"*Never underestimate the power of* the *microbe*" - Louis Pasteur

Prokaryotic cell and Eukaryotic cell

Prokaryotic Cell:

- Pro- first/before karyon : Nucleus so these are cell before nucleus present inside or without nucleus.
- **Cell Structure mainly composed of –**

a) Cell Wall :

The Danish investigator Christian Gram introduced differential Staining called Gram Staining in 1884, based on the ability of certain **bacterial cells to retain the dye crystal violet after decolouration with 95% ethanol. Cells that retained the stain were** called gram positive and those cannot retain but stained with saffrenin are gram negative bacteria.

b) Membrane :

Cell doors for inside & outside transport for nutrients, molecules, toxins. receptor sites for bacteriophages.

c) Capsules :

Some bacterial cells produce a capsule or a slime layer of material external to the cell. Capsules are composed of either polysaccharides (high molecular-weight polymers of carbohydrates) or polymers of amino acids called polypeptides (often formed from the D- rather than the L-isomer of an amino acid).

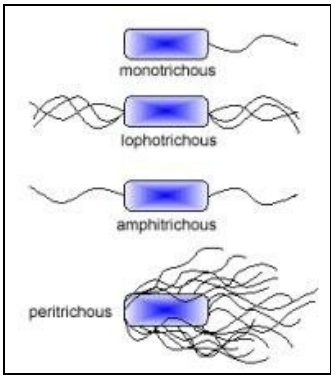
Remember: Grifith Expt Smooth & Rough colonies of *S.pneumoniae* are because of capsule.

d) Pili or Fimbriae:

Pili (from Latin meaning "hair") or fimbriae (from Latin meaning "fringe"), Generalized or common pili play a role in cellular adhesion to surfaces or to host cells.

e) Flagella:

Used for locomotion, based on position there are following types divided:



g) Mesosomes:

- **Infoldings of the cell surface membrane.**
- **Site of respiratory enzymes, compared with mitochondria in eukaryotes.**
- **Associated with DNA during cell division.**
- **Organising the separation of two daughter molecules of DNA after replication**
- **Helping in the formation of new cross walls between the daughter cells.**

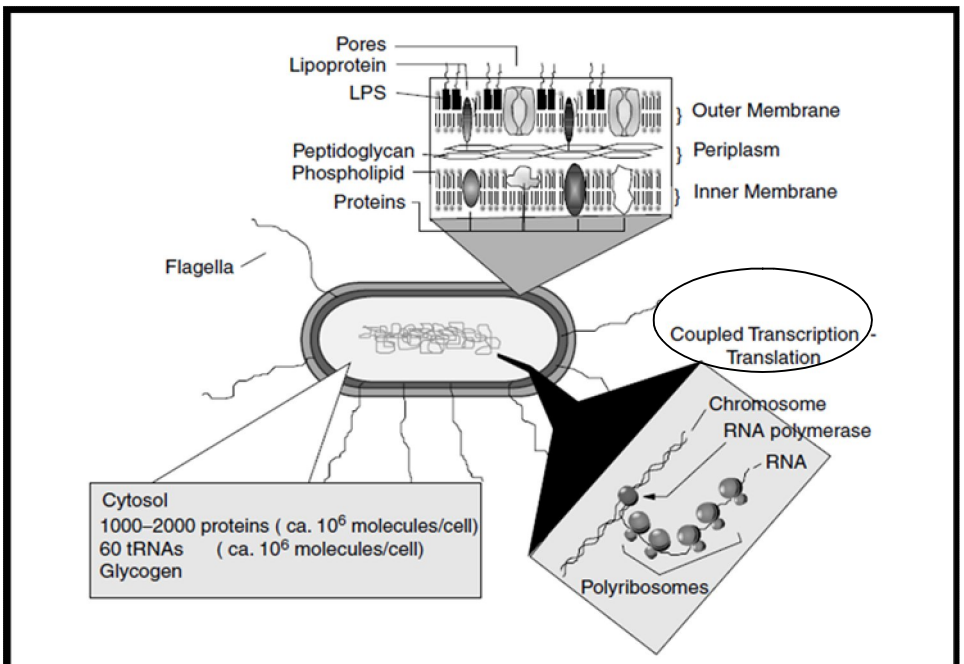


Fig. 1-1. Diagrammatic representation of a "typical" bacterial cell (*Escherichia coli*). Portions of the cell are enlarged to show further details. Image taken from: Moat & Foster 4th Ed.

