The Plant Cell, Chapter 2

<u>Chapter 2 – The Plant Cell</u>

Macroscopic time-lapse video of plants

The tree of life

Properties of prokaryotic and eukaryotic cells

The ***Cell Theory*** – cells are the basic unit of life

Cell wall structure and function

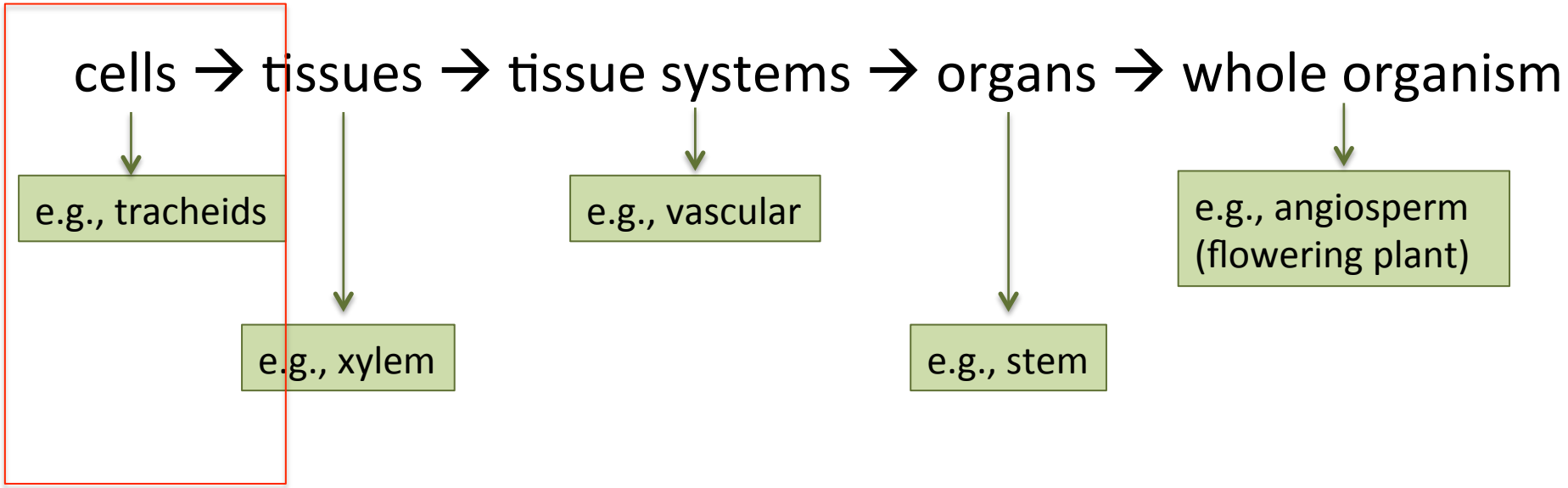
Major ***organelles*** in the eukaryotic plant cell

All cells have a ***plasma membrane***, a selective barrier

The ***central vacuole*** and ***osmosis*** – the passive movement of water

Cell division (***mitosis***) in a plant cell

Hierarchical organization of ***multicellular*** organisms (e.g., plants, animals)

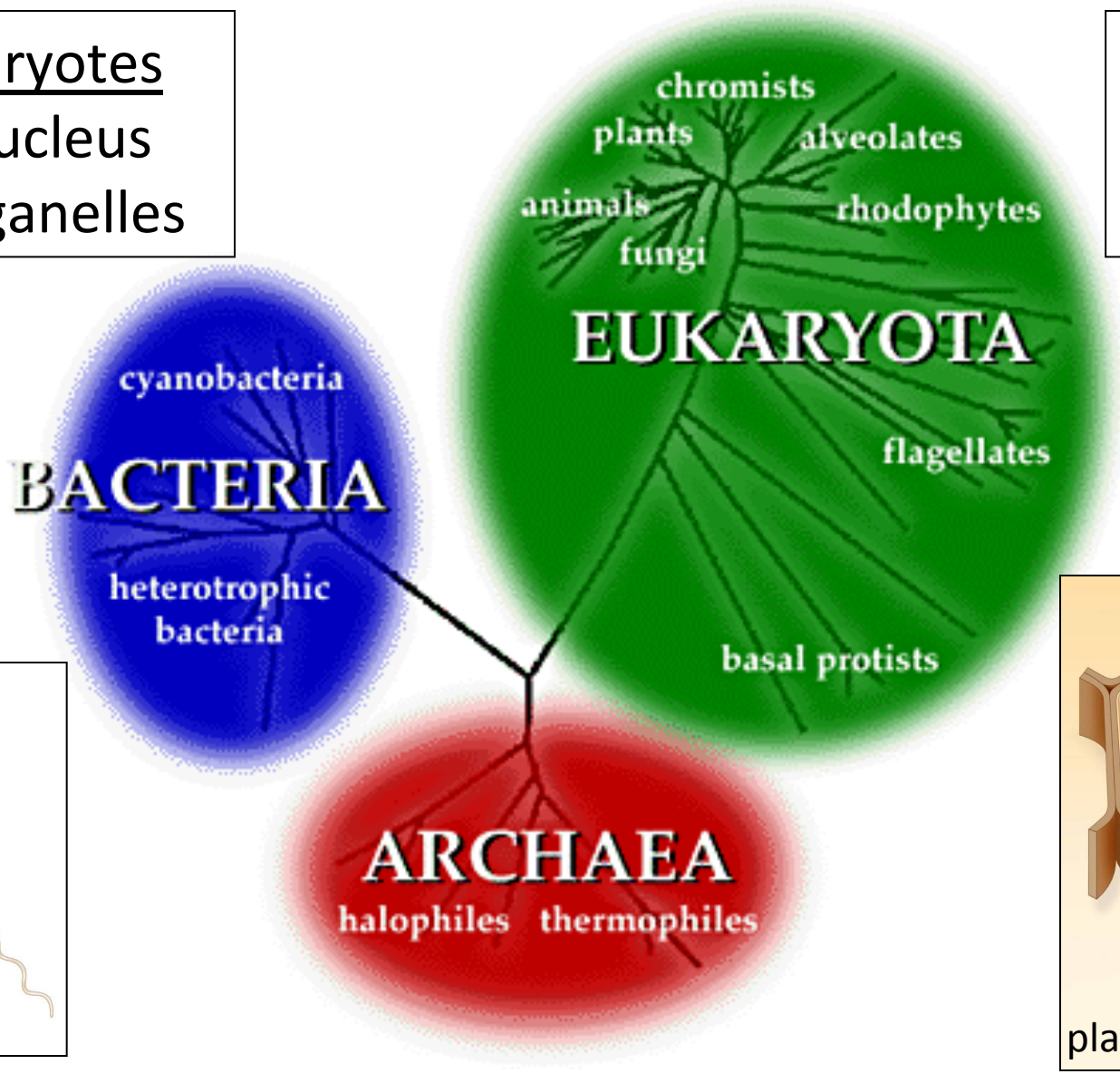


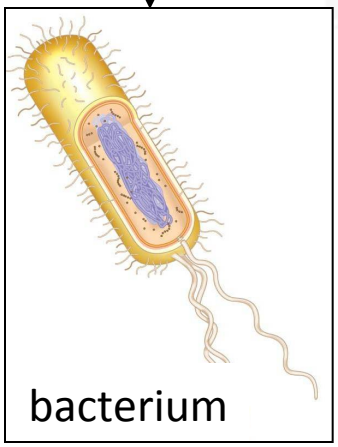
Macro time lapse video

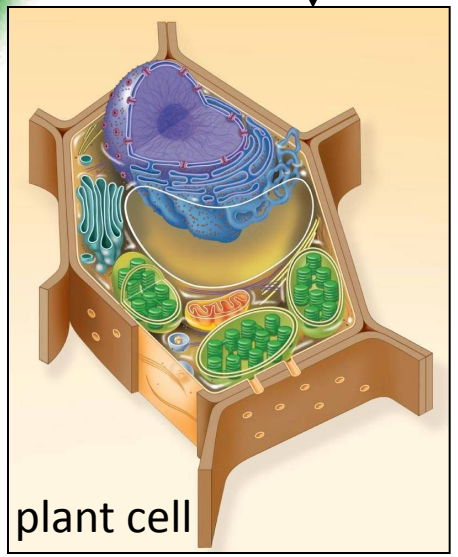
The 3 *Domains of Life*

Prokaryotes
No nucleus
No organelles

Eukaryotes
Nucleus
Organelles




bacterium


plant cell

Basic features of *all* cells

1. **Plasma membranes** – a selective barrier made of lipids and proteins
2. **Cytoplasm** – a jellylike fluid containing all organelles and other components
3. **Chromosomes** - carry genes in the form of DNA, chromosomes duplicate before cell division
4. **Ribosomes** – small complexes of proteins and RNA molecules that are sites of protein assembly

"Understanding science can change your perception of things when you look beyond what meets the eye and better understand things at a smaller, microscopic level…" *PBIO6 student*

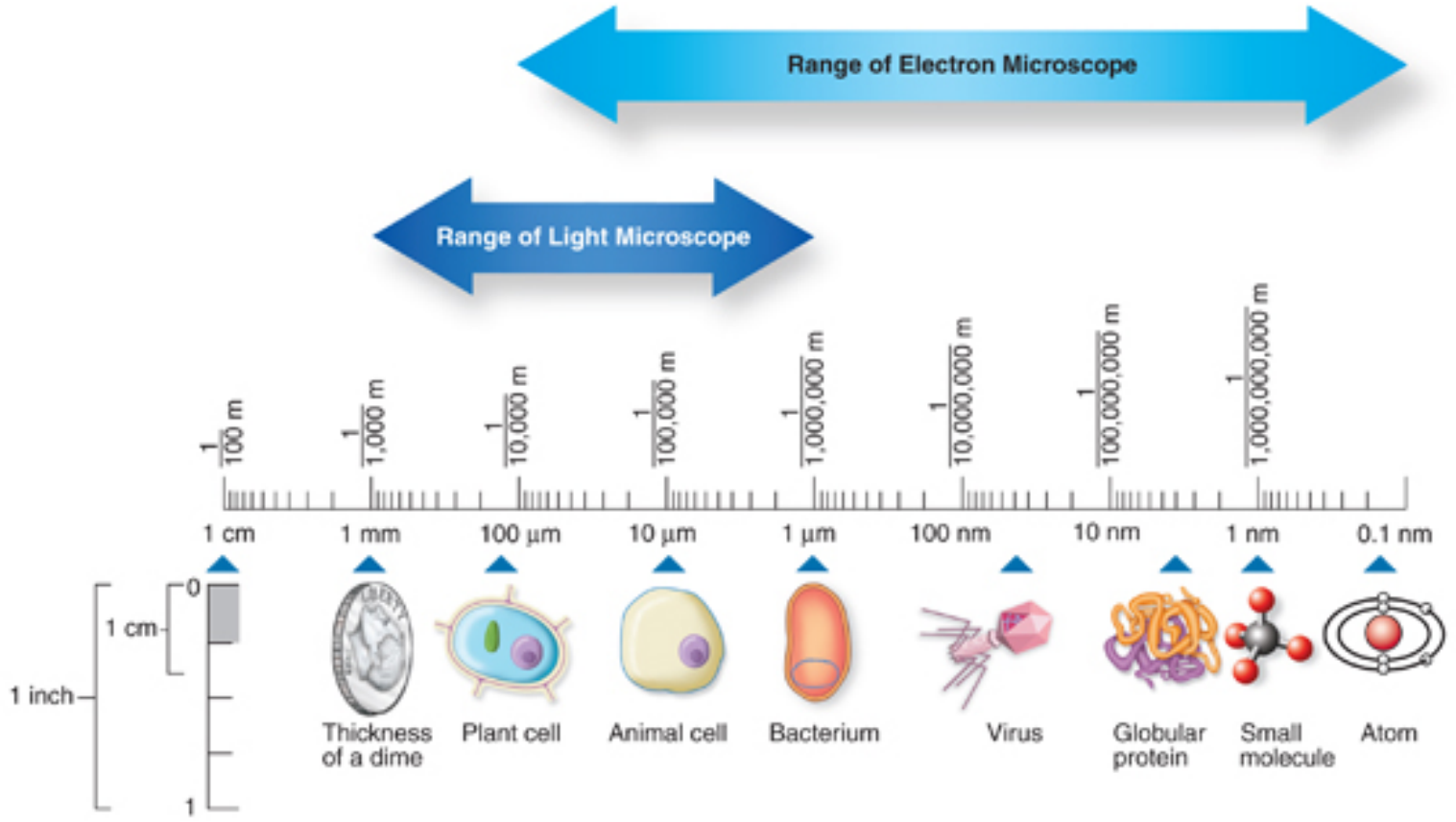


Figure 2.1 Biological measurements. The scale ranges from 1 centimeter (0.01 meter) down to 0.1 nanometer (0.000000001 meter).

