Physiology

بسم الله الرحمن الرحيم

ما قدّر الرحمن سوف يكون
والعسر بالصبر الجميل يهون
اليسر آتٍ لا محالة يا أخي
إن ضمّن الكاف العظيمة نون

اسم المساقphysiology

مدرس المساقDr. Suhad

المحاضرةlecture two

part (1).

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PHYSIOLOGY

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LECTURE 2, PART (1): CELLULAR LEVEL OF ORGANIZATION

Objectives

1. Discuss **cellular level of organization. (Continue the previous lecture)---Part (1)**

2. Describe **transport processes of solutes and water .---- Part (2)**

(Pages 60-84 of the reference)

THE CYTOPLASM

- **Cytoplasm** consists of all the cellular contents between the plasma membrane and the nucleus.

- It has two components:
- **(1) the cytosol,** is the fluid portion of the cytoplasm that surrounds organelles.
- **(2) organelles**, are tiny structures that perform different functions in the cell.

THE CYTOPLASM

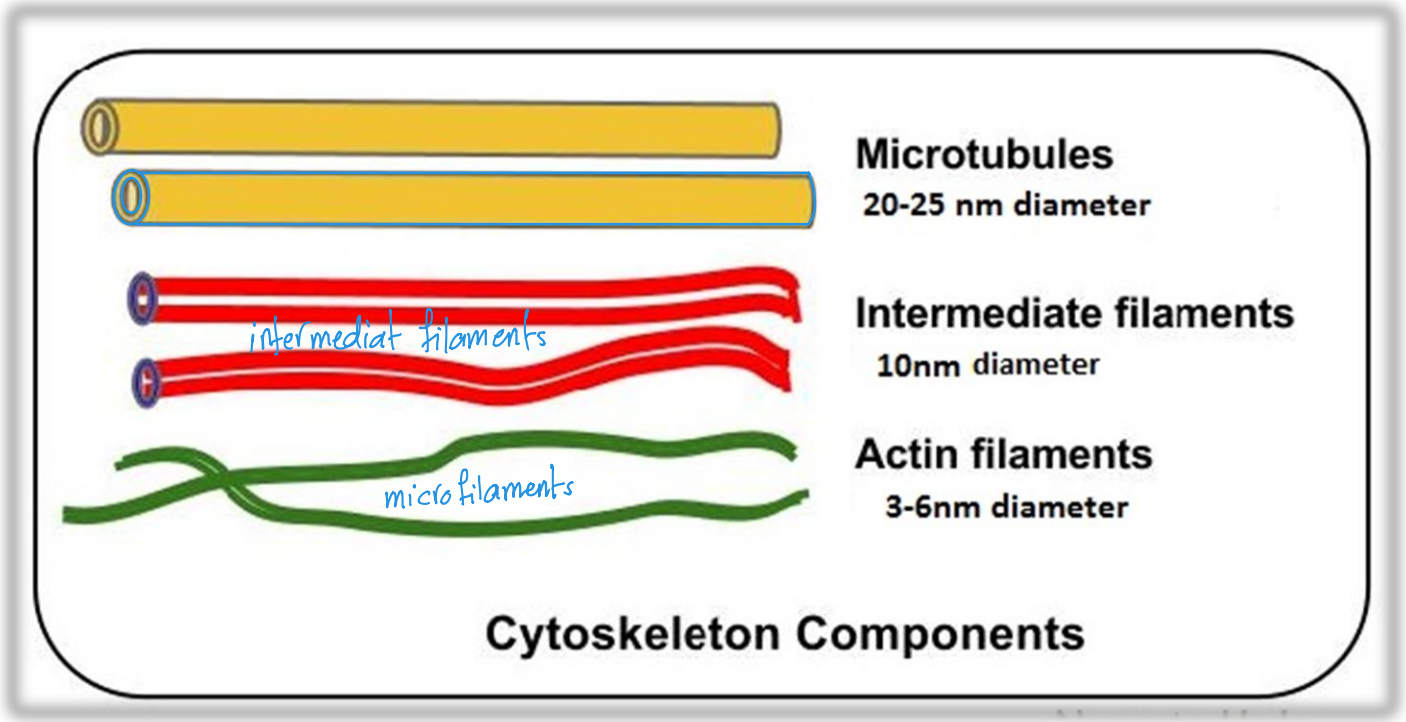
- **Cytosol:**

1. Contains **75–90% water** plus various dissolved and suspended components (i.e. glucose, amino acids, fatty acids, proteins, lipids, ATP, and waste products).

2. It is **the site of many chemical reactions** required for a cell's existence (i.e. glycolysis, maintenance of cell structures and for cell growth).

THE CYTOPLASM

- The **cytoskeleton** is a network of protein filaments that extends throughout the cytosol (**microfilaments, intermediate filaments, and microtubules**).



THE CYTOPLASM

- **Microfilaments:**

1. Are the thinnest elements of the cytoskeleton.
2. They are composed of the proteins actin and myosin.
3. They have two general functions: help generate movement (muscle contraction, cell division, and cell locomotion) and provide mechanical support (basic strength and shapes of cells).

- **Intermediate filaments:**

1. Are thicker than microfilaments but thinner than microtubules.
2. They are found in parts of cells subject to mechanical stress.
3. They help stabilize the position of organelles such as the nucleus and help attach cells to one another.

