

Overview of Prokaryotic Cells and Eukaryotic Cells

By

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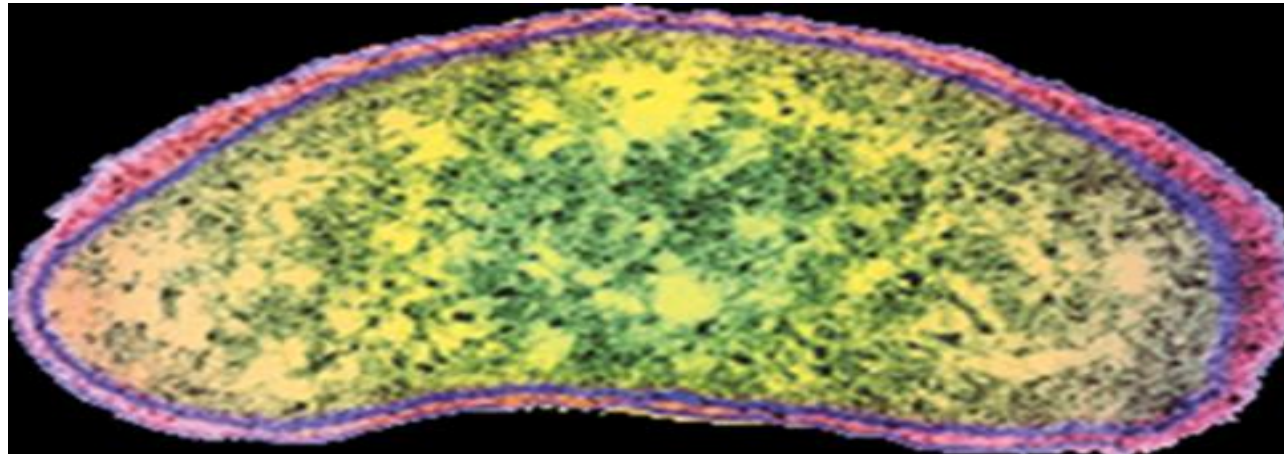
Lecture Objectives

By the end of this lecture, participants should be able to:

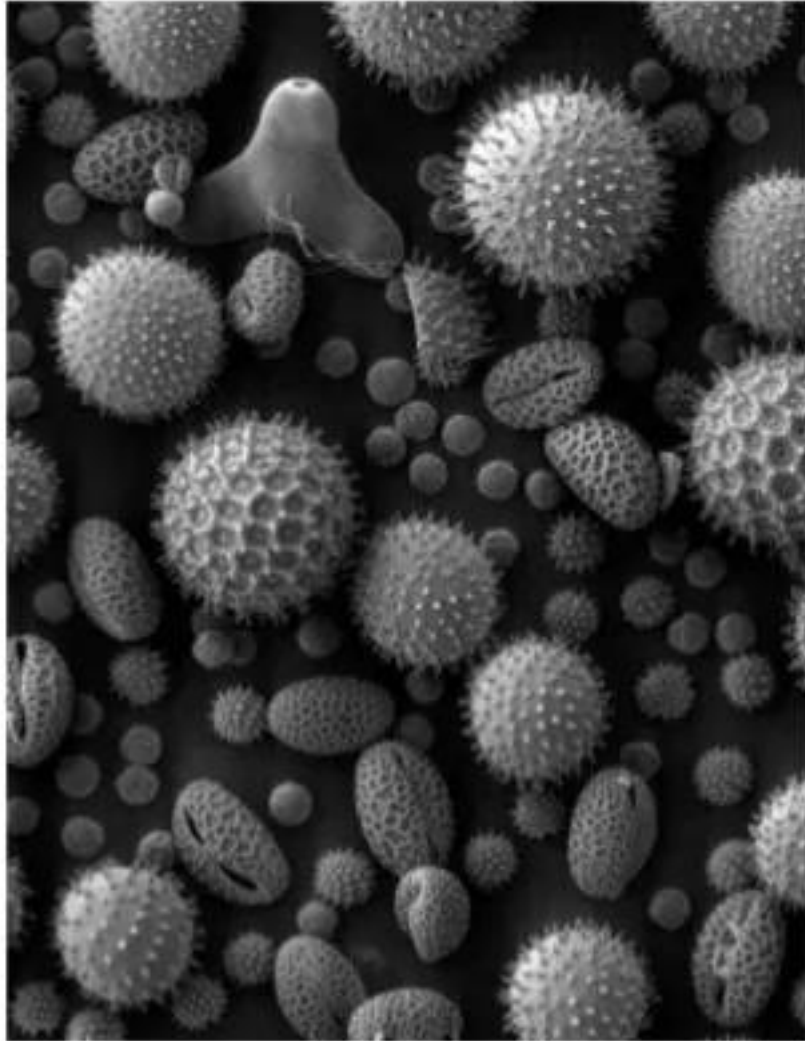
- Define prokaryotic and eukaryotic cells
- Differentiate between them based on structure and function
- Identify cell components
- Classify organisms as prokaryotic or eukaryotic

Introduction

- All organisms except Viruses are made of cells
- Cell is the most basic unit of life
- New cells are always made from existing cells.
- Made of a cell or plasma membrane and cytoplasm

