

The enzymes and the checks HL

60 minutes • D1.1.8, D1.1.9 • Chapters 9, 10

Primase, polymerases III and I, ligase, and proofreading

BY THE END, STUDENTS CAN

- ☐ State what DNA primase, DNA polymerase I, DNA polymerase III and DNA ligase each do D1.1.8
- ☐ Explain how DNA polymerase III proofreads the strand it is building D1.1.9

TIMING

0-5	5 min	Do now: riddles of the fork	
5-15	10 min	Four enzymes	
15-23	8 min	Checking as it goes	
23-40	17 min	Run the fork, the whole fork	
40-52	12 min	Where did it go wrong?	
52-60	8 min	Exit	
	60 min	One lesson	

STARTER

- 5 min** **Do now: riddles of the fork**
- Five short riddles on the board, each describing an enzyme; students name them (Riddles of the fork, below).

ON THE BOARD, FROM THE GUIDE

Open the guide on the projector at each chapter (the links work in this PDF). Every figure plays from its own buttons, and the lesson's slides have the same figures, step by step, in the order of this plan.

09 Four enzymes at the fork

CHAPTER 09 IN THE SLIDES

Tap the parts of the figure in turn: The leading strand, An RNA primer, An Okazaki fragment, An RNA primer, An RNA primer, A nick, DNA ligase, DNA polymerase I, DNA polymerase III, DNA polymerase III, DNA primase and Helicase.

Predict box: A bacterium makes a faulty DNA ligase. What would you find in its newly copied DNA? Hands up or mini whiteboards first.

Answer A: Lagging strands left as short fragments

Remember it: Hungry Pandas Prefer Plain Lettuce (Helicase, DNA primase, DNA polymerase III, DNA polymerase I, DNA ligase).

10 Checking as it goes

CHAPTER 10 IN THE SLIDES

Step through the figure (5 steps, the arrow keys on a projector). Stop on each caption and ask what changed before you go on.

- DNA polymerase III adds nucleotides at the **3' end**.
- Rarely, a **mismatch** is joined in.
- It backs up and **removes** the mismatched nucleotide.
- It adds the **correct** one.
- Then it carries on: about 1 mistake in 10 million survives.

Step through the figure (5 steps, the arrow keys on a projector). Stop on each caption and ask what changed before you go on.

1. One **primer** starts the leading strand.
2. On the lagging strand: a new **primer** for every fragment.
3. **DNA polymerase I** swaps the RNA primer for DNA.
4. **DNA ligase** makes the last bond in the backbone.
5. A **mismatch** at the 3' end: what does DNA polymerase III do next?

Predict box: Without proofreading, DNA polymerase III gets about 1 base in 100,000 wrong. With it, about 1 in 10 million. Copying a bacterial chromosome means adding about 9 million new bases. About how many mistakes would each give? Hands up or mini whiteboards first.

Answer B: About 90 without, about 1 with it

THE LESSON

- 10**
min

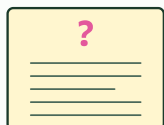
Four enzymes
Chapter 9's figure: tap each enzyme. Then the Hungry Pandas Prefer Plain Lettuce tiles and [chapter 9's](#) predict box.
-
- 8**
min

Checking as it goes
[Chapter 10's](#) figure, then [chapter 10's](#) predict box, worked on paper.
-
- 17**
min

Run the fork, the whole fork
Run the fork's higher level rounds in pairs ([chapter 10's](#) game). Each pair records its errors in every 1,000 bases and compares them with polymerase III's.
-
- 12**
min

Where did it go wrong?
Students hunt for the errors in a weak answer about building both new strands at a fork (Where did it go wrong?, below).
-

ACTIVITIES



WRITING · HL

Riddles of the fork

Five riddles, each an enzyme; students name them. "I open the door and the pairs let go; I break only the weakest bonds." (helicase) "I write in RNA, a few letters only, so the builder has somewhere to start." (primase) "I add to the 3' end and nowhere else, and I check each letter as I go." (DNA polymerase III) "I take out what was only ever a placeholder and put DNA in its place." (DNA polymerase I) "I add no letters at all; I make one bond where two pieces meet." (ligase)

Needs: the riddles on the board.



