كلية العلوم

القسم : علم الحياة

السنة : الثالثة

المادة : بيولوجيا حيوانية

المحاضرة :٣+٤ /نظري/د.ميسون

{{ مكتبة A to Z }}

2024 2025

Facebook Group : مكتبة A to Z

Eukaryotic Cells - Animal Cells and Endosymbiotic Theory

Human beings and all other animals are made of eukaryotic cells, which contain a number of components called organelles that are not present in prokaryotic cells, some of which resemble individual organisms unto themselves.

Because they are more complex, we know that eukaryotic cells evolved from prokaryotic cells.

Endosymbiotic Theory

Endosymbiotic theory proposes that billions of years ago there were many different types of bacteria floating around, all of which were unicellular.

Some of these species of bacteria acquired unique functions, like the ability to perform photosynthesis, or breathe oxygen[1].

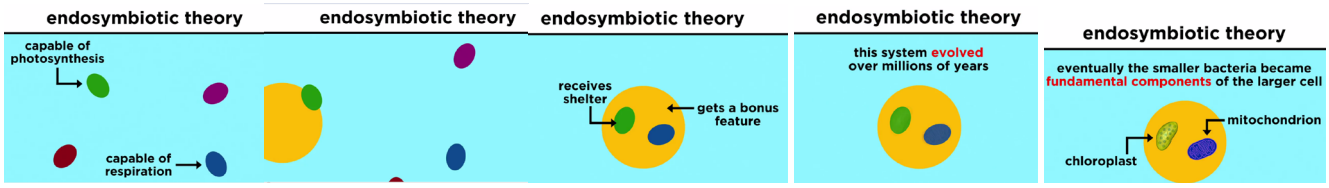
It is believed that larger host cells then enveloped[2] some of these smaller bacteria, and instead of digesting them, a mutual dependency arose[3], each relying on the other for some crucial function.

The smaller cell received protection, while the larger one reaped the benefits of some kind of energy-producing process.

This is where the name endosymbiotic comes from.

Endo means inside, and symbiosis refers to organisms living and working together.

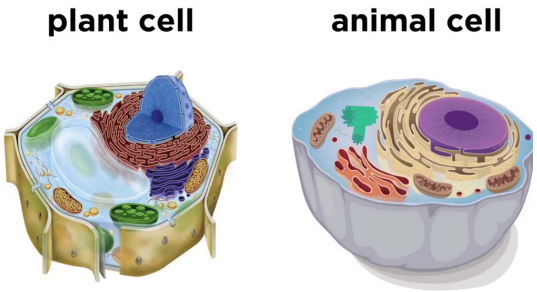
These smaller bacteria grew more specialized over millions of years of evolution, and eventually became some of the organelles we find within a single eukaryotic cell.



1 2 3 4 5

So what are these organelles exactly?

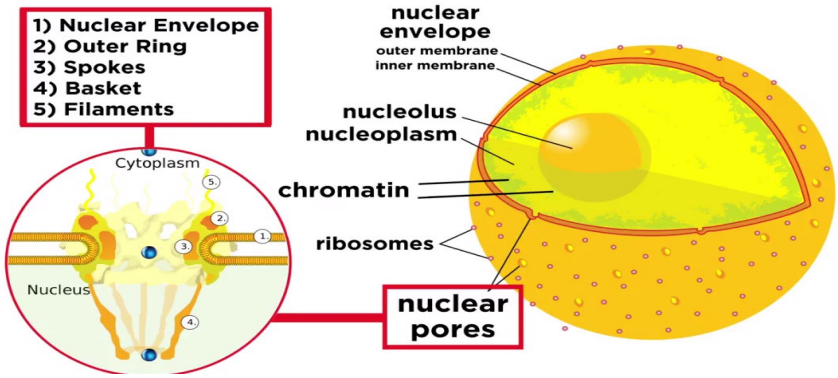
To answer that, let's first make the distinction between plant cells and animal cells, These are both examples of eukaryotic cells, but they differ in the precise components within.



Nucleus: Let's first take a look at animal cells, which are the kind inside you and me, since humans are considered part of the animal kingdom.

The first thing we want to point out is that while prokaryotic cells have their genetic information just floating in the middle of the cell, eukaryotic cells store their genetic information inside a nucleus.

