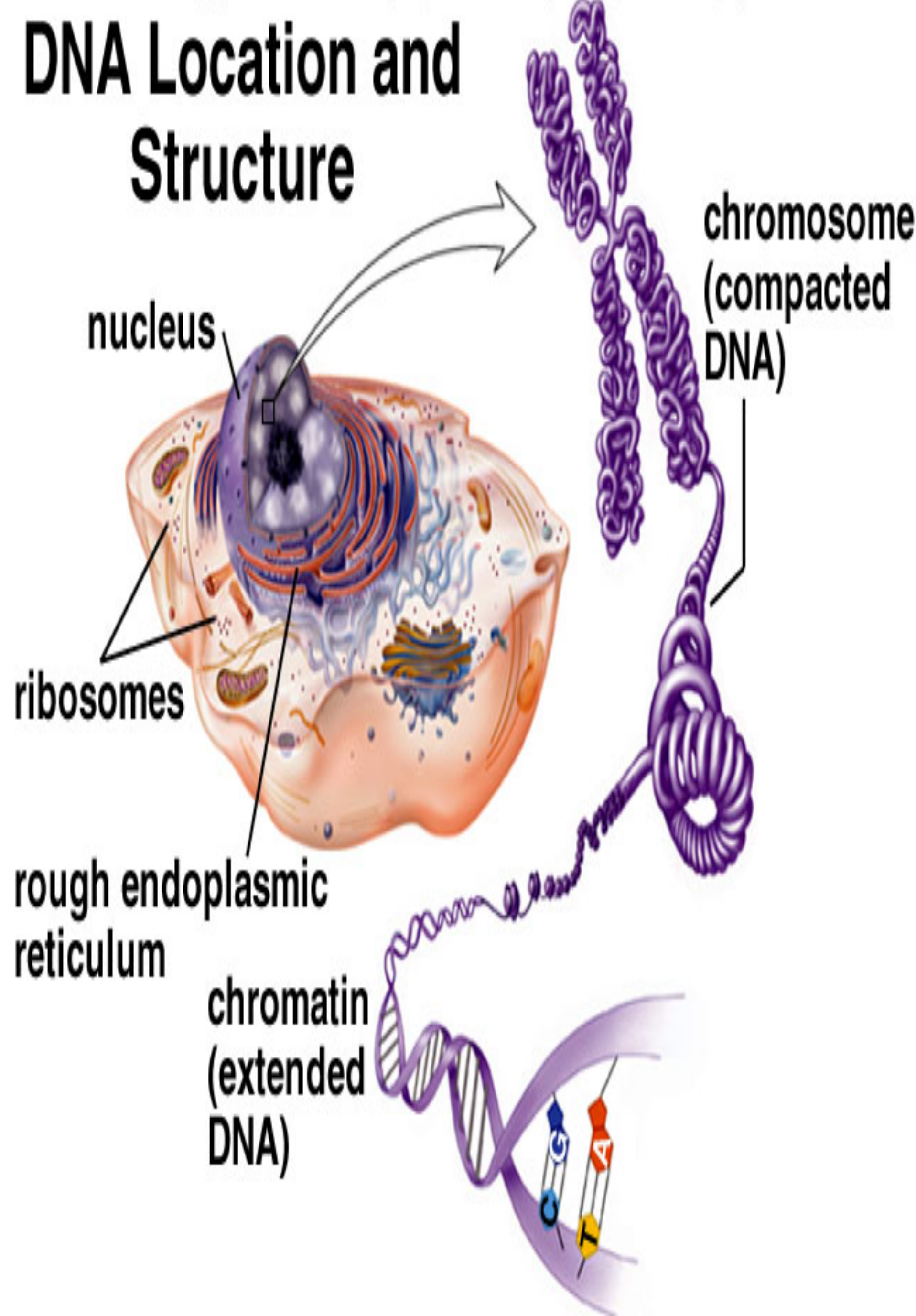
The Plant Cell wall

- Cell walls are held together by the ***middle Lamella***.
- Made up of:
- Cellulose
- Xyloglucan
- Pectin
- Proteins
- Ca ions
- Lignin
- other ions
- Water



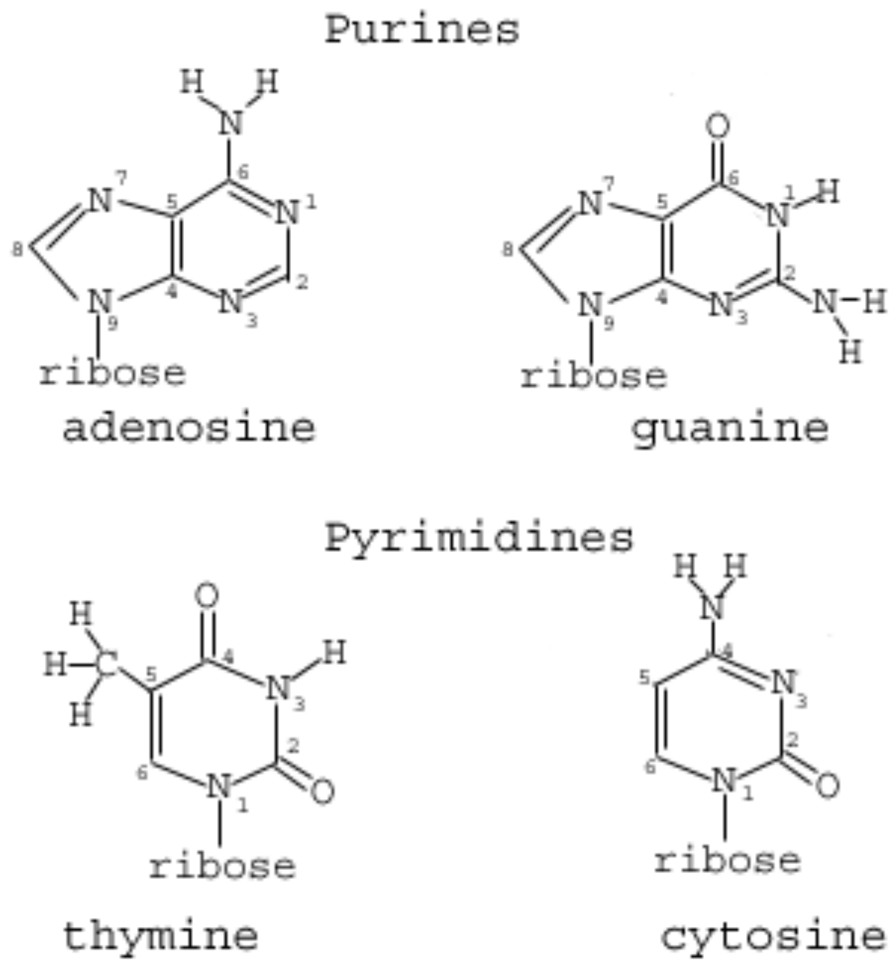
Replication of DNA

- Composed of 4 nucleotide bases, 5 carbon sugar and phosphate.
- Base pair = rungs of a ladder.
- Edges = sugar-phosphate backbone.
- Double Helix
- Anti-Parallel



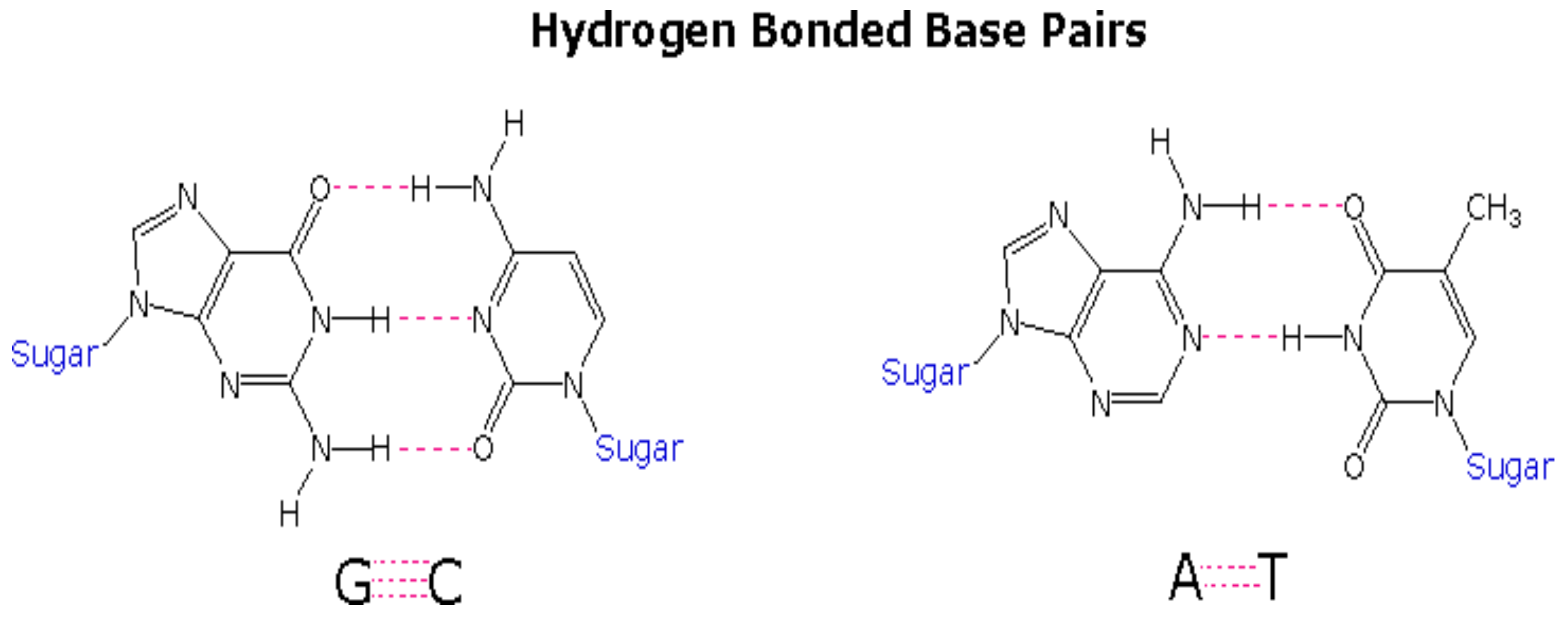
The bases

- Chargaff's Rules
- A=T
- G=C
- led to suggestion of a double helix structure for DNA



