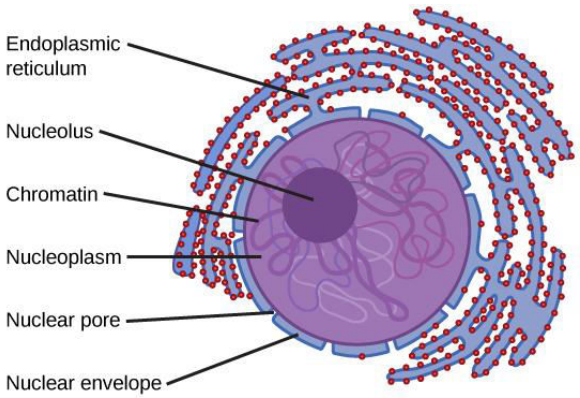
Eukaryotic Cells



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- Mitochondria
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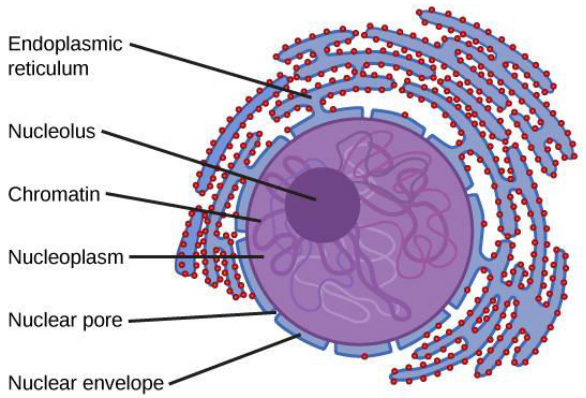
Introduction

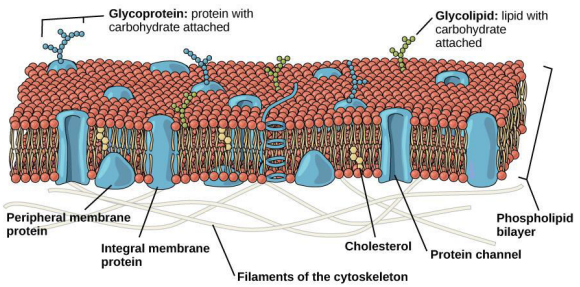
- Eukaryotic cells are larger than prokaryotic cells and have a "true" nucleus, membrane-bound organelles, and rod-shaped chromosomes.
- The nucleus houses the cell's DNA and directs the synthesis of proteins and ribosomes.
- Mitochondria are responsible for ATP production; the endoplasmic reticulum modifies proteins and synthesizes lipids; and the golgi apparatus is where the sorting of lipids and proteins takes place.
- Perixisomes carry out oxidation reactions that break down fatty acids and amino acids and detoxify poisons; vesicles and vacuoles function in storage and transport.
- Animal cells have a centrosome and lysosomes while plant cells do not.
- Plant cells have a cell wall, a large central vacuole, chloroplasts, and other specialized plastids, whereas animal cells do not.



Eukaryotic Nucleus

The Plasma Membrane and the Cytoplasm

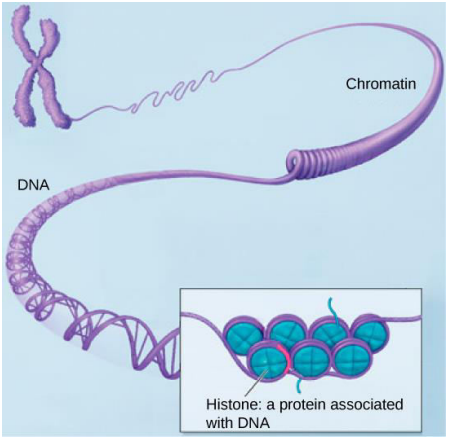
- All eukaryotic cells have a surrounding plasma membrane, which is also known as the cell membrane.
- The plasma membrane is made up by a phospholipid bilayer with embedded proteins that separates the internal contents of the cell from its surrounding environment.
- Only relatively small, non-polar materials can easily move through the lipid bilayer of the plasma membrane.
- Passive transport is the movement of substances across the membrane that does not require the use of energy while active transport is the movement of substances across the membrane using energy.
- Osmosis is the diffusion of water through a semi-permeable membrane down its concentration gradient; this occurs when there is an imbalance of solutes outside of a cell compared to the inside the cell.



Eukaryotic Plasma Membrane

The Nucleus and Ribosomes

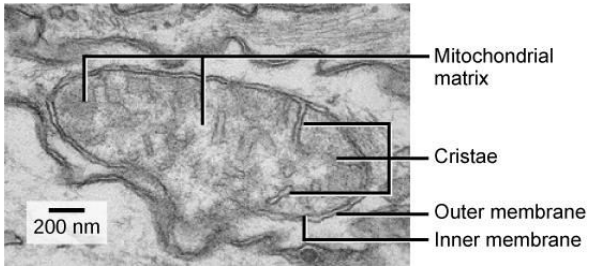
- The nucleus contains the cell's DNA and directs the synthesis of ribosomes and proteins.
- Found within the nucleoplasm, the nucleolus is a condensed region of chromatin where ribosome synthesis occurs.
- Chromatin consists of DNA wrapped around histone proteins and is stored within the nucleoplasm.
- Ribosomes are large complexes of protein and ribonucleic acid (RNA) responsible for protein synthesis when DNA from the nucleus is transcribed.



DNA is highly organized

Mitochondria

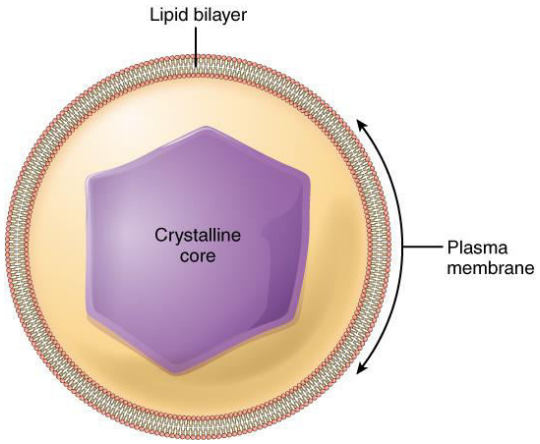
- Mitochondria contain their own ribosomes and DNA; combined with their double membrane, these features suggest that they might have once been free-living prokaryotes that were engulfed by a larger cell.
- Mitochondria have an important role in cellular respiration through the production of ATP, using chemical energy found in glucose and other nutrients.
- Mitochondria are also responsible for generating clusters of iron and sulfur, which are important cofactors of many enzymes.



Mitochondrial structure

Peroxisomes, Vesicles, and Vacuoles

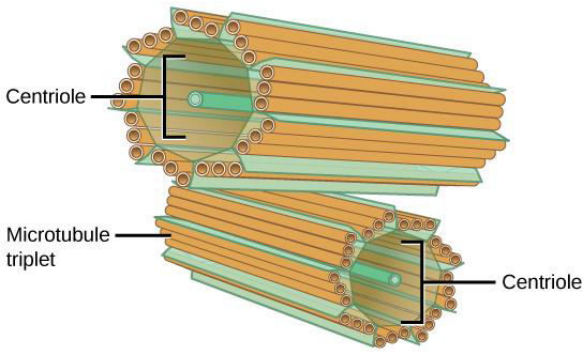
- Lipid metabolism and chemical detoxification are important functions of peroxisomes.
- Peroxisomes are responsible for oxidation reactions that break down fatty acids and amino acids.
- Peroxisomes oversee reactions that neutralize free radicals, which cause cellular damage and cell death.
- Peroxisomes chemically neutralize poisons through a process that produces large amounts of toxic H_2O_2, which is then converted into water and oxygen.
- The liver is the organ primarily responsible for detoxifying the blood before it travels throughout the body; as a result, liver cells contain large amounts of peroxisomes.



