

General Biology 1

BIO1101

Syllabus & Textbook: <http://goo.gl/rvgdrH>

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<u>Letter Grade</u>	<u>Numerical Ranges</u>
A	93-100
A-	90-92.9
B+	87-89.9
B	83-86.9
B-	80-82.9
C+	77-79.9
C	70-76.9
D	60-69.9
F	59.9 and below

OER

Lecture: <https://openlab.citytech.cuny.edu/bio-oer/page/2/>

Lab: <https://openlab.citytech.cuny.edu/bio-oer/>

Grade Breakdown:

Exams (4): 20% Each

Quizzes: 20% Average

Recap: Meeting 10

A. Cell Theory:

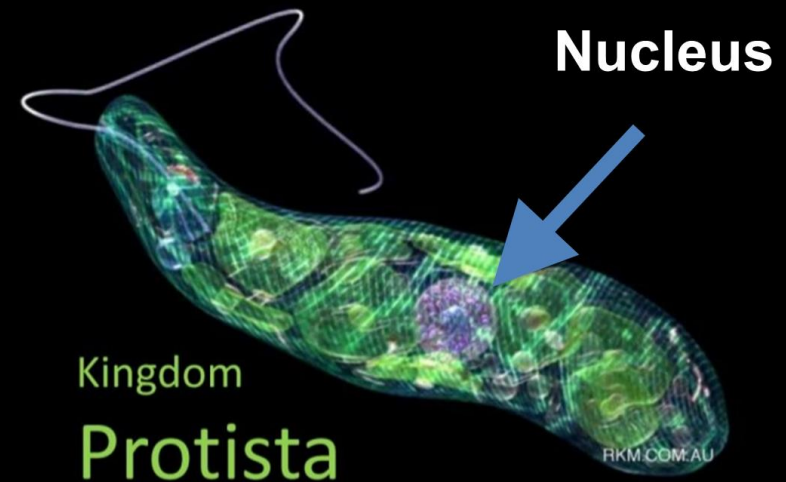
- 1) Basic component of life
- 2) All living things made of cells
- 3) Cells divide to make new cells

B. Basic of Cells - Cells interact with and respond to their environment

- 1) Plasma membrane – phospholipid bilayer
- 2) Domains: Prokaryote vs Eukaryotes
- 3) Prokaryotes (bacteria & archea)
- 4) Eukaryotes – Many Organelles

C. Eukaryotes

Protista – Single celled Eukaryotes
Animal, Fungi , Plants – Multi celled



D. Endosymbiosis/Endosymbiotic Capture:

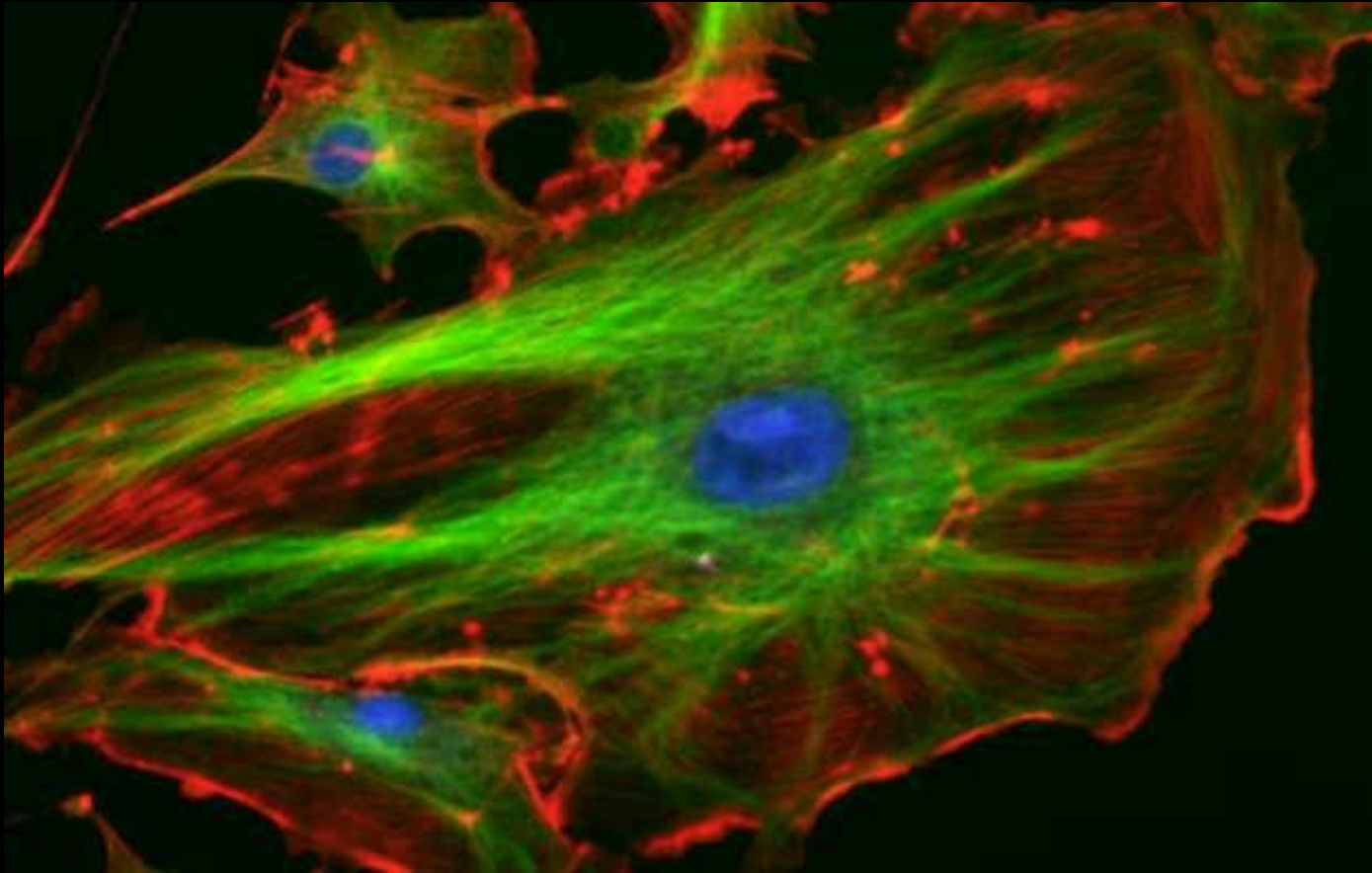
Mitochondria

Chloroplast

E. Multicellularity

<https://www.coursera.org/learn/astrobiology/lecture/X6NMT/the-rise-of-multicellularity>

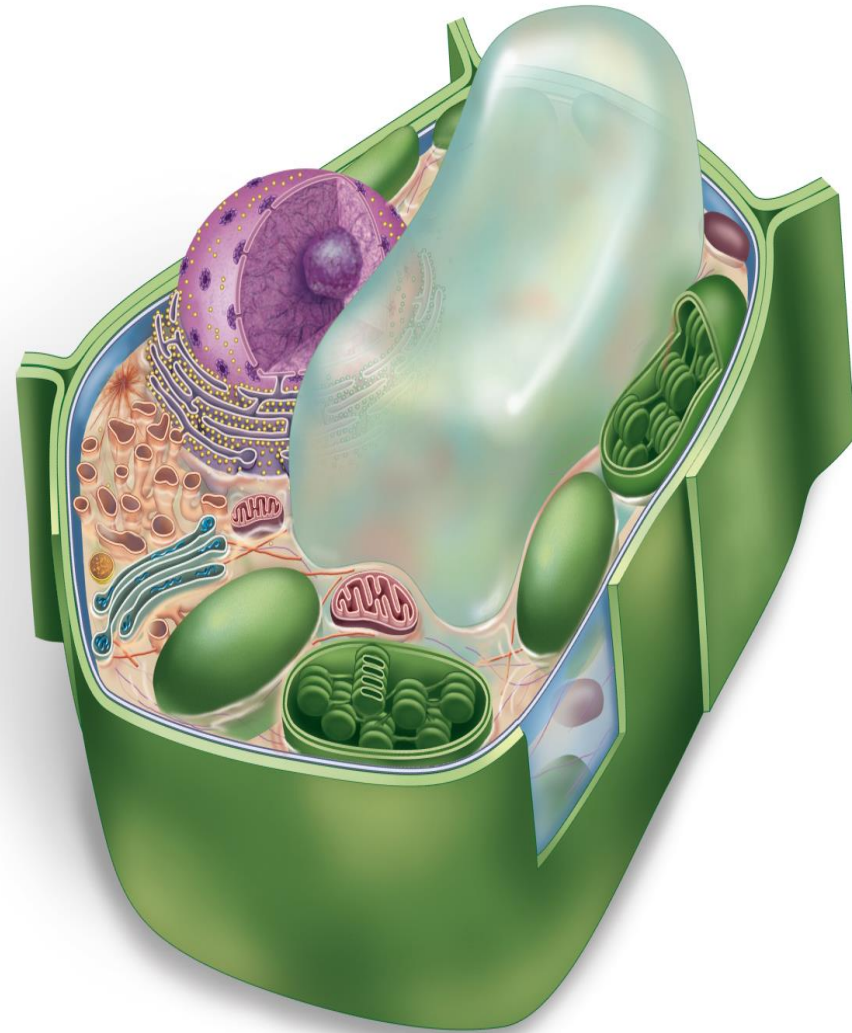
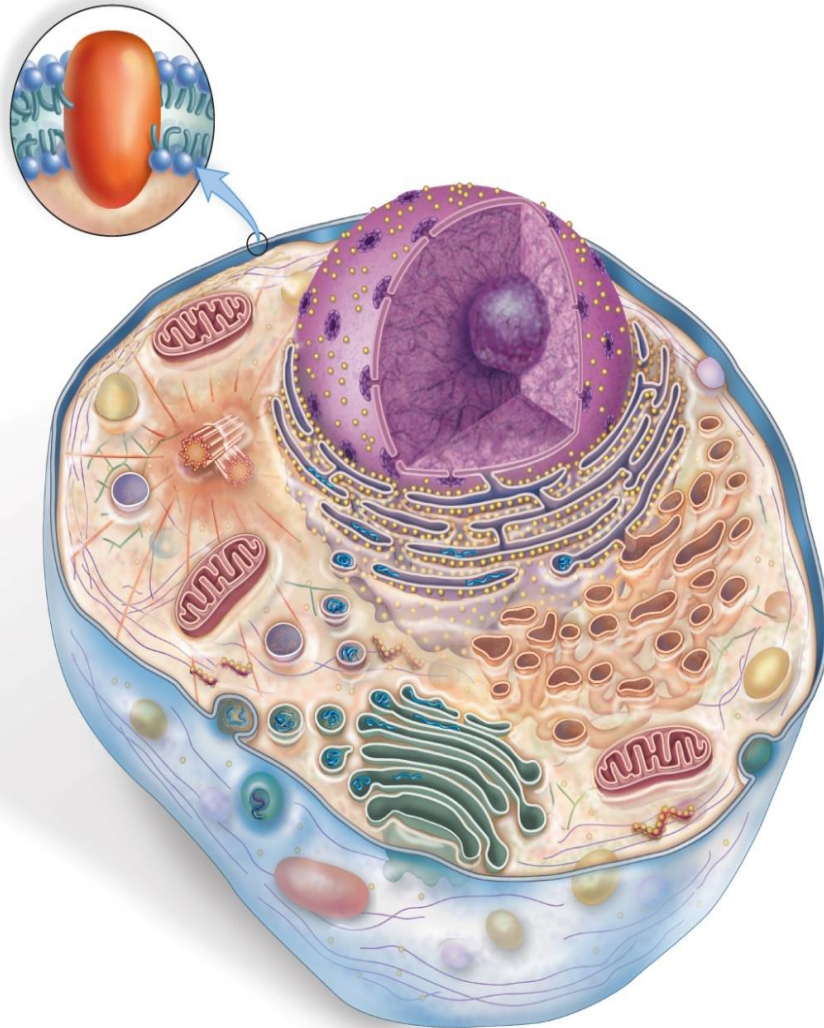
THE EUKARYOTIC CELL