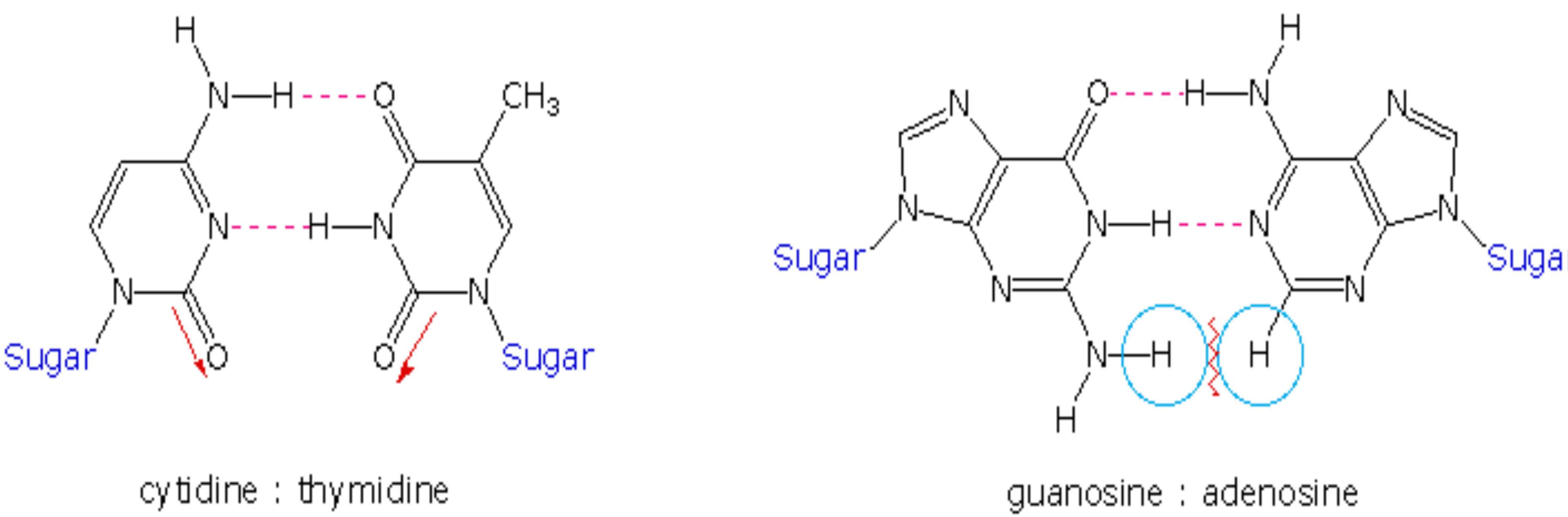
The Bases

- **Adenine** (A) always base pairs with **thymine** (T)
- **Guanine** (G) always base pairs with **Cytosine** (C)



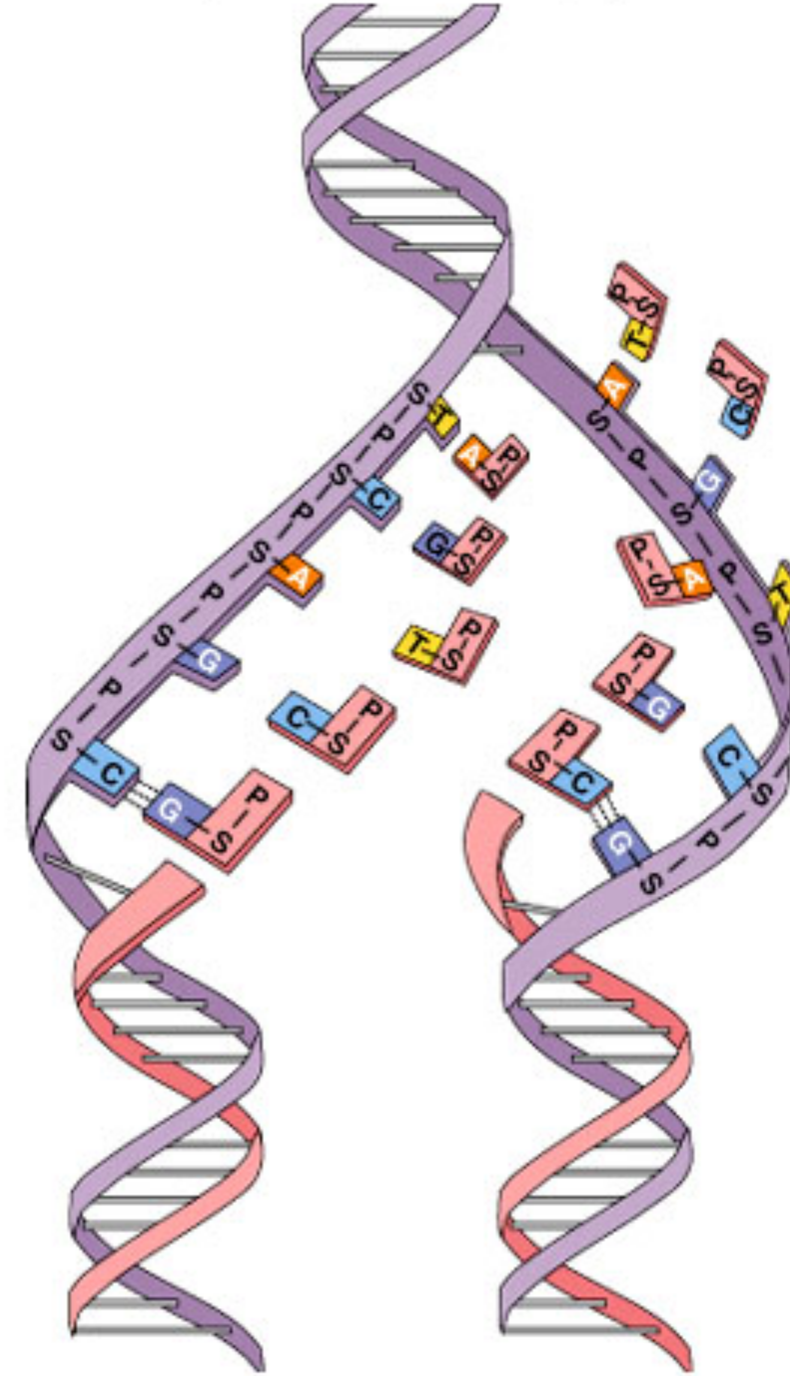
The Bases

- The C#T pairing on the left suffers from ***carbonyl dipole repulsion***, as well as ***steric crowding of the oxygens***. The G#A pairing on the right is also destabilized ***by steric crowding*** (circled hydrogens).



Unfavorable Interactions

DNA Replication



DNA Replication

- Adenine (A) always base pairs with thymine (T)
- Guanine (G) always base pairs with Cytosine (C)
- ALL Down to *HYDROGEN* Bonding
- Requires steps:
  - H bonds break as enzymes unwind molecule
  - New nucleotides (always in nucleus) fit into place beside old strand in a process called Complementary Base Pairing.
  - New nucleotides joined together by enzyme called *DNA Polymerase*

DNA Replication

- Each new double helix is composed of an old (parental) strand and a new (daughter) strand.

- As each strand acts as a template, process is called ***Semi-conservative Replication***.

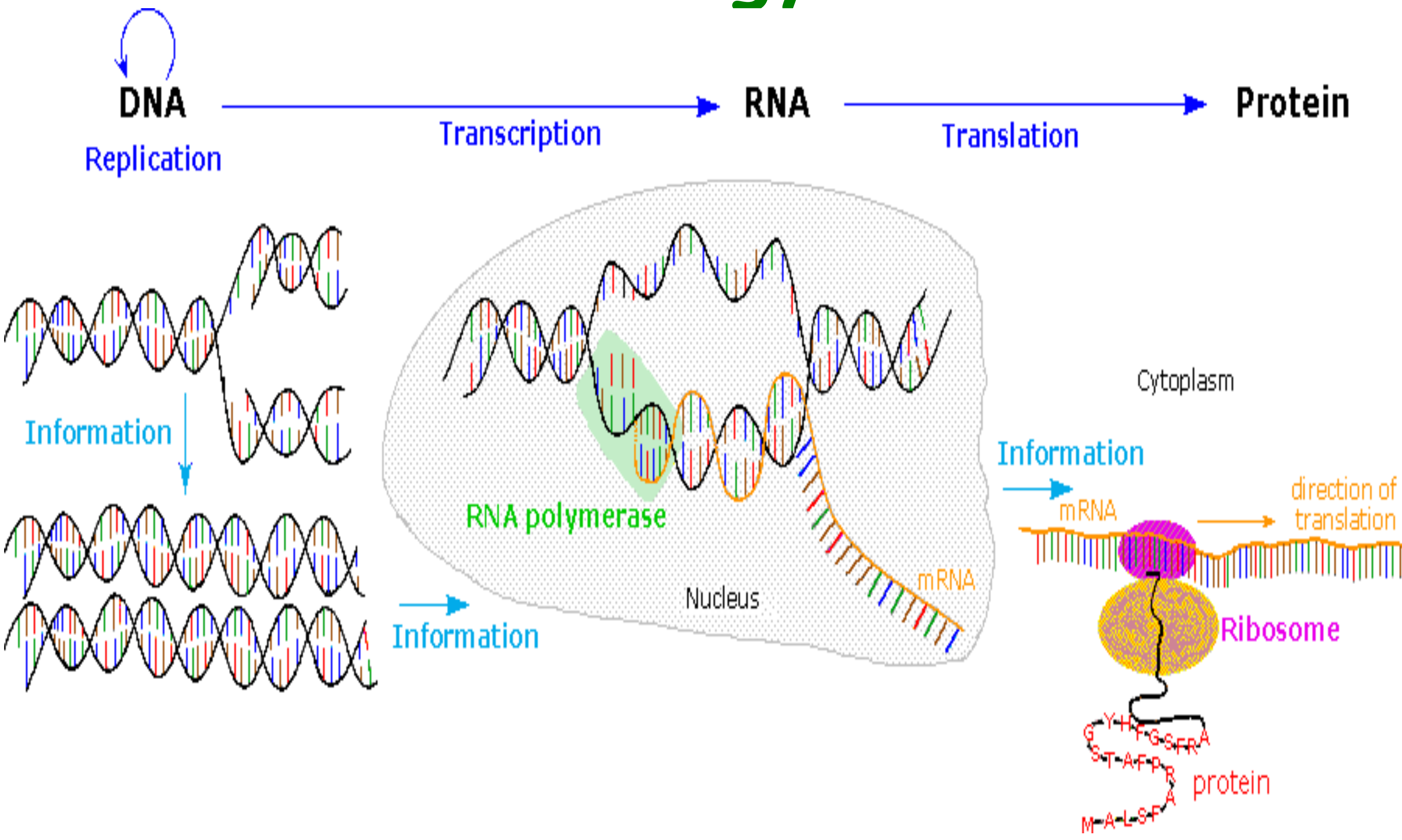
- Replication errors can occur. Cell has repair enzymes that usually fix problem. An error that persists is a **mutation**.
- **This is permanent, and alters the phenotype.**

