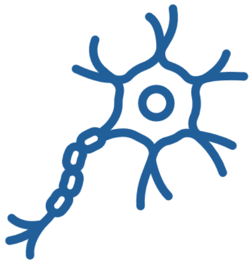


Travail personnel
Cell structure

Sophie Shrikhande

5C5

Content

Why did I choose this topic?

The reason I chose to write about cell structure is because I would like to study biology in the future, although I am still unsure which specific field I will pursue.

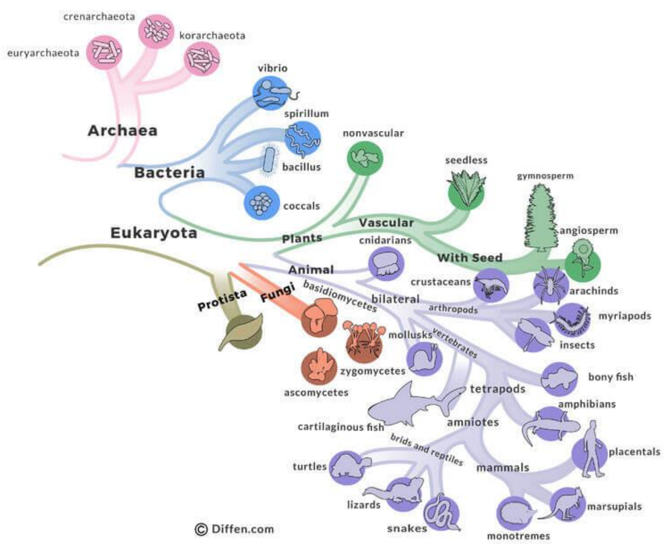
At first, I considered focusing on a topic related to one of biology's subfields, as I did for my last two travaux personnels. However, I ultimately chose a theme that forms the foundation of all areas in biology: the cell. I wanted to deepen my understanding of the field I'm passionate about by exploring its most fundamental unit—the building blocks of life.

Through this paper, I hope to gain insight into how any living organism is able to live, and perhaps even begin to understand what "life" means from a scientific perspective. I will not focus on the medical applications of cell biology, nor will I explore cellular evolution or the origins of life. Instead, I aim to approach cells the way someone might study animals: by examining their classification, their diversity—both in taxonomy and morphology—and the different ways they function, whether as independent single-celled organisms or as part of complex multicellular systems. I hope that by learning more about cells, I'll get a better idea of what part of biology I might want to focus on later.

Introduction

Cells are the smallest living units of all organisms and are, so to say, the building blocks of all living things. They can vary drastically, from the simplest bacteria to a brain neuron.

Though all cell types share three common features, they all possess: an outer shell called a plasma membrane, cytoplasm, which is a jelly-like fluid containing various cellular components, and DNA, the genetic material.



All cells are divided into two main classes, eukaryotic and prokaryotic, which are defined by whether they contain a nucleus or not.

Eukaryotic cells, animal or plant cells, possess organelles, for example, the nucleus, which contains the genetic material of the cell. Soley eukaryotes contain membrane-bound organelles (organelles enclosed by the cell membrane).

Prokaryotic cells have no nucleus and no membrane-bound organelles. They do have genetic material, although it is not contained inside a nucleus. Some do have cell structures that perform specialized functions, but instead of being enclosed by the membrane, they are outside of it. Prokaryotes are split into two main classes, archaea and bacteria.

Eukaryotic cells

Definition

A eukaryotic cell contains a membrane-bound nucleus and other membrane-bound compartments called organelles. Organelle originates from French, meaning “little organ”. There are various kinds of organelles, all with a specific task. The word eukaryotic comes from Greek, meaning “true kernel” or “true nucleus “. There are four types of eukaryotic cells: Animal, Plant, Fungi, and Protists.

Organelles

Definition

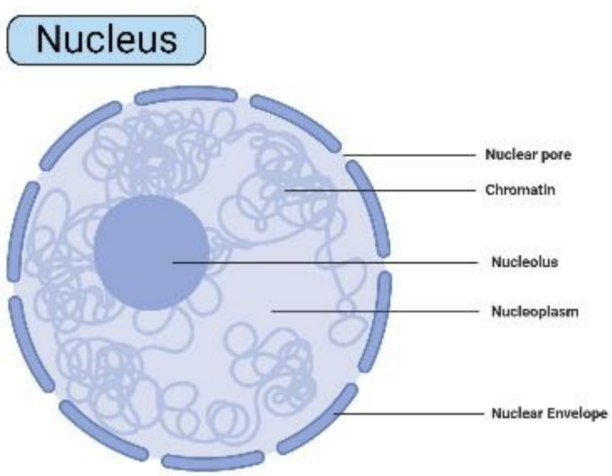
Organelles are specialized parts of a eukaryotic cell with unique functions. They are surrounded by a membrane, including the Nucleus, the control center of the cell.

Animal

Animal cell organelles include the nucleus, mitochondria, endoplasmic reticulum, Golgi apparatus, vesicles, and vacuoles. Ribosomes are not enclosed in a membrane, although they are still commonly referred to as organelles in eukaryotic cells.

Nucleus

The nucleus is the control center of a eukaryotic cell. It contains the cell’s genetic material, DNA, which dictates what the cell will do and in what manner. The spread-out form of DNA is called chromatin and is found inside the nuclear membrane. Moreover, the nucleus also contains a nucleolus, which is where ribosomes are produced.



Ribosomes

After leaving the nucleus, Ribosomes have the job of synthesizing, which is the process of making proteins. They either wander freely in the cell's cytoplasm or attach themselves to the endoplasmic reticulum, also known as the ER.

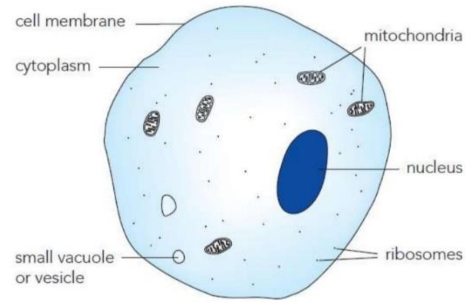
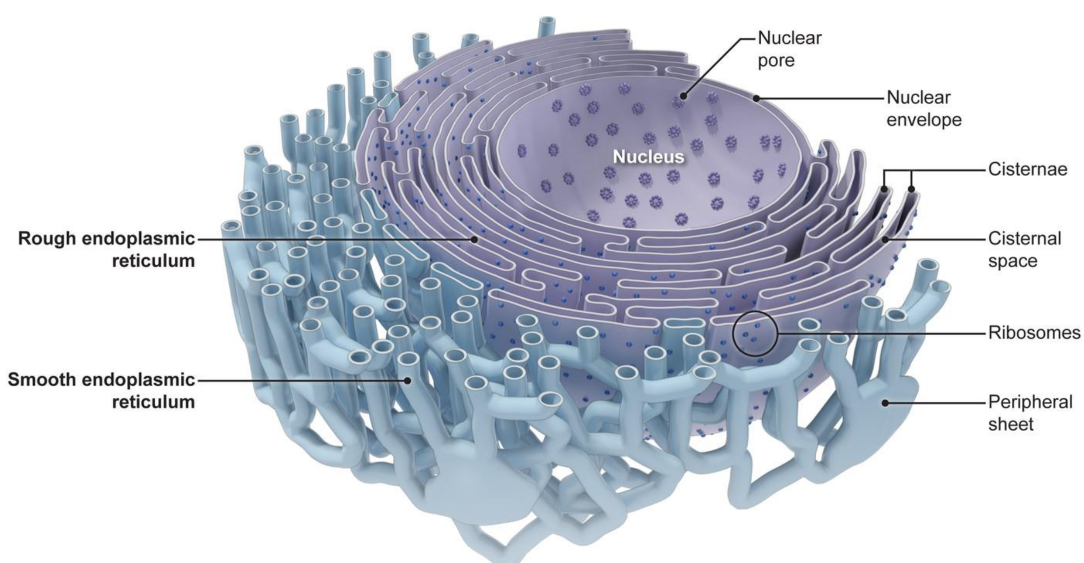


Figure 2.2: An animal cell as it appears through a light microscope.