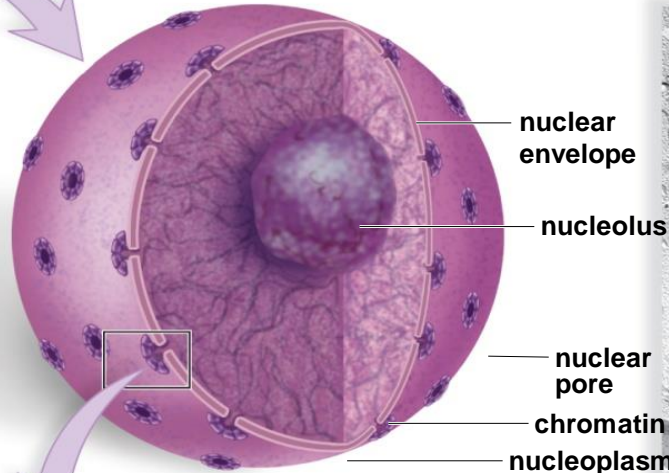
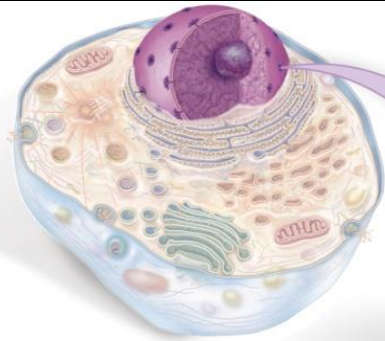
The Nucleus

- Surrounded by double lipid bilayer called nuclear envelope
- Usually the easiest organelle to see!
- Envelope has large pores, 100nm in diameter. The nuclear pore complex governs entry/exit from the nucleus.
- DNA is present in the nucleus in the form of chromatin, which is unwound chromosomes (made of DNA and protein)
- Nucleolus – a dense region (not membrane bound) where rRNA is transcribed and ribosomes are made

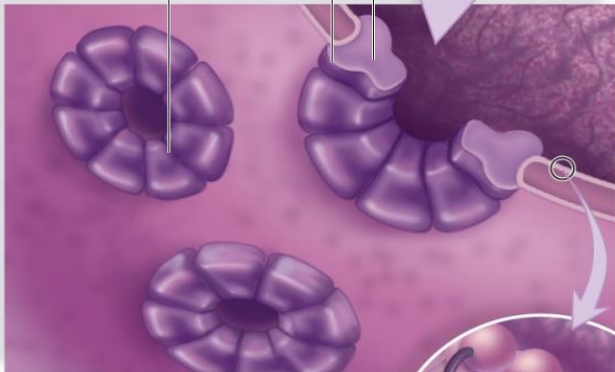
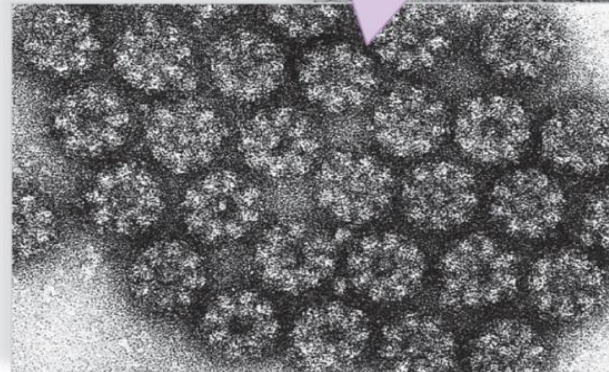
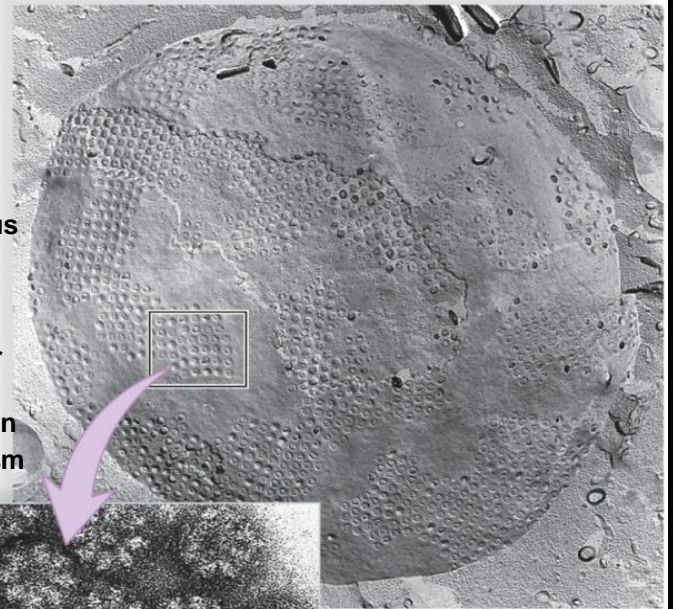
Animal and Plant Cell Anatomy



