Biology

Topic: cell structure

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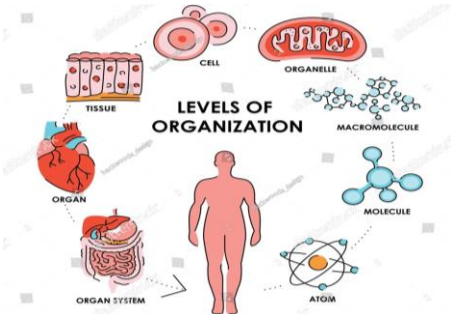


❖ Introduction

- A **cell** is the smallest unit of a living thing.

- cells are the basic building blocks of all organisms.

- Several cells of one kind that interconnect with each other and perform a shared function form **tissues**.

- These tissues combine to form an **organ** (your stomach, heart, or brain),

- several organs comprise an **organ system** (such as the digestive system, circulatory system, or nervous system).

- Several systems that function together form an organism (like a human being).

❖ Microscopy

• we cannot see individual cells with the naked eye (عين مجردة), so scientists use microscopes to study them.

• A microscope is an instrument that magnifies (تكبر) an object.

• We photograph most cells with a microscope, so we can call these images micrographs.

- **Types of micoscopes:**

1. light microscope

➔ Visible light passes and bends through the lens system to enable the user to see the specimen.
➔ used for viewing living organisms

• Most student microscopes are light microscopes.

• individual cells are generally transparent (شفافة), their components are not distinguishable (مميزة), they are colored with special stains (صبغات).

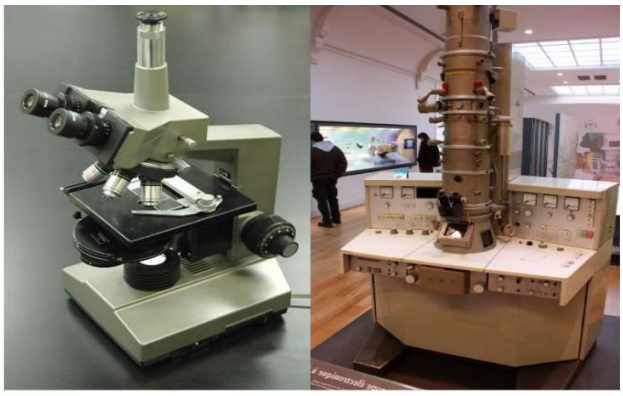
• Staining usually kills the cells.

2. Electron microscopes

➔ use a beam of electrons instead of a beam of light.

➔ Advantages:
1) allow for higher magnification and more detail تكبير وتفاصيل أعلى
2) it also provides higher resolving power. وضوح أكثر
3) In a transmission electron microscope, the electron beam penetrates the cell and provides details of a cell's internal structures. يخترق الخلية ويعطي تفاصيل التركيب الداخلي

➔ Disadvantages
1) electron microscopes are more bulky and expensive than light microscopes.



(a) (b)

(a)Most light microscopes in a college biology lab can magnify cells up to approximately 400 times.

(b)Electron microscopes provide a much higher magnification, 100,000x

- **Cytotechnologists** (cyto- = “cell”)

- are professionals who study cells via microscopic examinations and other laboratory tests.
- They are trained to determine which cellular changes are within normal limits and which are abnormal.

- Cytotechnologists play a vital role in saving people’s lives.
When doctors discover abnormalities early, a patient’s treatment can begin sooner, which usually increases the chances of a successful outcome.

❖ Types of cells

- There are many types of cells, which scientists group into one of two broad categories:

1.Prokaryotic: bacterial cells بدائية النواة

2.Eukaryotic: animal and plant cells حقيقية النواة

- All cells share four common components: التشابه

1) a plasma membrane: an outer covering that separates the cell’s interior from its surrounding environment

2) cytoplasm: consisting of a jelly-like cytosol within the cell in which there are other cellular components

3) DNA: the cell's genetic material

4) ribosomes: which synthesize proteins.