Peroxisomes

Animal Cells versus Plant Cells

- Centrosomes and lysosomes are found in animal cells, but do not exist within plant cells.
- The lysosomes are the animal cell's "garbage disposal", while in plant cells the same function takes place in vacuoles.
- Plant cells have a cell wall, chloroplasts and other specialized plastids, and a large central vacuole, which are not found within animal cells.
- The cell wall is a rigid covering that protects the cell, provides structural support, and gives shape to the cell.
- The chloroplasts, found in plant cells, contain a green pigment called chlorophyll, which captures the light energy that drives the reactions of plant photosynthesis.
- The central vacuole plays a key role in regulating a plant cell's concentration of water in changing environmental conditions.

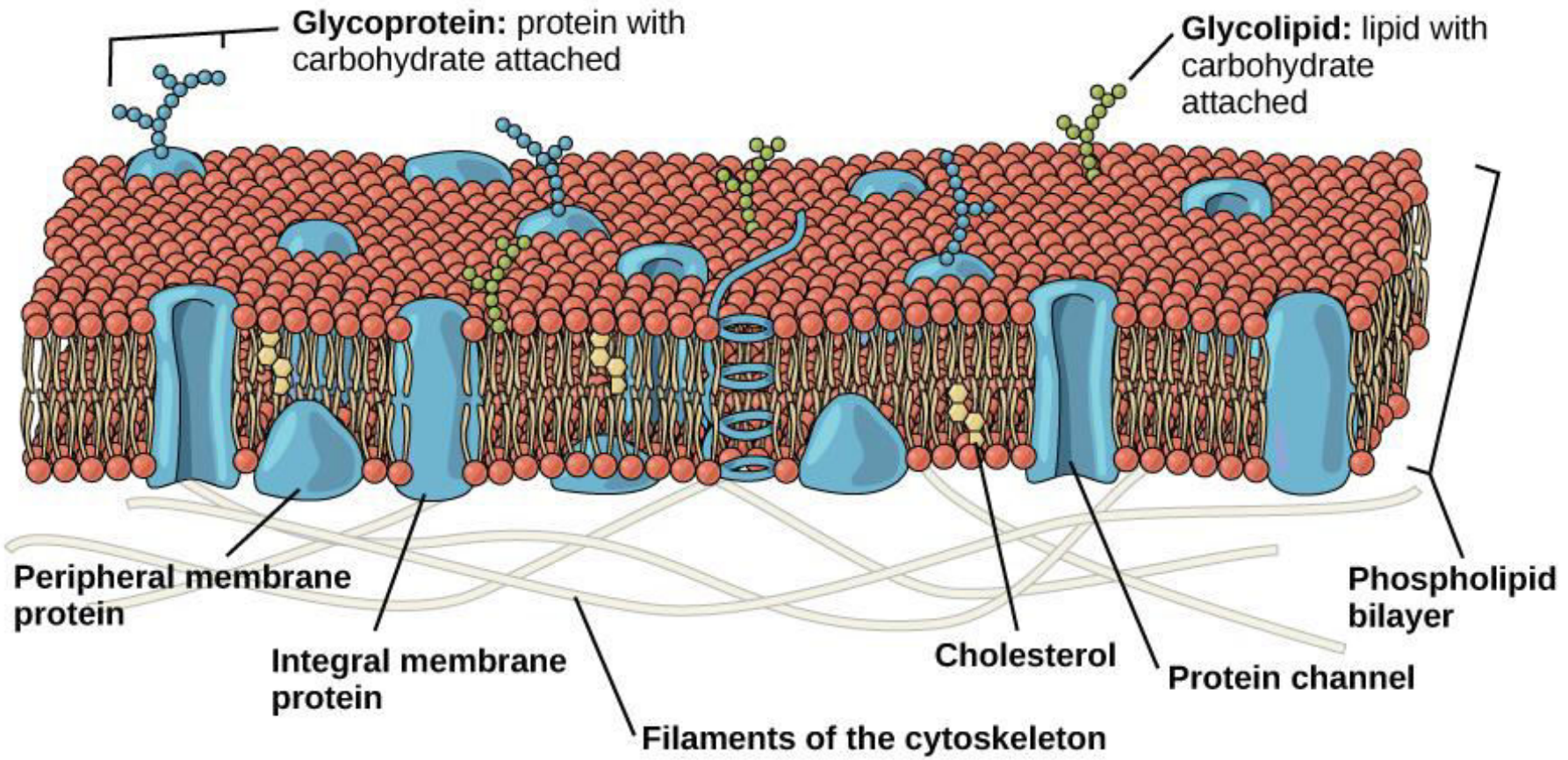


The Centrosome Structure

Key terms

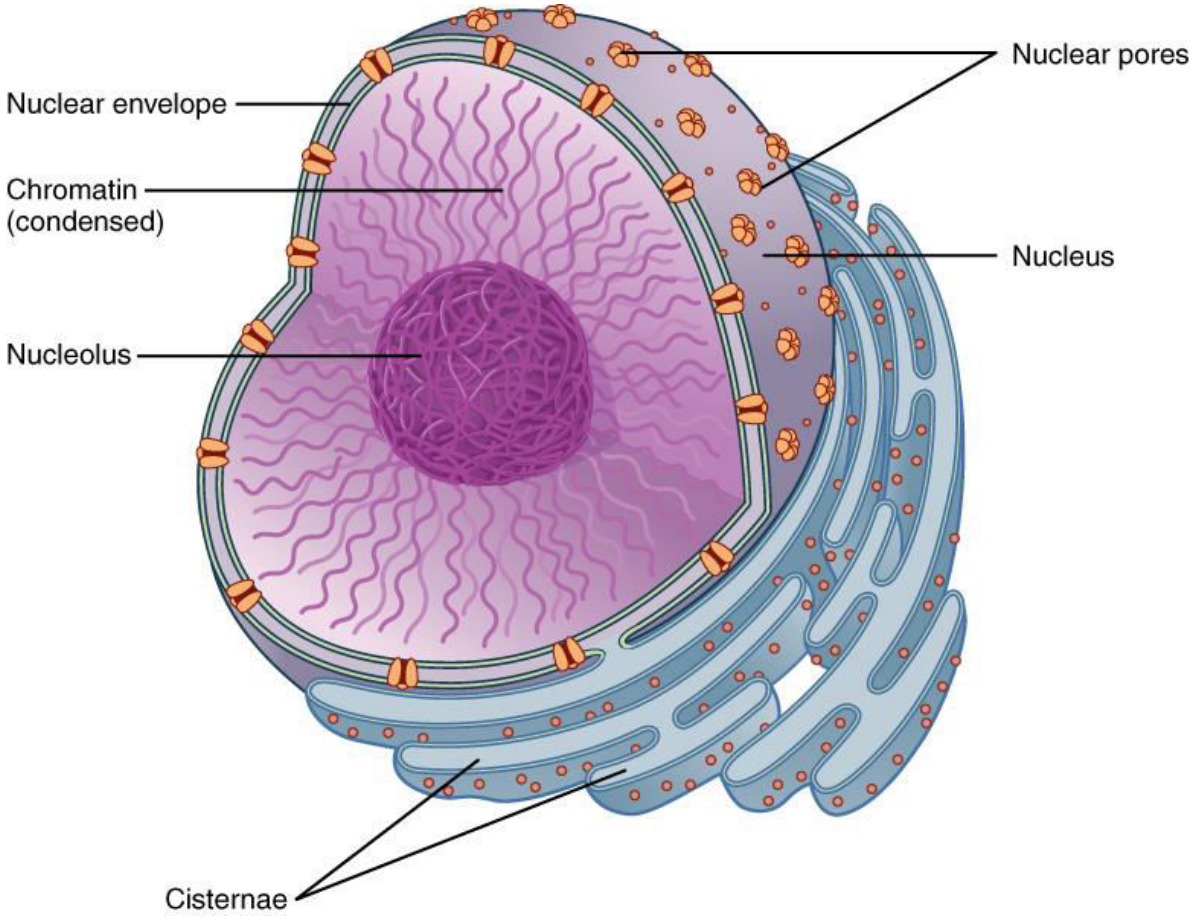
- **adenosine triphosphate** a multifunctional nucleoside triphosphate used in cells as a coenzyme, often called the "molecular unit of energy currency" in intracellular energy transfer
- **alpha-proteobacteria** A taxonomic class within the phylum Proteobacteria — the phototropic proteobacteria.
- **autotroph** Any organism that can synthesize its food from inorganic substances, using heat or light as a source of energy
- **chromatin** a complex of DNA, RNA, and proteins within the cell nucleus out of which chromosomes condense during cell division
- **cofactor** an inorganic molecule that is necessary for an enzyme to function
- **enzyme** a globular protein that catalyses a biological chemical reaction
- **eukaryotic** Having complex cells in which the genetic material is organized into membrane-bound nuclei.
- **free radical** Any molecule, ion or atom that has one or more unpaired electrons; they are generally highly reactive and often only occur as transient species.
- **heterotroph** an organism that requires an external supply of energy in the form of food, as it cannot synthesize its own
- **histone** any of various simple water-soluble proteins that are rich in the basic amino acids lysine and arginine and are complexed with DNA in the nucleosomes of eukaryotic chromatin
- **hypertonic** having a greater osmotic pressure than another
- **hypotonic** Having a lower osmotic pressure than another; a cell in this environment causes water to enter the cell, causing it to swell.

