

Building the chain, and one base wrong

60 minutes • D1.2.10, D1.2.11 • Chapters 6, 7

Elongation one codon at a time, peptide bonds, and how one substitution causes sickle cell anaemia

BY THE END, STUDENTS CAN

- ☐ Describe how the ribosome moves one codon at a time, joining each amino acid to the chain with a peptide bond
D1.2.10
- ☐ Explain how one base change in the haemoglobin gene causes sickle cell anaemia D1.2.11

TIMING

0-6	6 min	Do now: Translation in order	
6-16	10 min	The elongation cycle	
16-28	12 min	Paper ribosome	
28-40	12 min	One base, one amino acid	
40-52	12 min	The protein factory	
52-60	8 min	Exit	
	60 min	One lesson	

STARTER

6
min

Do now: Translation in order

Eight cards put in the order a message meets them (activity 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.

06 One codon at a time

CHAPTER 06 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. The next tRNA **pairs** with the open codon.
2. A **peptide bond** joins the chain to its amino acid.
3. The ribosome **moves** one codon along.
4. The empty tRNA **leaves**. Repeat.

Play the animation, One codon at a time. It loops; pause it on each moment below and ask what is happening (in the lesson slides it is a video).

1. A tRNA whose anticodon pairs with the codon brings the right amino acid.
2. A peptide bond joins the chain to the new amino acid.
3. The ribosome moves along one codon, and the empty tRNA leaves to collect another amino acid.
4. At a stop codon no tRNA fits, and the polypeptide is released.

Predict box: A polypeptide is 150 amino acids long. How many codons did the ribosome read to make it, counting the codon that ended it? Hands up or mini whiteboards first.

Answer B: 151

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 base differs in the gene for haemoglobin's beta chain.
2. So one **codon** in the mRNA differs.
3. So one **amino acid** differs: **valine** for glutamic acid.
4. The non-polar valine makes the molecules stick into **fibres**.
5. Fibres bend the cells into sickles that block small vessels.

Step through the figure (2 steps, the arrow keys on a projector). Stop on each caption and ask what changed before you go on.

1. The gene is transcribed and translated: Its 23 amino acids are joined by 22 peptide bonds: one of 20^{23} (about 8×10^{29}) possible chains this long. A ribosome makes the chain one amino acid at a time, and it starts to fold as it comes out.
2. It folds into a shape of its own, held by **weak bonds** between its side chains.

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. Which strand will you copy?
2. Pick the base that pairs: RNA has U, not T.
3. Which tRNA's anticodon pairs with this codon?
4. One base differs. What does it do to the protein?

Predict box: In a gene, one base changes so that an mRNA codon GAA becomes GAG. What happens to the polypeptide? Hands up or mini whiteboards first.

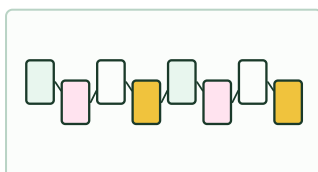
Answer C: No change: GAG also codes for Glu

Remember it: Same Swapped Stopped (Silent, Missense, Nonsense).

THE LESSON

10 min	The elongation cycle Chapter 6's step-through, then the ribosome film, One codon at a time, then chapter 6's predict box (151 codons).
12 min	Paper ribosome Groups slide the paper ribosome along a paper mRNA, ending on the model's limits (activity below).
12 min	One base, one amino acid Chapter 7's predict box (GAA to GAG) first, then figure 7.1, Fold a protein (make the sickle cell change, fold both and make a second copy of each) and Same, Swapped, Stopped. Then Sort the substitutions.
12 min	The protein factory In pairs, on a device each: rounds 1, 3 and 4 (round 2 and round 5 for homework).

ACTIVITIES

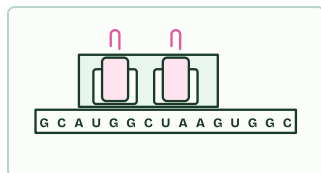


CARD SORT

Translation in order

Eight cards to put in the order a message meets them: mRNA, ribosome, codon, anticodon, tRNA, amino acid, peptide bond, polypeptide. Then one sentence linking each pair of neighbours.

Needs: sets of cards.



MODEL

Paper ribosome

A long mRNA strip (the demonstration gene of chapters 1 to 7, printed in codons), a ribosome card with two windows cut in it, and tRNA cards with the anticodon at the foot and an amino acid on a paper clip at the top. Groups slide the ribosome one codon at a time, dock the tRNA, move the paper clips onto the newest one, and send the empty tRNA back. Then ask what the model leaves out, and what it gets wrong: it has no energy, nothing forces the right tRNA to arrive, real bonds are chemical, and a ribosome is made of RNA and protein.

Needs: printed strips and cards, scissors, paper clips.

GAME

The protein factory

One device per pair. The standard level rounds are for lesson 3 and the higher level rounds for lesson 6; its record downloads as a CSV for a class comparison.

Needs: one device per pair.

PLENARY

8 min **Exit**
A short written question on translation or elongation from the D1.2 exam maker (in Practise and revise), marked in pairs against its markscheme.

WHAT STUDENTS GET WRONG

Amino acids in the chain are held by hydrogen bonds.

Peptide bonds; the hydrogen bonds are codon to anticodon.

Every mutation changes the protein. Silent substitutions do not.

Sickle cell haemoglobin cannot carry oxygen. It carries it; the harm is the fibres, the cell shape and the cells' short life.

STRETCH AND SUPPORT

Support: cut the figures' captions into cards to put in order, use the dotted key terms as a glossary, and give a codon table with the reading path printed on it (row, column, line).

Support: use the mnemonics (Apples Under umbrellas; Same, Swapped, Stopped) as starters.

Stretch: Reading Frame, a codon game whose last round adds insertions and deletions, a look ahead to D1.3.

Stretch: in the factory's round 5, find a single base change in the demonstration gene for each of Same, Swapped and Stopped, and explain why changes to the third base are most often silent.

IN THE GUIDE

- 6** [One codon at a time](#)
- 7** [One base, one amino acid](#)
- 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 D1.2, built from its key terms and ready to print
- A [pub quiz](#) with rounds on D1.2, to present or run with no projector
- An [escape room built from the question bank](#) on D1.2

ALREADY ON THE SITE FOR D1.2

- [Quiz: Protein Synthesis \(HL\)](#)
- [Quiz: Protein Synthesis](#)
- Revision map: [D1.2 Protein synthesis](#), to fill in
- Exam questions: [D1.2 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.

- [D1.2 Protein Synthesis \(SL\)](#)
- [D1.2 Protein Synthesis \(HL\)](#)

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 D1.2 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=D1.2&level=SL&paper=quiz&marks=15&src=ep