Nuclear Membrane: This nucleus has its own membrane, which unlike the cell membrane is actually a double membrane, and this nuclear envelope only lets certain things in or out by passing through tiny holes called pores.



Nuclear Membrane

In this way, it keeps all the genetic material, or chromatin, separate from the cytoplasm of the cell.

Within the nucleus is a smaller area called the nucleolus where ribosomal RNA is synthesized, as well as the parts of the ribosomes themselves.

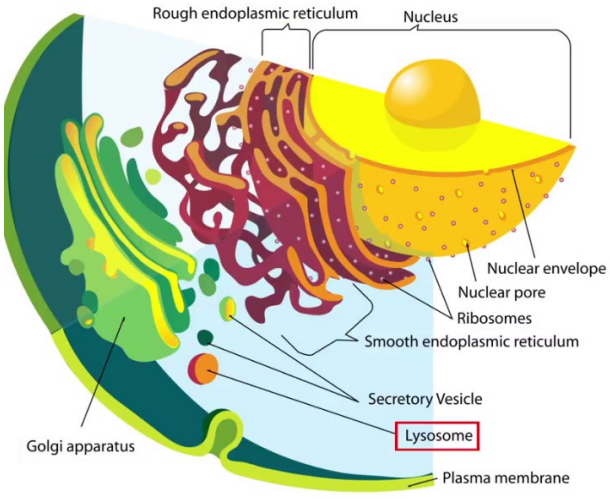
The large and small subunits of the ribosome are formed, which then exit the nucleus and assemble in the cytoplasm.

Some of these ribosomes can be found floating around in the cytosol, but some are stuck to the surface of the nucleus or other organelles like barnacles on a boat.

Ribosomes, which are present in both prokaryotic and eukaryotic cells, are made of ribosomal RNA and proteins, and these in turn synthesize all the proteins the cell needs to perform its various functions.

Endomembrane System: Other components of the cell come together to make up the endomembrane system.

This is a set of membrane bound regions, which consists of the nuclear envelope, the rough and smooth endoplasmic reticulum, Golgi apparatus, and lysosomes.



Endomembrane System

1- The rough and smooth endoplasmic reticulum

The rough ER: The rough endoplasmic reticulum is a network of membranes that enclose the ER lumen, which is the stuff inside, consisting of sacs called cisternae.

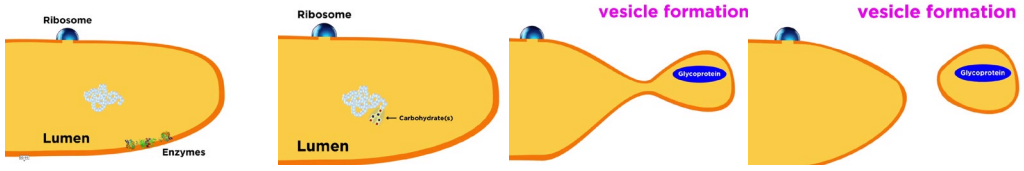
It's called the rough endoplasmic reticulum because its surface is studded with ribosomes, giving it a rough appearance.

These ribosomes synthesize polypeptides that are inserted directly into the ER lumen, where they are typically folded and modified by enzymes in the ER membrane, and sometimes affixed with a carbohydrate to make glycoproteins.

These are often intended for secretion from the cell, so they gather into a vesicle, which is like a bubble that buds from the ER membrane and then makes its way to the cell membrane, thus releasing its contents to the extracellular space.

The rough ER also synthesizes phospholipids that can be delivered to other parts of the endomembrane system, and it takes proteins synthesized by the ribosomes that will be cell membrane proteins, embeds them in its own membrane, and then delivers them via similar transport vesicles.

The rough ER is connected to the smooth ER, which is different in that it is not studded with ribosomes.



1 2 3 4

synthesize polypeptides

The smooth ER: It also has a wider variety of functions, like synthesis, metabolism, and storage of calcium ions to be used for signaling.

The smooth ER produces phospholipids and steroids like sex hormones.

Enzymes in the smooth ER can detoxify drugs and poisons, by adding hydroxyl groups to enhance water solubility and flush them from the body.

Next in the endomembrane system is the Golgi apparatus.

Most transport vesicles, like the ones going from the ER to the cell membrane, stop off here first.