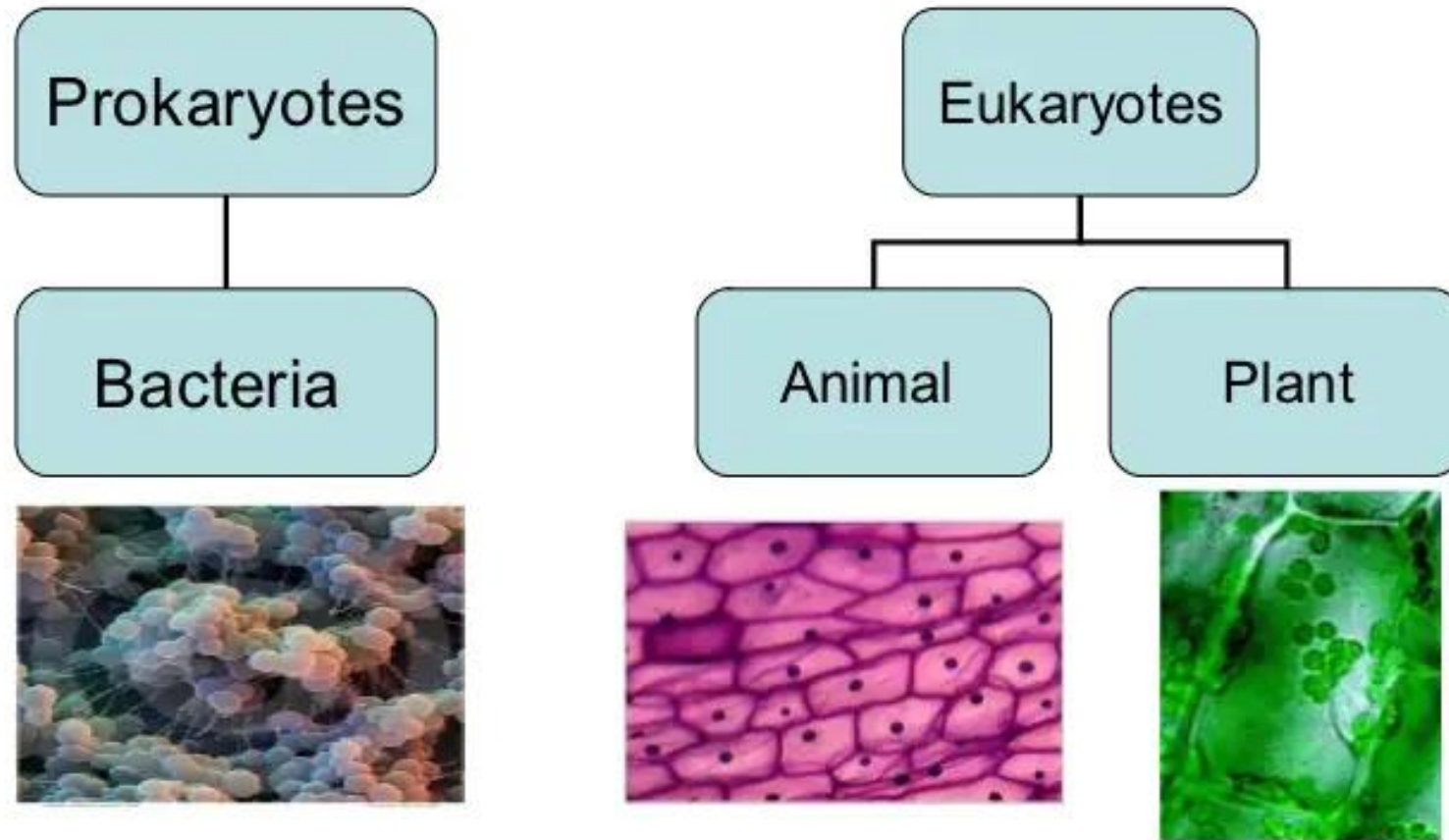


Cells come in all shapes and sizes!



- Most of the organisms you are familiar with are **multicellular-made up of many cells.**
- However, some organisms can be **unicellular-made up of only one cell.** Its entire body is just one super tiny cell!
- Only Two fundamental types of cells

