

Folding, quaternary structure, globular and fibrous proteins HL

60 minutes • B1.2.10 to B1.2.12 • Chapters 10, 11, 12

Non-polar inside and polar outside, quaternary structure, and globular against fibrous proteins

BY THE END, STUDENTS CAN

- ☐ Name the four kinds of bond that hold a tertiary structure, and say where polar and non-polar R groups end up
B1.2.9, B1.2.10
- ☐ Compare insulin, collagen and haemoglobin: chains, conjugated or not, globular or fibrous, and how form suits function B1.2.11, B1.2.12

TIMING

0-10	10 min	Paper folding	
10-25	15 min	Fold a protein	
25-35	10 min	Quaternary	
35-50	15 min	Globular or fibrous crossword	
50-60	10 min	An HL question on insulin and collagen	
	60 min	One lesson	

STARTER

- 10 min** **Paper folding**
Pairs fold a paper strip so the yellow squares end up inside, clip the two cysteines, then lay it in a tray of water (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.

10 Oily inside, watery outside

CHAPTER 10 IN THE SLIDES

Switch the figure through Unfolded, In water and In a membrane, and have the class say what will change before each.

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

- Type **ROSALIND FRANKLIN**: each letter is the code for one amino acid (the O is skipped: no amino acid has that letter). A ribosome makes the chain one amino acid at a time, and it starts to fold as it comes out.
- In water it folds: the **non-polar** ones gather inside, away from the water (6 of 7), and the polar ones face outwards. Hydrophobic interactions, hydrogen bonds and ionic bonds hold it.

Predict box: A protein dissolves in blood plasma. Where are most of its hydrophobic R groups? Hands up or mini whiteboards first.

Answer C: Clustered in the core of the protein, away from the water

11 More than one chain: quaternary structure

CHAPTER 11 IN THE SLIDES

Switch the figure through Insulin, Collagen and Haemoglobin, and have the class say what will change before each.

Predict box: A haemoglobin molecule is about 5 to 6 nm across. Could you see one with the best light microscope? Hands up or mini whiteboards first.

Answer B: No: it is far smaller than the smallest thing light can resolve, about 200 nm

Remember it: I See Him (Insulin, Collagen, Haemoglobin).

12 Balls and ropes: globular and fibrous proteins

CHAPTER 12 IN THE SLIDES

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 **insulin** molecule is a small rounded knot among water molecules. One **collagen** molecule is a long, thin rope, about 100 times longer than the knot is wide.
2. Insulin is **soluble**: dissolved in the plasma, it is carried round the body in the blood.
3. Insulin has a **precise shape** that fits the receptor on its target cells, liver, muscle and fat cells, like a key in a lock.
4. Collagen ropes lie side by side, staggered and **cross-linked**, into fibrils, and fibrils are bundled into fibres.
5. In a tendon, collagen fibres are **insoluble** and strong: they stay taut when muscle pulls on bone.

Predict box: A protein is long and thin, has a repeating sequence and does not dissolve in water. What is its most likely job? Hands up or mini whiteboards first.

Answer D: A structural protein, as found in tendons, skin and blood vessel walls

THE LESSON

15 min Fold a protein

In pairs, at Fold a protein under [chapter 10](#): fold a full name in water (a first name alone is usually too short to fold, and the element says so), then the made-up membrane protein across a membrane; then the sickle cell change with Make a second copy, and a frameshift. Each pair says what changed and why. The same chain folds the same way on every screen in the room.

10 min Quaternary

[Chapter 11](#)'s three proteins. Finish the four levels table. Cryo-EM discussion: why can't a light microscope see one protein? Optional: haemoglobin in 3D (activity below).

15 min Globular or fibrous crossword

Students start their crosswords in class and finish them at home (activity below).