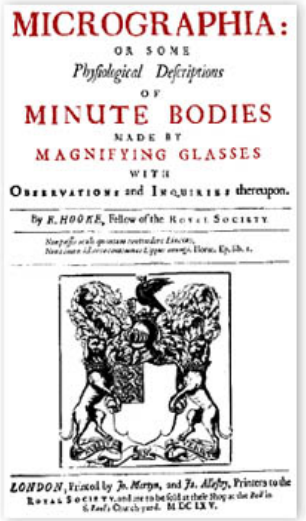
Range of measurements:

1 mm = 0.001 m, 10^{-3} m (thickness of a dime)

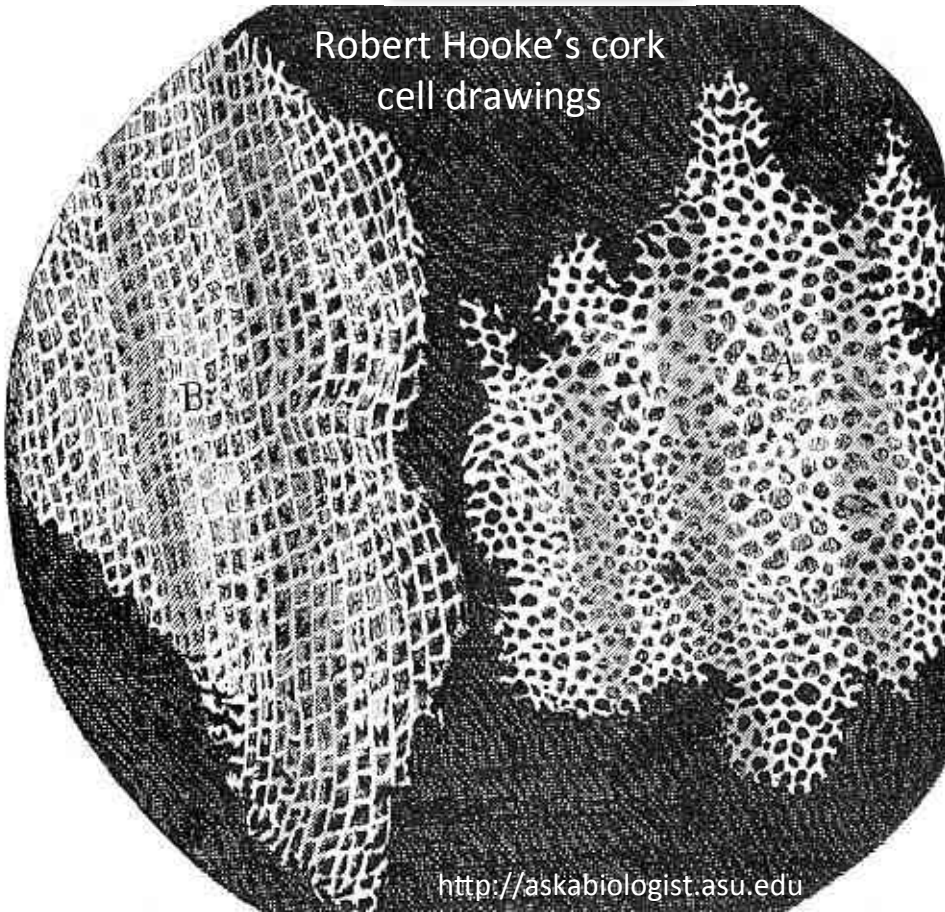
1 nm = 0.000000001 m, 10^{-9} m (size of a small molecule; e.g., methane CH_4)

Cell Theory

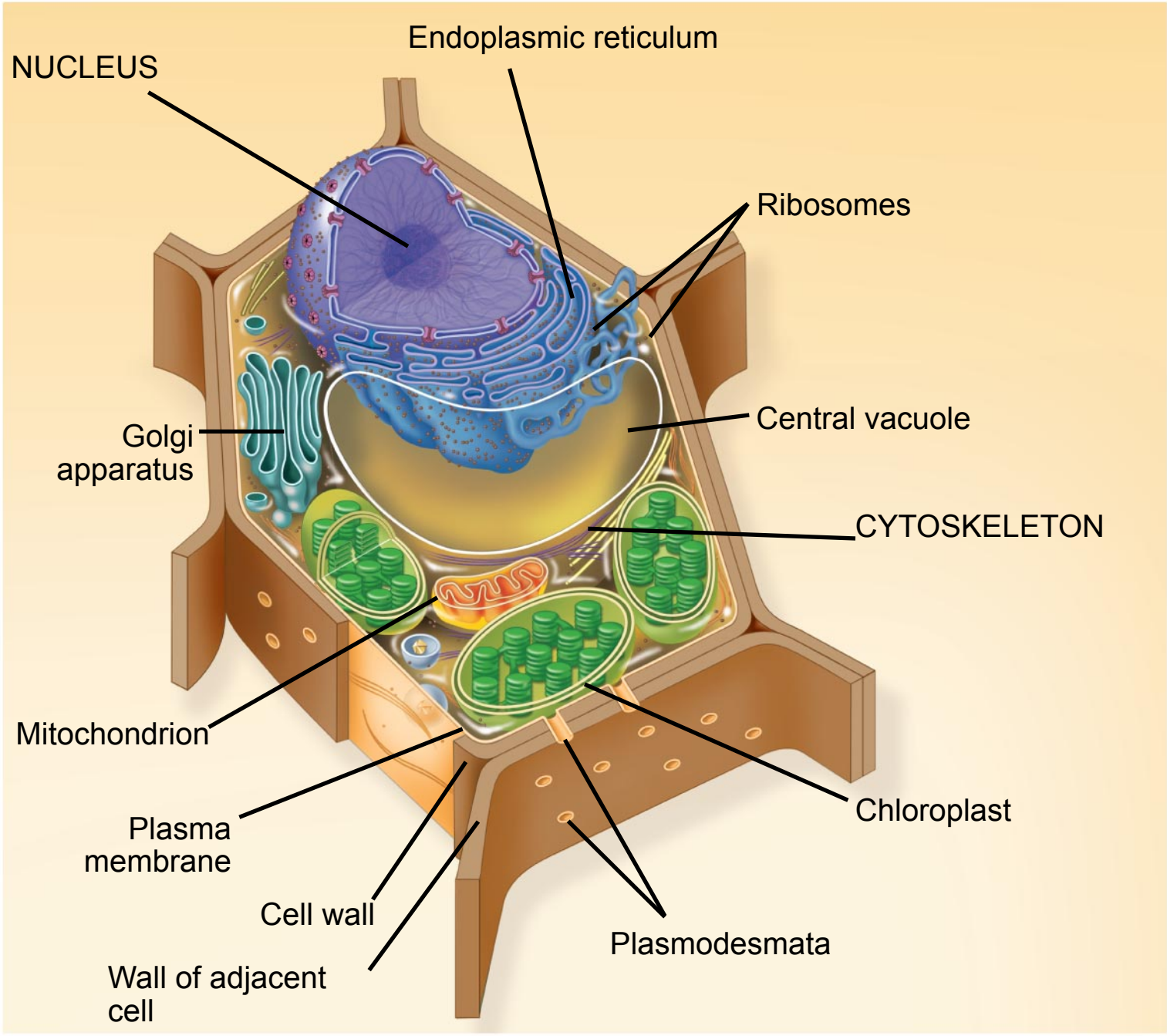
1. life cannot exist beneath the level of a cell
2. all organisms are composed of cells (both uni- and multi-cellular)
3. all cells arise from preexisting cells via cell division


MICROGRAPHIA:
OR SOME
Physiological Descriptions
OF
MINUTE BODIES
MADE BY
MAGNIFYING GLASSES
WITH
OBSERVATIONS and INQUIRIES thereupon.
By R. HOOKE, Fellow of the ROYAL SOCIETY.
LONDON, Printed by Jo. Martyn, and Ja. Allestry, Printers to the ROYAL SOCIETY, and are to be sold at their Shop at the Bell in S. Paul's Church-yard. M. DC. LX. V.

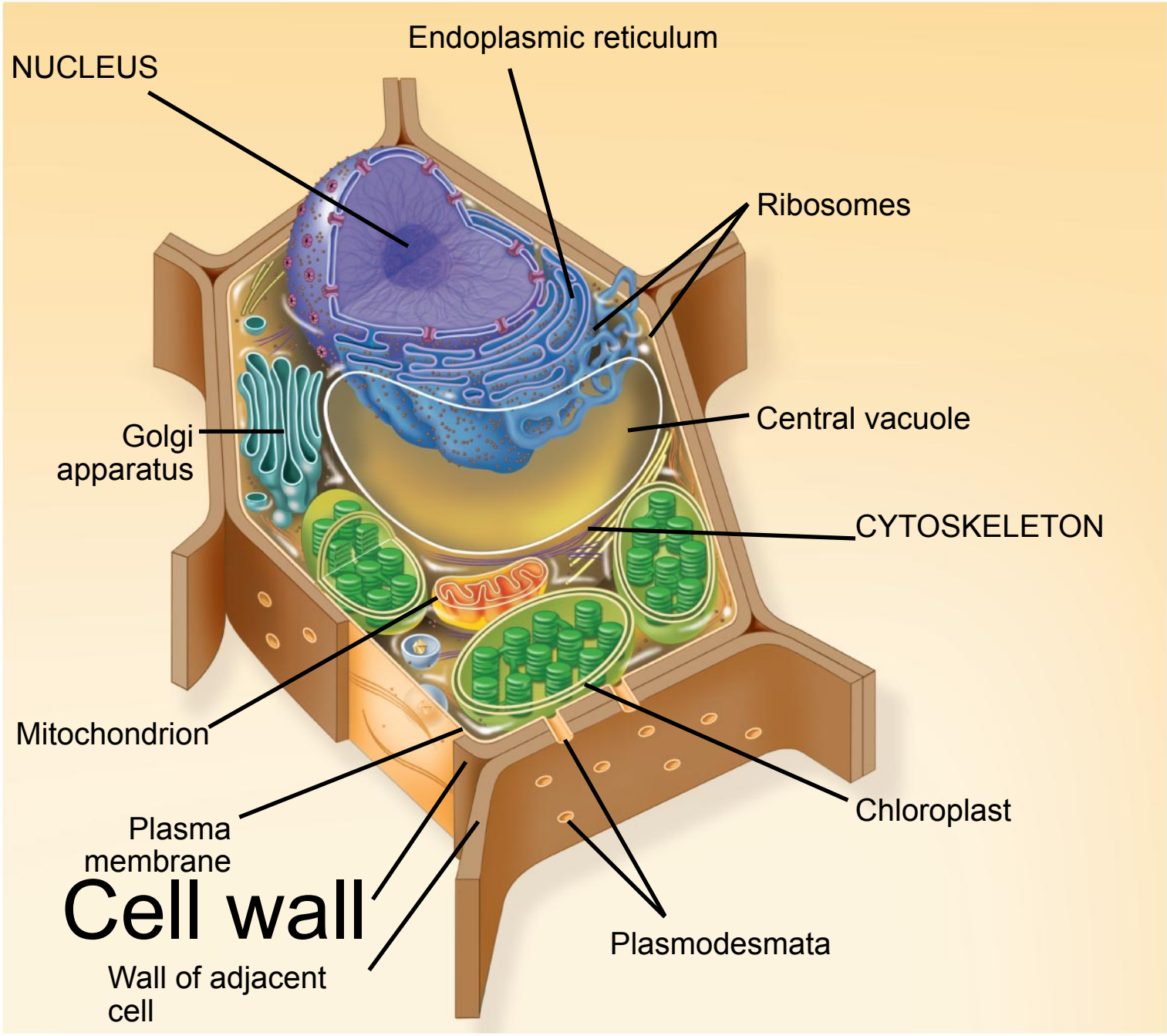
..2 Robert Hooke's microscope.



