Cell(s), building block(s) of life

levels of organization in the living world

Scale	Level of organization	Definition	Example
	Species	a group of individuals capable of reproducing with each other and giving birth to offspring that are themselves fertile	*Arabidopsis thaliana*
	Population	a group of individuals belonging to the same species, occupying the same geographical territory and perpetuating themselves there	Mongolian wild camels
m	Organism	single- or multi-cellular system that performs all the functions of living organisms	A houbara
cm 10^{-2} m	System	set of organs contributing to the same biological function	Respiratory system
	Organ (n.m.)		Stomac
mm 10^{-3} m	Tissu	a group of specialized cells performing the same function and linked together via their extracellular matrix	Epithelium
µm 10^{-6} m	Cell	smallest structural and functional unit with living characteristics	Neuron
	Organelle	compartment found in eukaryotic cells, delimited by one or more membranes and specialized in 1 or more specific function(s) in the life of the cell	Mitochondria
nm 10^{-9} m	Molecule	assembly of atoms bonded together	Glucose
	Atom	smallest structural and functional unit of matter	Carbon

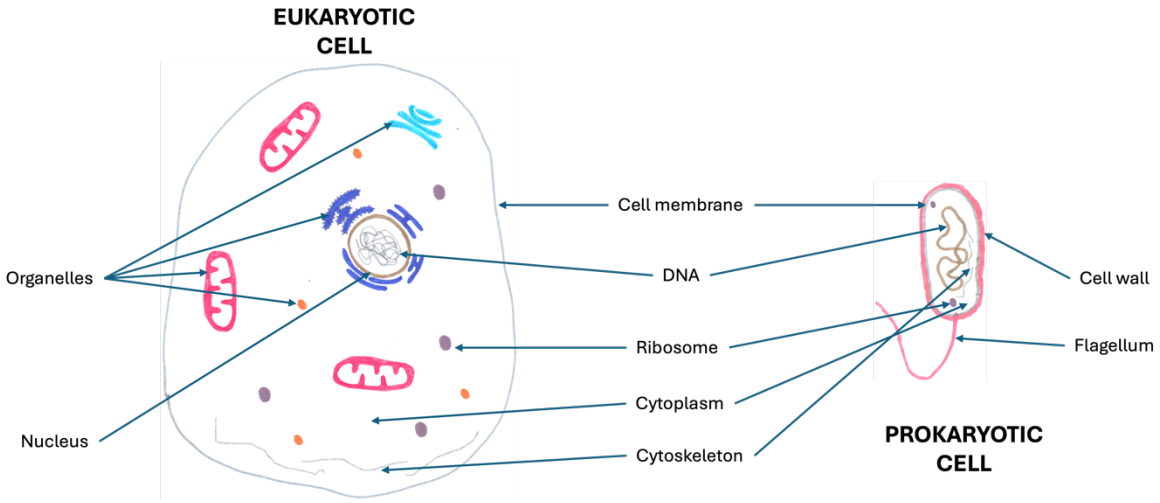
Unicellular vs. multi-cellular

Unicellular organisms (e.g. yeast, bacteria) are made up of a single cell, which performs all the organism's functions (feeding, movement, reproduction, etc.).

In multi-cellular organisms (= composed of several cells), the various functions of the organism are distributed between its different cells: their cells specialized in the same function join together (thanks to their extracellular matrix) to form a tissue.

Prokaryotic cells or eukaryotic cells

A cell consists of a space separated from their environment by a membrane. The inner space of the cell is the cytoplasm, and contains a liquid called cytosol.



Note: All cells have DNA.
In a eukaryotic cell, each molecule of DNA is associated to a protein, forming a chromosome.
All chromosomes are in the nucleus, protected by the nuclear membrane.
In a prokaryotic cell, naked DNA forms a loop.

Most unicellular organisms are prokaryotic cells (e.g. bacteria). This single cell performs all the organism's functions (feeding, movement, reproduction, etc.) at once.