- nucleolus a conspicuous, rounded, non-membrane bound body within the nucleus of a cell
- organelle A specialized structure found inside cells that carries out a specific life process (e.g. ribosomes, vacuoles).
- phospholipid Any lipid consisting of a diglyceride combined with a phosphate group and a simple organic molecule such as choline or ethanolamine; they are important constituents of biological membranes
- photosynthesis the process by which plants and other photoautotrophs generate carbohydrates and oxygen from carbon dioxide, water, and light energy in chloroplasts
- protist Any of the eukaryotic unicellular organisms including protozoans, slime molds and some algae; historically grouped into the kingdom Protoctista.



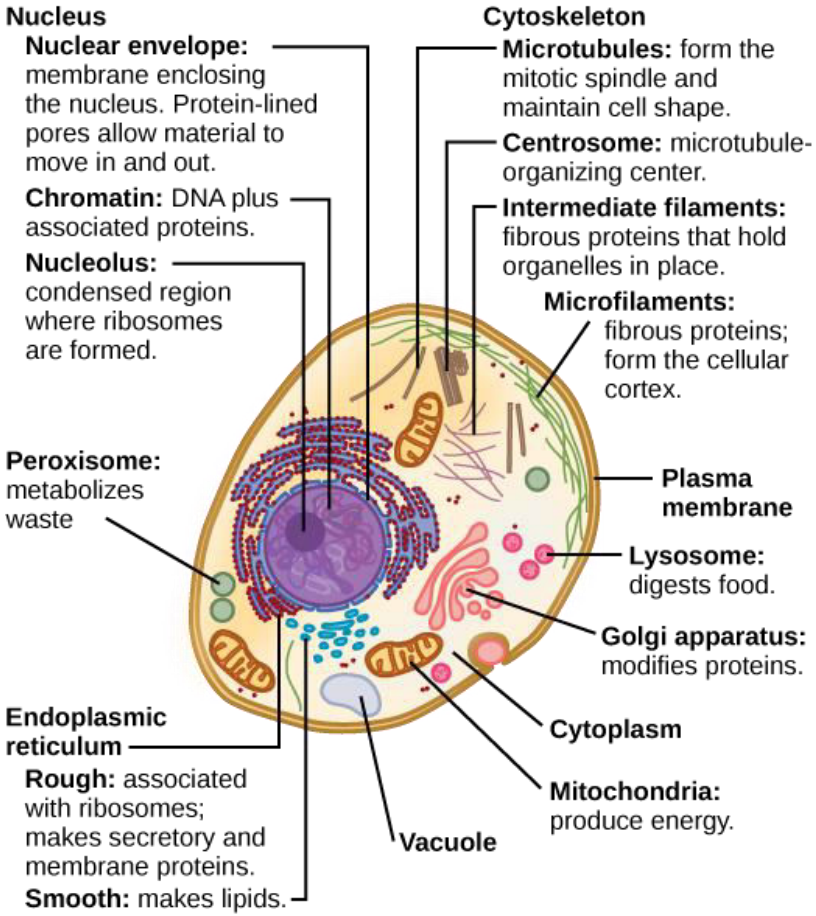
Eukaryotic Plasma Membrane

The eukaryotic plasma membrane is a phospholipid bilayer with proteins and cholesterol embedded in it.



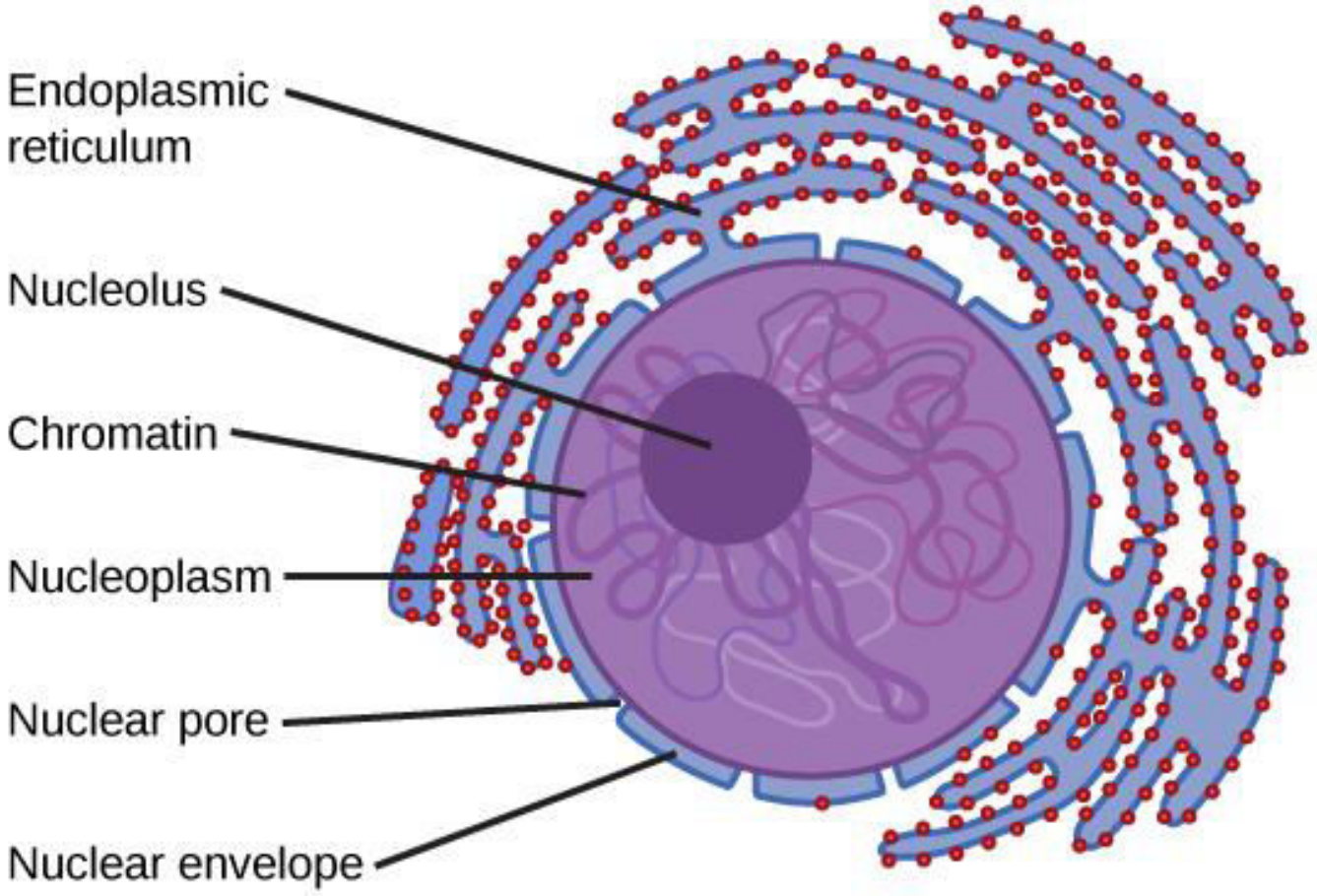
The nucleus stores the hereditary material of the cell

