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Comparing Prokaryotic and Eukaryotic Cells: An Overview

I. Prokaryotic and eukaryotic cells are similar in their chemical composition and chemical reactions.
2. Prokaryotic cells lack membrane-enclosed organelles (including a nucleus).
3. Peptidoglycan is found in prokaryotic cell walls but not in eukaryotic cell walls.
4. Eukaryotic cells have a membrane-bound nucleus and other organelles.

THE PROKARYOTIC CELL

I. Bacteria are unicellular, and most of them multiply *by* binary fission .

2. Bacterial species are differentiated *by* morphology, chemical composition, nutritional requirements, biochemical activities, and source of energy.

The Size, Shape, and Arrangement of Bacterial Cells

I. Most bacteria are 0.2 to 2.0 Mm in diameter and 2 to 8 Mm in length.
2. The three basic bacterial shapes are coccus (spherical), bacillus (rod -shaped), and spiral (twisted) .
3. Pleomorphic bacteria can assume several shapes

Structures External to theCell Wall

Glycocalyx

I. The glycocalyx (capsule, slime layer, or extracellular polysaccharide) is a gelatinous polysaccharide and/or polypeptide covering.
2. Capsules may protect pathogens from phagocytosis.
3. Capsules enable adherence to surfaces, prevent desiccation, and may provide nutrients.

Flagella

4. Flagella are relatively long filamentous appendages consisting of a filament, hook, and basal body.

5. Prokaryotic flagella rotate to push the cell.
6. Motile bacteria exhibit taxis; positive taxis is movement toward

an attractant, and negative taxis is movement away from a repellent.
7. Flagellar (H) protein is an antigen.

Axial Filaments

8. Spiral cells that move by means of an axial filament (endoflagellum) are called spirochetes.
9. Axial filaments are similar to flagella, except that they wrap around the cell.

Fimbriae and Pili

10. Fimbriae help cells adhere to surfaces.
II. Pili are involved in twitching motility and DNA transfer.

The Cell Wall

Composition and Characteristics

I. The cell wall surrounds the plasma membrane and protects the cell from changes in water pressure.
2. The bacterial cell wall consists of peptidoglycan, a polymer consisting of NAG and NAM and short chains of amino acids.
3. Penicillin interferes with peptidoglycan synthesis.
4. Gram-positive cell walls consist of many layers of peptidoglycan and also contain teichoic acids.
s. Gram-negative bacteria have a lipopolysaccharide-lipoprotei nphospholipid outer membrane surrounding a thin peptidoglycan laye r.
6. The outer membrane protects the cell from phagocytosis and from penicillin, lysozyme, and other chemicals.
7. Porins are proteins that permit small molecules to pass through the outer membrane; specific channel proteins allow other molecules to move through the outer membrane.
8. The lipopolysaccharide component of the outer membrane consists of sugars (O polysaccharides), which function as antigens, and lipid A, which is an endotoxin.

Cell Walls and the Gram Stain Mechanism

9. The crystal violet-iodine complex combines with peptidoglycan.
10. The decolorizer removes the lipid outer membrane of gram negative

bacteria and washes out the crystal violet.

Atypical Cell Walls

***II . Mycoplasma* is a bacterial genus that naturally lacks cell walls.**
12. Archaea have pseudomurein; they lack peptidoglycan.
13. Acid-fast cell walls have a layer of mycolic acid outside a thin peptidoglycan layer.

Damage to the Cell Wall

14. In the presence of lysozyme, gram-positive cell walls are destroyed, and the remaining cellular contents are referred to as a protoplast.
15. In the presence of lysozyme, gram-negative cell walls are not completely
destroyed, and the remaining cellular contents are referred to as a spheroplast.
16. L forms arc gram-positive or gram-negative bacteria that do not make a cell wall.
17. Antibiotics such as penicillin interfere with cell wall synthesis.

Structures Internal to theCell wall

The Plasma (Cytoplasmic) Membrane

1. The plasma membrane encloses the cytoplasm and is a lipid bilayer with peripheral and integral proteins (the fluid mosaic model).
2. The plasma membrane is selectively permeable.

3. Plasma membranes contain enzymes for metabolic reactions, such as nutrient breakdown, energy production, and photosynthesis.
4. Mesosomes, irregular infoldings of the plasma membrane, are artifacts, not true cell structures.
5. Plasma membranes can be destroyed by alcohols and polymyxins.

The Movement of Materials across Membranes

6. Movement across the membrane may be by passive processes, in which materials move from areas of higher to lower concentration and no energy is expended by the cell.
7. In simple diffusion, molecules and ions move until equilibrium is reached.
8. In facilitated diffusion, substances are transported by transporter proteins across membranes from areas of high to low concentration.
9. Osmosis is the movement of water from areas of high to low

concentration across a selectively permeable membrane until equilibrium is reached.

