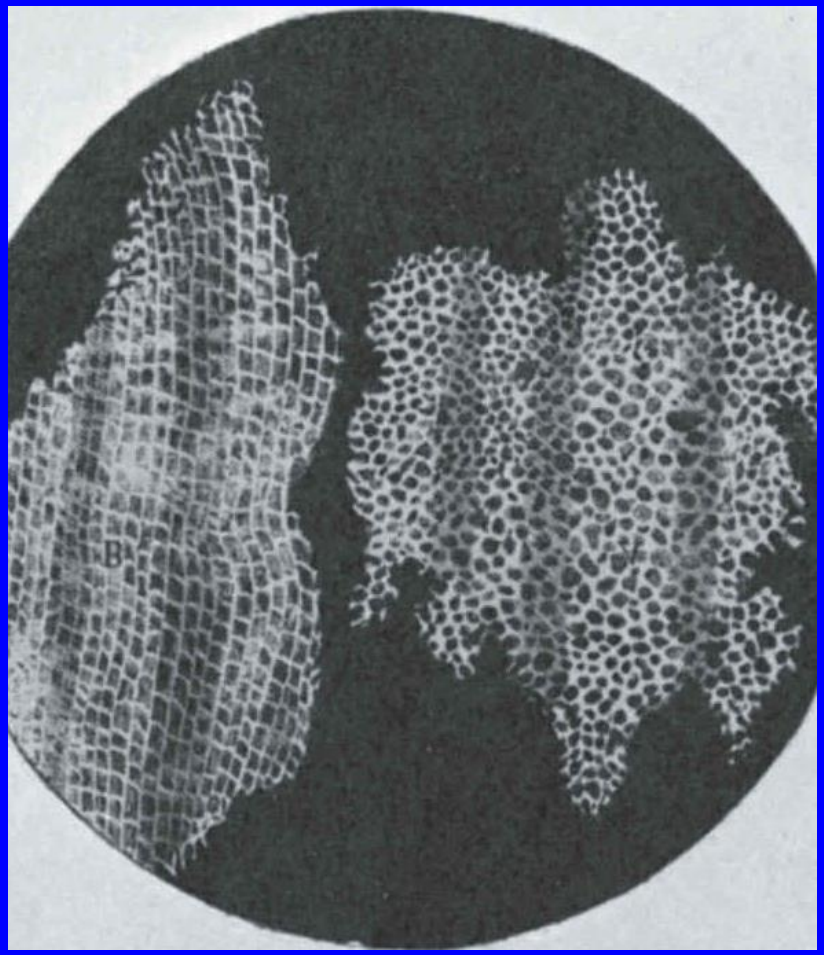
Chapter II Plant Cells and Tissues -Morphology of Cells

I. Cell is the basic unit of plant body.

- In 1665, the Englishman R. Hooke proposed and coined the term.
- In 1838, the German M. Schleiden proposed that cell was the basic unit of plant structure.
- In 1839, the German T. Schwann declared that cell was also the basic unit of animal structure, and developed the "Cell Theory".
- In the early 20th century: light microscope -microstructure.
- In the 1940s: electron microscope - ultrastructure.
- In the 1960s: tissue culture technique (genetic totipotency, functionally proved that cell was a basic unit).



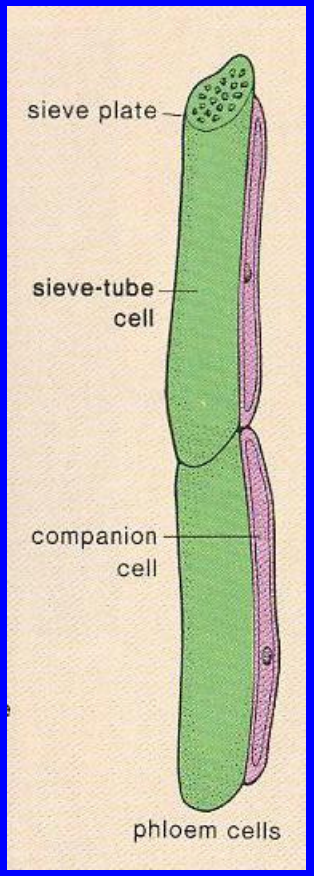
More than 300 years ago, Robert Hooks recorded the first images of plant cell walls in this *camera lucida* print of sections of the bark of cork oak.

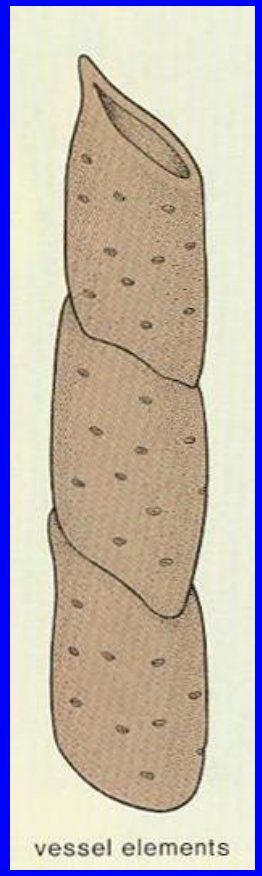
Transmission electron microscope

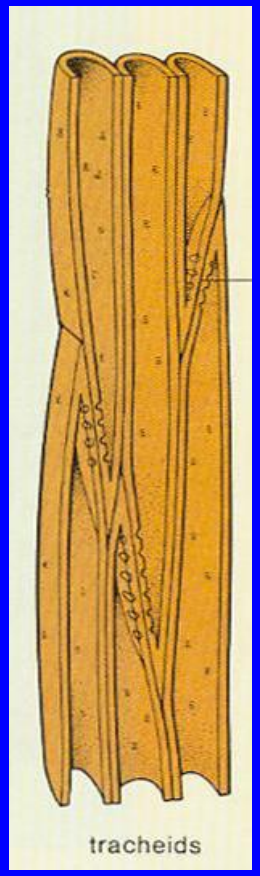
II. Shape and Size of Plant Cells

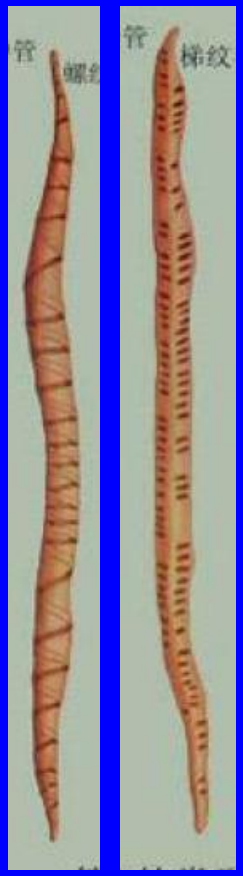
- Shape of plant cells: spherical, polyhedral, fusiform and columnar, etc.
- Size of plant cells: generally very small (e.g. coccus is only 0.5 μm), but large in a small portion (e.g. watermelon pulp and cotton seed trichome).
- Main factors affecting cell volume: dependent on nucleus; a cell with small volume has large relative surface area, and it is therefore easy for exchange of substances; the difference in size of cells at different positions is reflected in that the physiologically active cells are usually small; external environment (water manure, illumination, temperature and chemical agent, etc.)

