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Objectives of This Lesson

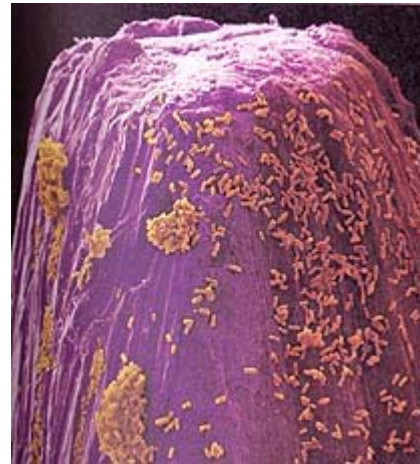
After completing this lesson, you will be able to:

- Recognize the general biology of a cell.
- Differentiate between prokaryotes and eukaryotes.
- List and classify the five main microorganism groups that are of concern to Public Health.
- Recall that the more complex or human-like a disease-causing microorganism is, the more difficult it becomes to treat.
- Describe how a virus differs from other microorganisms.

The Cell: The Basic Unit of Life

The cell is the basic unit of life - the smallest structure capable of basic life processes, such as taking in nutrients, getting rid of waste, and reproducing. All living things are made of cells. Some microscopic organisms, such as bacteria and protozoa, are unicellular, meaning they consist of a single cell. Animals, larger plants and many fungi are multicellular - composed of a great many cells working together. Cells carry out thousands of biochemical reactions each minute and reproduce new cells that continue life. Cells vary considerably in size. About 10,000 average-sized human cells can fit on the head of a pin.

Despite their individuality, cells display a remarkable ability to physically join or associate, communicate, and coordinate with other cells.



The above photograph demonstrates the size of bacterial cells in relation to a pinpoint.

Cell Components

Cells are made up of molecules - nonliving structures formed by the joining of atoms. Small molecules serve as building blocks for larger molecules.

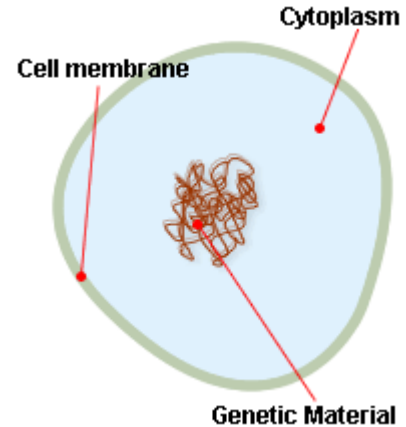
The four major molecules that underlie cell structure and participate in cell functions are:

- **Proteins**
.....
- **Nucleic acids**
 - **DNA** - contains the hereditary information for cells.
 - **RNA** - works with DNA to build the thousands of proteins the cell needs.
- **Carbohydrates**
.....
- **Lipids** (include fats and oils)
.....

The Basic Cell

All cells have at least three things in common:

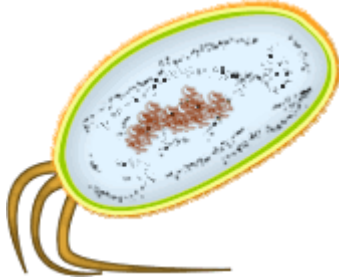
- **Cell membrane**
 - All cells have a phospholipid-based cell membrane. The cell membrane is selectively permeable in that it allows some materials to pass into or out of the cell but not others.
- **Cytoplasm**
 - Cells are filled with a complex collection of substances in a water-based solution. This substance is called cytoplasm. Cytoplasm in all cells has a number of common features. For example all cells have ribosomes. The first steps in cellular respiration take place in the cytoplasm.
- **Genetic Material**
 - Nucleic Acids (DNA)



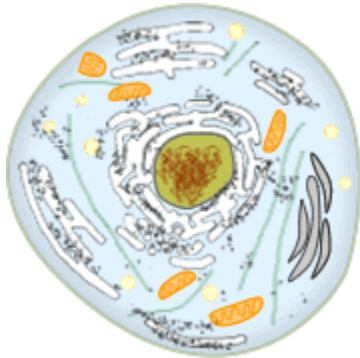
Prokaryotes and Eukaryotes

There are two general classes of cells, both of which clearly affect human health and are essential for maintaining life as we know it:

- **Prokaryotes**
 - Simple, smaller organisms. They are found only in single-celled and colonial organisms.