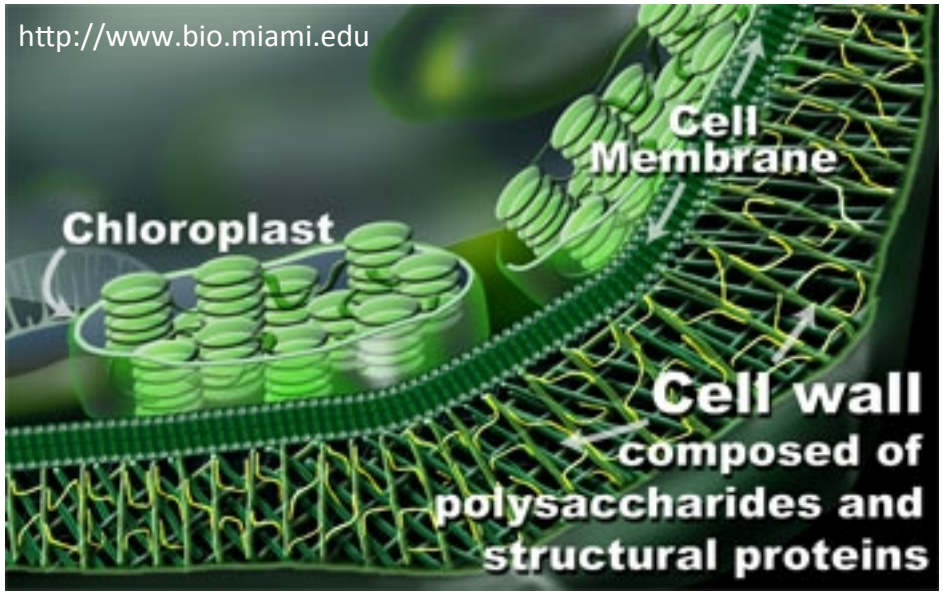
The Plant Cell



The Plant Cell



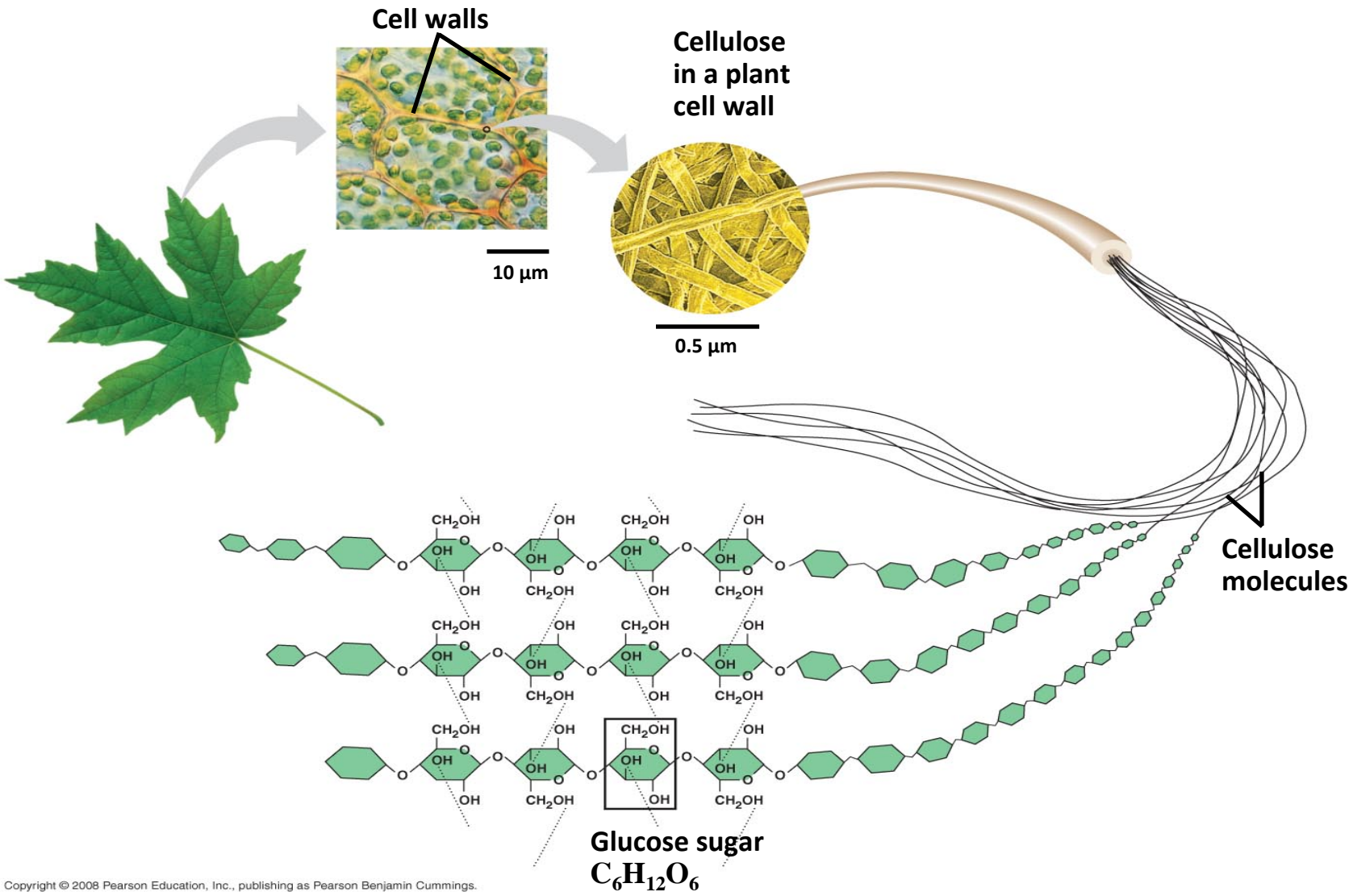
All plant cells are contained by a ***cell wall***



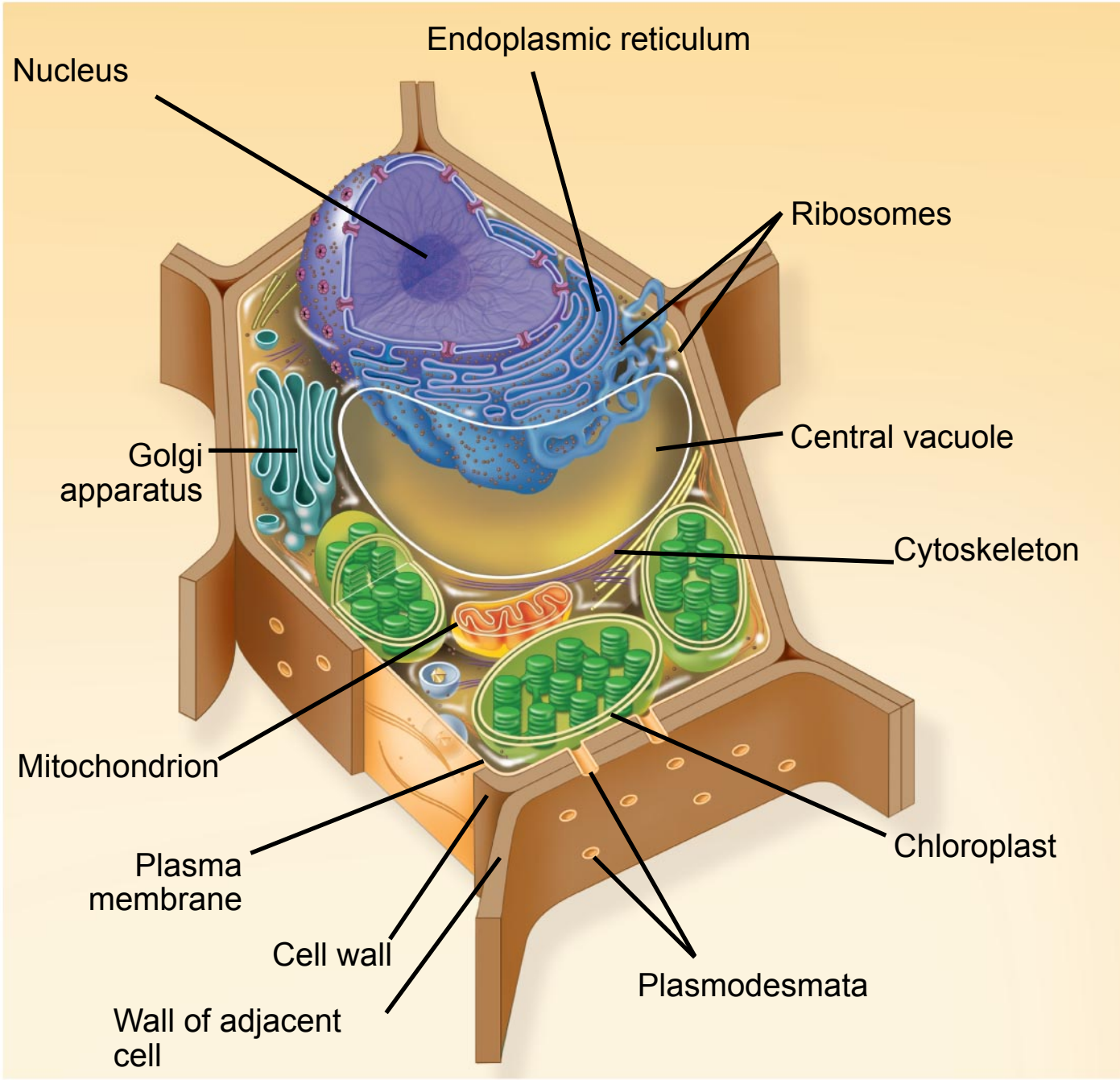
cell wall – the outer layer of a plant cell consisting of various carbohydrates (e.g., cellulose, pectin, lignin) and proteins

- *primary cell wall* is <u>thin</u> and <u>flexible</u>
- *secondary cell wall* is <u>stiff</u> (lignin) and <u>waterproof</u> (suberin)

Cellulose is a major part of the cell wall



The plant cell contains many ***organelles***, each with a specific structure and function



Nucleus = the cell's "information center"

