Name: **Date:** **Section:**

DNA Replication Simulator Activity: Modeling DNA Synthesis

The Amazing Process of DNA Replication

Phase 1: ENGAGE (5 minutes)

Getting Started:

Open peebedu.com and navigate to DNA Replication Simulator

Click through the introduction to learn about DNA replication.

The Big Question:

Before every cell division, DNA must be copied perfectly. How does a cell copy 3 billion base pairs without making mistakes? _____

Quick Review:

- DNA bases: A pairs with ___, G pairs with ___
- DNA strands run in opposite directions (antiparallel)
- New DNA is always built 5' to 3'

Think About It:

If you had to copy a book, would it be easier to: _____

□ Copy it all at once from start to finish

□ Copy it in sections with multiple helpers

DNA uses the second strategy! Let's see how.

Phase 2: EXPLORE (20 minutes)

Step-by-Step DNA Replication

Part A: Getting DNA Ready

1. **Tool 1 - Topoisomerase:**

Select and click on the DNA

What happens? _____

Why needed? Think of untangling headphone wires!

1. **Tool 2 - Helicase:**

Apply to the relaxed DNA

What it does: _____

What shape forms? This is the "replication _____"

Part B: Starting Points

1. **Tool 3 - Primase:**

Apply to the unwound DNA

Count the RNA primers:

- Bottom strand (leading): _____ primer(s)

Key Insight: DNA polymerase can't start from scratch!

Part C: Building New DNA

1. **Tool 4 - DNA Polymerase:**

Click on EACH strand separately!

Leading strand (bottom):

- Synthesis direction: Toward / Away from fork

Lagging strand (top):

- Synthesis direction: Toward / Away from fork

1. **Interactive Building:**

Drag the correct nucleotides!

Tips for success:

- A matches with ___

- Watch the "Need: __" hint
- Green = correct, Red = wrong

Part D: Finishing Up

1. **Tool 5 - DNA Ligase:**

Apply to complete replication

What does it connect? _____

These chunks are called "_____ fragments"

Phase 3: EXPLAIN (15 minutes)

Making Sense of What You Saw

1. **The Key Patterns (Find 3):**

- Pattern 2: Leading strand = _____, Lagging = _____

1. **Fill in the Process Map:**

DNA twisted → Topoisomerase → DNA _____

DNA closed → Helicase → DNA _____

No starting point → Primase → RNA _____

Template ready → DNA Polymerase → New _____

Fragments separate → Ligase → Continuous _____

1. **The Replication Team:**

Match each enzyme to its job:

Enzyme: Job:

- Topoisomerase • Joins DNA pieces
- Helicase • Adds RNA starters
- Primase • Untwists DNA
- DNA Polymerase • Unzips DNA
- Ligase • Builds new DNA

1. **Why Different on Each Strand?**

Draw arrows showing synthesis direction:

Leading strand: ——————————→

Lagging strand: ←——— ←——— ←———

The lagging strand is made backwards in pieces because _____

Phase 4: ELABORATE (12 minutes)

Real-World Connections

Application Scenarios:

1. **DNA Testing:**

Crime labs use PCR to copy DNA evidence.

Which enzyme is most like the one in PCR? _____

Why do they heat the DNA first? (Hint: What does helicase do?) _____

1. **Cancer and Replication:**

Some cancers have mutations in DNA repair enzymes.

Predict what happens if:

- Polymerase makes more mistakes: _____

1. **Antibiotics:**

Some antibiotics block bacterial DNA replication.

Good target enzyme: _____

Why it works: _____

Design Challenge:

You're creating a replication inhibitor drug.

- Target which step? _____

- Side effects to consider? _____

Phase 5: EVALUATE (8 minutes)

Show What You Know

1. **Sequence the Steps:**

Number in order (1-5):

___ DNA polymerase synthesizes new strands

___ Ligase joins fragments

___ Helicase unwinds DNA

___ Primase adds RNA primers

___ Topoisomerase relaxes DNA

1. **Explain the Difference:**

Your friend asks: "Why can't both strands be copied the same way?"

Your answer: _____

1. **Problem Solving:**

A cell has a mutation - it can't make Okazaki fragments.

- Which enzyme is probably broken? _____

- Can the cell still replicate its DNA? Yes / No / Partially

1. **Make Connections:**

How does accurate DNA replication relate to:

- Inheritance: _____
- Cancer: _____

Model Check:

- One thing that surprised you: _____

Vocabulary Summary:

- **Replication Fork:** Y-shaped region where DNA unwinds
- **Leading Strand:** Synthesized continuously toward fork
- **Lagging Strand:** Synthesized in fragments away from fork
- **Okazaki Fragments:** Short DNA pieces on lagging strand
- **Semiconservative:** Each new DNA has one old strand, one new