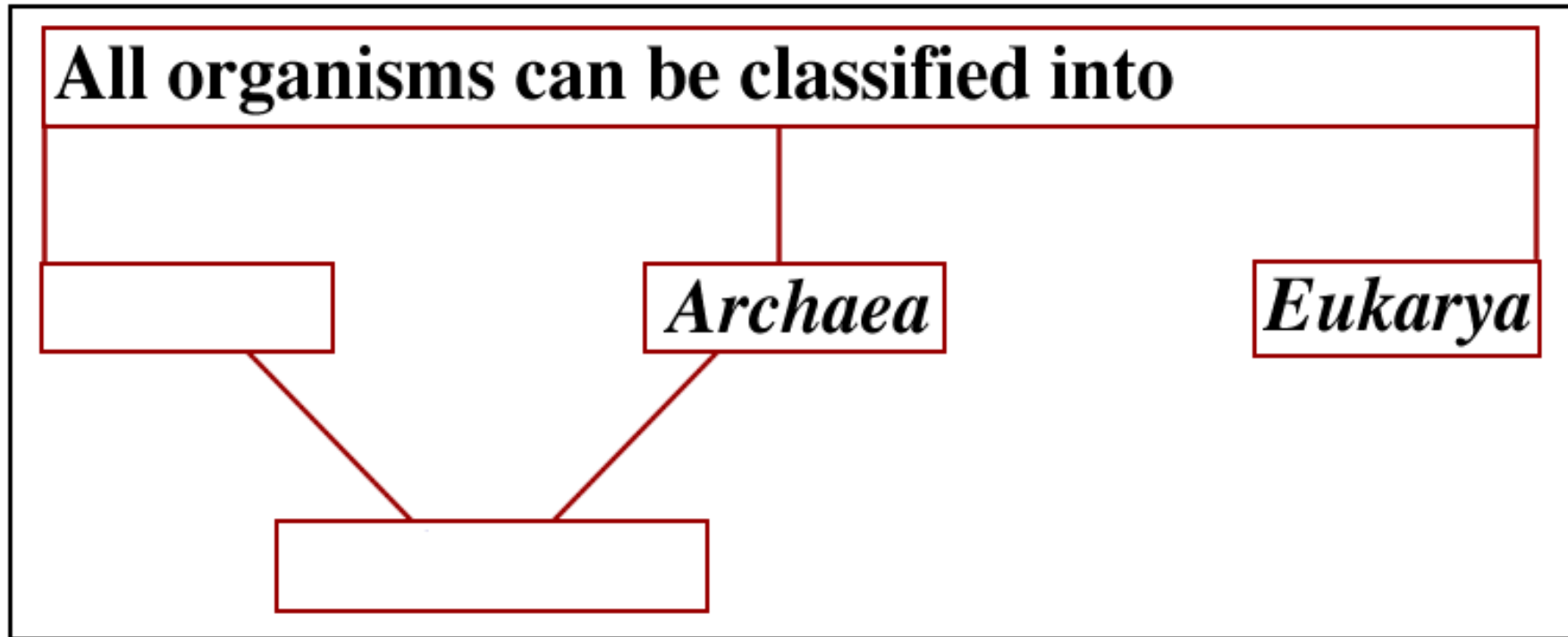


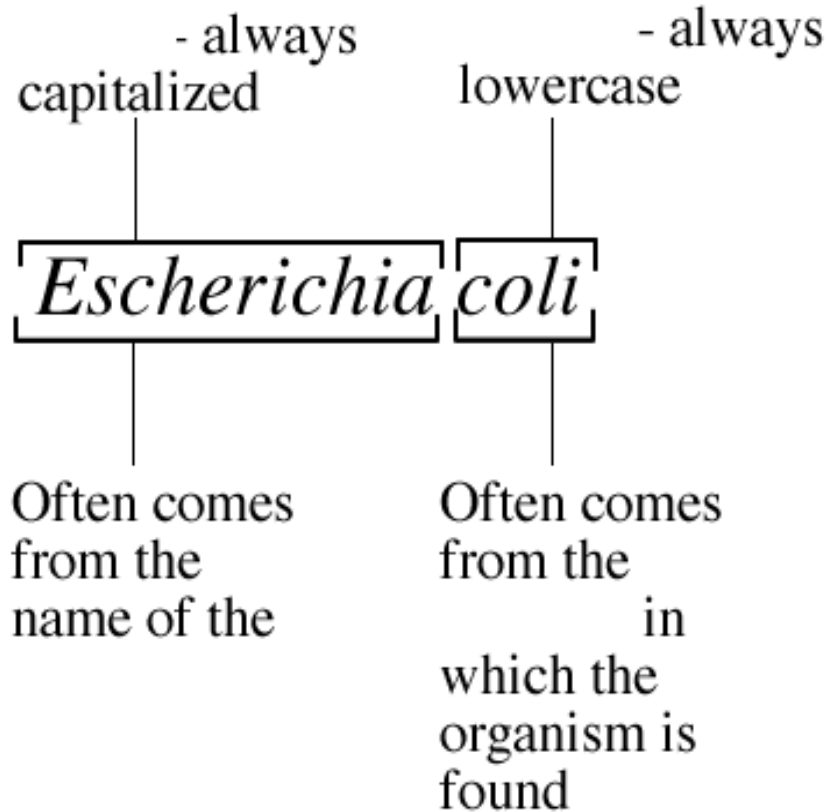
Lecture 3, Chapter 3: Cell Structure and Function of *Bacteria* and *Archaea*