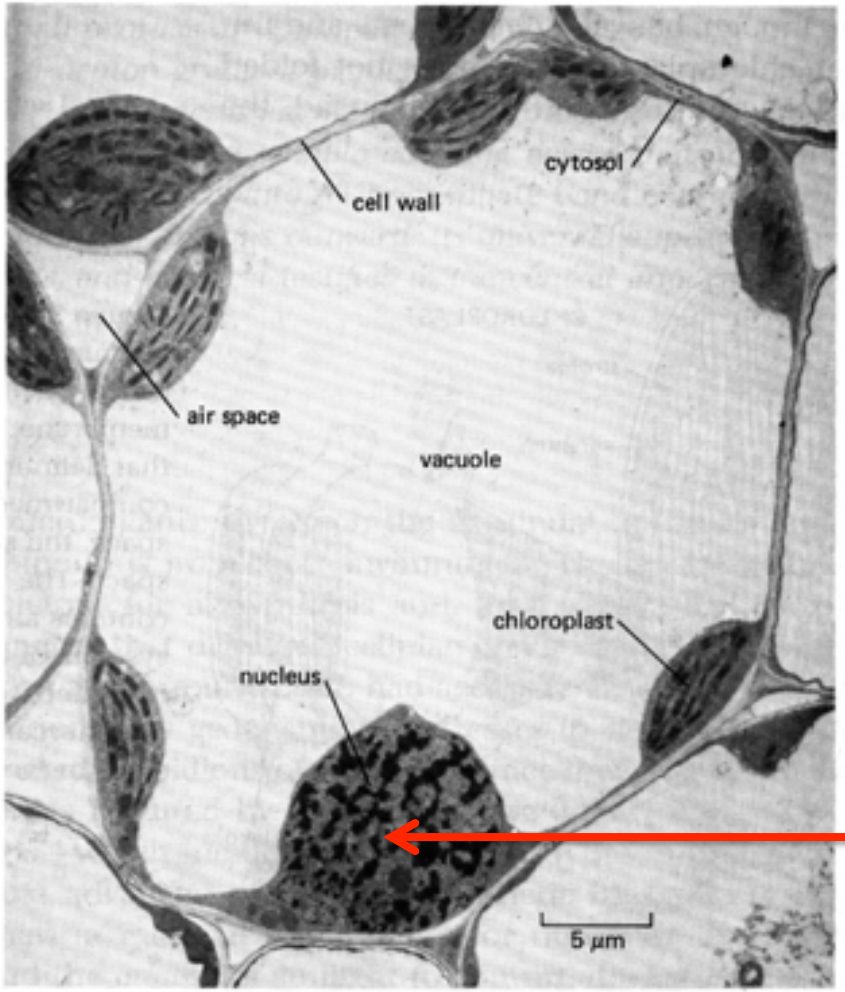


Figure 9–40 An electron micrograph of a wheat leaf cell. Note the ring of cytoplasm-containing chloroplasts that surrounds a large vacuole. (Courtesy of Kitty Plaskitt.)

The nucleus contains ***chromosomes*** - long strands of DNA that contain genes

nucleus

http://mimp.mems.cmu.edu

DNA and genes

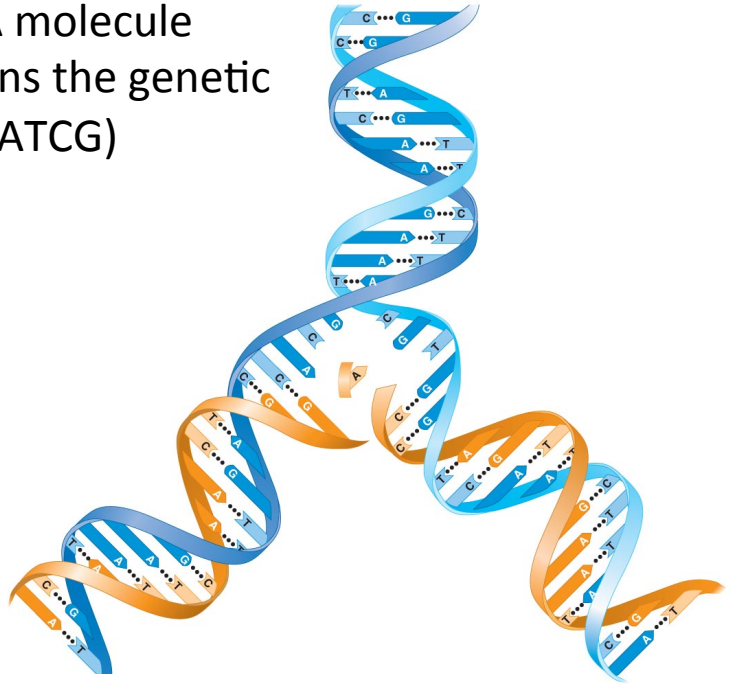
```
TGAATTCGTG GGTCGAAGAG CCCTTTGCCT CGTCTCTCTG GTACCGTGTA TGTCAAAGGT    60
TCGCTTGCAC ACTGAACTTC ACGATGGCTA CTCTTCCTCA GAAAGACCCC GGTTATATTG   120
TAATTGATGT CAACGCGGGC ACCGCGGACA AGCCGGACCC ACGTCTCCCC TCCATGAAGC   180
AGGGCTTCAA CCGCCGCTGG ATTGGAACTA ATATCGATTT CGTTTATGTC GTGTACACTC   240
CTCAAGGTGC TTGTACTGCA CTTGACCGTG CTATGGAAAA GTGTTCTCCC GGTACAGTCA   300
GGATCGTCTC TGGCGGCCAT TGCTACGAGG ACTTCGTATT TGACGAATGC GTCAAGGCCA   360
TCATCAACGT CACTGGTCTC GTTGAGAGTG GTTATGACGA CGATAGGGGT TACTTCGTCA   420
GCAGTGGAGA TACAAATTGG GGCTCCTTCA AGACCTTGTT CAGAGACCAC GGAAGAGTTC   480
TTCCCGGGGG TTCCTGCTAC TCCGTCGGCC TCGGTGGCCA CATTGTCGGC GGAGGTGACG   540
GCATTTTGGC CCGCTTGCAT GGCCTCCCCG TCGATTGGCT CAGCGGCGTG GAGGTCGTCG   600
```

Genetic code for the hexose oxidase gene

genetic code = a unique sequence of ATCG molecule

- each letter represents a nitrogen-containing molecule called a ***base***

A DNA molecule contains the genetic code (ATCG)

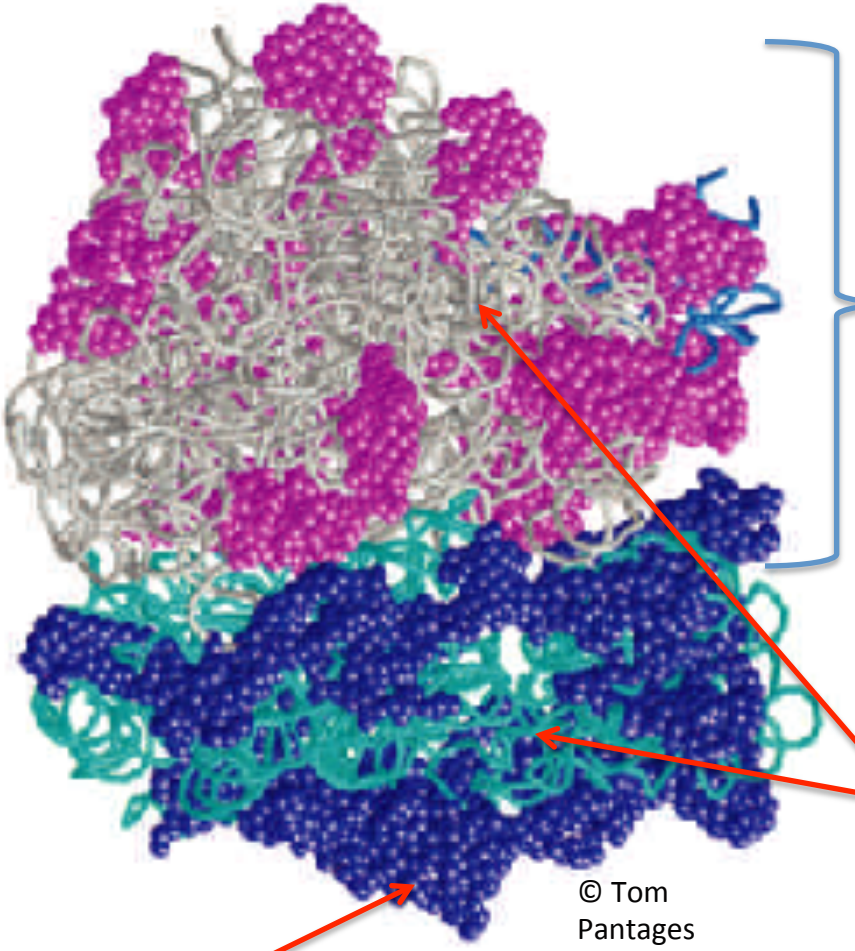


A duplicating DNA molecule

Genes contain instructions for the assembly of the <u>entire</u> organism!

Genes contain instructions for making **proteins…**

Ribosomes are sites of protein assembly



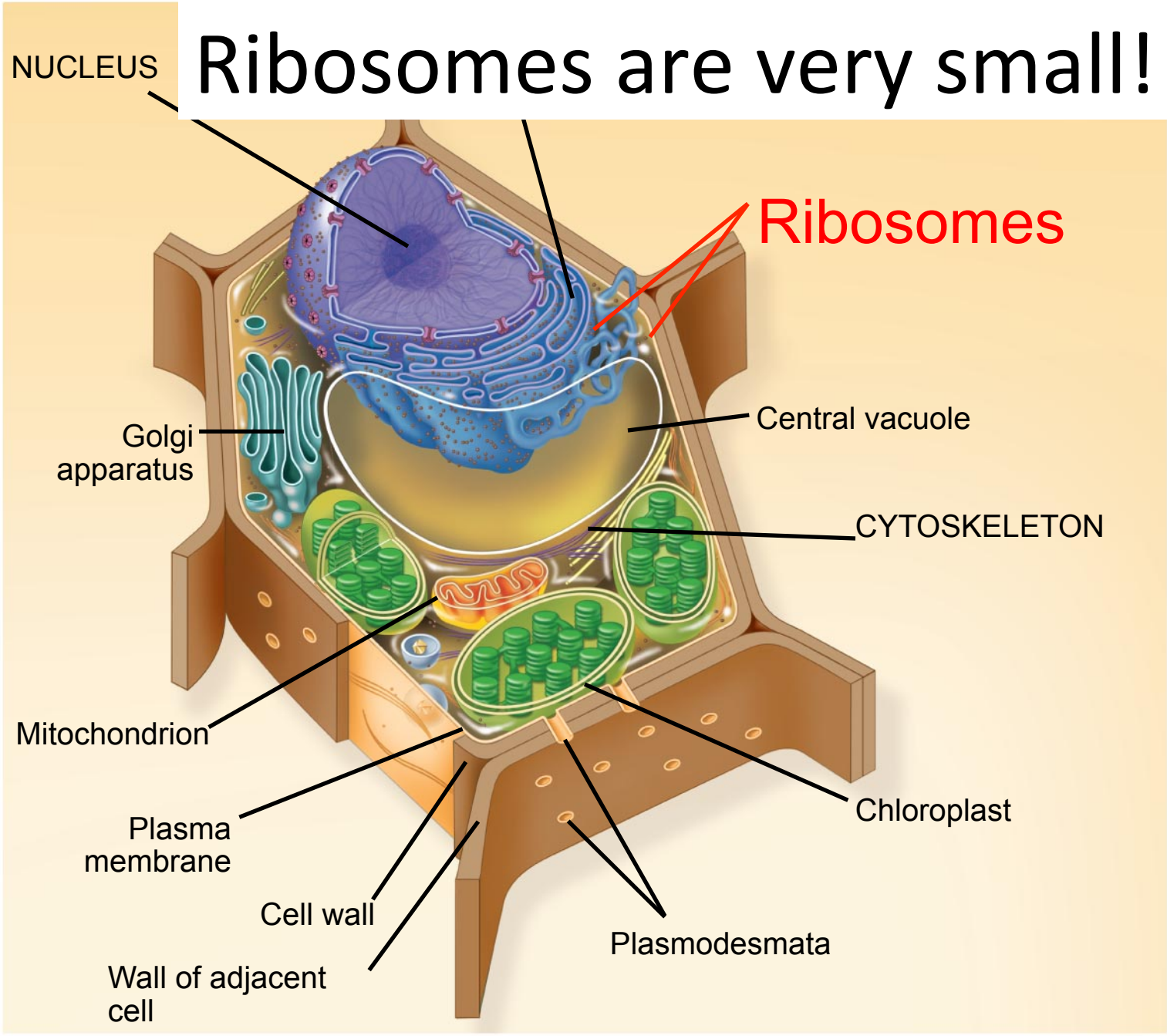
A **ribosome** is a molecule consisting of *RNA* and *proteins*.