Endoplasmic reticulum

There are two types of endoplasmic reticulum, the Rough ER and the Smooth ER. The rough one (rER) has ribosomes attached to it, whereas the smooth one (sER) does not. The endoplasmic reticulum is a membrane-enclosed passageway that transports materials such as proteins and lipids. These materials emerge from the ER in small vesicles and are received by the Golgi apparatus, also known as the Golgi body.



Golgi apparatus

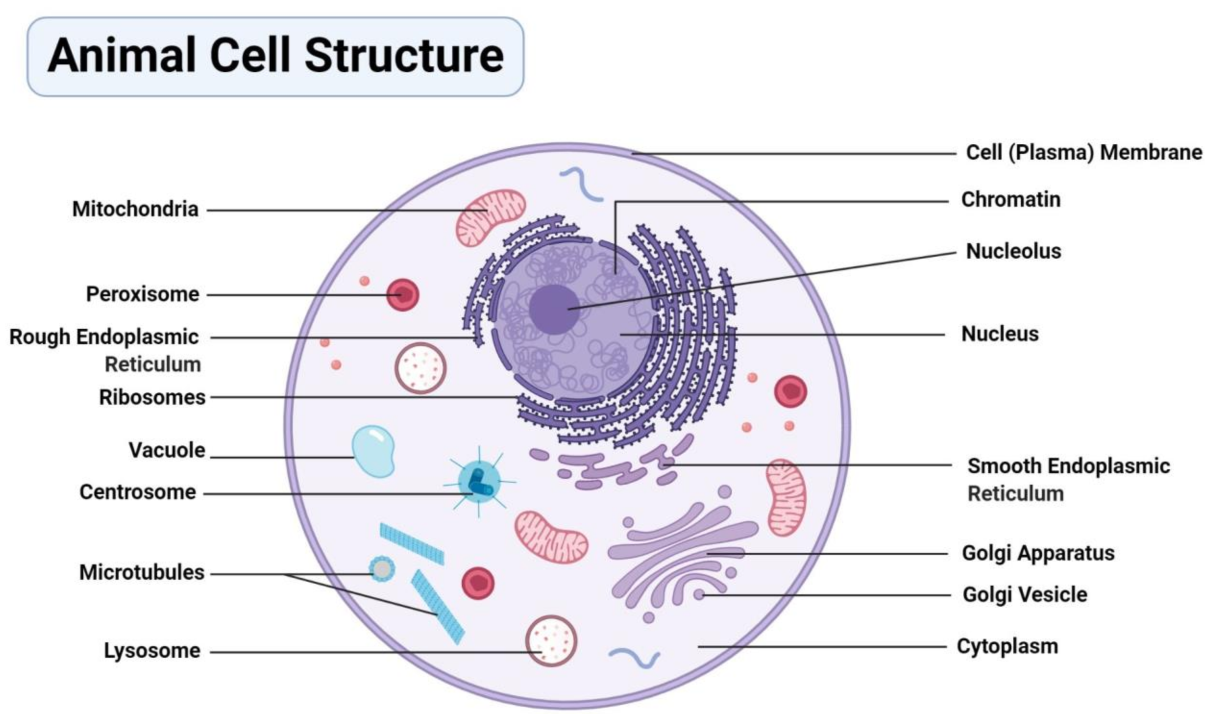
As Proteins and lipid molecules move through the Golgi apparatus, they are customized and processed into forms that the cell can use. It does this by either folding the proteins into usable shapes or by adding other materials to them. Materials such as lipids or carbohydrates

Lysosome

Lysosomes are the waste collectors of the cell; they collect worn-out or damaged cell parts. They are filled with enzymes, which break down the cellular debris.

Mitochondrion

Mitochondria are the powerhouse of a cell; their primary function is to generate large quantities of energy in the form of ATP (adenosine triphosphate). Additionally, they store calcium for cell signaling, generate heat, and trigger cell growth and death.



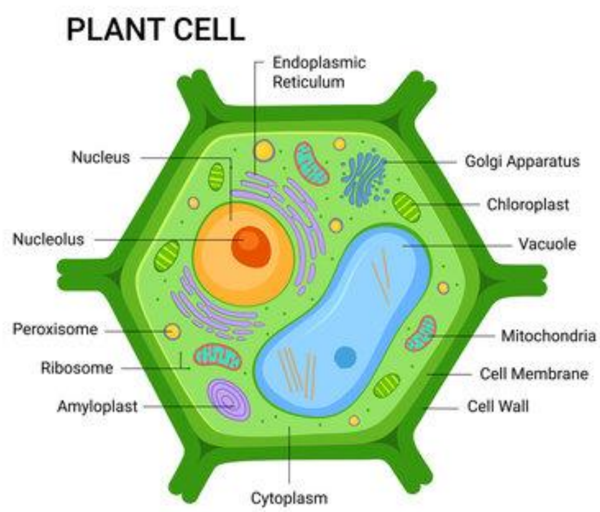
Plant

Unlike animal cells, plant cells have a cell wall surrounding the cell membrane. The plant's cell plays a crucial role in the plant's life, it is composed of cellulose, which distinguishes it from other cell walls, such as bacteria cell walls, which are composed of peptidoglycan.

Chloroplast

A key difference in plant cells is the presence of chloroplasts, though they are also found in some types of algae (which are not plants but protists). A chloroplast is the organelle where photosynthesis occurs. They are very similar to mitochondria in the way that they both generate energy (ATP) for their cells. They also possess a crucial pigment called chlorophyll; its role is to absorb light energy during the process of photosynthesis. It is also the reason why we see most plants as green.

Vacuoles



Another important characteristic of a plant cell is the presence of one or multiple vacuoles, which are storage organelles. In plants, they enable cells to grow large without accumulating the mass that would make metabolism complicated. (Metabolism is the process of chemical reactions turning food into energy for an organism.) Vacuoles enclose the cell sap, which is a water solution of salts and sugars that is kept at a high concentration level by the active transport of ions[1] throughout the vacuole's membrane.