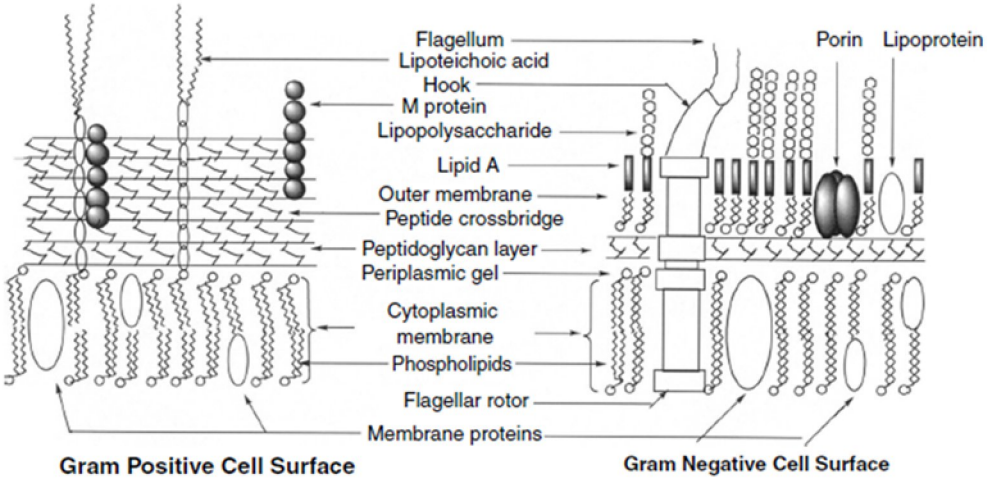


Fig. 1-2. Composition of the cell surfaces of gram-positive and gram-negative bacteria. Not all structures shown are found in all organisms. For example, M protein is only used to describe a structure in some of the streptococci. Also, not all organisms have flagella. **Moat & Foster 4th Ed.**

Substance	% of total dry weight	Number of molecules
Macromolecule		
Protein	55.0	2.4×10^6
RNA	20.4	
23S RNA	10.6	19,000
16S RNA	5.5	19,000
5S RNA	0.4	19,000
Transfer RNA (4S)	2.9	200,000
Messenger RNA	0.8	1,400
Phospholipid	9.1	22×10^6
Lipopolysaccharide	3.4	1.2×10^6
DNA	3.1	2
Murein	2.5	1
Glycogen	2.5	4,360
Total macromolecules	**96.1**	
Small molecules		
Metabolites, building blocks, etc.	2.9	
Inorganic ions	1.0	
Total small molecules	**3.9**	

Table 2.1: Observed macromolecular census of an *E. coli* cell. Adapted from Neidhardt *et al.* and Schaechter *et al.*.

TABLE 7-1. Major Components of Cells of Various Classes of Organisms

Higher Eukaryotes	Lower Eukaryotes			Prokaryotes
Metazoan	Protozoan	Algae	Fungi	Eukaryotes and Archaebacteria[a]
Nucleus	Macronucleus	Nucleus	Nucleus	Nucleoid
Nuclear membrane	Nuclear membrane	Nuclear membrane	Nuclear membrane	No nuclear membrane[b]
Nucleolus	Nuclear elements			
Ribosomes	Ribosomes	Ribosomes	Ribosomes	Ribosomes
40S, 60S/80S	40S, 60S/80S	40S, 60S/80S	40S, 60S/80S	30S, 50S/70S
Cell respiration in mitochondria 70S ribosomes	Cell respiration in mitochondria 70S ribosomes	Cell respiration in mitochondria 70S ribosome	Cell respiration in mitochondria 70S ribosomes	Cell respiration in cytoplasmic membrane Mesosomes
Endoplasmic reticulum	Endoplasmic reticulum	Endoplasmic reticulum	Cytoplasm	Cytoplasm
Golgi apparatus	Dictyosomes	Dictyosomes		
Inclusions	Specialized organelles	Chloroplasts	Inclusions	Inclusions
Lysosomes				
Peroxisomes				
Phycobilisomes				
Plasma membrane	Plasma membrane	Plasma membrane	Cytoplasmic membrane	Cytoplasmic membrane
No cell wall	No cell wall	Cell wall chitin, glycans	Cell wall chitin, glycans	Cell wall peptidoglycan[a]
Undulating flagella or cilia	Undulating flagella or cilia	Undulating flagella or cilia	Undulating flagella or cilia	Rotating flagella

[a] Although comparable to eubacteria in many respects, the archaebacteria (*Archaea*) do not produce a cell wall peptidoglycan comparable to that produced by eubacteria. They also differ from eubacteria in a number of other characteristics not included in this table.
[b] Some species of eubacteria and archaebacteria have now been shown to have a nuclear membrane.

Eukaryotes :

Eu – True & karyon : Nucleus so these are cells having true nucleus .