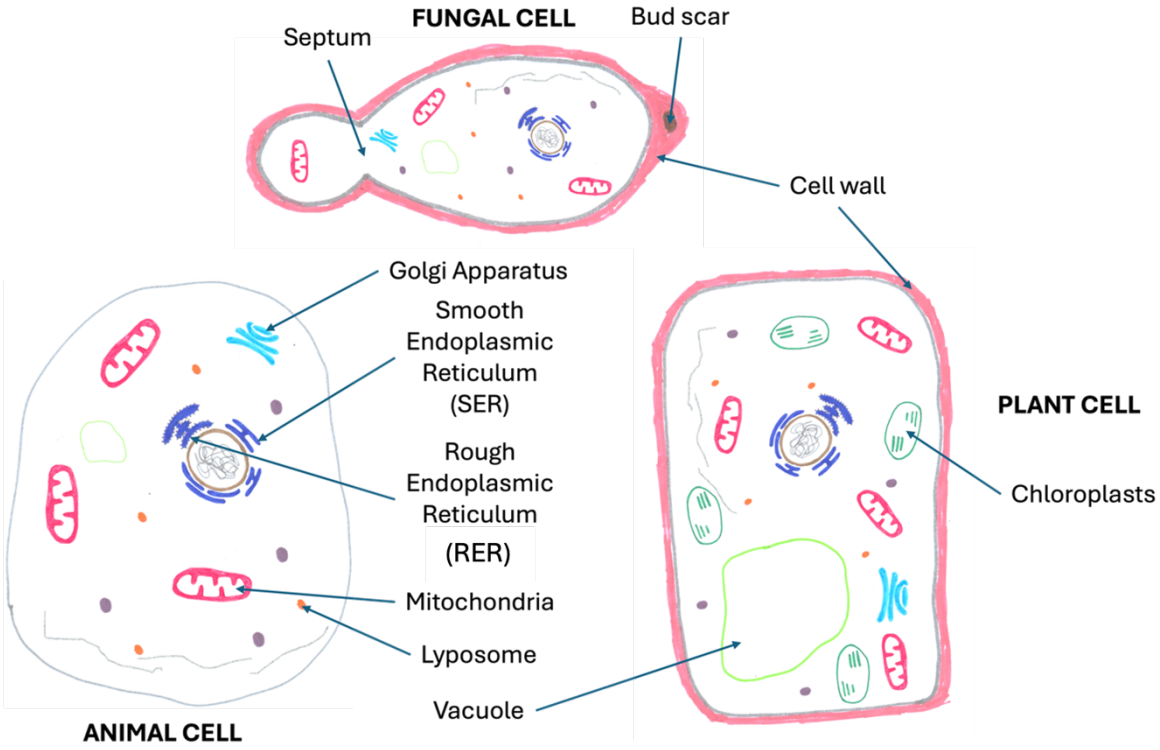
Unlike prokaryotic cells, eukaryotic cells are compartmentalized, i.e. contain organelles, each organelle having a specific role.

One exception, however: both types of cells contain ribosomes, who are organelles producing proteins. However, the ribosomes of prokaryotic cells (70S) and eukaryotic cells(80S) have some differences:

	Prokaryotic cells	Eukaryotic cells
Type	70S ribosomes *Note: They can also be found in mitochondria of eukaryotic cells*	80S ribosomes
Size	20 – 30 nm long 17 – 21 nm large	30 – 35 nm long, 20 – 24 nm large
Weight *Note: 1 Da = 1.66x10-27 kg*	2.7 – 3.0 MDa	4.0 – 4.5 MDa
Synthesis	Synthesized in the cytoplasm	Synthesized in the nucleolus Note: the nucleolus is a part of the nucleus
Effect of antibiotics	Protein synthesis is inhibited by antibiotics	No inhibition

Diversity and organization of eukaryotic cells

There are 3 main classes of eukaryotic organisms: fungi, plants (both chlorophyllous and non-chlorophyllous) and animals.



Key differences in plants, animals and fungi

Characteristics	Plant	Fungi	Animal
Multicellular	X	X	X
Cell walls	X	X	
Chloroplasts	X		
Mobility			X
Organelles and Nucleus	X	X	X
Method of nutrient retrieval	Photosynthesis	Absorption	Ingestion

Role of the different structures in a cell

Name of the structure or the organelle	Prokaryotic cell	Eukaryotic cell			Definition
		Fungi	Plant	Animal	
Plasmic membrane	X	X	X	X	Cell perimeter, separating the intracellular space from the extracellular environment.
Cytoplasm	X	X	X	X	Cell contents, including all cytosol (liquid) and organelles
Genetic material (n.m.)	X	X	X	X	DNA is the universal genetic material
Cell wall	X	X	X		Extracellular molecules (e.g. cellulose + pectin in plants) produced by the cell itself, enabling cells to adhere to each other to form tissues. Called the plant wall for plant cells where it is thick and rigid, and responsible for their geometric shape and rigidity.
Nucleus		X	X	X	Organelle containing the genetic material
Mitochondria		X	X	X	Organelle bounded by a double membrane and responsible for energy production through cellular respiration
Rough Endoplasmic Reticulum (RER) or Smooth Endoplasmic Reticulum (SER)		X	X	X	Delimited organelle responsible for synthesizing proteins (RER) or lipids (SER)
Golgi apparatus		X	X	X	Organelle in the form of stacked “bags”, ensuring the maturation and distribution of proteins
Lysosome		X	X	X	Organelle specialized in the degradation of molecules
Vacuole		X	X	X	Organelle for storing water and cellular waste products
Chloroplast			X		Organelle that produces organic matter through photosynthesis
Cytoskeleton	X	X	X	X	Made up of microtubules, actin filaments, and intermediate filaments, these structures give the cell its shape and help organize the cell's parts. In addition, they provide a basis for movement and cell division
Ribosome	X	X	X	X	organelle made of both RNA and protein which is the site of protein synthesis in the cell