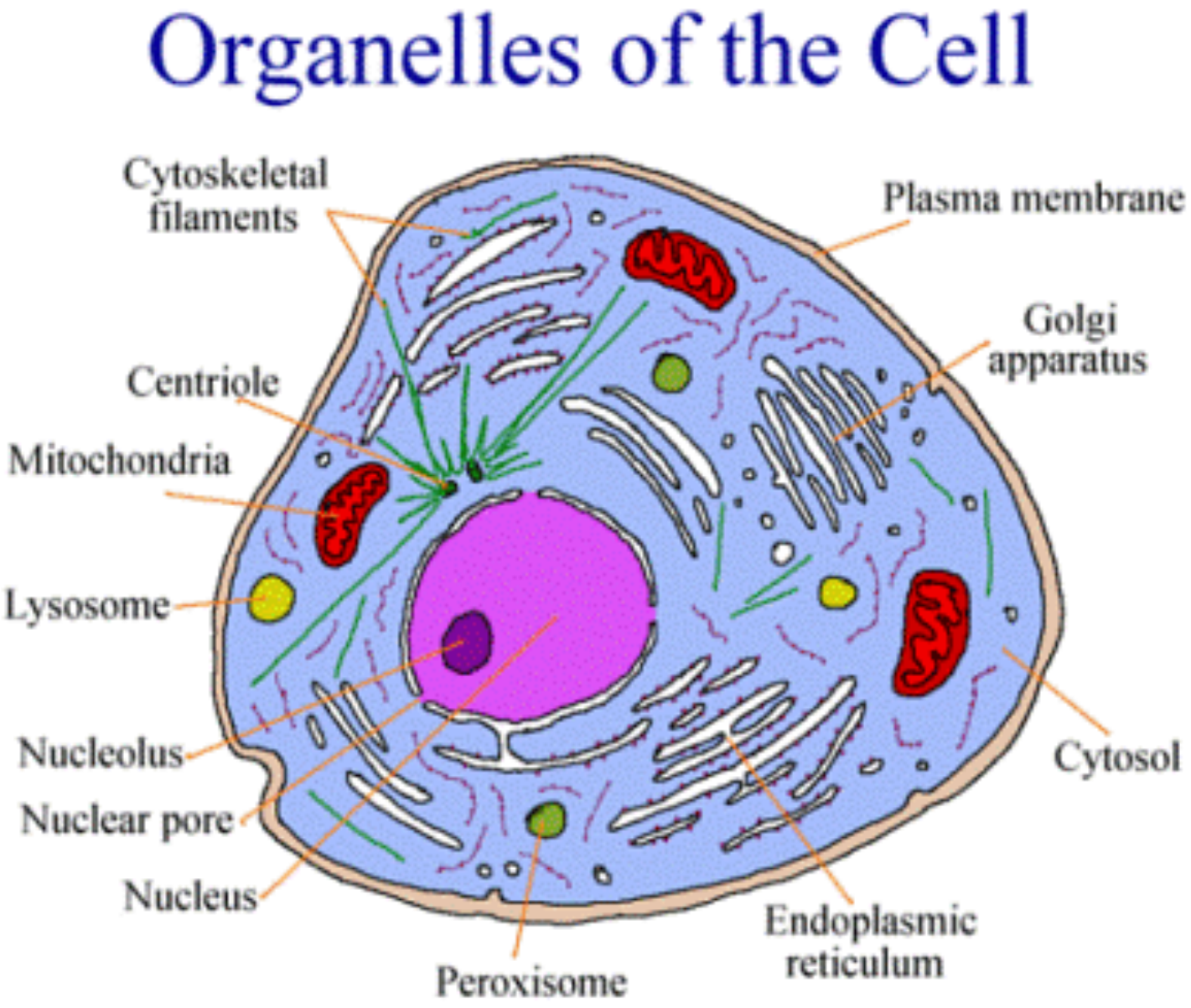
THE CYTOPLASM

- **Microtubules:**

1. Are the largest of the cytoskeletal components.
2. They are composed mainly of the protein tubulin.
3. They help determine cell shape.
4. They also function in the movement of organelles.

THE ORGANELLES

Organelles are **specialized structures** within the cell that have characteristic shapes, and they perform specific functions in cellular growth, maintenance, and reproduction. They often cooperate to maintain homeostasis.