I. Nomenclature

A. The binomial system of nomenclature = a two-word naming system.

** Name is always **

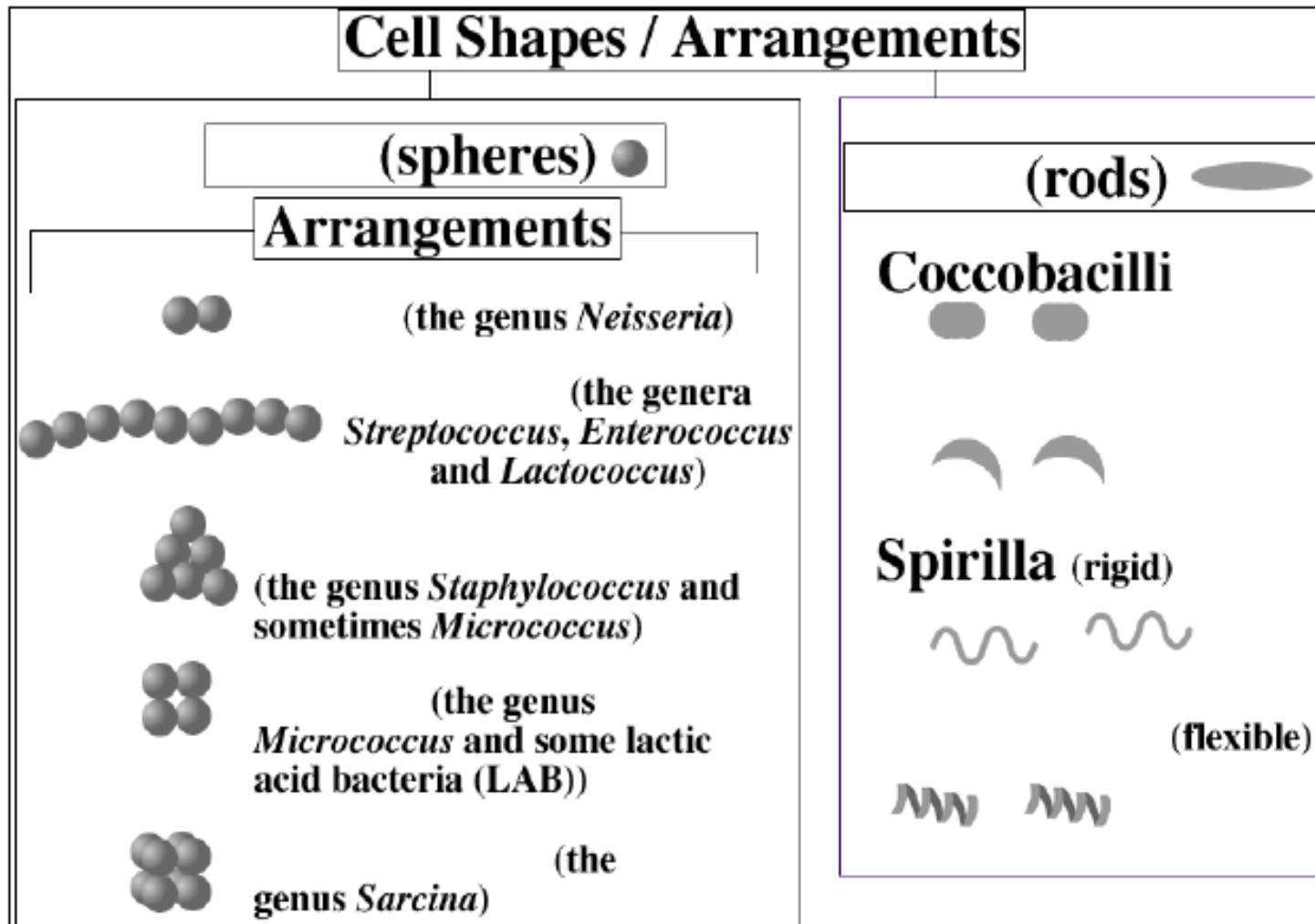


B. The genus name is commonly after it has been written out in full once:

C. Members of the same species may vary. These differences result in these organisms given a different

II. Bacterial and archaeal cell shapes, size, arrangements and reproduction

A. Shapes and arrangements



***Bacteria and Archaea that vary in their shape are called . Some bacterial and archaeal cells have unusual shapes (e.g. square) and some have surface extensions called that affect their shape.**

B. Bacterial and archaeal cells vary greatly in size. Many range from _____, and are often _____ than eukaryotic cells.

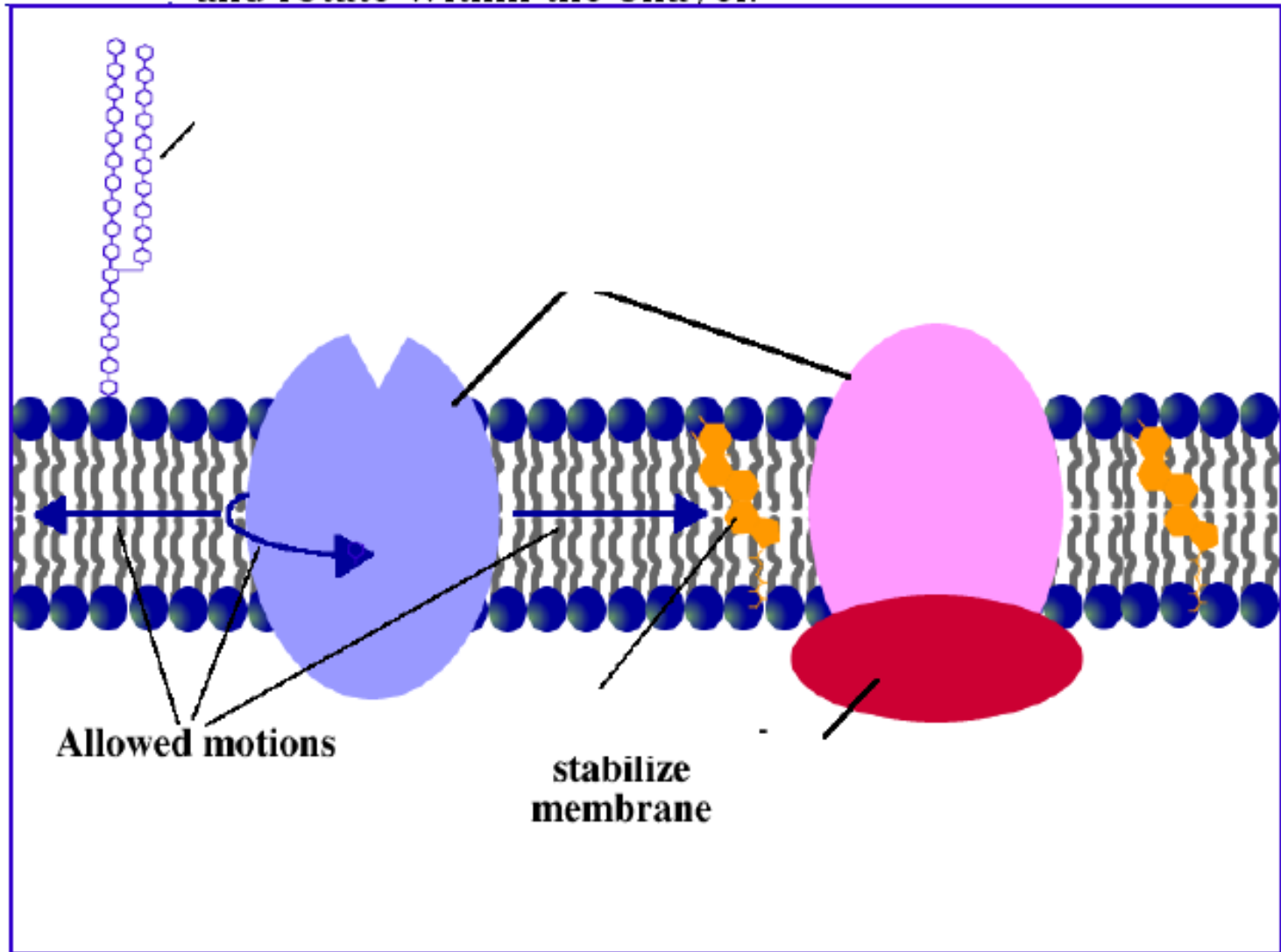
However there are exceptions to this rule (e.g. *Thiomargarita namibiensis* can be as large as 750 μm in diameter and *Epulopiscium fishelsoni* can reach 600 by 80 μm).

C. *Bacteria* and *Archaea* often reproduce via _____ though budding, fragmentation and other mechanisms are observed.

III. Bacterial cell components

A. The plasma membrane

1. The **fluid mosaic model**, developed in 1972 by S. Jonathan Singer and Garth L. Nicolson, describes the membrane as a structure in which both proteins and lipids can diffuse and rotate within the bilayer.

