

# Functional Anatomy of Prokaryotic and Eukaryotic Cells

## Prokaryotic Cells

- Comparing prokaryotic and eukaryotic cells
  - Prokaryote comes from the Greek words for \_\_\_\_\_
  - Eukaryote comes from the Greek words for \_\_\_\_\_

### Prokaryote

- One circular chromosome, not in a membrane
- No histones
- No membrane-bound organelles
- Peptidoglycan cell walls
- \_\_\_\_\_

- Average size:  $0.2 - 1.0 \mu\text{m} \times 2 - 8 \mu\text{m}$
- Basic shapes:

- Unusual shapes
  - Star-shaped *Stella*
  - Square *Haloarcula*
- Most bacteria are \_\_\_\_\_
- A few are \_\_\_\_\_

### Eukaryote

- Paired chromosomes, in nuclear membrane
- \_\_\_\_\_
- Organelles
- Polysaccharide cell walls
- Mitotic spindle

## Arrangements

- Pairs: Diplococci, diplobacilli
- Clusters:
- Chains: Streptococci, streptobacilli

## Glycocalyx

- Outside cell wall
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- A capsule is neatly organized
- A slime layer is unorganized and loose
- Extracellular polysaccharide allows cell to attach
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## Flagella

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- Made of chains of flagellin
- Attached to a protein hook
- Anchored to the wall and membrane by the basal body

## Flagella Arrangement

Monotrichous

Amphitrichous

Lophotrichous

Peritrichous

## Motile Cells

- Rotate flagella to run or tumble
- Move toward or away from stimuli (taxis)
- Flagella proteins are H antigens (e.g., \_\_\_\_\_)

## Axial Filaments

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- Anchored at one end of a cell
- Rotation causes cell to move
- Fimbriae allow attachment
- Pili are used to transfer DNA from one cell to another

## Cell Wall

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- Made of peptidoglycan (in bacteria)

## Peptidoglycan

- Polymer of disaccharides: N-acetylglucosamine (NAG) and N-acetylmuramic acid (NAM)
- Linked by polypeptides

## Gram-Positive Cell Walls

- Thick peptidoglycan
- \_\_\_\_\_
- In acid-fast cells, contains mycolic acid

## Gram-Negative Cell Walls

Thin peptidoglycan

Outer membrane

## Gram-Positive Cell Walls

- Teichoic acids
  - Lipoteichoic acid links to plasma membrane
  - Wall teichoic acid links to peptidoglycan
- May regulate movement of cations.
- Polysaccharides provide antigenic variation.

## Gram-Negative Outer Membrane

- Lipopolysaccharides, lipoproteins, phospholipids
- Forms the periplasm between the outer membrane and the plasma membrane.
- Protection from phagocytes, complement, and antibiotics
- O polysaccharide antigen, e.g., \_\_\_\_\_
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- Porins (proteins) form channels through membrane.

## Gram Stain Mechanism

- Crystal violet-iodine crystals form in cell.
- Gram-positive
  - Alcohol dehydrates peptidoglycan
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- Gram-negative
  - Alcohol dissolves outer membrane and leaves holes in peptidoglycan.
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## Atypical Cell Walls

- Mycoplasmas
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  - Sterols in plasma membrane
- Archaea
  - Wall-less (or)
  - Walls of pseudomurein (lack NAM and D amino acids)

## Damage to Cell Walls

- Lysozyme digests disaccharide in peptidoglycan.
- Penicillin inhibits peptide bridges in peptidoglycan.
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- Spheroplast is a Gram-positive cell that has almost completely lost its cell wall.
- L forms are wall-less cells that swell into irregular shapes.
- Protoplasts and spheroplasts are susceptible to osmotic lysis.

## Plasma (Cell) Membrane

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- Selectively permeability
- Damage to the membrane by alcohols, quaternary ammonium (detergents), and polymyxin antibiotics causes leakage of cell contents.

## Movement Across Membranes

- What is osmosis?
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- What happens to a cell when placed in a:
  - Hypertonic solution?
  - Hypotonic solution?
  - Isotonic solution?

## Cytoplasm

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## Nuclear Area

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## Inclusions

- Storage granules of chemicals; often energy reserves.

## Endospores

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- Resting cells
- Resistant to desiccation, heat, chemicals, radiation, and “time”
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- Sporulation: Endospore formation
- Germination: Return to vegetative state
  
- Eukaryotic version:
  - fungal spores –
  - Protozoan cysts –

## Study Objectives

1. Describe the 3 most common morphologies of bacteria. What are some of the other possible shapes?
2. Compare and contrast the cell walls of gram (-) and gram (+) bacteria.
3. Discuss the structure and function of the bacterial capsule, slime layer, pili and fimbriae.
4. List the four arrangements of flagella in bacteria.
5. In general, compare and contrast the similarities and differences between prokaryotic and eukaryotic cells.
6. Define protoplasts, spheroplasts and L-forms.
7. Describe the effects of lysozyme and penicillin on bacterial cell walls.