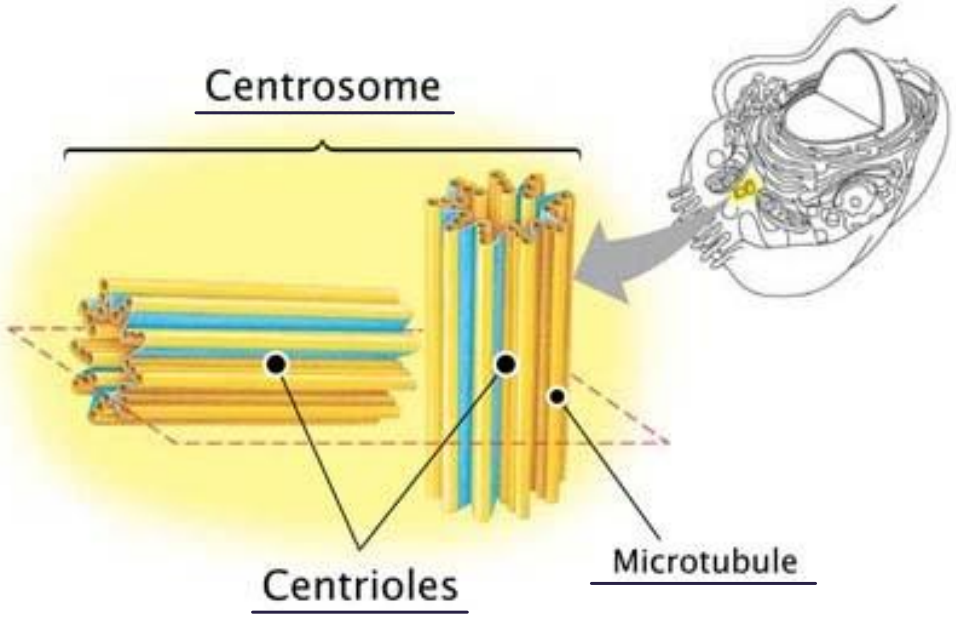


THE ORGANELLES

1. Centrosome. ⇒ main function :- cell division ?
   - بتكون عبارة عن قطبين (من أقطاب الخلية) اسمهم centrioles
   - centrioles consist of microtubule
   - microtubule نوع الـ cytoskeleton
   - centrosome الـ protein الموجود بالـ centrosome نوع الـ tubular
   - function: - cell division - cell movement
   - الـ centrioles بتشكل الـ spindle fibers (الخيوط المغزلية) اللي بتشد الكروموسوم ليصير 2 كروماتايد وهيك يصير division/cell mitosis خلص الـ
2. Cilia and Flagella. ⇒ (شعيرات وليس أهداب)
   - cilia ← شعيرات صغيرة كلها تتحرك بنفس الـ direction و بشكل rotational
   - طيب شو وظيفتها؟ لنفرض واحد عنده مخاط ... بالمخاط كرة طبيعي من الجسم إنه يطرد هاد بالمخاط لحاله قبل تناول الأدوية كيف؟ عن طريق الـ cilia لأن وظيفتها تطلع الـ dust أو الـ mucus
   - حسب نوع الكائنات الحية
     - prokaryotic: حركة الـ flagella زي الـ cilia Rotational
     - Eukaryotic: بتكون حركتها bending movement
     - ما بتحركوا مع بعض ولا بنفس الاتجاه
     - بتكون موجودة فقط عند الـ mail (sperm)
3. Ribosomes. ⇐ هو مكان تصنيع الـ proteins ... ممكن يكون
   - cytoplasm طاير بالـ ← free
   - وملتصق على عضو تاني اسمه endoplasmic reticulum فبخلي سطحها خشن بفي من ribosome فبكون نوعها rough endoplasmic reticulum الحالة
   - so... the main function of endoplasmic reticulum إنه يأخذ الـ proteins اللي تم تصنيعها عن طريق الـ ribosome الموجودة على سطح الـ Rough E.R
   - طيب.. شو الـ function للـ smooth E.R؟
     1. بعمل على تصنيع الـ lipids و الـ carbohydrates
     2. مكان لتصنيع الـ lipid bilayer blasma membrane أو الـ
     3. تخزين جزيئات الـ Ca^+ بسؤول عن الـ skeletal الـ contraction muscle
4. Endoplasmic Reticulum. ⇒
   - sorting تقل Rough E.R فبتجي الـ next للـ proteins عشان تاخذه للـ Golgi complex اللي هو cell organelles
   - هلأ.. الـ Golgi complex راح يأخذ الـ proteins من الـ Rough E.R و بعمل عليهم بعض الـ modifications (تعديلات على الـ structre) sorting قبل الـ
   - so... the main function of G.C is:-
     1. modification on proteins
     2. sorting
     3. packaging inside a vesecles
   - vesecles بعدها بتطلع هاي الـ sacs على شكل Golgi complex من الـ و بتروح إما إلى
5. Golgi Complex. ⇐
6. lysosomes or
7. peroxisomes or
8. proteasomes ← enzymes تحتوي على
   - enzymes النوع الموجودة فيها
     - Oxidaze enzyme
     - Catalase enzyme: في بالجسم مركب H_2O_2 يحتوي على toxic atom وهو H_2 بتخلص من الهيدروجين بيجي عندك H_2O_2 الـ catalase enzyme و بعطينا H_2O و O
   - unessential or unneeded الـ proteins أو اللي بتكون disfunctional وهاي بميزه بوصيه بالي فيه أنه بطل الـ proteins بالي بالجسم هش بحاجة إليها الهيدروجين ١ـ٣ هاي الـ enzymes ب proteasase تحليل بروتين
   - وهاي الـ protein بتم تحطيمها إلى amino acids ممكن الخلية
     - تستخدمها في بناء تاني proteins
     - تتخلص من هاي الـ a.a
6. Lysosomes. → enzymes يحتوي على proteins تعمل على تحليل الـ
   - enzymes
     - digestive
     - hydrolytic
   - طيب شو الأشياء اللي بتكسرها هاي الـ enzymes؟
     1. digestion of unneeded substances ممكن يكون protein معين مثلاً
     2. autophagy → بتكون في الجسم ما بده cell يأخذها فبتعمل هاي الـ lysosomes بالخلية الـ cell بتعرف الـ digestive enzyme بتقلها تحليل وتكسير
     3. digestion of virus or Bacteria
     4. autolysis
7. Peroxisomes.
8. Proteasomes.
9. Mitochondria. ⇒
   - power house of the cell عندها بتصير عملية إنتاج الطاقة (ATP) وتصنيع الطاقة و يحتوي على
     - outer membrane
     - inner membrane * فيه غشاء داخلي
       - * في space فيها matrix و fluid
   - * أعداد الـ mitochondria تختلف حسب الـ structure - مثلاً الـ muscles لأنها بحاجة إلى ATP أكبر فبتكون فيها mitochondria أكثر
10. Nucleus.
    - control center of the cell
    - envelope الغشاء المحيط فيها عبارة عن very thick و يحتوي على (غلاف) و بتكون فتحات لتسهيل مرور الأشياء إلى داخل الخلية
    - * أهم معلومة عن الـ nucleus
      - structure بالـ
      - function و الـ shape و الـ
      - الخلية و يتم فيها تصنيع الـ Ribosomes