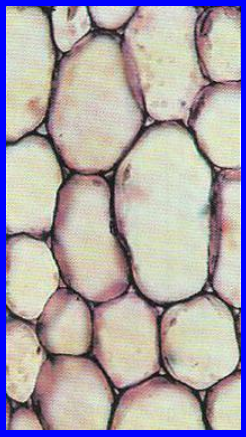
Chapter II Plant Cells and Tissues - Morphology of Cells



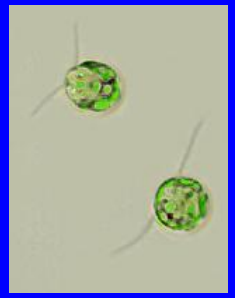


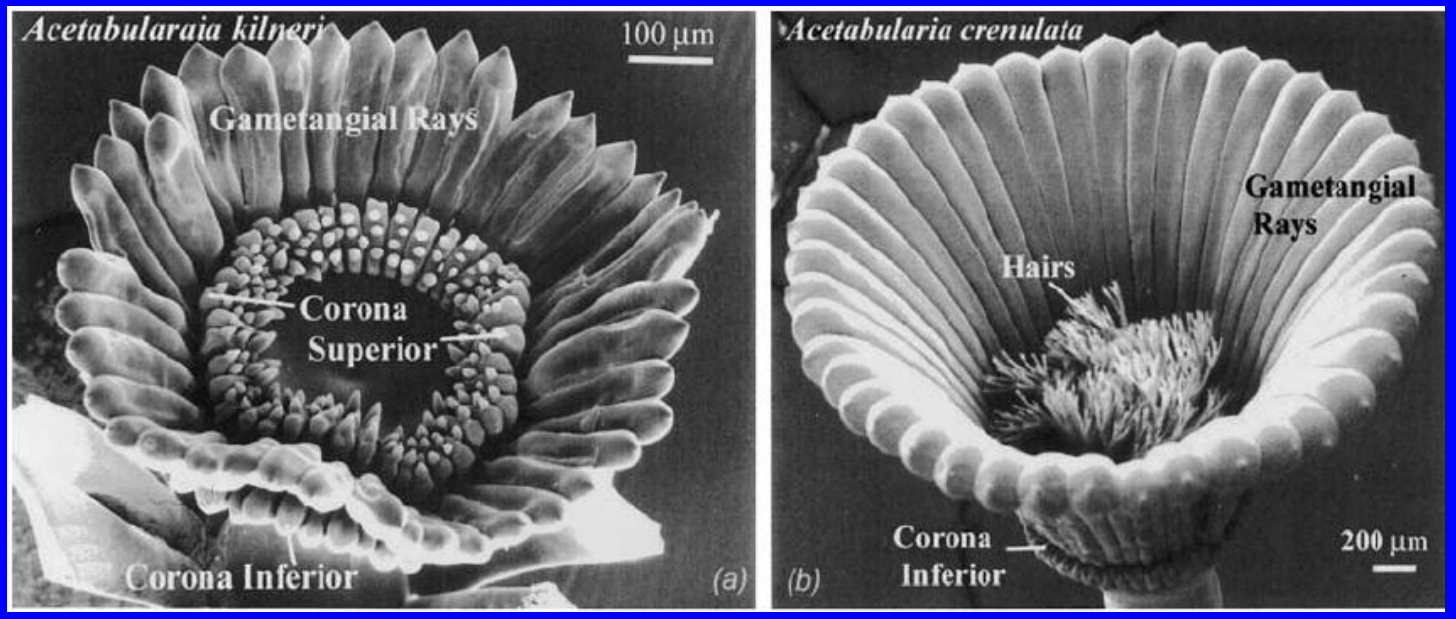






Morphology of plant cells.





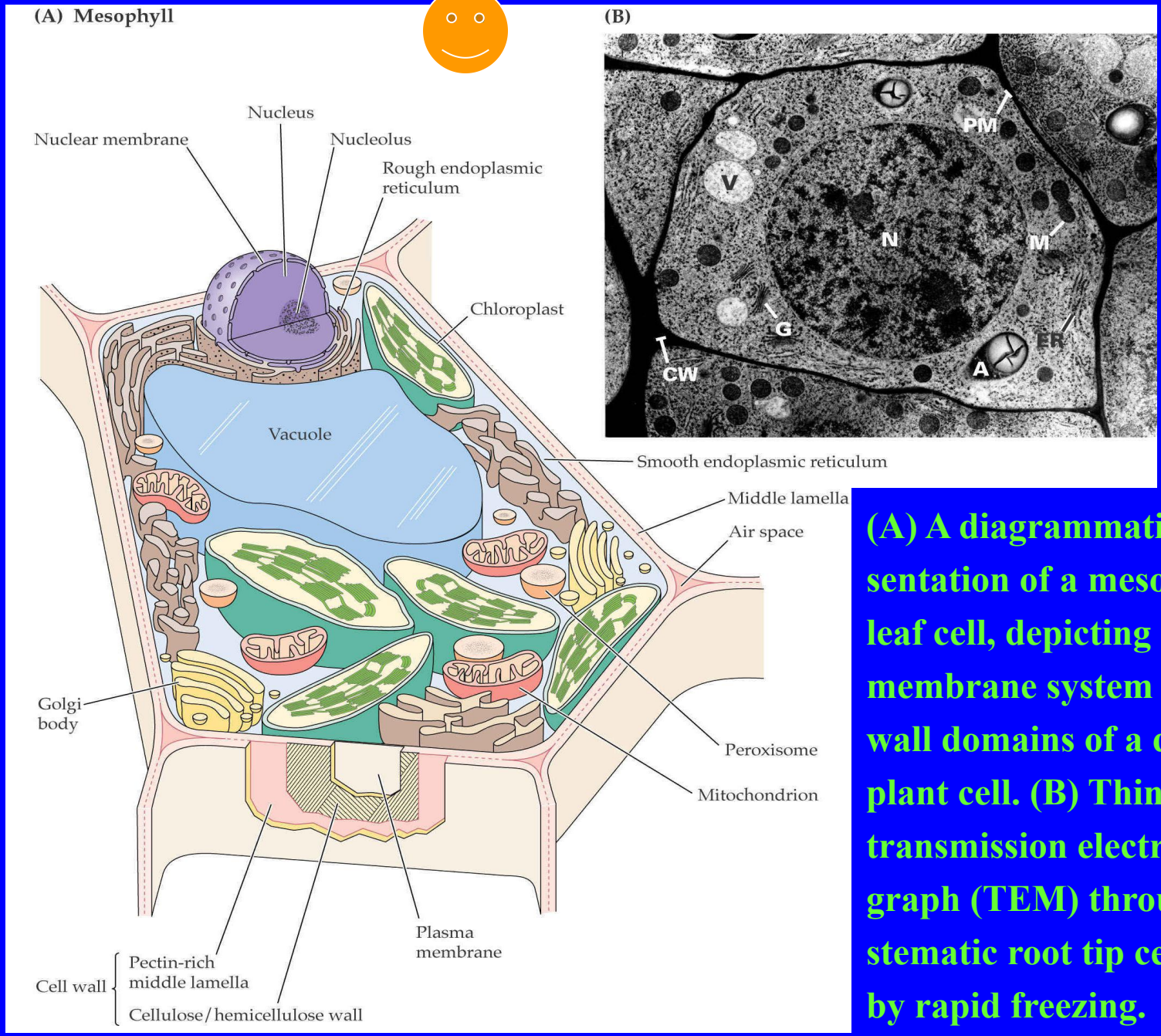
Structure of the thallus of *Acetabularia*. (*a*) and (*b*) are scanning electron micrographs; (*c*) is a light micrograph. (From Berger et al., 2003)

III. Basic Structure of Plant Cells

(I) Protoplast

1. Definition: Composed of protoplasm, it is the main place for all kinds of cellular metabolism, and the most important portion of a cell.
2. Protoplasm: Protoplasm is the living substance of a cell, and the physical basis of cell structure and life.
3. Basic components: water, nucleic acid, protein, carbohydrates and lipids.