The nucleus is the control center of the cell.The nucleus of living cells contains the genetic material that determines the entire structure and function of that cell.



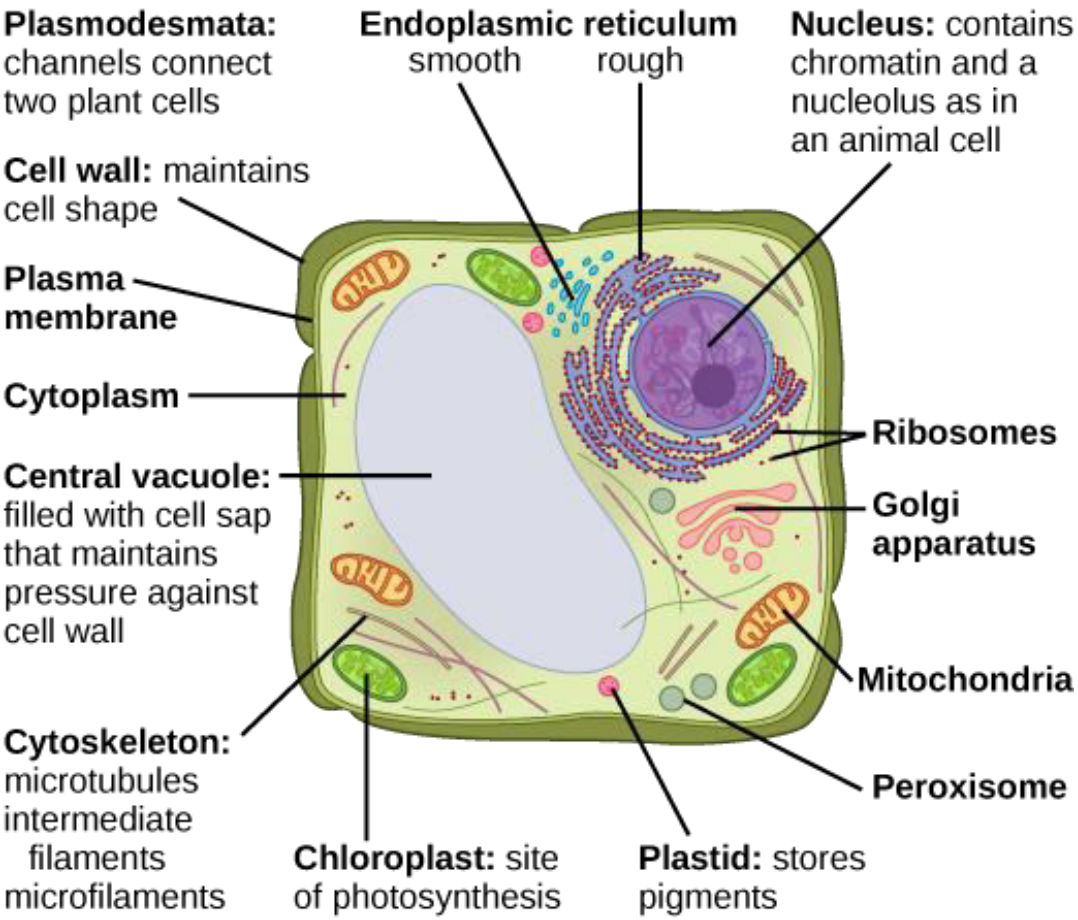
Animal Cells

Despite their fundamental similarities, there are some striking differences between animal and plant cells.Animal cells have centrioles, centrosomes, and lysosomes, whereas plant cells do not.