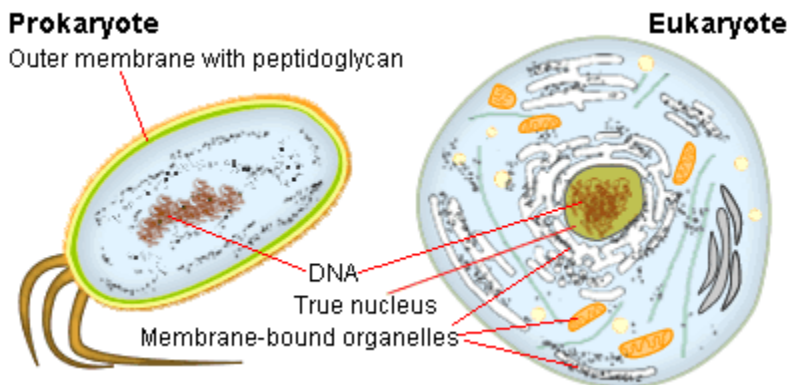
- **Eukaryotes**
 - Complex and larger organisms. They have organelles with their own membranes. Eukaryotic organisms can be either single-cellular or multicellular.



Prokaryotes and Eukaryotes: Key Differences

The most important difference between prokaryotes and eukaryotes is that eukaryotes have:

- **A true nucleus**
 - Prokaryotes *do not have* a true nucleus. DNA floats freely in the cytoplasm.
 - Eukaryotes *have* a true nucleus. DNA is held within a membrane-bound nucleus.
- **Membrane-bound organelles**
 - Prokaryotes do not have organelles.
 - Eukaryotes have organelles. These organelles are highly specialized structures which allow them to exhibit more sophisticated intracellular division of labor than is possible in prokaryotic cells: intracellular compartmentalization of energy, reproduction, and other cell functions.



Prokaryotes and Eukaryotes: Additional Differences

Additional differences between prokaryotes and eukaryotes include:

- **Size**
 - Eukaryotic cells are, on average, ten times the size of prokaryotic cells.
- **DNA composition and length**
 - The DNA of eukaryotes is much more complex and therefore much more extensive than the DNA of prokaryotes.
- **Cell Wall**
 - Prokaryotes have a cell wall composed of peptidoglycan, a single large polymer of amino acids and sugar. Many types of eukaryotic cells also have cell walls, but none made of peptidoglycan.

Prokaryotes and Eukaryotes: Sorting Exercise

The characteristics listed below describe either prokaryotic or eukaryotic cells. Use the arrow buttons to sort the characteristics under their proper heading. If a characteristic is sorted incorrectly, the system will encourage you to try again.

Prokaryote		Eukaryote
	« usually smaller »	
	« usually larger »	
	« more complex »	
	« more simple »	
	« exist in multi-cellular forms »	
	« either unicellular or colonial »	
	« lacks a true nucleus »	
	« has membrane bound nucleus »	
	« has organelles »	
	« lacks organelles »	
	« has a cell wall made of peptidoglycan »	

Pathogenic Microorganisms

Not all microorganisms are pathogenic or capable of causing diseases or infections. There are 5 microbial groups that are of concern to the public health worker:

- Bacteria
- Fungi
- Protozoa
- Helminths (Worms)
- Viruses

Pathogenic Microorganisms: Structural Classification

Below is a structural classification chart of the microbial groups:

Microorganism	Prokaryote	Eukaryote	Acellular
Bacteria	***		
Fungi		***	
Protozoa		***	
Helminths		***	
Virus			***

- Notice there is only one prokaryote: bacteria
- Notice that a virus is **not** a cell

Complexity of Pathogenic Microorganisms

The more complex or human-like the microorganism is, the more difficult it is to treat. Prokaryotes are simpler organisms compared to eukaryotes, and they are less "human-like". A disease caused by bacteria (a prokaryote) is usually easier to treat than a disease caused by a fungus (a eukaryote.) The medicines used for bacterial infections are generally less toxic to eukaryotic cells.

