

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

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.

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.

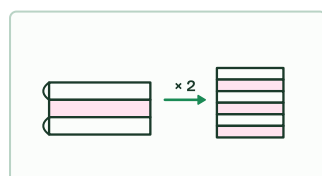
20 min The dry lab in pairs

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

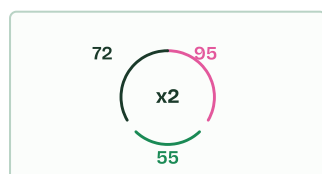


ESTIMATE

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.

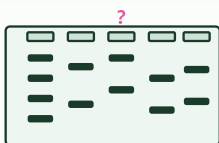


DRAWING

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?](#)
- 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 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