Chapter II
Plant Cells and Tissues
- Morphology of Cells

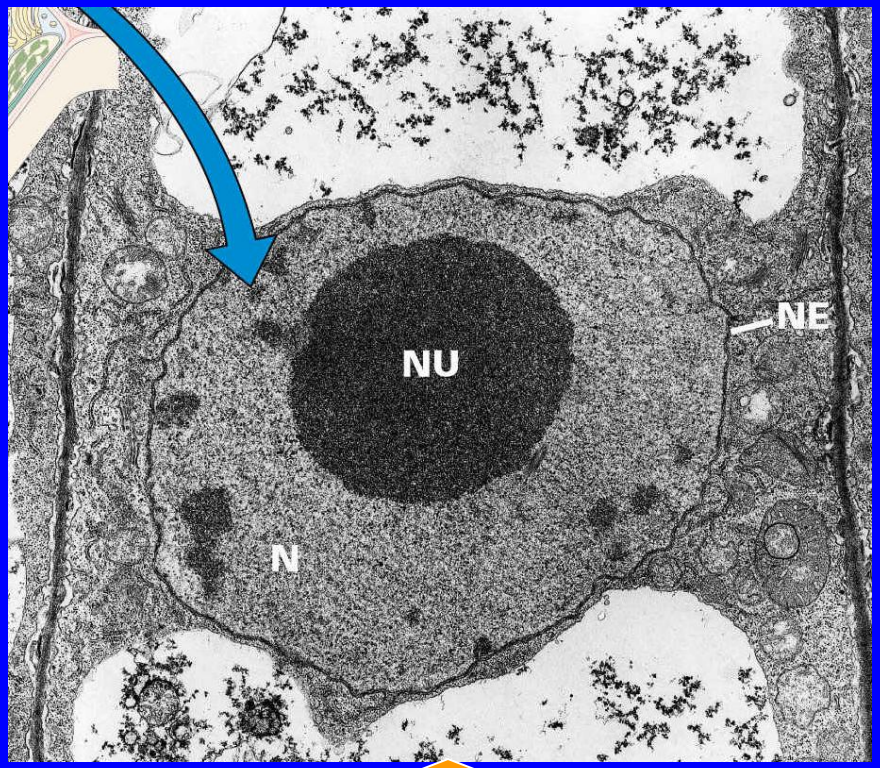


(A) A diagrammatic representation of a mesophyll leaf cell, depicting the principal membrane system and cell wall domains of a differentiated plant cell. (B) Thin-section transmission electron micrograph (TEM) through a meristematic root tip cell preserved by rapid freezing.

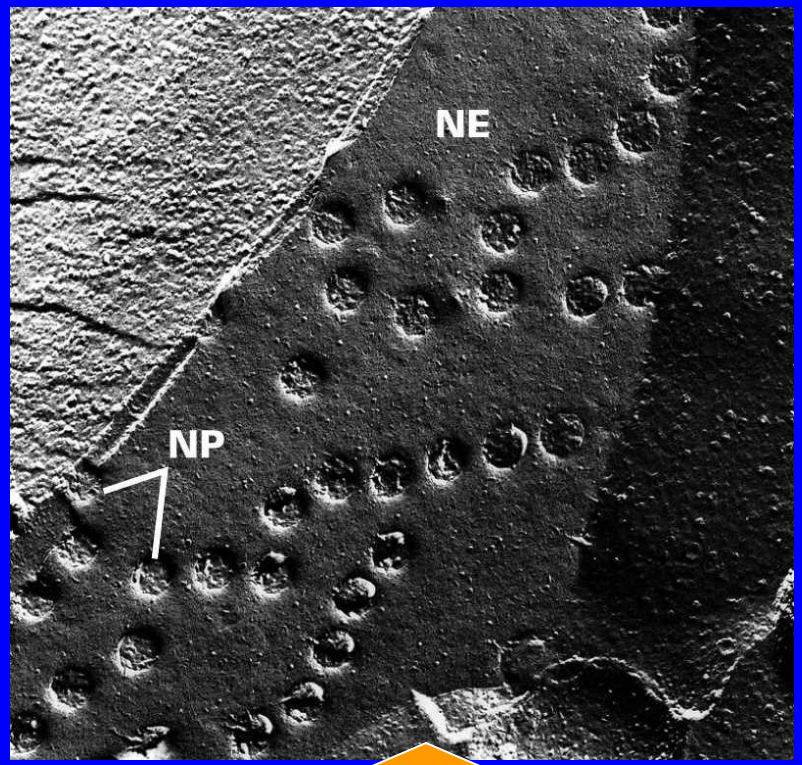
4. Basic Structure

- Nucleus
  - Nuclear membrane (inner and outer nuclear membranes, with nuclear pores).
  - Nucleoplasm
    - Nucleolus (synthesizes and stores RNA)
    - Chromatin (main form of existence of genetic materials, composing of DNA and protein)
    - Nuclear sap (matrix without obvious structure, composing of protein, RNA and enzymes)

Chapter II Plant Cells and Tissues - Morphology of Cells

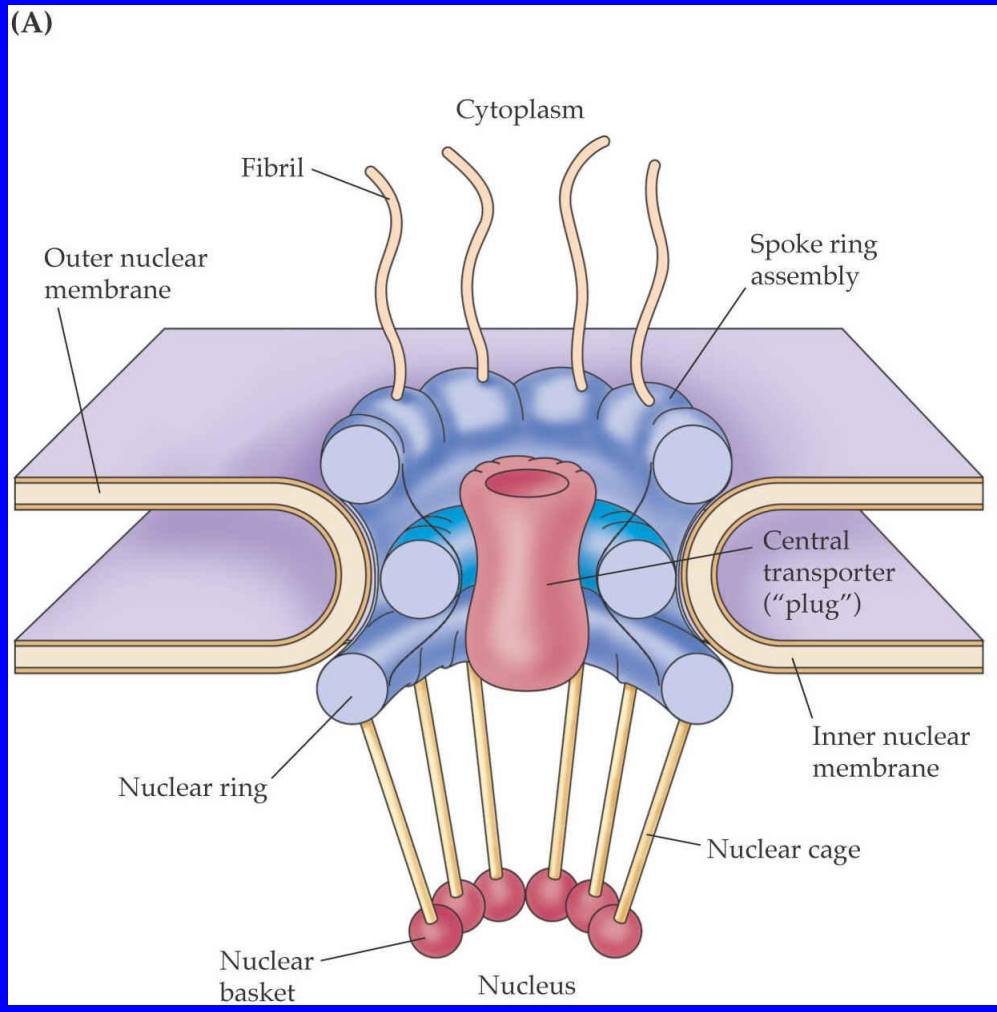


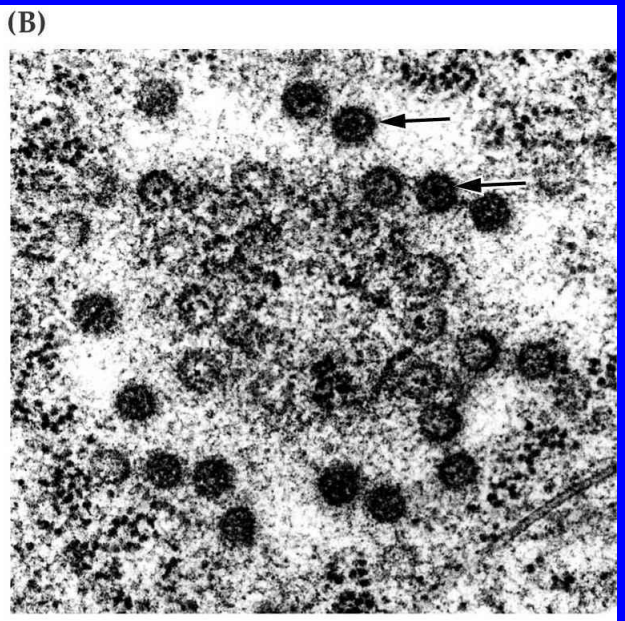
TEM showing the nucleus of a bean root tip cell.