RNA

proteins
(pink and purple)

The Plant Cell

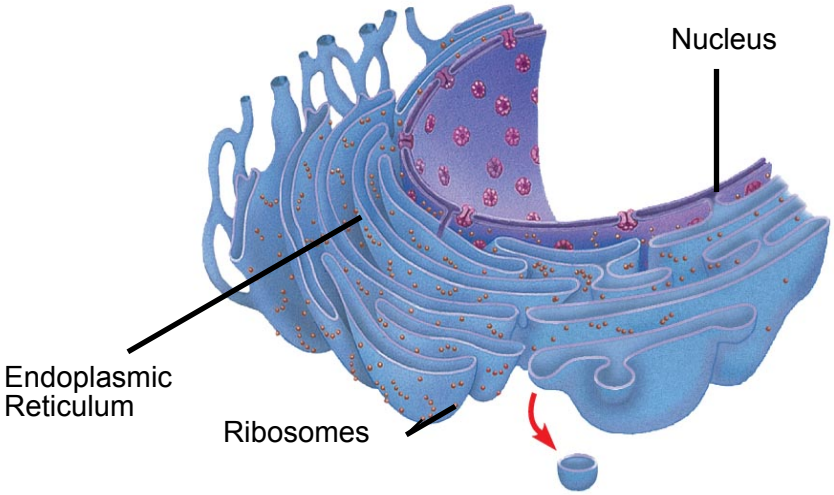
Ribosomes are very small!

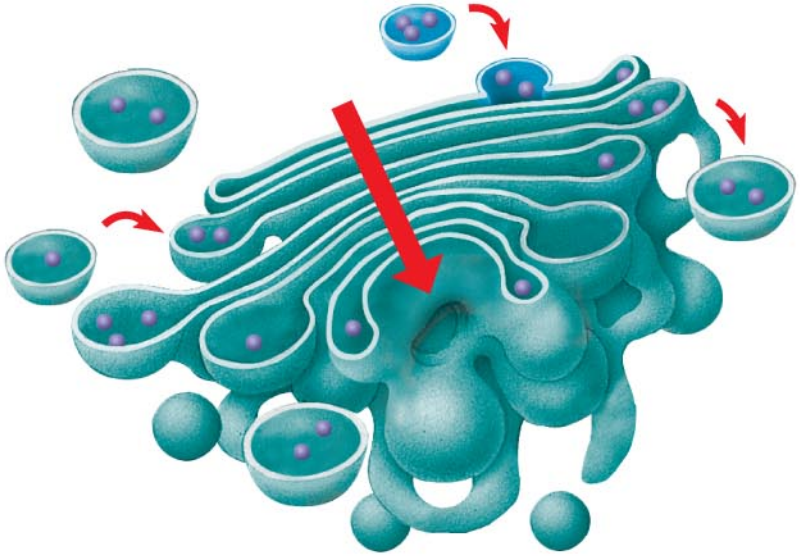


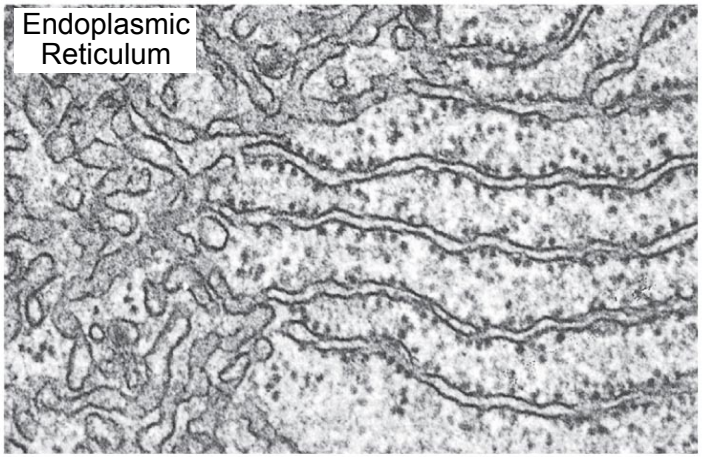
Many **proteins** are **processed and shipped** after leaving the ribosome

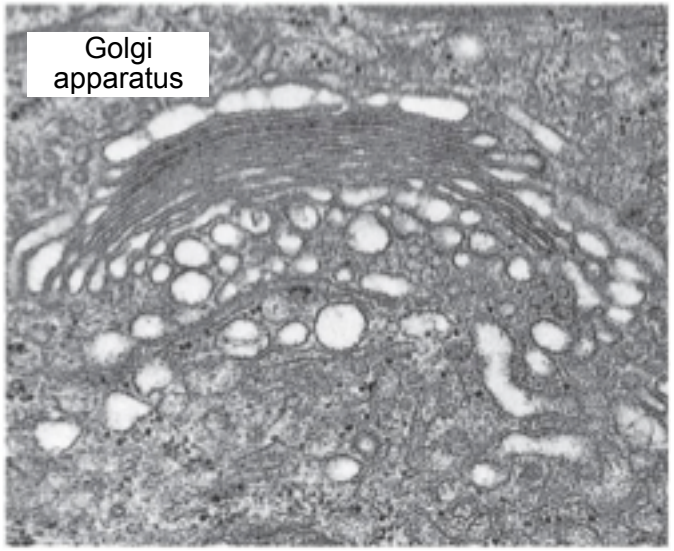
Endoplasmic reticulum **–** protein processing

Golgi apparatus – the "warehouse;" proteins are shipped to their final destination

