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 — NGSS Questions

1.

> *Simulation Task: Activate the micropipette and collect one oocyte from the egg test tube. Deposit it on the microscope workspace and hover over it to view its alleles and sex chromosome. Then collect one spermatozoon, deposit it near the oocyte, and observe the ICSI fertilization. Hover over the resulting zygote to view its combined genotype.*

Explain how each gamete contributes one set of chromosomes during fertilization so that the resulting zygote has a complete set from both parents. Use the genotype you observed in the simulation to support your explanation.

HS-LS3-1

2.

> *Simulation Task: Perform a second fertilization using a different oocyte and spermatozoon. Hover over the new embryo and compare its genotype for all three genes (HBB, HEXA, CFTR) and its sex chromosomes to the first embryo you created.*

Describe how the random combination of gametes during fertilization produces offspring with different allele combinations. Use the genotypes of your two embryos as evidence in your answer.

HS-LS3-2

3.

> *Simulation Task: Create a third embryo and hover over it to view the karyotype tooltip. Identify the sex chromosomes (XX or XY) and the genotype for the HBB gene. Determine whether this embryo is homozygous dominant, heterozygous, or homozygous recessive for the HBB gene.*

Explain how a parent with a heterozygous genotype (such as HBB: Aa) can pass either the dominant or recessive allele to offspring during meiosis. Describe why this means two carrier parents can produce a child affected by sickle cell disease.

HS-LS3-1

4.

> *Simulation Task: Perform at least four fertilizations total. For each embryo, hover to view its genotype and record the HBB, HEXA, and CFTR results. Count how many embryos are carriers (heterozygous) for at least one gene versus how many have all homozygous dominant genotypes.*

Explain why the three genes (HBB, HEXA, CFTR) sort independently during meiosis, producing many different genotype combinations in the embryos. Describe how this independent sorting of chromosomes increases genetic variation in offspring.

HS-LS3-2

5.

> *Simulation Task: Among your embryos, find one that is homozygous recessive (aa, tt, or cc) for any gene. If none are affected, create additional embryos until you find one. Compare this embryo's genotype to a healthy embryo's genotype for the same gene.*

Describe how the genotype of an organism determines whether it is unaffected, a carrier, or affected by a recessive genetic disorder. Explain why an embryo must inherit a recessive allele from both parents to be affected.

HS-LS3-1

6.

> *Simulation Task: Consider two parents who are both heterozygous carriers for sickle cell disease (HBB: Aa). Think about the alleles each parent can pass on through their gametes and the possible allele combinations in offspring.*

In the box below, draw a diagram showing the possible offspring genotypes when two parents who are both carriers (Aa) for the HBB gene have children. Label each possible offspring genotype and indicate which would be unaffected, carriers, or affected by sickle cell disease.

Draw your diagram here.

HS-LS3-1

7.

> *Simulation Task: Click New Samples to reset the laboratory and observe that the new set of gametes carries different allele combinations than the previous set. Consider how this variation in each generation could affect a population over many generations.*

Explain how the genetic variation produced by meiosis and fertilization provides the raw material for natural selection to act on in a population. Describe how a trait like sickle cell carrier status could become more or less common in a population over many generations depending on environmental conditions.

HS-LS4-2