*These are two distinct types of cells with
STRUCTURAL differences.*

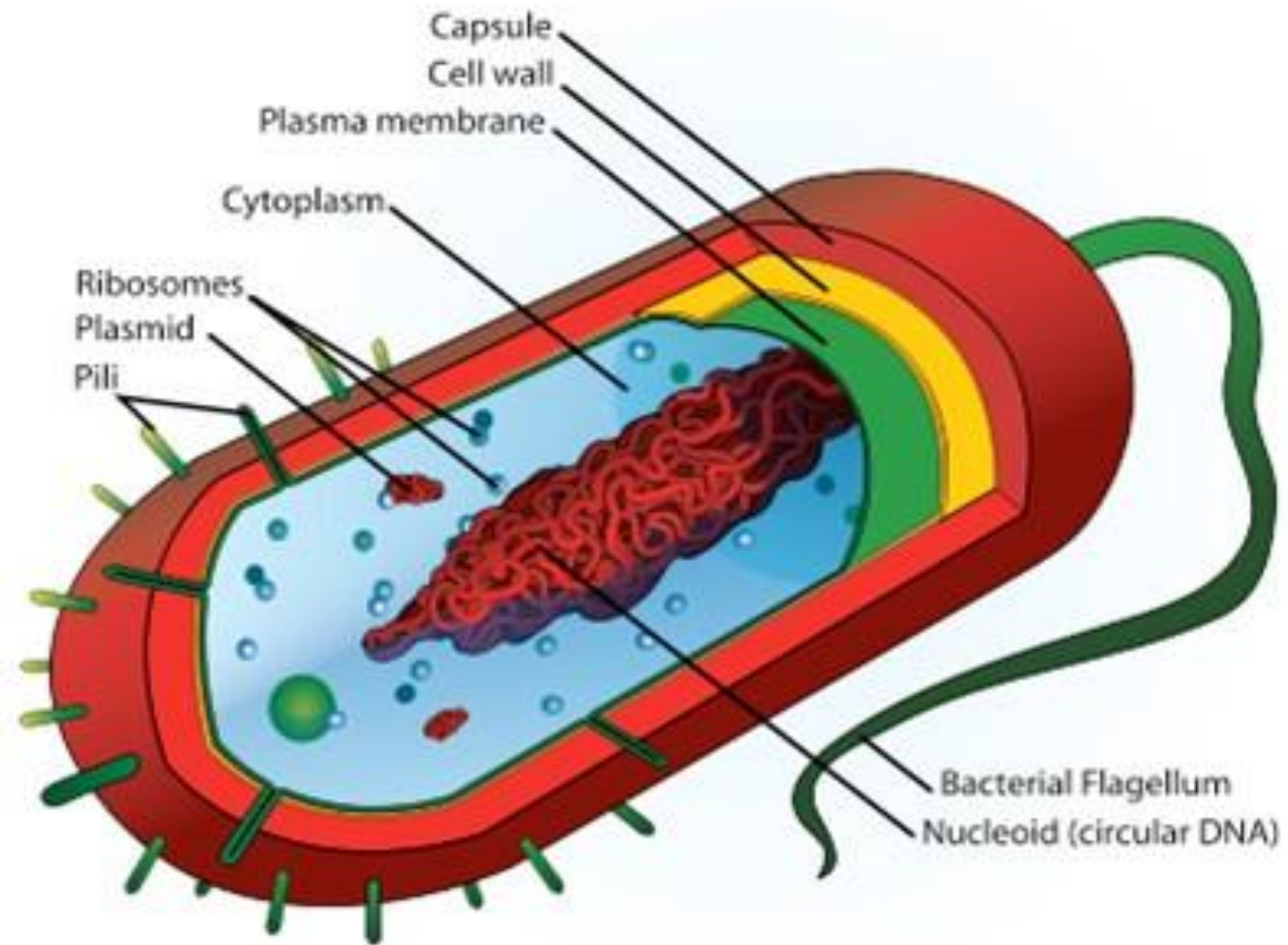


Fundamental Cell Types are:

1. Prokaryotic Cells which domains Bacteria e.g E- Coli.
2. Eukaryotic Cells- Animals, plants, protozoa, fungi

Prokaryotic Cell

- Pro ---before; karyon ---nut/nerve (nucleus)
- They are referred to as “primitive cells”
They lack membrane-bound organelles (no nucleus, no mitochondria, no vacuoles, etc.)
- Example: bacteria (i.e. E. Coli) – found in soil, water, on your skin, in your intestine



Components of Prokaryotes and Their Functions

- **Cell Wall:** Provides structural support, maintains cell shape, and protects the cell from external pressures.
- **Cell Membrane** (Plasma Membrane): Regulates the movement of substances in and out of the cel.
- **Cytoplasm:** The “inside” of the cell, it contains cytosol (fluid of the cell)
- **Nucleoid :** A part of the cytoplasm where genetic information is found.

- **Components of Prokaryotes and Their Functions Contd.**

- **Plasmids:** are extra-nucleoid DNA.
- **Ribosome:** They are smaller and has 70S ribosome.
- **Flagella (if present):** Long thread-like attachment use for movement.
- **Pili (if present):** Thread-like projection and more numerous than the flagella.
- **Capsule (if present):** Protects the cell from desiccation, phagocytosis, and other environmental stresses.
- **The prokaryotic cytoskeleton:** Plays a crucial role in cell division, shape determination, and other essential cellular processes.

- Prokaryotic cells divide **asexually by binary fission** (similar to mitosis).
- They duplicate their chromosome (their circular DNA) and then split in half (each new daughter cell gets half the cytoplasm and 1 chromosome, are similar to original parent cell) .
- Conjugation (with pili) allows genetic variation i.e. a new combination of DNA.

