Name: _____ **Period:** _____ **Date:** _____

> Open **peebedu.com** and navigate to **ELISA Virtual Laboratory**. Click the **Put on gloves** button to begin. The simulation provides four assay types (Direct, Indirect, Sandwich, and Case Study) with a full set of reagents including antigens, antibodies, blocking buffer, and three substrate options. Use the **Molecular View** button to observe antibody-antigen interactions at the molecular level.

Part 1 — Model Evaluation (MAPP Framework)

Scientific models are simplified representations of complex biological phenomena. Use the MAPP framework below to evaluate the ELISA Virtual Laboratory as a scientific model.

M — Mode

What type of model is the ELISA Virtual Laboratory? Describe how this computational simulation represents the process of detecting specific proteins using antibody-antigen interactions. In your answer, identify at least three specific simulation elements and explain what each one is designed to show about ELISA techniques.

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A — Accuracy

(a) Identify two things this simulation represents **accurately** about ELISA techniques. For each, name the specific simulation feature and explain what aspect of the real laboratory technique it demonstrates.

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(b) Identify two things this simulation **oversimplifies or leaves out** about ELISA. Consider what you cannot observe in the simulation that would be important for a complete understanding of how antibody-based detection works in a real immunology lab.

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P — Purpose

What is the learning goal of this simulation? Explain how the ELISA Virtual Laboratory is designed to help you understand how antibody-antigen specificity is used to detect target proteins in biological samples. In your answer, connect at least one specific simulation feature to a biological application of why ELISA techniques matter for diagnosing diseases or analyzing gene products.

P — Permanency

Could this model change with new scientific evidence? Describe one way that new discoveries or technologies might change or improve a simulation like the ELISA Virtual Laboratory. Explain why scientific models, including computational simulations, are revised as new evidence becomes available.

Small-Group Discussion

With your group, discuss the following:

- What are the strengths of this simulation as a model for ELISA techniques?
- What are its limitations?
- If you could add one feature to improve this simulation, what would it be and why?
- How does the Molecular View help you connect the procedural steps of ELISA to the molecular-level interactions between antibodies and antigens?

Part 2 — Free Response Questions

Conceptual Analysis

Question 1 — Antibody-Antigen Specificity in Direct ELISA

*Simulation Task: Select the **Direct ELISA** assay type and complete the full protocol: put on gloves, coat the well with antigen, add blocking buffer, add the primary antibody, wash the plate, add TMB substrate, and read the plate. Then repeat the protocol but **skip the blocking step** and observe how the results differ.*

(A) (1 pt) **Describe** how ELISA uses the specificity of antibody-antigen interactions to detect a target protein in a sample.

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(B) (1 pt) **Explain** why the blocking step is necessary in an ELISA protocol.

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(C) (1 pt) **Predict** how the signal-to-noise ratio would change if a patient sample contained a very low concentration of the target antigen compared to a sample with a high concentration.

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(D) (1 pt) **Justify** why ELISA is considered a reliable biotechnology technique for clinical diagnostics by explaining how positive and negative controls validate the assay results.

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Analyze Model / Visual Representation

Question 2 — Comparing ELISA Variants

*Simulation Task: Switch between all three assay types — **Direct, Indirect**, and **Sandwich ELISA** — and use the **Molecular View** to observe the differences in how antibodies and antigens are layered in each variant. Pay attention to how many antibody layers are present and where the enzyme label is attached in each assay type.*

(A) (1 pt) **Describe** how genetic engineering techniques, including antibody-based detection methods like ELISA, allow scientists to analyze specific gene products (proteins) in biological samples.

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(B) (1 pt) **Explain** how the three ELISA variants (direct, indirect, and sandwich) differ in their use of antibodies to detect the target antigen.

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(C) (1 pt) **Represent** the molecular architecture of a Direct ELISA and an Indirect ELISA side by side.

Draw your diagrams here.

(D) (1 pt) **Explain** how a novel pathogen entering a population could act as a selective pressure.

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