In the chart below, a plus (+) means that the characteristic is present in the microorganism, a minus (-) means the characteristic is missing, and both a plus and a minus (+/-) means the characteristic is sometimes present while at other times absent.

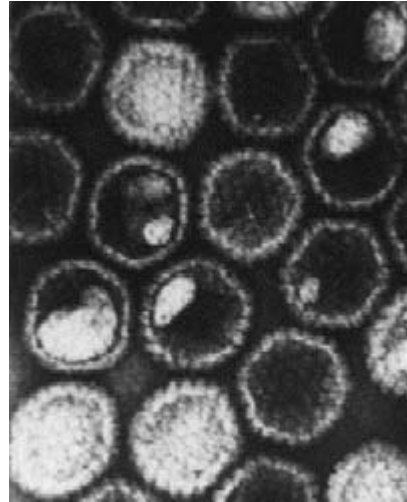
Cell Complexity and Organization

Function or Structure	Characteristic	Prokaryotic Cells	Eukaryotic Cells	Viruses
<i>Genetics</i>	Nucleic Acids	+	+	+
	Chromosomes	+	+	-
	True Nucleus	-	+	-
	Nuclear Envelope	-	+	-
<i>Reproduction</i>	Mitosis	-	+	-
	Production of Sex Cells	+/-	+	-
	Binary Fission	-	+	-
<i>Biosynthesis</i>	Independent	+	+	-
	Golgi Apparatus	-	+	-
	Endoplasmic Reticulum	-	+	-
	Ribosomes	+ (unique structure)	+	-
<i>Respiration</i>	Enzymes	+	+	-
	Mitochondria	-	+	-
<i>Photosynthesis</i>	Pigments	+/-	+/-	-
	Chloroplasts	-	+/-	-
<i>Motility/Locomotor Structures</i>	Flagella	+/-	+/-	-
	Cilia	-	+/-	-
	Cell Wall	+	+/-	-
<i>Shape/Protection</i>	Capsule	+/-	+/-	-
	Spores	+/-	+/-	-
<i>Size (general)</i>	>>>>>	0.5 - 3.0 microns	2 - 100 microns	<<0.2 microns

Virus: The Ultimate Parasite

Note that viruses are unique among the five microorganisms:

- **They are acellular (not a cell)**
 - Viruses are unique among microorganisms in that they consist solely of nucleic acids and proteins and are not technically viable living organisms. A virus is **not** a cell, which is why it cannot be classified as either prokaryote or eukaryote.
- **They require a host cell**
 - The key difference between a virus and a cellular microorganism is that a virus requires a host cell in which to grow and replicate.
- **They are thought of as the "ultimate parasite"**
 - There is a virus for virtually all living organisms, or all cells, including other microorganisms. Since these viruses invade and "hijack" their host's internal cell machinery and become the "master" of their host, they can be thought of as "the ultimate parasite."



Herpesvirus

Question 1 of 6

Prokaryotes have simpler cellular structures than eukaryotes.

- A. True
- B. False

Submit Answer

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Question 2 of 6

Prokaryotes and eukaryotes do not share any features of their respective cell machinery:

- A. True
- B. False

Submit Answer

Question 3 of 6

The main feature of eukaryotes is a membrane-bound nucleus.

- A. True
- B. False

Submit Answer

Question 4 of 6

Intracellular compartmentalization of energy, reproduction and other cell functions are characteristics of prokaryotes.

- A. True
- B. False

Submit Answer

Question 5 of 6

In general, the closer an infectious agent's physiology is to ours, the more difficult it is to treat.

- A. True
- B. False

Submit Answer

Question 6 of 6

Viruses are considered:

- A. Prokaryotic
- B. Eukaryotic
- C. None of the above

Submit Answer