

DNA replication

Two one-hour lesson plans, and two more at higher level

Four one-hour lessons cover D1.1: two for the standard level statements and two more for higher level (the guide gives D1.1 two hours at SL and two more at HL). The plan follows the chapters, so a class can read the guide for homework and use the lesson for the activities. Every figure plays on a projector: step through it with the arrow keys and stop on each caption. Run the fork is played twice, its standard level rounds in lesson 1 and its higher level rounds in lesson 4, and the PCR and gel dry lab is the main task of lesson 2.

LESSON	COVERS	FOCUS	CHAPTERS
1 Copying the code	D1.1.1 to D1.1.3	Why cells copy DNA, how the copy stays exact, and the two enzymes that do it	1, 2, 3
2 Amplify, separate, identify	D1.1.4, D1.1.5	PCR, gels and DNA profiles, and why more markers mean fewer false matches	4, 5, 6, lab
3 Two directions at one fork HL	D1.1.6, D1.1.7	Why polymerase adds only at the 3' end, and what that means for the two new strands	7, 8
4 The enzymes and the checks HL	D1.1.8, D1.1.9	Primase, polymerases III and I, ligase, and proofreading	9, 10

The guide, for the class to read and play: biologybybradford.com/guides/ib-biology-d1-1-dna-replication

Copying the code

60 minutes • D1.1.1 to D1.1.3 • Chapters 1, 2, 3

Why cells copy DNA, how the copy stays exact, and the two enzymes that do it

BY THE END, STUDENTS CAN

- ☐ Explain why cells copy their DNA, and why every copy must carry the same base sequence D1.1.1
- ☐ Explain what semi-conservative means, and how complementary base pairing makes copying accurate D1.1.2
- ☐ Describe what helicase and DNA polymerase do at a replication fork D1.1.3

TIMING

0-6	6 min	Do now: draw it again	
6-14	8 min	Why copy, and how many times?	
14-26	12 min	One old strand, one new	
26-40	14 min	Unzip, then build	
40-54	14 min	Improve the answer	
54-60	6 min	Exit	
	60 min	One lesson	

STARTER

6
min

Do now: draw it again

Students sketch one nucleotide the IB way, then three nucleotides of one strand paired with their partners (Draw it again, below). Check the drawings against the ones in A1.2.

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.

01 A copy for every new cell

CHAPTER 01 IN THE SLIDES

Step through the figure (4 steps, the arrow keys on a projector). Stop on each caption and ask what changed before you go on.

1. A cell holds one copy of its **DNA**.
2. Before it divides, it **copies** it, so each new cell has a full set.
3. Cells divide to **reproduce**, to **grow** and to **replace** what is lost.
4. Every one of your cells came from one by **division**.

Predict box: You began as one fertilised egg and now have about 30 trillion cells. If every cell divided in step, about how many rounds of copying and dividing would it take? Hands up or mini whiteboards first.

Answer B: About 45

02 One old strand, one new

CHAPTER 02 IN THE SLIDES

Switch the figure through Conservative, Semi-conservative, Dispersive and What they saw, and have the class say what will change before each.

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 molecule: two **old** strands.
2. A new partner is built along each strand: its **template**.
3. Each new molecule keeps one old strand: **semi-conservative**.
4. Copied again: **every** strand is a template.
5. Count the old strands.

Predict box: A DNA molecule is copied, and then both copies are copied again. Of the four molecules, how many still contain a strand from the original? Hands up or mini whiteboards first.

Answer C: Two: each old strand sits in one molecule

03 Unzip, then build

CHAPTER 03 IN THE SLIDES

Tap the parts of the figure in turn: An old strand, An old strand, Hydrogen bonds, A new strand, A new strand, Exposed bases, Exposed bases, A free nucleotide, A free nucleotide, DNA polymerase, DNA polymerase and Helicase.

Step through the figure (4 steps, the arrow keys on a projector). Stop on each caption and ask what changed before you go on.

1. One molecule: two **old** strands.
2. **Helicase** unwinds the helix and breaks the hydrogen bonds.
3. **DNA polymerase** joins nucleotides that pair with each exposed base.
4. Two molecules, each with one **old** strand and one **new**.

Predict box: A drug stops helicase but leaves DNA polymerase working. What happens to replication? Hands up or mini whiteboards first.

Answer A: It stops: polymerase needs single strands to read

THE LESSON

8
min

Why copy, and how many times?