- Differences between prokaryotes and eukaryotes: الاختلافات

1) Cell Size:

- **Prokaryotic** (At 0.1 to 5.0 μm in diameter) cells are significantly smaller than eukaryotic cells(10 to 100 μm in diameter

➔ The prokaryotes small size allows ions and organic molecules that enter them to quickly diffuse to other parts of the cell.
➔ any wastes produced within a prokaryotic cell can quickly diffuse.

2) complexity

- A **prokaryote** is a simple, mostly single-celled (unicellular)
- **eukaryotic** cells have a more complex structure than prokaryotic cells.

3) nucleus and membrane bounded organelles

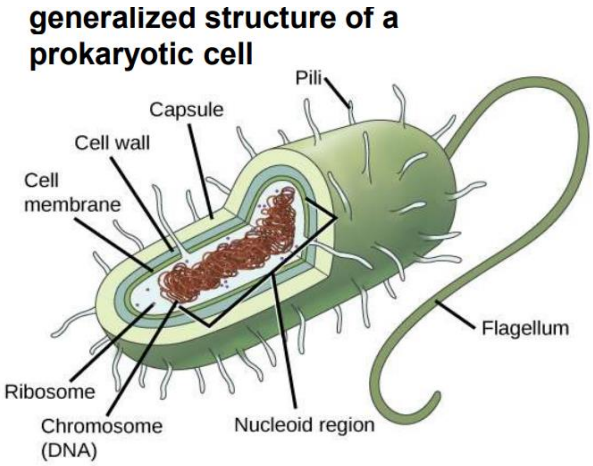
- **prokaryote** cell is organism that lacks a nucleus, or any other membrane-bound organelle

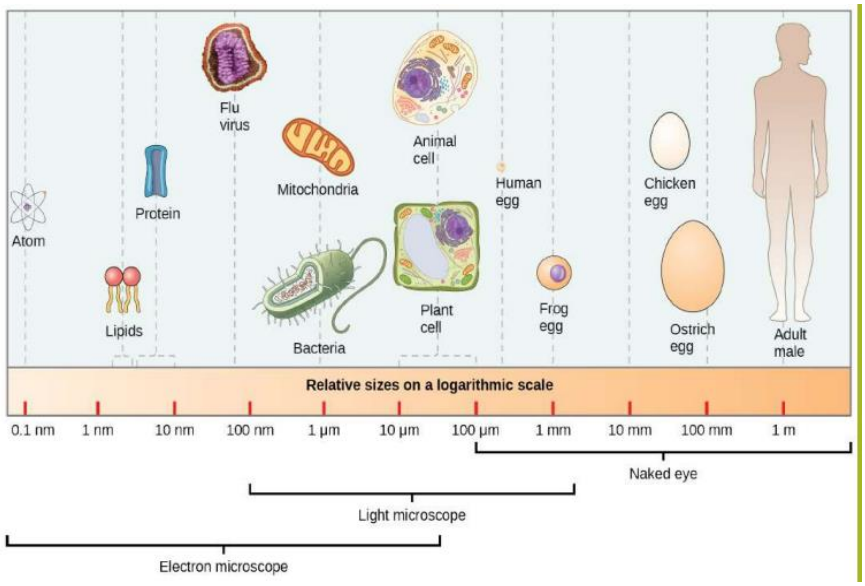
- **eukaryotic** cells have:

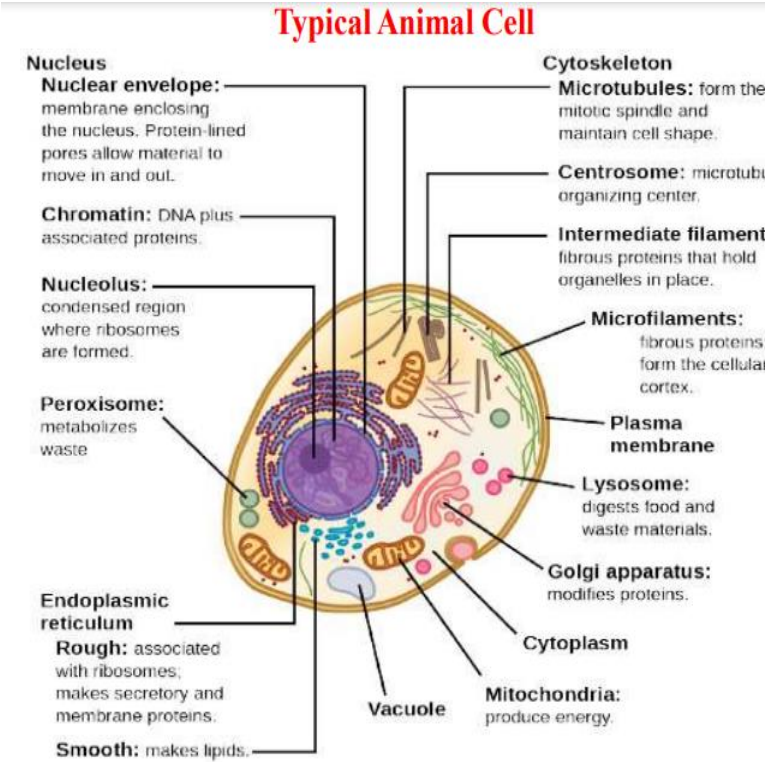
1) a membrane-bound nucleus (true nucleus)

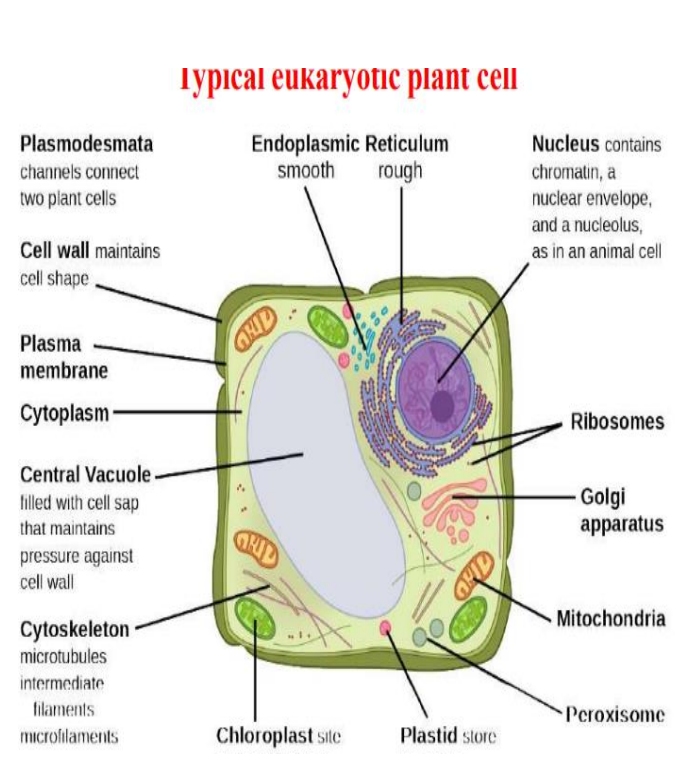
2) numerous membrane-bound organelles such as the endoplasmic reticulum, Golgi apparatus, chloroplasts, mitochondria, and others

3) several, rod-shaped chromosomes.