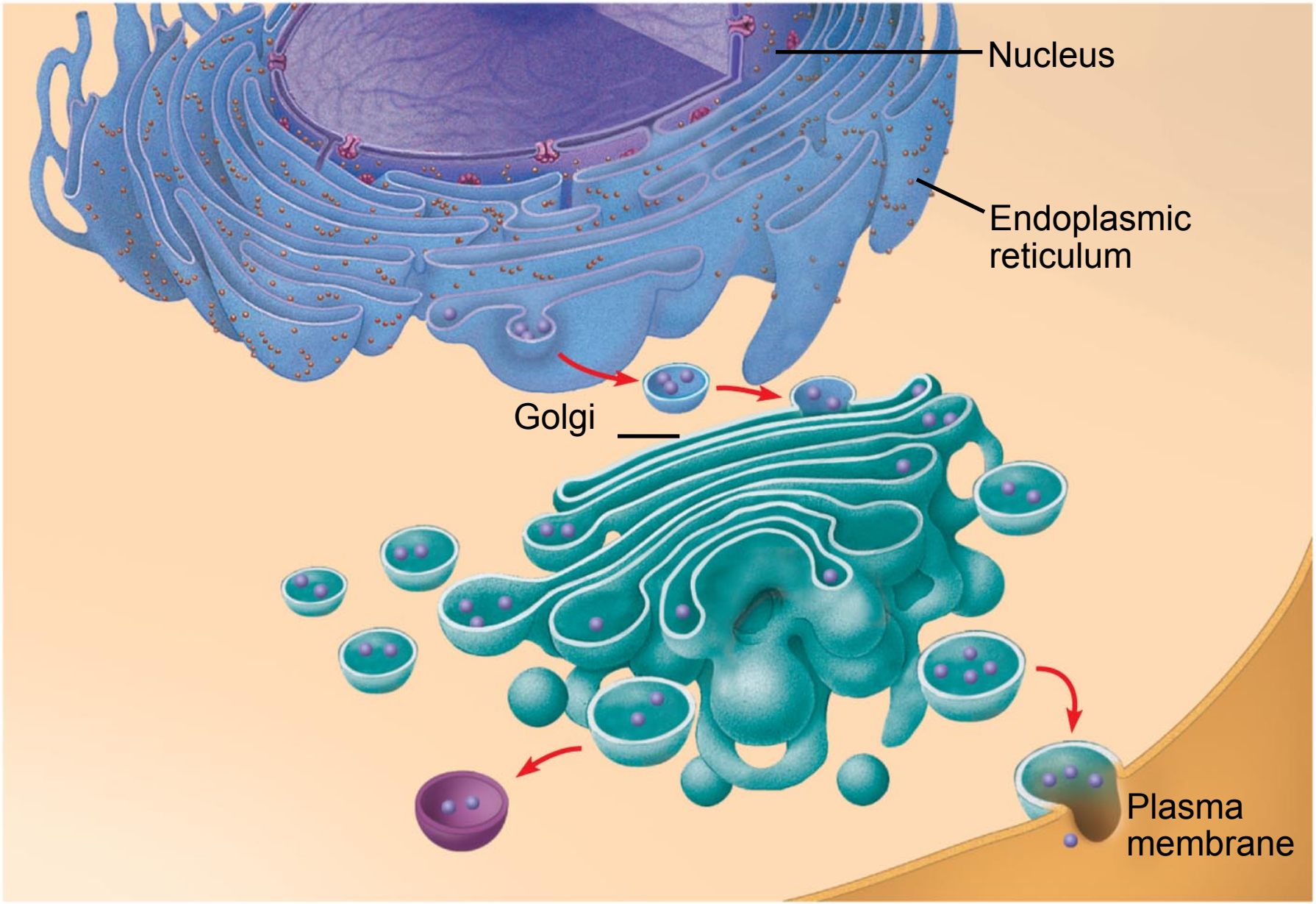








Connections within a cell



Biofuels: Using enzymes to make corn ethanol

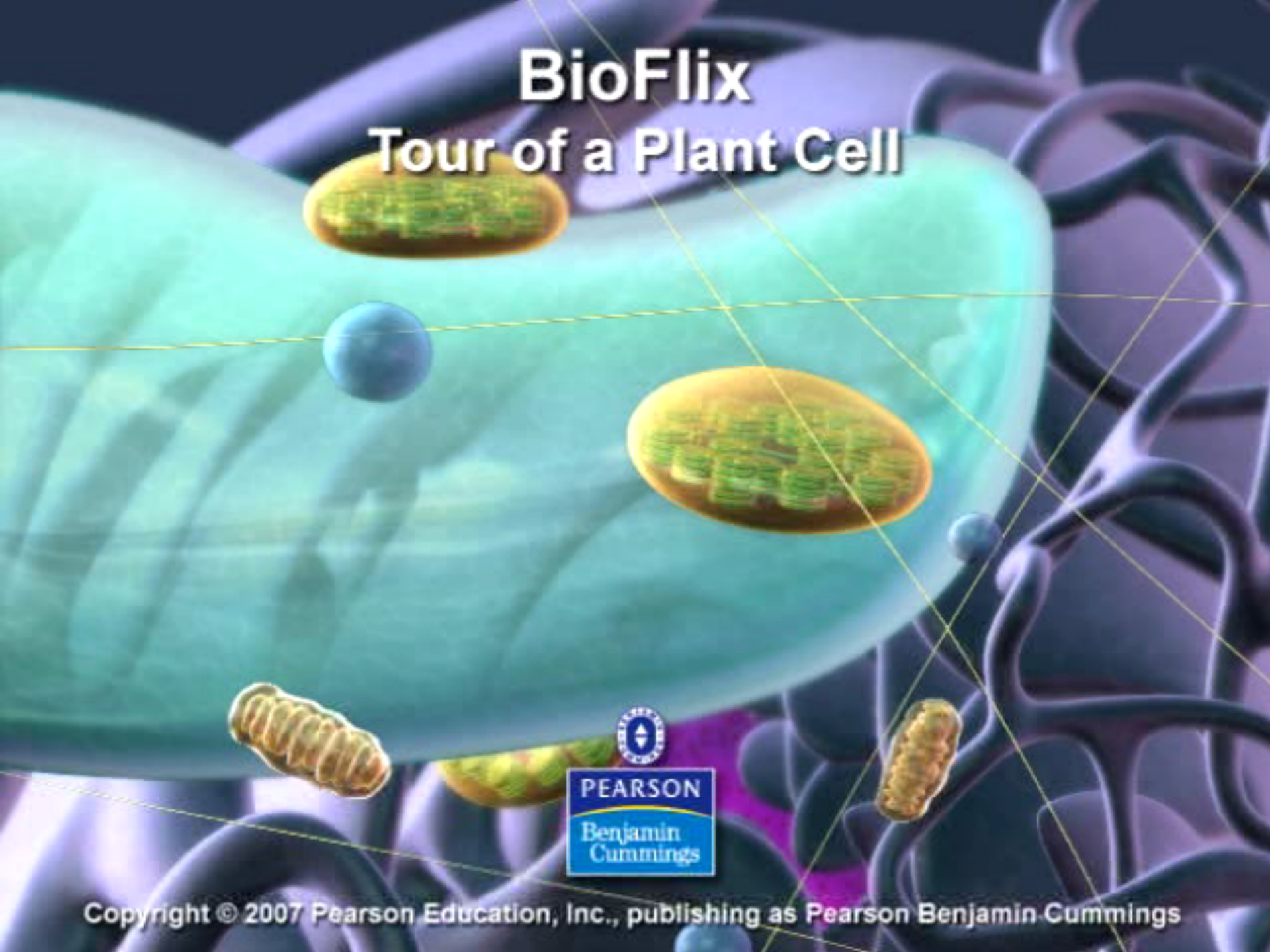
A vial of enzymes for cellulosic ethanol production.
Denmark-based company Novozyme

Link to NYT story on Blackboard.

enzyme = a protein catalyst used for a specific chemical reaction

Corn ethanol production has traditionally used enzymes to break down *starch* (e.g., from corn kernel) to make ethanol.

The future → <u>Cellulosic ethanol</u> using enzymes to break down *cellulose* (e.g., from cornstalks) to make ethanol.



Basic features of *all* cells

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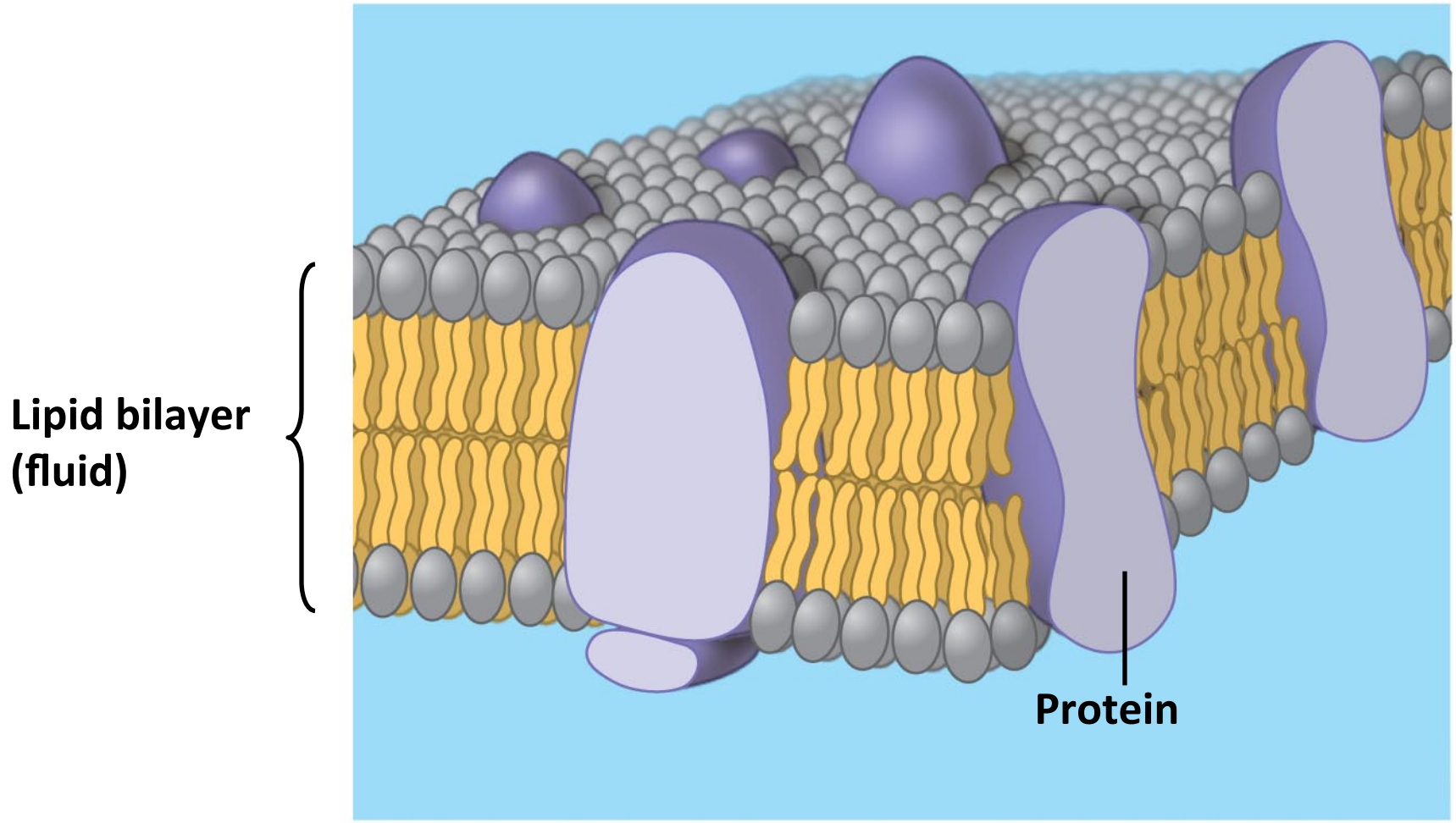
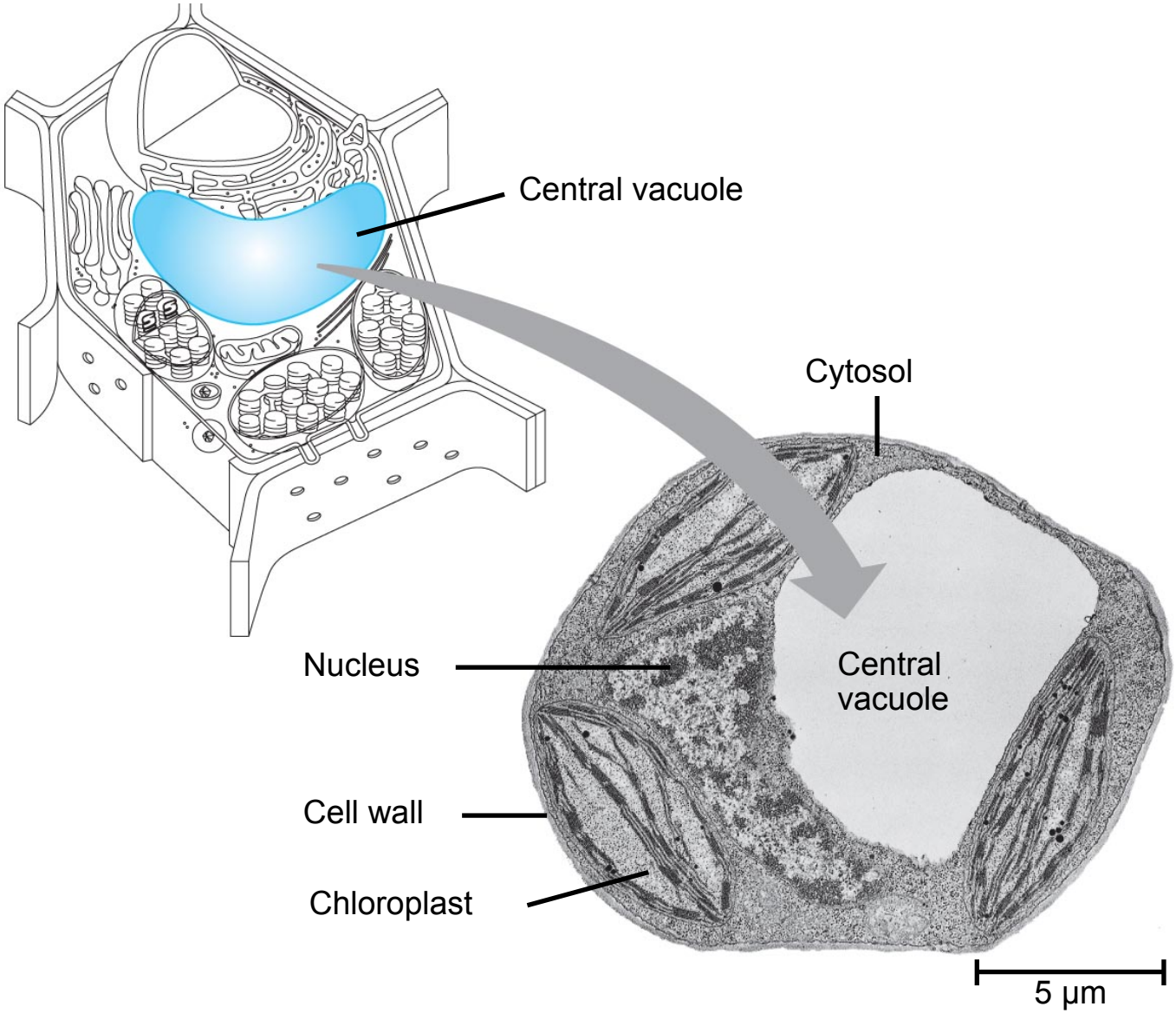
The plasma membrane creates a ***selective barrier***