[1] (ions are negatively or positively charged molecules and atoms, not neutral like "normal" atoms/molecules, which enables them to absorb or releases electrons)

Fungi

The cell wall of fungi is primarily made of chitin and glucans, which are tough, flexible polysaccharides. These, especially chitin, give structural stability and strength to the cell wall. Their plasma membranes are similar to those of other eukaryotes; however, their structure is stabilized by something called ergosterol. Ergosterol is a steroid molecule, a sterol's function is to maintain the fluidity of the cell membrane. Animal cells for example have cholesterol as their steroid molecules, which are a class of lipids. The fact that fungi possess ergosterol instead of cholesterol is a key characteristic in differentiating fungi from other eukaryotic cells.

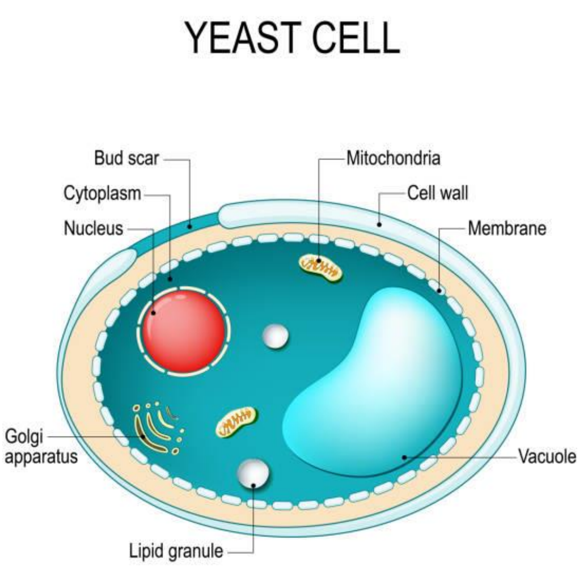
A major characteristic of fungi is the fact that they can be either multicellular, unicellular, or dimorphic, which is when a fungus becomes either multicellular or unicellular depending on the conditions of its environment.

Vacuoles

Such as plant cells, some fungi cells have vacuoles, although unlike plant cells they do not possess chloroplasts or chlorophyll. They use vacuoles for nutrition storage, growth without too much mass like with plants, and for waste management.

How to distinguish fungi from plants

The most efficient way to differentiate the two is by looking at their cells. The most obvious difference is the way these cells maintain their shape. Plant cell walls are made up of cellulose, whereas fungi cell walls are primarily made up of chitin. This substance (chitin) also makes up the exoskeleton of betels, the wings of butterflies, and the beaks of giant squids.



Fungi cells do not possess chlorophyll, unlike in plants. This leads to another key difference, the way they acquire energy. Chlorophyll enables plants to harness sunlight for photosynthesis, converting water and carbon dioxide into sugars. In contrast, fungi must obtain their nutrients from their surrounding environment, much like animals do, though their method of obtaining energy is slightly different. We, as animals, take our food from our environment, put it into our bodies, and digest it to absorb its nutrients. The way that fungi do it is the same just in reverse. They produce chemicals to first digest their food (still in their environment), and then they will absorb it into their bodies. This process is known as external digestion.

Fungal external digestion

The way fungi get their energy is by digesting the nutrients of their environment. They do this by releasing digestive enzymes into their surroundings, breaking down organic materials such as dead plants, animals, or decaying matter. This process breaks down complex substances into simpler compounds that the fungi can absorb.

Many fungi are decomposers, meaning they feed on dead or decaying organic matter, such as fallen leaves, dead trees, and animal remains. By breaking down this material, fungi help recycle nutrients into the ecosystem.

Some fungi form symbiotic relationships with plants, such as mycorrhizal fungi, which live in the roots of plants. In exchange for sugars and other nutrients from the plant, the fungus helps the plant absorb water and minerals from the soil.

Then there are the parasitic fungi, they feed on living organisms, including plants, animals, and even other fungi. They may infect their host and draw nutrients directly from it, sometimes harming the host in the process. An example of this type of fungus is Aspergillus. This type of fungi can cause a fungal infection that can affect the human respiratory system, called Aspergillosis. This mold can be found everywhere, it is usually harmless, however, when people with either weakened immune systems, underlying lung diseases, or asthma, inhale the Aspergillus spores, it can cause severe illnesses. These illnesses can vary from allergic reactions to mild to severe infections. The most serious form of aspergillosis is invasive aspergillosis, this occurs when the fungal infection spreads from your lungs to your blood vessels and beyond. Depending on the type of aspergillus, treatment can vary from antifungal medication to (in extreme cases) surgery.

Lifecycle

A fungus' life begins as a spore, it can get carried by either the wind or an unsuspecting animal, for example, an insect. When it finds a suitable environment, this differs in species, it will sprout (in other words, germinate) and later begin growing these long thin strands known as hyphae. They will stretch out in the soil or plants to look for nutrients. As they grow, the hyphae will start forming a network known as the mycelium. As these mycelial networks grow, they may encounter other mycelia networks, this is when one of two things can happen. They are either compatible or incompatible. If they are incompatible, which is more likely to occur, they will wage war against each other, and both try their best to destroy each other. They will defend themselves by creating anti-fungal compounds. Sometimes, these battles occur in hosts such as trees, their wood ends up having these beautiful intricate patterns known as splatted wood.

If they so happen to be compatible, instead of fitting each other, they will merge their mycelia. This fusion of mycelia results in the formation of spores, which are eventually found in the fungus's fruiting bodies. This is one way that fungi can reproduce, however, they are also capable of reproducing asexually. In many species, the fruiting body is what we recognize as mushrooms, they are in charge of releasing the spores into the air so that they may start a new mycelium.

Septa (singular, septum)

In fungi, septa are the internal walls that separate the hyphae into individual cells. They usually have pores that enable nutrients and organelles, such as mitochondria, ribosomes, and sometimes even nuclei, to flow between cells. These types of hyphae are called septate hyphae. However, this is not the only type that exists; the hyphae of some fungi are not separated by septa. These are called coenocytic hyphae, which are large, multinucleated cells.

Protists

Protists comprise mostly of unicellular organisms (organisms with only one cell) and simple multicellular organisms (organisms with multiple cells). In general, protists are organisms with a nucleus enclosed by a membrane and do not fit in any other eukaryotic kingdoms (animal, plant, fungi). This kingdom has an immense variety of cell types and structures, so scientists divided them into four phyla: protists that resemble more animal cells, protists that resemble more plant cells, and protists that resemble more fungi cells. However, scientists are still discussing and arguing the manner in which they should classify protists, so these pieces of information might become obsolete.

Protozoa

Protozoa (singular, protozoan) are the “animal resembling protists”, which are unicellular. They are known for being “animal-like” due to the fact that they are capable of locomotion, they have no cell-wall, and are heterotrophs, meaning that they cannot make their food and must consume other organisms such as plants, animals, or decomposed material to obtain energy. Although they are not animals, they are believed to be the ancestors of animals.

They have been classified into four sub-phyla based on the manner in which they move, by Honigberg and his team. This classification is based solely on their movement and has nothing to do with their phylogenetic relationships.

