The Cell (organelles)

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01

Eukaryotic Cells

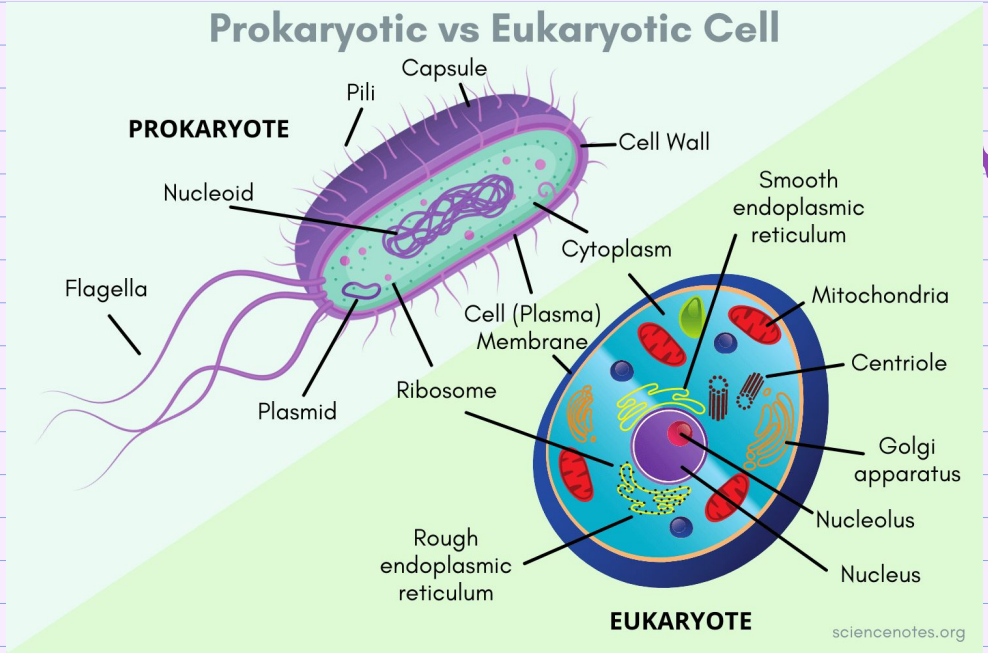
Prokaryotic vs. Eukaryotic Cells

Similarities:

- Plasma membrane
- Cytosol
- Chromosomes
- Ribosomes

Differences:

- Nucleus vs. nucleoid
- Definition of cytoplasm
- Size
- Membrane-bound organelles
    - Compartmentalization



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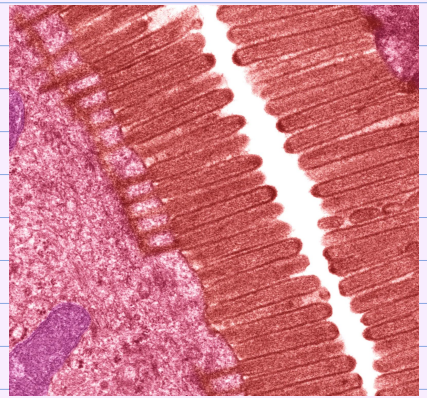
Plasma Membrane + Cell Size

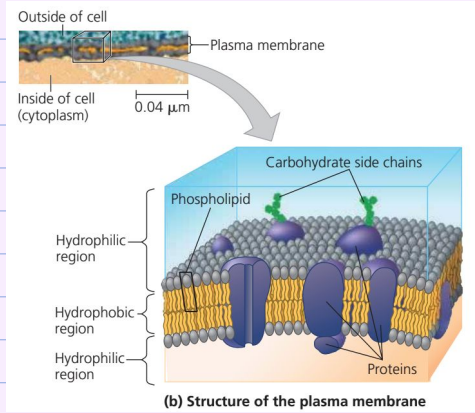
Plasma membrane is a selective barrier

Size:

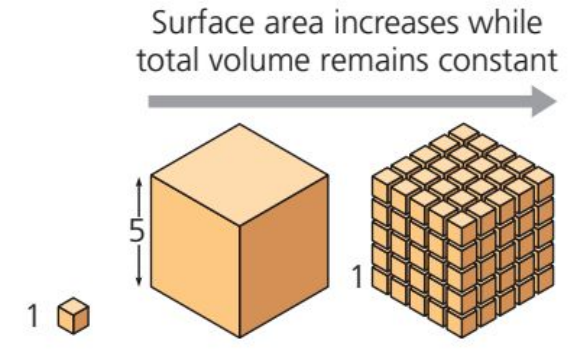
- Surface area grows more slowly than volume
  - SA = side^2
  - V = side^3
- High SA:V ratio is needed to conduct exchange
  - Microvilli



https://cdn.britannica.com/58/243958-050-76072C77/Microvilli-lining-small-intestine-human.jpg