PROKARYOTES

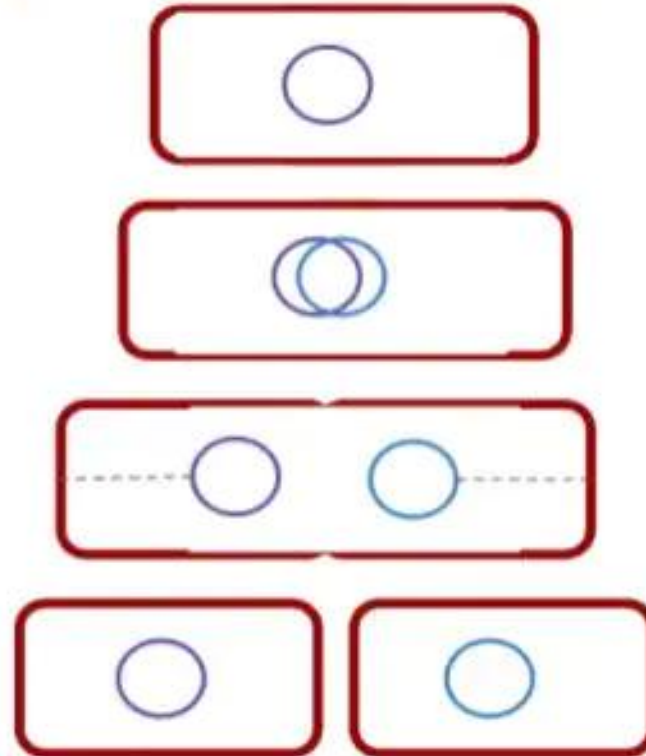
REPRODUCE

through binary fission

The closed-loop DNA of the bacterium makes copies through semi-conservative DNA replication.

New plasmids are pulled to opposing poles by the spindle fibres.

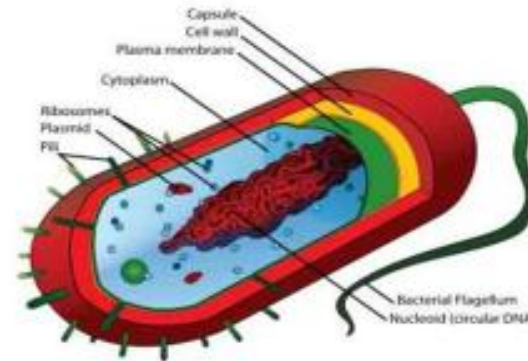
The bacterium divides in two.



Prokaryote Genetics

Nucleoid

- Region of cytoplasm where prokaryote's **genome (DNA)** is located.
- Usually a singular, circular chromosome.



Plasmid

The prokaryotic cytoskeleton: It is a network of protein filaments found in prokaryotic cells (bacteria and archaea).

- Small extra piece of chromosome/genetic material.
- 5 - 100 genes
- Not critical to everyday functions.
- Can provide a variety of functions to promote:
 - Antibiotic resistance
 - Virulence factors
(molecules produced by pathogen that specifically influence host's function to allow the pathogen to thrive)
 - Promote **conjugation**
(transfer of genetic material between bacteria through cell-to-cell contact)

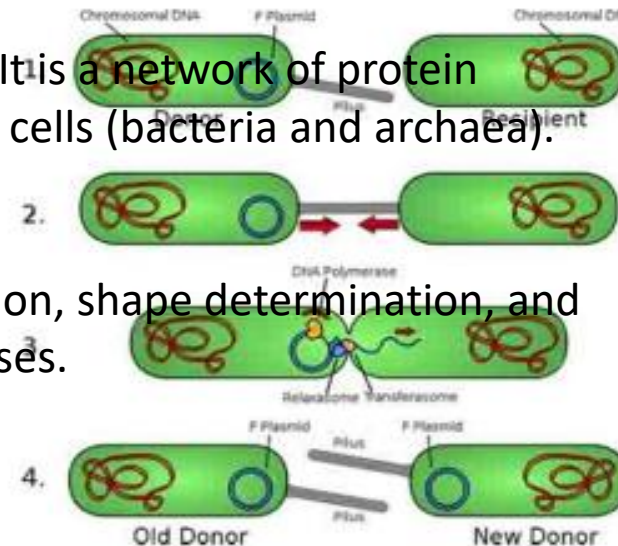
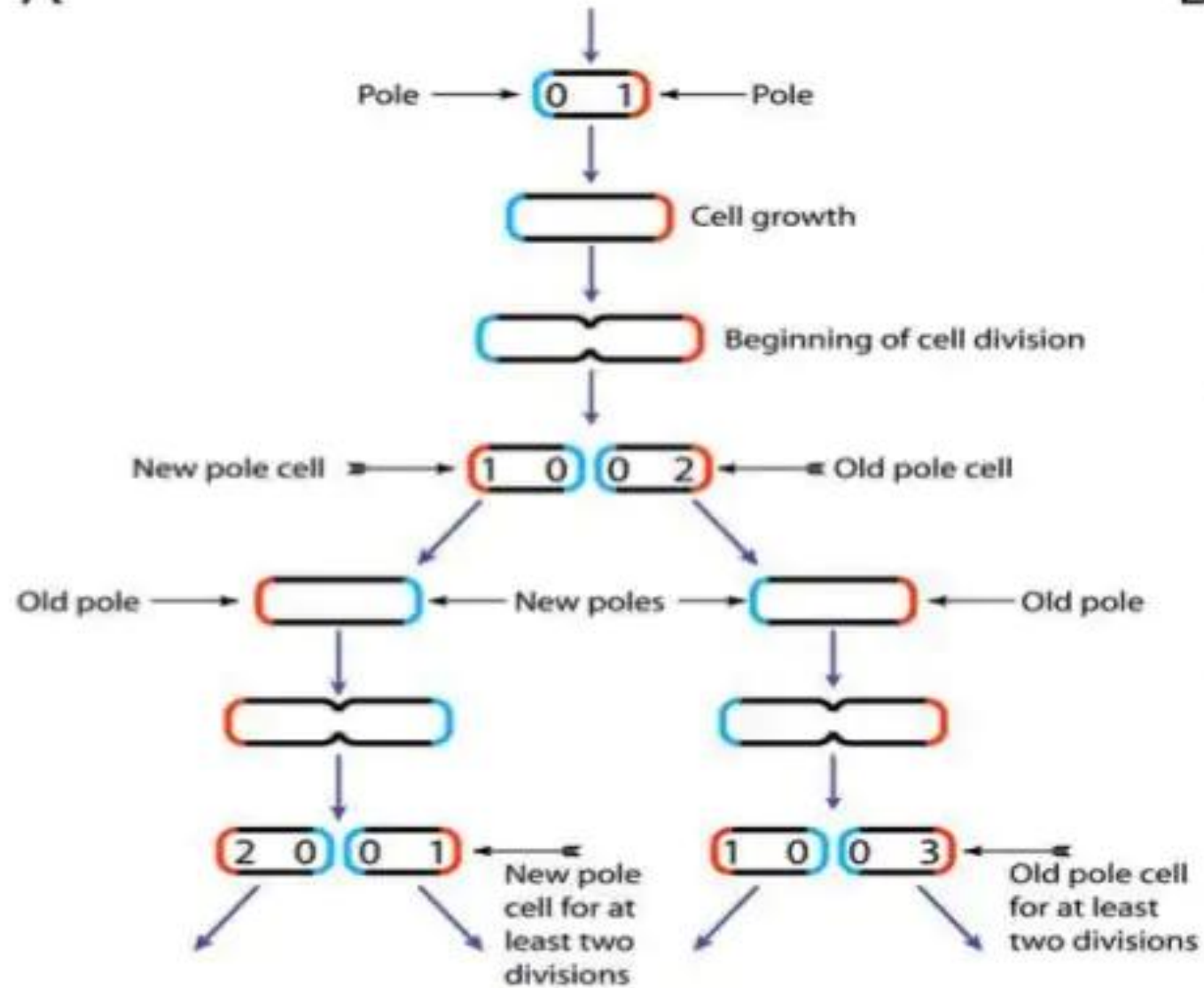