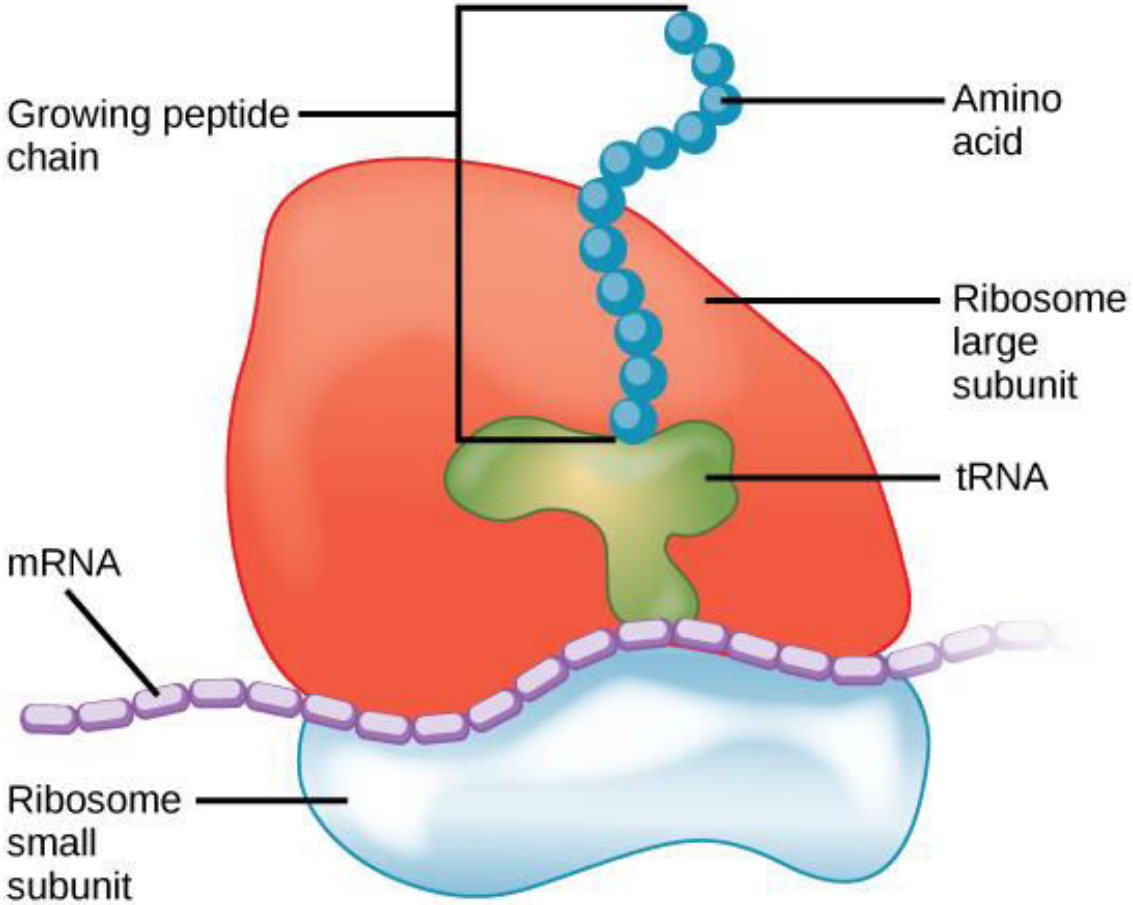
Eukaryotic Nucleus

The nucleus stores chromatin (DNA plus proteins) in a gel-like substance called the nucleoplasm.The nucleolus is a condensed region of chromatin where ribosome synthesis occurs.The boundary of the nucleus is called the nuclear envelope.It consists of two phospholipid bilayers: an outer membrane and an inner membrane.The nuclear membrane is continuous with the endoplasmic reticulum.Nuclear pores allow substances to enter and exit the nucleus.



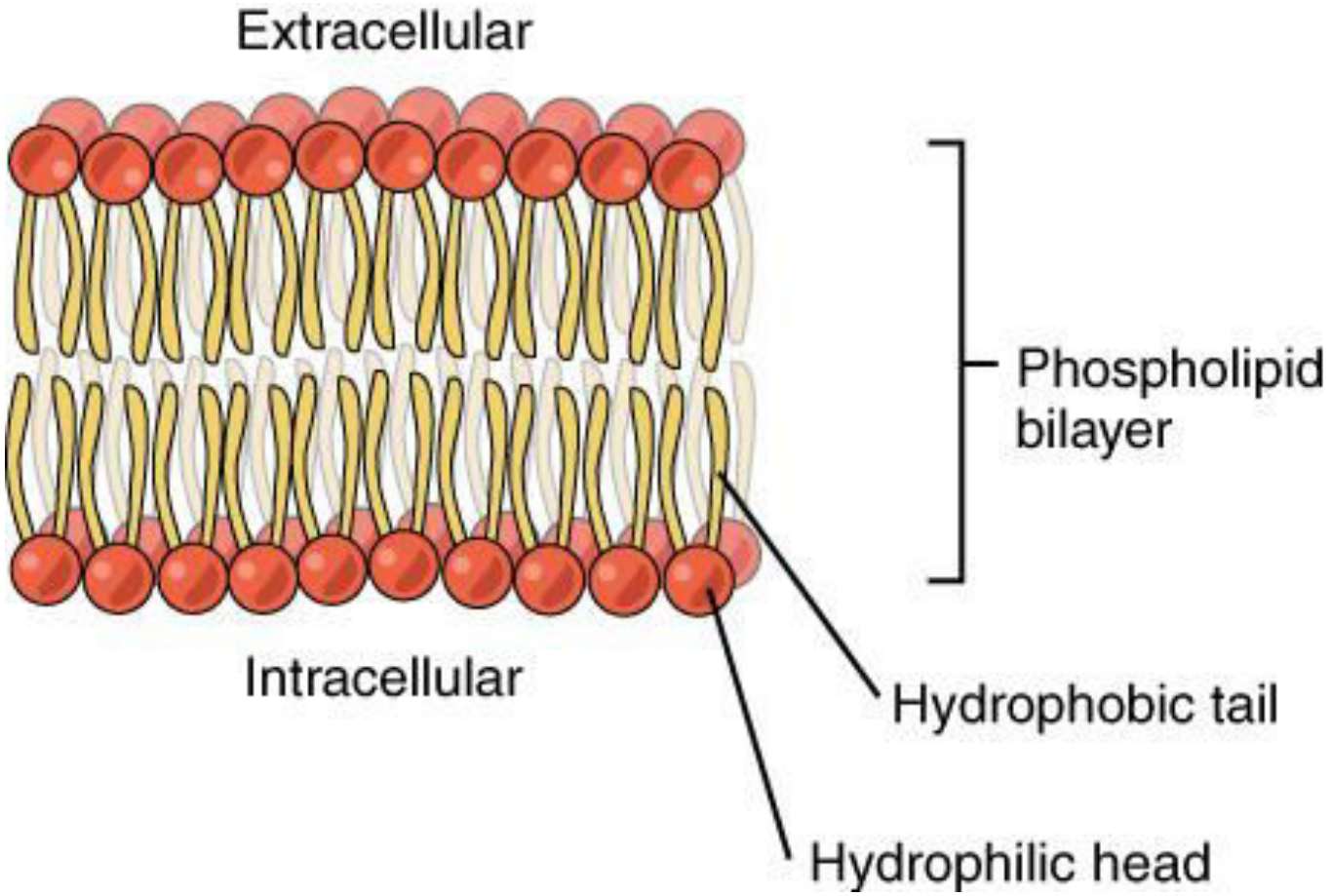
Plant Cells

Plant cells have a cell wall, chloroplasts, plasmodesmata, and plastids used for storage, and a large central vacuole, whereas animal cells do not.



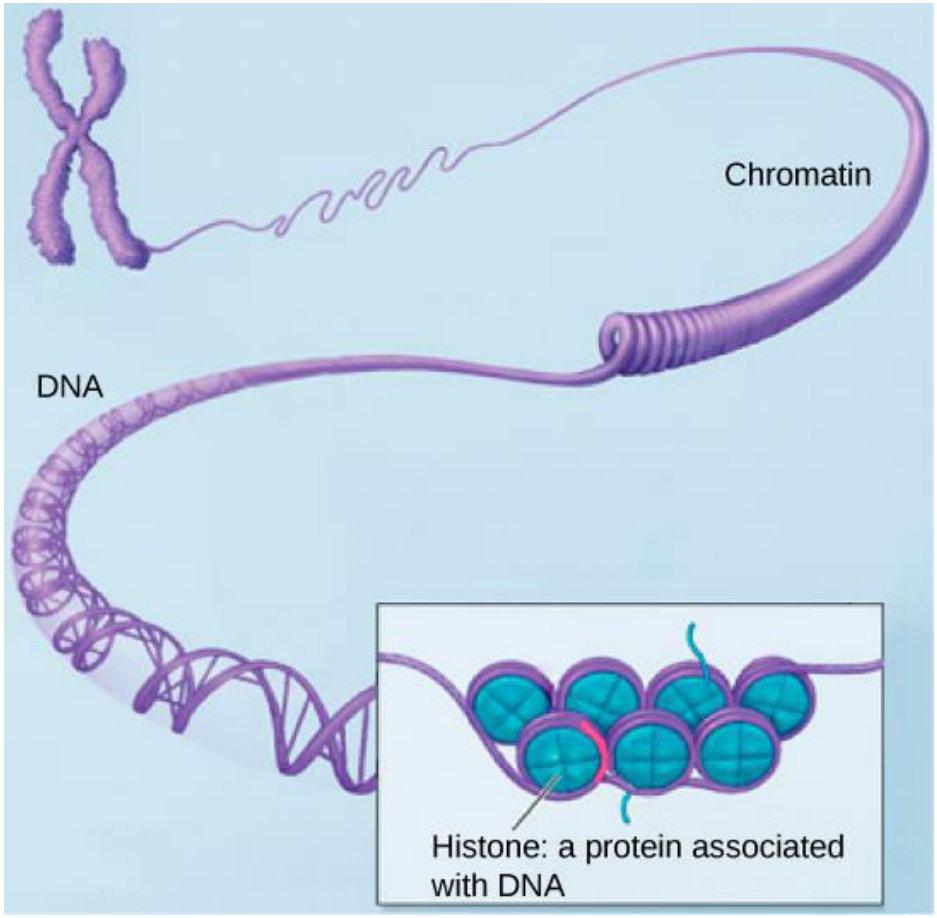
Ribosomes are responsible for protein synthesis

Ribosomes are made up of a large subunit (top) and a small subunit (bottom).During protein synthesis, ribosomes assemble amino acids into proteins.



