Name: _____ **Date:** _____

Answer Key: Getting High-Strung Over Hypertonic Solutions: 11th Grade Cytology

Surface area-to-volume ratios, endosymbiosis evidence, and specialized membrane protein kinetics. Students will evaluate complex physiological scenarios to analyze how organelle malfunctions disrupt cellular homeostasis.

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1. A researcher observes a cell with an unusually high density of Smooth Endoplasmic Reticulum (SER). In which of the following specialized human cells would this most likely be an adaptive feature?

Answer: B) A Leydig cell in the testes responsible for testosterone synthesis

The Smooth ER is the primary site for lipid and steroid hormone synthesis; cells like Leydig cells require extensive SER to produce testosterone, whereas the other options focus on protein synthesis (Rough ER) or lack organelles entirely.

2. The _____ theory is supported by the fact that mitochondria and chloroplasts possess their own circular DNA and 70S ribosomes, similar to modern prokaryotes.

Answer: B) Endosymbiotic

The Endosymbiotic Theory posits that key eukaryotic organelles originated as symbiotic prokaryotes, evidenced by their independent genomes and bacterial-like ribosomes.

3. As a cell increases in size, the surface area-to-volume ratio decreases, significantly limiting the efficiency of diffusion-based nutrient exchange.

Answer: A) True

Volume increases by the cube while surface area only increases by the square; a lower ratio means the membrane cannot support the metabolic demands of the internal volume.

4. If a mutation causes a defect in the Signal Recognition Particle (SRP) that docks with the Rough ER, where would proteins destined for secretion most likely accumulate?

Answer: C) Within the cytosol

SRP is required to translocate the ribosome-protein complex to the ER membrane; without it, translation finishes in the cytosol, and the protein never enters the endomembrane system.

5. The movement of water through _____ proteins is a form of facilitated diffusion that allows cells to regulate osmotic pressure faster than simple diffusion.

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Answer: B) Aquaporin

Aquaporins are specialized channel proteins that facilitate the rapid transport of water molecules across the hydrophobic lipid bilayer.

6. Lysosomal enzymes, such as acid hydrolases, are most active at a neutral pH of 7.0 found in the general cytoplasm.

Answer: B) False

Lysosomal enzymes are specifically adapted for acidic environments (pH ~4.5-5.0), a safety mechanism that prevents them from digesting the cell if the lysosome ruptures.

7. A patient is diagnosed with a disorder characterized by the inability to break down very-long-chain fatty acids (VLCFAs). Which organelle is most likely dysfunctional?

Answer: B) Peroxisome

Peroxisomes contain enzymes like catalase and those involved in beta-oxidation of very-long-chain fatty acids, a role distinct from the general metabolic tasks of mitochondria.

8. In the fluid mosaic model, _____ molecules act as a 'fluidity buffer,' preventing the membrane from becoming too rigid in cold temperatures or too fluid in heat.

Answer: B) Cholesterol

Cholesterol wedges between phospholipids, interfering with their packing at low temperatures and restricting movement at high temperatures to maintain membrane integrity.

9. Which of the following scenarios best describes the role of the cytoskeleton in maintaining cellular function during mitosis?

Answer: A) Actin filaments forming the contractile ring during cytokinesis

During the final stage of animal cell division, actin microfilaments create a cleavage furrow to pinch the cell into two, while microtubules form the spindle fibers to move chromosomes.

10. Active transport is the only mechanism of cellular transport that requires the direct or indirect expenditure of metabolic energy (ATP).

Answer: A) True

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Unlike passive transport (diffusion, osmosis) which follows a concentration gradient, active transport moves substances against a gradient and necessitates energy.