Image: [Prokaryotic Cell Diagram](#); M. Ruiz, [Bacterial conjugation](#), Adenosine

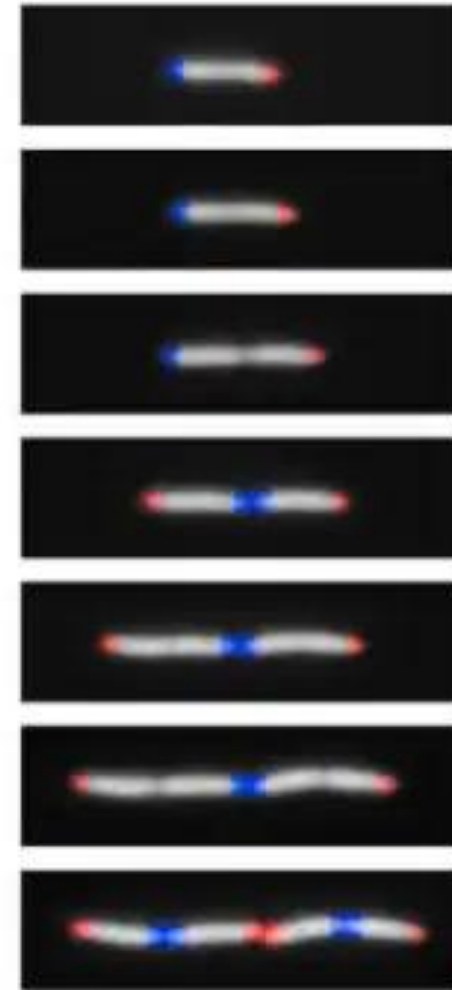
From the [Virtual Microbiology Classroom](#) on [ScienceProfOnline.com](#)

Prokaryotes divide by **binary fission**.