Protein synthesis in Plants

Central Dogma of Molecular Biology

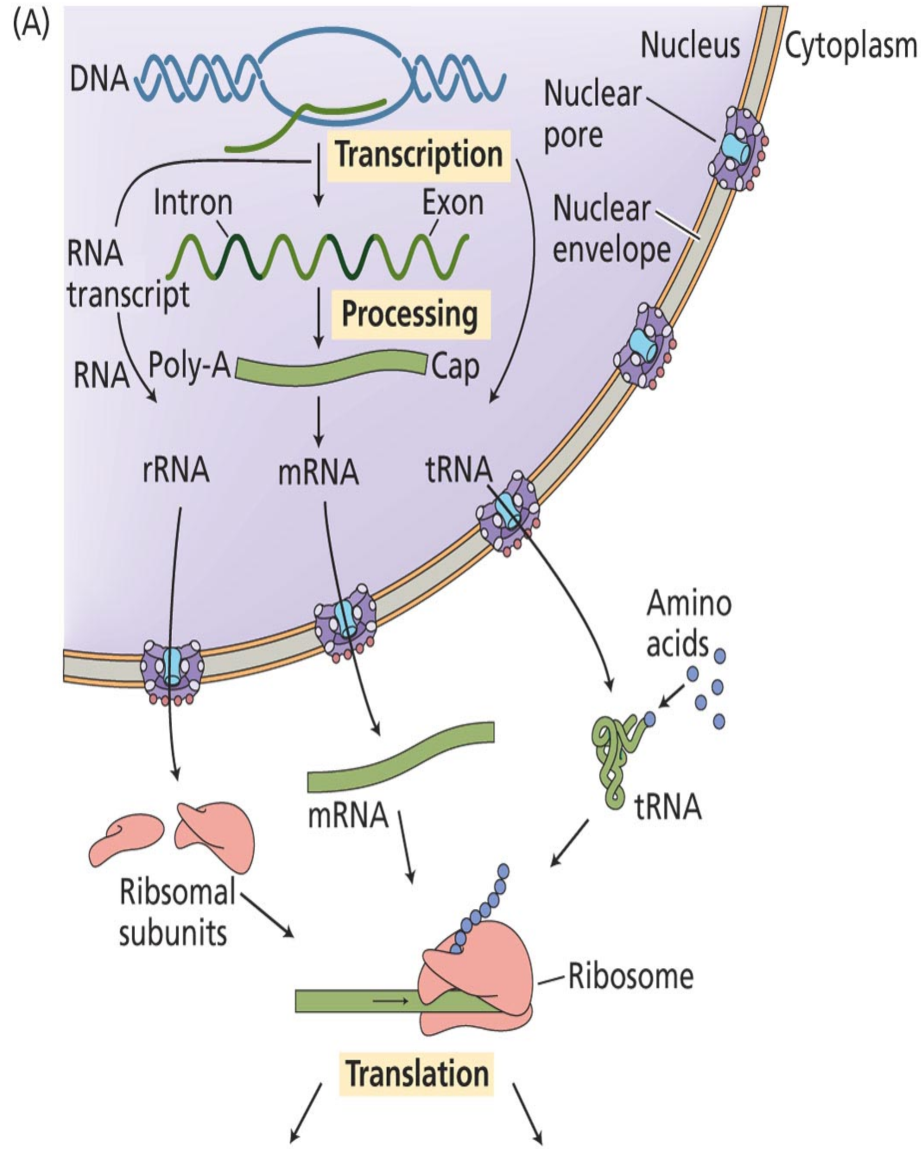
- DNA holds the code
- DNA makes RNA
- RNA makes Protein
- DNA to DNA is called ***REPLICATION***
- DNA to RNA is called ***TRANSCRIPTION***
- RNA to Protein is called ***TRANSLATION***

Central Dogma of Molecular Biology



Summary of protein synthesis

- ***Proteins***:
- Chains of Amino Acids
- Three nucleotide base pairs code for one amino acid.
- Proteins are formed from RNA
- The nucleotide code must be translated into an amino acid code.



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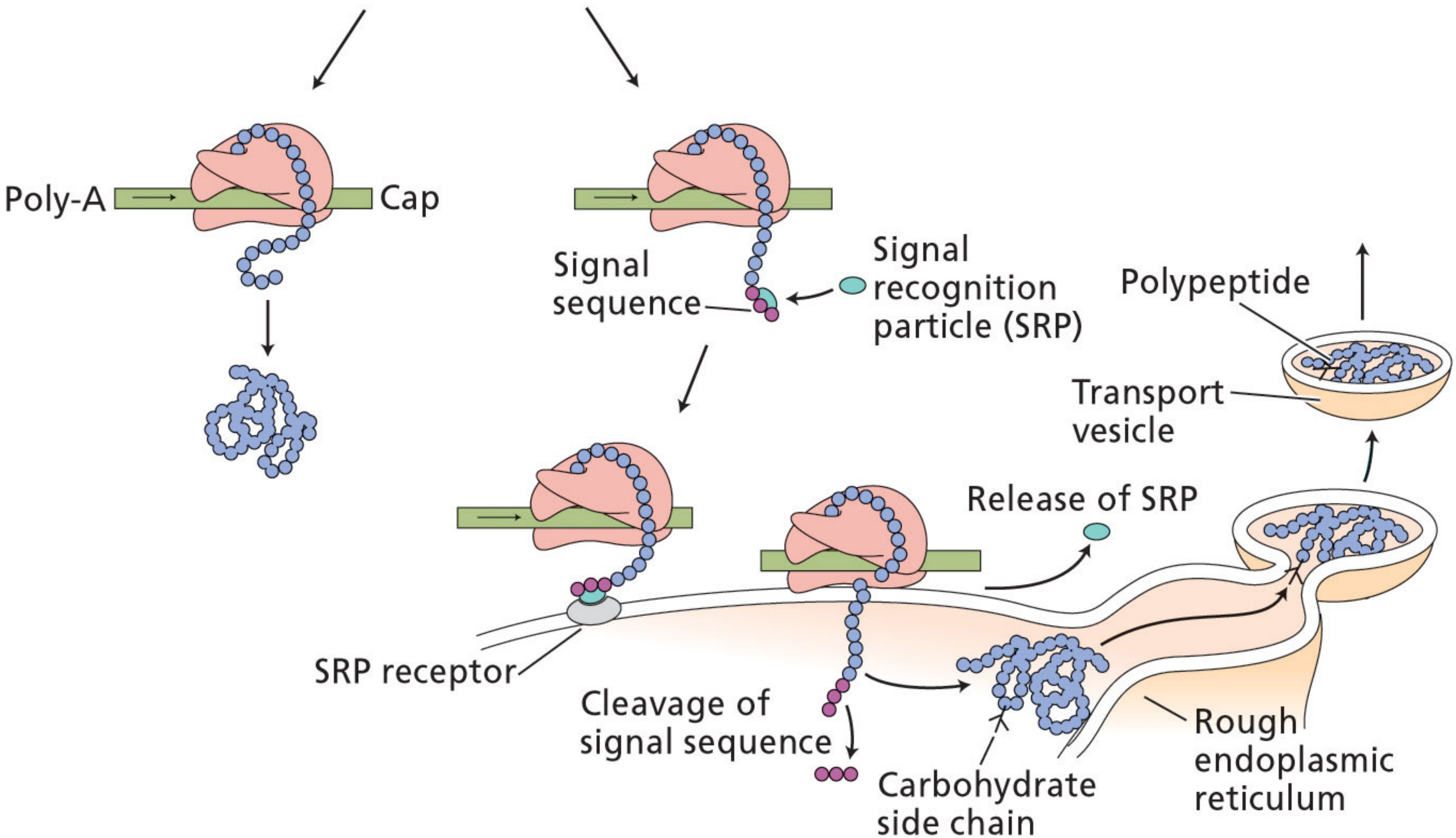
Occurs in the cytoplasm or on Rough ER



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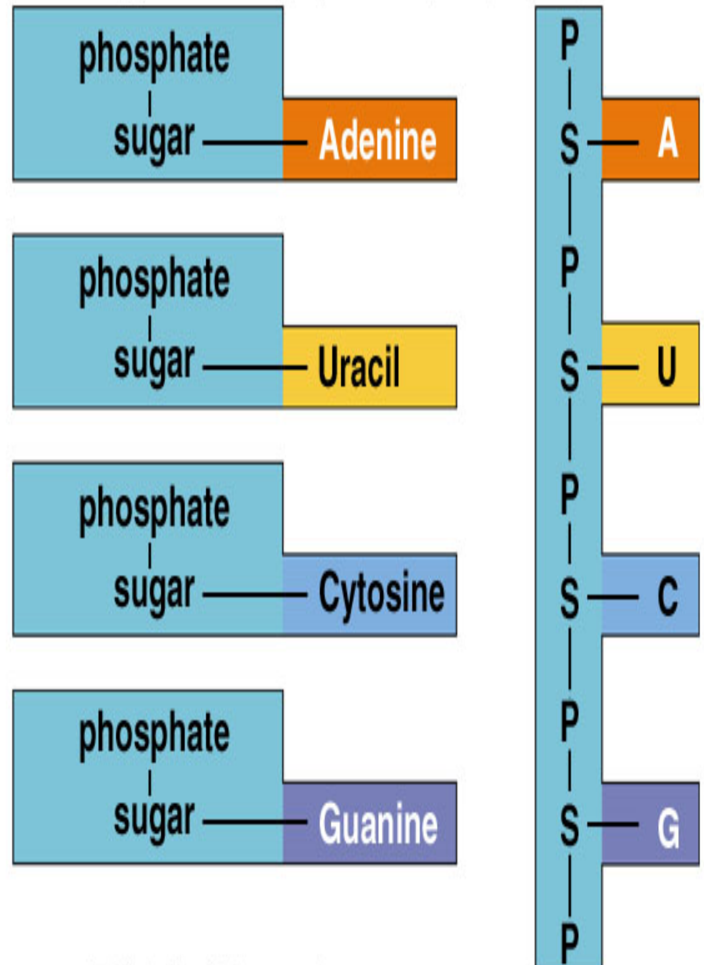
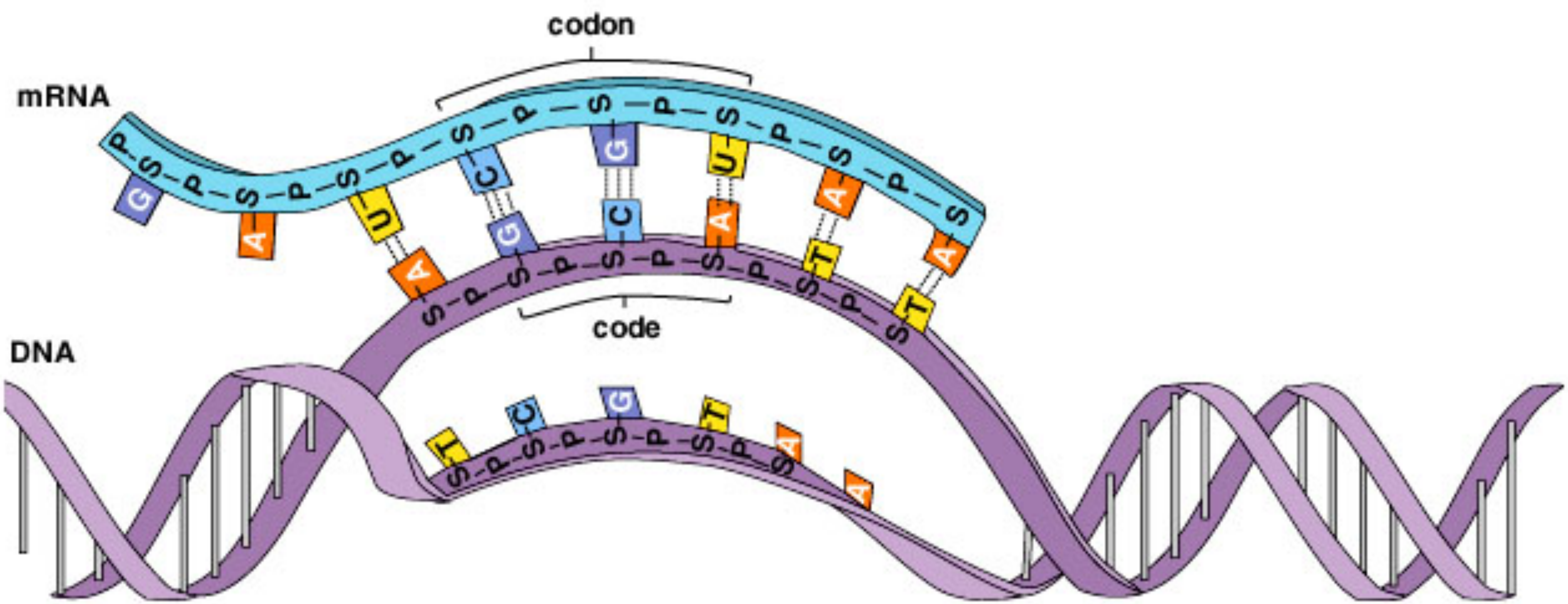
RNA