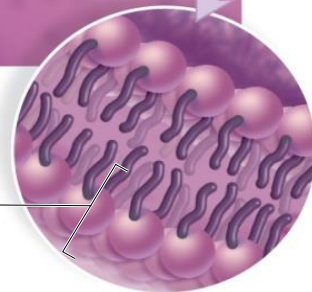
The Nucleus



Nuclear envelope:
inner membrane
outer membrane
nuclear pore



phospholipid

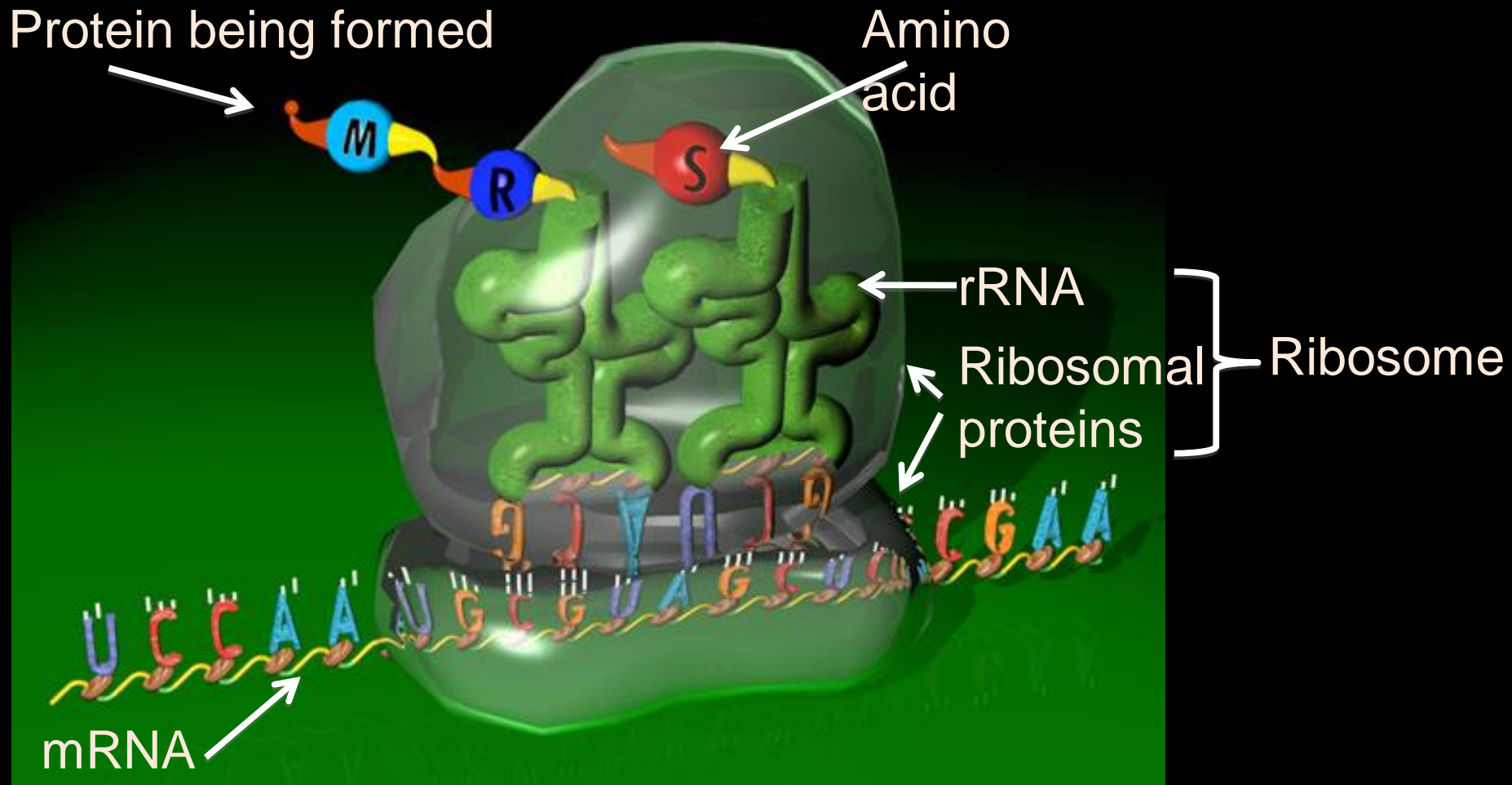


Ribosomes

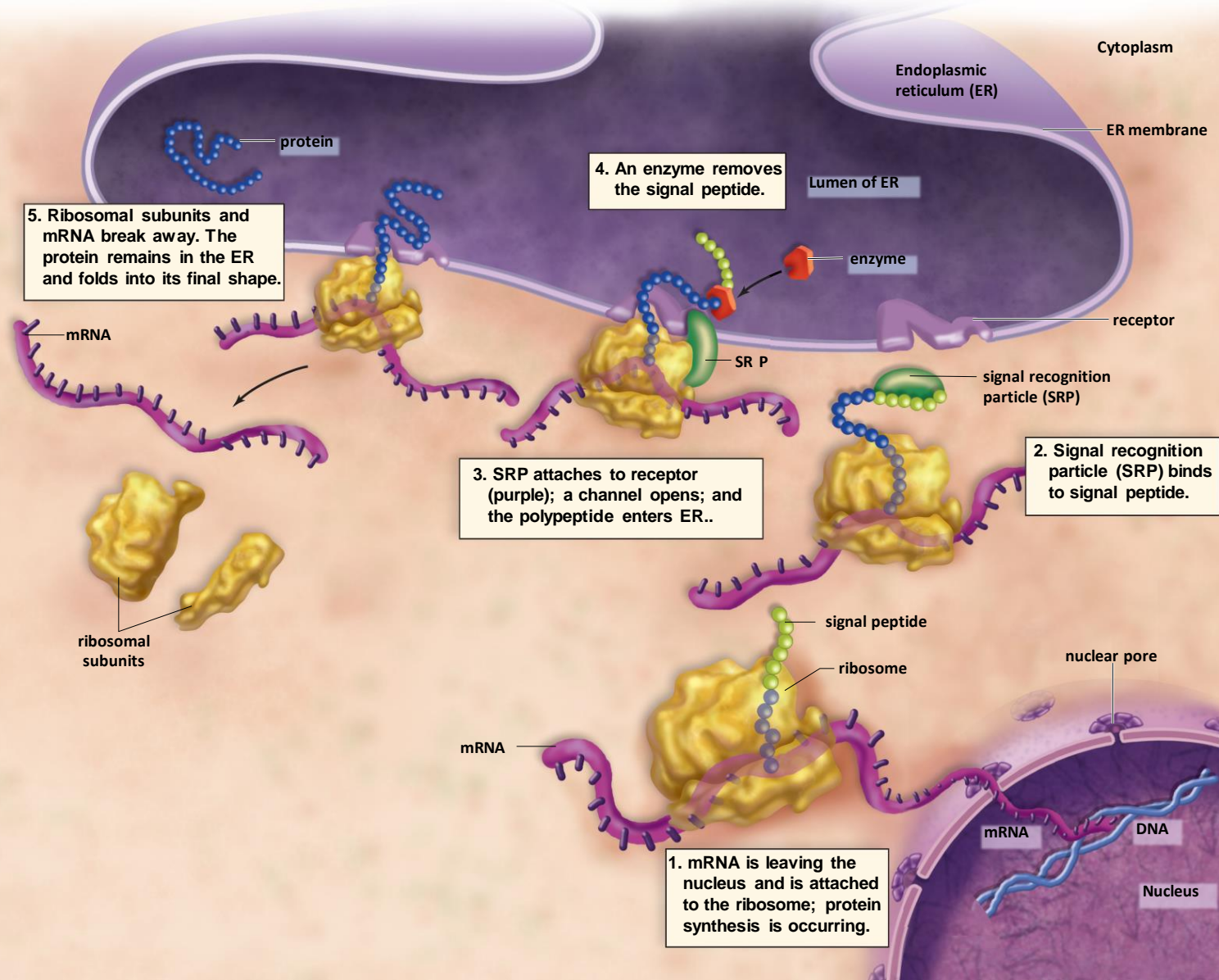
- Perform all protein synthesis in the cell
- Composed of rRNA (made in nucleolus) and proteins
- Ribosomes are Non-membrane bound
- May be :
 - Free ribosomes in the cytoplasm, either singly or in groups, called **polyribosomes**
 - These make proteins that will be located in the cytosol, nucleus, mitochondria, etc.
 - On the endoplasmic reticulum (thereby making the ER “rough”) – rough endoplasmic reticulum (RER)
 - These make proteins that will be located in the ER, Golgi, Plasma Membrane, Lysosome, or secreted outside of the cell

Ribosomes – Not membrane bound

- Ribosomes perform all protein synthesis in the cell



Function of ribosomes



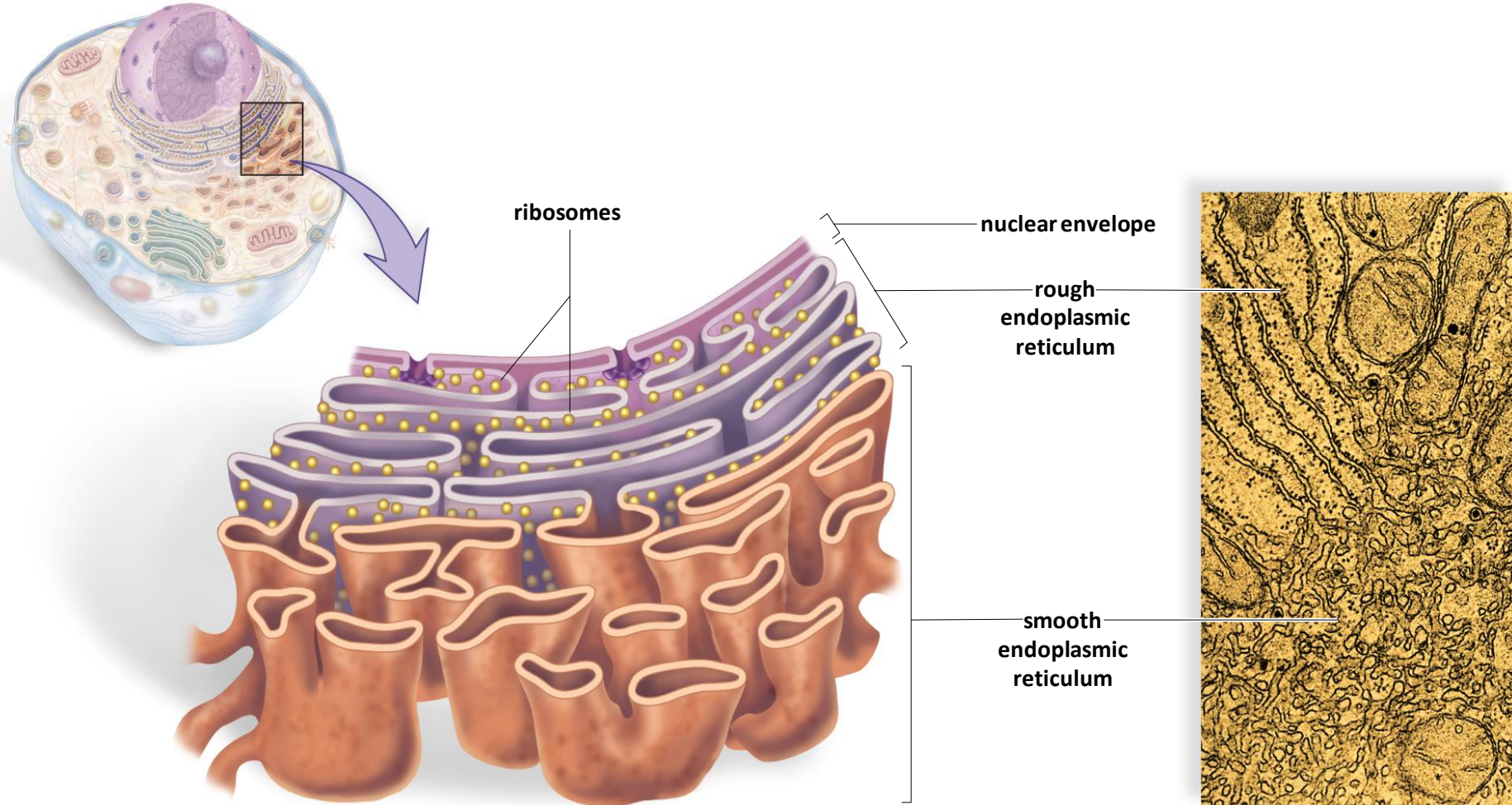
Endomembrane System

- Series of **intracellular membranes** that compartmentalize the cell
- have **same structure as PM**, but different components “floating” in the lipid bilayer
- Restrict enzymatic reactions to specific compartments
- Consists of:
 - **Nuclear envelope**
 - **Membranes of endoplasmic reticulum**
 - **Vacuole**
 - **Golgi apparatus**
 - **Vesicles (several types)**
 - Transport materials between organelles of system

Endomembrane System:

The Endoplasmic Reticulum

- A system of membrane channels and **sacculles** (flattened vesicles) continuous with the outer membrane of the nuclear envelope