(b) Structure of the plasma membrane



Animal Cell (cutaway view of generalized cell)

ENDOPLASMIC RETICULUM (ER): network of membranous sacs and tubes; active in membrane synthesis and other synthetic and metabolic processes; has rough (ribosome-studded) and smooth regions

Rough ER | Smooth ER

Flagellum: motility structure present in some animal cells, composed of a cluster of microtubules within an extension of the plasma membrane

Centrosome: region where the cell's microtubules are initiated; contains a pair of centrioles

CYTOSKELETON: reinforces cell's shape; functions in cell movement; components are made of protein. Includes:

- **Microfilaments**
- **Intermediate filaments**
- **Microtubules**

Microvilli: membrane projections that increase the cell's surface area

Peroxisome: organelle with various specialized metabolic functions; produces hydrogen peroxide as a by-product and then converts it to water

Mitochondrion: organelle where cellular respiration occurs and most ATP is generated

Nuclear envelope: double membrane enclosing the nucleus; perforated by pores; continuous with ER

Nucleolus: nonmembranous structure involved in production of ribosomes; a nucleus has one or more nucleoli

Chromatin: material consisting of DNA and proteins; visible in a dividing cell as individual condensed chromosomes

NUCLEUS

Plasma membrane: membrane enclosing the cell

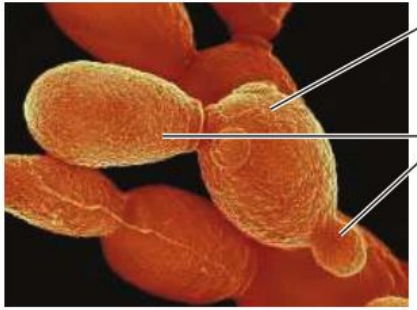
Ribosomes (small brown dots): complexes that make proteins; free in cytosol or bound to rough ER or nuclear envelope

Golgi apparatus: organelle active in synthesis, modification, sorting, and secretion of cell products

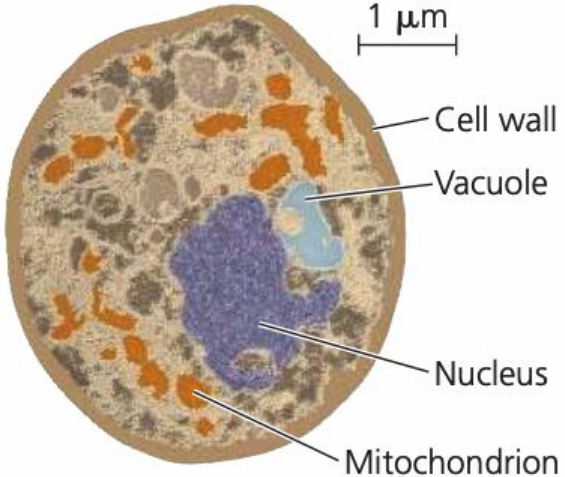
Lysosome: digestive organelle where macromolecules are hydrolyzed