- Formed from 4 nucleotides, 5 carbon sugar, phosphate.
- **Uracil is used in RNA.**
  - ***It replaces Thymine***
- The 5 carbon sugar has an extra oxygen.
- RNA is single stranded.



RNA Structure

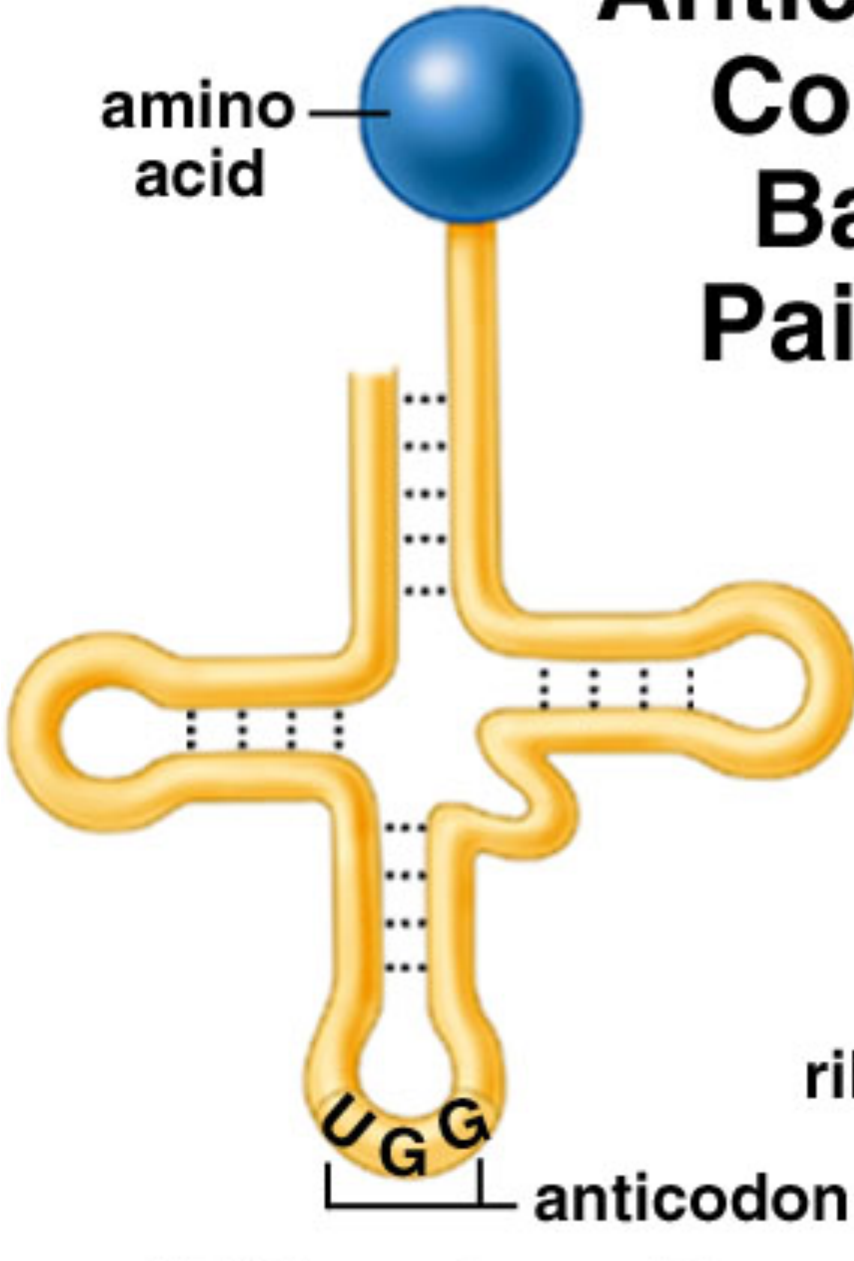
Transcription



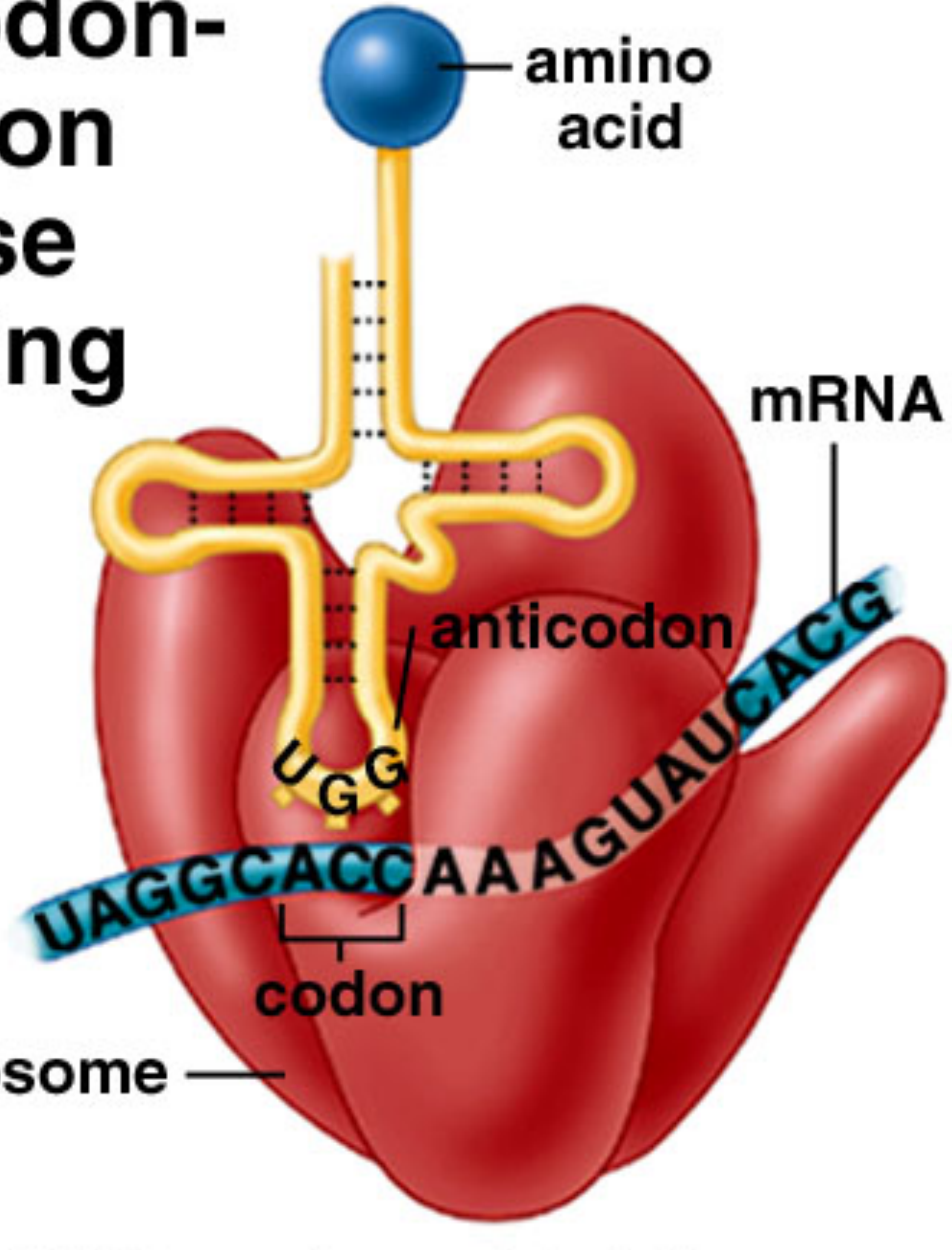
Translation

- Translation requires:
  - Amino acids
  - *Transfer RNA:* (tRNA) Appropriate to its time, transfers AAs to ribosomes. The AA's join in cytoplasm to form proteins. 20 types. ***Loop structure***
  - *Ribosomal RNA:* (rRNA) Joins with proteins made in cytoplasm to form the subunits of ribosomes. ***Linear molecule.***
  - *Messenger RNA:* (mRNA) Carries genetic material from DNA to ribosomes in cytoplasm. ***Linear molecule***.