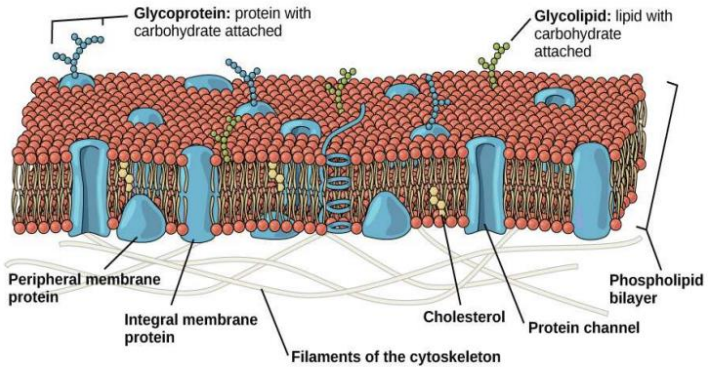








❖ The Plasma Membrane

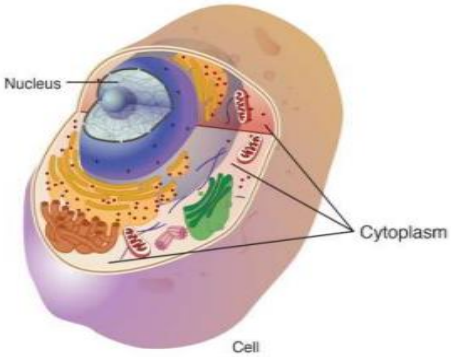


• plasma membrane: a phospholipid bilayer with embedded proteins that separates the internal contents of the cell from its surrounding environment

• The plasma membrane controls the passage of organic molecules, ions, water, and oxygen into and out of the cell.

• Wastes (such as carbon dioxide and ammonia) also leave the cell by passing through the plasma membrane.

❖ The Cytoplasm



• The cytoplasm is the cell's entire region between the plasma membrane and the nuclear envelope

• It is comprised of organelles suspended in the gel-like **cytosol,** the cytoskeleton, and various chemicals

• cytoplasm consists of 70 to 80 % water

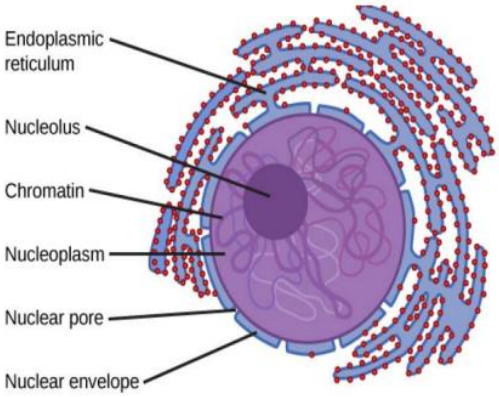
• cytoplasm has a semi-solid consistency, which comes from the proteins within it.

• cytoplasm contain also:

1. Glucose and other simple sugars
2. polysaccharides,
3. amino acids,
4. nucleic acids, fatty acids,
5. and derivatives of glycerol are also there.
6. cytoplasm contain elements such as Ions of sodium, potassium, calcium, and many other elements also dissolve in the cytoplasm

• Many metabolic reactions, including protein synthesis, take place in the cytoplasm.

❖ The Nucleus



• the nucleus is the most prominent organelle in a cell

• The nucleus houses the cell's DNA and directs the synthesis of ribosomes and proteins.

• The **nuclear envelope**:

➔ is a double-membrane structure that constitutes the nucleus' outermost portion

➔ Both the nuclear envelope's inner and outer membranes are phospholipid bilayers.

➔ The nuclear envelope is punctuated with pores that control the passage of ions, molecules, and RNA between the nucleoplasm and cytoplasm.

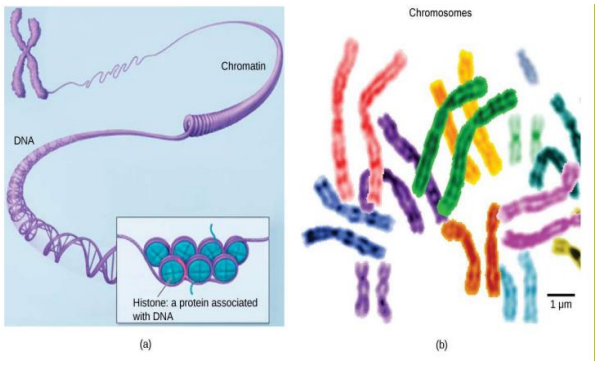
• **The nucleoplasm:**
➔ is the semi-solid fluid inside the nucleus, where we find the chromatin and the nucleolus.