Mastering Biology **BioFlix® Animation: Tour of an Animal Cell**

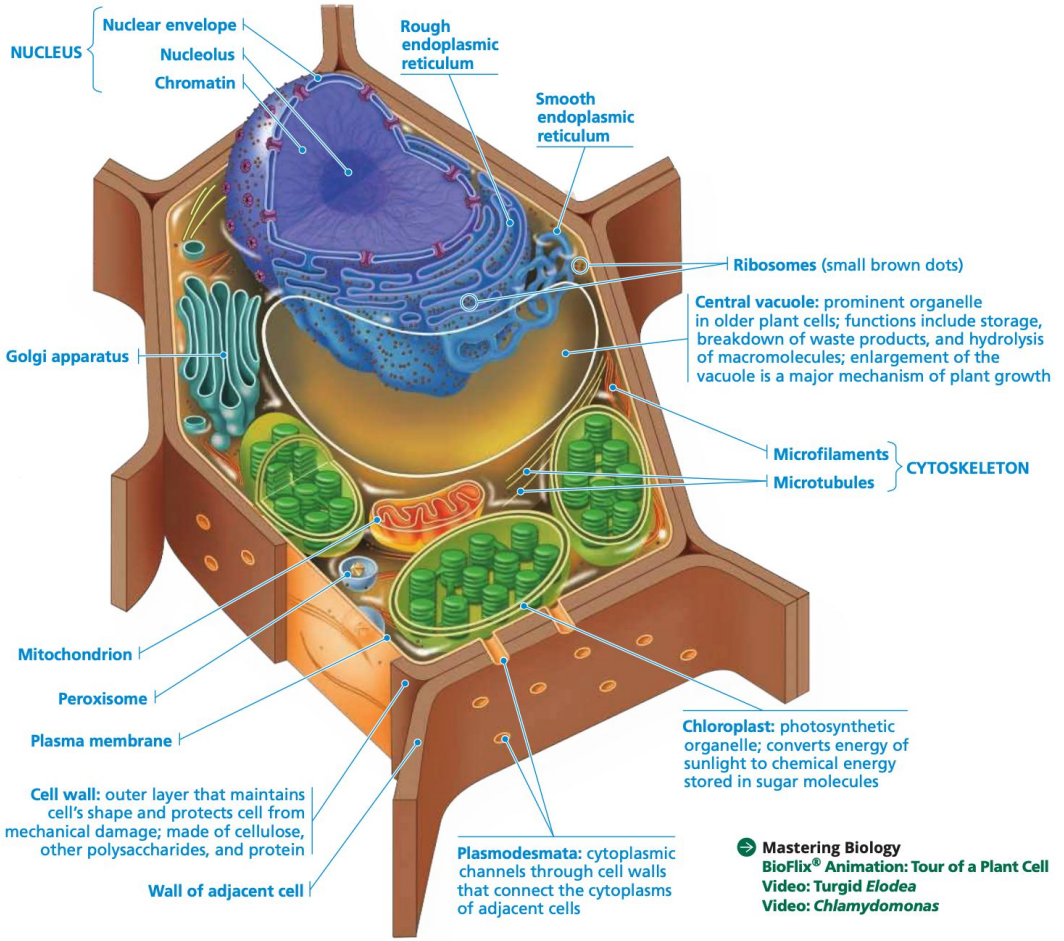
Unicellular Fungi



Yeast cells: reproducing by budding (above, colorized SEM) and a single cell (right, colorized TEM)



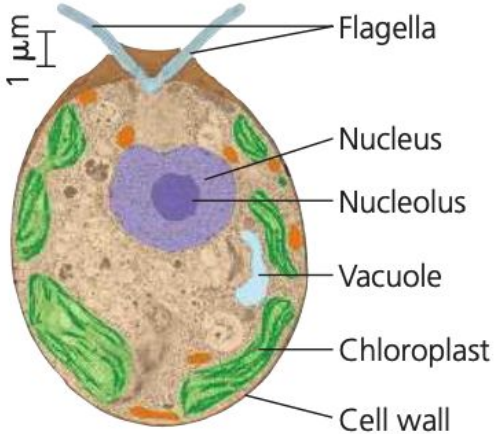
Plant Cell (cutaway view of generalized cell)

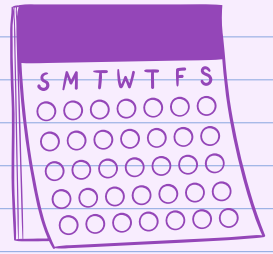


Mastering Biology
BioFlix® Animation: Tour of a Plant Cell
Video: Turgid *Elodea*
Video: *Chlamydomonas*

Unicellular Algae

Unicellular green alga *Chlamydomonas* (above, colorized SEM; right, colorized TEM)

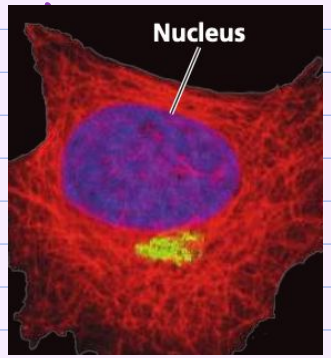




02

organelles

Nucleus



Nucleus
- Contains most genes
- Surrounded by nuclear envelope
  - Double membrane
- Pore complex lines nuclear pores
- Nuclear lamina lines nuclear side of envelope
  - Intermediate filaments, maintain nucleus shape
- Nuclear matrix throughout inside

DNA
- Chromosomes are made of chromatin
  - DNA wrapped around histones

Nucleolus (can be multiple)
- rRNA synthesized here
- Proteins imported from cytoplasm assembled with rRNA → ribosomal subunits

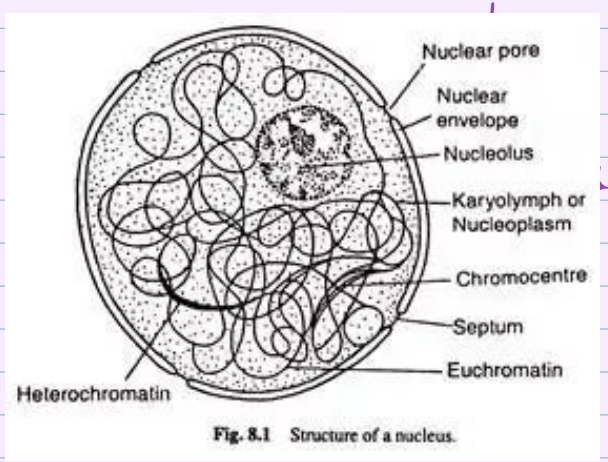
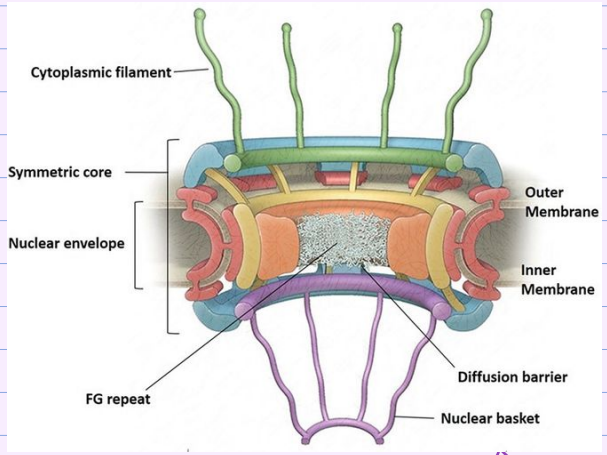