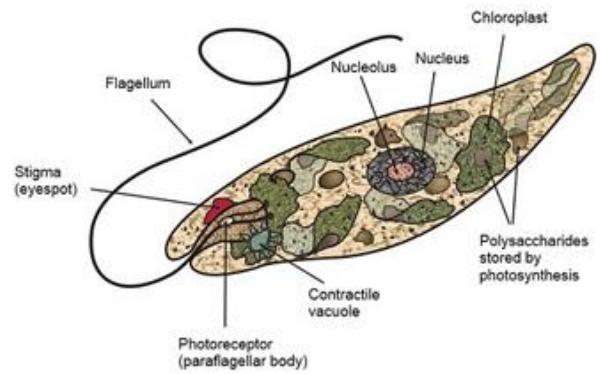
1. *Sarcomastigophora*

This sub-phylum is furthermore divided into three super classes. One of them is the super class Mastigophora, also known as the flagellates. Flagellates have flagellums, which are hairlike structures that lash like whips and provide the cell with movement. Mastigophora includes two classes: Phytomastigophora and Zoomastigophora.

In the Phytomastigophorea Class are protozoa that contain chlorophyll, which means that they can produce their food photosynthetically just like plants. The distinction between phytoflagellates and algae is unclear; some phytoflagellates are classified as algae in some botanical classifications.

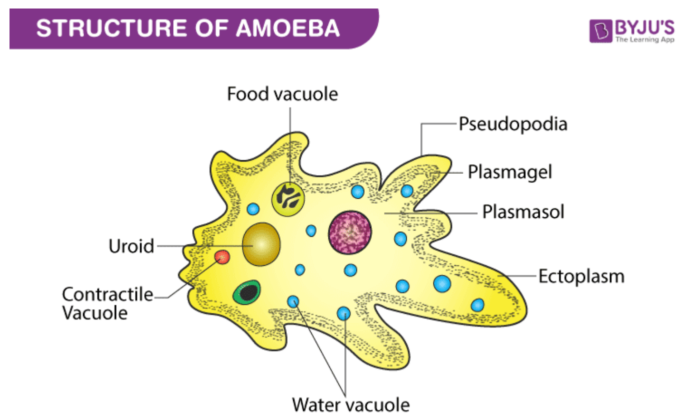
In the Zoomastigophorea Class are protozoa, which are Heterotrophs, which means they obtain their energy by consuming other organisms, which is why they are commonly referred to as consumers. They (Heterotrophs) are usually classified by what they eat, for example, carnivores, herbivores, etc.

However, more recent classifications of this group have questioned the taxonomic usefulness of the terms, as some zooflagellates have been found to have photosynthetic abilities, and some phytoflagellates have heterotrophic abilities.



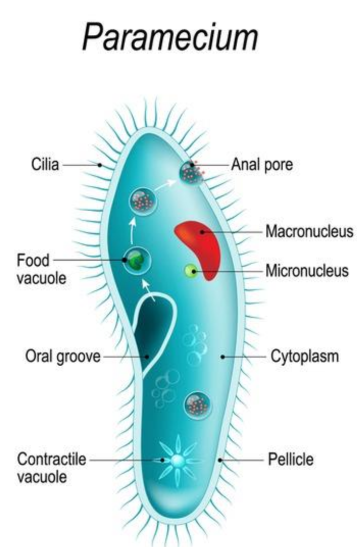
2. *Sarcodina*

In modern science, the term for the Sarcodina subphylum is mainly referred to as amoeboid protozoa. Amoeboid use pseudopods to move; their cell membrane extends in one area, causing the cytoplasm to flow into the protrusion, forming a pseudopod. This allows the organism to move, for example, to distance itself from light or to capture food. The pseudopods can extend in different directions to surround and engulf food, which is then absorbed into the cell.



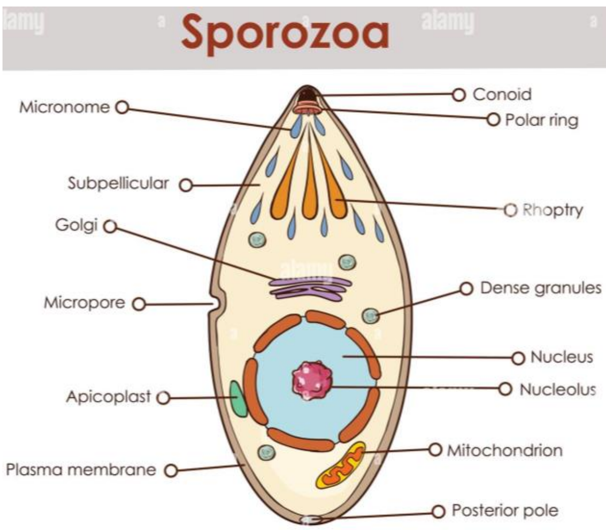
3. *Ciliophora*

Ciliophora only has one class, class Ciliatea. Ciliates use cilia for locomotion, which are hair-like projections that beat in unison (kind of like the oars of a boat) to move the organism through water or sweep food toward it.



4. Sporozoa

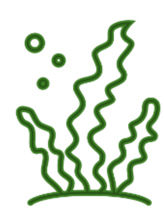
This subphylum has protist species that have no organelles for locomotion. They sometimes might have pseudopods; however, they are solely useful for gathering food. The species in this subphylum are solely endoparasites, which means they live inside their host (instead of on them, those parasites are called ectoparasites). Sporozoan are further divided into three classes: Telosporea, Toxoplasmea, and Haplosporea.



Algea

Algea are the plant resembling protists. This subkingdom contains both unicellular and multicellular organisms; an example of multicellular algae is seaweed. Algea share a couple of characteristics with plants; for example, they are all photosynthetic, contain chloroplasts, and have cell walls. However, neither unicellular nor multicellular algae have the body of a plant. The bodies of algae are not differentiated the way a plant is into stem, leaves, and roots. Some species of algae are capable of locomotion; they do this with either flagella or pseudopods. They are not plants; however, they are believed to be the ancestors of plants or share the same ancestor.

Algae play a vital role in our aquatic ecosystems; they not only provide oxygen, such as Phytoplankton, which are responsible for most of the transfer of carbon dioxide from the atmosphere to the ocean, but are also a food source and a shelter for a multitude of



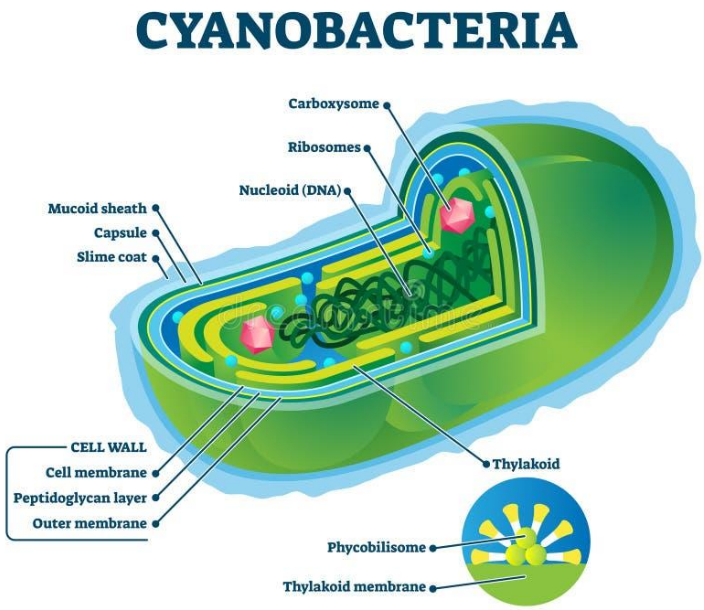
marine life. Take the great kelp forests, for example, they can be found throughout the ocean in both tropical and arctic climates. A vast variety of sea organisms rely on them for food and protection against predators. An example would be the sea urchin. They feast upon the roots of the kelp, which makes sure the kelp forest never grows to a size where it can become invasive. However, if the sea urchins become too abundant, then that is when the sea otters come into play; they not only hunt sea urchins and keep them in check, but also rely on the kelp. Sea otters are mammals and therefore need oxygen to breath, so when they go to sleep they will lie on their backs and rest their young ones on their bellies, but to ensure they do not drift away into open waters, one of them will hold on to the top most part of the kelp and then hold hands with the rest of the raft[2].

