Three edits, and what a swapped base does

60 minutes • D1.3.1 and D1.3.2 • Chapters 1, 2

Substitutions, insertions and deletions as changes to the base sequence, and why a substitution may be silent, missense or nonsense

BY THE END, STUDENTS CAN

- [ ] Distinguish between substitutions, insertions and deletions as changes to the base sequence of a gene D1.3.1
- [ ] Explain why a base substitution may or may not change an amino acid, and what a SNP is D1.3.2

TIMING

0–8	8 min	**Do now: read in threes**
8–20	12 min	**Three kinds of edit**
20–30	10 min	**The code is degenerate**
30–48	18 min	**Edit a gene**
48–54	6 min	**SNPs**
54–60	6 min	**Exit**
	60 min	**One lesson**

STARTER

8 min

Do now: read in threes

The word frameshift activity below, round one only: the sentence on the board, students swap one letter, then remove one, and say which edit wrecks more. Leave the answers on the board for lesson 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 Three ways to change a gene

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 short gene: twelve bases, read as **four codons**.
2. A **substitution**: the T at base 7 becomes a C. Only the third codon changes.
3. An **insertion**: one G added after base 4. Every base after it moves along one.
4. A **deletion**: base 5 lost. The bases close up, and every codon after it is new.

> **Predict box:** A gene of 900 bases becomes 901 bases long. Which kind of mutation could this be? Hands up or mini whiteboards first.
>
> **Answer B: An insertion, because one extra base has been added somewhere in the sequence**

02 One base swapped

CHAPTER 02 IN THE SLIDES

Step through the figure (3 steps, the arrow keys on a projector). Stop on each caption and ask what changed before you go on.

1. A made-up gene: its coding strand in codons, the mRNA under it and the amino acid each codon codes for.
2. One base **substituted**: codon 2, AAA, becomes TAA, a stop codon. Translation ends there: a **nonsense** mutation.
3. One base **deleted** from codon 4. Every codon after it is read in a new frame, so every amino acid from there changes: a **frameshift**.

Predict box: The codon GGU codes for glycine, and so do GGC, GGA and GGG. The U is replaced by an A. What is the result? Hands up or mini whiteboards first.

Answer B: A silent mutation, because GGA still codes for glycine

Remember it: Same Mistake Stop (Silent, Missense, Nonsense).

THE LESSON

12 min

Three kinds of edit

Chapter 1's figure, step by step. Students copy the gene and write each edited version under it, marking the codons that change. Then the predict box on a gene that gets one base longer.

10 min

The code is degenerate

The codon tool from D1.2 (or a printed codon table). Pairs find three amino acids with four codons and say which base differs between them. Land on: a change at the third base is often silent.

18 min

Edit a gene

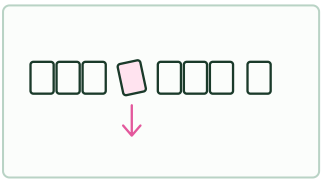
The gene editing tool in chapter 2, one device per pair. Pairs work through the five tasks and record, for each, the codon before and after, the amino acid before and after, and the name of the result. Then the mnemonic tiles.

6 min

SNPs

Define a SNP from chapter 2. Ask why two people can differ at a SNP and have identical proteins.

ACTIVITIES



WORD GAME

Read it in threes

Write a sentence of three-letter words on the board, such as THE OLD MAN SAW THE DOG (or let the class write one). Round one: swap one letter, then remove one, and read on in threes. Round two: add one letter, then remove a whole word. Students name each edit (substitution, deletion, insertion) and say how much of the sentence survives. Then ask what the ribosome is doing that the reader is doing.

Needs: the board; letter cards are a bonus.

TOOL

Five tasks

The gene editing tool in chapter 2: change one base and keep the protein, change one amino acid, stop the chain early, shift the frame, and delete without shifting it. Pairs record each edit in a table: base number, change, codon before and after, amino acid before and after, result. A pair that finishes early finds the edit that changes the most amino acids with one deletion.

Needs: one device per pair; a printed table.

PLENARY

6 min

Exit

Give a substitution that is silent and one that is missense in the codon GCU (alanine), and say why each is which.

WHAT STUDENTS GET WRONG

"A mutation always harms." Many are silent or neutral. Whether a change matters depends on the codon, the amino acid and where it sits in the protein.

"A substitution changes the whole protein." It changes one codon, so one amino acid at most, unless it makes a stop codon.

STRETCH AND SUPPORT

Support: give the captions of each figure as a cut-up storyboard to put in order, and use the key terms (tap the dotted words) as a glossary.

Support: a codon table with the four codons for each amino acid grouped, so students see at once that the third base often does not matter.

IN THE GUIDE

1 Three ways to change a gene

2 One base swapped

All The whole guide, with the figures that play

PPTX This lesson's slides, in the order of this plan

EXAM PRACTICE

Check yourself

Set it for homework: a fresh paper of exam-bank questions on D1.3 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=D1.3&level=SL&paper=quiz&marks=15&src=ep

PRACTISE AND REVISE

BUILD FOR YOUR CLASS

- Tarsia puzzle, dominoes and picture reveal on D1.3, built from its key terms and ready to print
- A pub quiz with rounds on D1.3, to present or run with no projector
- An escape room built from the question bank on D1.3

ALREADY ON THE SITE FOR D1.3

- Lesson: Mutations & Gene Editing
- Quiz: Mutation & Gene Editing
- Revision map: D1.3 Mutation and gene editing, to fill in
- Exam questions: D1.3 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.

- D1.3 Mutations and Gene Editing
- C3.2–D1.3 Defence Against Disease & Mutations

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.