Fig. 8.1 Structure of a nucleus.



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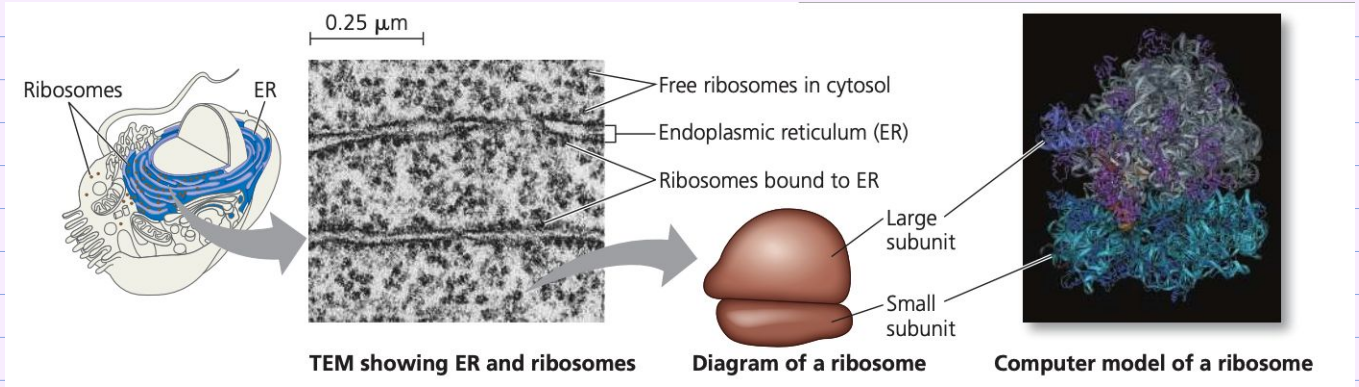
Ribosomes

- Made of rRNAs and protein
  - Not actually organelles because they don't have a membrane!
- Lots of protein synthesis = lots of ribosomes and nucleoli
- Location
  - Free ribosomes – cytoplasm
    - Most products function in cytosol
  - Bound ribosomes – outside of RER or nuclear envelope
    - Most products function in membranes or outside of the cell



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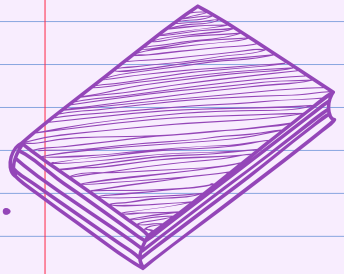
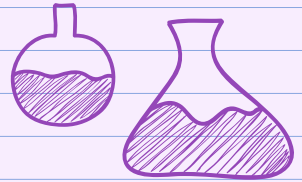
Endomembrane System





Endomembrane system

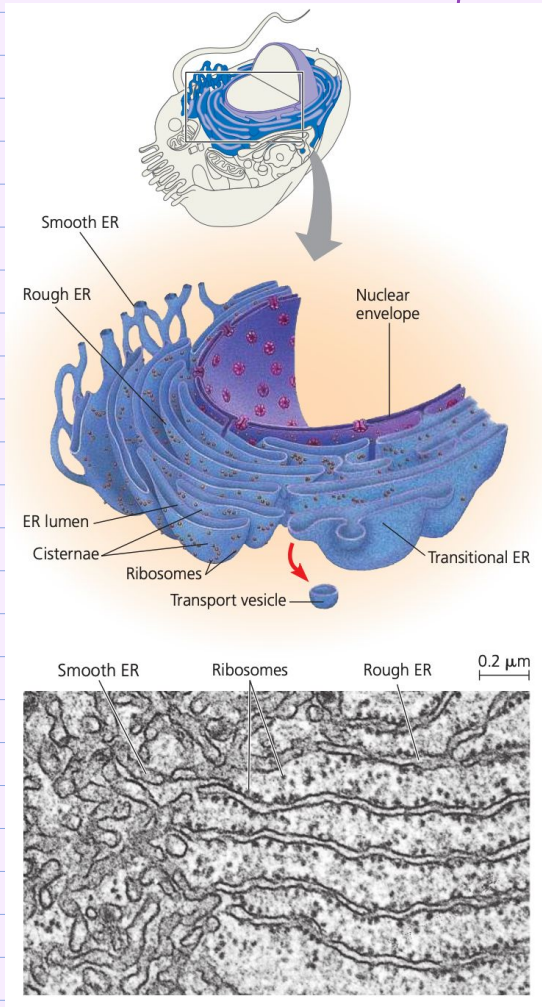
- Components
  - Nuclear envelope
  - Endoplasmic reticulum
  - Golgi apparatus
  - Lysosomes
  - Vesicles and vacuoles
  - Plasma membrane
- Purpose
  - Make proteins
  - Transport proteins into membranes or out of the cell
  - Metabolism + movement of lipids
  - Detoxifiying poisons
- Transport done either through membranes connecting with each other or vesicles

