IVF Simulator

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

> Open **peebedu.com** and navigate to **IVF Simulator**. Read the introduction popup, which describes sexual reproduction, the IVF process, and preimplantation genetic testing (PGT) for three monogenic disorders: sickle cell disease (HBB gene), Tay-Sachs disease (HEXA gene), and cystic fibrosis (CFTR gene). Click **Begin Laboratory Session** to enter the virtual IVF laboratory.

Part 1 — Model Evaluation (MAPP Framework)

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

M — Mode

What type of model is the IVF Simulator? Describe how this computational simulation represents the process of in vitro fertilization and genetic inheritance. In your answer, identify at least three specific simulation elements and explain what each one is designed to show about sexual reproduction and heredity.

A — Accuracy

(a) Identify two things this simulation represents **accurately** about fertilization and genetic inheritance. For each, name the specific simulation feature and explain what biological concept it demonstrates.

(b) Identify two things this simulation **oversimplifies or leaves out** about sexual reproduction and inheritance. Consider what you cannot observe in the simulation that would be important for a complete understanding of how gametes form and how alleles are transmitted.

P — Purpose

What is the learning goal of this simulation? Explain how the IVF Simulator is designed to help you understand how haploid gametes fuse during fertilization to form a diploid zygote with new allele combinations. In your answer, connect at least one specific simulation feature to the biological significance of genetic variation produced by fertilization.

P — Permanency

Could this model change with new scientific evidence? Describe one way that new discoveries in genetics or reproductive biology might change or improve a simulation like the IVF Simulator. 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 fertilization and genetic screening?
- What are its limitations?
- If you could add one feature to improve this simulation, what would it be and why?
- How does the simulation help you connect the molecular-level concept of allele combinations to the medical application of preimplantation genetic testing?

Part 2 — Free Response Questions

Conceptual Analysis

Question 1 — Fertilization and Allele Combinations

> *Simulation Task: Activate the micropipette and collect one oocyte and one spermatozoon. Deposit both onto the microscope workspace to perform ICSI. Once the zygote forms, hover over the embryo to view its complete karyotype and genotype for all three genes (HBB, HEXA, CFTR). Record the allele combinations. Repeat the fertilization with a second pair of gametes and compare the two embryos' genotypes.*

(A) (1 pt) **Describe** how meiosis produces haploid gametes and how the fusion of two haploid gametes during fertilization restores the diploid chromosome number in the zygote.

(B) (1 pt) **Explain** how the combination of alleles in your two embryos demonstrates that fertilization increases genetic variation by creating new combinations of alleles in the zygote.

(C) (1 pt) **Predict** the probability that an embryo produced from two parents who are both heterozygous carriers for sickle cell disease (HBB: Aa) would be homozygous recessive (aa) and affected by the disease.

(D) (1 pt) **Justify** why preimplantation genetic testing for monogenic disorders like sickle cell disease, Tay-Sachs disease, and cystic fibrosis relies on the predictable patterns of Mendelian inheritance described by the law of segregation.

EK 5.1.A.1, 5.3.A.2

Analyze Model / Visual Representation

Question 2 — Genotype, Phenotype, and Genetic Screening

> *Simulation Task: Perform at least four separate fertilizations by collecting different oocyte-sperm pairs. For each resulting embryo, hover to view the karyotype and record the genotype for all three genes and the sex chromosomes. Identify which embryos are healthy (no homozygous recessive genotypes and no chromosomal abnormalities) and which are affected or carriers.*

(A) (1 pt) **Describe** the relationship between an organism's genotype and its phenotype, using the HBB gene as a specific example from the simulation to distinguish among homozygous dominant, heterozygous, and homozygous recessive genotypes.

(B) (1 pt) **Explain** how the independent assortment of alleles for the HBB, HEXA, and CFTR genes during meiosis contributes to the variety of genotype combinations observed across your four embryos.

(C) (1 pt) **Represent** the possible allele combinations for the HBB gene when two heterozygous parents (Aa × Aa) produce offspring.

Draw your Punnett square here.

(D) (1 pt) **Explain** how a single nucleotide mutation in the HBB gene leads to the production of an altered hemoglobin protein that causes sickle cell disease.

EK 5.1.A.1, 5.3.A.2