When it comes to the classification of algae, it is changing frequently and rapidly due to constant new taxonomic information and discoveries. It was formerly classified into three major groups based on their pigment molecules in their chloroplasts: red algae, green algae, and brown algae. However, the current taxonomic classifications are more varied, and they all share a common set of pigment types. It is composed of a total of eight phyla or sub-phyla, which are based on evolutionary lineage, pigment composition, storage products, cell wall structure, flagella, and cellular organization. Algae are now defined more as organisms that can photosynthesize in aquatic environments. They usually all have a nucleus (seeing as they are classified under eukaryotes), however, there is an organism where scientists are not so sure where they should place it in the taxonomic tree. That is the cyanobacteria, for in theory it is a bacterium and is also classified as one, for it does not possess a membrane-bound nucleus. Nonetheless, they are photosynthetic and aquatic and have a lot in common with other algae species, to the point where we named them blue-green algae, and do not have a place to put them in.

The way we formerly classified algae, before we had the technology to study DNA strands, was based on their pigment, the way they absorbed light, and photosynthesized. Plants have chlorophyll for photosynthesis, which gives the plant its green pigment, due to how they absorb light waves. Some forms of algae photosynthesize in the same manner; however, many species, in addition to chlorophyll, possess additional pigments called phycobilin. The algae that appear green absorbs red light and reflect green light, which is the reason for their appearance. The problem for algae

[2] A group of otters in the water is called a raft, if they are on land they are called a romp.

species that live in deep waters is that red light cannot penetrate such depths, however, blue light can. Therefore, those species of algae (for example, kelp) have additional pigments, such as phycobilin, which can absorb blue light waves and later transfer the energy to chlorophyll for photosynthesis. This results in the algae appearing in a more reddish-brown color, which can vary depending on the kind of additional pigment that they possess.



Smile and water molds

Fungus-like protists share many features with fungi. Like fungi, they are heterotrophs, meaning they must obtain food outside themselves. They also have cell walls; however, they are composed of cellulose, whereas fungi cell walls are made up of chitin. Just like fungi, they reproduce by forming spores. The only difference is that fungus-like protists can reproduce sexually or asexually, depending on the species. Fungus-like protists can develop movement like an amoeba, especially when it comes to helping them reach food sources. The two major types of fungus-like protists are slime molds and water molds.

Slime Molds

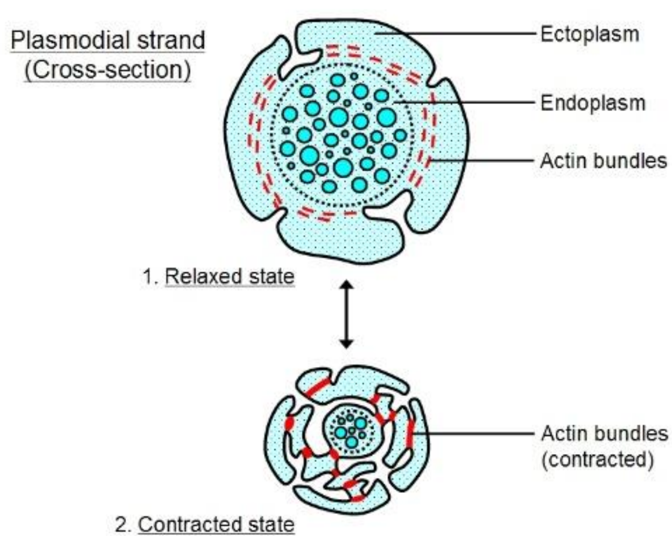
Slime molds usually measure about one or two centimeters, but a few slime molds are as big as several meters. They often have bright colors, such as vibrant yellow. Others are brown or white.

Stemonitis is a kind of slime mold that forms small brown bunches on the outside of rotting logs. Physarum polycephalum lives inside rotting logs and is a gooey mesh of yellow “threads” that are several centimeters long. Fuligo, sometimes called “vomit mold”, is a yellow slime mold found in decaying wood.

There are two major types of slime molds based on how they swarm. When food is scarce, individual cells swarm together to form a blob-like mass. The first type is acellular; when these individual cells come together, they fuse into a single cell with many nuclei. The second type is cellular, which means that when they swarm, they remain as individual cells.

Water Molds

Water molds live in water or moist soil. They can be parasites of plants and animals, getting their nutrients from these organisms and also from decaying organisms. They are a common problem for farmers since they cause a variety of plant diseases. One of the most famous of these diseases was the protist that caused the Irish potato famine in the 1800s. at this time, potatoes were the main source of food for many of the Irish people. The failure of the potato crop meant that many people in Ireland died of starvation or migrated to other countries.



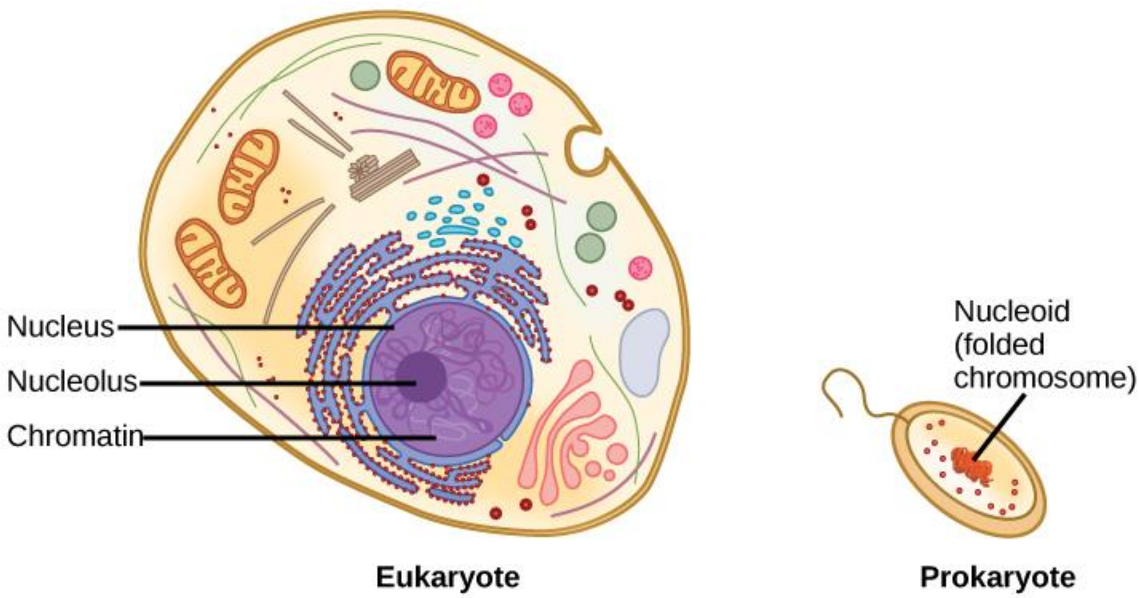
Prokaryotic cells

Definition

A prokaryotic cell is defined as not possessing a nucleus or any other organelle because of the absence of internal membranes. They are always unicellular organisms, which means they are only composed of one cell. Moreover, they are divided into two categories: bacteria and archaea. They both have many things in common, but some fundamental characteristics differentiate them.