Centrosome

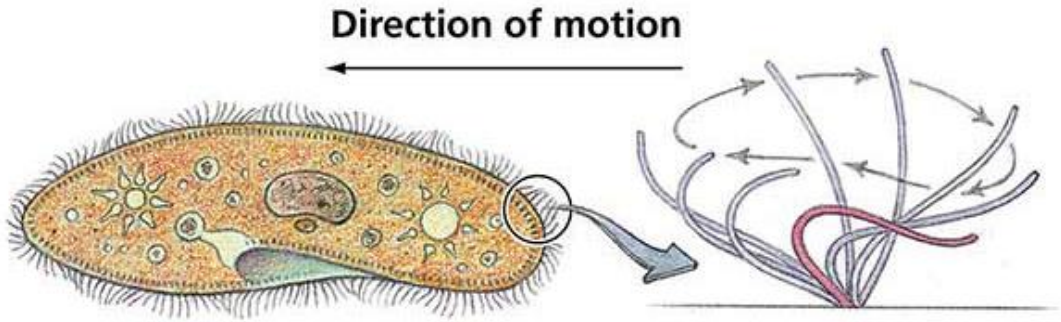
- Is located near the nucleus and it consists of two components: **a pair of centrioles and pericentriolar material**.
- **The centrioles** are cylindrical structures (microtubules). Surrounding the centrioles is pericentriolar material which contains the **tubulin complexes**.
- These complexes organize centers for growth of the mitotic spindle (cell division).



Faneem moh

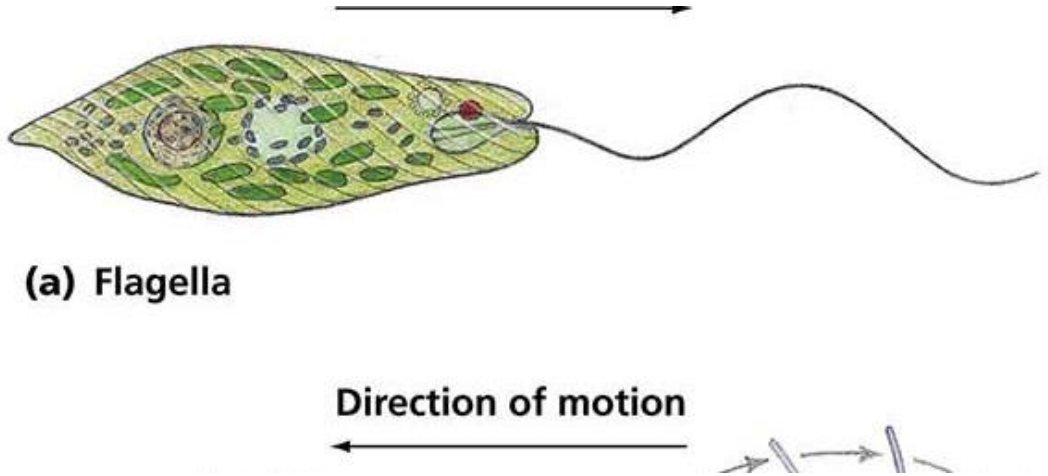
Cilia

- **Microtubules are the dominant components of cilia and flagella**. Both are motile projections. However, cilia is present throughout the surface of a cell, but flagella is present at both the ends or all over the surface.
- Hair-like structure.
- **The main function of motile cilia is to keep the airways clear of mucus and dust.**



(b) Cilia

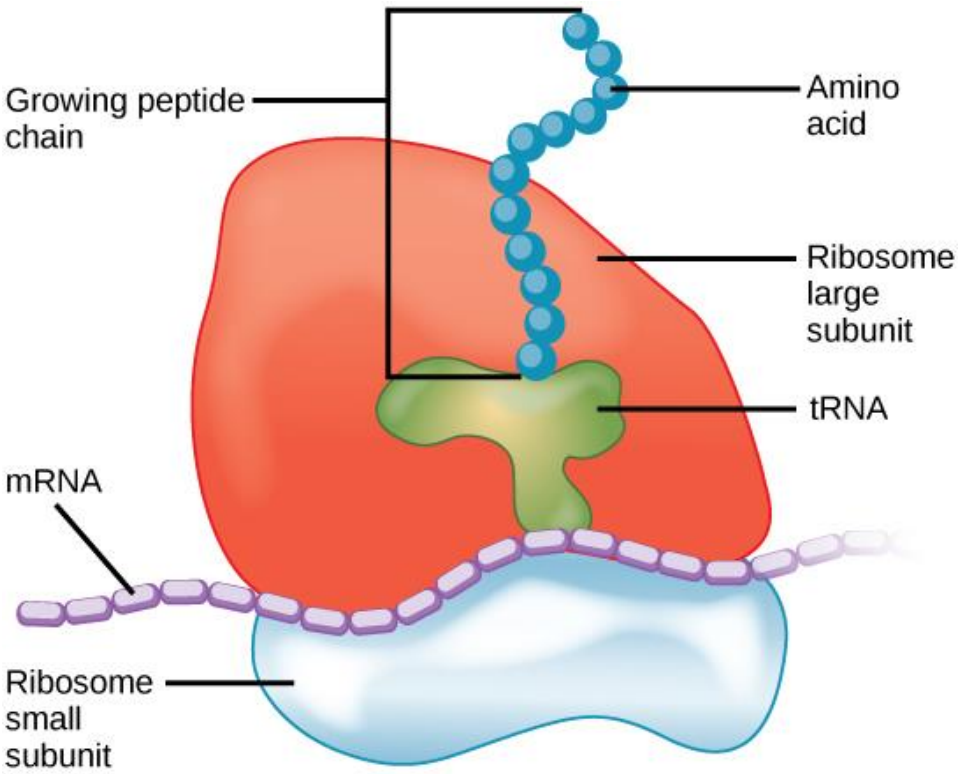
Flagella



- Flagella are similar in structure to cilia but are typically much longer.
- **Flagella usually move an entire cell (i.e. sperm).**
- **The motion of cilia is rotational, very fast moving. The motion of flagella is rotary movement in prokaryotes whereas it is bending movement in eukaryotes. Cilia beat in coordination or one after the other. Flagella beat independent of each other.**