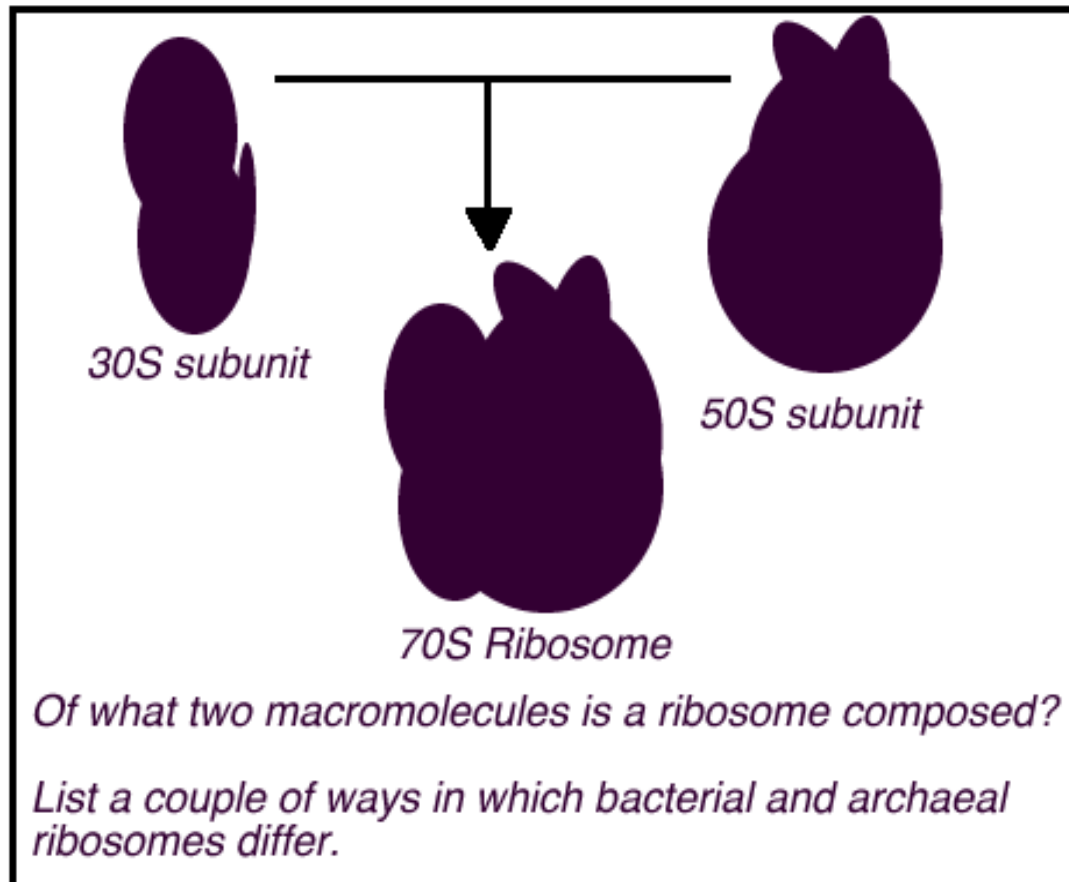


B. The cytoplasmic matrix

1.
 - a. inclusions - most are unbound but some are bound, generally by a
 - 1.) granules
 - 2.) poly- β -hydroxybutyrate granules
 - 3.) (metachromatic or volutin) granules
 - 4.) cyanophycin granules (used by cyanobacteria to store)
 - b.
 - 1.) protein-composed polyhedrons that encase enzymes
 - 2.) Carboxysomes (in cyanobacteria)- store CO_2 and serve as a site for CO_2 fixation.
 - c. Other inclusions
 - 3.) - contain metallic compounds ($\text{Fe}_3\text{O}_4 / \text{FeS}_2$) that enable bacteria to move in response to the earth's magnetic field.
 - 4.)
 - a.) Allow bacteria that live in the water to to the desired level (e.g. cyanobacteria)
 - b.) aggregates of large numbers of which are hollow-cored proteins permeable to gas.

2. Ribosomes

- a. _____
- b. Composed of a _____ which are made up of _____
- c. The _____ of a ribosome is measured in _____ units. These units reflect the rate of movement of the ribosome and its subunits in an ultracentrifuge.
- d. *Bacteria* and *Archaea* have a _____ which is composed of a _____



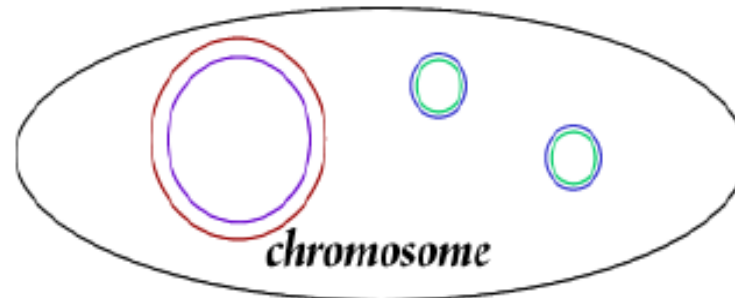
3. The nucleoid

a. Comprised primarily of _____ and some RNA and protein.

b. The bacterial and archaeal chromosome is generally a _____. However, there are some bacterial exceptions (e.g. *Streptomyces* species with linear chromosomes* and *Borrelia* and *Vibrio* that have more than 1 chromosome)

4. Plasmids

a. Extrachromosomal DNA that _____ of the chromosome.



Bacterial Cell

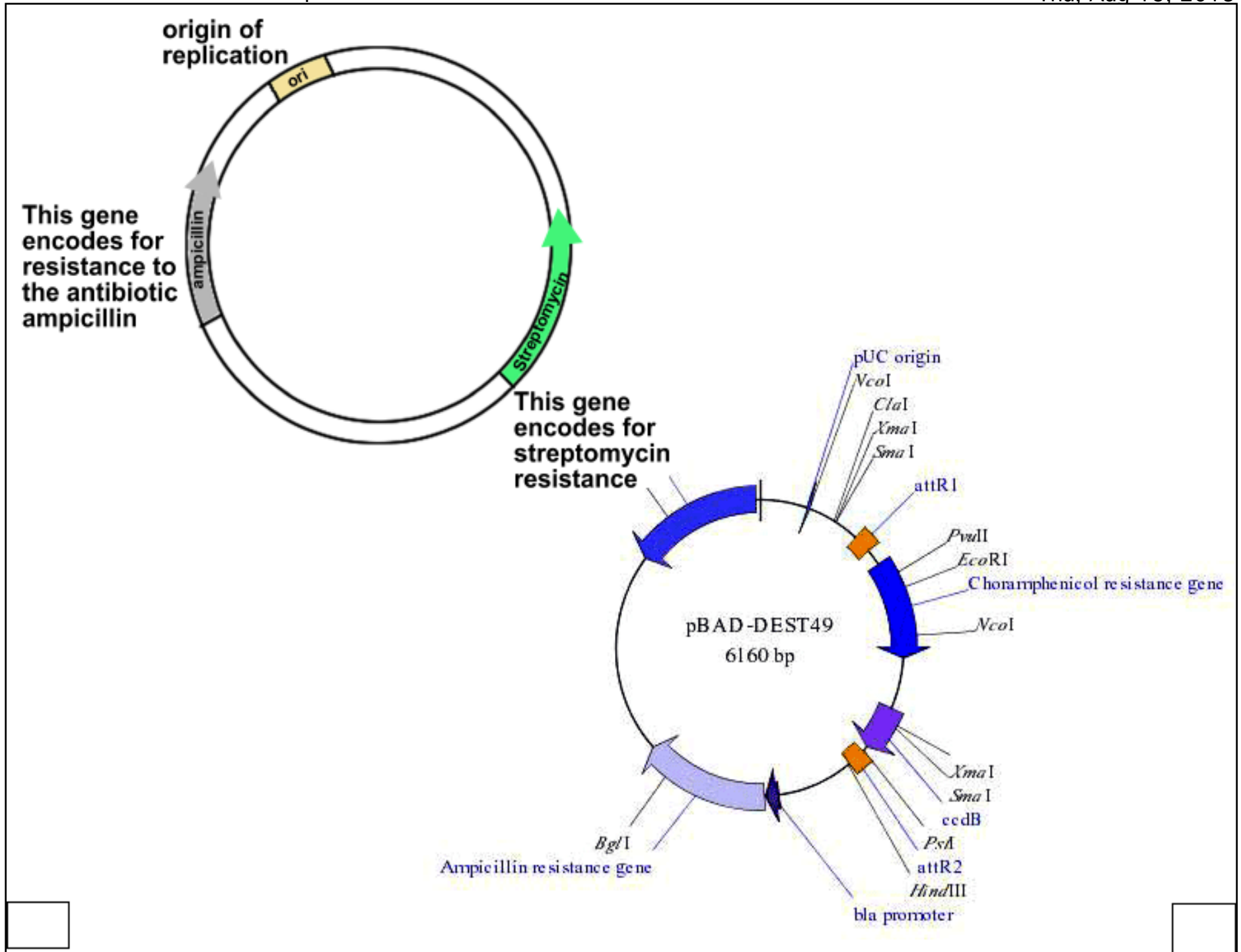
b. Most plasmids are _____ pieces of double-stranded DNA. However, some linear plasmids have been observed.

c. Not required for growth or replication, but can give a _____ to the microorganism (e.g. drug resistance).

d. Some plasmids are _____ (can be transferred from one cell to another via cell-to-cell contact).

e. Often used by researchers to _____

*Bao, K. & Cohen, S.N. (2003) Recruitment of terminal protein to the ends of *Streptomyces* linear plasmids and chromosomes by a novel telomere-binding protein essential for linear DNA replication. *Genes & Dev.* 17: 774-785