Genetics

They do not possess a nucleus; their genetic material is usually a single chromosome. It has a circular form and is comprised of a piece of double-stranded DNA, which is located in an area of the cell called the nucleoid.



Structure

In prokaryotic cells, all the intercellular structures that are water-soluble, such as proteins, DNA, and metabolites, are found in the cell's cytoplasm, which is enclosed by the cell membrane. Instead, of being separated into different cellular compartments, which is usually the case in eukaryotic cells.

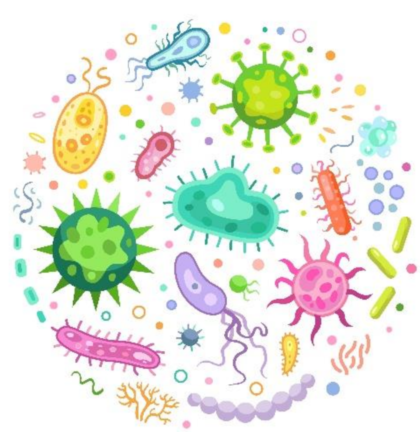
Moreover, there are some exceptions in this domain, such as cyanobacteria, which, like some prokaryotes, can form large colonies. Some bacteria possess protein-based microcompartments, which are believed to function as primitive organelles enclosed by protein shells. Some prokaryotes become multicellular in stages in their life cycle; one example is myxobacteria.

Research

Since Prokaryotes have such a wide diversity of species, every species has a different way of foraging for food, converting energy, fighting predators, and reproducing. Therefore, cultivating them in the laboratory for research has proven extremely difficult and complex. Most of the microorganisms out there have not yet been found, and most of the knowledge that we possess about microorganisms has been based on organisms raised in pure culture.

However, there are some new methods that modern-day scientists use to identify and assess microorganisms that cannot be cultured in the laboratory. These methods enable scientists to expand the range of microorganisms beyond the ones that we can cultivate in pure culture.

One of these methods is called metagenomics, met meaning “beyond” and genomics meaning “the study of genomes”. In this process, instead of isolating and growing the individual species that are found in a sample, which is often not even possible with most species, scientists analyze all the DNA found in a sample. They study the genetic material, which is directly recovered from an environmental sample, such as seawater, soil, feces, etc. They do this by first collecting an environmental sample, subsequently extracting all the genomes of every organism found in the sample. After sequencing the DNA, we are left with millions of short DNA reads. This is where Bioinformatics comes into play. Scientists are able to analyze them by using various software to firstly identify the different organisms through their taxonomy, and secondly, to predict their biological function through their genes.



Bacteria

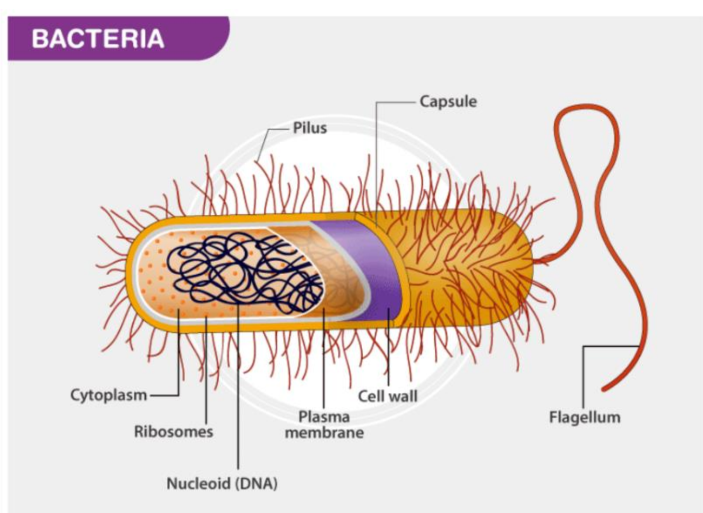
Definition

Bacteria are always unicellular organisms; seeing as they are prokaryotes, they have no membrane-bound nucleus or any other internal structures. Some can cause diseases; however, most are harmless and can be beneficial to other organisms, such as bacteria found in the human gut, which assist with digestion.

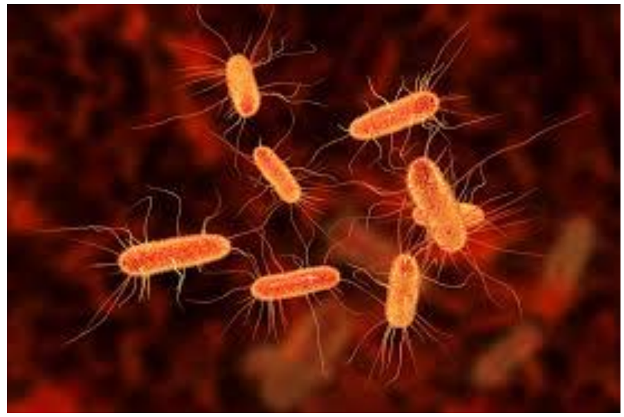
An important distinction between Archaea and Bacteria is their separate evolutionary lineages. Even though they are classified together as prokaryotes, archaea are thought to have a closer lineage to eukaryotes than to bacteria, considering that many scientists believe that archaea are the ancestors of eukaryotes. On a taxonomic level, we distinguish bacteria from archaea based on the lipid composition of their cell membranes and the characteristics of their cell walls.

Structure

Seeing as they do not have any internal structures, the plasma membrane performs the functions that, in eukaryotic cells, are carried out by specialized organelles. They have a cell wall, similar to that of plants and fungi cells; however, bacterial cell walls are made of peptidoglycan, molecules composed of sugars and amino acids, which act as a layer of protection. In addition, it helps maintain the cell's shape and prevents dehydration. It also gives the cell its characteristic shape, which varies drastically between species and phyla; these can be either rod-shaped, coccus, or spiral. Many also have a capsule, which can be viewed as a layer of slime outside the cell's cell wall; it's mainly composed of polysaccharides and polypeptides. It allows the cell to attach itself to surfaces in its environment and acts as a protection against immune cells. Some bacterial species are capable of locomotion through flagella, and some are able to attach themselves to surfaces with their pili.



