Problem Set #1
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Cell Biology

Question 1:
What is the approximate size of the following:

a. E. coli
b. Yeast
c. Mammalian Cell
d. Antibody
e. Ribosome

Answer:

a. 1-2µm
b. 4-6µm
c. 10-100µm
d. 2-10nm
e. 10nm (20-30nm)

Question 2:
What are the volumes of E. coli, yeast, and a HeLa cell?

Answer: 1fL, 30-60fL, 3000fL

Question 3:
What are the two main classes of bacteria and what differentiates them?

Answer:
Gram + and Gram – bacteria.
They are differentiated based on the structure of their cell wall and their response to Gram staining, a laboratory technique used to classify bacteria.
Gram +: Plasma membrane -> Periplasmic space -> Peptidoglycan
Gram -: Plasma membrane -> Periplasmic space -> Peptidoglycan -> Periplasmic space -> Outer membrane

Question 5:
Name one example of a Gram+ and one Gram – bacterium.

Answer: S. aureus = Gram + ; E. coli = Gram –

Question 6:
What is the peptidoglycan layer primarily made of?

Answer:
1. Sugars (Glycan Chains):
   - N-acetylglucosamine (NAG)
   - N-acetylmuramic acid (NAM)
2. Peptide Chains (Cross-Linking Bridges):
   - Short peptide chains (made of amino acids) are attached to the NAM molecules.
   - These peptides cross-link between NAM molecules, providing strength and rigidity.

Question 7:
What is the mode of action of a beta-lactam antibiotic?

a) They bind to ribosomes and thus inhibit translation.
b) They insert into the cell membrane and thus burst open the cells leading to cell death.
c) They bind to penicillin binding proteins and inhibit peptidoglycan layer formation.
d) They are generally toxic to all cells.

Answer: c

Question 8:
What is required to fit a bacterial genome into a bacterial cell?

Answer: Bacterial genomes need to be condensed, as a random coil volume of their genome without condensation is ~2 orders of magnitude larger than the volume of a bacterium. Condensation is in part achieved through DNA binding proteins.

Question 9:
How are plasmids transferred from one bacterium to another?

Answer: Via the process of conjugation and the use of a pilus that connects two cells.

Question 10:
What types of endoplasmic reticuli exist and what are their main functions?

Answer:
Rough Endoplasmic Reticulum (site of protein synthesis and initial folding)
Smooth Endoplasmic Reticulum (lipid synthesis, detoxification and storage of calcium ions for cellular signaling)

Question 11:
Which of the following transport mechanisms requires energy in the form of ATP?

a) Simple diffusion
b) Facilitated diffusion
c) Primary active transport
d) Secondary active transport

Answer: c

Question 12:
What is endocytosis and name three endocytic pathways?

Answer:
Endocytosis is the process by which cells internalize extracellular material by engulfing it within vesicles formed from the plasma membrane. This allows cells to take in nutrients, regulate membrane composition, and respond to environmental signals.

Three Major Endocytic Pathways:

1. Phagocytosis ("Cell Eating")
2. Pinocytosis ("Cell Drinking")
3. Receptor-Mediated Endocytosis (Clathrin-Mediated Endocytosis)

Question 13:
Name the 3 structural components of the cytoskeleton.

Answer: Microtubules, microfilaments, and intermediate filaments.

Question 14:
By what process do bacteria divide?

a) Mitosis
b) Binary fission
c) Meiosis
d) All of the above

Answer: b

Question 15:
Number the following steps in Mitosis in the order in which they occur.

__ Anaphase
__ Metaphase
__ Prophase
__ Cytokinesis
__ Telophase

Answer:

3 Anaphase
2 Metaphase
1 Prophase
5 Cytokinesis
4 Telophase

Question 16:
What is the difference between mitosis and meiosis?

Answer:

• Mitosis produces two genetically identical diploid cells for growth and repair.
• Meiosis produces four genetically unique haploid gametes for sexual reproduction, increasing genetic diversity.