The things inside the vesicles, like proteins, are modified and stored, and later sent to where they need to go.

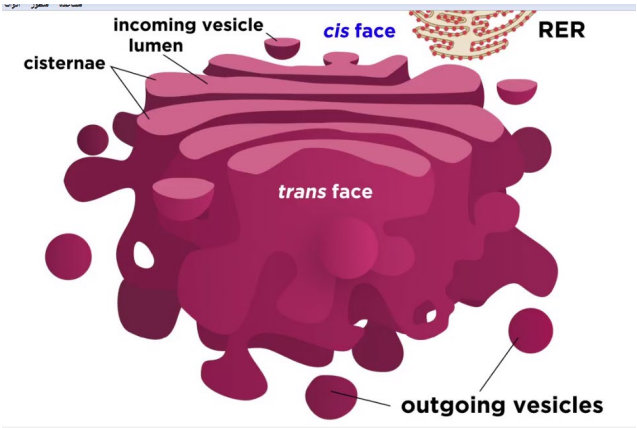
2- The Golgi apparatus

The Golgi apparatus consists of a series of stacks, and there is a cis face, usually facing the ER, where vesicles arrive, and a trans face, where vesicles leave.

In between, molecules will be modified, with sugars removed or substituted, and generally prepared for their eventual function.

This is all done piecewise as the components move from one cisterna to the next, as each of these sections has its own set of enzymes.

Before sending things off, products are given molecular tags like phosphate groups, which is kind of like an address on a piece of mail to target things for various parts of the cell, and some vesicles also have certain molecules on their surfaces that can be recognized by specific organelles, which helps target vesicle delivery.



The Golgi apparatus

3- The lysosome

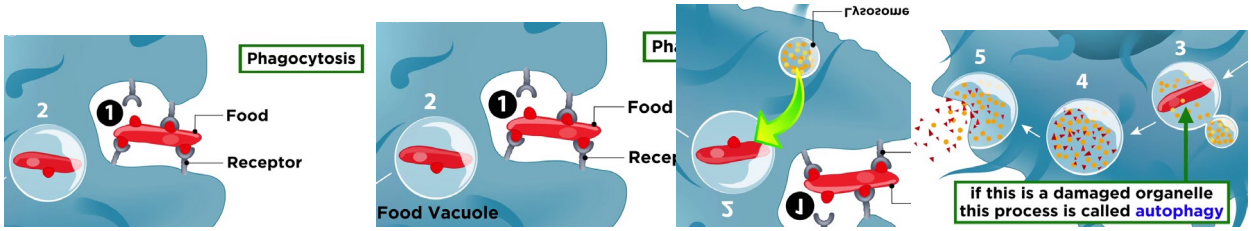
This is a sac containing an environment that is much more acidic than the rest of the cell, and it holds enzymes that digest large molecules via hydrolysis, which is the breakdown of a compound due to reaction with a water molecule.

When food enters a cell through a vesicle, by a process called phagocytosis, multiple vesicles fuse to form a vacuole.

Then, a lysosome will fuse with the vacuole and break apart the big chunks of food into smaller bits.

Lysosomes can also digest damaged organelles that need to be dismantled in a process called autophagy.

This allows the cell to maintain optimal functionality.



Mitochondria: There are a few organelles that are not part of the endomembrane system, and a crucial one is the mitochondrion.

There are hundreds of mitochondria in most eukaryotic cells, and these are the sites that carry out cellular respiration, which generates most of the energy the cell needs to go about its business.

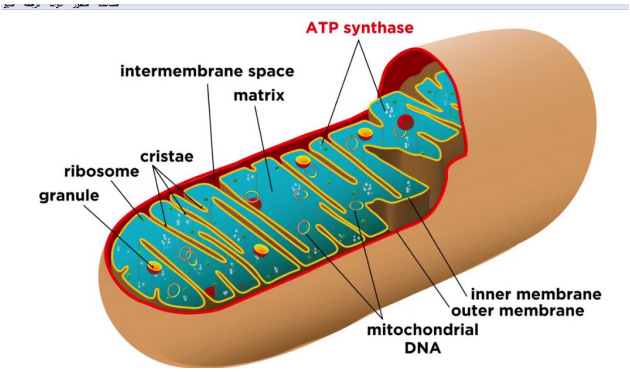
Cellular respiration occurs in three steps, glycolysis, the citric acid cycle, and oxidative phosphorylation.