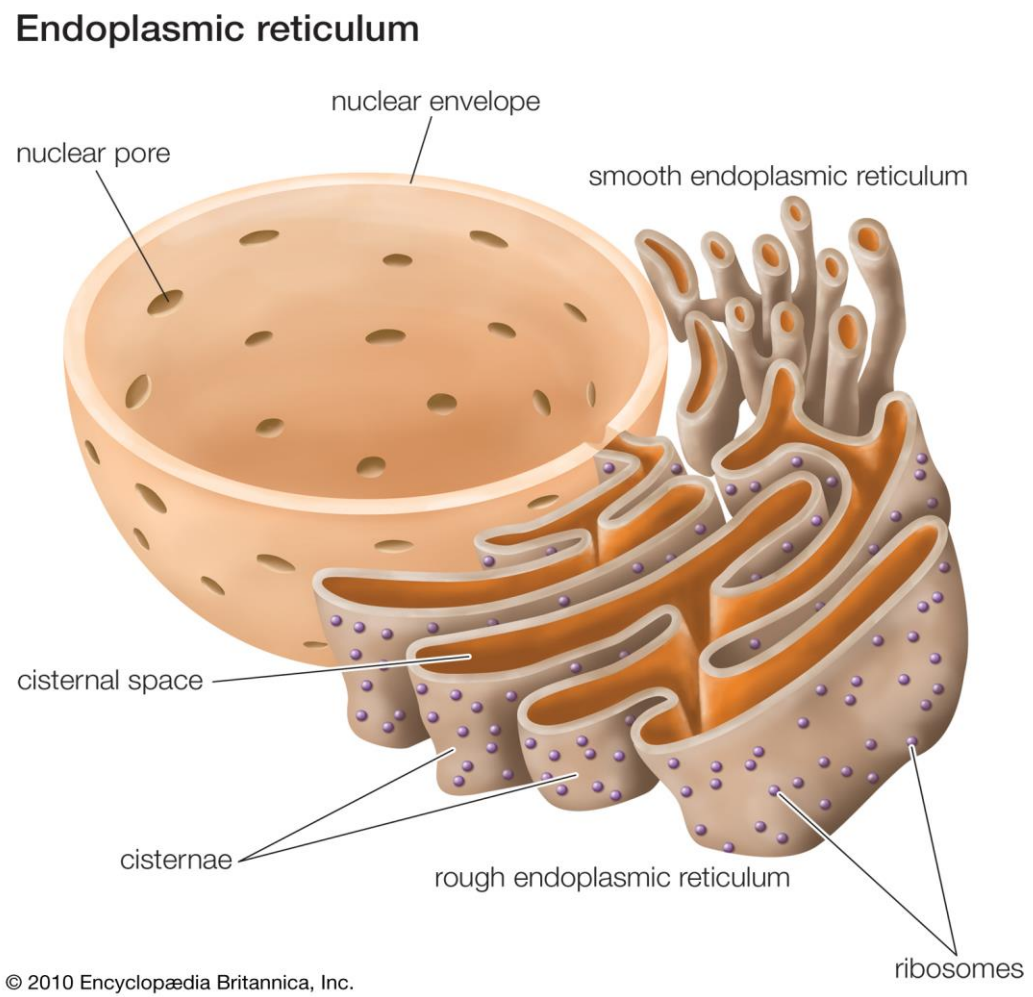
Ribosomes

- **Are the sites of protein synthesis.**
- The name of these tiny structures reflects their high content of one type of ribonucleic acid (ribosomal RNA, or rRNA).
- "Scattered throughout cytoplasm": Some ribosomes are attached to the outer surface of the nuclear membrane and to an endoplasmic reticulum. Ribosomes are also located within mitochondria. Other ribosomes are "free" or unattached to other cytoplasmic structures.



Endoplasmic Reticulum

- **The endoplasmic reticulum (ER)** is a network of membranes in the form of flattened sacs or tubules.
- The ER extends from the nuclear envelope (membrane around the nucleus), to which it is connected and projects throughout the cytoplasm.
- Cells contain two distinct forms of ER (**rough ER and smooth ER**), which differ in structure and function.