Anticodon-Codon Base Pairing



tRNA–amino acid



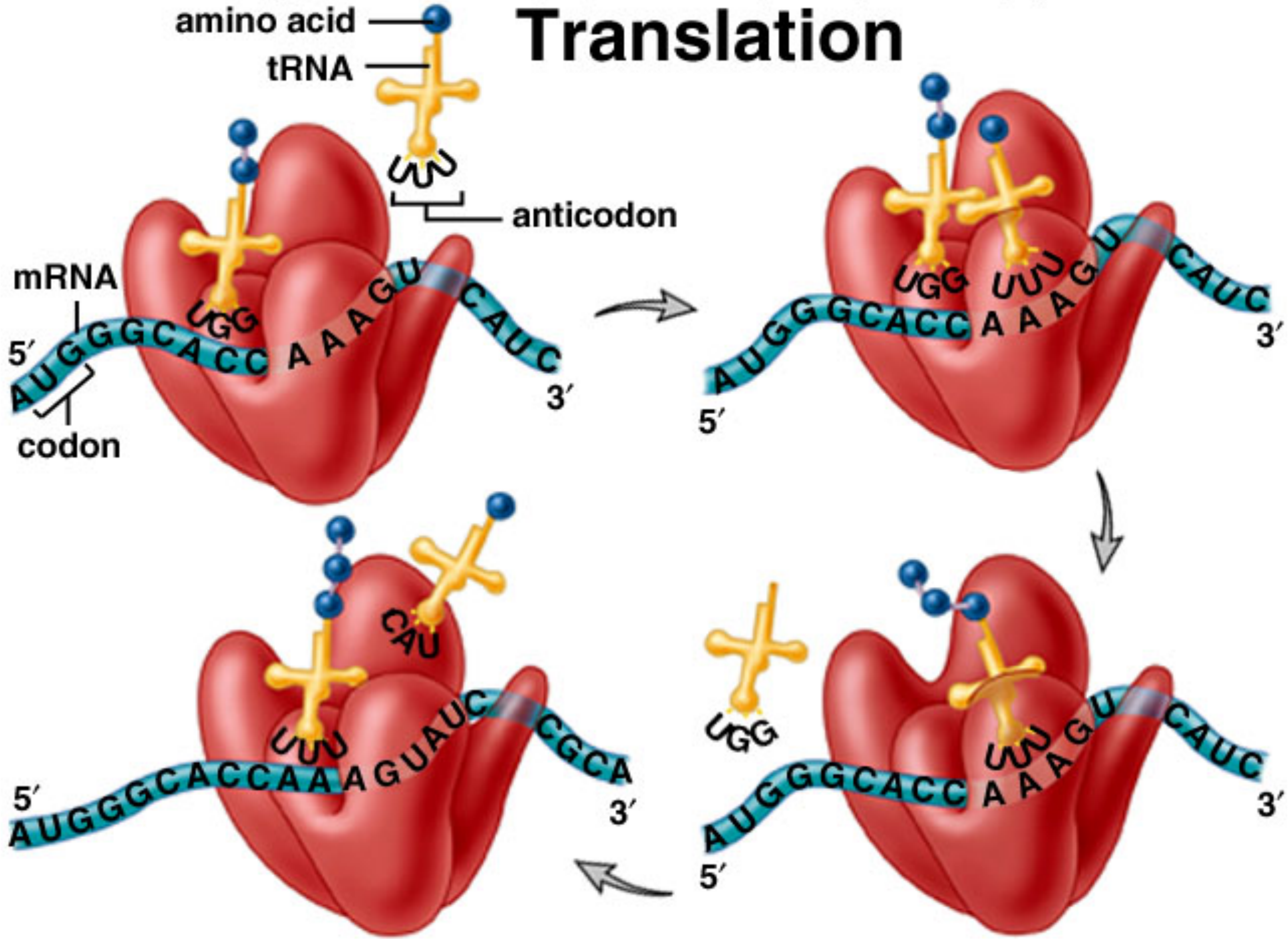
tRNA–amino acid at ribosome

Translation

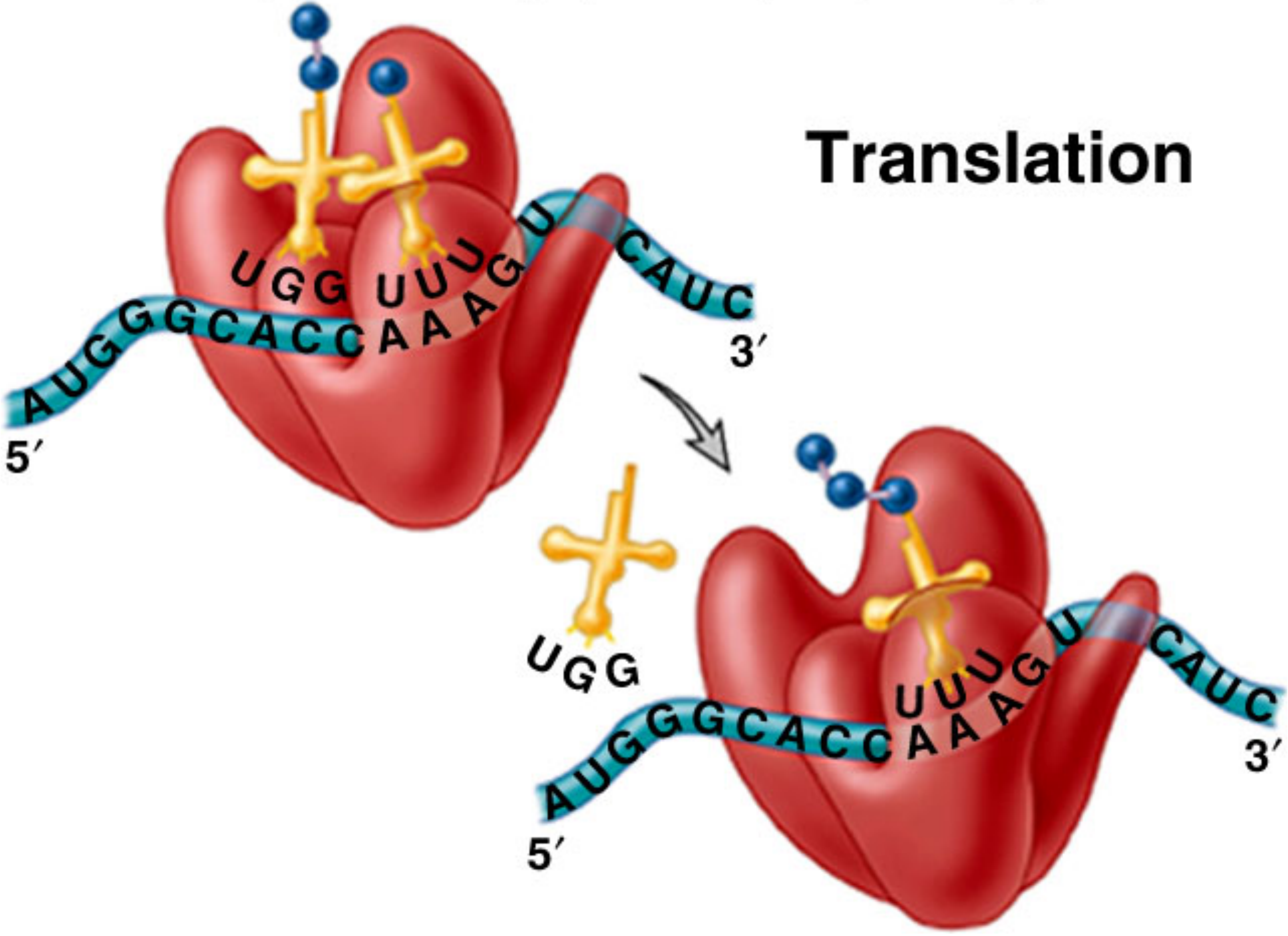
- ***Initiation*—**
  - mRNA binds to smaller of ribosome subunits, then, small subunit binds to big subunit.
  - **AUG** start codon--complex assembles
- ***Elongation*—**
  - add AAs one at a time to form chain.
  - Incoming tRNA receives AA's from outgoing tRNA. Ribosome moves to allow this to continue
- ***Termintion*—**