• **Chromatin and Chromosomes**

➔ **chromosomes:** structures within the nucleus that are made up of DNA, the hereditary material.

➔ In eukaryotes, chromosomes are linear structures.
➔ In humans, the chromosome number is 46

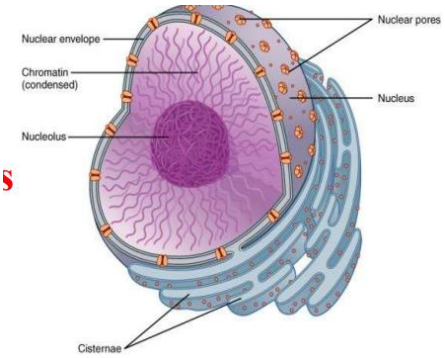
➔ **Chromatin:** describes the material that makes up chromosomes both when condensed and decondensed.



(a) levels of chromatin's organization (DNA and protein). (b) paired chromosomes.

• **The Nucleolus**

➔ nucleolus: sections of DNA that encode ribosomal RNA aggregates the ribosomal RNA with associated proteins to assemble the ribosomal subunits that are then transported out through the pores in the nuclear envelope to the cytoplasm.



❖ **Ribosomes**

➔ Ribosomes are the cellular structures responsible for protein synthesis

➔ which are large protein and RNA complexes, consist of two subunits, large and small

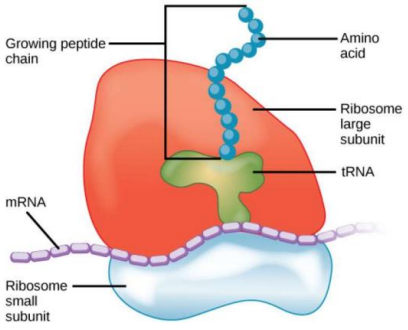
➔ They may be attached to the plasma membranes or the endoplasmic reticulum

➔ Ribosomes receive their “orders” for protein synthesis from the nucleus where the DNA transcribes into mRNA→ mRNA travels to the ribosomes, which translate the code into a specific order of amino acids in a protein → Amino acids are the building blocks of proteins.

➔ Because protein synthesis is an essential function of all cells (including enzymes, hormones, antibodies, pigments, structural components, and surface receptors), there are ribosomes in practically every cell.

➔ Ribosomes are particularly abundant in cells that synthesize large amounts of protein.

➔ For example, the pancreas is responsible for creating several digestive enzymes and the cells that produce these enzymes contain many ribosomes.



➔ large subunit (top) and a small subunit (bottom) comprise ribosomes

❖ Mitochondria

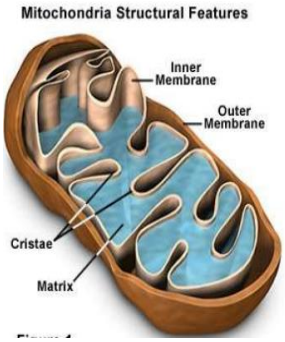
• Mitochondria (powerhouses) or “energy factories” of both plant and animal cells

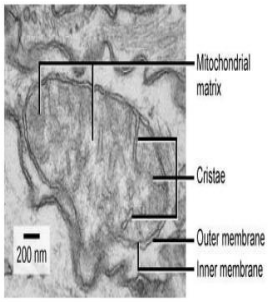
• They are responsible for making adenosine triphosphate (ATP), the cell’s main energy-carrying molecule.

• ATP represents the cell's short-term stored energy.

• Cellular respiration is the process of making ATP using the chemical energy in glucose and other nutrients.

➔ In mitochondria, this process uses oxygen and produces carbon dioxide as a waste product.