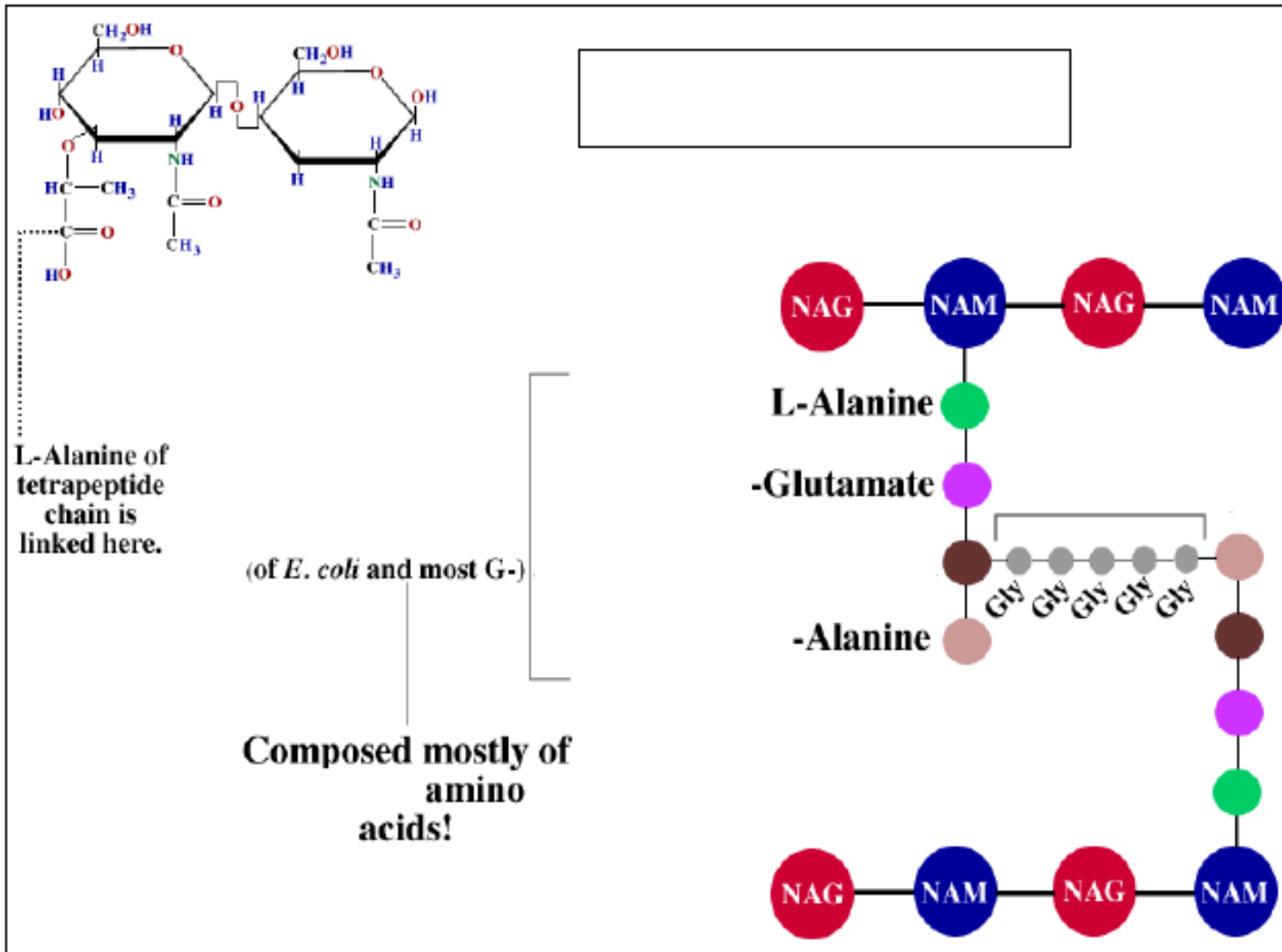


C. The bacterial cell wall

1. Peptidoglycan (murein)

a. Provides

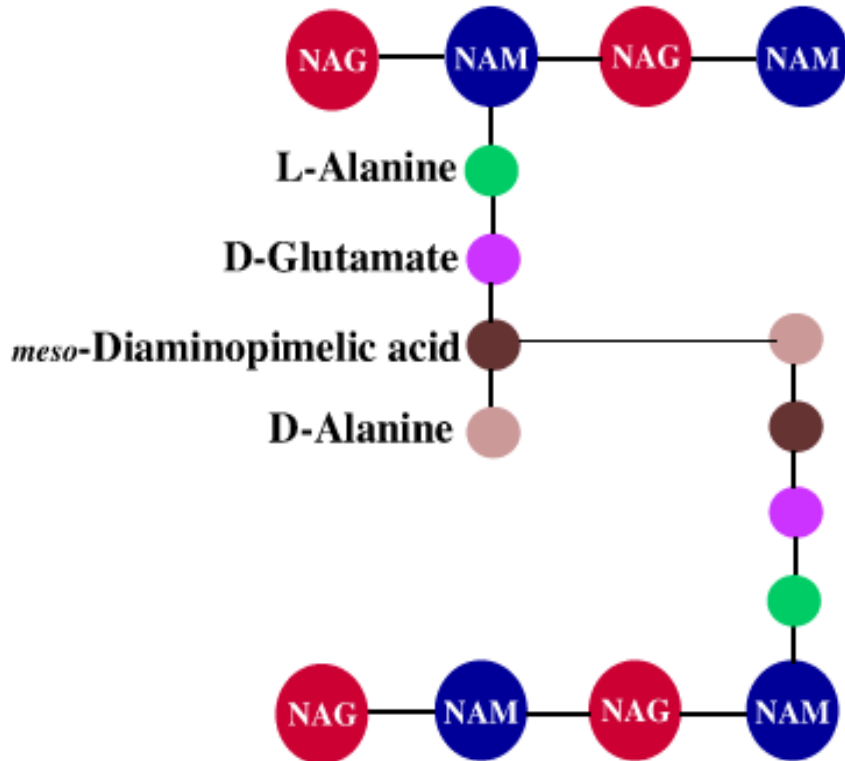
b. Alternating series of the sugar derivatives N-acetylmuramic acid () and N-acetylglucosamine (). There are 4 amino acids attached to each NAM called the



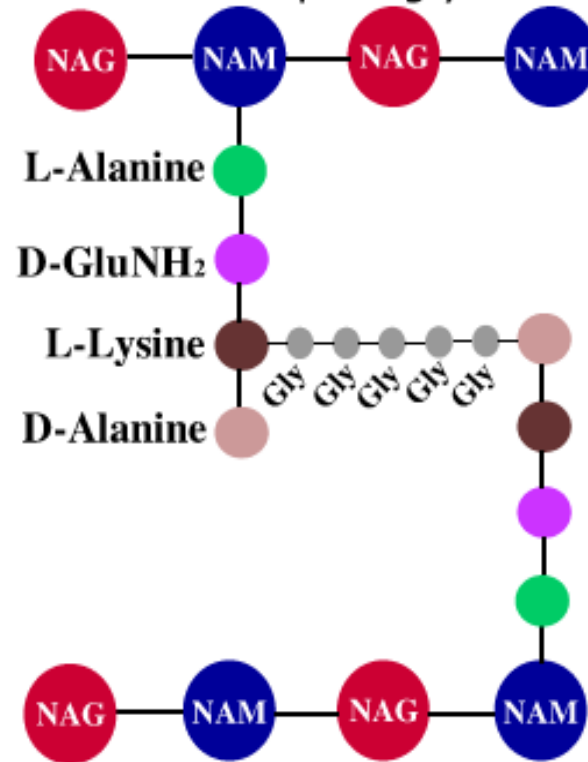
c. The peptidoglycan layer is such as
sugars, amino acids and ions. It is also somewhat malleable.

d. Peptidoglycan but retains
similarities within groups (e.g. in *E. coli* and most Gram-negatives, the terminal D-alanine residue of one tetrapeptide chain is directly linked to the *meso*-diaminopimelic acid residue of the neighboring tetrapeptide chain. However, in the peptidoglycan of *S. aureus*, the peptide interbridge links the terminal D-ala with position 3 of the neighboring tetrapeptide chain (see image below).)