  Stop codon--complex falls apart

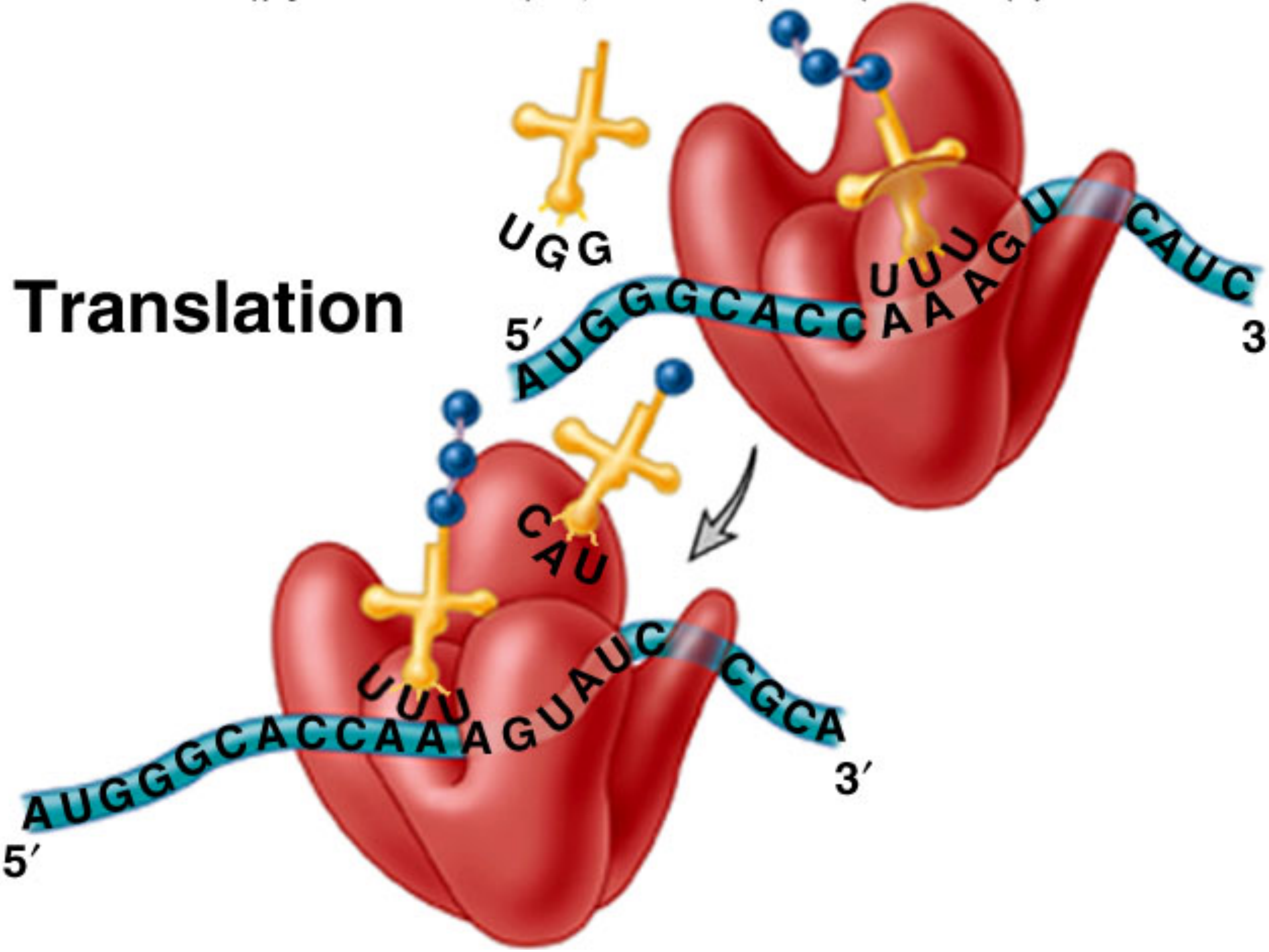
Translation

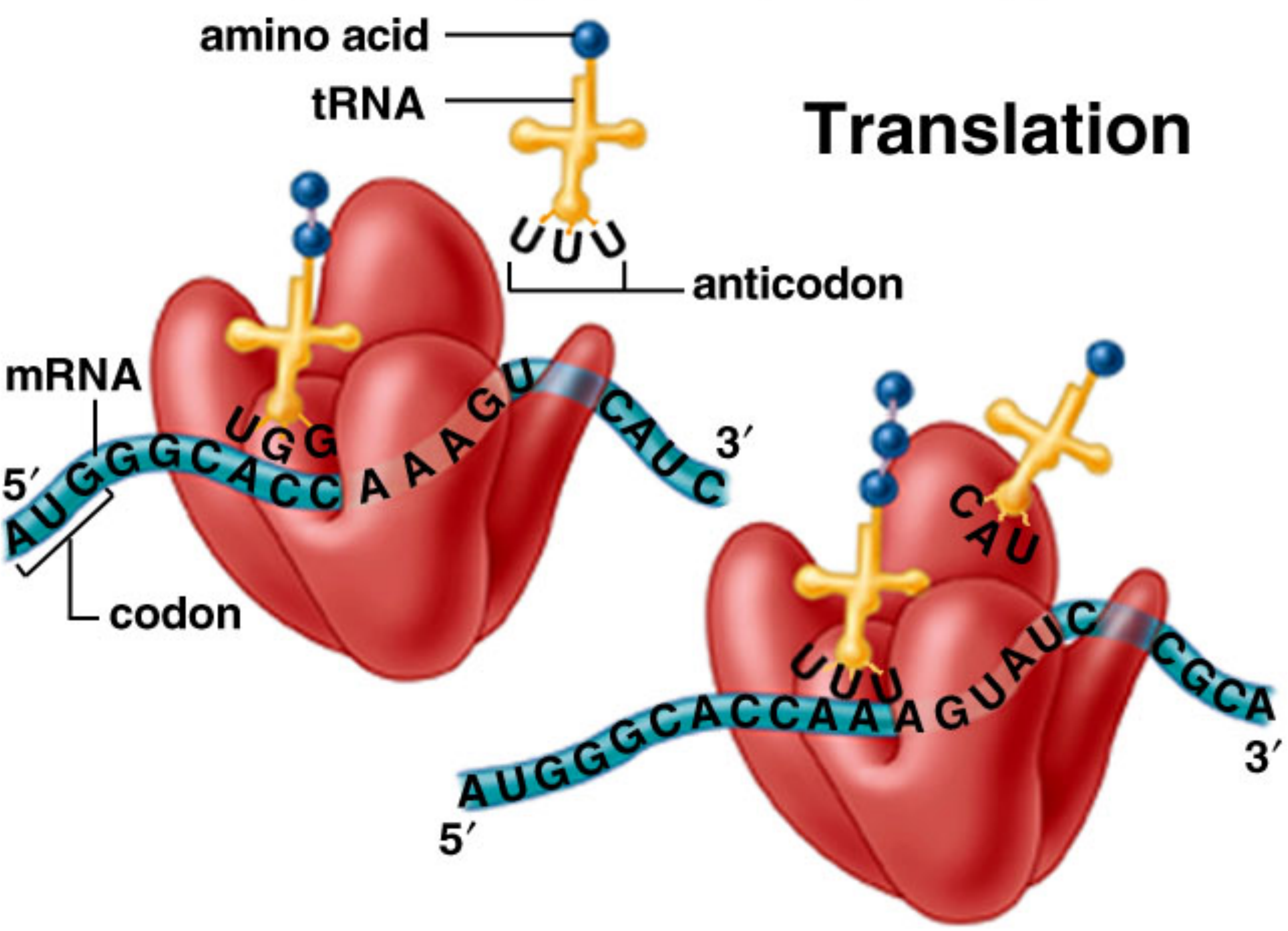


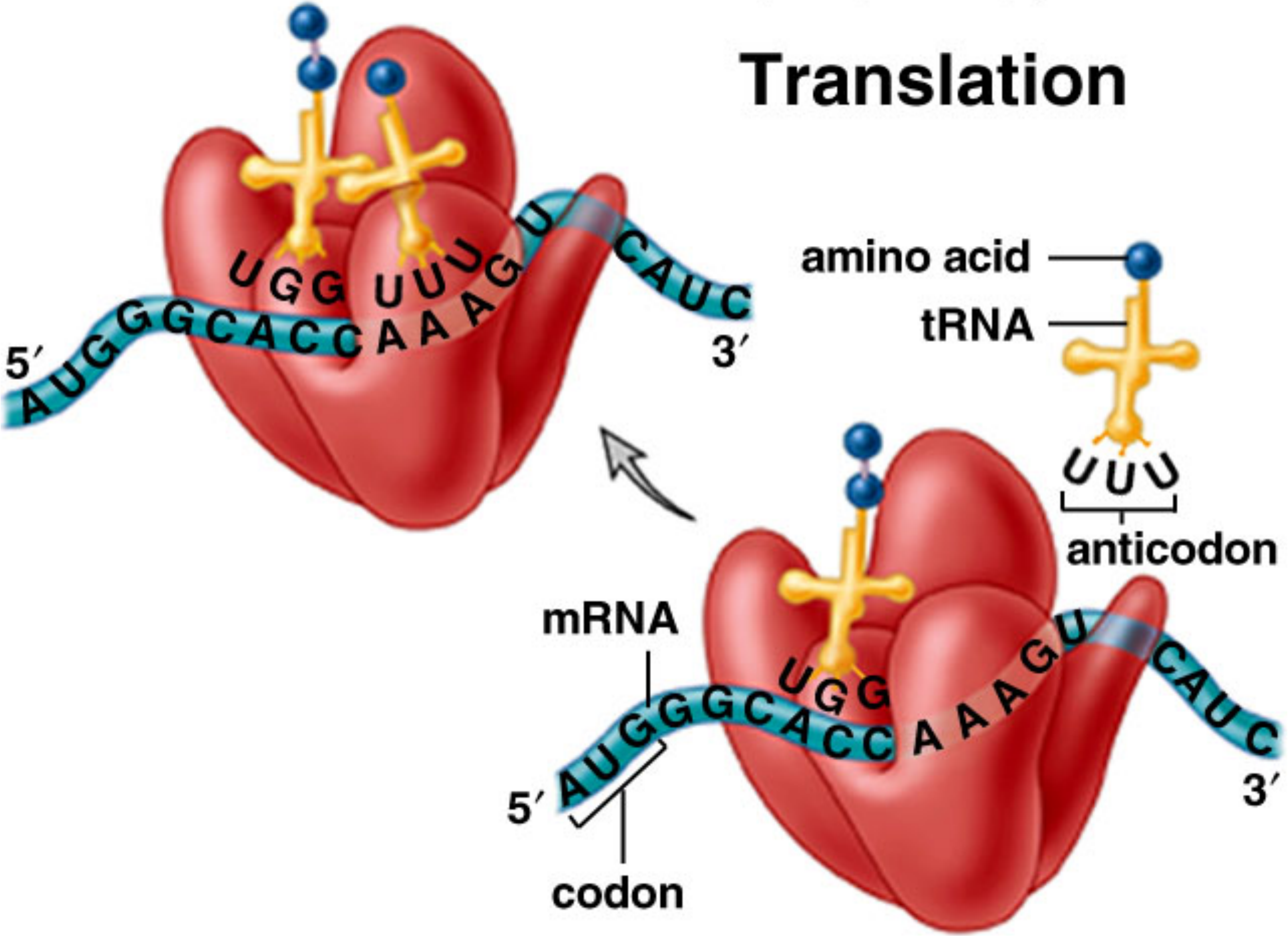
Translation



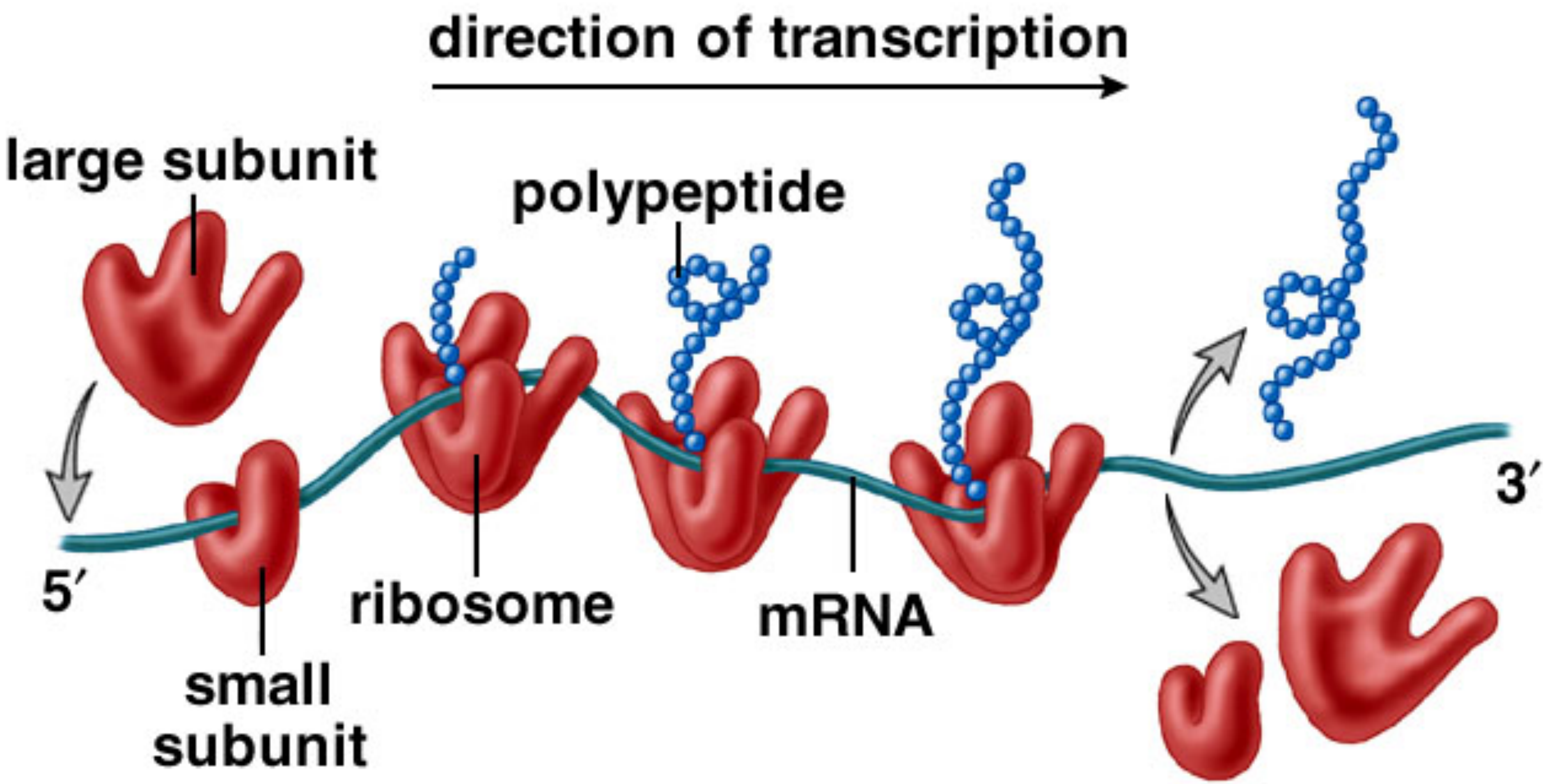
Translation




amino acid
tRNA
Translation
UUU
anticodon
mRNA
UGG
5′
AUGGGCACCAAAGUCAUC
3′
codon
CAU
UUU
AUGGGCACCAAAGUAUCCGCA
5′
3′


Translation
amino acid
tRNA
anticodon
UUU
mRNA
codon
5′
3′
AUGGGCACCAAAGUCAUC
UGG
UUU

Polyribosome Structure



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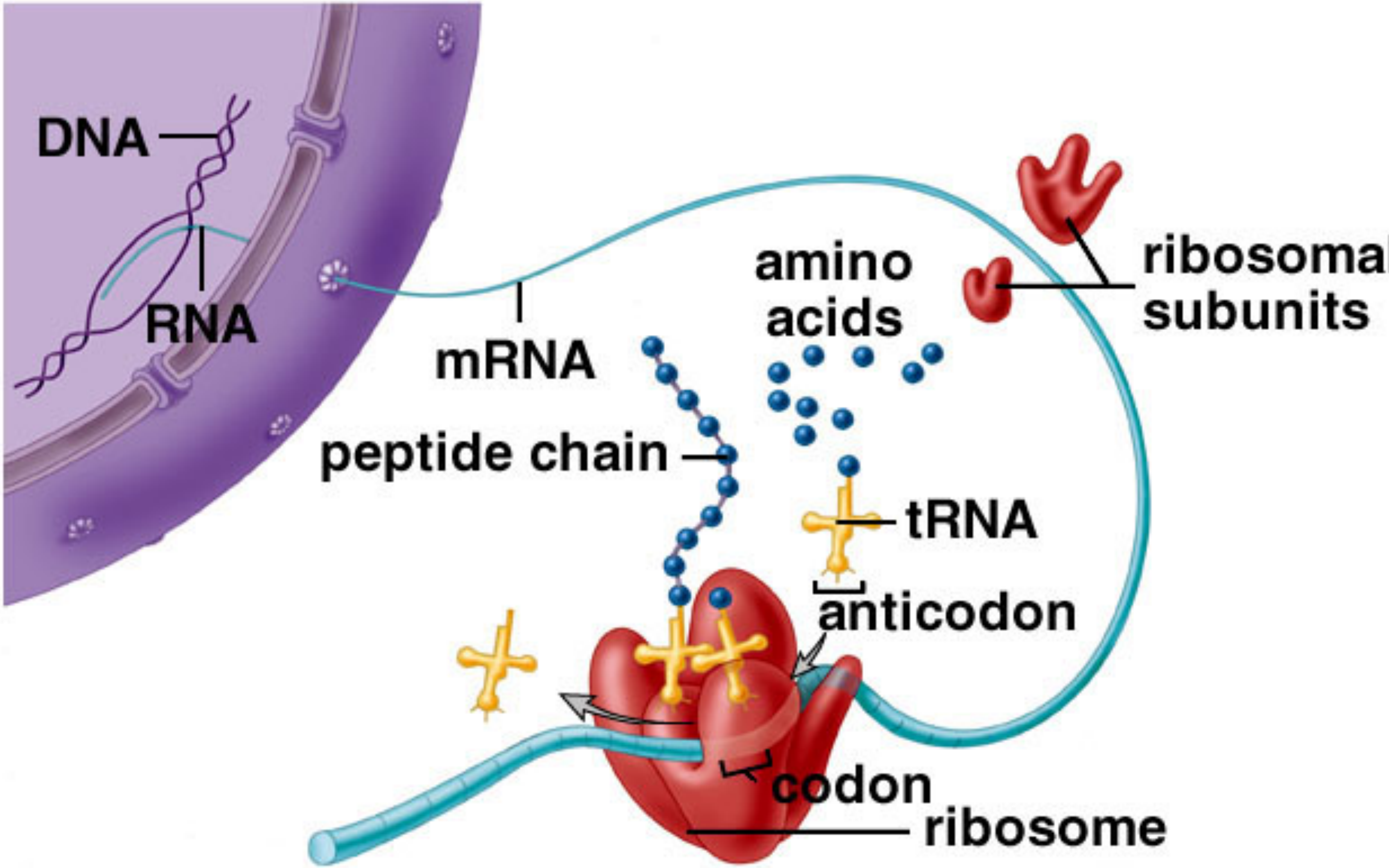
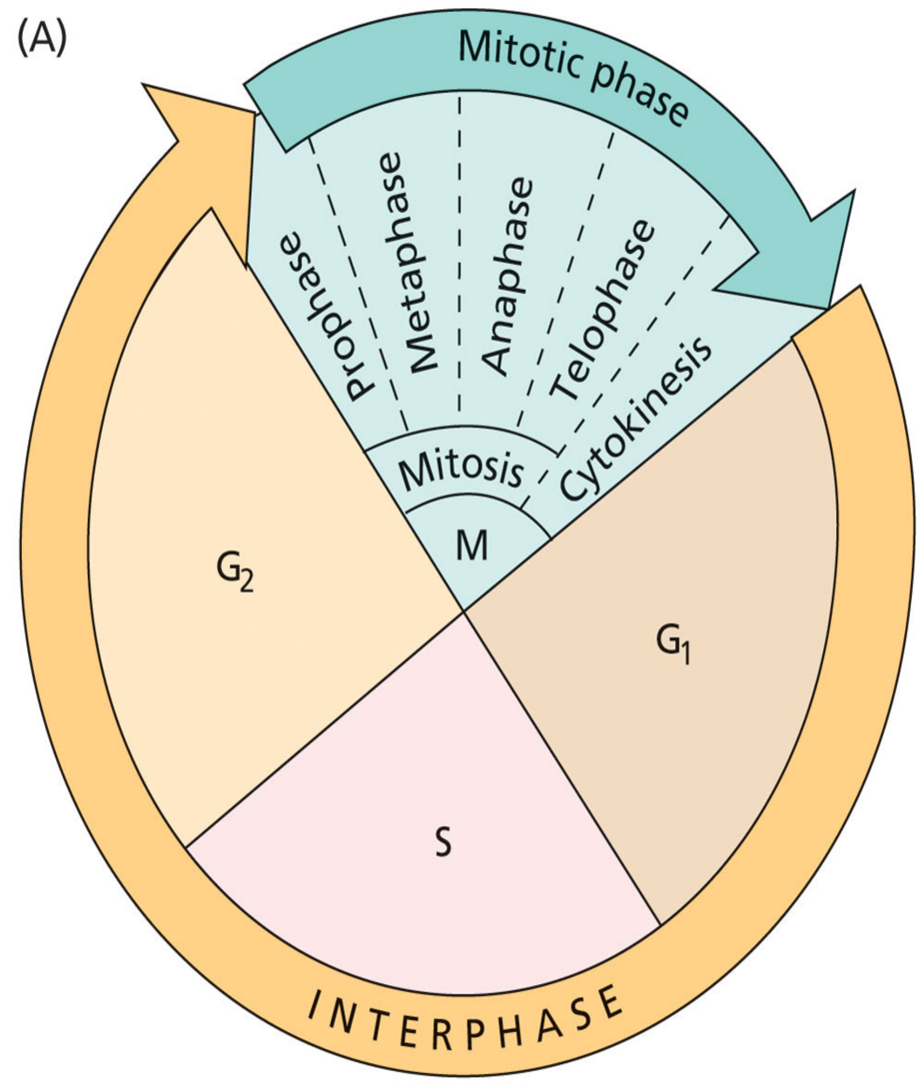
Summary of Gene Expression



Cell Division in Plants

Most plant cells divide by Mitosis

- ***Mitosis***: Process of division that produces two daughter cells with identical chromosomal content of parent cell.
- Mitosis is one stage of the cell cycle.
- Cell cycle--cycle of stages a cell goes through in order to grow and divide.



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Stages of Division

- ***Prophase***--nuclear envelope breakdown, chromosome condensation, spindle formation.
- ***Metaphase***--chromosomes are lined up precisely on the metaphase plate, or middle of the cell.
- ***Anaphase***--spindle pulls sister chromatids apart.
- ***Telophase***--chromatids begin to decondense and become chromatin. Spindle disappears.
- ***Cytokinesis***--divide cell and organelles. Actin ring, or cleavage furrow splits cell.