Chapter 1's figure on the board, then chapter 1's predict box (how many rounds) by show of hands. Land on doubling: it comes back in lesson 2.

12
min

One old strand, one new

Chapter 2: the predict box first (four molecules, how many hold an old strand), then chapter 2's figure step by step. Then the How we know box: show chapter 2's Meselson and Stahl states, and students predict each model's tubes on mini whiteboards before each state is shown (Predict the tubes, below).

14
min

Unzip, then build

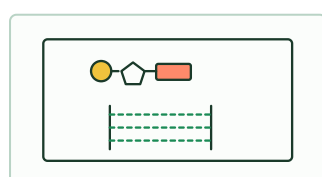
Chapter 3's figure: tap helicase and DNA polymerase. Then Run the fork's standard level rounds in pairs (chapter 3's game): compare each pair's speed with the real polymerase's.

14
min

Improve the answer

Students mark a weak eight-mark answer about copying a skin cell's DNA against the points the class has agreed from chapters 1 to 3, then rewrite it (Improve the answer, below).

ACTIVITIES

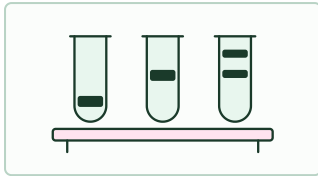


DRAWING

Draw it again

Students sketch one nucleotide the IB way: a circle for the phosphate, a pentagon for the sugar and a rectangle for the base. Then they draw three nucleotides of one strand paired with three of its partner, running the other way, A with T and C with G. They check against the drawings in A1.2.

Needs: mini whiteboards and pens.



DATA

Predict the tubes

With [chapter 2's](#) Meselson and Stahl figure on the board, pairs draw the three tubes that each model predicts before its state is shown. Then they draw the tubes that were observed and say which generation ruled out which model.

Needs: mini whiteboards.

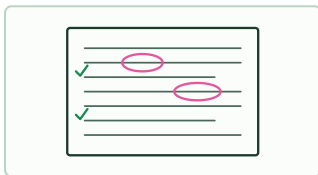


DOODLE

Meselson and Stahl doodle

Homework after lesson 1, in the summary doodle style: three small doodles and eight keywords that fit on one sticky note, telling the story of the experiment. A small prize for the best.

Needs: sticky notes and pens.



WRITING

Improve the answer

The question: "A skin cell is about to divide. Explain how it makes two identical copies of each of its DNA molecules. (8 marks)" Give students this weak answer: "The DNA comes apart into two halves. Each half picks up new bases that match it. An enzyme sticks them together. You end up with two lots of DNA that are the same because the bases match up."

Students mark it against the points the class agrees from chapters 1 to 3: helicase named, hydrogen bonds broken, strands as templates, free nucleotides (not "bases"), complementary pairing, DNA polymerase joining nucleotides, semi-conservative explained, two identical molecules, and why (growth, repair, reproduction). Then they rewrite it. Tips to draw out: begin by saying what replication is, name each enzyme and give its job in the same sentence, write "nucleotides" where the weak answer says "bases", and reach for the exact term ("semi-conservative", "complementary", "hydrogen bonds") rather than an everyday phrase that circles it.

Needs: the answer printed or on the board.

PLENARY

6

min

Exit

"Explain why DNA replication is described as semi-conservative, using the words template and complementary." Homework: the Meselson and Stahl doodle (below).

WHAT STUDENTS GET WRONG

Replication happens during division. It happens before it, in interphase.

The new molecule is all new, or each strand is half old and half new. It is one whole old strand and one whole new one (the site's misconception 38).

Helicase breaks the strands, or the bonds between sugar and phosphate. It breaks only the hydrogen bonds between bases.

DNA polymerase "adds bases". It adds nucleotides.

STRETCH AND SUPPORT

Support: use the dotted key terms as a glossary, and cut [chapter 4's](#) captions up for students to put in order.

Stretch: Meselson and Stahl ran a third generation. Predict the bands for each model, and the ratio of hybrid to light.