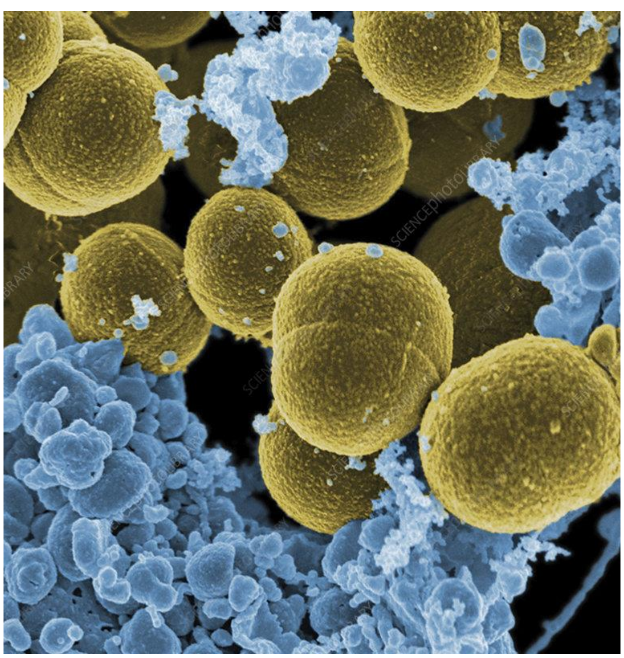
Comparison of Coli bacteria and Staphylococcus



Coli bacteria and Staphylococcus are two different major genera of bacteria that vary in shape, structure, and the manner in which they group together. When it comes to morphology, Coli bacteria are rod-shaped, in contrast to Staphylococcus, which are small and round, known as cocci. Coli typically appear as single rods or in pairs. On the other hand, Staphylococcus tends to cluster in groups resembling bunches of grapes.

Most Coli bacteria are capable of locomotion through flagella and have pili or fimbriae, which are hair-like structures that they use to stick to surfaces or host cells. Whereas Staphylococcus generally are nonmotile, there are some exceptions, however, they are rare.

Both Coli and Staphylococcus may possess a capsule, which is a protective outer layer that can help them evade a host's immune system. However, the presence and structure of the capsule can vary among species and strains. Neither genus forms spores, meaning they do not produce the tough, dormant structures that some other bacteria use to survive extreme conditions.



Archaea

Archaea are the oldest known living organisms on Earth and are thought to have been the first living organisms. They are extremophiles, meaning they are known for being able to survive in extreme conditions and are thought to prefer them. Such conditions include deep-sea vents, saline waters, hot springs, and even below petroleum deposits. Most archaea species are anaerobic, which means they live in low-oxygen environments. We are unsure of what most archaea species need to survive, and some of their living conditions are so extreme; it makes it impossible for them to be cultured in laboratories. Meaning we have to use culture-independent techniques to identify them.

Archaea vs Bacteria vs Eukaryotes

They share characteristics with both bacteria and eukaryotes; they have no nucleus and no membrane-bound organelles like bacteria. Also, like bacteria, they have a single circular chromosome of DNA. However, they share some genes, metabolic pathways, ribosomal proteins, and enzymes that are also observed in eukaryotes. Even though they are classified together with bacteria, most of them share more characteristics in structure with eukaryotes, which is why they believe archaea to be their ancestors.

Archaea cell membrane

These organisms also possess unique features. One such feature is their cell membranes. In archaea, the fats (known as lipids) in the membrane are connected to a molecule called glycerol by a special type of chemical link known as an ether bond. On the other hand, bacteria and eukaryotes have a different type of link, called an ester bond. This slight variation enhances the stability of archaea cell membranes, particularly in extreme conditions such as high heat or acidity.

Archaea cell walls

There are various types of cell walls in archaea, but all bacteria possess peptidoglycan. Therefore, the absence or presence of peptidoglycan is a distinguishing feature between archaea and bacteria.

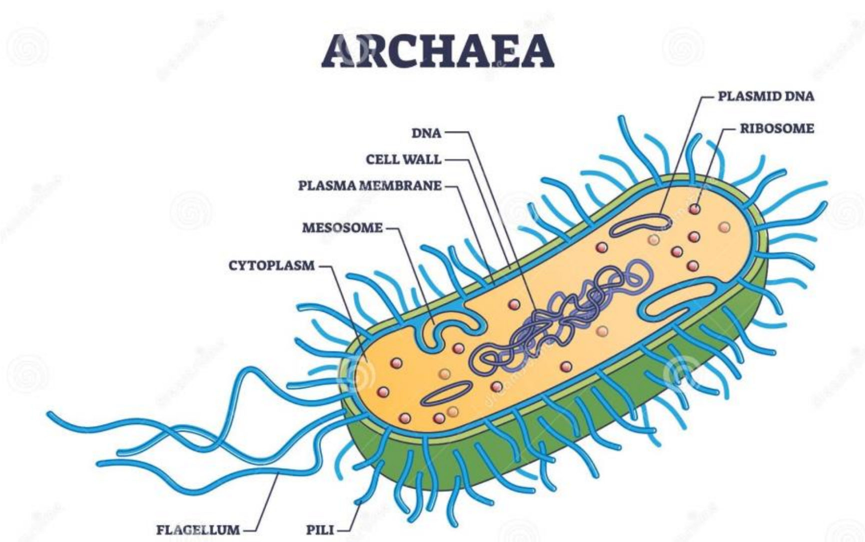
Archaea reproduction

Due to the harsh environment that they inhabit, archaea must reproduce asexually; they either do this by budding, fission, or fragmentation. Binary fission is the process where the archaeal cell copies its DNA, to then split itself into two equal cells. It's a method of cloning because both cells are identical. In budding, a small new cell begins to grow out from the side of the parent cell. Over time, this new cell enlarges until it is ready to separate. Once it fully develops, it breaks off and becomes an independent cell. During fragmentation, the organism breaks off some of itself and forms a new cell, which produces genetically identical organisms.

Nourishment

Seeing that most archaea live in extreme environments, therefore, most archaea are chemotrophs, meaning that they derive their energy and nutrients by breaking down molecules found in their environment. The majority of this group of archaea are chemoautotrophs, meaning they derive their energy from inorganic chemicals, such as hydrogen, sulfur, etc. A few of them are phototrophs, which means they obtain their energy from sunlight; however, not in the same way as plants do, for they cannot perform photosynthesis. Instead, they use a sort of light-powered proton pump, which is a pigment called bacteriorhodopsin. Because of this, they are not considered photoautotrophs, like plants or cyanobacteria, but rather photoheterotrophs. Even if rare, some archaea organisms acquire their energy from carbon, these are autotrophs and heterotrophs. Archaea autotrophs can fix carbon dioxide to produce their own organic compounds, similar to plants. Archaea heterotrophs obtain carbon by consuming organic compounds made by other organisms.

Unlike bacteria, there are no parasitic archaea that we know of. Some archaea species do live in or on other organisms; however, they have mutualistic relationships with their host, which means both organisms benefit from each other, for example, by assisting with digestion.



Plasma membrane

The primary function of the plasma membrane, also called the cell membrane, is to separate the interior of the cell from its outside environment. Other than that, it regulates the transport of materials entering and exiting the cell, such as nutrients or expelling toxins. The cell membrane is lined with proteins, which are crucial for cell communication. Furthermore, it is vital for the cells' structure, as it enables the cell to hold its shape.

Protoplasm

When one uses the term protoplasm, one refers to everything that resides inside the cell membrane. Cytoplasm refers to all the contents inside the cell membrane, excluding the nucleus.

