

PCR Animations and Paperclip PCR Teacher Notes

PCR Animations

If this is the first time that students are introduced to PCR, it is recommended that you also utilize the PCR animations found in the PowerPoint, and listed below:

- 1) <http://www.dnalc.org/ddnalc/resources/pcr.html> - A two-part click-through animation from the DNA Learning Center at Cold Springs Harbor Laboratory. Part 1 highlights each step of PCR for each cycle, including denaturing of template strands, annealing of primers to their respective templates, and elongation to synthesize the new DNA strands. Part 2 is a click-through graph showing how many total number of DNA copies versus target copies during each cycle of PCR.
- 2) <https://www.hhmi.org/biointeractive/polymerase-chain-reaction-pcr> -- (0:53). This is a narrated version of the famous HHMI PCR animation, in which the narrative describes what is seen during PCR: denaturation, annealing and elongation. Outstanding graphics include the temperature(s) of each cycle and the 'wiggle of molecules due to Brownian motion.
- 3) <https://www.youtube.com/watch?v=iQsu3Kz9NYo> – (3:55) This video has been produced in the Institute of General Organic Chemistry of the CSIC (IQOG-CSIC), Spain, by Guillermo Corrales, as part of its task for promoting Science Communication and may be freely used for educational and science popularization purposes. It begins with a sample (piece of bone) and continues through an animation of each cycle of PCR occurring in a thermocycler. *Note:* There is no narration for the video; instead a dramatic instrumental track is used in the background.
- 4) <http://www.youtube.com/watch?v=x5yPkxCLads> – (2:13) This is a spoof about PCR based on the song "We Are the World," created by the scientists at the biotechnology company Bio-Rad.

PCR Paperclip Manipulation

The PCR Paperclip Manipulation activity is designed to introduce students to polymerase chain reaction (PCR) using paperclips to represent DNA bases, utilizing the international standard color key used in DNA sequencing:

Adenine = Green paper clips

Cytosine = Blue paper clips

bind to

binds to

Thymine = Red paper clips

Guanine = Black paper clips

The instructions for the PCR Paperclip Manipulation are written allow two options for implementation:

1. Teachers provide template DNA and / or primers as paperclips already clipped together.
 - a. PRO: This more accurately represents how scientists typically begin a PCR experiment – with the template DNA and primers at the tube at the start of the reaction. It also shortens the amount of in-class time required for students to complete this activity. *NOTE:* If students are provided with templates and / or primers, it is suggested that use the 5' labels on each DNA strand to note that these are the original strands / primers provided, and should not be disassembled by students.
 - b. CON: It requires additional teachers or teaching assistance / lab aid preparation time to make the DNA templates and primers (one copy of each template stand of DNA and 7 copies each, Primer 1 and Primer 2), as noted below. In addition,

students will need to be told not to disassemble the original DNA template strands and/or primers they were provided (see note above).

2. Teachers may wish to have students synthesize the DNA template and primers.
 - a. PRO: This will allow students to spend more time familiarizing themselves with the idea of DNA synthesis and the colors used for each DNA base.
 - b. CON: Requires additional class time for set-up and clean-up.

It is strongly encouraged that students label at least the 5-prime, if not also the 3-prime, ends of each DNA strand, to help orient them during the 5' to 3' elongation step.