A



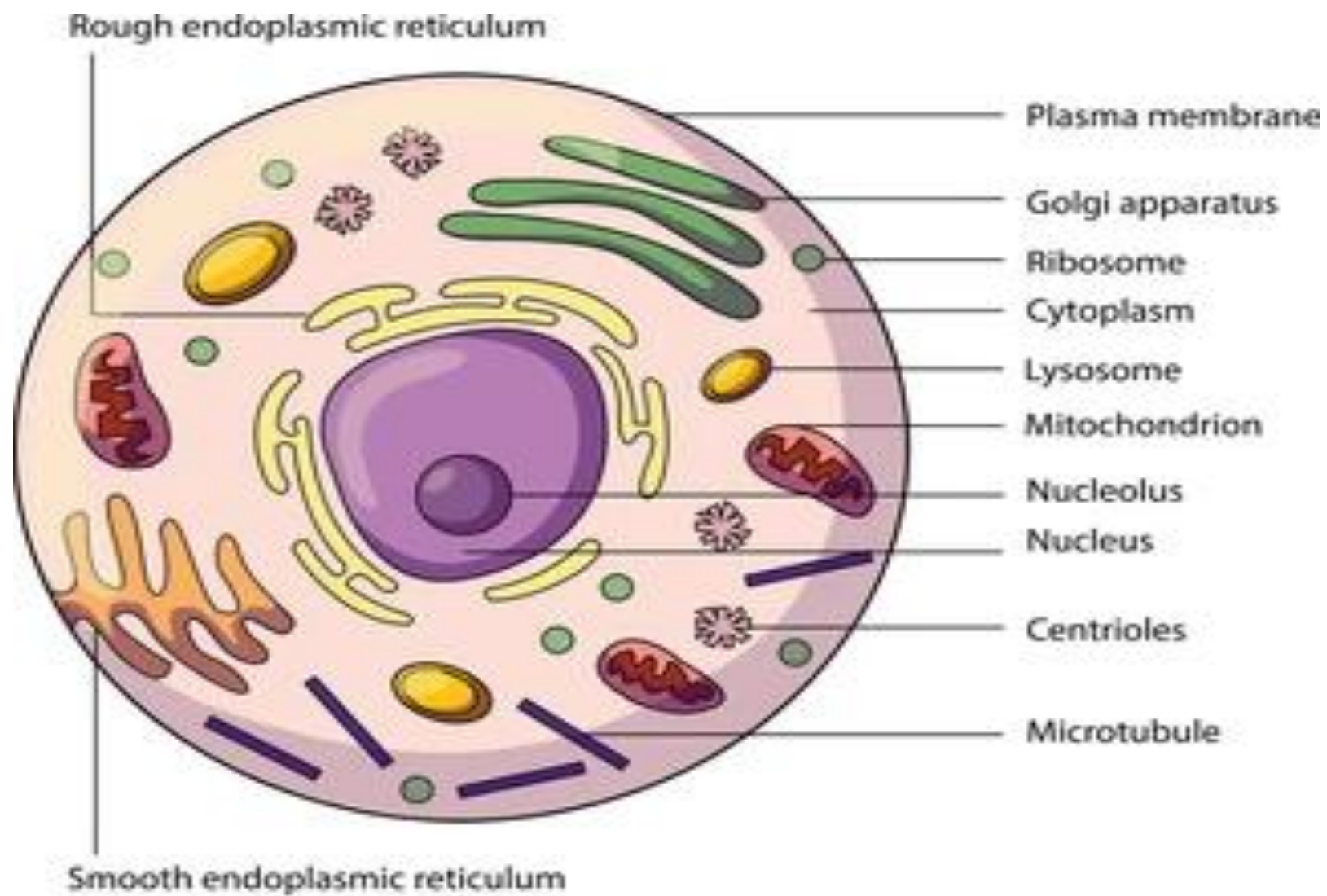
B



Life cycle of *E. coli* from: http://en.wikipedia.org/wiki/Escherichia_coli

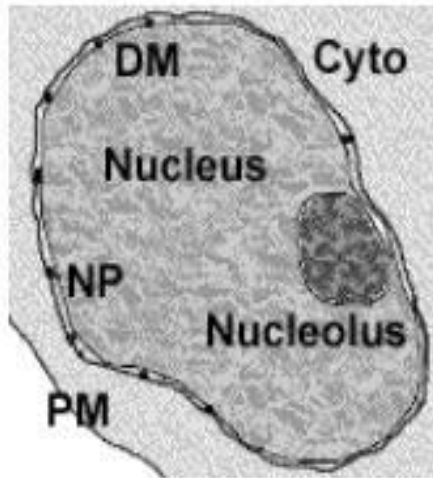
Eukaryotic Cells: Found in multicellular organism

- EuTrue
- The cells have membrane-bound nucleus and membrane-bound organelles
- Example: Animal cells, plant cells, fungi protozoa



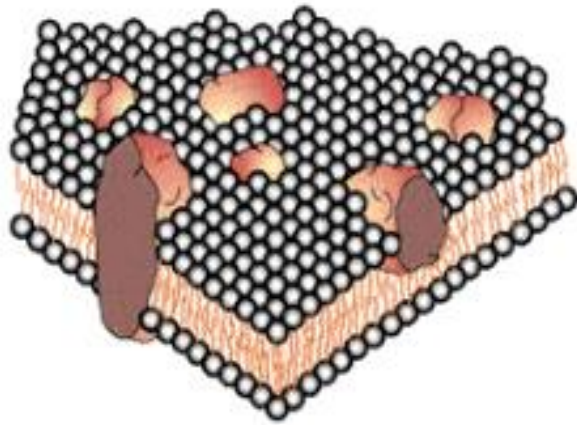
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Nucleus: This is the largest of the organelles. The nucleus contains the chromosomes which during interphase are to be found in the nucleolus.



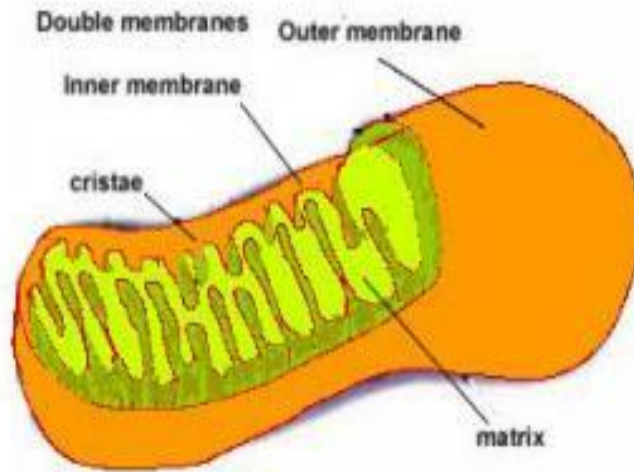
- The nucleus has a double membrane with pores(NP).
- The nucleus controls the cell's functions through the expression of genes.
- Some cells are multi nucleated such as the muscle fibre.