Endoplasmic Reticulum

- Account for more than 50% of a cell's membranes
- Consists of a network of membranous tubules and cisternae (sac-like)
    - ER lumen (cisternal space) separated from cytosol
- Continuous with nuclear membrane

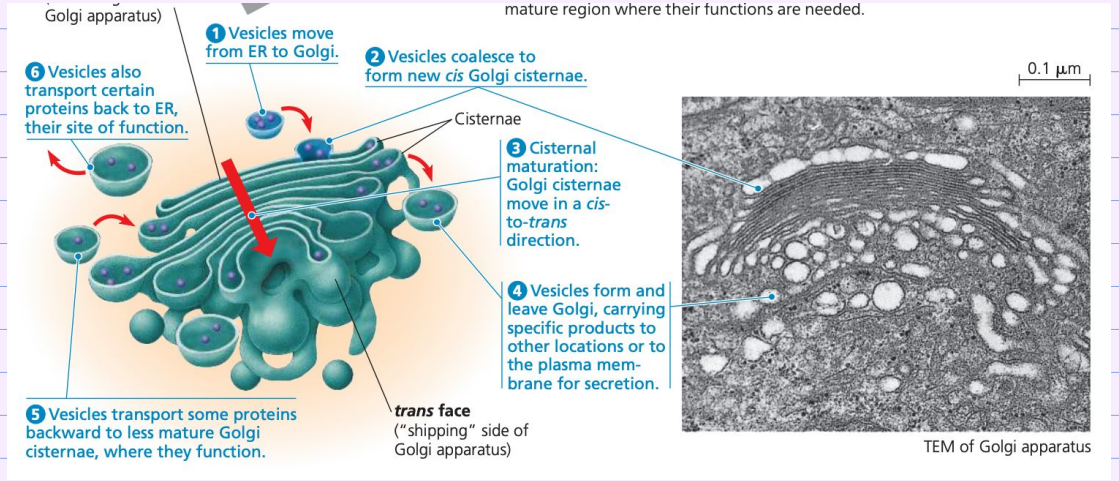
Smooth ER
- Lipid synthesis – such as hormones from steroids
- Carbohydrate metabolism
- Detoxification of drugs/poisons
    - Hydroxylation
- Storing calcium ions – muscle contractions

Rough ER
- Secretory proteins
    - Glycoproteins
    - Bud off in transport vesicles
- Membrane-making



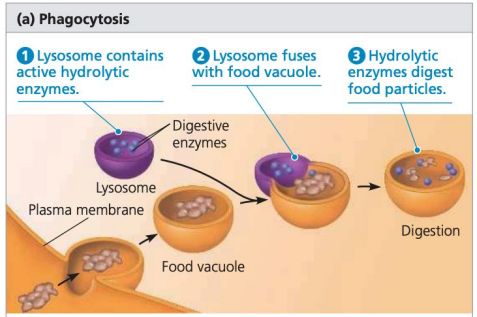
Golgi Apparatus/Body/Complex

- Like the warehouse of the cell
- ER products are modified, stored, and sent elsewhere
- Flattened membranous sacs (cisternae)
- Directionality
  - Cis face receives vesicles from the ER
  - Trans face sends vesicles elsewhere
- Modifications happen between arrival and departure
- May manufacture macromolecules
  - Pectins for plant cell walls
- Cisternal maturation model
  - Cisternae move forward

