

Proteins

Two one-hour lesson plans, and two more at higher level

Two one-hour lessons cover the standard level statements and two more cover higher level (the guide gives B1.2 two hours at SL and two more at HL). The plan follows the chapters, so a class can read the guide for homework and use the lesson for the activities. B1.2 has no dry lab of its own: the enzyme practicals belong to C1.1, and the amylase home lab is linked from [chapter 5](#). Every figure plays on a projector: step through it with the arrow keys and stop on each caption.

LESSON	COVERS	FOCUS	CHAPTERS
1 Amino acids and peptide bonds	B1.2.1, B1.2.2 and B1.2.4	Drawing a generalised amino acid, joining two by condensation, and why chains of twenty kinds are endless	1, 2
2 Diet, variety and denaturation	B1.2.3 to B1.2.5	Essential amino acids in the diet, and how heat and pH denature a protein	3, 4, 5
3 R groups and the levels of structure HL	B1.2.6 to B1.2.9	Sorting R groups, then the primary, secondary and tertiary structure and the bonds that hold each	6, 7, 8, 9
4 Folding, quaternary structure, globular and fibrous proteins HL	B1.2.10 to B1.2.12	Non-polar inside and polar outside, quaternary structure, and globular against fibrous proteins	10, 11, 12

The guide, for the class to read and play: biologybybradford.com/guides/ib-biology-b1-2-proteins

Amino acids and peptide bonds

60 minutes • B1.2.1, B1.2.2 and B1.2.4 • Chapters 1, 2

Drawing a generalised amino acid, joining two by condensation, and why chains of twenty kinds are endless

BY THE END, STUDENTS CAN

- ☐ Draw a generalised amino acid and name the four groups on its alpha carbon B1.2.1
- ☐ Explain how condensation joins amino acids with peptide bonds, write the word equation and draw a dipeptide B1.2.2
- ☐ Explain why the number of possible polypeptides is practically endless B1.2.4

TIMING

0-5	5 min	Do now: draw it from memory	
5-15	10 min	The five strokes	
15-30	15 min	Model it, then draw it	
30-40	10 min	Peptide bonds	
40-55	15 min	Your name in amino acids	
55-60	5 min	Exit	
60 min		One lesson	

STARTER

5 Do now: draw it from memory

min

Students draw an amino acid with no notes, label the two functional groups and say what the side chain is. Keep the drawings: they are checked against the figure in the next step.

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 Every amino acid is built on the same core

CHAPTER 01 IN THE SLIDES

Step through the figure (6 steps, the arrow keys on a projector). Stop on each caption and ask what changed before you go on.

1. The **alpha carbon** makes four bonds.
2. An **amine group** goes on the left bond: a nitrogen with two hydrogens.
3. A **carboxyl group** goes on the right bond: a carbon with a double bond to one oxygen and a single bond to an OH.
4. One **hydrogen** atom goes on the bottom bond.
5. The last bond carries the **R group**. It stands for whatever side chain this amino acid has.
6. Three different amino acids: the same core in each, and only the **R group** differs.

Predict box: A student draws an alpha carbon bonded to -NH₂, -COOH, R and -OH. What is wrong with the drawing? Hands up or mini whiteboards first.

Answer B: The fourth group should be a single hydrogen atom, not -OH

Remember it: A Cat Has Rhythm (Amine group, Carboxyl group, Hydrogen, R group).

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. Two amino acids, R_1 and R_2 , with the carboxyl group of the first facing the amine group of the second.
2. The **OH** from the carboxyl group and one **H** from the amine group are lit: they will leave as **water**.
3. The carbon bonds to the nitrogen and the water drifts away. The new C-N bond is a **peptide bond**.
4. A **dipeptide**, drawn as an examiner wants it. It still has an amine group at one end and a carboxyl group at the other.

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. Two **amino acids**.
2. The OH of one's **carboxyl group** and an H of the other's **amine group** face each other.
3. They leave as **water**, and a **peptide bond** joins the carbon to the nitrogen: **condensation**, making a **dipeptide**.
4. Add water and the peptide bond splits again, the OH back to the carbon and the H to the nitrogen: **hydrolysis**.