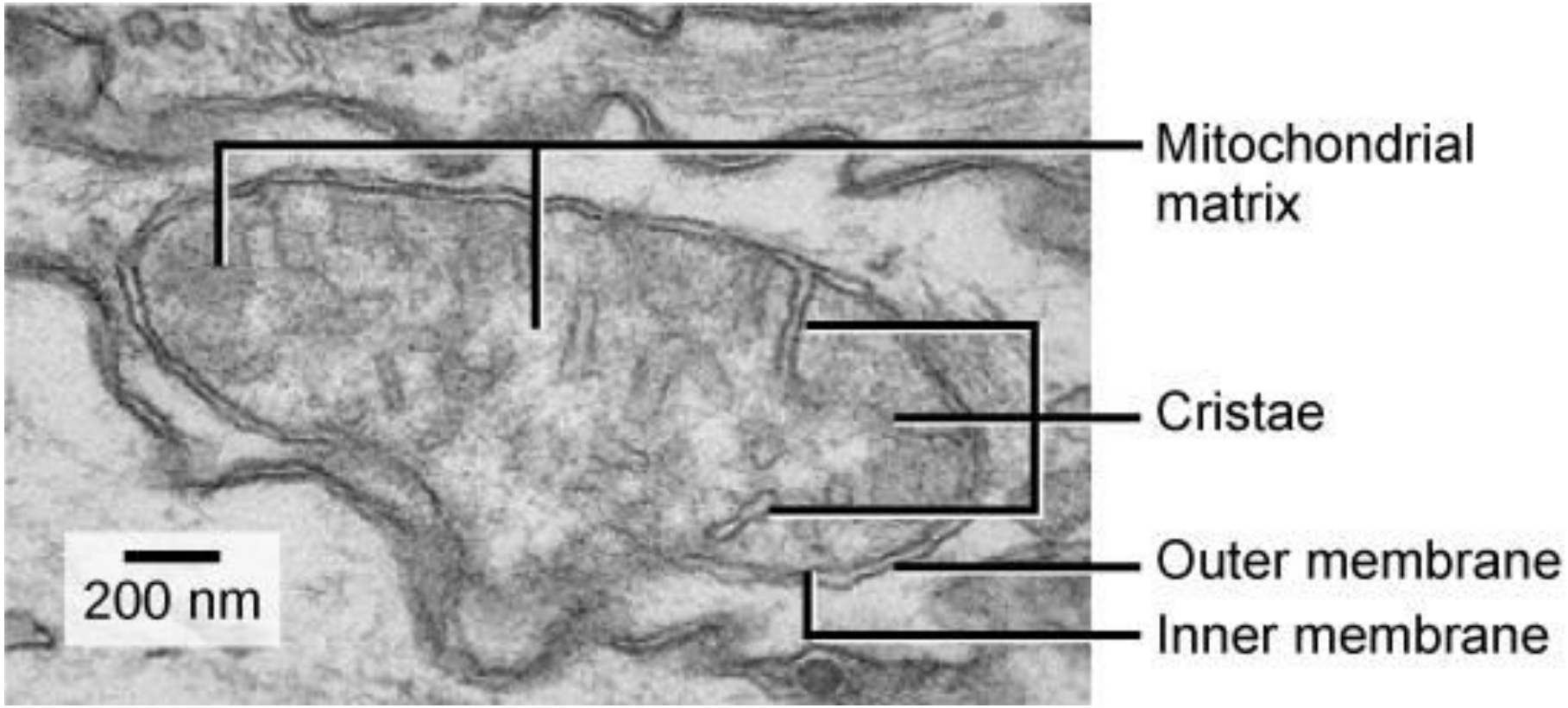
Phospholipid Bilayer

The phospholipid bilayer consists of two adjacent sheets of phospholipids, arranged tail to tail.The hydrophobic tails associate with one another, forming the interior of the membrane.The polar heads contact the fluid inside and outside of the cell.