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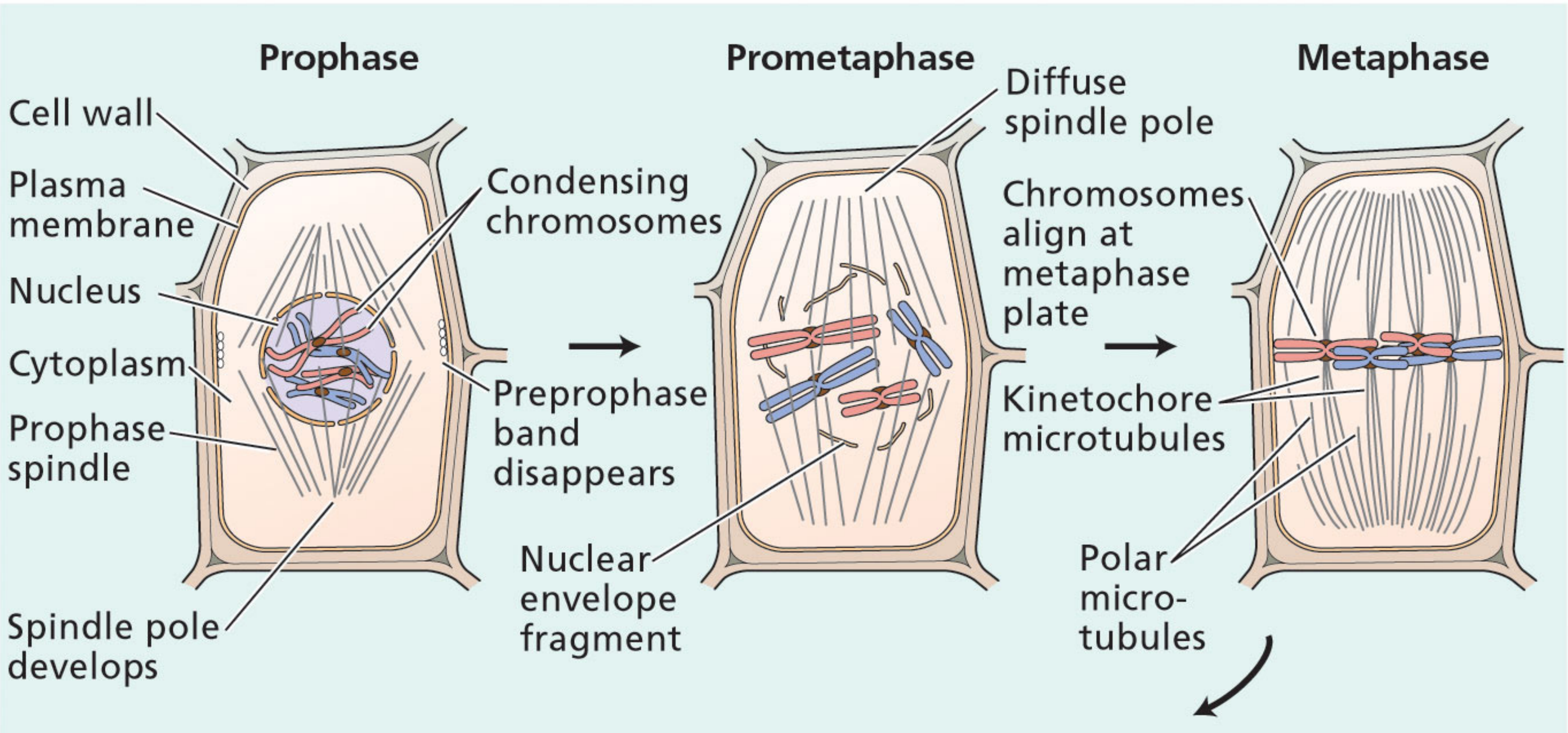
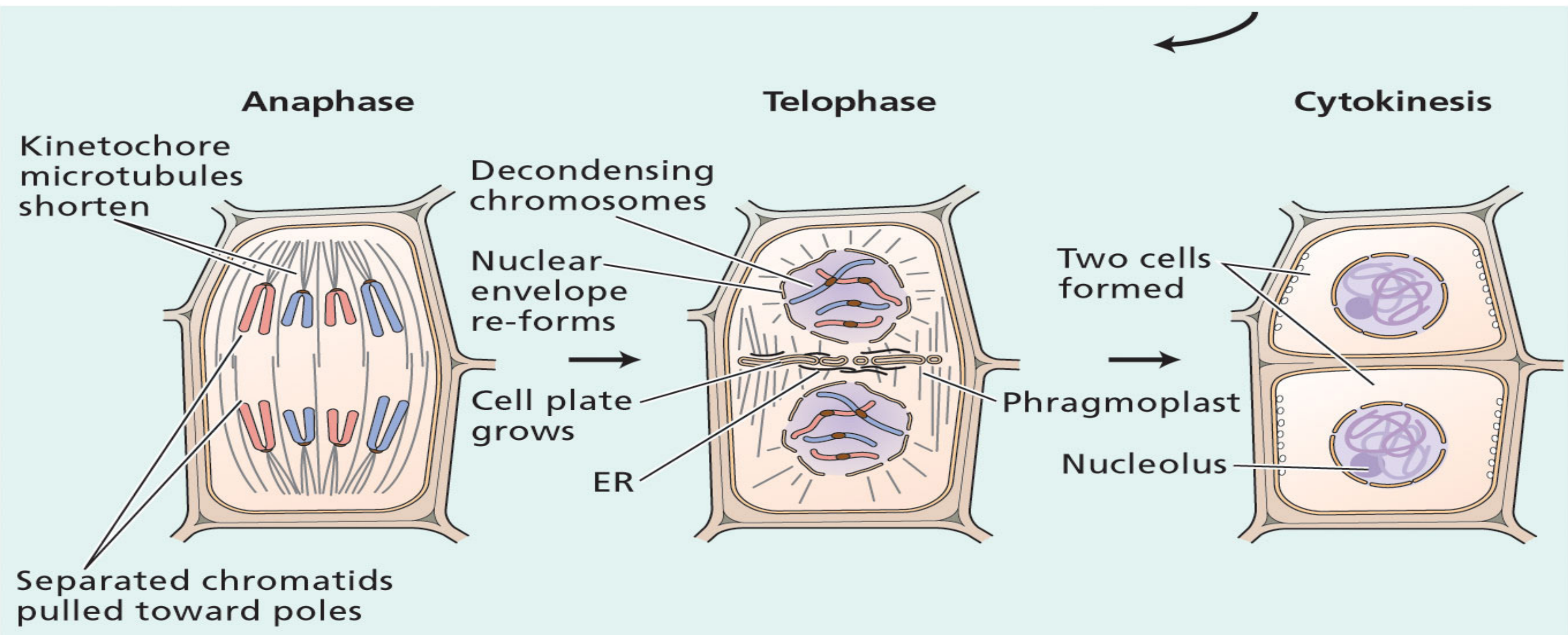


- ***Anaphase***--spindle pulls sister chromatids apart.
- ***Telophase***--chromatids begin to decondense and become chromatin. Spindle disappears.
    - ***NEW CELL WALL IS FORMED***
- ***Cytokinesis***--divide cell and organelles. Actin ring, or cleavage furrow splits cell.



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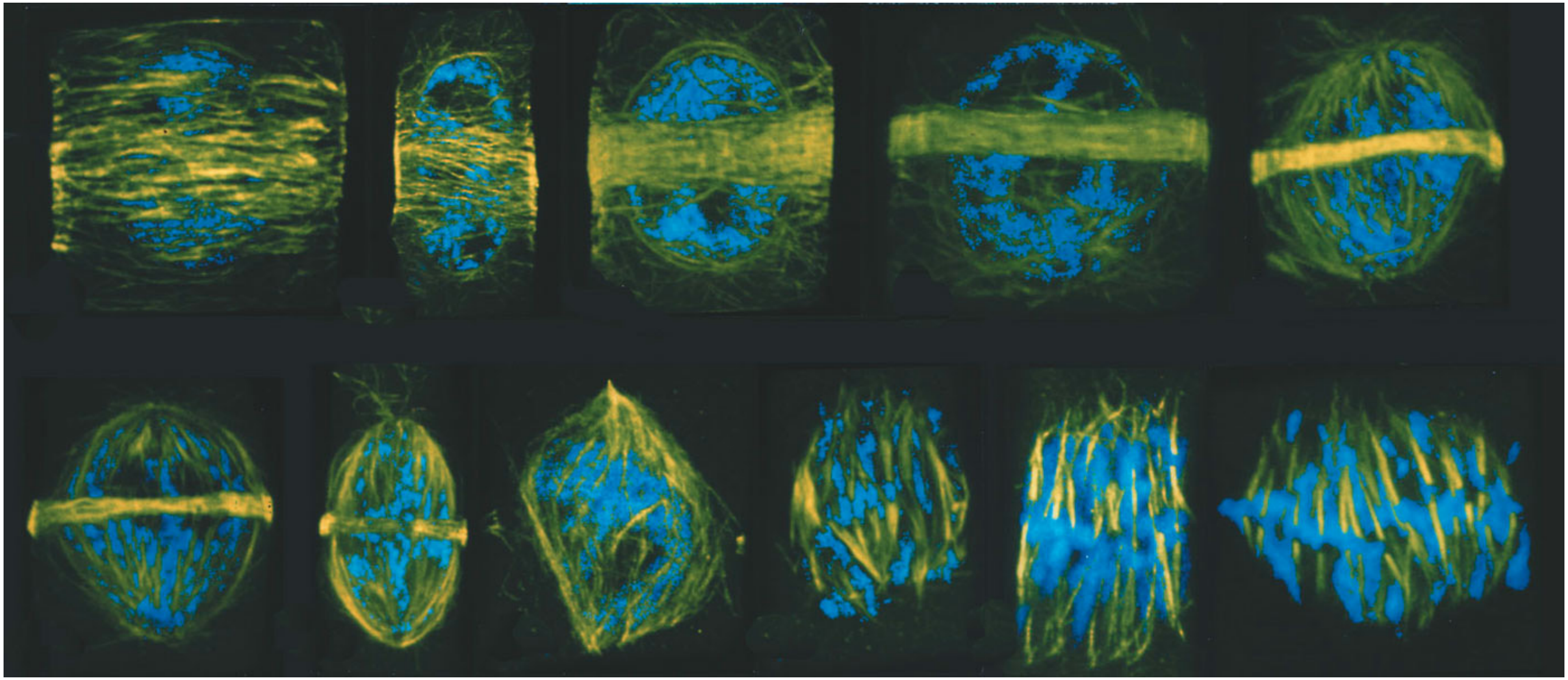
Remember the cytoskeleton?

- Changes in microtubule arrangements (yellow) during different stages of the cell cycle of wheat root cells. DNA is shown in blue.



ANY QUESTIONS?