ACTIVITIES

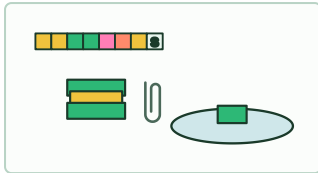
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WRITING · HL

Four levels table

Students fill a table with a row each for primary, secondary, tertiary and quaternary structure and columns for what it is, what holds it, a sketch and an example. On the sketches they place the labels: peptide bond, amine group, carboxyl group, hydrogen bond (between which groups?), disulfide bond, ionic bond, hydrophobic interactions and prosthetic group.

Needs: an A3 table template.

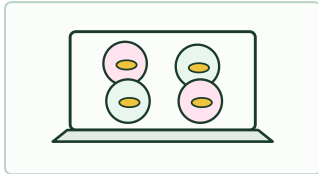


MODEL · HL

Paper folding

Give each student a strip of paper squares coloured yellow (hydrophobic), green (polar), two pink or coral (charged) and two marked S (cysteine). They fold it so every yellow is hidden inside and the greens face out, clip the two S squares together, and lay it in a tray of water: which colours touch the water? Then they fold a chain in Fold a protein, under [chapter 10](#), and compare.

Needs: printed strips, paper clips, a tray of water.

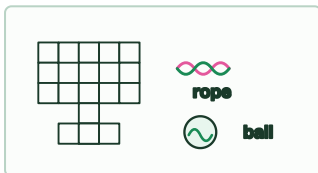


DIGITAL MODEL · HL, OPTIONAL

Haemoglobin in 3D

Students open a haemoglobin entry and an insulin entry in the RCSB Protein Data Bank's free 3D viewer. They count the chains, find the four haem groups, and colour the structure by hydrophobicity to see where the non-polar amino acids are. Suggested entries: haemoglobin 4HHB and insulin 4INS (check the entry IDs open before the lesson).

Needs: devices.



RESEARCH AND WRITING · HL

Globular or fibrous crossword

Each student researches one protein and writes a crossword of 10 to 12 clues, every clue a question about its structure and function; they swap and solve. Globular: an enzyme (catalase, amylase, lipase, DNA polymerase), insulin, glucagon, haemoglobin, myoglobin, an antibody, albumin, ferritin, growth hormone. Fibrous: collagen, keratin, elastin, silk fibroin, titin. Discussion cases: myosin (a fibrous tail with globular heads), actin and tubulin (globular units that make structural filaments), and fibrin (fibrous, built when the soluble fibrinogen of blood plasma is cut). Steroid hormones such as oestradiol and testosterone are lipids, not proteins.

Needs: squared paper or a free crossword maker.

PLENARY

10
min

An HL question on insulin and collagen

A written question on form and function, peer-marked. Homework: [the Check step](#) at HL.

WHAT STUDENTS GET WRONG

Quaternary means four chains, and conjugated means two proteins joined. Quaternary means more than one chain; conjugated means a non-polypeptide part.

Collagen is made of alpha helices. Its three chains each form a narrower helix of their own.

Globular always means functional and fibrous always structural. Actin and tubulin are globular units that build structural filaments.

Hydrophobic R groups are repelled by water. Water bonds to itself instead, which leaves them together.

STRETCH AND SUPPORT

Support: give a word bank for the four levels table.

IN THE GUIDE

- 10** [Oily inside, watery outside](#)
- 11** [More than one chain: quaternary structure](#)
- 12** [Balls and ropes: globular and fibrous proteins](#)
- 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 B1.2, built from its key terms and ready to print
- A [pub quiz](#) with rounds on B1.2, to present or run with no projector
- An [escape room built from the question bank](#) on B1.2

ALREADY ON THE SITE FOR B1.2

- [Quiz: Proteins \(HL\)](#)
- Revision map: [B1.2 Proteins](#), to fill in
- Exam questions: [B1.2 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.
- [B1.2 Proteins](#)

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 B1.2 at higher level each time, marked as students go and saved to their Exam practice when they are signed in.

biologybybradford.com/exam-maker/sit?topics=B1.2&level=HL&paper=quiz&marks=15&src=ep