Cytoplasm

Cytoplasm is the semifluid substance situated externally of the nuclear membrane and inside the cell membrane. It is sometimes referred to as the non-nuclear part of the protoplasm. The main component of the cytoplasm is the cytosol, it is the semi-fluid that fills the inside of the cell, which is comprised of water, ions, and macromolecules. In eukaryotes, the cytoplasm contains all the organelles. In prokaryotes, seeing as they lack a nucleus, cytoplasm refers to everything found inside the cell membrane.

Cytoskeleton

The cytoskeleton is a system composed of filaments or fibers. It is found in the cytoplasm of eukaryotic cells. The fundamental roles of the cytoskeleton are organizing the other components of the cell, maintaining the cell's shape, and being responsible for the cell's locomotion (the movement of the cell) and the movement of the various cell organelles. The cytoskeleton's filaments are so small that we were oblivious to their existence until the invention of the electron microscope.

Genetic material

DNA

DNA is a string of molecules; it consists of two strands that are wound into a double helix. These molecules are called nucleotides. It holds genetic information. It's the text of a book, like the text that holds the information of the story; in the case of DNA, it holds the genetic instructions for life. Nucleotides are the building blocks of DNA. There are four different types: adenine (A), thymine (T), cytosine (C), and guanine (G).

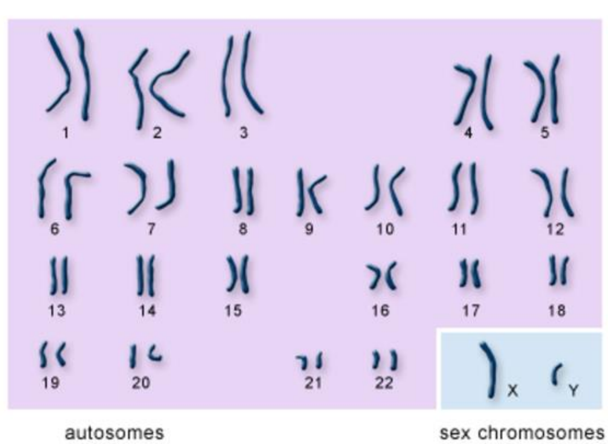
In eukaryotic cells, it is contained in a nucleus. Prokaryotic cells do possess DNA; they simply do not contain it in a nucleus, for they do not have one.

Genes

A gene is a segment of DNA, a sort of paragraph of the set of instructions that make you. They contain the instructions for making specific proteins or RNA molecules. You inherit your genes from your parents, they dictate how you are supposed to look, if you have any genetic illnesses, and so on.

Chromosomes

Seeing as DNA is rather fragile, it is of the utmost importance that they are carefully packaged and protected during the cell's division process. Therefore, they are looped and coiled into a structure called a chromosome to strengthen them. If a gene is a specific paragraph, then the chromosome is a chapter. We have 46 chromosomes in total, 23 pairs. 23 from our father and 23 from our mother. 22 of these pairs are called autosomes, they look the same in both females and males. The last pair, pair 23, is known as the sex chromosome; it differs between males and females. Females have two X chromosomes, while males have one X and one Y chromosome.

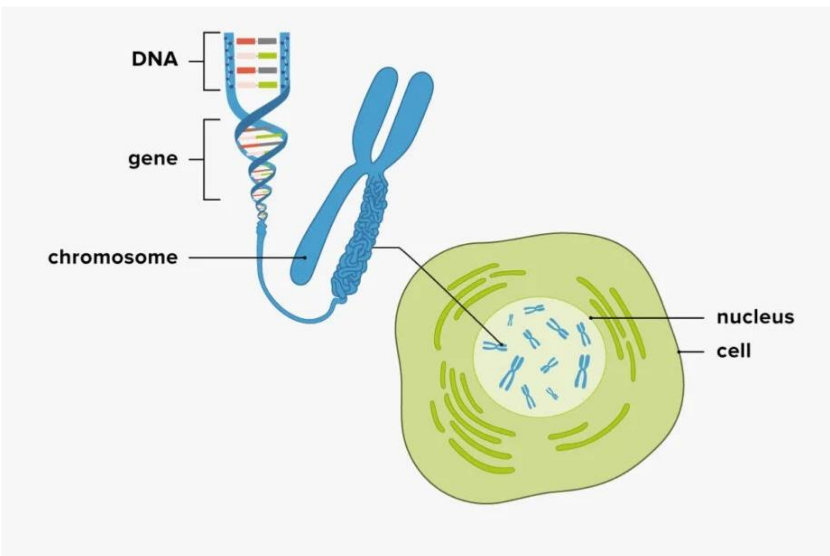


U.S. National Library of Medicine

Genomes

A genome is an organism's complete set of genetic material. If the DNA code is a text of instructions that's carefully organized into paragraphs (genes) and chapters (chromosomes), then the entire book from start to finish would be the genome. Almost every human's genome, chromosomes, and genes are organized in the same way. It's DNA, the words of the story, that makes us all slightly different (mainly in looks).

In humans, the cell genome (all the genetic material found in a cell) is made up of 23 pairs of chromosomes, in total 46, and each chromosome contains thousands of genes. For other organisms, such as bacteria, the genome is usually a single circular DNA molecule, but the same basic principles apply.



Cell communication

Cell communication is highly important between complex multicellular organisms. It enables cells to work with one another; they do so through chemical signaling. This communication can take place over short distances, for example between neurons, or over long distances, such as hormonal signaling in the endocrine system.

There are four different kinds of cell communication: these are either between two different cells or a single cell signaling itself. The way that this operates, the signaling cell will send out a signal molecule (sort of message one could say), called a ligand (ligand comes from the Latin word "ligare," meaning to bind), to the responding cell. The latter will receive this ligand with a receptor, there are receptors which are a part of the cell membrane, however, there are also intercellular receptors which are found in the cytoplasm. Receptors are molecules where a ligand can bind and later be brought into the cell.

1. Juxtacrine signaling

Juxtacrine signaling happens when two cells are bound to each other by a gap junction. The signaling cell sends the ligand through the gap junction to the other cell.

2. Paracrine signaling

Paracrine signaling affects solely the cells in the signaling cell's proximity; cells communicate over relatively short distances and are not attached to one another. An example of paracrine signaling is the communication between neurons.

3. Endocrine signaling

Endocrine signaling is used when two cells need to communicate over a long distance. To make this possible, the ligands are carried to their intended cell through the circulatory system.

4. Autocrine signaling

The last form of cell communication is simply the cell signaling or informing itself to do a specific task.

Conclusion

In conclusion, I have found this topic extremely interesting, and it has aided me in excluding some branches of biology that I would not wish to study. Through my research on microorganisms, I found that studying them in a laboratory is not for me. As I was researching and learning more about the studies conducted on cells, I realized how uncertain we are about the classification, origins, and relationships of cells. The more I wrote on this subject, the more I came to realize that we will and never can be sure if what we observe and theorize in the natural world is true. Unlike in physics and chemistry, where consistent laws allow for high predictability, I have found that biology, with its many variables and exceptions, often defies such expectations. Take the assumption that only eukaryotes (plants and algae) are capable of photosynthesis, for instance, which has been proven wrong due to the exceptions of some bacterial species (for example, cyanobacteria). These variables and many exceptions are, however, what make biology so interesting for me; they leave open the possibility of new discoveries.

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