E. coli Peptidoglycan



S. aureus Peptidoglycan

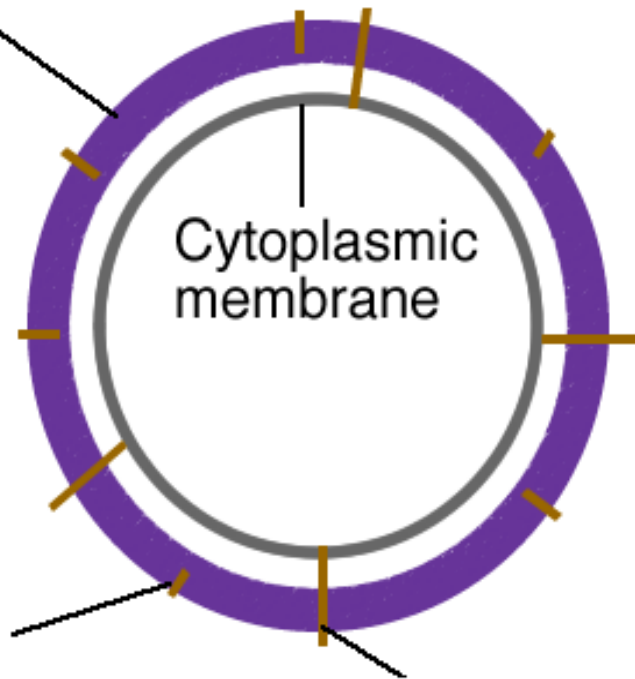


e. There is absolutely nothing like it in , therefore it
makes a good for antimicrobial substances (e.g. and
)

2. The Gram-positive cell wall

Gram-positive Cells

Cell Wall = , as many as 30 sheets of glycan chains.



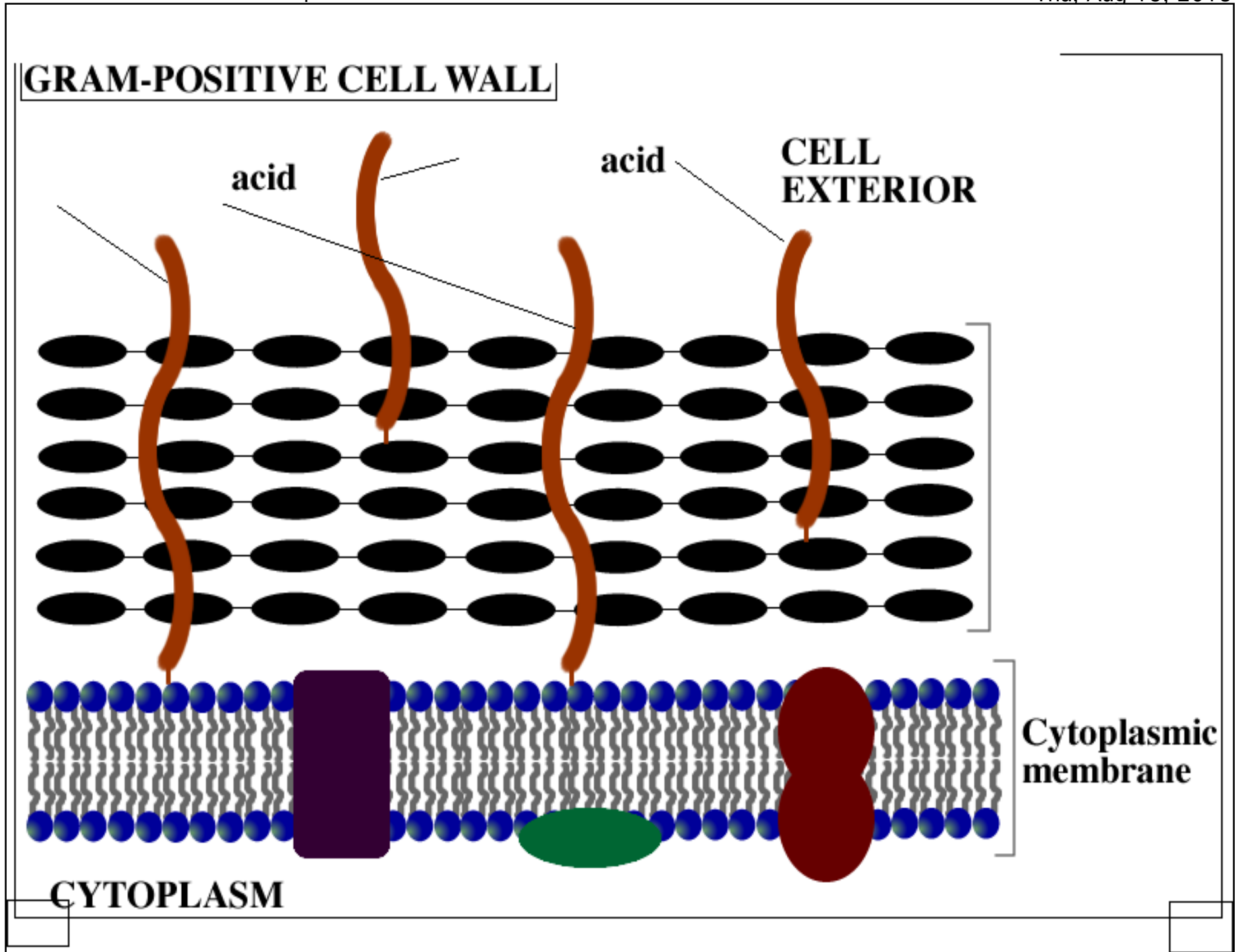
teichoic acids:

are of glycerol-phosphate or ribitol-phosphate to which various sugars and D-alanine are attached.

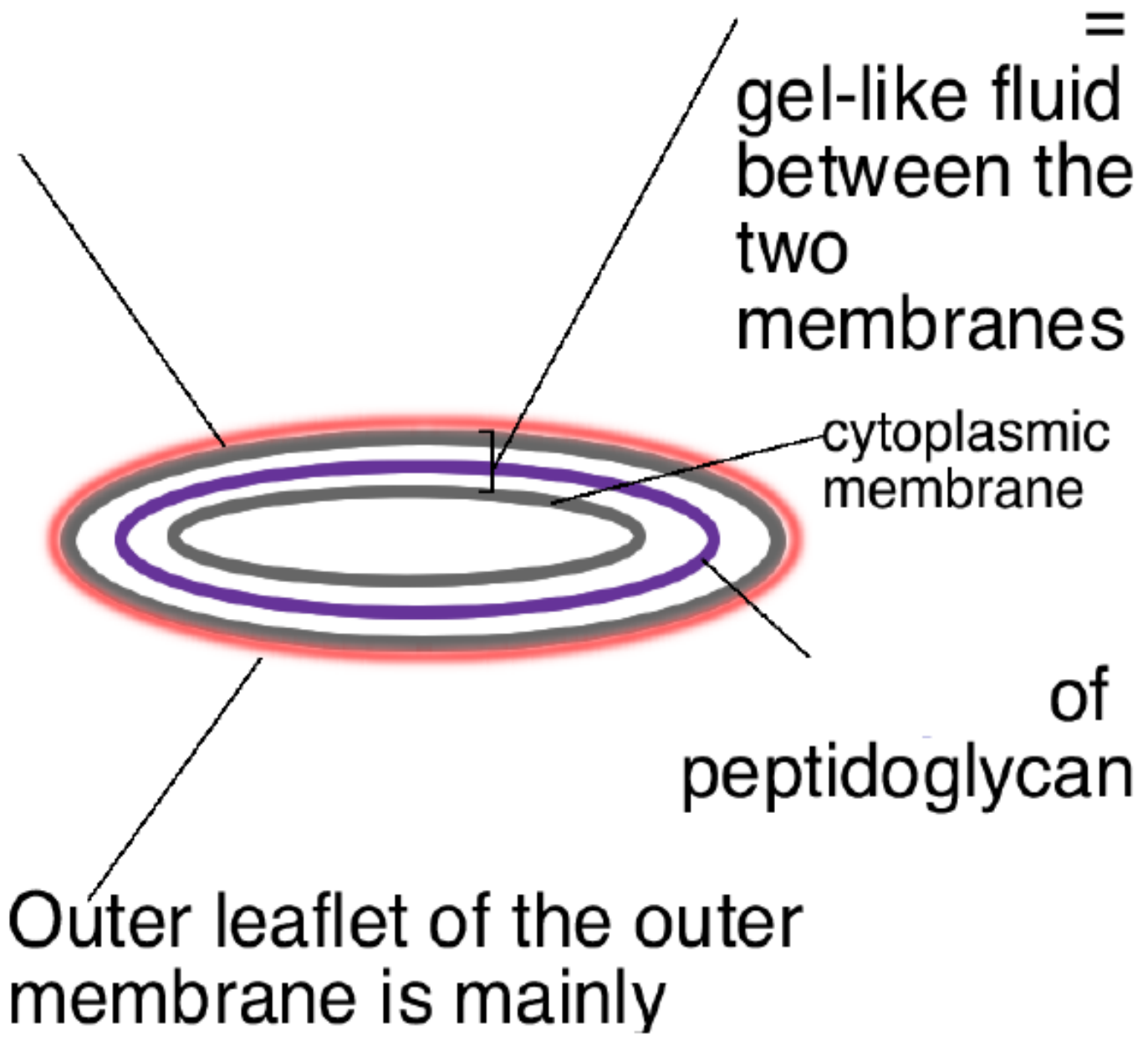
are generally attached to but some are attached to the and are called lipoteichoic acids.