➔ The carbon dioxide that you exhale with every breath comes from the cellular reactions that produce carbon dioxide as a byproduct.

• Muscle cells need considerable energy to keep your body moving.

➔ When the cells don’t get enough oxygen, they do not make much ATP. Instead, producing lactic acid accompanies the small amount of ATP they make in the absence of oxygen.

❖ Peroxisomes

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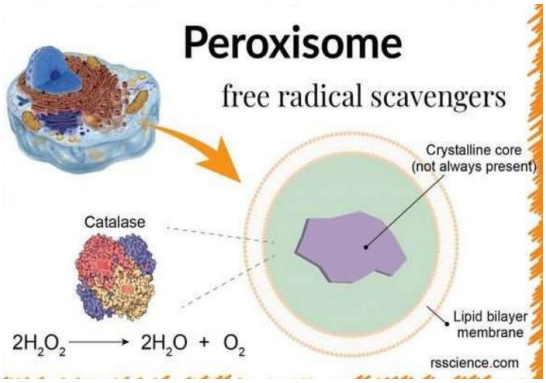
• Peroxisomes are small, round organelles enclosed by single membrane.

• functions: 1) carry out oxidation reactions that break down fatty acids and amino acids.

2) detoxify many poisons that may enter the body.



➔ Many of these oxidation reactions release hydrogen peroxide, H2O2, which would be damaging to cells; however, when these reactions are confined to peroxisomes, enzymes safely break down the H2O2 into oxygen and water.

➔ For example, peroxisomes in liver cells detoxify alcohol.

❖ Vesicles and Vacuoles

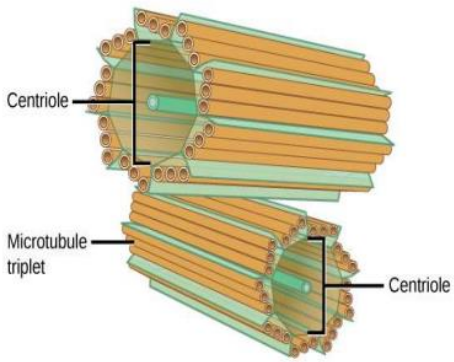
• Vesicles and vacuoles are membrane-bound sacs that function in storage and transport.

• The vacuoles are larger than vesicles, there is a very subtle distinction between them.

• Vesicle membranes can fuse with either the plasma membrane or other membrane systems within the cell.

• The vacuole's membrane does not fuse with the membranes of other cellular components. مكونات تتحد

❖ The Centrosome



• The centrosome is a microtubule-organizing center found near the nuclei of animal cells.

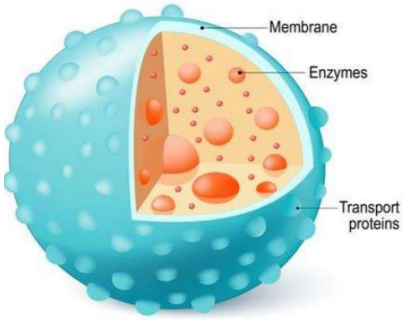
• It contains a pair of centrioles, two structures that lie perpendicular to each other.
متعامدات

• Each centriole is a cylinder of nine triplets of microtubules.

• The centrosome replicates itself before a cell divides, and the centrioles appear

• The centrosome pulling the duplicated chromosomes to opposite ends of the dividing cell.

❖ Lysosomes



• Most plant cells do not have lysosomes.

• The lysosomes are the cell's garbage disposal.
قمامة التخلص

• In plant cells, the digestive processes take place in vacuoles.

• Enzymes within the lysosomes aid in breaking down proteins, polysaccharides, lipids, nucleic acids, and even worn-out organelles.

• These enzymes are active at a much lower pH than the cytoplasm's. Therefore, the pH within lysosomes is more acidic than the cytoplasm's pH.

❖ Endoplasmic Reticulum

• The endoplasmic reticulum (ER) is a series of interconnected membranous sacs and tubules that collectively modifies proteins and synthesizes lipids.