IN THE GUIDE

- 1** [A copy for every new cell](#)
- 2** [One old strand, one new](#)
- 3** [Unzip, then build](#)
- A11** [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](#)

EXAM PRACTICE

Check yourself

Set it for homework: a fresh paper of exam-bank questions on D1.1 at standard 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=SL&paper=quiz&marks=15&src=ep



Amplify, separate, identify

60 minutes • D1.1.4, D1.1.5 • Chapters 4, 5, 6 • The dry lab

PCR, gels and DNA profiles, and why more markers mean fewer false matches

BY THE END, STUDENTS CAN

- ☐ Outline how PCR copies a small sample of DNA, with primers, three temperatures and Taq polymerase D1.1.4
- ☐ Explain how gel electrophoresis separates DNA fragments by size, and read sizes against a ladder D1.1.4
- ☐ Use DNA profiles to settle paternity and forensic cases, and explain why more markers mean fewer false matches D1.1.5

TIMING

0–5	5 min	Do now: fold and double	
5–17	12 min	One PCR cycle	
17–25	8 min	Run the gel	
25–45	20 min	The dry lab in pairs	
45–55	10 min	How many markers?	
55–60	5 min	Exit	
	60 min	One lesson	

STARTER

5
min

Do now: fold and double

Students fold a strip of paper in half again and again and count the layers, then estimate what thirty doublings would give (Fold and double, below).

ON THE BOARD, FROM THE GUIDE

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04 A millionfold copy

CHAPTER 04 IN THE SLIDES

Step through the figure (6 steps, the arrow keys on a projector). Stop on each caption and ask what changed before you go on.

1. A sample of DNA, too little to study.
2. About 95 °C: the strands **separate**.
3. About 55 °C: **primers** bind at each end of the target.
4. About 72 °C: **Taq polymerase** extends each primer.
5. One cycle: the copies **double**.
6. Thirty cycles later: how many?

Predict box: PCR uses a DNA polymerase from bacteria that live in hot springs. Why not a polymerase from human cells? Hands up or mini whiteboards first.

Answer B: A human polymerase would be denatured at 95 °C each cycle

Remember it: Dragons Always Exhale (Denaturation, Annealing, Extension).

05 Sorted by size

CHAPTER 05 IN THE SLIDES

Slide the figure through Run time (min) 0, Run time (min) 30 and Run time (min) 58, and have the class say what will change before each.

Predict box: Fragments of 300, 1,000 and 5,000 base pairs are run on the same gel. Which ends up nearest the wells? Hands up or mini whiteboards first.

Answer C: 5,000 base pairs: long fragments move slowest

06 Profiles, parents and crime scenes

CHAPTER 06 IN THE SLIDES

Switch the figure through Paternity and Crime scene, and have the class say what will change before each.

Switch the figure through 1 marker, 3, 10 and 20, and have the class say what will change before each.

Predict box: At one marker, 1 person in 10 shares the crime-scene pattern by chance. With ten independent markers, each 1 in 10, how many people in a city of 10 million would you expect to match by chance? Hands up or mini whiteboards first.

Answer A: Almost certainly none of them

THE LESSON

12 min One PCR cycle

Chapter 4's figure step by step, then the Dragons Always Exhale tiles. Chapter 4's predict box on Taq polymerase by vote, then chapter 4's worked example.

8 min Run the gel

Chapter 5's slider on the board, then chapter 5's predict box. Add "run to red": DNA runs towards the positive electrode.

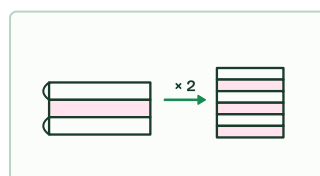
20 min The dry lab in pairs

The dry lab: Who's the father? first with three markers, then with more, then Whose blood? Pairs report the number of markers they needed (Who's the father? Who did it?, below).

10 min How many markers?

Chapter 6's figure 6.2 and its predict box, then How conclusive is DNA evidence? as a class discussion.

ACTIVITIES

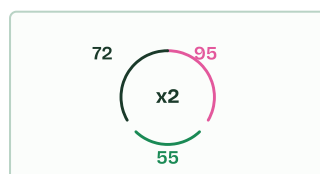


ESTIMATE

Fold and double

Students fold a strip of paper in half again and again and count the layers; most give up at six or seven folds, with 64 or 128 layers. Then: one molecule doubling for 30 cycles. How many copies? (1,073,741,824.)

Needs: strips of scrap paper.

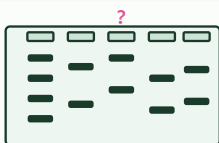


DRAWING

A keyword diagram of PCR

Students draw one PCR cycle as a loop, using keywords only, for three marks: the three temperatures and what each does, primers, Taq polymerase, and the copies doubling.