Plasma membrane: controls which substances can enter and exit a cell. It is a fluid structure that can radically change shape.



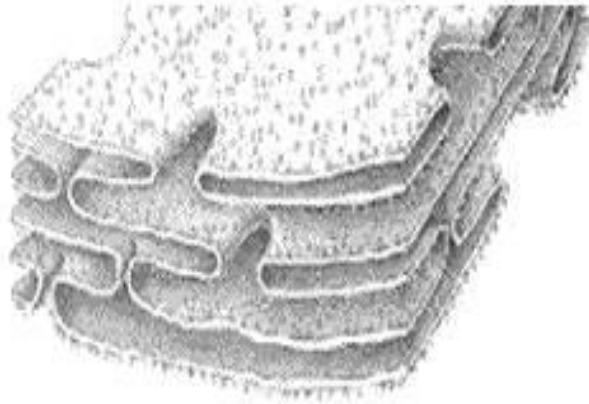
- The membrane is a double layer of water repellant molecules.
- Receptors in the outer surface detect signals to the cell and relay these to the interior.
- The membrane has pores that run through the water repellant layer called channel proteins.

Mitochondria: location of aerobic respiration and a major synthesis of ATP region.



- Double membrane organelle.
- Inner membrane has folds called cristae. This is the site of oxidative phosphorylation.
- Centre of the structure is called the matrix and is the location of the Krebs cycle.
- Oxygen is consumed in the synthesis of ATP on the inner membrane
- The more active a cell the greater the number of mitochondria.

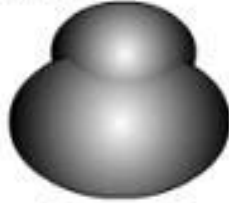
Rough endoplasmic reticulum (rER): protein synthesis and packaging into vesicles.



- rER form a network of tubules with a maze like structure.
- In general these run away from the nucleus
- The 'rough' on the reticulum is caused by the presence of ribosomes.
- Proteins made here are secreted out of the cell

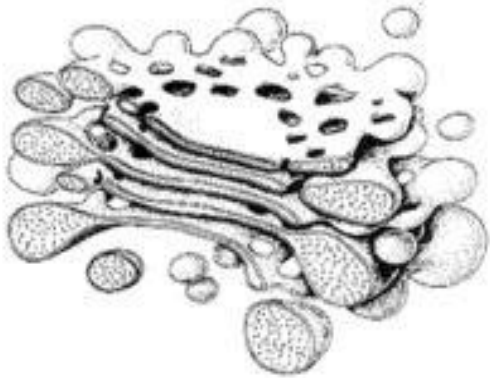
Ribosomes: the free ribosome produces proteins for internal use within the cell.

small sub unit



large sub unit

Golgi apparatus: modification of proteins prior to secretion.



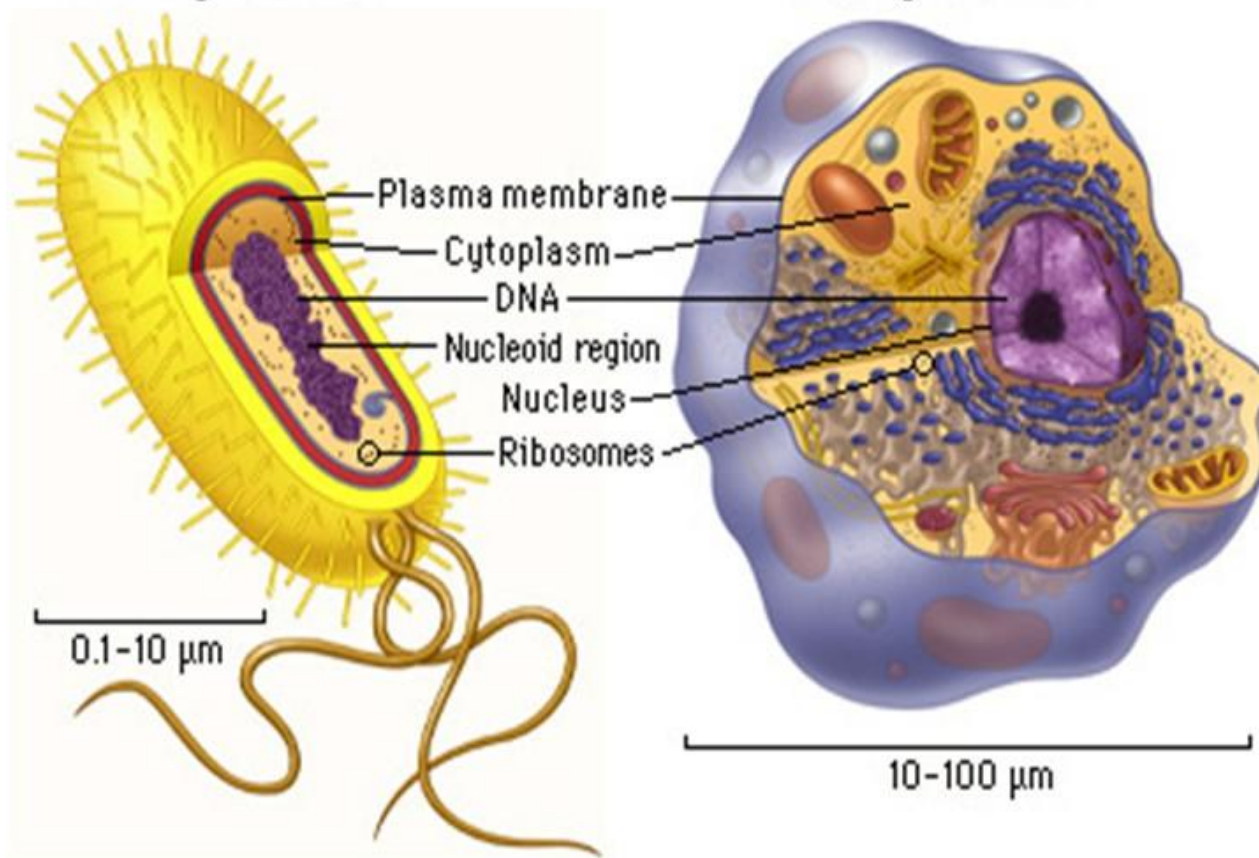
- proteins for secretion are modified
- possible addition of carbohydrate or lipid components to protein
- packaged into vesicles for secretion