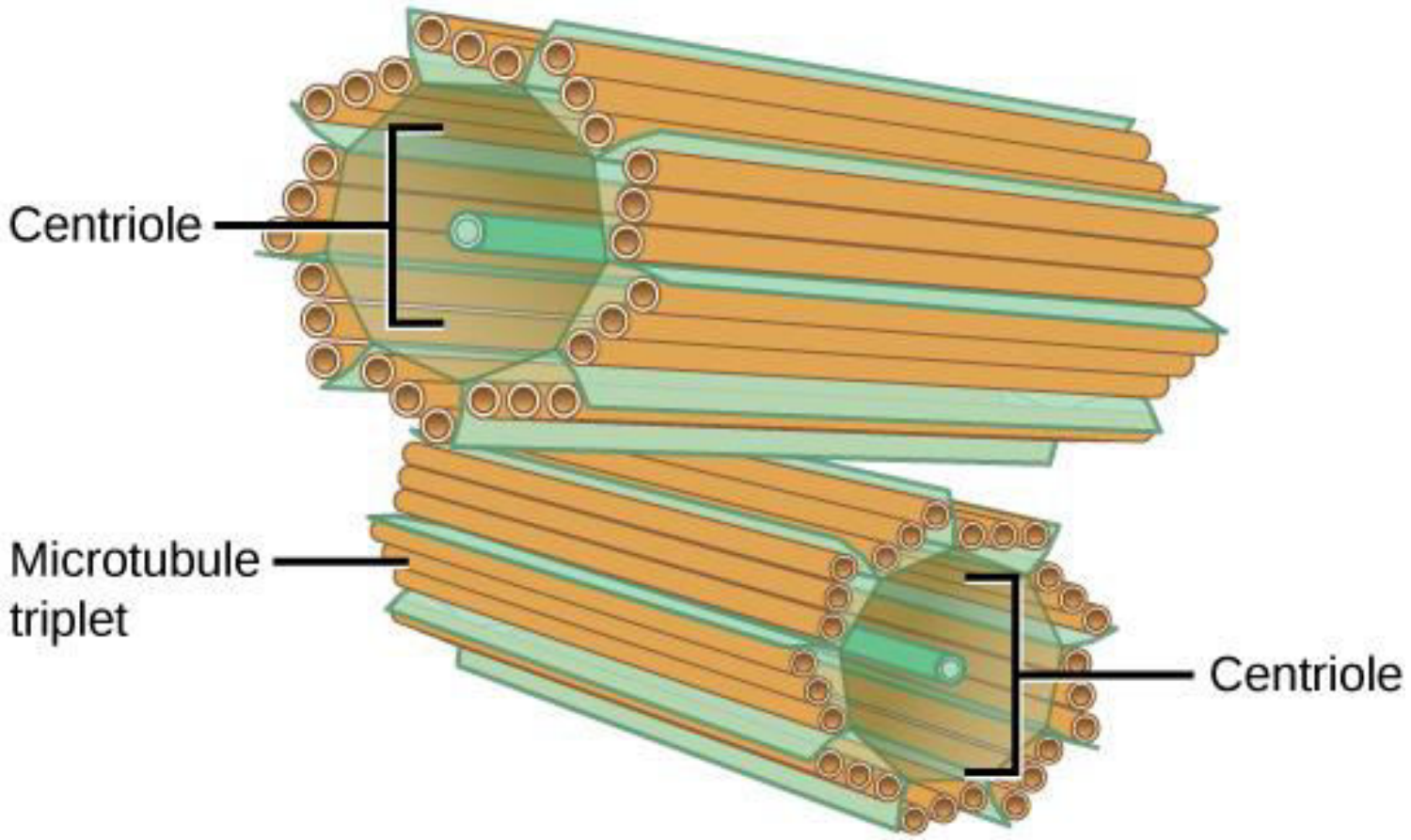
DNA is highly organized

This image shows various levels of the organization of chromatin (DNA and protein).Along the chromatin threads, unwound protein-chromosome complexes, we find DNA wrapped around a set of histone proteins.



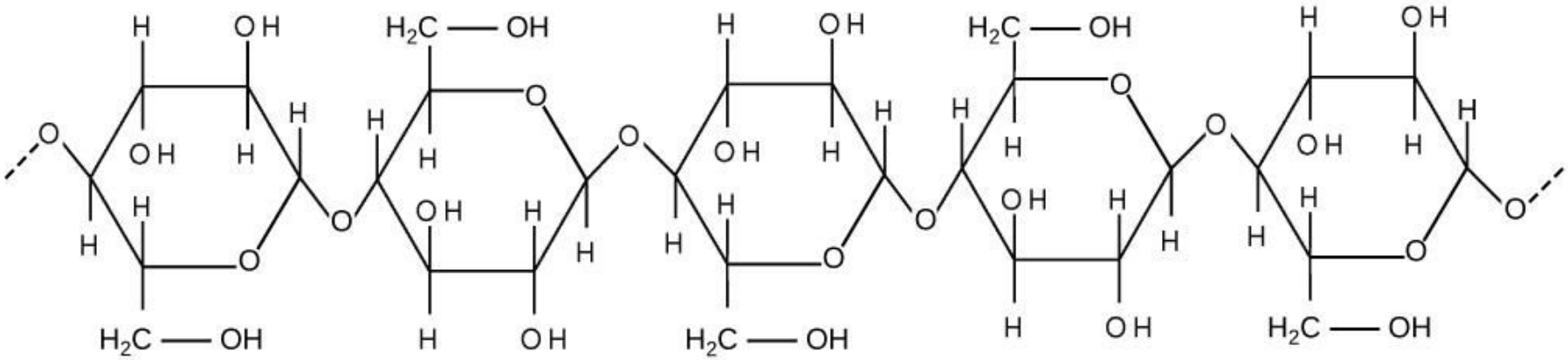
Mitochondrial structure

This electron micrograph shows a mitochondrion as viewed with a transmission electron microscope.This organelle has an outer membrane and an inner membrane.The inner membrane contains folds, called cristae, which increase its surface area.The space between the two membranes is called the intermembrane space, and the space inside the inner membrane is called the mitochondrial matrix.ATP synthesis takes place on the inner membrane.



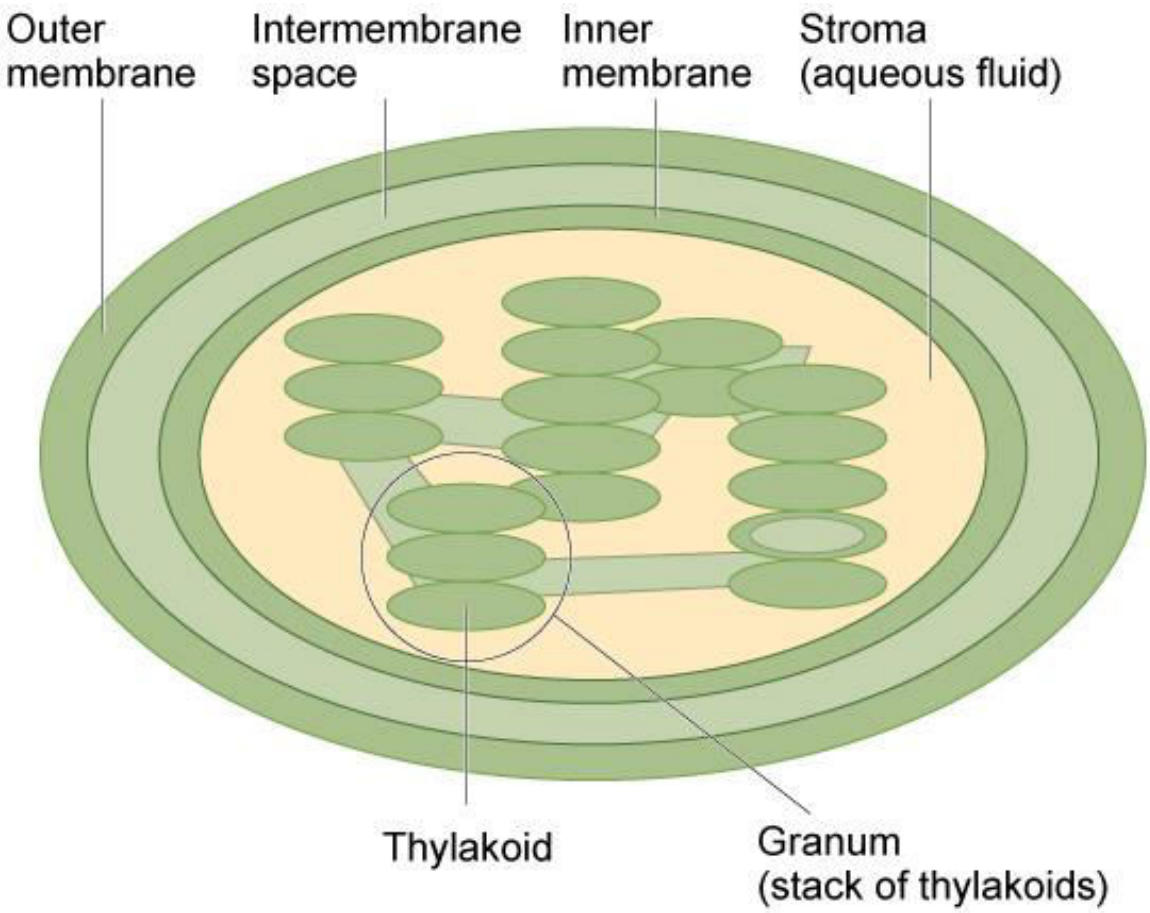
The Centrosome Structure

The centrosome consists of two centrioles that lie at right angles to each other.Each centriole is a cylinder made up of nine triplets of microtubules.Nontubulin proteins (indicated by the green lines) hold the microtubule triplets together.



