Name: _____ **Date:** _____

Answer Key: Epistemological Boundaries: Advanced Scientific Method Quiz for 12th Grade

Falsifiability, statistical significance, and peer review methodologies. Analyze the rigorous frameworks that separate robust empirical evidence from pseudoscience.

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1. In a longitudinal study examining the efficacy of a new CRISPR-Cas9 gene therapy, researchers fail to reject the null hypothesis ($p > 0.05$). What is the most rigorous scientific interpretation of this result?

Answer: B) The data does not provide sufficient evidence to support the treatment's efficacy.

In 12th-grade statistics and science, failing to reject the null hypothesis means the evidence is insufficient to claim an effect, but it does not 'prove' the inverse is true.

2. Philosopher Karl Popper argued that for a theory to be considered truly scientific, it must possess the quality of _____, meaning it must be capable of being proven false by observation.

Answer: C) Falsifiability

Falsifiability is a cornerstone of the modern scientific method, distinguishing scientific claims from dogmatic or pseudoscientific ones.

3. A double-blind peer review process is primarily designed to mitigate cognitive biases, such as the halo effect or confirmation bias, within the scientific community.

Answer: A) True

Double-blinding ensures that neither the authors nor the reviewers know each other's identities, reducing subjective bias in evaluating the study's merits.

4. When analyzing the results of a double-blind clinical trial for a new neuro-inhibitor, a researcher notices a 'Type II error.' What has occurred in the context of the scientific method?

Answer: B) The researcher failed to detect a real effect that was present (False Negative).

A Type II error occurs when the null hypothesis is false, but the researcher fails to reject it, essentially missing a real scientific discovery.

5. In high-energy physics, such as the discovery of the Higgs Boson, a threshold of _____ sigma is required to claim a formal discovery, representing a 1 in 3.5 million chance of a fluke.

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Answer: C) Five

The 5-sigma standard is the rigorous benchmark for 'discovery' in particle physics, demonstrating the importance of statistical significance in the scientific method.

6. In the hierarchy of scientific evidence, a meta-analysis of randomized controlled trials (RCTs) is generally considered to have higher evidentiary value than a singular observational case study.

Answer: A) True

Meta-analyses synthesize data from multiple high-quality studies, providing a more robust and generalized conclusion than individual observations.

7. Which of the following scenarios best illustrates the concept of 'serendipity' integrated with the formal scientific method?

Answer: B) A researcher accidentally contaminates a Petri dish, leading to the discovery of penicillin through rigorous follow-up.

Alexander Fleming's discovery of penicillin is a classic example of serendipity—where an unexpected observation is pursued using the systematic scientific method.

8. Thomas Kuhn's 'The Structure of Scientific Revolutions' suggests that science does not always progress linearly, but rather through _____, where an old model is replaced by a fundamentally different one.

Answer: B) Paradigm shifts

A paradigm shift represents a fundamental change in the basic concepts and experimental practices of a scientific discipline.

9. If a researcher is studying the 'Leidenfrost Effect' and measures how droplet volume influences evaporation time on a surface at a constant 250°C, what is the 'controlled variable'?

Answer: C) The temperature of the surface.

The surface temperature is held constant to ensure that changes in evaporation time are due solely to changes in droplet volume (independent variable).

10. Inductive reasoning moves from specific observations to broad generalizations; however, it cannot provide absolute certainty in the same way that deductive reasoning can.

Answer: A) True

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Inductive reasoning creates probable conclusions and is central to hypothesis formation, whereas deduction provides logically certain conclusions based on true premises.