PCR simulation activity

Students work in groups of 4, each group should have…

- 1 piece of double stranded paper 'template' DNA
- Some primers
- Some nucleotides
- Scissors
- Sticky tape
- Instruction sheet

Cycle 1

Use scissors to cut the double-stranded template DNA in half.

This represents the high temperature denaturation step (95°C) in PCR, which breaks the hydrogen bonds between the two DNA strands.

Students should take one template strand between two and move on to the next step.

Match the primers next to their complementary sequences on the single-stranded template DNA and stick them in place with tape.

This represents primer annealing to the template DNA at the low temperature annealing step (55°C) in PCR.

We have shaded the primer annealing sites on the template DNA to assist students in the first cycle of the activity – in future cycles they will need to find the annealing sites themselves.

Extend new sequence from the primers using tape to attach each new nucleotide to the previous nucleotide and the template strand.

This represents the action of DNA polymerase in the 72°C extension step of PCR, which creates a new strand of DNA starting at the 3' end of each primer, incorporating new nucleotides complementary to the template strand. The product is a double-stranded section of DNA with one strand made up of the original template DNA and the other made of newly synthesised DNA.

Students should add nucleotides in the correct order, starting at the 3' end of the primer, not add all of the Ts first, then the As etc – this isn't how DNA polymerase works!

It may be easier to lay down a long strip of tape first and then stick the new nucleotides onto it in turn.

Note: Students often add nucleotides to both ends of the primer, whereas DNA extension only happens in one direction, from the 3' end of the primer. They can't be expected to know this already and don't need to know the details of 5' and 3' in DNA, but a simple explanation along the lines of 'DNA molecules are chemically different at each end, giving them a start and an end. DNA polymerase recognises this and only extends the DNA from the end of the primer, not the start, in one direction'

Cycle 2

Use scissors to cut the two newly created strands of dsDNA in half.

This represents the second high temperature step (95°C) in PCR, which breaks the hydrogen bonds between the DNA strands.

Match new primers next to their complementary sequences on the four template DNA strands and stick them in place with tape.

This represents primer annealing to the template DNA at the second low temperature step (55°C) in PCR.

There won't be any shaded primer annealing sites on the newly synthesised DNA to assist students – they need to find the annealing sites themselves.

Students may prefer to work individually at this point if they'd like to copy all of the DNA strands.

Extend new sequence from the primers using tape to attach each new nucleotide to the previous nucleotide and the template strand.

This represents the action of DNA polymerase in the second 72°C extension step of PCR, which creates new strands of DNA starting at the 3' end of each primer.

Cycle 3

Use scissors to cut the four newly created strands of dsDNA in half.

At the start of Cycle 3, each group should have eight single-stranded DNA molecules – two of these will be the exact length of the target DNA sequence.

The activity can be continued as long as desired, but it's best to aim to get to at least the first step in Cycle 3 so that students can see the target DNA sequence being produced.