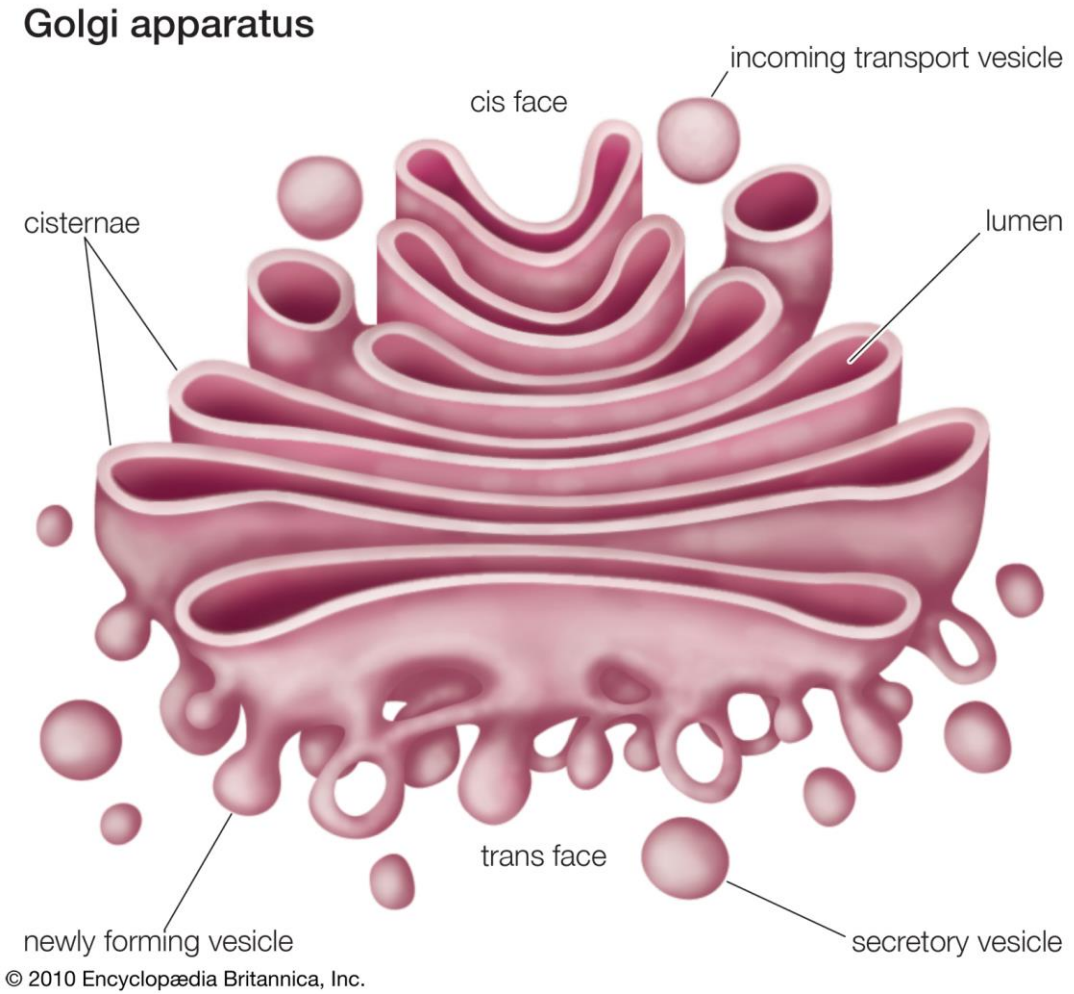
Endoplasmic Reticulum

- The outer surface of **rough ER** is studded with ribosomes (membrane-bound ribosomes). Proteins synthesized by ribosomes enter spaces within the ER for processing and sorting. Thus, rough ER produces secretory proteins, membrane proteins, and many organellar proteins.

- Unlike rough ER, **smooth ER** does not have ribosomes on its membrane. However, smooth ER contributes to lipids and carbohydrates synthesis, making phospholipids bilayer for cell membranes as well as it stores and releases calcium ions that trigger contraction in muscle cells.

Golgi Complex

- Most of the proteins synthesized by ribosomes attached to rough ER are ultimately transported to other regions of the cell (i.e. **Golgi complex**).