TEM of a nuclear envelope with nuclear pores.

Chapter II Plant Cells and Tissues - Morphology of Cells



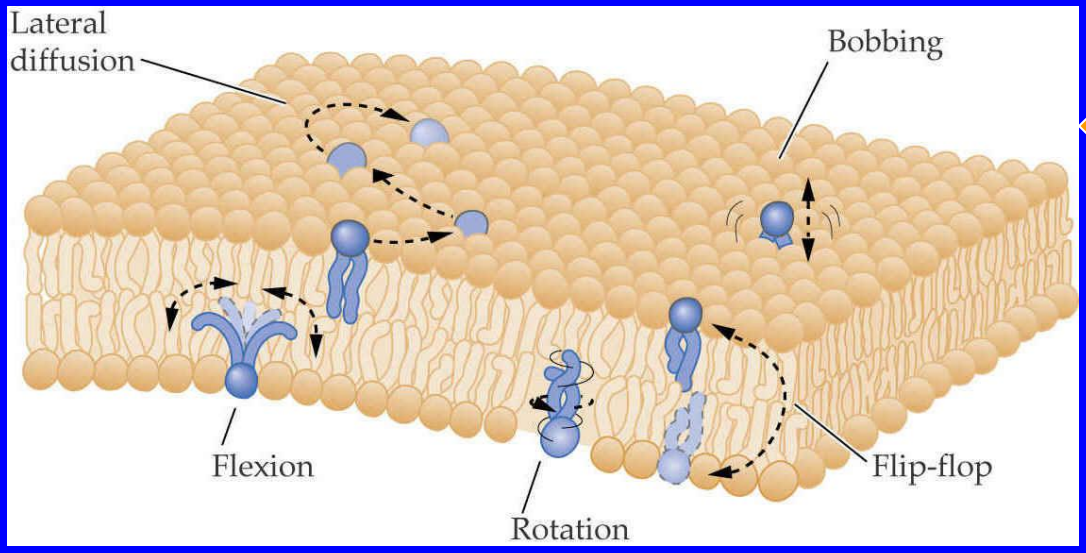


(A) Diagram of a nuclear pore complex in a nuclear membrane. (B) TEM showing a tangential thin section through nuclear pore complexes of a tobacco root tip.

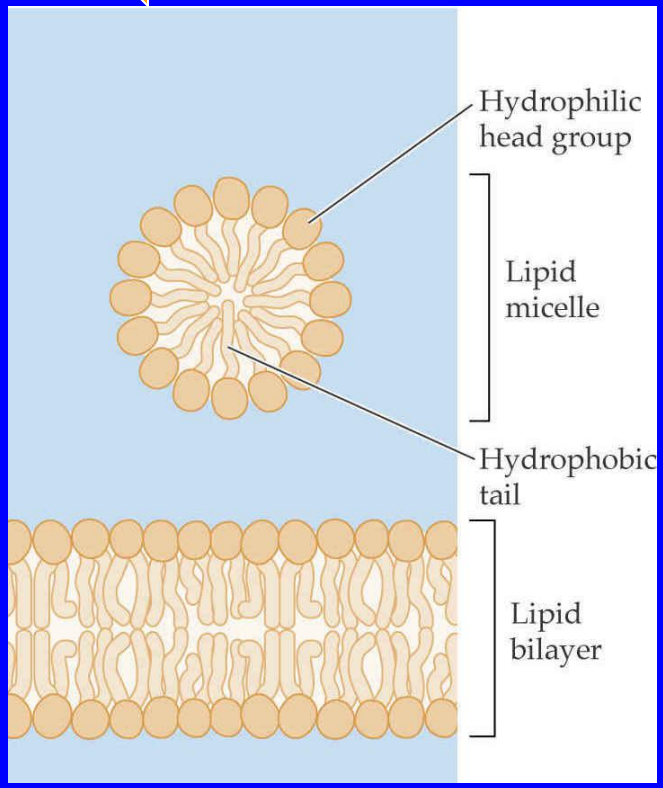
Chapter II Plant Cells and Tissues - Morphology of Cells

Cytoplasm

- Plasma membrane (selective permeability, active transport, information exchange, cell recognition and defending against disease germs, etc.)`
- Cytosol (the portion of cytoplasm with no special structure that can be identified under electron microscope, composing of water, inorganic salt, gas, carbohydrates, amino acid, nucleotide, zymoprotein and RNA, making cytoplasmic movement, acting as medium and providing place and raw material)
- Organelle (microstructure or micro-organ with certain structure and special function in cytoplasm)

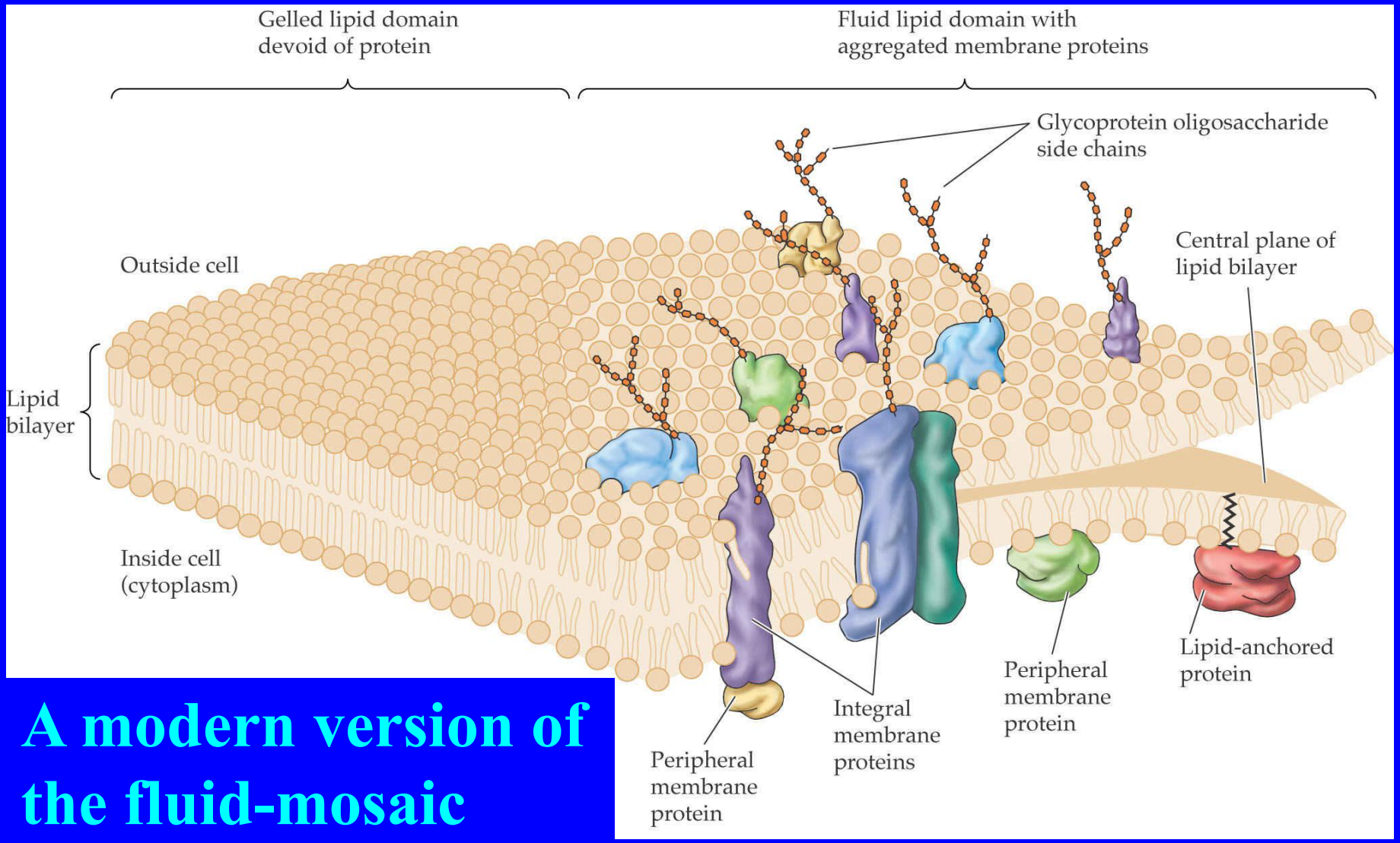


Mobility of phospholipid molecules in a lipid bilayer.