Needs: paper.



DATA

Who's the father? Who did it?

The teacher prints three cases from [the dry lab](#) (Print this gel on the bench gives the lanes and the question, with no answer): a paternity case, a crime scene and a case review. Pairs decide each one and write the band-by-band reason.

Needs: the printed gels.



DISCUSSION

How conclusive is DNA evidence?

In what ways does a DNA profile resemble a fingerprint left on a glass, and where does the comparison break down? How much weight should a jury give a match? Where could a mistake creep in: contamination, relatives, mixtures, tiny samples, human error? Land on this: a match is strong evidence, a mismatch excludes, and more markers make a chance match rarer.

Needs: nothing.

DRY LAB

PCR and gel: whose DNA is it?

[The dry lab](#), with the tasks and questions under it. Pairs share one device, and the results download as a CSV for a class graph of the chance of a false match against the markers run.

Needs: one device per pair.

PLENARY

5

min

Exit

Students draw a keyword diagram of one PCR cycle, with what happens to the number of copies, for three marks (A keyword diagram of PCR, below).

WHAT STUDENTS GET WRONG

PCR copies the whole genome. It copies the stretch between the two primers.

Taq is used because it is fast. It is used because it survives 95 °C (misconception 18 is the related belief that every enzyme works best at 37 °C, with Taq as its counter-example).

Large fragments travel further. Small ones do: the gel holds large ones back (misconception 77).

DNA moves to the negative electrode. It is negative, so it moves to the positive one.

A profile match at one marker proves who it was. Many people share one marker; many markers together make a chance match rare.

Profiling cuts DNA with restriction enzymes. Modern profiling copies STR markers by PCR and sizes them.

Contamination does not matter because PCR is sensitive. It matters more (misconception 76).

STRETCH AND SUPPORT

Support: use the dotted key terms as a glossary, and cut [chapter 4's](#) captions up for students to put in order.

Support: use the Dragons Always Exhale tiles as a starter in lesson 2.

Stretch: a PCR runs at 90 % efficiency, not 100 %. How many copies of one molecule after 30 cycles? (1.9^{30} , about 230 million.) Why does real PCR level off?

Stretch: in [the dry lab's](#) harder cases a brother of a suspect matches at several markers. Why do relatives make profiling harder, and what would a lab do?

IN THE GUIDE

- 4** [A millionfold copy](#)
- 5** [Sorted by size](#)
- 6** [Profiles, parents and crime scenes](#)
- Lab** [Dry lab: PCR and gel: whose DNA is it?](#)
- A11** [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

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ALREADY ON THE SITE FOR D1.1

- [Quiz: DNA Replication \(HL\)](#)
- [Quiz: DNA Replication](#)
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CARD SETS ON SPLYCR

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- [D1.1 DNA Replication](#)

EXAM PRACTICE

Check yourself

Set it for homework: a fresh paper of exam-bank questions on D1.1 at standard 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=SL&paper=quiz&marks=15&src=ep



Two directions at one fork HL

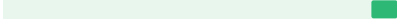
60 minutes • D1.1.6, D1.1.7 • Chapters 7, 8

Why polymerase adds only at the 3' end, and what that means for the two new strands

BY THE END, STUDENTS CAN

- ☐ Explain why DNA polymerases add nucleotides only to the 3' end, so new strands grow 5' to 3' D1.1.6
- ☐ Compare replication on the leading and lagging strands, with Okazaki fragments and RNA primers D1.1.7

TIMING

0-6	6 min	Do now: ends and numbers	
6-16	10 min	Only at the 3' end	
16-28	12 min	One strand smooth, one in pieces	
28-48	20 min	Be the fork	
48-56	8 min	A written question	
56-60	4 min	Exit	
	60 min	One lesson	

STARTER

6
min

Do now: ends and numbers

Students sketch a short double strand, number the carbons of one nucleotide and mark the 5' and 3' ends of both strands.

ON THE BOARD, FROM THE GUIDE

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07 Only ever at the 3' end

CHAPTER 07 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.

- Every strand has a **5'** end and a **3'** end.
- DNA polymerase joins a nucleotide's 5' phosphate to the **3' end**.
- There is nothing to join to at the **5' end**.
- So new strands grow **5' to 3'**.
- The templates are antiparallel, so the new strands grow in **opposite** directions.