Contributes structure and an overall to the cell wall.

Recognized by our body's

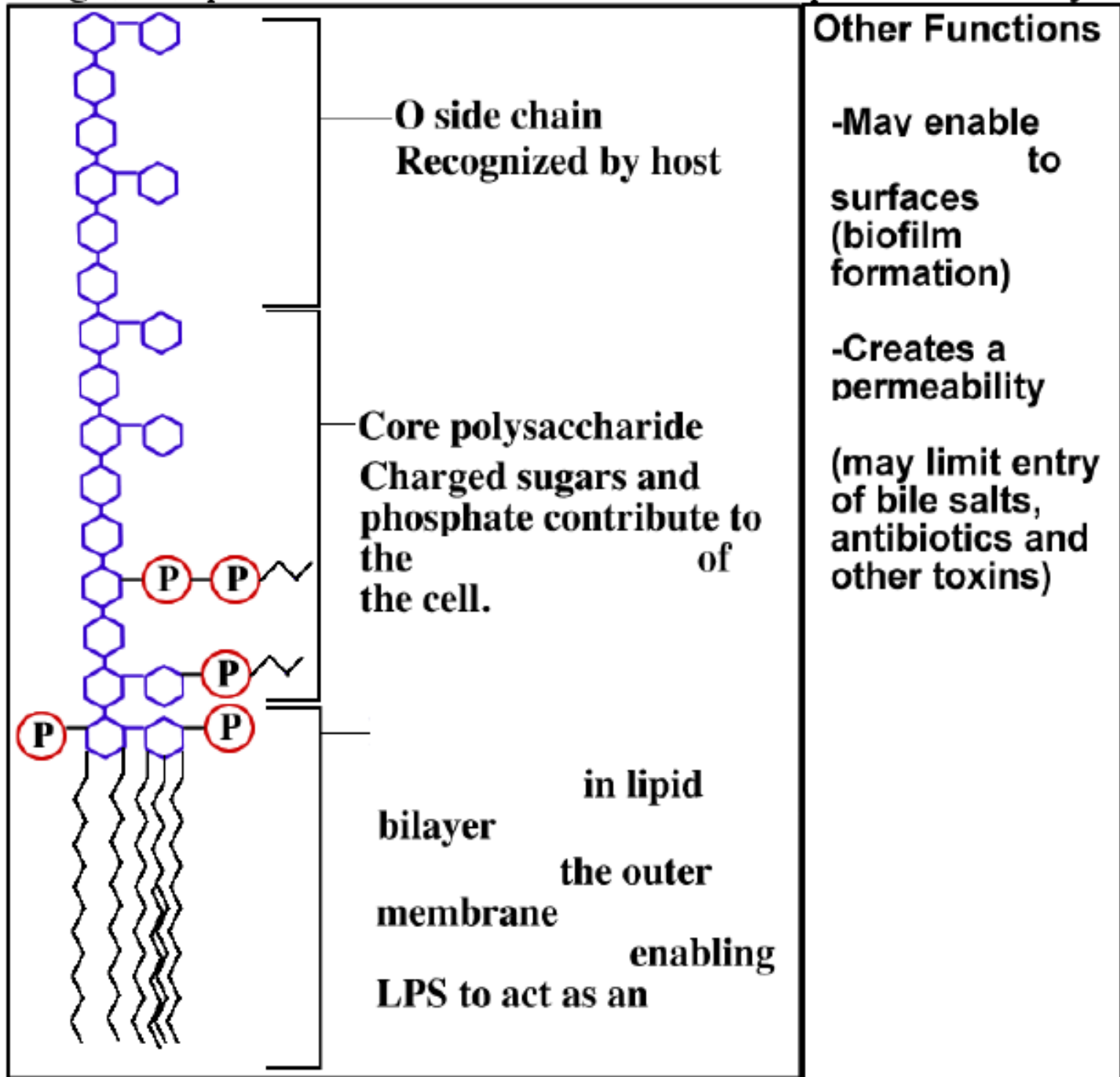


3. The Gram-negative cell wall



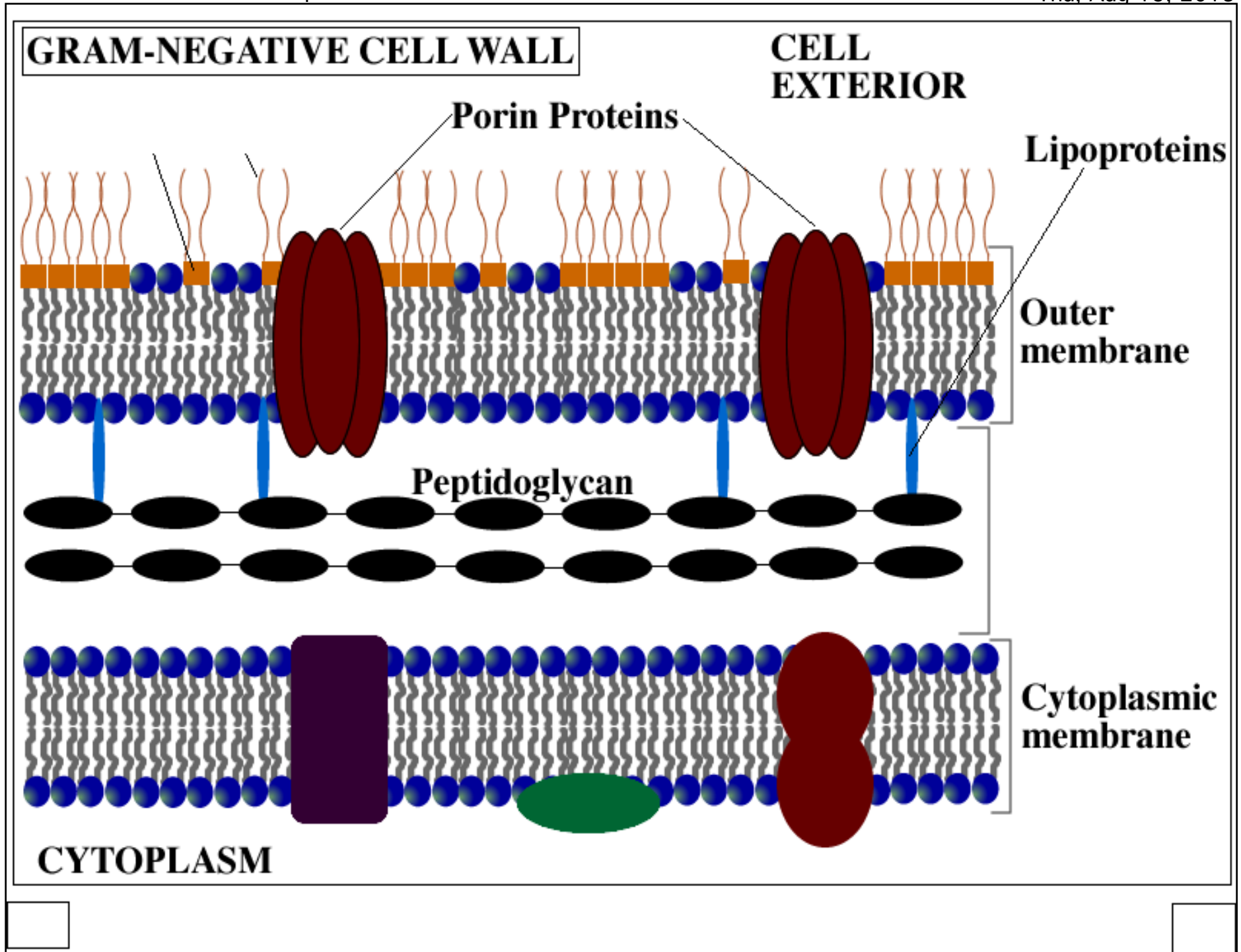
MODEL

a. LPS: Large, complex molecule that contains both lipid and carbohydrate.