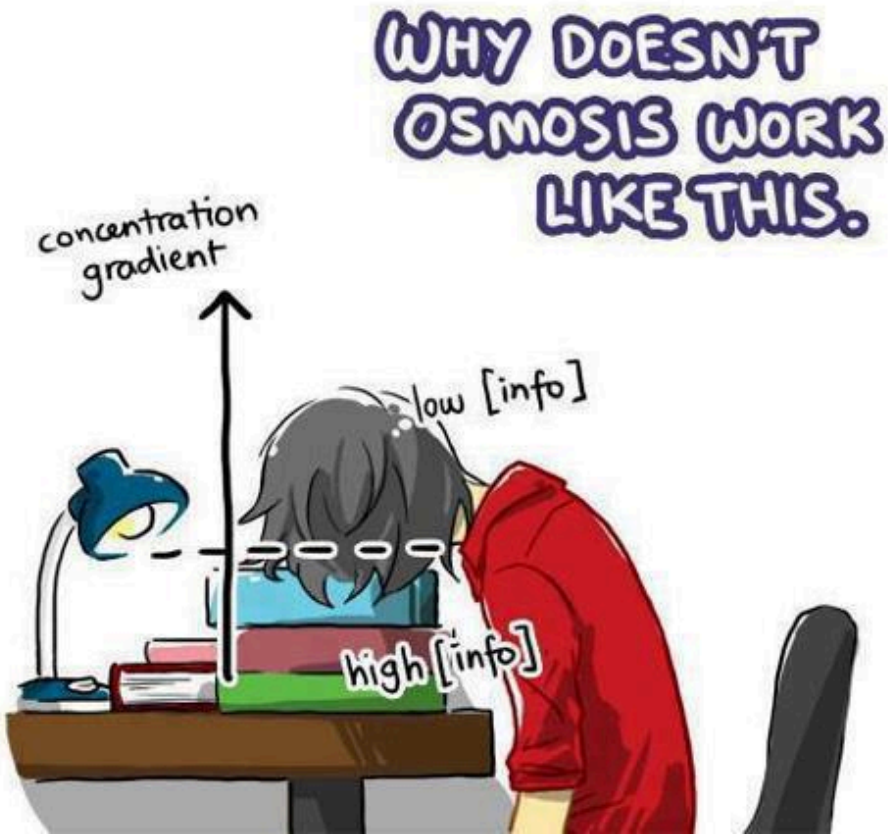


selective barrier → the solution *inside* the cell differs from the solution *outside* the cell

Central vacuole – a membrane-bound vesicle within plant cell with specialized functions



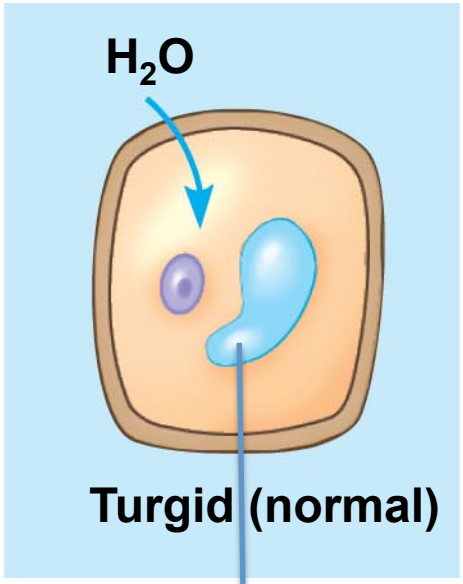
Osmosis - the passive movement of *water* across a plasma membrane

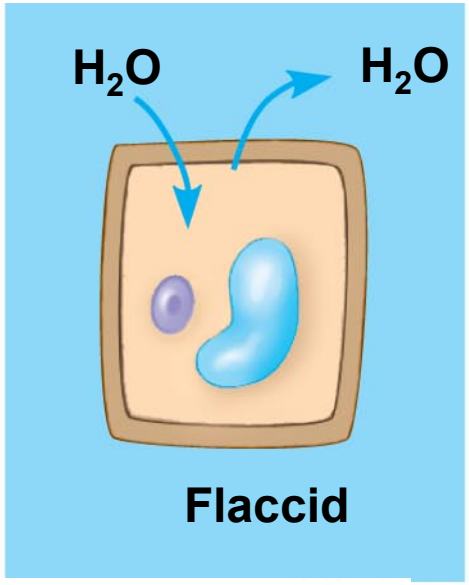


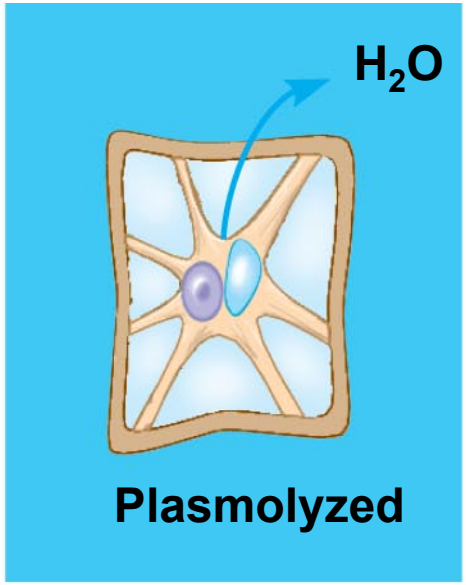
http://weknowmemes.com

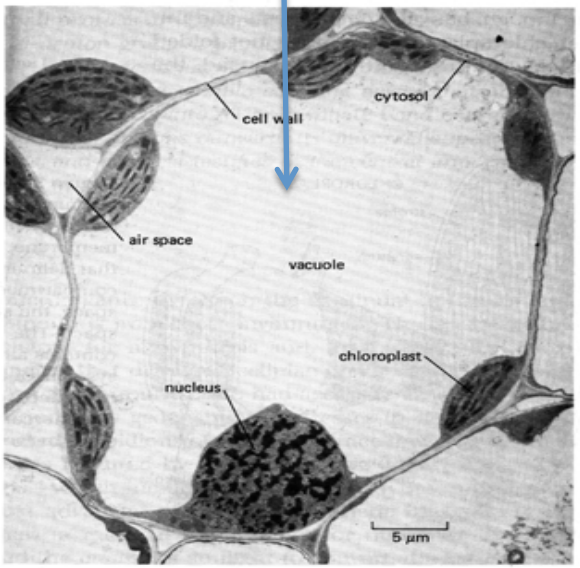
Direction of water movement:
high concentration → low concentration

Osmosis (passive water movement) in plant cells





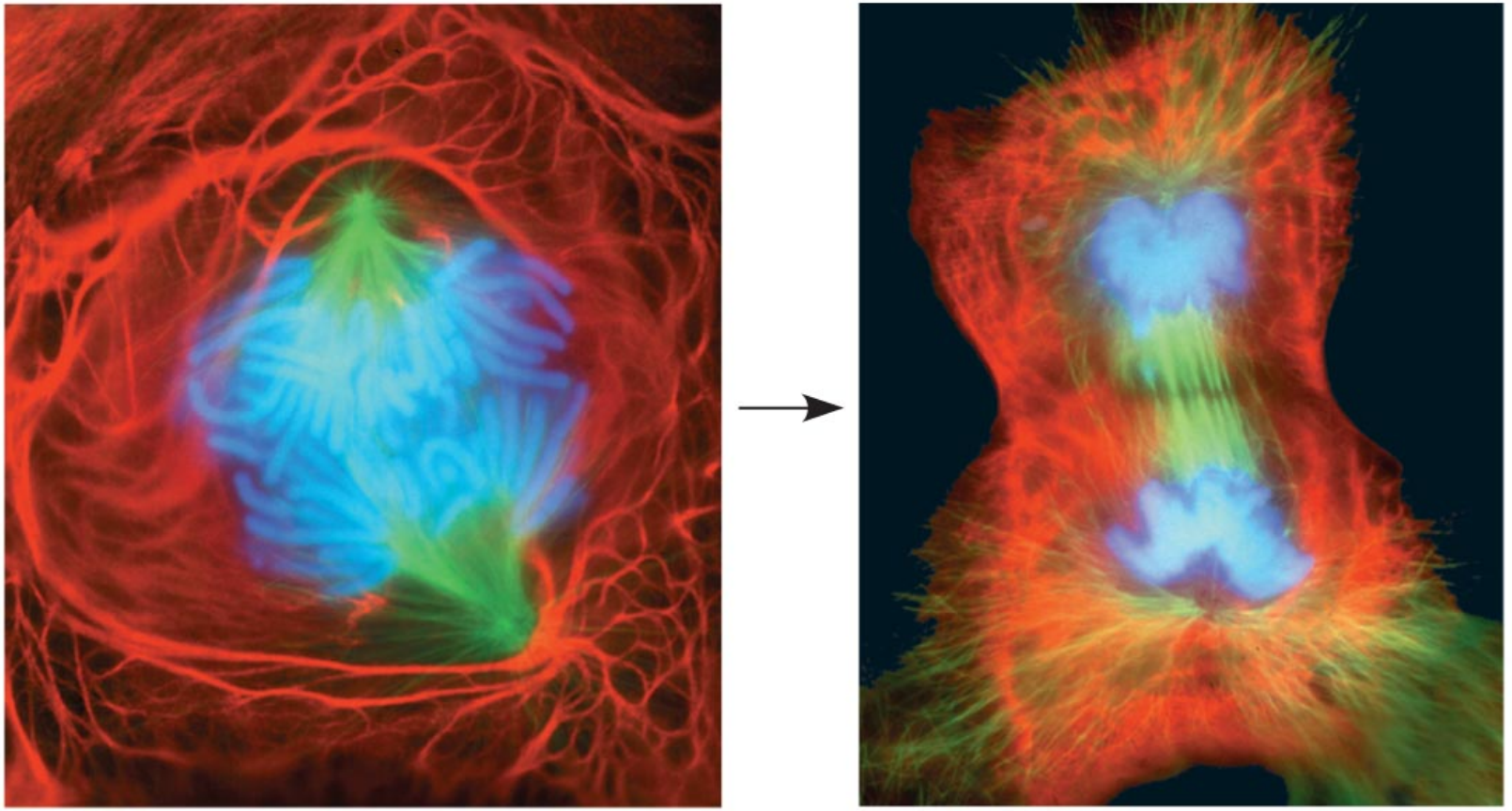




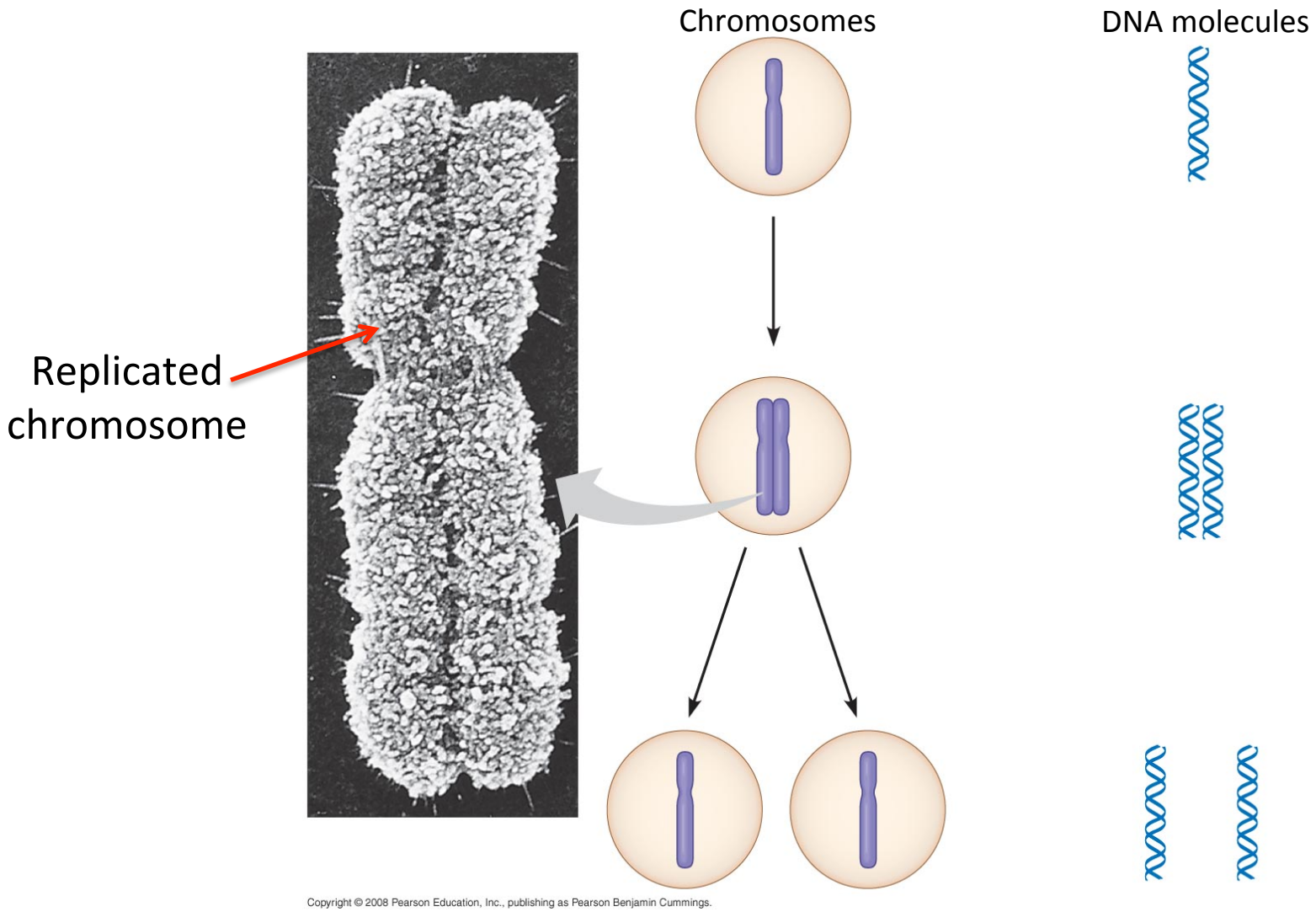
Cell division produces 2 identical cells