10. In active transport, materials move from areas of low to high concentration by transporter proteins, and the cell must expend energy.

II. In group translocation, energy is expended to modify chemicals and transport them across the membrane.

Cytoplasm

12. Cytoplasm is the fluid component inside the plasma membrane.

13. The cytoplasm is mostly water, with inorganic and organic molecules, DNA, ribosomes, and inclusions.

The Nucleoid

14. The nucleoid contains the DNA of the bacterial chromosome.

15. Bacteria can also contain plasmids, which are circular, extrachromosomal DNA molecules.

Ribosomes

16. The cytoplasm of a prokaryote contains numerous 70$ ribosomes; ribosomes consist of rRNA and protein.

17. Protein synthesis occurs at ribosomes; it can be inhibited by certain antibiotics.

Inclusions

18. Inclusions arc reserve deposits found in prokaryotic and eukaryotic cells.

19. Among the inclusions found in bacteria are metachromatic granules (inorganic phosphate), polysaccharide granules (usually glycogen or starch), lipid inclusions, sulfur granules, carboxysomes (ribulose 1,5-diphosphate carboxylase), magnetosomes (Fe_3O_4), and gas vacuoles.

Endospores

20. Endospores are resting structures formed by some bacteria; they allow survival during adverse environmental conditions.

21. The process of endospore formation is called sporulation; the return of an endospore to its vegetative state is called germination.

THE EUKARYOTIC CELL

Flagella and Cilia

1. Flagella are few and long in relation to cell size; cilia are numerous and short.
2. Flagella and cilia are used for motility, and cilia also move substances along the surface of the cells.
3. Both flagella and cilia consist of an arrangement of nine pairs and two single microtubules.

The Cell Wall and Glycocalyx

1. The cell walls of many algae and some fungi contain cellulose.
2. The main material of fungal cell walls is chitin.
3. Yeast cell walls consist of glucan and mannan.
4. Animal eells are surrounded by a glycocalyx, which strengthens the cell and provides a means of attachment to other cells.

The Plasma (Cytoplasmic)Membrane

1. Like the prokaryotic plasma membrane, the eukaryotic plasma membrane is a phospholipid bilayer containing proteins.
2. Eukaryotic plasma membranes contain carbohydrates attached to the proteins and sterols not found in prokaryotic cells (except *Mycoplasma* bacteria).

5. The Golgi complex consists of flattened sacs called cisterns. It functions in membrane formation and protein secretion.
6. Lysosomes are formed from Golgi complexes. They store digestive enzymes.
7. Vacuoles are membrane-enclosed cavities derived from the Golgi complex or endocytosis. They are usually found in plant cells that store various substances, increase cell size, and provide rigidity to leaves and stems.
8. Mitochondria are the primary sites of ATP production. They contain 70S ribosomes and DNA, and they multiply *by* binary fission.
9. Chloroplasts contain chlorophyll and enzymes for photosynthesis. Like mitochondria, they contain 70S ribosomes and DNA and multiply by binary fission.
10. A variety of organic compounds are oxidized in peroxisomes. Catalase in peroxisomes destroys H_2O_2.
11 . The centrosome consists of the pericentriolar material and centrioles. Centrioles are 9 triplet microtubules involved in formation of the mitotic spindle and microtubules.

The Evolution of Eukaryotes

1. According to the endosymbiotic theory, eukaryotic cells evolved from symbiotic prokaryotes living inside other prokaryotic cells.

Q1/ 1- Why is an endospore called a resting structure? Of what advantage is an endospore to a bacterial cell?

2- Compare and contrast the following:
a. simple diffusion and facilitated diffusion
b. active transport and facilitated diffusion
c. active transport and group translocation

Q2/ Match the structures in column A to their functions in column B?

(Column A)	(Column B)
a.Cell wall	1. Attachment to surfaces
b. Endospore	2. Cell wall formation
c. Fimbriae	3. Motility
d. Flagella	4. Protection from osmotic lysis
e. Glycocalyx	5 . Protection from phagocytes
I. Pili	6. Resting
g. Plasma membrane	7. Protein synthesis
h. Ribosomes	8. Selective permeability
9. Transfer of genetic material	

Q2/ Match the characteristics of eukaryotic cells in column A with their functions In column?

(Column A)	(Column B)
a… Pericentriolar material	1. Digestive enzyme storage
b... Chloroplasts	2.oxidation of fatty acids
c…. Golgi complex	3. Microtubule formation
d…. Lysosomes	4. Photosynthesis
e… Mitochondria	5 . Protein synthesis
f… Respiration	6- Respiration
g…. Rough ER	7. Secretion

References': 1- Microbiology an introduction TENTH EDITION. Gerard. Tortora.2010.

2- Microbiology an introduction TWELFTH EDITION. Gerard. Tortora.2016.