- b. - most abundant membrane protein - the outer membrane to the peptidoglycan layer.
- c. - span the outer membrane to through which small molecules can pass.





Practice:

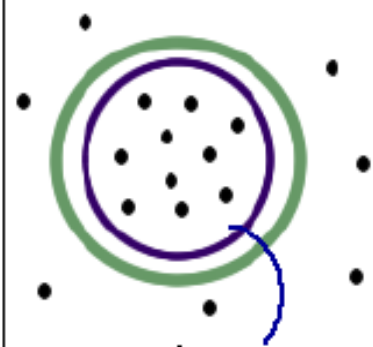
In lab we work with the Gram-negative bacterium *Klebsiella pneumoniae*. Which of the following typify the cell wall of this bacterium?

- a. A thick peptidoglycan layer
- b. Lipoteichoic acid
- c. Lipopolysaccharide (LPS)
- d. a negative charge
- e. a and b
- f. c and d

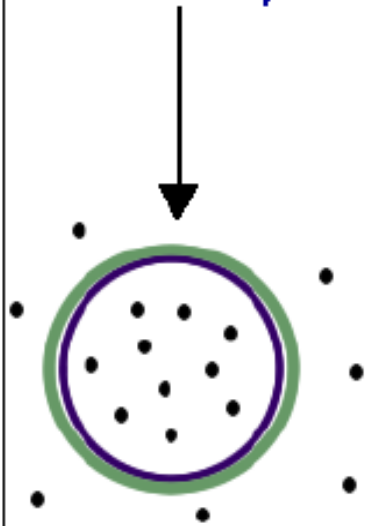
*Note - we will talk more about archaeal cell walls during our survey of *Archaea* later in the semester.

4. The cell wall protects most bacteria from destruction by osmotic pressure.

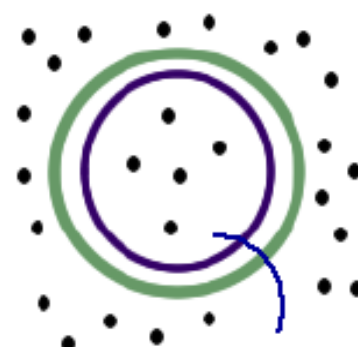
Water Diffusion =



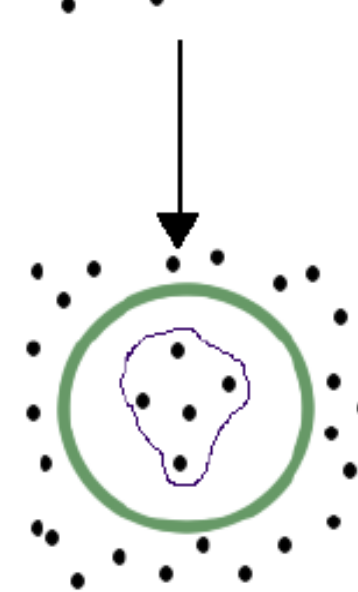
The concentration of salts and other molecules (solute) inside the cell is higher than the solute concentration outside the cell = a hypotonic environment.



The cytoplasmic membrane is pushed against the cell wall. The cell wall keeps the cell from lysing.



The concentration of salts and other molecules (solute) inside the cell is lower than the solute concentration outside the cell = a hypertonic environment.



The cytoplasmic membrane is pulled away from the cell wall.

What is a protoplast? a spheroplast?

D. Layers external to the cell wall

1. Glycocalyx - a layer, outside the cell wall, that is made of

It functions either in

a. - if layer is very distinct and well-organized.

Discussed in detail in lab.

b. - if the layer is diffuse and irregular.

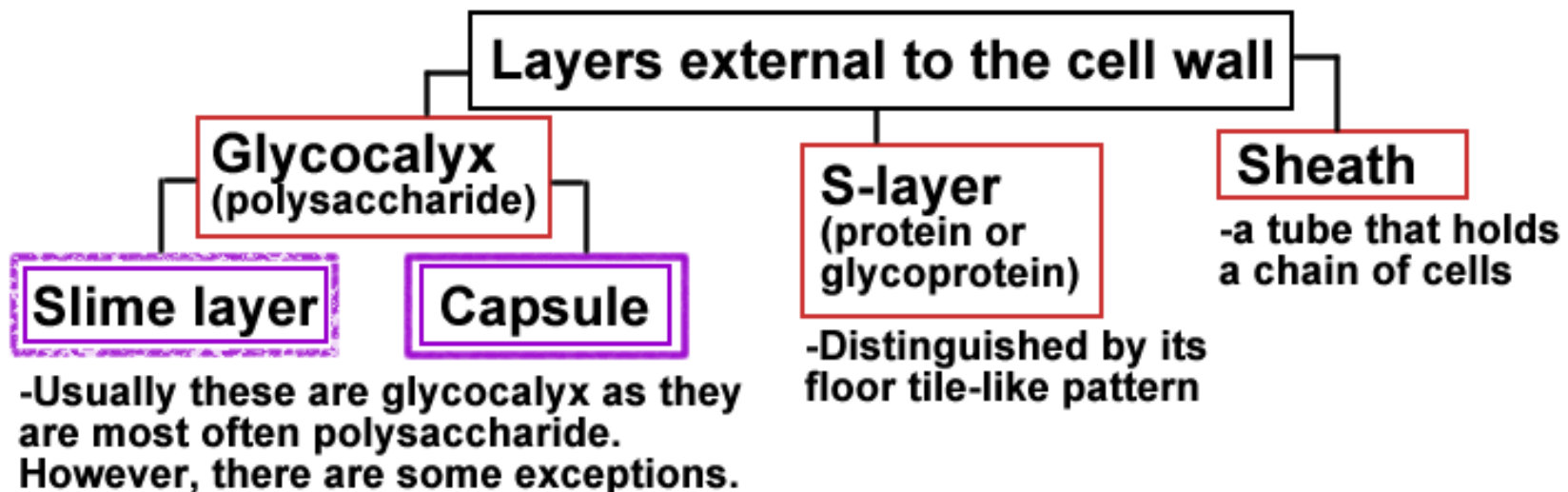
2.

a. a regularly and distinctively structured layer of
common among both bacterial and archaeal cells.