0.0 μm

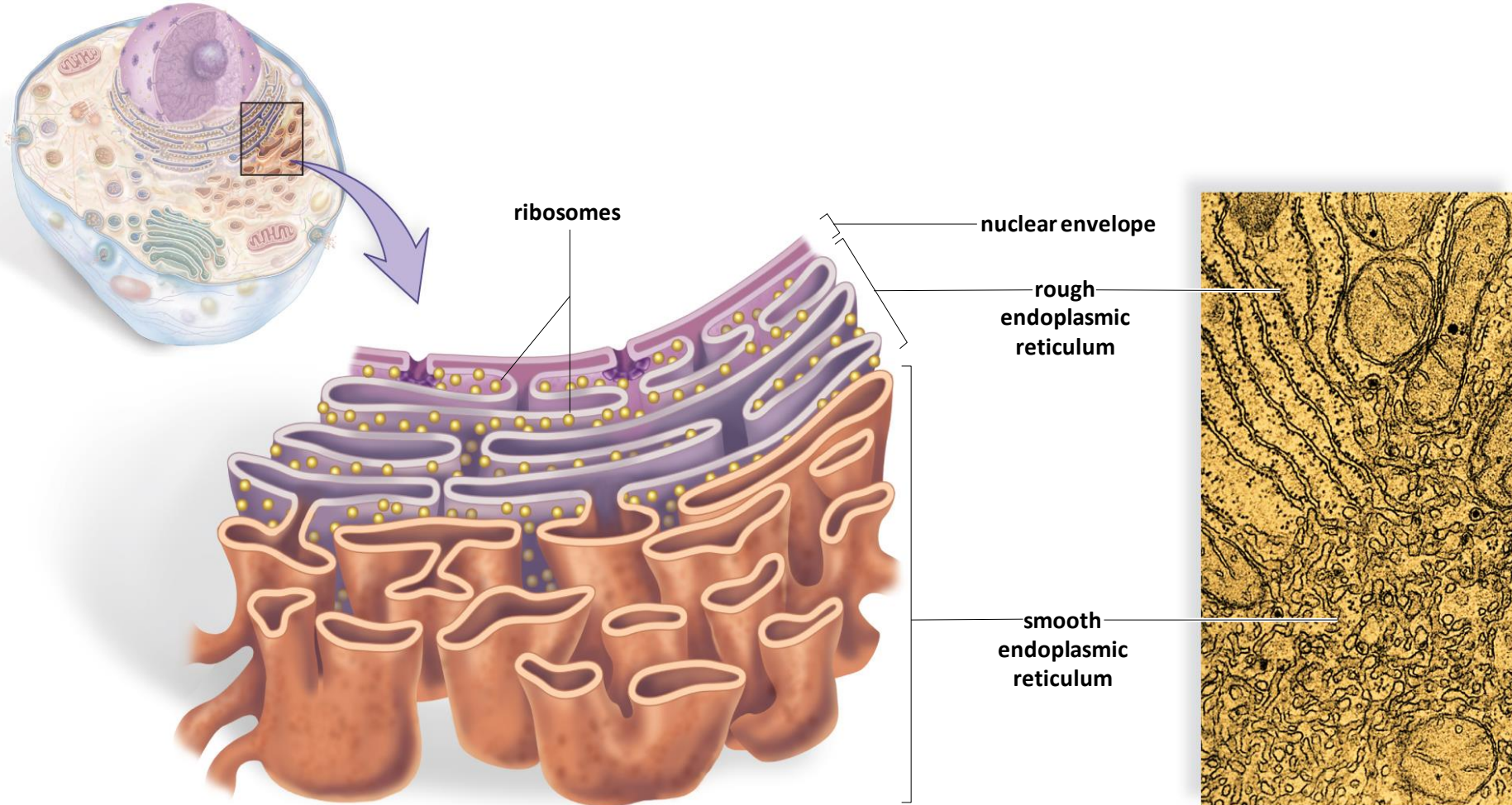
Endomembrane System: The Endoplasmic Reticulum

- **Rough ER:** Studded with ribosomes on cytoplasmic side
 - Synthesizes, modifies and processes proteins destined for: the PM, secretion, or anywhere in endomembrane system (lumen OR membrane-bound)
 - Adds sugar to protein > Results in glycoproteins
 - So, the rough ER is the **first-stop “shipping center”** for many proteins
- **Smooth ER:** No ribosomes
 - Site of various synthetic processes
 - Synthesis of: Lipids, Steroid hormones, Carbohydrates
 - Detoxification (of drugs / poisons)
 - Calcium storage (in muscle cells)
 - Forms **transport vesicles**

Endomembrane System:

The Endoplasmic Reticulum

- A system of membrane channels and **sacculles** (flattened vesicles) continuous with the outer membrane of the nuclear envelope

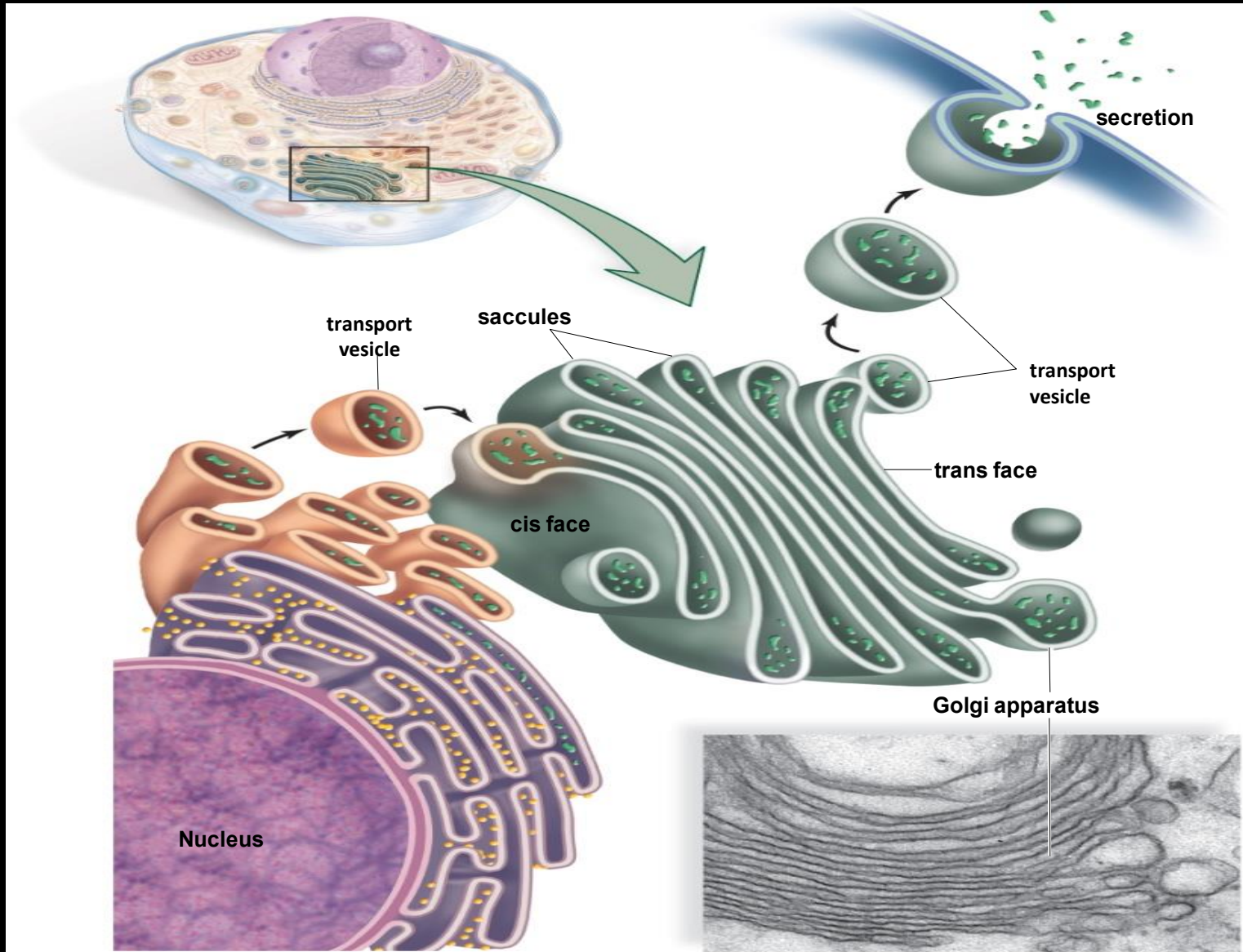


0.0 μm

Endomembrane System: The Golgi Apparatus

- Consists of 3-20 flattened, curved saccules
- Resembles stack of hollow naan/pita
- **Modifies proteins and lipids**
 - Receives vesicles from ER on cis (or inner face)
 - Packages them in vesicles
 - Prepares for “shipment” in v Packages them in vesicles from trans (or outer face)
 - Within cell
 - Export from cell (secretion, exocytosis)

Endomembrane System: The Golgi Apparatus



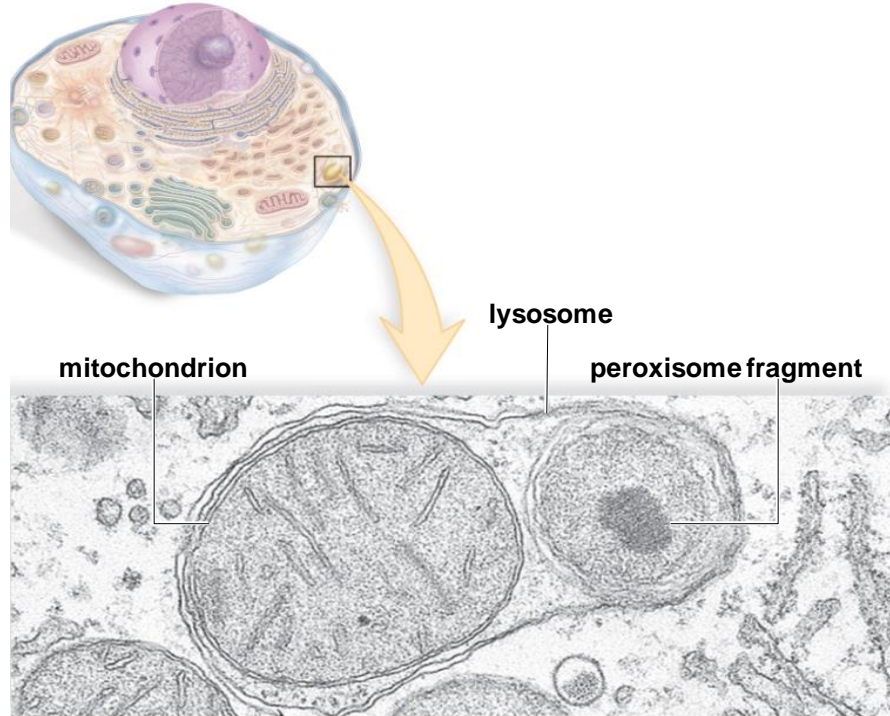
Endomembrane System:

Lysosomes

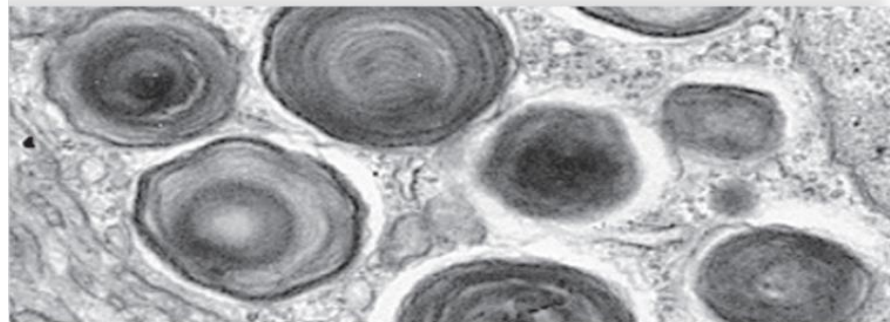
- The “stomach” of the cell (not in plants)
- Membrane-bound vesicles
 - Produced by the Golgi apparatus
 - Contain powerful hydrolytic (digestive) enzymes and are highly acidic
 - Digestion of large molecules
 - Recycling of cellular resources
 - Apoptosis (programmed cell death, like tadpole losing tail)
- Some genetic diseases
 - Caused by defect in lysosomal enzyme
 - Lysosomal storage diseases (Tay-Sachs)

https://en.wikipedia.org/wiki/Tay%E2%80%93Sachs_disease

Endomembrane System: Lysosomes



- a. Mitochondrion and a peroxisome in a lysosome
- b. Storage bodies in a cell with defective lysosomes



Endomembrane System:

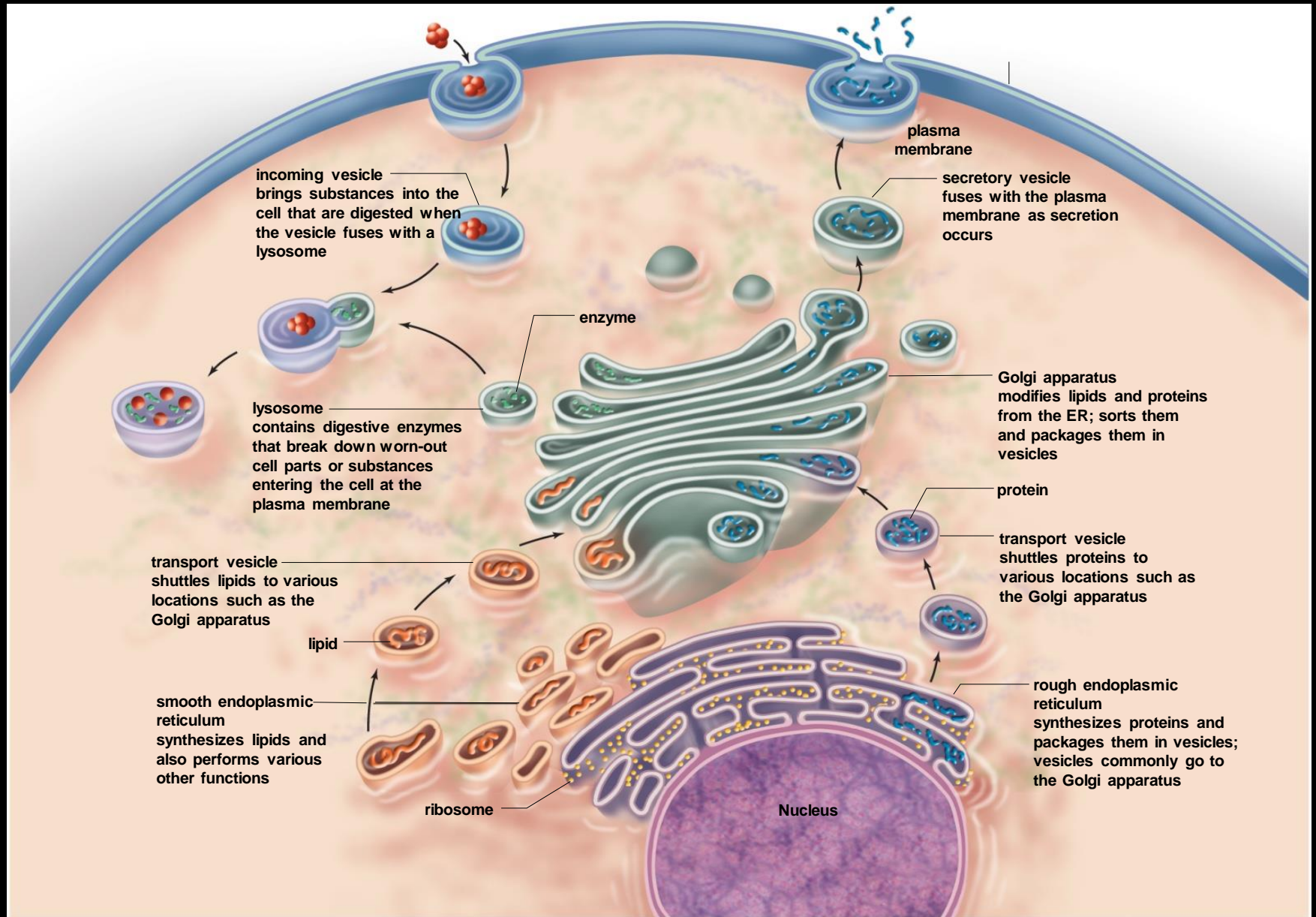
Lysosomes

- pH = 5, **Very acidic**, like the stomach!
 - Acid helps break macromolecules down to monomers
 - **Hydrolytic enzymes** only work at low pH!
 - Thus, they will not be active until they reach the lysosome!
 - Also, protects the cell in case the lysosome leaks!
- Everything in the Lysosome came from the Golgi via vesicles
 - And from the rough ER before that!

Endomembrane System: Summary

- Proteins produced in rough ER and lipids from smooth ER are carried in vesicles to the Golgi apparatus.
- The Golgi apparatus modifies these products and then sorts and packages them into vesicles that go to various cell destinations.
- Secretory vesicles carry products to the membrane where exocytosis produces secretions.
- Lysosomes fuse with incoming vesicles and digest macromolecules.

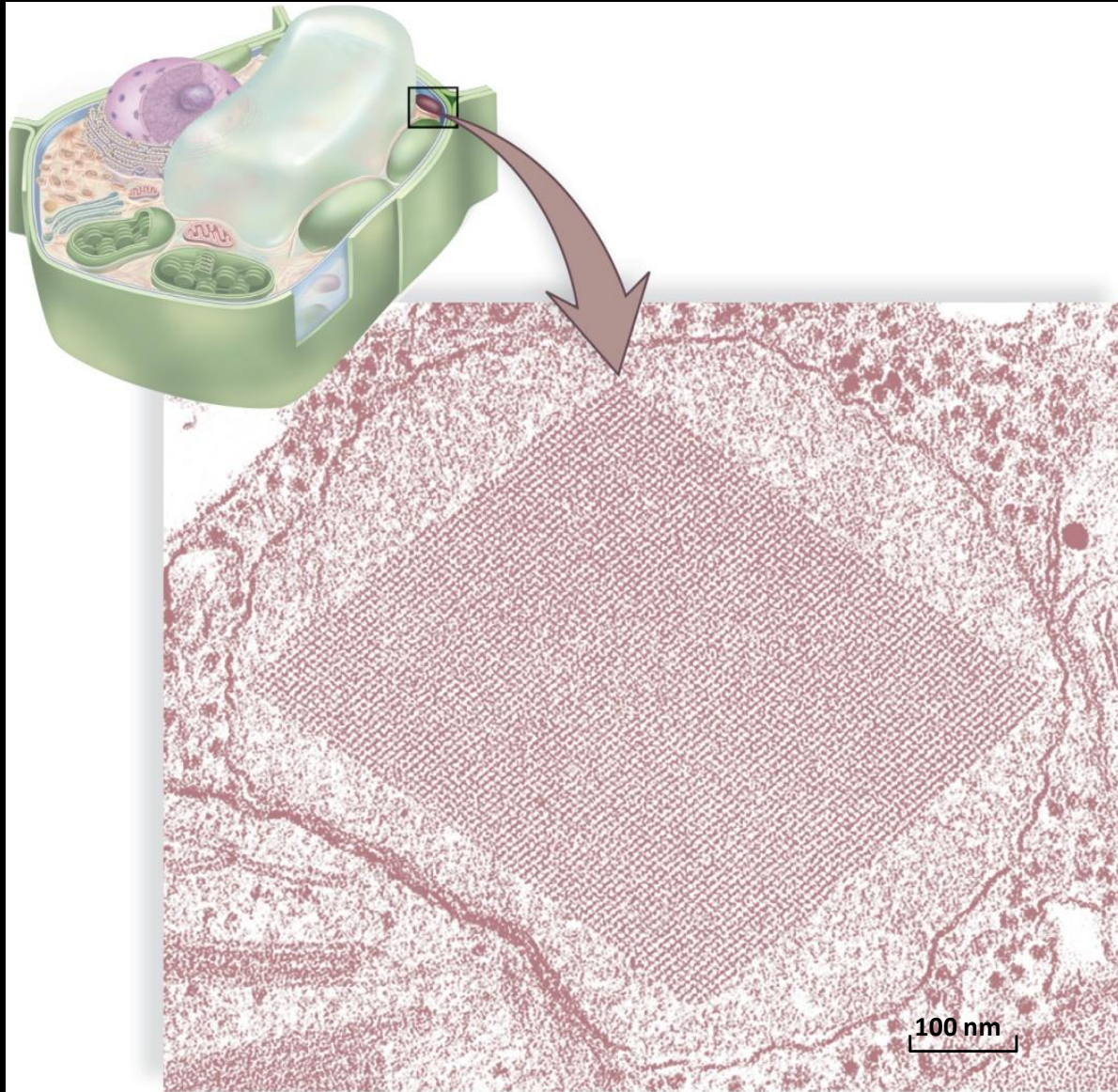
Endomembrane System: A Visual Summary



Peroxisomes

- Similar to lysosomes
 - Membrane-bounded vesicles
 - Enclose enzymes
- However
 - Enzymes synthesized by free ribosomes in cytoplasm (instead of ER)
 - Active in lipid metabolism
 - Catalyze reactions that produce **hydrogen peroxide H_2O_2**
 - Toxic
 - Broken down to water & O_2 by catalase