Cross-sectional view of a lipid micelle and a lipid bilayer in aqueous solution.

Chapter II Plant Cells and Tissues - Morphology of Cells



A modern version of the fluid-mosaic membrane model.

Chapter II Plant Cells and Tissues - Morphology of Cells

5. Organelle

(1) Plastid

① Definition: It is a kind of organelles related to the synthesis and storage of carbohydrates.

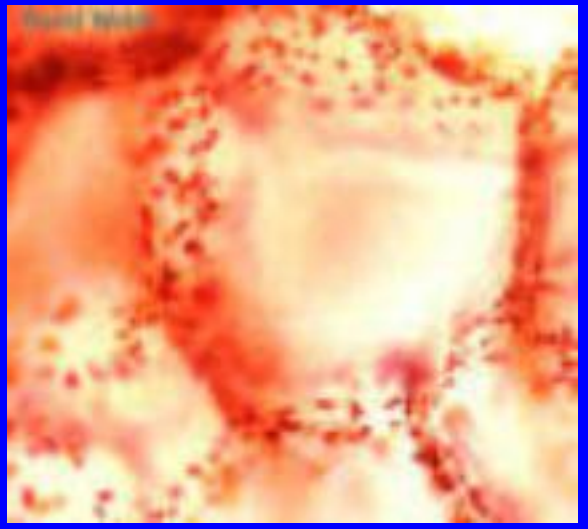
②Category:

	Grana	Pigments	Color	Function
Chloroplast	Yes	Chlorophyll, lutein & carotene	Green	Photosynthesis
Chromoplast	None	Carotene & lutein	Yellow, Orange & salmon pink	Accumulation of starch and lipids
Leucoplast	None	None	None	Synthesis of starch and lipids

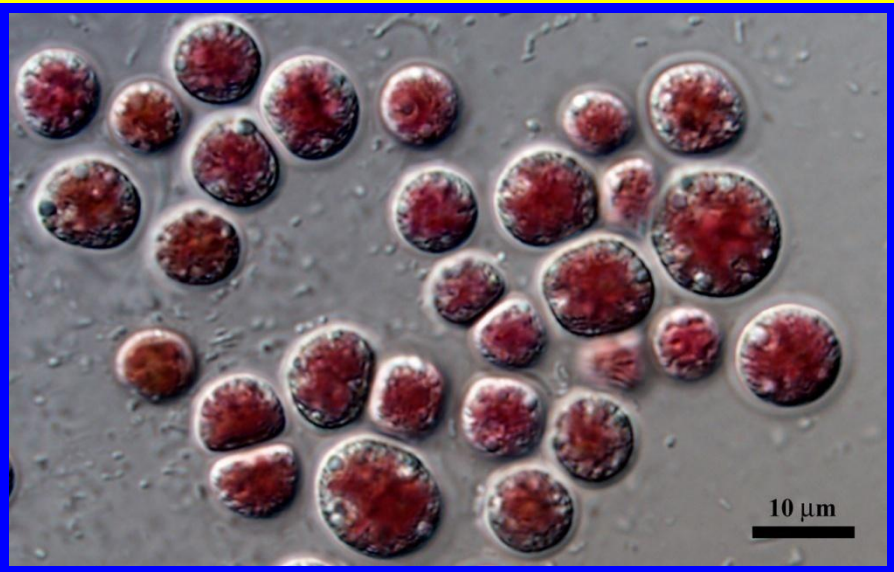
Chapter II Plant Cells and Tissues - Morphology of Cells