b. may protect against pH fluctuations, osmotic stress, enzymes,

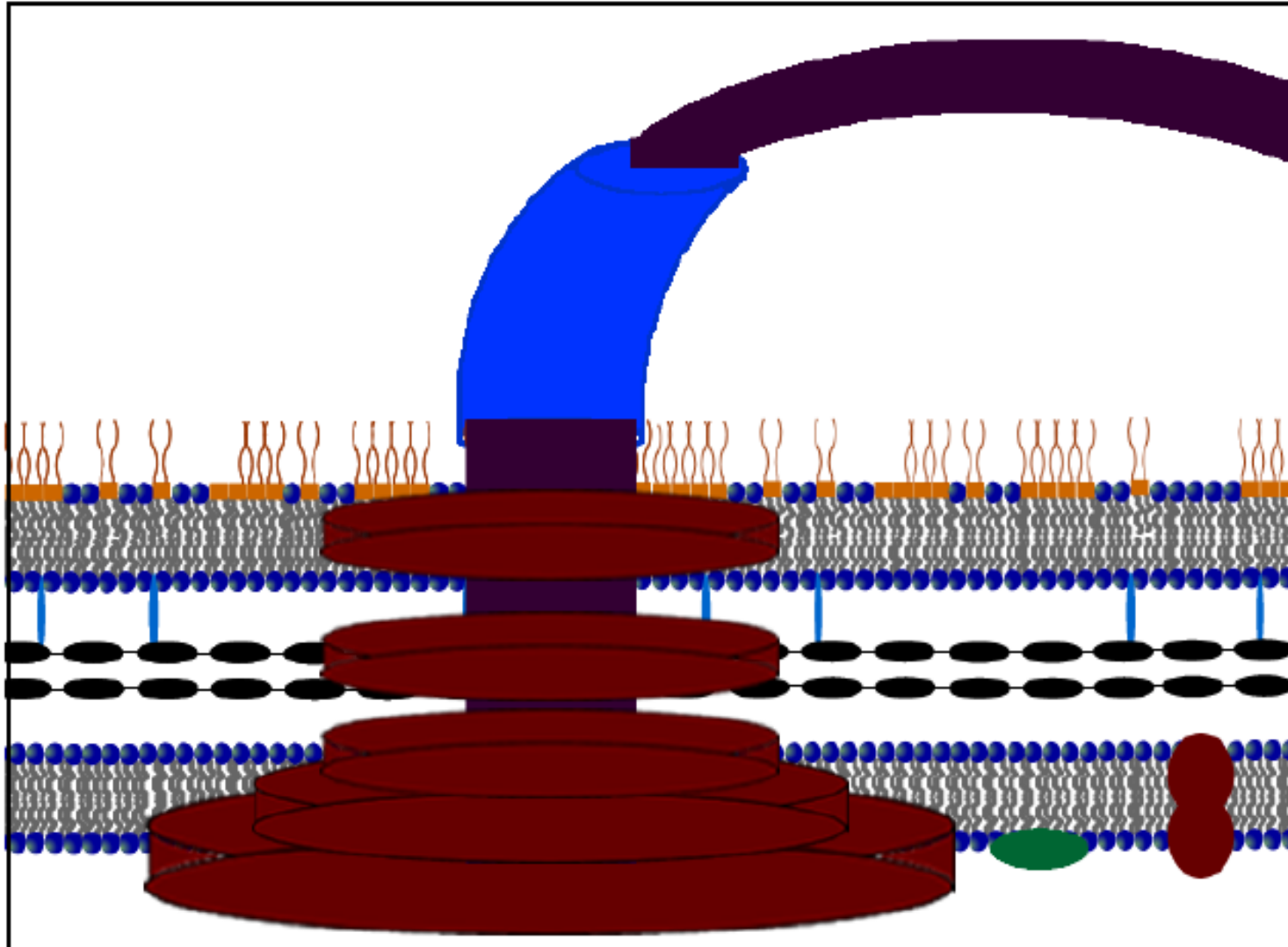
c. may help maintain cell shape, rigidity, promote cell adhesion and protect against

3. - Bacteria that live in aquatic environments may form a
that surrounds and holds a linear chain of cells together.



4. Flagellum (plural: flagella)

- a. _____ responsible for motility.
- b. Uses PMF as an energy source to spin the _____
- c. Can be _____ (e.g. *Helicobacter pylori*).



d. distribution

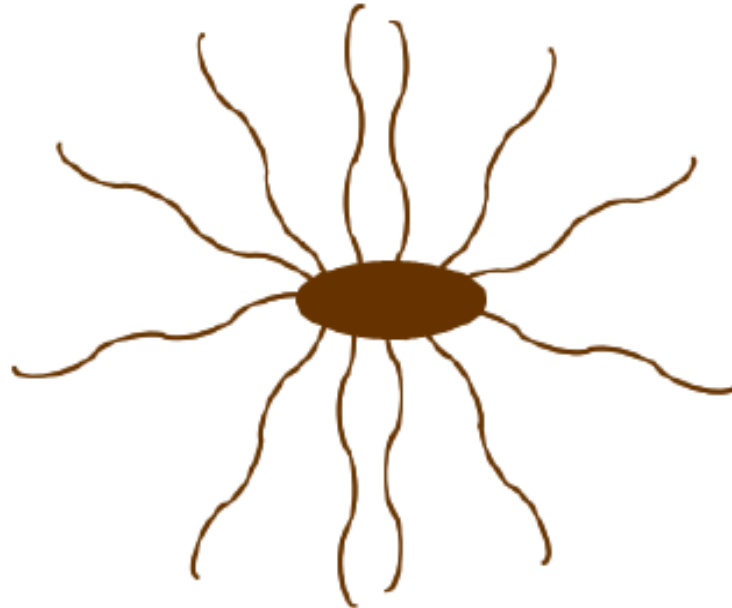
- 1.) bacteria have 1 flagellum.
If the single flagellum is at one end of the cell, then it is called a flagellum



- 2.) bacteria have a single flagellum at each pole.
3.) bacteria have a cluster of flagella at one or both ends of the cell.

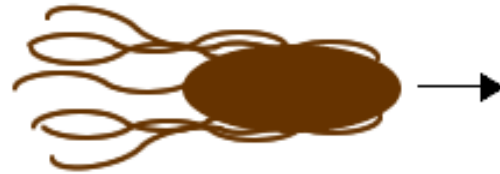


- 4.) bacteria have flagella distributed over the

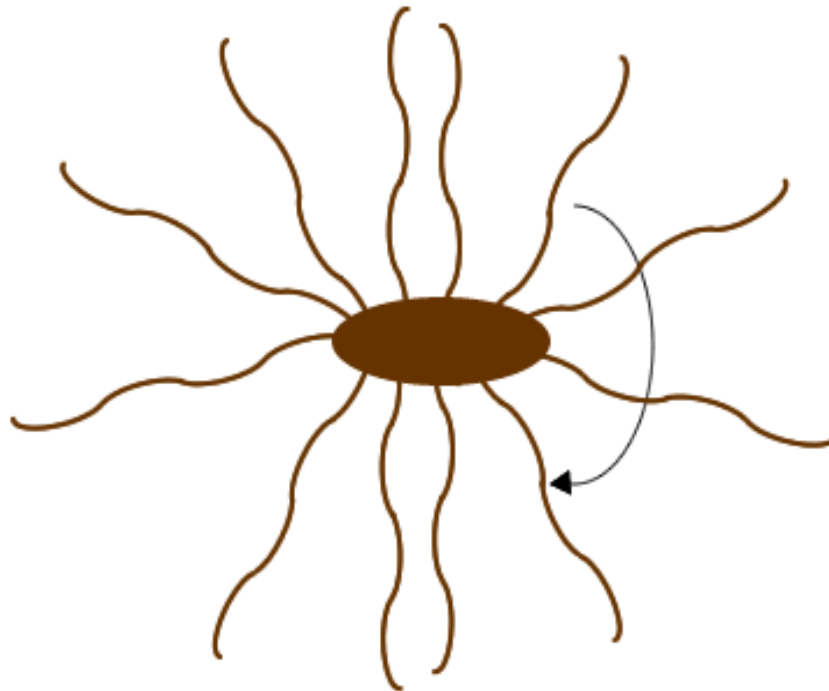


5.) The direction of rotation of the flagella determines the nature of the movement.

counterclockwise rotation =



clockwise rotation =



6.) Chemotaxis

-motile bacteria move

(toxins). They do this by comparing the current environment with the environment that they were in a few seconds before -

The chemical attractant or repellent binds to on the surface of the cytoplasmic membrane. These receptors send signals to

-In the absence of a chemical gradient, there are of runs and tumbles. The bacterium

Fig. 3.50 or 3.51 a and b

-When there is a chemical gradient of an attractant, the
and the bacterium

(b)



d. Pili / fimbriae

- 1.) _____ than flagella.
- 2.) Composed of protein subunits arranged helically to create a _____
- 3.) Allow for _____ to specific surfaces.
- 4.) Assist in _____ on solid media via short, quivering movements.
- 5.) Conjugation = _____

Fig. 3.40 or 3.42