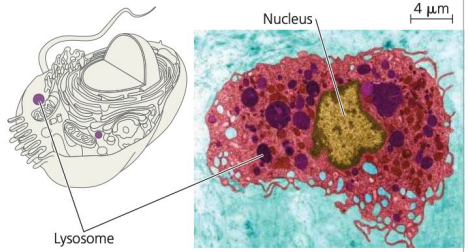


Lysosomes

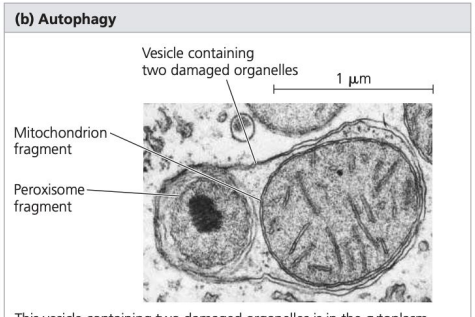
- Sac of hydrolytic enzymes
  - Work best in acidic conditions (which lysosomes provide)
    - Good in cases of leakage
- Phagocytosis for food/immune purposes
  - Food vacuole
- Autophagy
- Tay-Sachs disease – missing enzyme that digests lipids



A lysosome fuses with a food vacuole during the process of phagocytosis by a unicellular protist.



In this colorized TEM of a macrophage (a type of white blood cell), lysosomes are purple. They contain enzymes that digest foreign particles such as bacteria and pollen.



This vesicle containing two damaged organelles is in the cytoplasm of a rat liver cell (TEM).

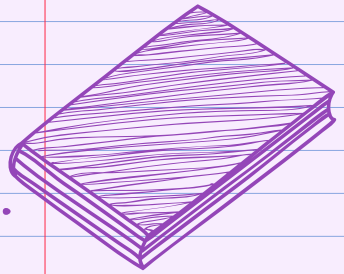
The vesicle with damaged organelles fuses with a lysosome. The organelles are then digested and their components recycled.

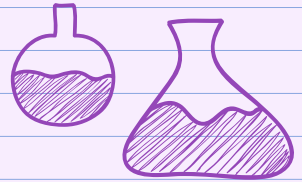
Vacuoles

- Large vesicles
- Come from ER and Golgi apparatus
- Food vacuoles
- Contractile vacuoles in unicellular protists
- Hydrolysis in plants and fungi
- Small vacuoles in plants
    - Hold organic compounds like food
    - May hold poison
- Central vacuole
    - A bunch of smaller vacuoles coalesce
    - Cell sap – lots of inorganic ions like potassium and chloride

03

Mitochondria and Chloroplasts



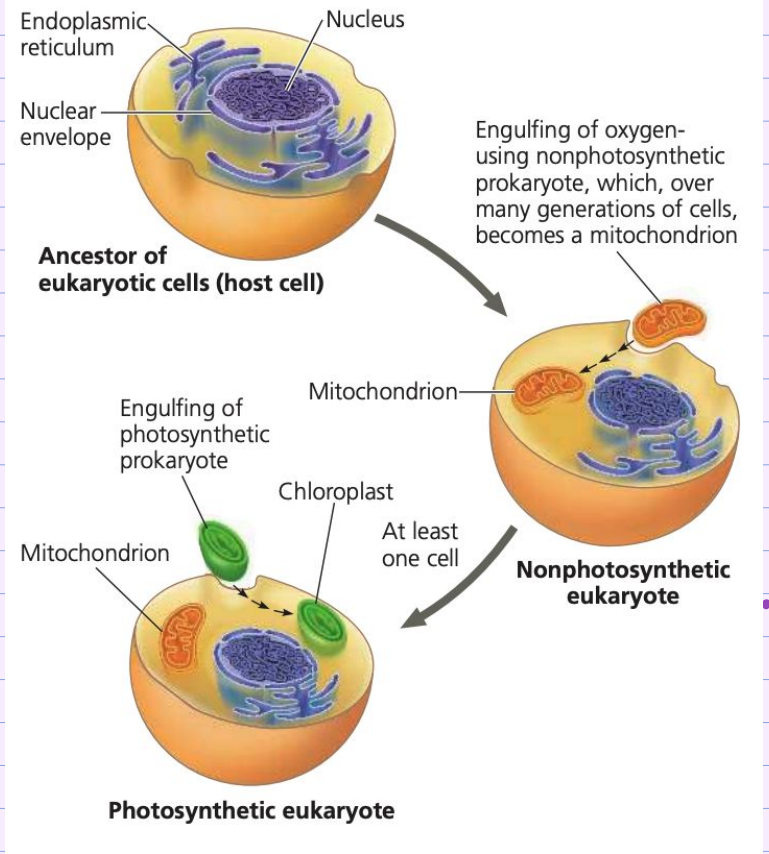


Endosymbiont Theory

Host cell (proto-eukaryotic) engulfed aerobic prokaryotic cell, which becomes an endosymbiont