A dividing cell

** chromosomes containing DNA are labeled blue and spindle fibers are green*



The cell duplicates its chromosomes and divides them equally into 2 new cells during ***mitosis***



An elaborate and coordinated series of events during **mitosis** and **cytokinesis** yields 2 identical cells

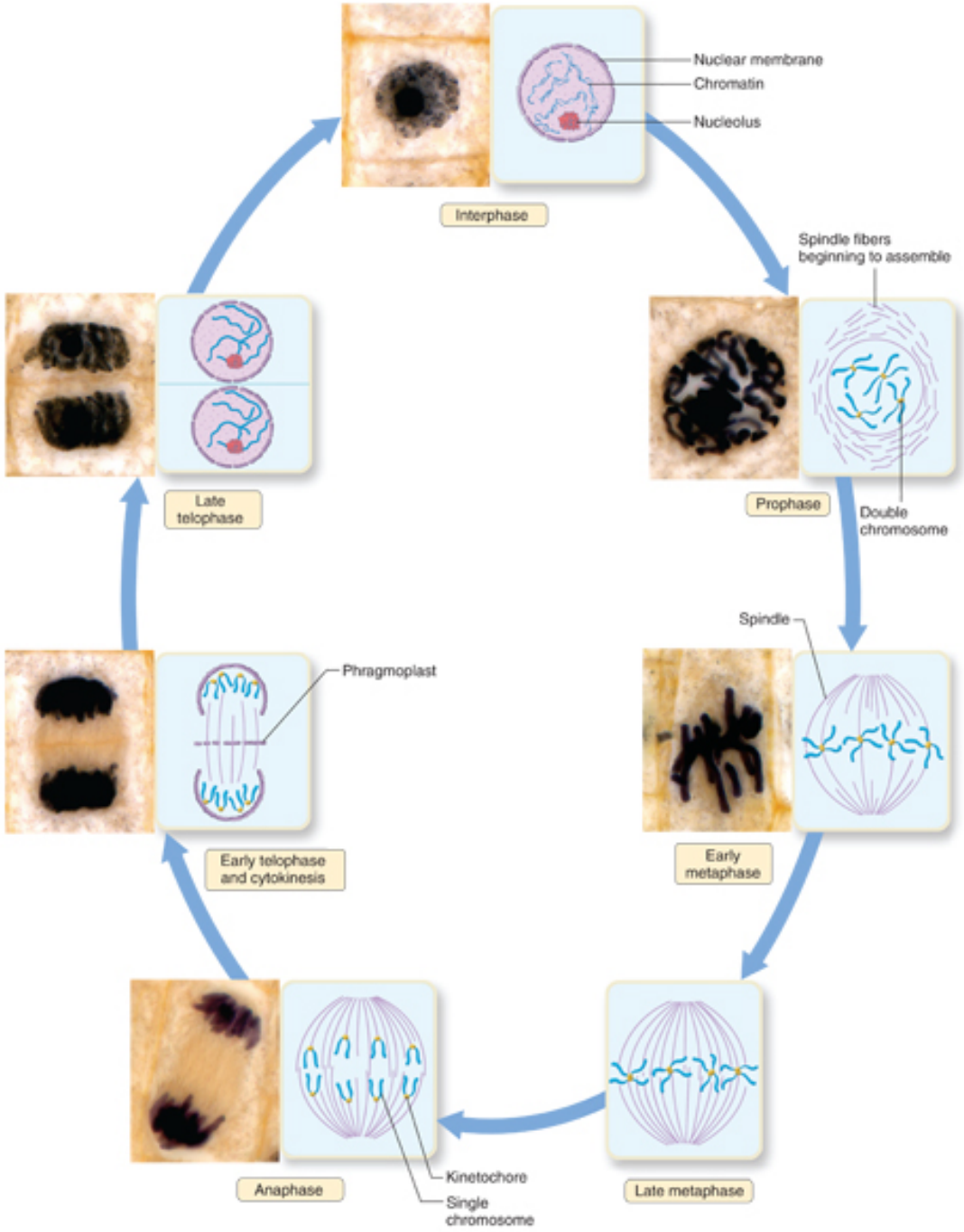
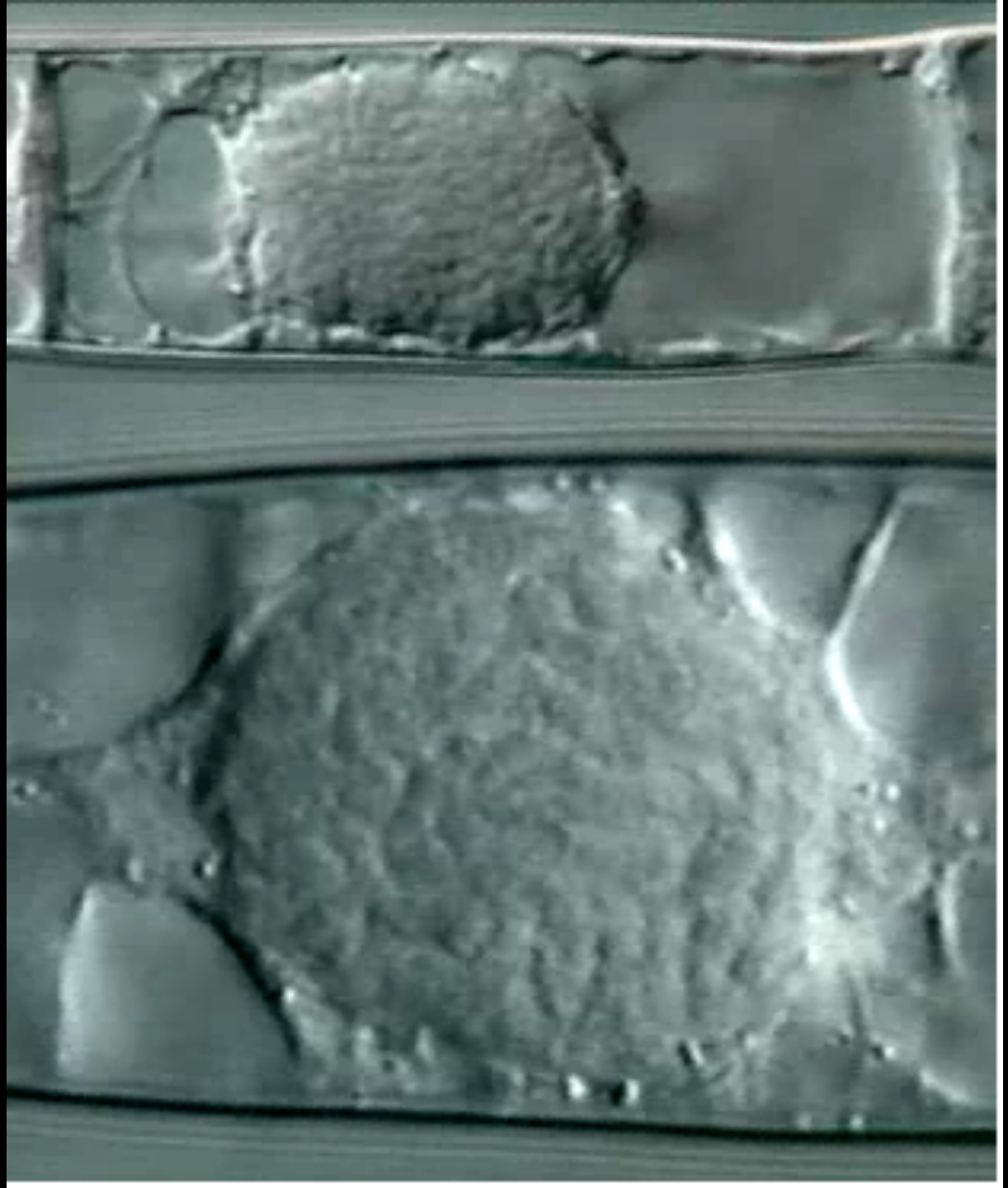


Figure 2.10 Mitosis in a plant cell.



Lecture Review, Chapter 2

- What are the 4 basic features of all living cells?
- What are the major tenets of the cell theory?
- Compare and contrast prokaryotic and eukaryotic cells.
- Describe the structure and function of the cell wall and plasma membrane.
- Define chromosome. How do DNA and genes relate to chromosomes?
- Define organelle, and be able to label the organelles in a plant cell.
- How do the following organelles interact within a cell: nucleus, endoplasmic reticulum, Golgi apparatus, ribosomes?
- Define osmosis. Which is the most ideal for a plant cell: water moving into the cell, water moving out of the cell, or water moving at equal rates into and out of a cell?
- Define mitosis. What is the direct result of 1 round of mitosis in a plant?

Good summary table (focus on cell structures discussed in lecture)

Table 2.1
Plant Cell Structures and Their Functions

Structure	Description	Function
Cell wall	Cellulose fibrils	Support and protection
Plasma membrane	Lipid bilayer with embedded proteins	Regulates passage of materials into and out of cell
Central vacuole	Fluid-filled sac	Storage of various substances
Nucleus	Bounded by nuclear envelope; contains chromatin	Control center of cell; directs protein synthesis and cell reproduction
Nucleolus	Concentrated area of RNA and protein within the nucleus	Ribosome formation
Ribosomes	Assembly of protein and RNA	Protein synthesis
Endoplasmic reticulum	Membranous channels	Transport and protein synthesis (rough ER)
Golgi apparatus	Stack of flattened, membranous sacs	Processing and packaging of proteins; secretion
Chloroplast	Double membrane-bound; contains chlorophyll	Photosynthesis
Leucoplast	Colorless plastid	Storage of various materials, especially starch
Chromoplast	Pigmented plastid	Imparts color
Mitochondrion	Double membrane-bound	Cellular respiration
Microbodies	Vesicles	Various metabolic reactions
Cytoskeleton	Microtubules and microfilaments	Cell support and shape
Plasmodesmata	Cytoplasmic bridges	Movement of materials between cells