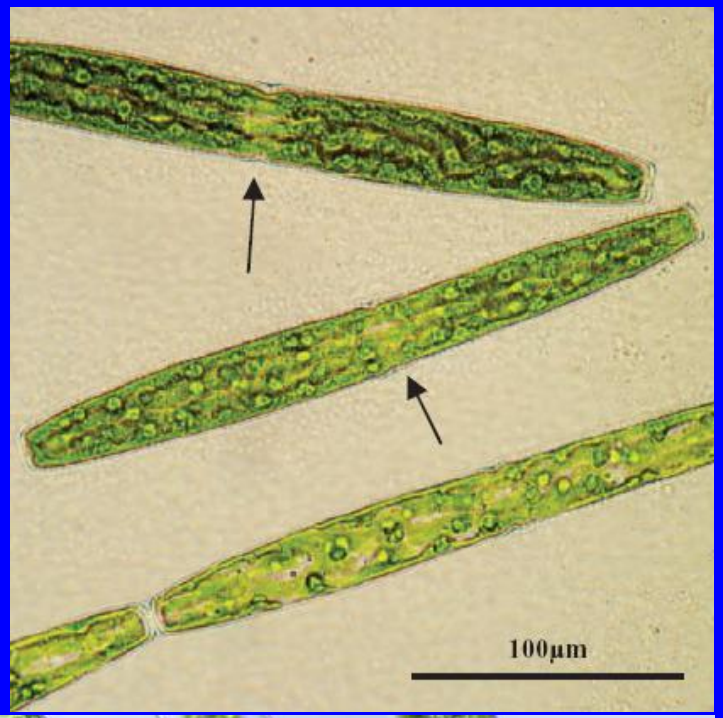
Chloroplast

Leucoplast

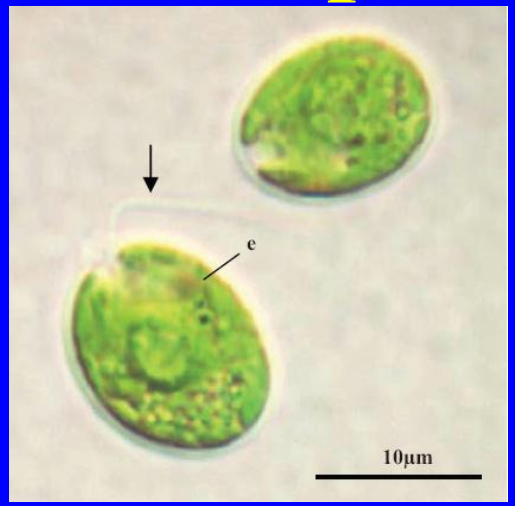


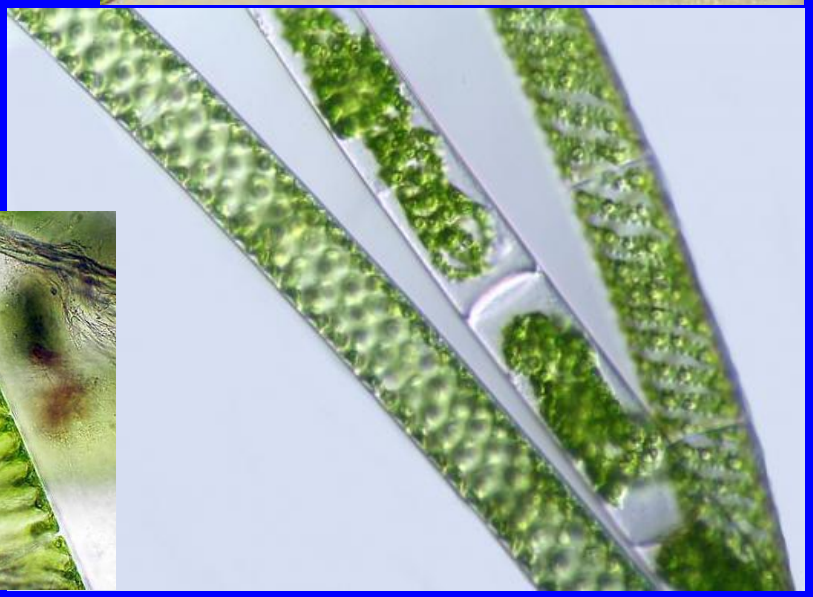
Chromoplast





Morphology of chloroplasts in algae





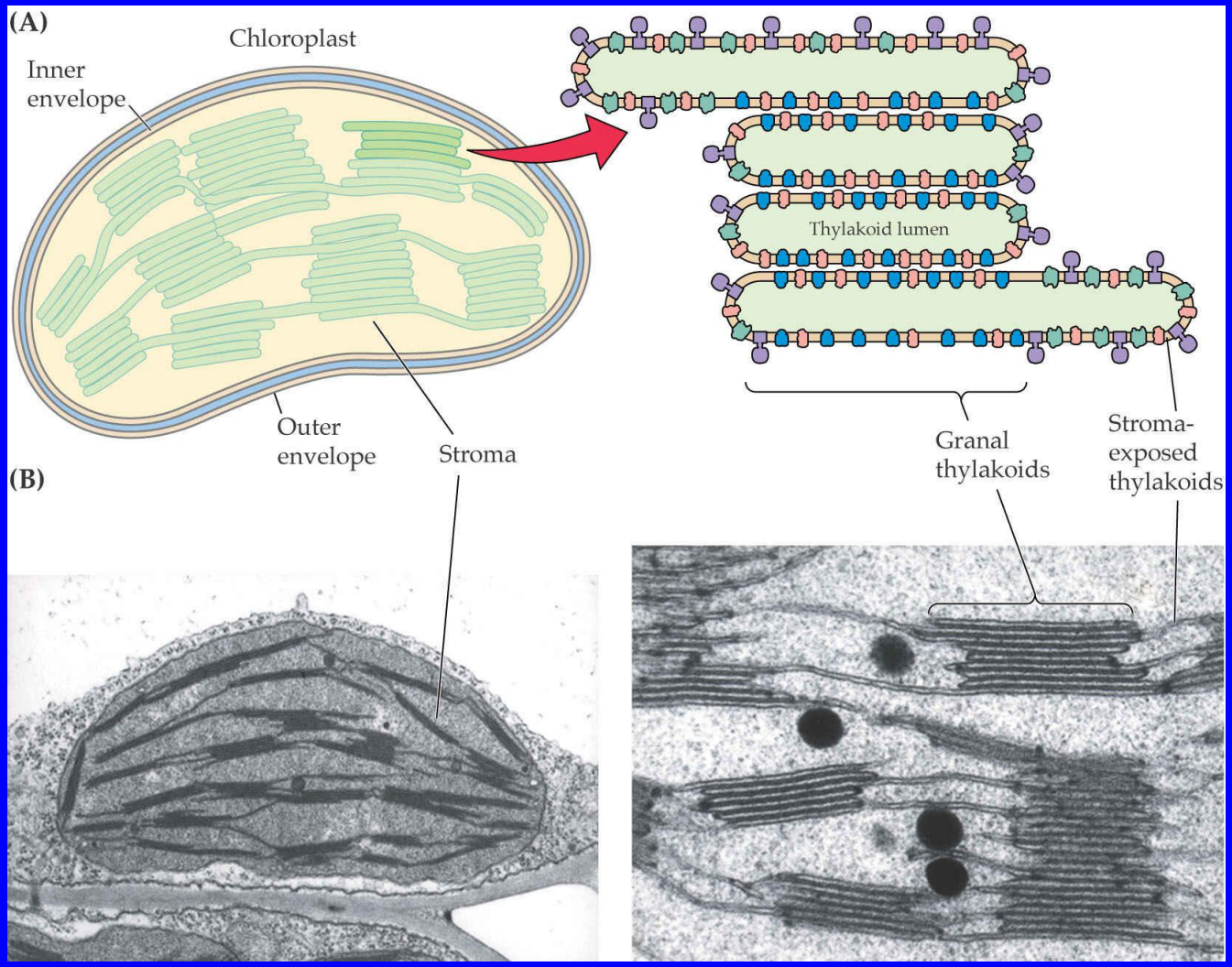
Chapter II Plant Cells and Tissues - Morphology of Cells

③ Structure:

- Membrane (inner and outer membranes)
- Grana (composing of thylakoids, including stroma thylakoid)
- Stroma (zymoprotein)

④ Pigments:

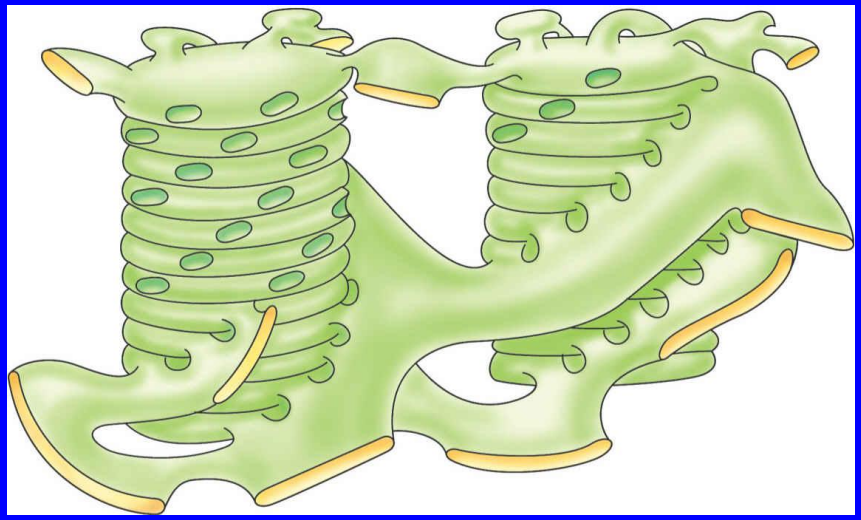
- Chlorophyll (primary pigment, absorbing and utilizing light energy).
- Carotenoid (accessory pigment, absorbing and transmitting light energy)
- Phycobilin (accessory pigment, absorbing and transmitting light energy)



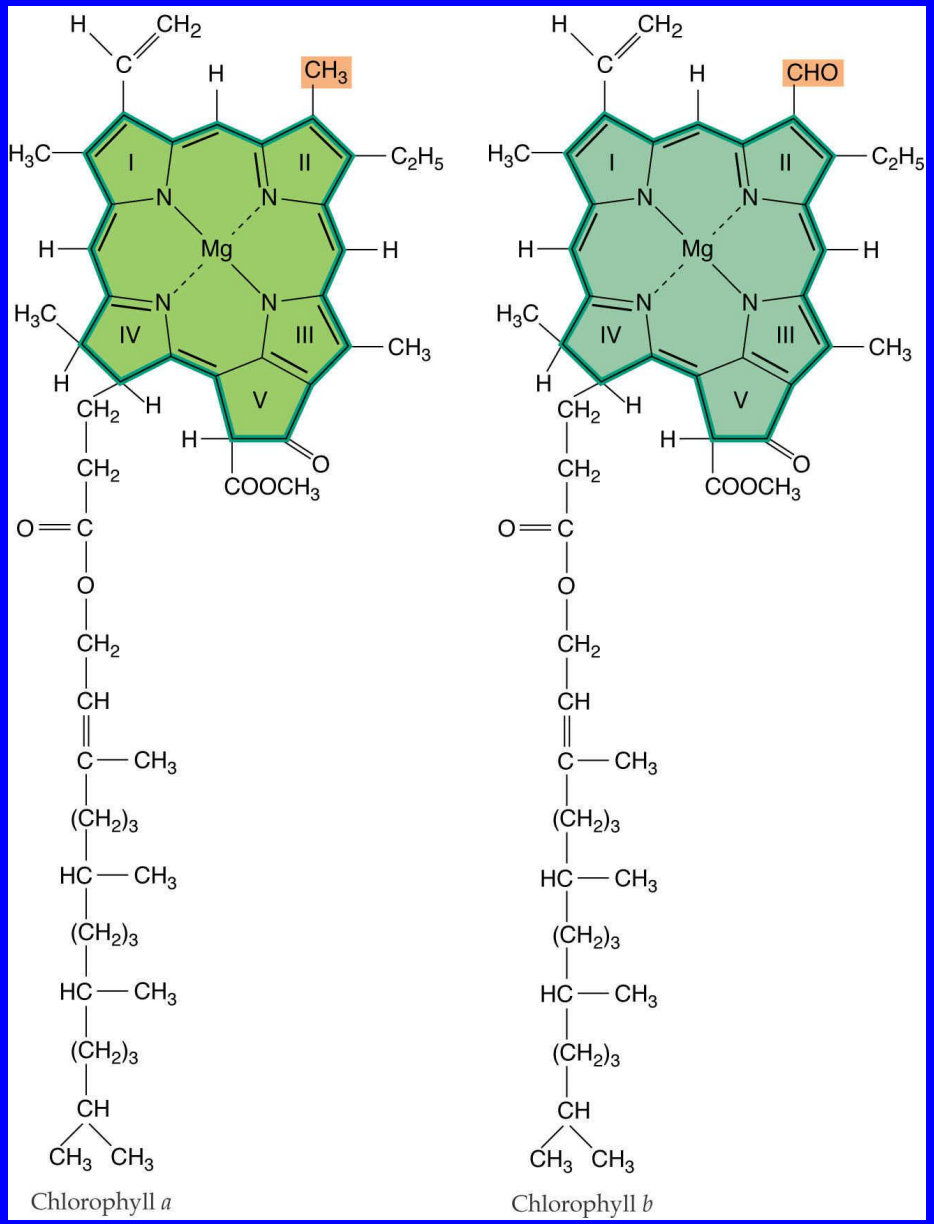
Schematic diagram (A) and trans-mission electron micro-graphs (B) of plant chloroplast.