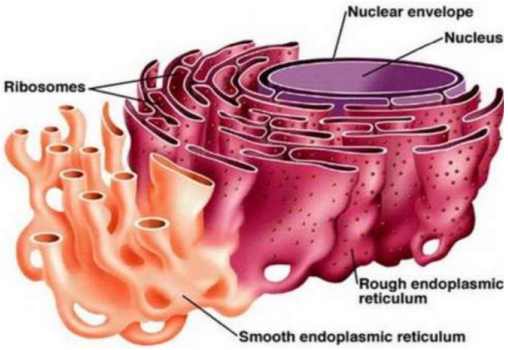
There are two types of ER: 1. the rough ER and 2. the smooth ER

Rough ER

• named the rough endoplasmic reticulum (RER) because the ribosomes attached to its cytoplasmic surface. **RER Functions:**

1) Ribosomes transfer their newly synthesized proteins into the RER's lumen where they undergo structural modifications: such as folding or acquiring side chains.

➔ These modified proteins incorporate into cellular membranes of the ER or other organelles' membranes.



2) The RER also makes phospholipids for cellular membranes.

3) The RER is engaged in modifying proteins (such as enzymes) that secrete from the cell

• The RER is abundant in cells that secrete proteins.
This is the case with liver cells, for example.

Smooth ER

• The smooth endoplasmic reticulum (SER) is continuous with the RER but has few or no ribosomes on its cytoplasmic surface

SER functions include:

1. Synthesis of carbohydrates, lipids, and steroid hormones
2. Detoxification of medications and Poisons
3. Storing calcium ions.

• In muscle cells, a specialized SER, the sarcoplasmic reticulum, is responsible for storing calcium ions that are needed to trigger the muscle cells' coordinated contractions.

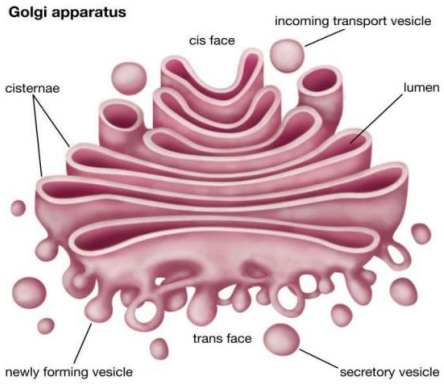
❖ Golgi Apparatus

• The Golgi apparatus (also called the Golgi body), a series of flattened membranes

• **Functions:** Sorting, tagging, packaging, and distributing lipids and proteins takes place in Golgi apparatus

• We call the Golgi apparatus' the cis face. The opposite side is the trans face.

• The transport vesicles that formed from the ER travel to the cis face, fuse with it, and empty their contents into the Golgi apparatus' lumen.



• Proteins and lipids travel through the Golgi undergo further modifications that allow them to be sorted.

• The most frequent modification is: adding short sugar molecule chains.

• These modified proteins and lipids then tag with phosphate groups or other small molecules in order to travel to their proper destinations.

• The modified and tagged proteins are packaged into secretory vesicles that bud from the Golgi's trans face

• The cells that engage in a great deal of secretory activity (such as salivary gland cells that secrete digestive enzymes or immune system cells that secrete antibodies) have an abundance of Golgi.

ER make proteins and lipids➔ travel to cis face of golgi➔ modification (adding short sugar chain)➔ tagging with phosphorus groups➔ packaged into secretory vesicles➔ bud from trans face of golgi to their destination

❖ Animal Cells versus Plant Cells

• Both animal and plant cells have microtubule organizing centers (MTOCs)

• Animal cells also have centrioles associated with the MTOC: a complex we call the centrosome.

• Animal cells each have a centrosome and lysosomes; whereas most plant cells do not.

• Plant cells have a cell wall, chloroplasts and other specialized plastids, and a large central vacuole; whereas animal cells do not.