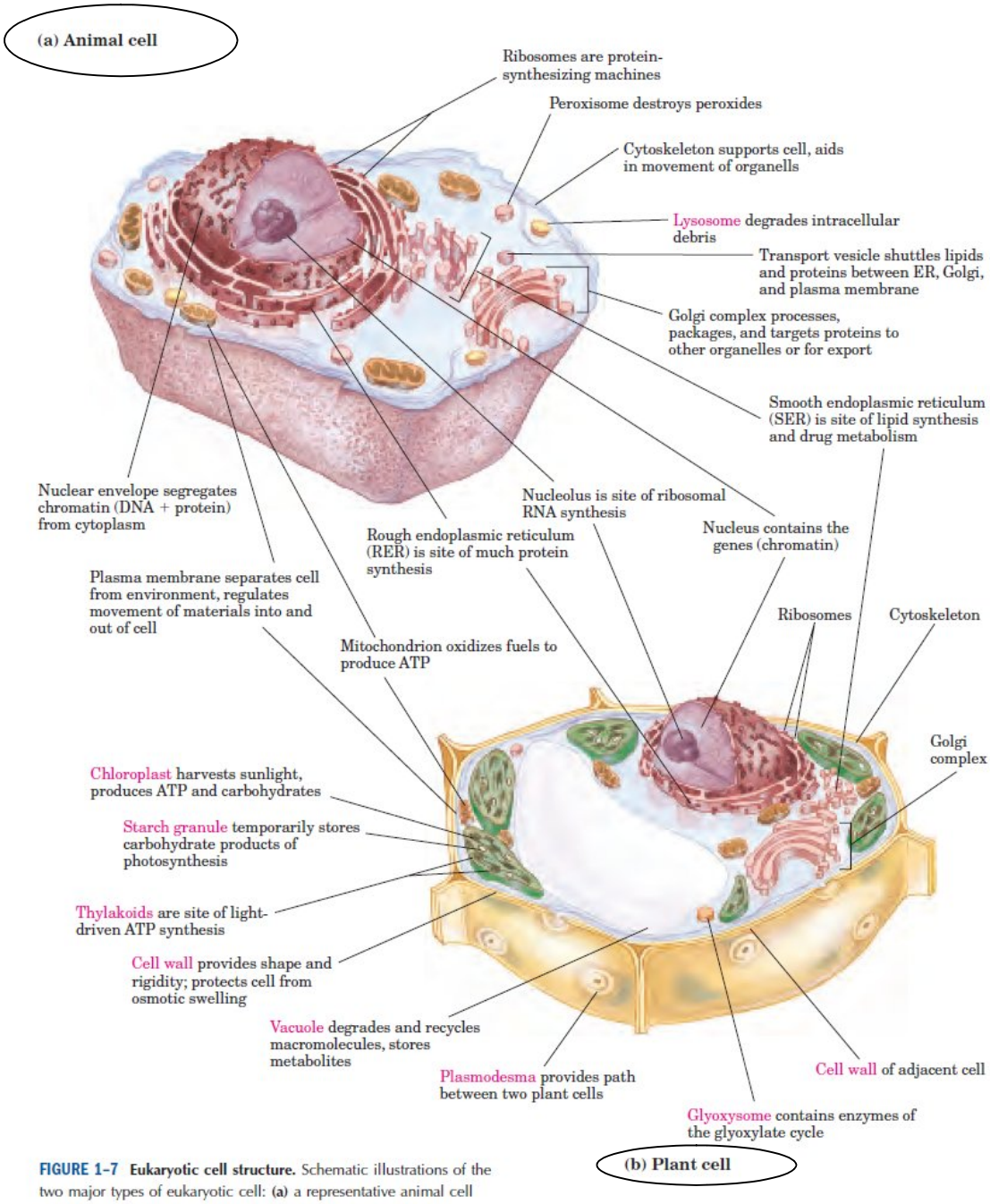


FIGURE 1–7 **Eukaryotic cell structure.** Schematic illustrations of the two major types of eukaryotic cell: **(a)** a representative animal cell and **(b)** a representative plant cell. Plant cells are usually 10 to 100 μm in diameter—larger than animal cells, which typically range from 5 to 30 μm. Structures labeled in red are unique to either animal or plant cells.

Image Taken from: Principles of Biochemistry by Lehninger

- Relation of Surface area to volume ratio with rate of diffusion of molecules into & out of cell:

$$\frac{\text{Surface area}}{\text{Volume}} = \frac{4\pi r^2}{4/3\,\pi r^3} = \boxed{\frac{3}{r}}$$

Rule : A the ratio of surface area to volume decreases , the rate of diffusion is unable to keep up with the rate of metabolism within the cell.

- ✓ The secret behind high rate of metabolism & how they divide once every 20 minutes.

For Bacterium , Having Cell diameter : 0.5 um so radius = 0.5 / 2 = 0.25 um

$$\frac{\text{Surface area}}{\text{Volume}} = \frac{3}{r} = \frac{3}{0.25}\ \text{um}^{-1} = 12\ \text{um}^{-1} = 12 \times 10^6\ \text{m}^{-1}$$

For amoeba, having Cell diameter : 150 um so radius = 150 / 2 = 75 um

$$\frac{\text{Surface area}}{\text{Volume}} = \frac{3}{r} = \frac{3}{75}\ \text{um}^{-1} = 0.04\ \text{um}^{-1} = 4 \times 10^4\ \text{m}^{-1}$$

Mind Teasers:

- ❖ How first cell has arose???
- ❖ Are we Develop from a Single Cell???
- ❖ Are viruses can be called as Cell???
- ❖ Do we have control over our cell???
- ❖ Cell possesses intelligence to take decisions independently???
- ❖ Even Single Cells Can Have Sex??? ☐ Male Or ☐ Female