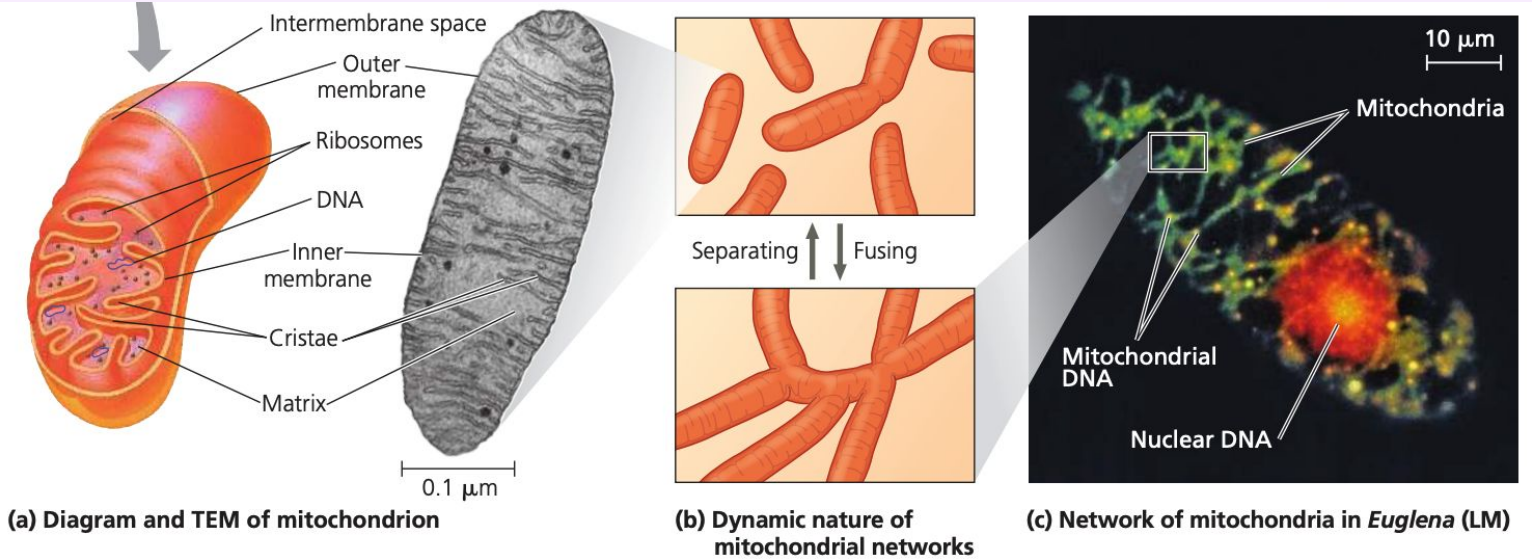
Reasons/proof

- Double membrane
- Have their own ribosomes + circular DNA
- Autonomous within the cell



Mitochondria

Can form a “power grid” in skeletal muscles



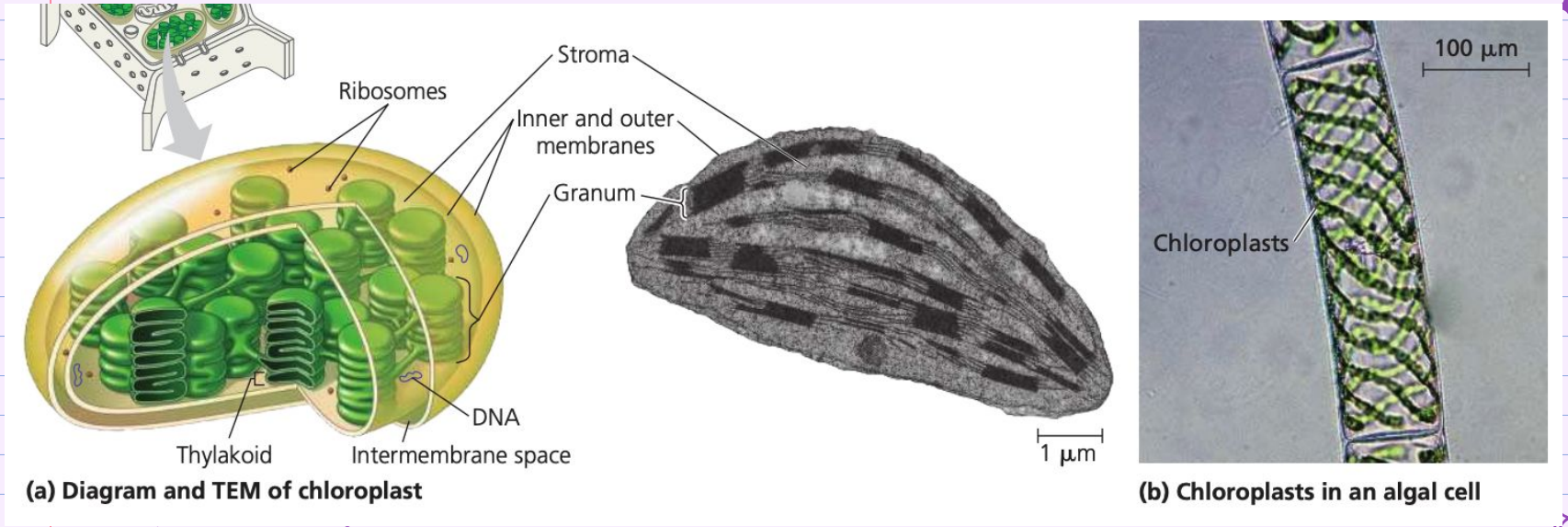
(a) Diagram and TEM of mitochondrion

(b) Dynamic nature of mitochondrial networks

(c) Network of mitochondria in *Euglena* (LM)