Mitochondria also have two membranes.

The outer membrane is smooth, but the inner membrane makes many folds called cristae.

The area in between the two membranes is the intermembrane space, while the innermost part is called the mitochondrial matrix.

The matrix contains circular DNA molecules called mitochondrial DNA, and ribosomes, as well as many of the enzymes that carry out cellular respiration, while some of these enzymes can be found in the inner membrane itself.



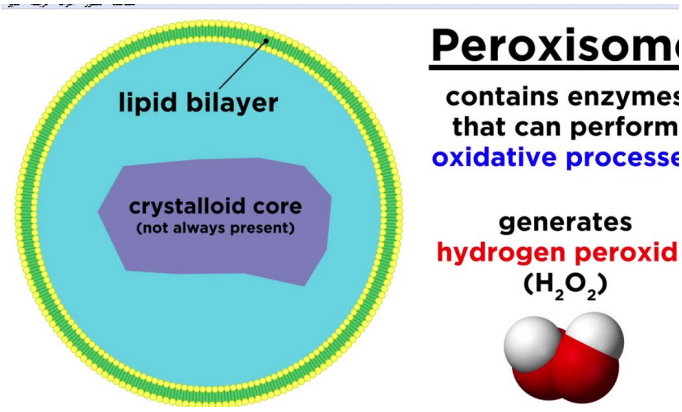
Mitochondria

Peroxisome: Another organelle that also has metabolic function is the peroxisome.

This contains enzymes that perform oxidative processes, which make hydrogen peroxide as a byproduct.

These work with mitochondria by breaking down fatty acids into smaller components that are ready for cellular respiration.

That's all the organelles, so what else is in there?



Peroxisome

Cytoskeleton: Well the cellular components are typically tethered to something called the cytoskeleton.

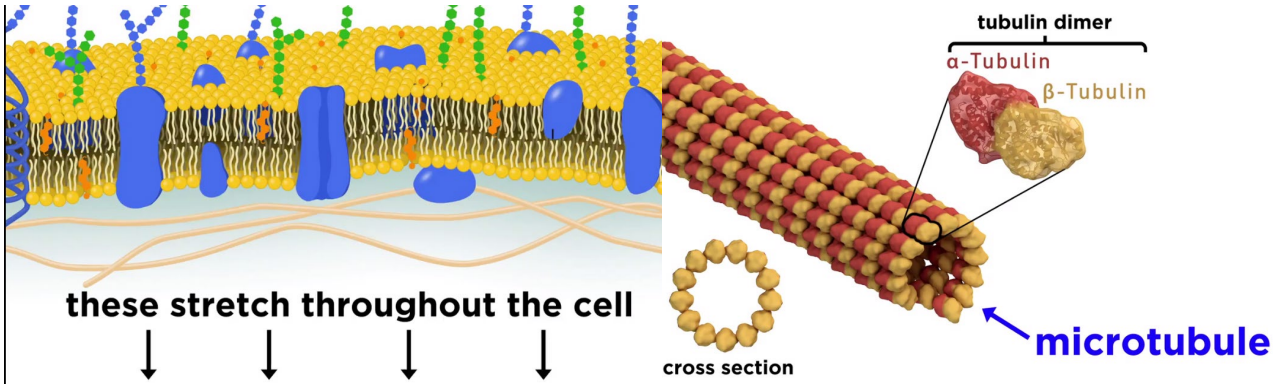
This is a network of fibers that stretch throughout the cytoplasm of the cell and keep everything nice and organized.