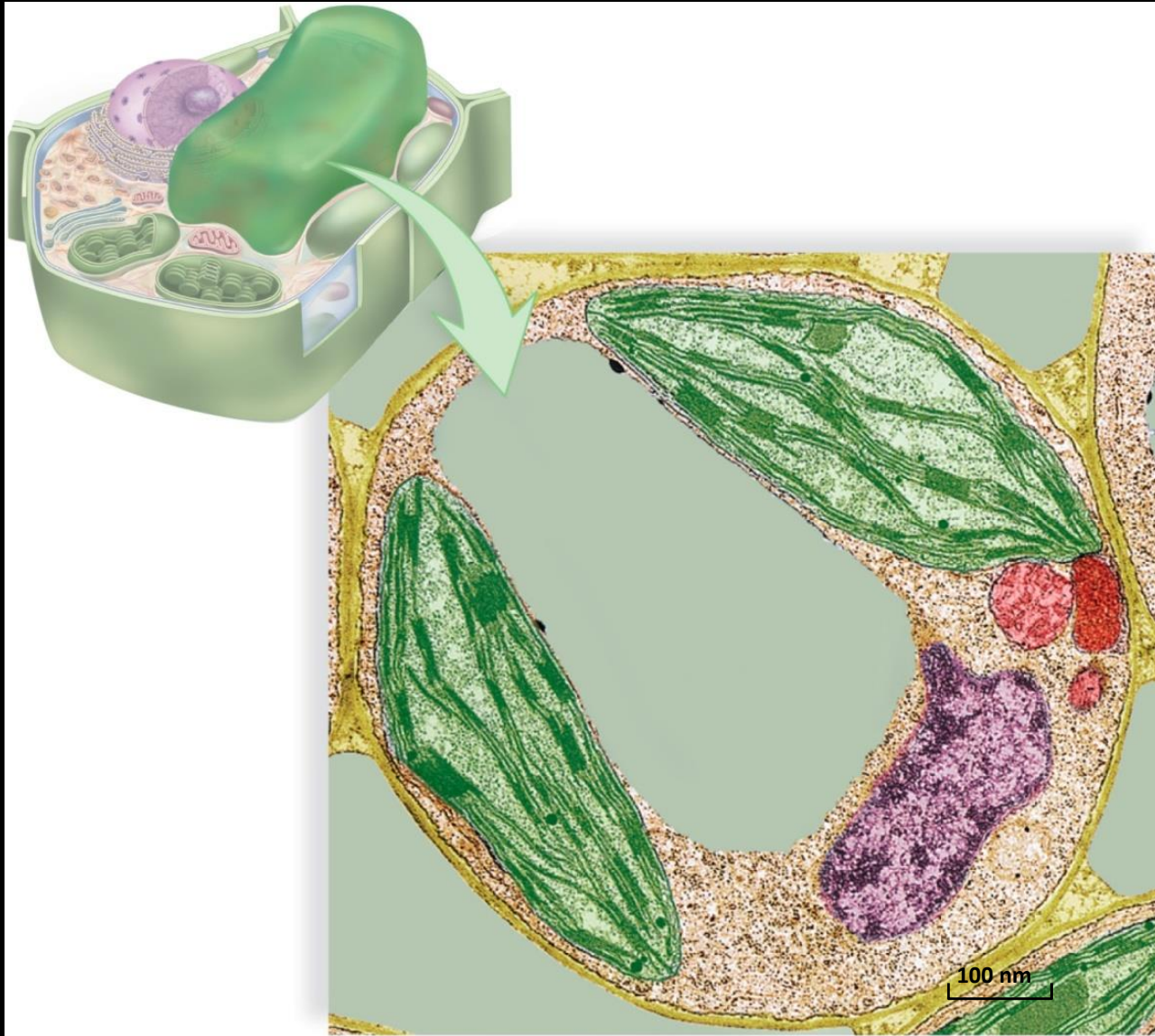
Peroxisomes



Vacuoles

- Membranous sacs that are larger than vesicles
 - Store materials that occur in excess
 - Others very specialized (contractile vacuole)
- Plants cells typically have a central vacuole
 - Up to 90% volume of some cells
 - Functions in:
 - Storage of water, nutrients, pigments, and waste products
 - Development of turgor pressure
 - Some functions performed by lysosomes in other eukaryotes

Vacuoles



Other Membrane-bound organelles: **Mitochondria and chloroplasts**

- The two energy organelles
- **Mitochondria** are the “power stations” of the cell
 - All **cellular respiration** takes place here
 - Harvests energy from sugars and fats
 - **All** Eukaryotic cells have mitochondria
- **Chloroplasts** harvest solar energy
 - synthesize glucose from carbon dioxide and water (**photosynthesis**)
 - **Only found in plants and some algae**
- Both organelles are semi-autonomous
 - have SOME of their own DNA, have their own ribosomes
 - replicate independently of the rest of the cell

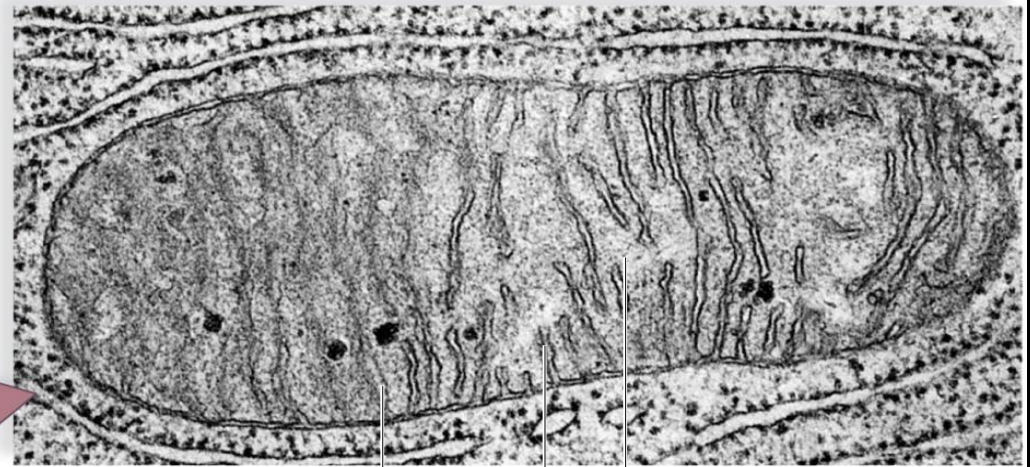
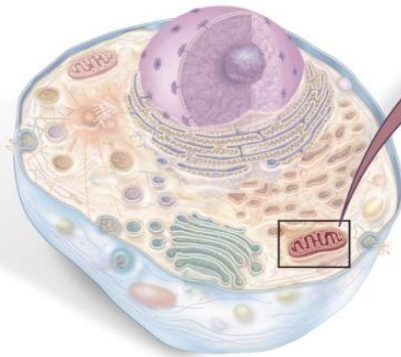
Energy-Related Organelles

Mitochondria

- Smaller than chloroplast
- Surrounded by a double membrane
 - Inner membrane surrounds the **matrix** and is convoluted (folds) to form **cristae**.
 - Matrix – Inner semifluid containing respiratory enzymes
 - Break down carbohydrates
- Involved in cellular respiration
- Produce most of ATP utilized by the cell

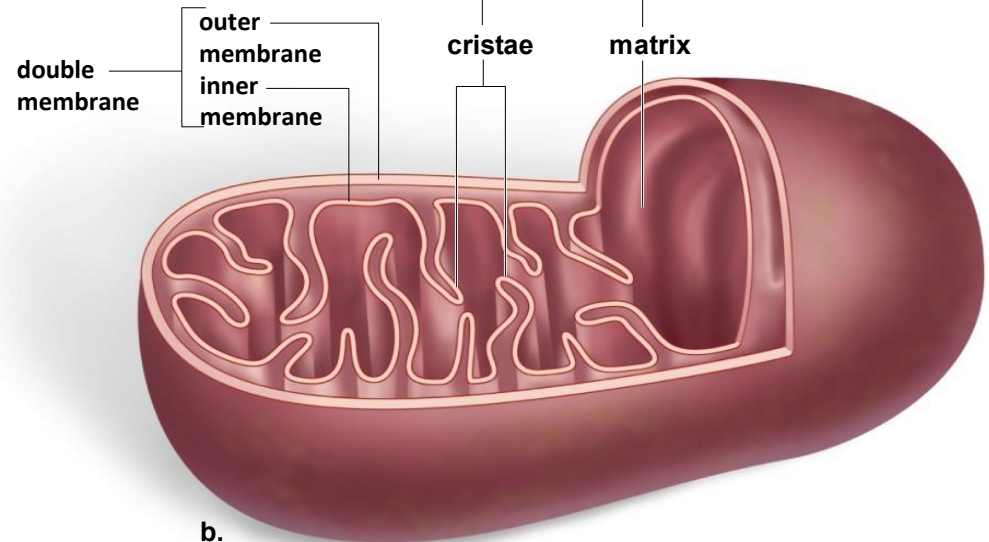
Mitochondrial Structure

Structure to know



a.