Golgi Complex

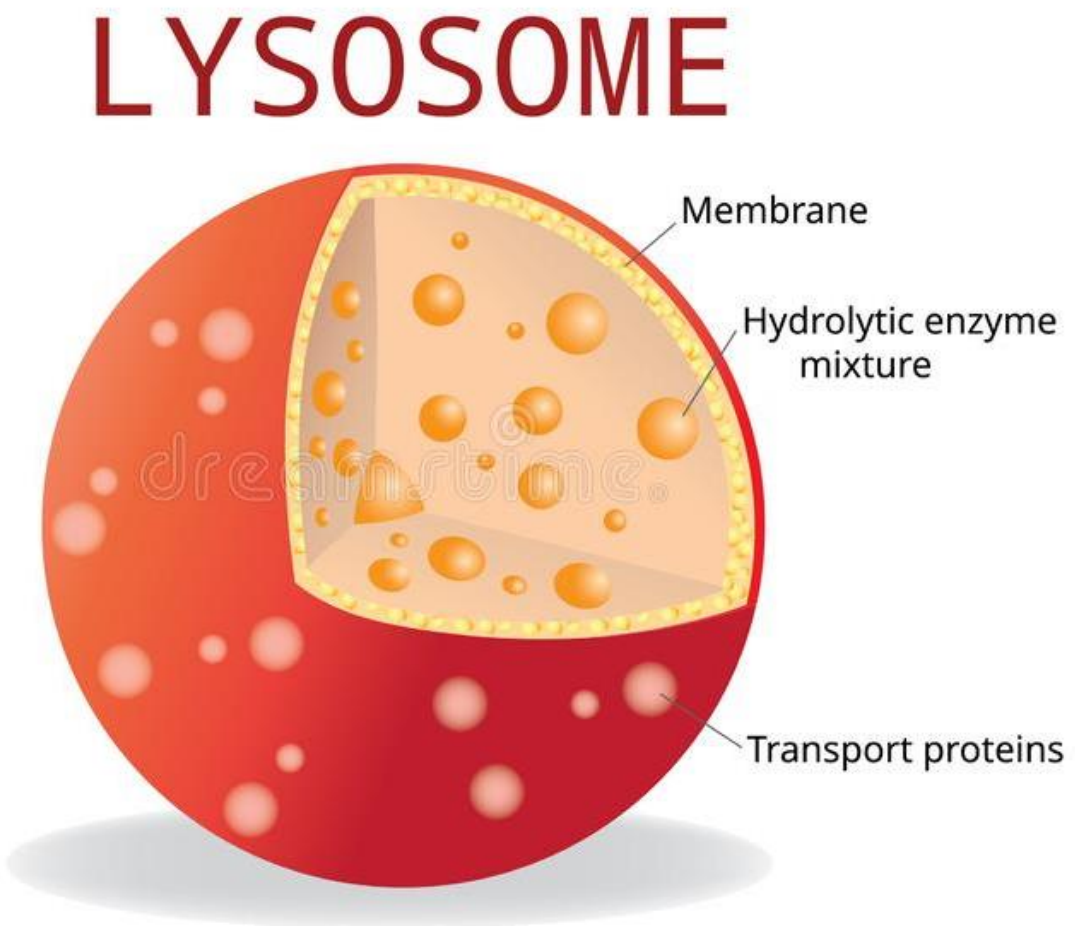
- **Functions of Golgi Complex:**

1. Modifies, sorts, packages, and transports proteins received from the rough ER (through face or cis entry). Enzymes in the middle site of the Golgi complex modify the proteins to form glycoproteins, glycolipids, and lipoproteins.

2. Forms secretory vesicles that discharge processed proteins via exocytosis (through exist or trans face) into extracellular fluid and forms transport vesicles that carry molecules to other organelles, such as lysosomes.

Lysosomes

- **Lysosomes** are membrane-enclosed vesicles that form from the Golgi complex.
- They can contain as many as 60 kinds of **powerful digestive and hydrolytic enzymes** that can break down a wide variety of molecules.



Lysosomes

- **Functions of lysosomes:**

1. **Digest substances (within the cell)** that enter a cell via endocytosis and transport final products of digestion into cytosol.
2. Carry out **autophagy**, the digestion of worn-out organelles.
3. Implement **autolysis**, the digestion of an entire cell.
4. Accomplish **extracellular digestion**.

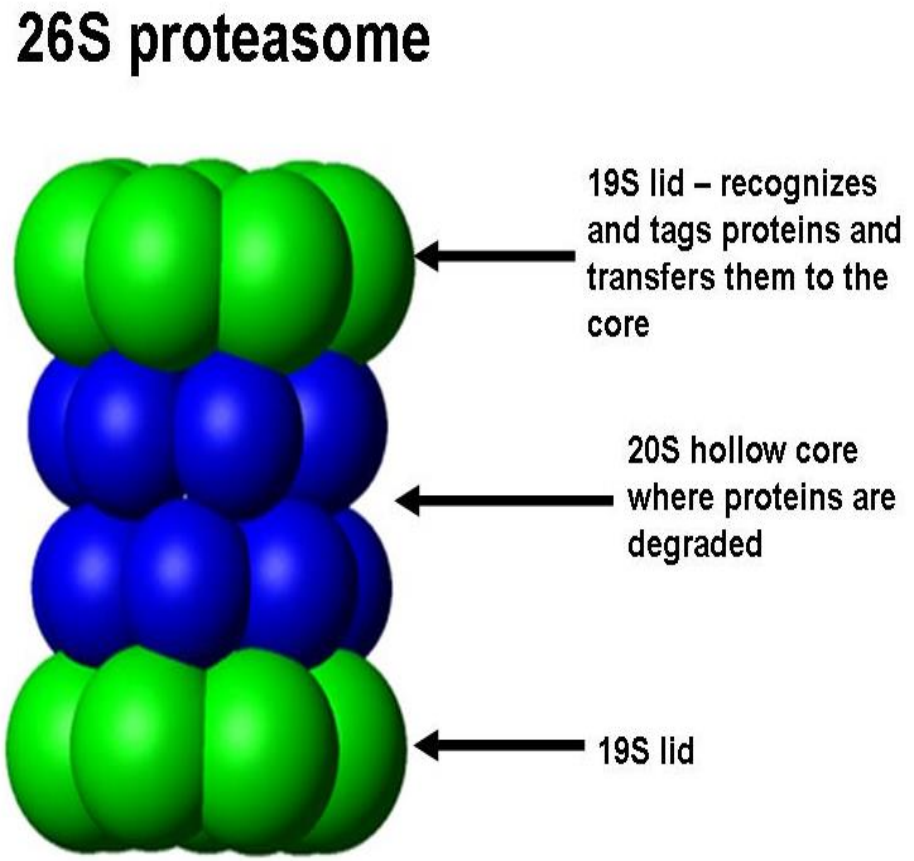
Peroxisomes

- **Peroxisomes** contain several **oxidases**, enzymes that can oxidize (remove hydrogen atoms from) various organic substances.
- They protect the cells from oxidative damage.
- They protect other parts of the cell from the toxic effects of potentially toxic compounds.
- Peroxisomes are very abundant in the liver, where **detoxification of alcohol** and other damaging substances occurs.
- Peroxisomes also contain the enzyme **catalase**, which decomposes by-product of the oxidation reactions which is hydrogen peroxide (H_2O_2); thus, it decomposes hydrogen peroxide to water and oxygen.