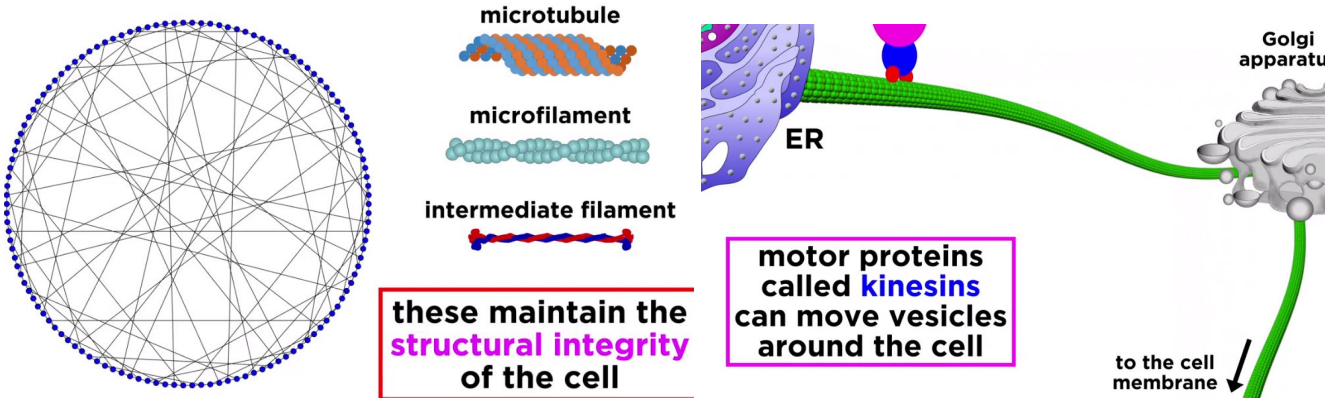
These fibers consist of hollow microtubules made of tubulin dimers, microfilaments made of two intertwined strands of actin, and intermediate filaments made of coiled keratins.

Beyond organization, these also determine and maintain the shape and structural integrity of the cell.

Sometimes vesicles utilize motor proteins to deliver their contents to their destinations by moving along microtubules, like from the ER to the Golgi apparatus or from the Golgi apparatus to the cell membrane.

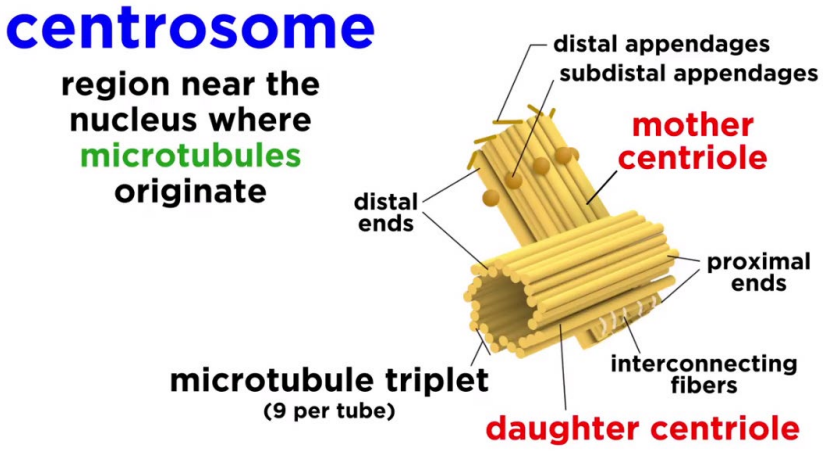
This is a process that requires ATP to power, and two components move sequentially along the microtubule in an action that looks a lot like walking.





Cytoskeleton

Centrosome: In animal cells, microtubules grow outwards from a centrosome, which is located near the nucleus, and consists of a pair of centrioles, which have microtubules arranged in a ring, nine sets of three to be exact.



Centrosome

The animal cell is a tiny factory

Now that we know a bit about the structure and function of each organelle, we can almost view the cell as a tiny factory, with each component serving a specific purpose.

The plasma membrane is like the security guard at the gate, deciding what can go in or out.

Once inside, we see the cytoskeleton, which is the system of girders that provides structure, and the cytoplasm, which is the factory floor.

The nucleus is the central office where the boss sits, giving out orders from the genetic instructions.

The endoplasmic reticulum is the assembly line, and the ribosomes are the little factory workers, building all the proteins the cell needs.

The Golgi apparatus is the sorting and shipping center, the lysosomes are the maintenance and disposal workers, while the mitochondria are the furnace or power plant that powers the whole show.

Of course this is just an analogy, none of these organelles have any sentience, but it illustrates how a cell is much greater than the sum of its parts, a living system with components that cooperate for survival.

