Name: _____ **Date:** _____

Answer Key: Invisible Giants: The High-Stakes 11th Grade Microbiology Challenge

Learners synthesize metabolic pathways and evaluate pathogenicity mechanisms within complex microbial ecosystems to conclude their advanced cellular biology unit.

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1. A researcher discovers a soil bacterium that utilizes H_2S as an electron donor and CO_2 as a carbon source. How should this organism be categorized based on its metabolic requirements?

Answer: B) Chemolithoautotroph

Chemolithoautotrophs obtain energy from the oxidation of inorganic compounds (like H_2S) and use inorganic carbon (CO_2) as their primary carbon source.

2. Reverse transcriptase is an enzyme unique to retroviruses that allows them to bypass the Central Dogma of Molecular Biology by synthesizing DNA from an RNA template.

Answer: A) True

Retroviruses use reverse transcriptase to convert their viral RNA genome into DNA, which is then integrated into the host genome, reversing the standard DNA-to-RNA flow.

3. When measuring microbial growth in a closed system, the stage characterized by a high rate of horizontal gene transfer and peak metabolic activity is labeled the _____ phase.

Answer: C) Log (Exponential)

The log phase is the period of most rapid reproduction and cellular activity, making it the primary window for metabolic studies and genetic interaction.

4. A patient is infected with a pathogen that utilizes Type III Secretion Systems (T3SS) to inject effector proteins into host cells. Which organism is most likely responsible?

Answer: B) Gram-negative Pseudomonas aeruginosa

Type III Secretion Systems are specialized protein apparatuses found in many pathogenic Gram-negative bacteria used to manipulate host cell physiology.

5. Archaea differ significantly from Bacteria in their membrane composition; specifically, Archaea utilize _____ bonds to link glycerol to isoprenoid side chains.

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Answer: C) Ether

Archaeal membranes contain ether-linked lipids, which are more chemically stable than the ester-linked lipids found in Bacteria and Eukarya, allowing them to survive extreme environments.

6. Bacteriophages undergoing the lysogenic cycle immediately cause the lysis of the host cell to release new virions.

Answer: B) False

In the lysogenic cycle, the viral genome (prophage) integrates into the host's chromosome and remains dormant; cell lysis occurs only during the lytic cycle.

7. Which of the following describes the role of 'quorum sensing' in microbial populations?

Answer: B) Chemical signaling to coordinate group behaviors like biofilm production

Quorum sensing is a density-dependent cell-to-cell communication mechanism that allows bacteria to synchronize gene expression once a population threshold is reached.

8. In the context of the Nitrogen Cycle, the process of _____ involves the biological reduction of nitrate (NO_3^-) to nitrogen gas (N_2) by facultative bacteria.

Answer: D) Denitrification

Denitrification is an anaerobic process performed by bacteria like Pseudomonas that returns nitrogen to the atmosphere, completing the cycle.

9. Prions are infectious agents composed entirely of misfolded proteins and lack any nucleic acid component.

Answer: A) True

Unlike viruses or bacteria, prions contain no DNA or RNA; they cause disease by inducing normal cellular proteins to fold into the same abnormal, pathogenic shape.

10. How does the CRISPR-Cas9 system function naturally within a bacterial cell?

Answer: B) As an adaptive immune system against bacteriophage infections

CRISPR-Cas9 serves as a prokaryotic immune system that 'remembers' viral DNA from previous encounters to specifically target and cleave subsequent invading DNA.