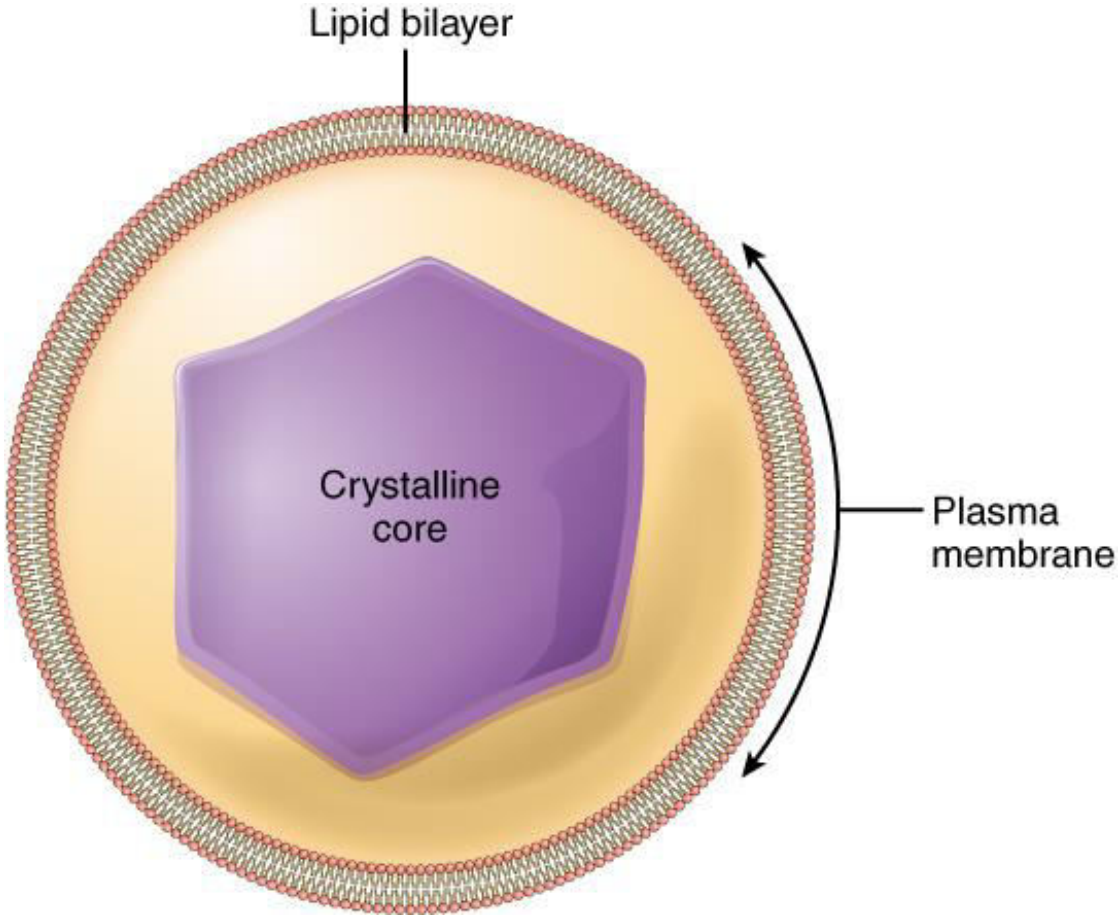
Cellulose

Cellulose is a long chain of β-glucose molecules connected by a 1-4 linkage.The dashed lines at each end of the figure indicate a series of many more glucose units.The size of the page makes it impossible to portray an entire cellulose molecule.



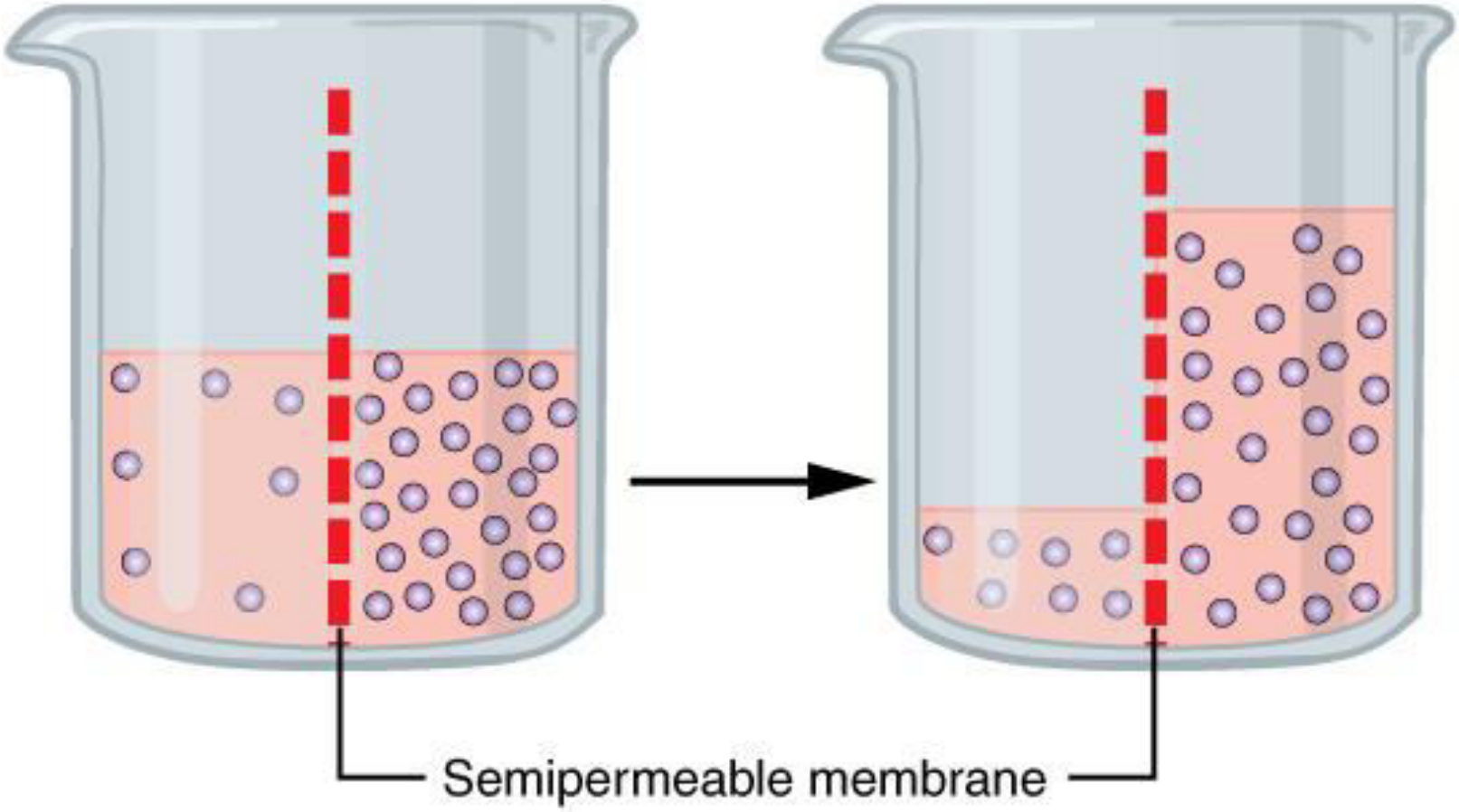
The Chloroplast Structure

The chloroplast has an outer membrane, an inner membrane, and membrane structures called thylakoids that are stacked into grana.The space inside the thylakoid membranes is called the thylakoid space.The light harvesting reactions take place in the thylakoid membranes, and the synthesis of sugar takes place in the fluid inside the inner membrane, which is called the stroma.



Peroxisomes

Peroxisomes are membrane-bound organelles that contain an abundance of enzymes for detoxifying harmful substances and lipid metabolism.



Osmosis

Osmosis is the diffusion of water through a semipermeable membrane down its concentration gradient.If a membrane is permeable to water, though not to a solute, water will equalize its own concentration by diffusing to the side of lower water concentration (and thus the side of higher solute concentration).In the beaker on the left, the solution on the right side of the membrane is hypertonic.