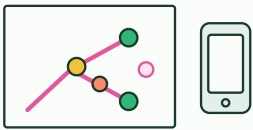
WRITING · HL

Where did it go wrong?

The question: "Describe how both new strands are built at a replication fork in a bacterium. (8 marks)" Give students this answer to correct: "Helicase splits the DNA by breaking the bonds between the sugars and phosphates. Primase adds a DNA primer to the 5' end of each strand. DNA polymerase I then adds nucleotides in the 3' to 5' direction. The lagging strand is copied later, which is why it lags, in Okazaki fragments. Ligase removes the primers and joins the fragments. Polymerase III checks the whole strand at the end for mistakes."

There are eight errors. Helicase breaks hydrogen bonds, not the bonds between sugar and phosphate. The primer is RNA. A primer is laid where copying starts, and nucleotides are added to its 3' end. It is polymerase III, not polymerase I, that adds most nucleotides. New strands grow 5' to 3'. The lagging strand is made at the same time as the leading strand, discontinuously. Polymerase I removes the primers, and ligase only joins. And proofreading removes the last nucleotide added, at the 3' end, as the strand is built.

Needs: the answer printed.



POSTER · HL

Poster, then a commentary

Homework after lesson 4. Students draw a fork on A3 with every enzyme and its job, the leading and lagging strands, Okazaki fragments, primers, and the 5' and 3' ends. Then they record a two-minute spoken walk-through over photos of the poster. The poster stays within the guide: no gyrase and no single-strand binding proteins.

Needs: A3 paper, coloured pens and a phone.

PLENARY

8

min

Exit

"Describe the roles of four enzymes in DNA replication." Four marks. Then set the poster and commentary for homework (Poster, then a commentary, below).

WHAT STUDENTS GET WRONG

Polymerase III removes primers, and ligase adds nucleotides. Polymerase I removes and replaces primers, and ligase makes one bond.

Primers are DNA. They are RNA.

Proofreading checks the finished strand. It removes the last nucleotide added, as it goes.

STRETCH AND SUPPORT

Support: use the Hungry Pandas Prefer Plain Lettuce tiles as a starter in lesson 4.

Stretch: why might a polymerase that can only extend from a correctly paired 3' end be more accurate than one that could also start strands? (Hint: the need for a primer and proofreading go together.)

IN THE GUIDE

- 9 [Four enzymes at the fork](#)
- 10 [Checking as it goes](#)
- All [The whole guide, with the figures that play](#)
- PPTX [This lesson's slides, in the order of this plan](#)

PRACTISE AND REVISE

BUILD FOR YOUR CLASS

- [Tarsia puzzle, dominoes and picture reveal](#) on D1.1, built from its key terms and ready to print
- A [pub quiz](#) with rounds on D1.1, to present or run with no projector
- An [escape room built from the question bank](#) on D1.1

ALREADY ON THE SITE FOR D1.1

- Quiz: [DNA Replication \(HL\)](#)
- Quiz: [DNA Replication](#)
- Revision map: [D1.1 DNA replication](#), to fill in
- Exam questions: [D1.1 in the exam maker](#), a paper with its markscheme

CARD SETS ON SPLYCR

- Open a set to host it as a class game, or make a copy to edit.
- [D1.1 DNA Replication](#)

How this was made. The course structure, the activities and the teaching choices come from my own classroom, my presentations and my years of teaching IB and AP Biology. I use Claude, an AI, to help write and build the interactive guides, lesson plans, slides and practice questions, and to draw the diagrams and code the interactives. I direct the work and review it against the IB and AP specifications before it goes live.

EXAM PRACTICE

Check yourself

Set it for homework: a fresh paper of exam-bank questions on D1.1 at higher level each time, marked as students go and saved to their Exam practice when they are signed in.

biologybybradford.com/exam-maker/sit?topics=D1.1&level=HL&paper=quiz&marks=15&src=ep