Wishing you the best of luck

Dr. Maissoun Ziadeh

Eukaryotic	حقيقية النواة	Tiny Holes	ثقوب صغيرة
Endosymbiotic	التعايش الداخلي	Pores	المسام
Theory	نظرية	The Genetic Material	المادة الوراثية
Components	المكونات	Nucleolus	النويّة
Organelles	العضيات	Is Synthesized	يتم تصنيع
Prokaryotic	بدائية النواة	Subunits	الوحدات الفرعية
Resemble	يشبه	Stuck To	عالق على
Individual	الفردية	Barnacles	محار البرنقيل
Proposes	تقترح	Endomembrane System	نظام الغشاء الداخلي
Floating around	تطفو في الجو	Regions	المناطق
Unicellular	أحادية الخلية	Endoplasmic Reticulum	الشبكة الإندوبلازمية
Species	الأنواع	Lysosomes	الجسيمات الحالة
Acquired	اكتسبت	Lumen	تجويف
Unique Functions	وظائف فريدة	Sacs	أكياس
Ability	القدرة	Cisternae	إنتفاخات -خزانات
To Perform	إجراء	Studded	مرصع
Photosynthesis	التمثيل الضوئي	Polypeptides	عديد الببتيدات
Is Believed	يُعتقد	Inserted	إدخال
Host cells	الخلايا المضيفة	Folded	طي
Enveloped	غطت	Modified	تعديل
A Mutual Dependency	اعتماد متبادل	Affixed	لصق
Arose	نشأ	Glycoproteins	البروتينات السكرية
Crucial Function	الوظائف الحاسمة	Intended	مخصصة
Received	تلقت	Secretion	الإفراز
Protection	الحماية	Vesicle	حويصلة
Reaped	جنت	Buds	تتبرعم
Energy-producing	إنتاج الطاقة	Embeds	تدمج
Specialized	تخصص	Metabolism	التمثيل الغذائي
Evolution	التطور	Steroids	المنشطات
Distinction	نميز	Detoxify	إزالة السموم
Are Considered	يعتبرون	To Enhance	لتعزيز
Nucleus	نواة	Solubility	الذوبان
Membrane	غشاء	Flush	طرد
By Passing	من خلال المرور	Stacks	تكدسات

Substituted	استبدال	Hollow	المجوفة
Eventual Function	الوظيفة النهائية	Microtubules	الأنابيب الدقيقة
Piecewise	على مراحل	Tubulin Dimers	بروتينات تتشكل من أنيبيبات صغيرة - التوبولين
Molecular Tags	علامات جزيئية	Microfilaments	الخيوط الدقيقة
To Target	لاستهداف	Intertwined Strands	خيوط متشابكة
Recognized	التعرف	Intermediate Filaments	خيوط وسيطة
Sac	كيس	Coiled	ملفوف
Acidic	حمضية	Integrity	سلامة
Hydrolysis	التحلل المائي	Utilize	تستخدم
Breakdown	تحلل	Motor Proteins	البروتينات الحركية
Phagocytosis	البلعمة	Destinations	وجهاتها
Fuse	تندمج	Sequentially	بالتتابع
Vacuole	فجوة	Centrosome	جسيم مركزي
Chunks	قطع	Centrioles	المريكزات
Damaged Organelles	العضيات التالفة	Tiny Factory	مصنع صغير
Autophagy	الالتهام الذاتي	View	رؤية
Allows	يسمح	Specific Purpose	غرض محددً
To Maintain	الحفاظ	Security Guard	حارس الأمن
Optimal	المثلى	Gate	البوابة
Cellular Respiration	التنفس الخلوي	System Of Girders	نظام العوارض
Glycolysis	تحلل السكر	Floor	أرضية
Oxidative Phosphorylation	الفسفرة التأكسدية	Central Office	المكتب المركزي
The Innermost Part	الجزء الأعمق	The Assembly Line	خط التجميع
Mitochondrial Matrix	مصفوفة الميتوكوندريا	Workers	عمال
Circular	دائرية	Sorting	الفرز
Carry Out	تقوم	Shipping	الشحن
Peroxisome	الجسيمات التأكسدية	Maintenance	الصيانة
Oxidative	الأكسدة	Disposal	التخلص
Byproduct	منتج ثانوي	Furnace	الفرن
Cytoskeleton	الهيكل الخلوي	Power Plant	محطة الطاقة
Tethered	تربط	Analogy	تشبيه
Fibers	الألياف	Sentience	وعي