200 nm



b.

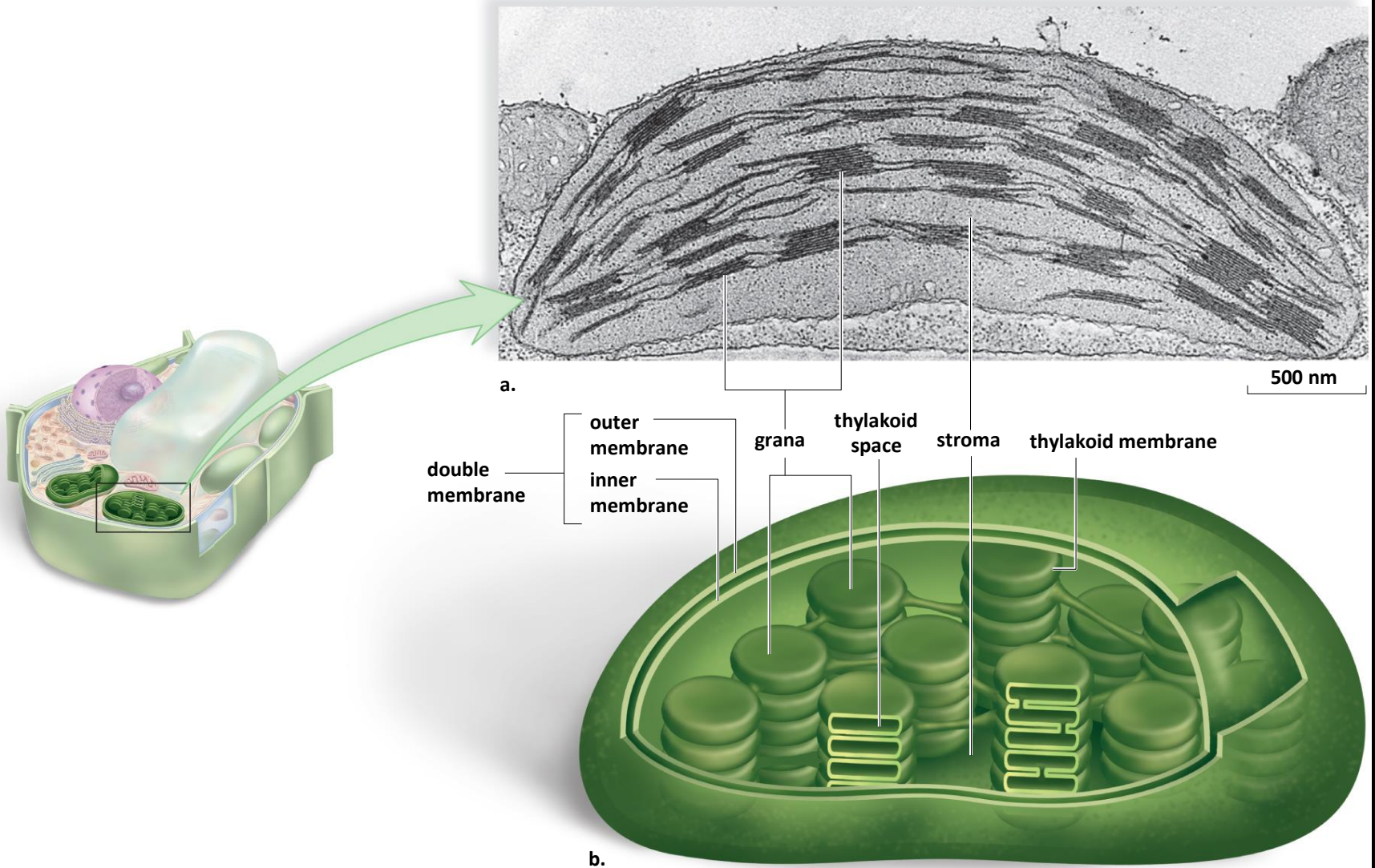
Energy-Related Organelle

Chloroplasts

- **Plastid**
- Bound by a double membrane organized into flattened disc-like sacs called **thylakoids**
- Chlorophyll and other pigments **capture solar energy**
- Enzymes synthesize **carbohydrates**
- Plastid: Organelle of plants and algae bounded by a double membrane and containing internal membranes or vesicles

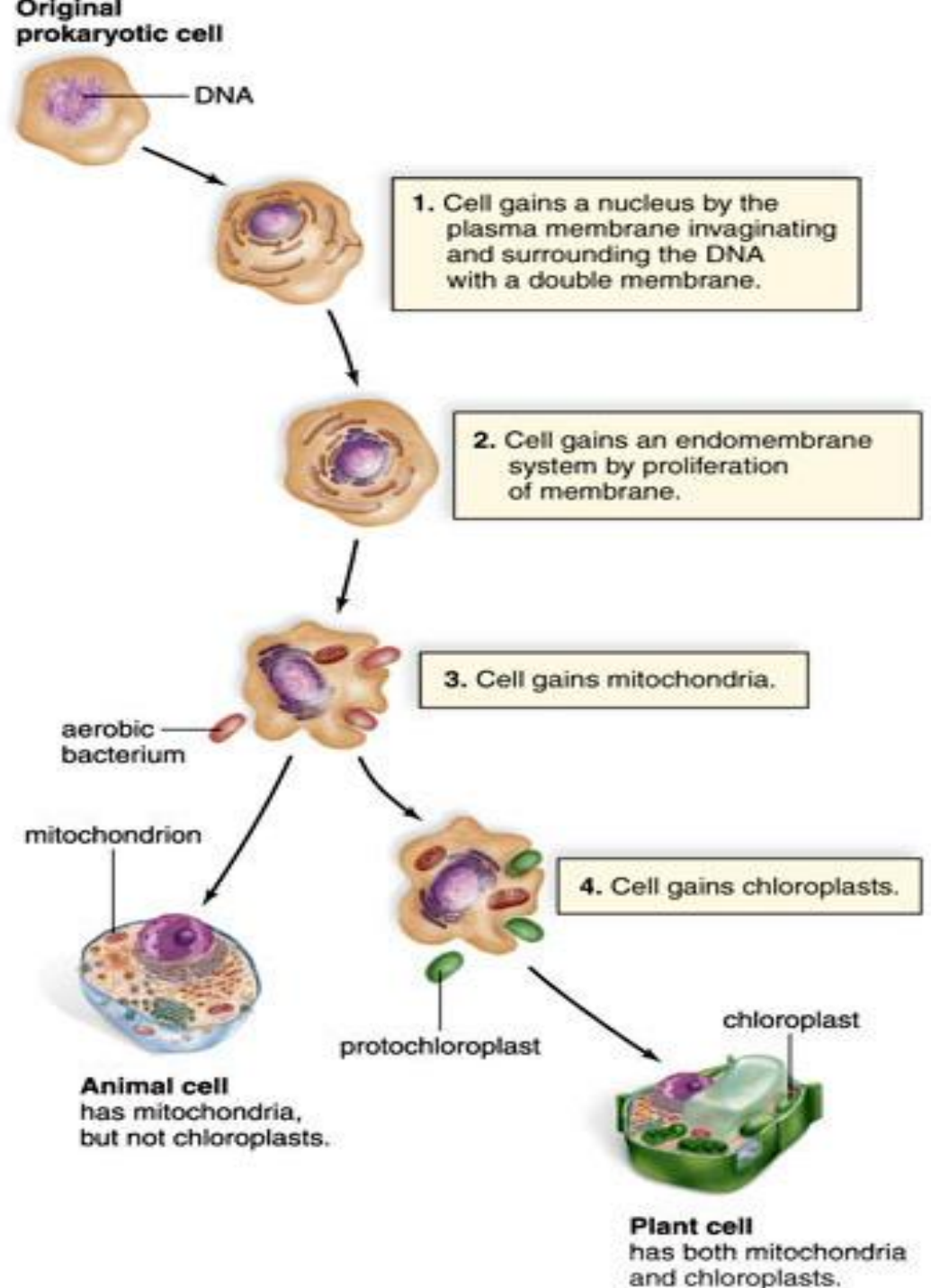
Chloroplast Structure

Structure to know



Acquisition of Organelles

A model for the origin of Eukaryotes through serial endosymbiosis

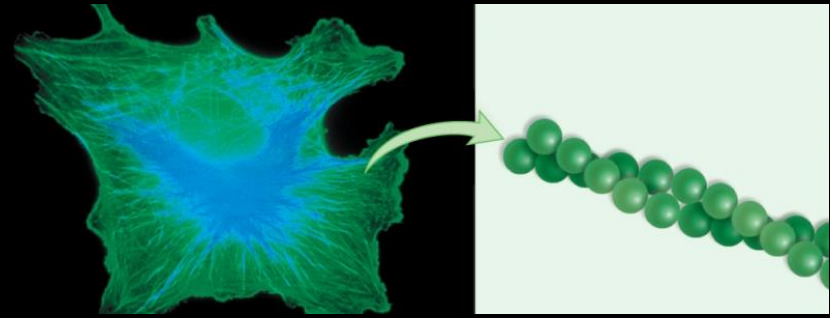


The Cytoskeleton

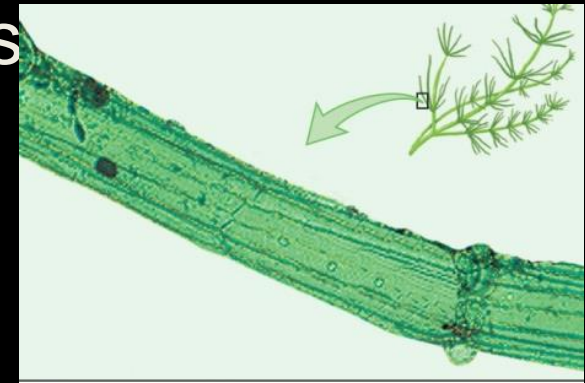
- Maintains cell shape
- Assists in movement of cell and organelles
- Three types of macromolecular fibers
 - Microtubules
 - Actin Filaments (microfilaments)
 - Intermediate Filaments
- Assemble and disassemble as needed