Chloroplast

- Type of plastid
  - Amyloplast (type of leucoplast)
  - Chromoplast

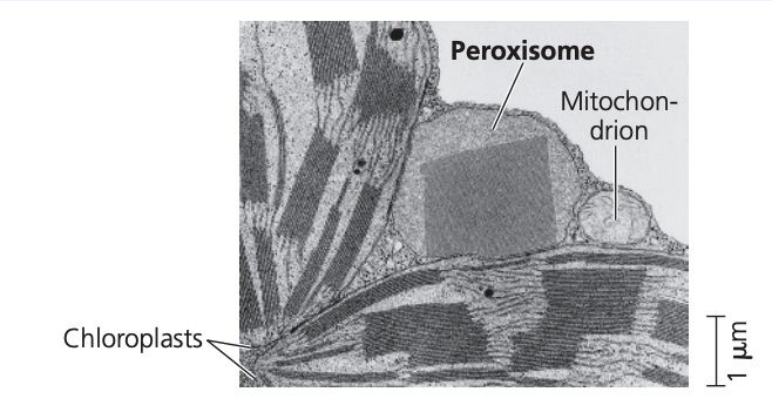


(a) Diagram and TEM of chloroplast

(b) Chloroplasts in an algal cell

Peroxisomes

- Single membrane
- Has enzymes which removes hydrogens from stuff and add it to O2 to make H2O2
    - Catalase neutralizes peroxide
- Glyoxysomes



44. The size of an amphibian or reptile matters in terms of thermal interactions with the environment. The larger the animal the _____ and the _____.

A. Lower the surface: volume ratio - lower the heat exchange.
B. Higher the surface: volume ratio - higher the heat exchange.
C. Higher the surface: volume ratio - lower the rate of water loss.
D. Higher the heat exchange - higher the rate of water loss.
E. Higher the surface: volume ratio - lower the heat exchange.

Which of the following BEST describes the function of the golgi (read as: GOAL-gee) complex:
W) metabolism of carbohydrates
X) production of peroxides
Y) modification and packaging of proteins for exocytosis
Z) storage of lipids

Name all of the following 4 organelles that are bounded by a double membrane: nucleus; mitochondrion; lysosome; chloroplast

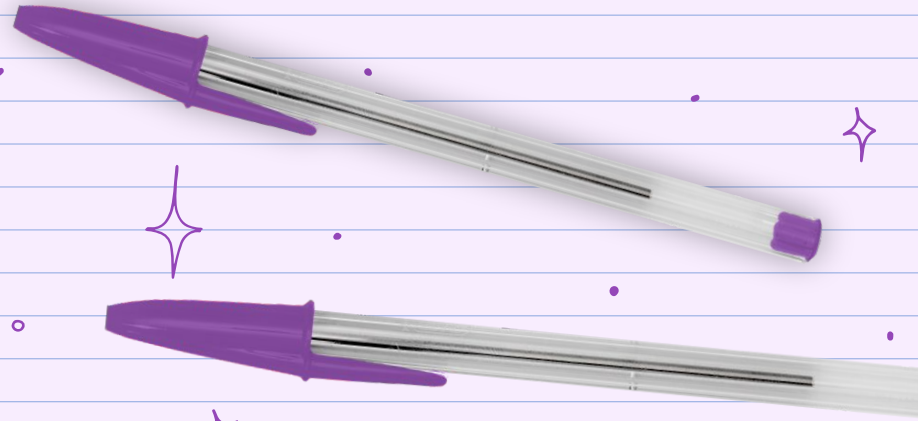
Which of the following pairs correctly matches the cellular structure or organelle with its function?
W) Nucleolus and rRNA synthesis
X) Smooth endoplasmic reticulum and carbohydrate synthesis
Y) Centriole and transport of vesicles
Z) Golgi apparatus and protein synthesis

Kent holds up a potato at dinner and announces to his family that the spud is actually made up of cells with lots of large organelles that contain the carbohydrates stored by the plant. What are these organelles called?

Which of the following proteins would likely be synthesized by a cytosolic ribosome instead of an ER-bound ribosome?
W) Insulin
X) Actin
Y) Subunits for a potassium channel
Z) G protein-coupled receptor

The nucleus is enveloped by a net-like array of protein filaments that maintain the shape of the nucleus. What is this array known as?

THANKS!



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