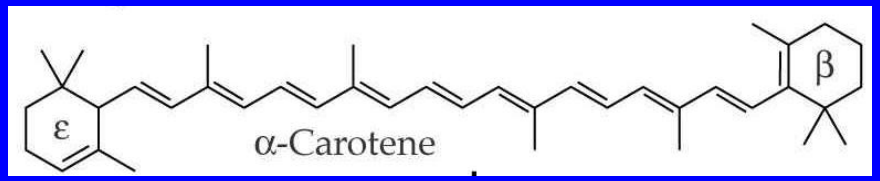
TEM depicting a single granum and associated stroma thylakoids of a freeze-fractured pea chloroplast.

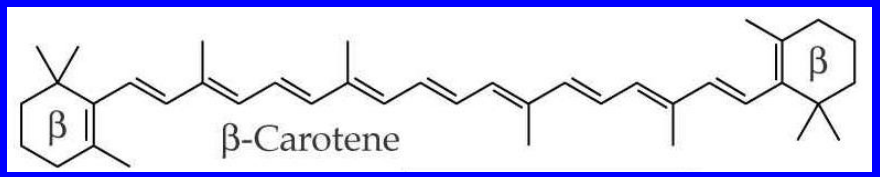
Diagram illustrating the spatial relationship between stacked grana and interconnecting stroma thylakoids.

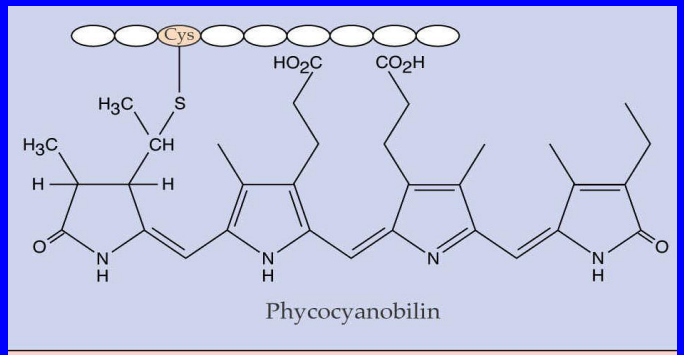


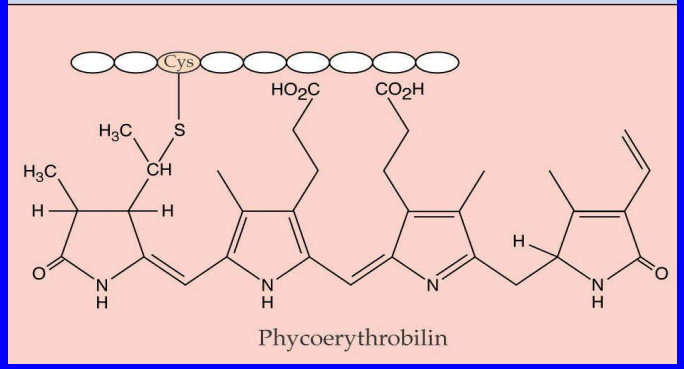
Chapter II Plant Cells and Tissues - Morphology of Cells