Predict box: A free nucleotide arrives at the 5' end of a growing new strand, and its base pairs with the template. What happens? Hands up or mini whiteboards first.

Answer B: It is not joined: there is no free 3' OH there

Step through the figure (6 steps, the arrow keys on a projector). Stop on each caption and ask what changed before you go on.

1. Helicase opens the fork and moves on.
2. **Leading strand**: one primer, then built **continuously**, towards the fork.
3. **Lagging strand**: built away from the fork, so it must start again.
4. Each new stretch gets its own **primer**.
5. The lagging strand comes in **Okazaki fragments**.
6. One primer on the leading strand; one per fragment on the lagging strand.

Predict box: A fork opens 10,000 bases of a bacterial chromosome. Okazaki fragments there are about 1,000 to 2,000 nucleotides long. How many RNA primers does each new strand need? Hands up or mini whiteboards first.

Answer C: Leading just 1, lagging about 5 to 10

THE LESSON

10
min

Only at the 3' end

Chapter 7's figure, one step at a time, then chapter 7's predict box on mini whiteboards.

12
min

One strand smooth, one in pieces

Chapter 8: the predict box first (primers on each strand), then chapter 8's figure step by step.

20
min

Be the fork

In groups of five, students act out a fork with paper strips and sticky notes, then swap roles (Be the fork, below).

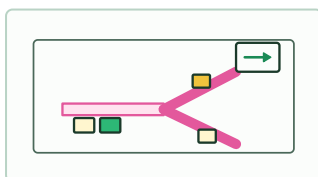
8
min

A written question

Set a compare-and-contrast question on the leading and lagging strands from the D1.1 exam maker (in Practise and revise), timed, then marked in pairs against its markscheme.

A mnemonic for the board once chapter 8's predict box is answered (not before, as it gives the answer away): "Lagging needs lots": lots of primers, lots of fragments, lots of sealing.

ACTIVITIES



MODEL · HL

Be the fork

A table-top role play of a fork. Two long paper strips are taped down running opposite ways, each with its 5' and 3' ends marked, and a stack of sticky-note nucleotides sits to one side. The roles: helicase slides a ruler along to "open" the strips a hand's width at a time; primase places a different colour of sticky note, written in RNA letters; polymerase III may only place notes moving away from a primer in the 5' to 3' direction of the new strand, shown by an arrow card held in one direction; polymerase I swaps primer notes for DNA notes; ligase draws the last link with a pen. Run it for a few minutes, then swap roles. Finish on the limits of the model: no hydrogen bonds, no twist, no speed, and enzymes not to scale.

Needs: paper strips, two colours of sticky notes, arrow cards and pens.

PLENARY

4
min

Exit

"Why can the lagging strand not be copied continuously?" One sentence.

WHAT STUDENTS GET WRONG

New strands grow 3' to 5', or the template is read 5' to 3'. New strands grow 5' to 3', and templates are read 3' to 5'.

The lagging strand is copied after the leading strand. Both are made at the same time, the lagging one in pieces.

Only the lagging strand needs a primer. Both do: the leading strand once.

STRETCH AND SUPPORT

Support: cut [chapter 8's](#) captions up for students to put in order, and give a fork outline with the enzymes' places marked for the higher level drawing.

Stretch: in *E. coli* two forks leave one starting point and meet halfway round the circle. Sketch both forks and mark the leading and lagging strands at each.

IN THE GUIDE

- 7** [Only ever at the 3' end](#)
- 8** [One strand smooth, one in pieces](#)
- A11** [The whole guide, with the figures that play](#)
- PPTX** [This lesson's slides, in the order of this plan](#)

PRACTISE AND REVISE

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CARD SETS ON SPLYCR

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- [D1.1 DNA Replication](#)

EXAM PRACTICE

Check yourself

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



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

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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

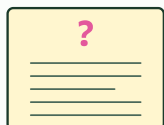
Four enzymes
Chapter 9's figure: tap each enzyme. Then the Hungry Pandas Prefer Plain Lettuce tiles and [chapter 9's](#) predict box.
-
- 8**
min

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

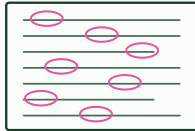


WRITING · HL

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.



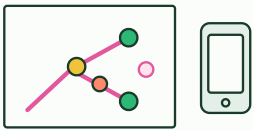
WRITING · HL

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