Lysozyme:

- Vesicles in the above diagram that have formed on the golgi apparatus.
- Containing hydrolytic enzymes.
- Functions include the digestion of old organelles, engulfed bacteria and viruses.

Prokaryotic cell

Eukaryotic cell



Prokaryotic Cells

- small cells ($< 5\ \mu\text{m}$)
- always unicellular
- no nucleus or any organelles
- DNA is circular associated with proteins to form chromatin
- ribosomes are small (70S)
- cell division is by binary fission
- reproduction is always asexual

Eukaryotic cells

- larger cells ($> 10\ \mu\text{m}$)
- often multicellular
- always have nucleus and other membrane-bound organelles
- DNA is linear(in multiple strands) and
- ribosomes are large (80S)
- cell division is by mitosis or meiosis
- reproduction is asexual or sexual

Structure	Animal cells	Plant cells
cell membrane	Yes	yes
nucleus	Yes	yes
nucleolus	yes	yes
ribosomes	yes	yes
ER	yes	yes
Golgi	yes	yes
centrioles	yes	no
cell wall	no	yes
mitochondria	yes	yes
chloroplasts	no	yes
One big vacuole	no	yes
cytoskeleton	yes	Yes

Advantages of each kind of cell architecture

Prokaryotes	Eukaryotes
simple and easy to grow	can specialize
fast reproduction	Multi-cellularity
all the same	can build large bodies

Answers

Feature	Animal	Plant
Cell Wall	Not present as animal cells only have a plasma membrane	Cell wall present along with an inner plasma membrane
Chloroplast	Not present	Present in plant cells that photosynthesis
Carbohydrate storage	Glycogen	Starch
Vacuole	Not usually present. Small temporary vacuoles sometimes found.	Large fluid-filled vacuoles often present. Surrounded by a membrane called the tonoplast. This control substances moving from the cytoplasm to the vacuole and visa-versa.
Shape	Able to change shape. Usually rounded	Fixed shape. Usually rather irregular.

Ascribe the cell characteristics to either plants or animals cell

Only have a plasma membrane	PLANT	Plant cells that photosynthesis
Glycogen		Starch
Small temporary vacuoles sometimes found	ANIMAL	Surounded by the membrane called the tonoplast
Able to change shape		Fixed shape
Alonge with the inner plasma membrane		

Implications for Genetics

- 1. Genetic variation: Understanding the differences between prokaryotes and eukaryotes helps us appreciate the mechanisms of genetic variation.
- 2. Gene regulation: Knowing how prokaryotes and eukaryotes regulate gene expression is crucial. for understanding how genes are turned on or off in response to environmental cues.
- 3. Disease mechanisms: Many diseases, such as bacterial infections, involve prokaryotes, while others, such as genetic disorders, involve eukaryotic cells.
- 4. Genetic engineering: Understanding the differences between prokaryotes and eukaryotes is essential for developing genetic engineering techniques.

Answers

- Bacteria and cyanobacteria - prokaryote.
- All other cells - eukaryote.
- No nucleus - prokaryote.
- True nucleus - eukaryote.
- Lack membrane bound organelles - prokaryote.
- Possess subcellular organelles - eukaryote.
- Evolve from much smaller prokaryotic cells - eukaryote.
- Contain DNR - prokaryote and eukaryote.
- DNR is visible as a long irregularly shaped molecule - prokaryote.
- DNR is packaged together with special proteins called chromosomes - eukaryote.
- Specific number of chromosomes - eukaryote.
- Cell membrane, cytoplasm and various organelles - prokaryote and eukaryote.
- Have ribosome and make proteins - prokaryote and eukaryote.