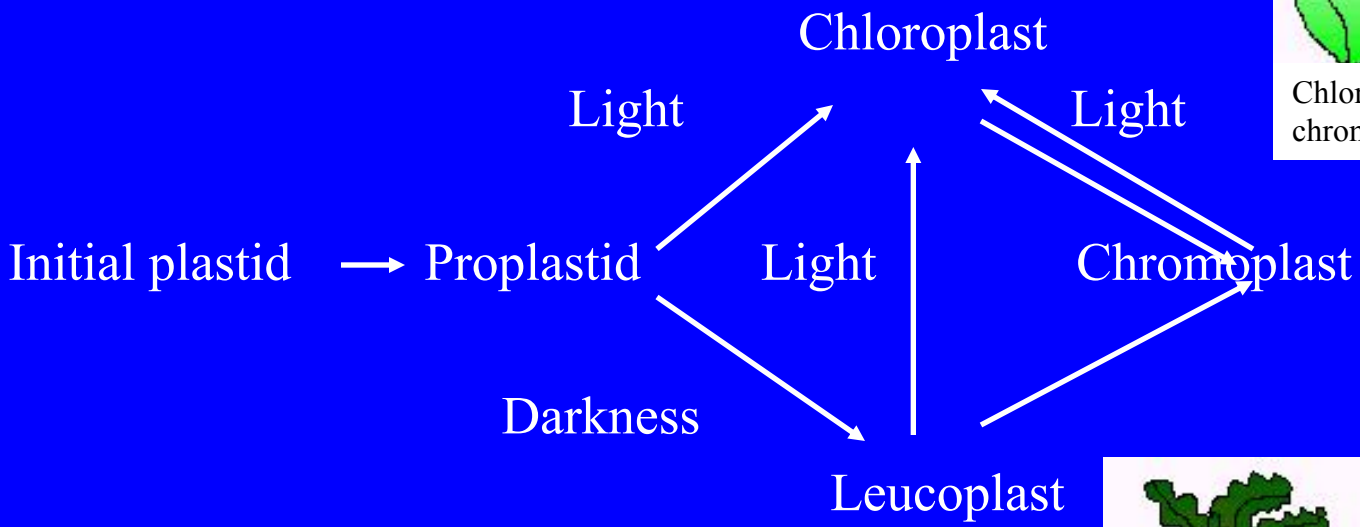


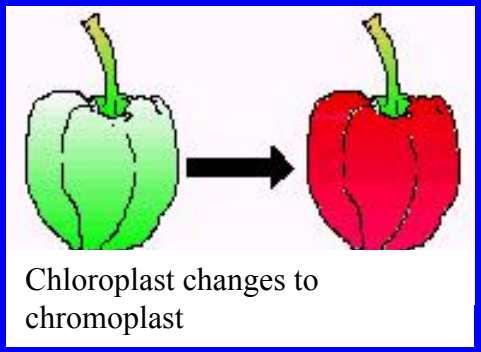


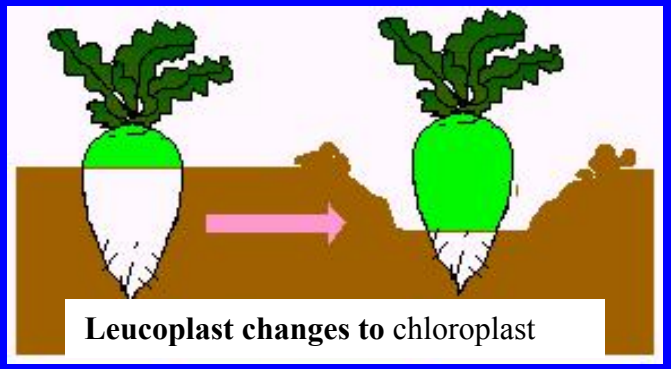


Chapter II Plant Cells and Tissues - Morphology of Cells

⑤Plastid development and evolution




Chloroplast changes to chromoplast

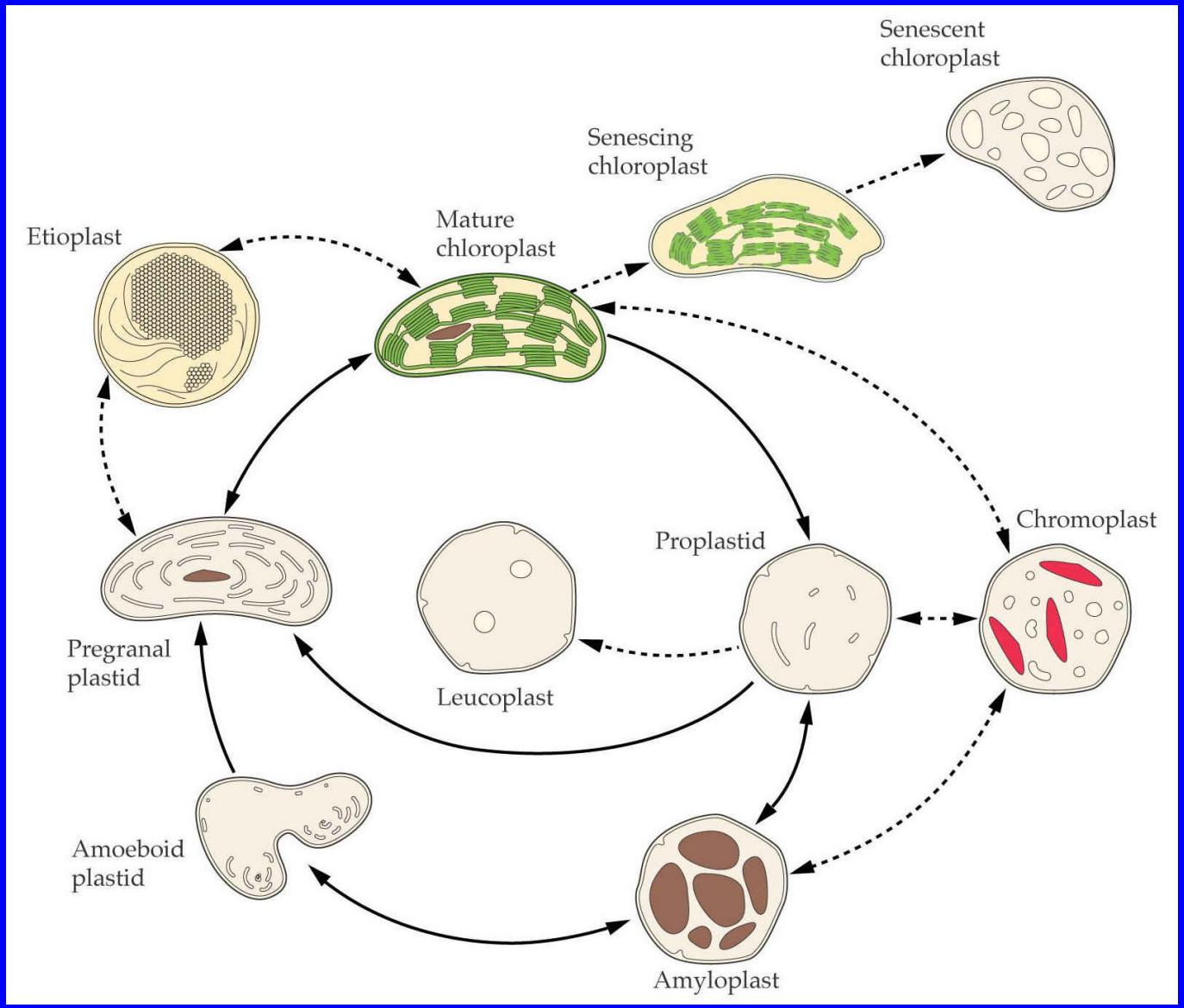

Leucoplast changes to chloroplast

E.g. Tomato: white→green →salmon pink

Carrot: salmon pink→green

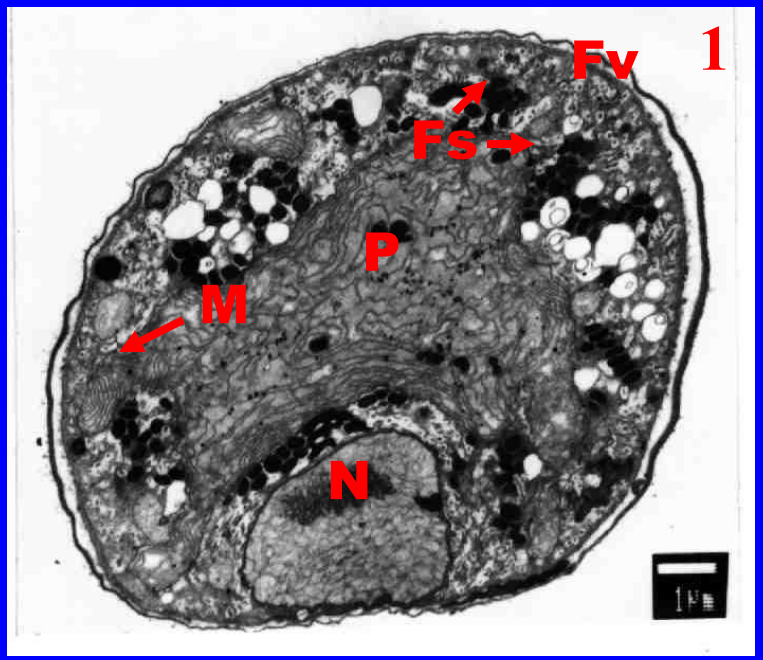
Mung bean sprout: white →green

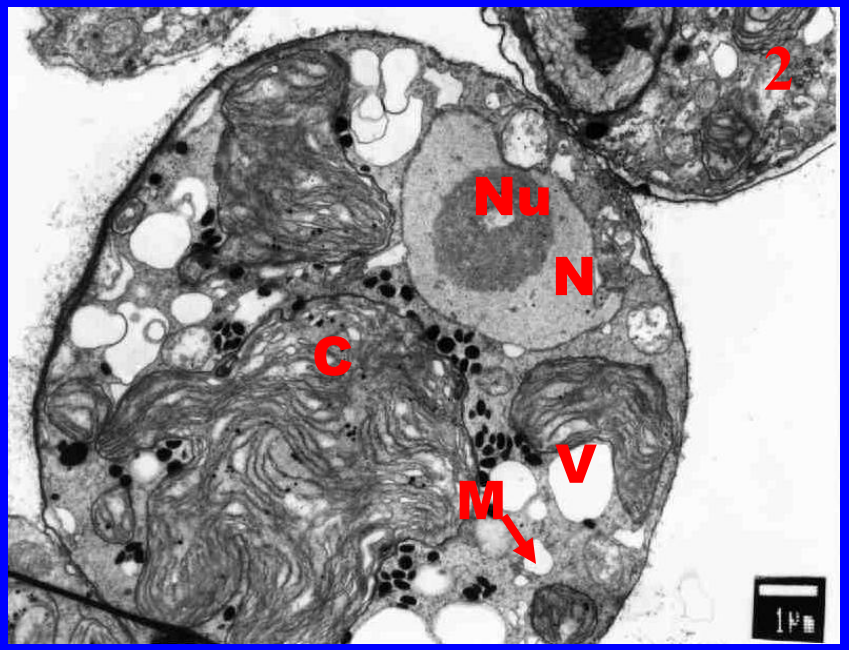
Chapter II Plant Cells and Tissues - Morphology of Cells



The plastid develop-mental cycle and the inter-conversion of various plastid types.

Ultrastructure of unreleased monospore isolated from *Porphyra yezoensis* thallus after enzymatic dissociation. Fig. 1 showing fibrillar vesicle (Fv), floridean starch (Fs), mitochondria (M), nucleus (N), and pyrenoid (P), and Fig. 2 showing chloroplast (C), mitochondria (M), nucleus (N), nucleolus (Nu), and vacuole (V).





Assignments

- What are the types of plastids? Illustrate the relationship among them, and describe the way of their evolution.