Proteasomes

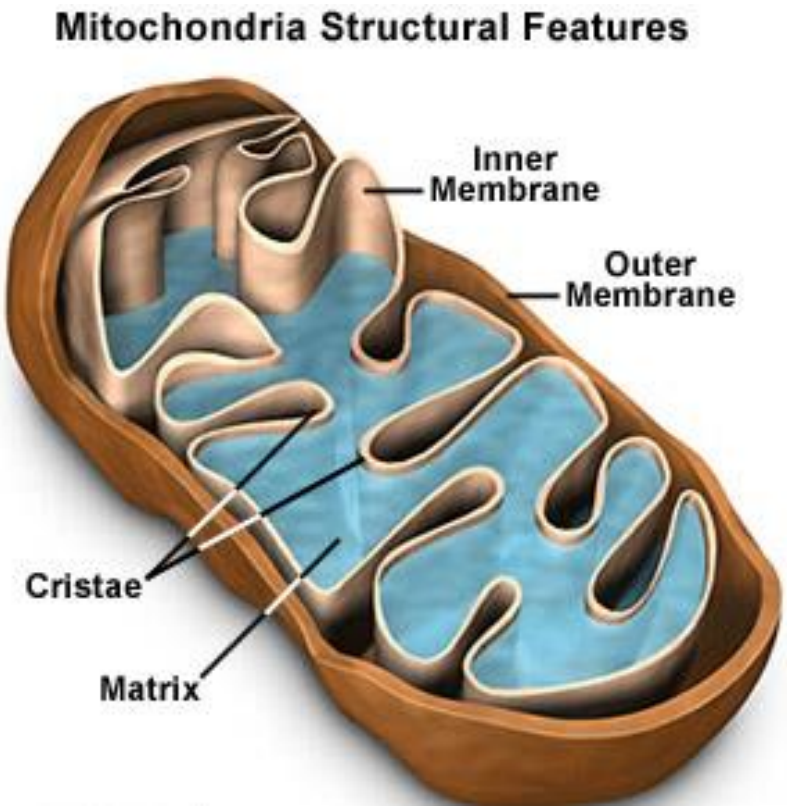
- Cytosolic proteins require disposal at certain times in the life of a cell. **Continuous destruction of unneeded, damaged, or faulty proteins** is the function of tiny barrel-shaped structures consisting of four stacked rings of proteins around a central core called **proteasomes.**

- Proteasomes were so named because they contain **proteases, enzymes that cut proteins into small peptides**. Once the enzymes of a proteasome have chopped up a protein into smaller chunks, **other enzymes then break down the peptides into amino acids, which can be recycled into new proteins.**



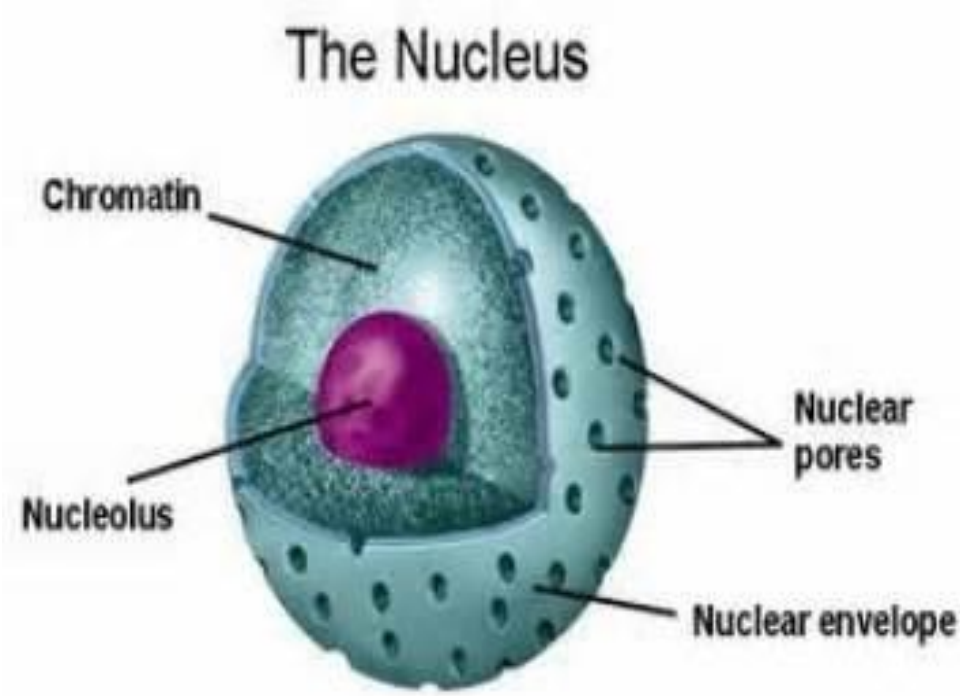
Mitochondria

- **Mitochondria** generate most of the ATP through aerobic (oxygen requiring) respiration, ("**powerhouses**" of the cell). The enzymes that catalyze the chemical reactions which are part of the aerobic phase of cellular respiration are located in the mitochondria.
- Active cells that use ATP at a high rate—such as those found in the muscles, liver, and kidneys—have a large number of mitochondria.
- A mitochondrion consists of an **outer mitochondrial membrane** and an **inner mitochondrial membrane** with a small fluid-filled space between them (**mitochondrial matrix**.).



Nucleus

- **The nucleus** is a spherical or oval-shaped structure that usually is the most prominent feature of a cell.
- Most cells have a single nucleus, although some, such as mature red blood cells, have none. Other types of cells have multiple nuclei.
- A double membrane called the **nuclear envelope** separates the nucleus from the cytoplasm. Many openings called **nuclear pores** extend through the nuclear envelope.
- The complex of DNA, proteins, and some RNA is called **chromatin**. The total genetic information carried in a cell, or an organism is its **genome**.



Nucleus

- **Functions of nucleus:**

1. Controls **cellular structure**.
2. Directs **cellular activities**.
3. **Produces ribosomes** in nucleoli.
4. Nuclear pores control the **movement of substances** between the nucleus and cytoplasm.