The Cytoskeleton

Actin Filaments



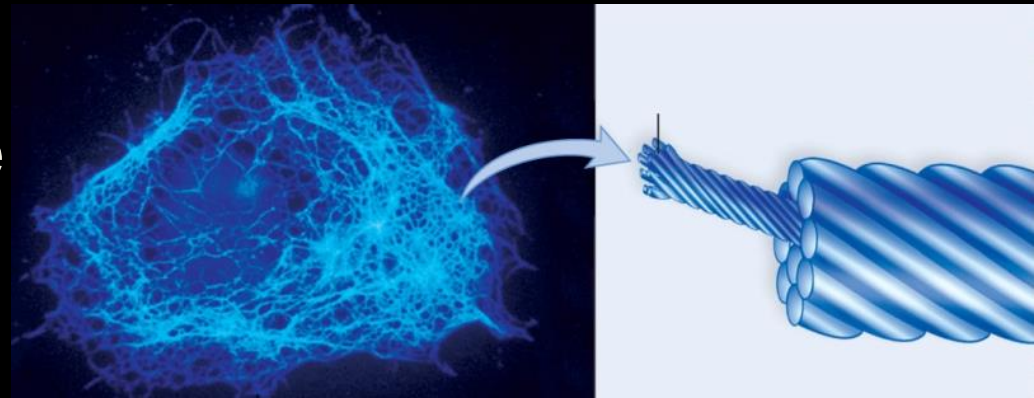
- Extremely **thin filaments** like twisted pearl necklace
- Dense web just under plasma membrane maintains cell shape
- **Support** for microvilli in intestinal cells
- **Intracellular traffic control**
 - For moving stuff around within cell
 - Cytoplasmic streaming
- Function in **pseudopods** of amoeboid cells
- Pinch mother cell in two after animal mitosis
- Important component in **muscle contraction** (other is myosin)



The Cytoskeleton: Intermediate Filaments



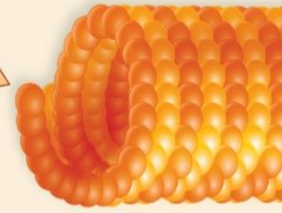
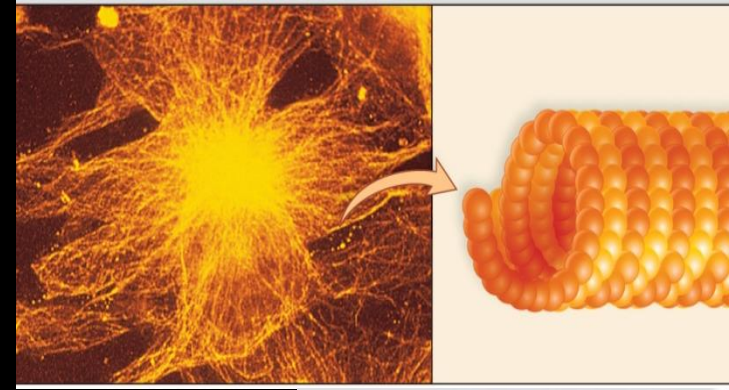
- **Intermediate in size** between actin filaments and microtubules
- Rope-like assembly of fibrous polypeptides
- Vary in nature
 - From tissue to tissue
 - From time to time
- Functions:
 - Support nuclear envelope
 - Cell-cell junctions, like those holding skin cells tightly together



The Cytoskeleton

Microtubules

- Fat, spiral, hollow tubes
- Polymer of tubulin proteins (α and β)
- Functions:
 - Chromosome Segregation (in mitosis)
 - Movement of organelles and vesicles
 - Provide structure to flagella / cilia
 - Motility
- Often organized at a central structure called the “centrosome”
 - Animal centrosomes contain two centrioles (aid cell division)



The Cytoskeleton

Centrioles

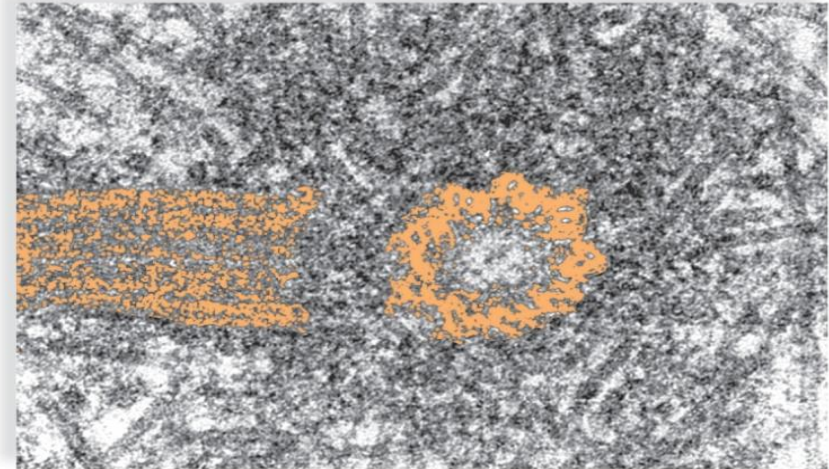
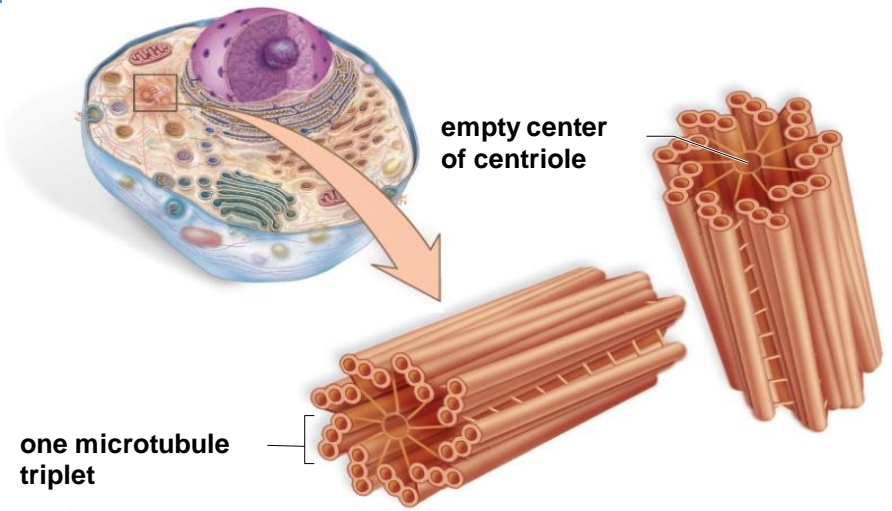
- Short, hollow cylinders

- Composed of 27 microtubules
- Microtubules arranged into 9 overlapping triplets

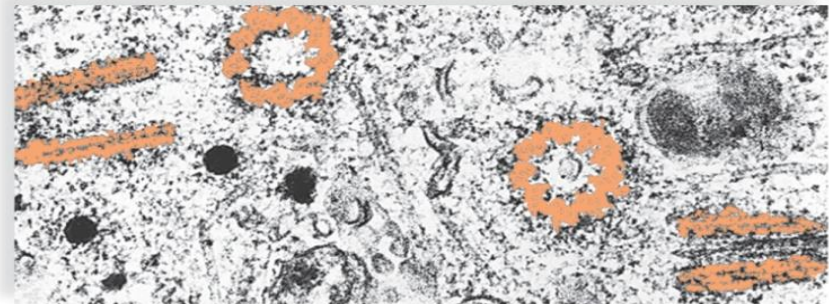
- **One pair per animal cell**

- Located in **centrosome** of animal cells
- Oriented at right angles to each other
- Separate during mitosis to determine plane of division

- May give rise to basal bodies of cilia and flagella



one centrosome: one pair of centrioles

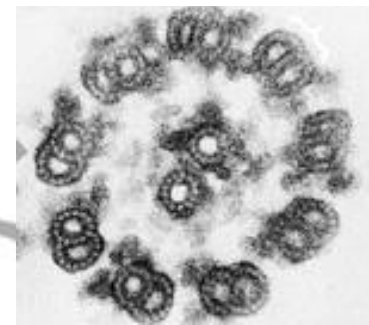
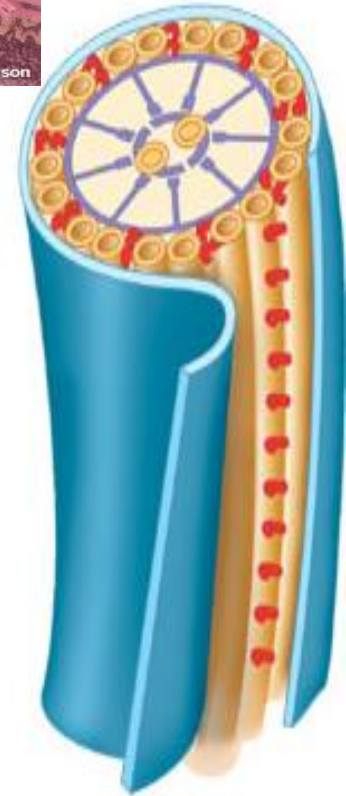


two centrosomes: two pairs of centrioles

200 nm

Flagella and Cilia

- In eukaryotic cells, these are made of microtubules (MTs) with outer covering of plasma membrane
- The 9+2 arrangement:
 - 9 doublets of MTs in a circle around two central single tubules
- Anchored in the cell to a **basal body**
 - Cilia are smaller and usually exist in larger numbers; move in coordinated waves like oars
- Flagella are long and cells usually have just one or two; Flagella move like a propeller or cork screw



Review Questions

- What is a centriole? A centrosome?
- Which organelle has a lumen with low pH? Why?
- What organelle performs cellular respiration?
- Circle the organelles that **WOULD** be found in a prokaryote:
 - Nucleus, Golgi, ribosome, Chloroplast, Plasma membrane
- What organelles perform detox. of drugs/poisons?
- Circle the organelles that are part of the Endomembrane system:
 - Lysosome, chloroplast, Golgi apparatus, vacuole, Endoplasmic Reticulum, Mitochondria
- What organelles synthesize proteins?
- What are the building block proteins of:
 - Microtubules, actin filaments, intermediate filaments