Predict box: Two different amino acids, A and B, are joined by one peptide bond. How many different dipeptides could they make? Hands up or mini whiteboards first.

Answer C: Two: A's carboxyl to B's amine, or B's carboxyl to A's amine, and these are different molecules

THE LESSON

10
min

The five strokes

Play [chapter 1](#)'s figure one step at a time, with students drawing along on paper. Turn over the A Cat Has Rhythm tiles. Pairs then check each other's drawing for the five things an examiner looks for: the alpha carbon, the amine group, the carboxyl group, the hydrogen and the R group, with every bond showing.

15
min

Model it, then draw it

With model kits, pairs build two amino acids, take the OH and the H away as water, join the C to the N and then draw the dipeptide and write the word equation (activity below). Then they add a third amino acid.

10
min

Peptide bonds

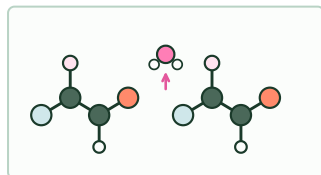
[Chapter 2](#): the bond builder on the board, joining two different amino acids both ways round, then the predict box. Write the word equation once more, from memory.

15
min

Your name in amino acids

Students spell a word in the one-letter code, draw it as a chain, mark the bonds and count the water released (activity below).

ACTIVITIES



MODEL

Model it, then draw it

Pairs build two amino acids from a molecular model kit (two of the simplest, any two), take an -OH from one carboxyl group and an -H from the other amine group, join them as water, and connect the C to the N. Then they draw the dipeptide on paper and write the word equation. Last, they build a third amino acid and add it.

Needs: molecular model kits (or snatoms, as in A1.1), one per pair.



PUZZLE

Your name in amino acids

Each student spells a word or their name in the one-letter amino acid code (a table of the twenty letters on the board), draws it as a chain of beads, marks the peptide bonds, and marks the free amine group at one end and the free carboxyl group at the other. They count the bonds and the water released and work out how many sequences of that length could exist (20^n). The letters B, J, O, U, X and Z have no standard amino acid (O and U are codes for rare extra ones, not the twenty). Inside a chain only the two ends keep a free amine or carboxyl group, so label the alpha carbons and R groups on every amino acid, but the amine and carboxyl only at the ends. Then they type the word into Fold a protein, under [chapter 4](#), which counts its peptide bonds and the 20^n again, and watch the chain fold; a short word stays loose, and the element says it is too short to fold up.

Needs: a printed one-letter table.

PLENARY

5
min

Exit

How many different tripeptides are possible, and why? ($20 \times 20 \times 20 = 8,000$, because every position has twenty choices.)

WHAT STUDENTS GET WRONG

The peptide bond in the wrong place: between alpha carbons, through an oxygen, or to an R group. Ring the C-N between the C=O and the N-H.

Water from one amino acid. The OH comes from the carboxyl group of one and the H from the amine group of the other.

Twenty amino acids, so twenty proteins. The order makes the protein.

STRETCH AND SUPPORT

Support: give a traceable amino acid template, to trace and then to complete.

Support: use the four Remember it tiles as starters.

Support: cut the figures' captions up for students to put in order.

IN THE GUIDE

- 1 [Every amino acid is built on the same core](#)
- 2 [Peptide bonds join amino acids, and water leaves](#)
- 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](#)

EXAM PRACTICE

Check yourself

Set it for homework: a fresh paper of exam-bank questions on B1.2 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=B1.2&level=SL&paper=quiz&marks=15&src=ep



Diet, variety and denaturation

60 minutes • B1.2.3 to B1.2.5 • Chapters 3, 4, 5

Essential amino acids in the diet, and how heat and pH denature a protein

BY THE END, STUDENTS CAN

- ☐ Explain why some amino acids must come from food, and what that means for a vegan diet B1.2.3
- ☐ Explain why the number of possible polypeptides is practically endless B1.2.4
- ☐ Explain how heat and pH denature a protein, and why it then stops working B1.2.5

TIMING

0–5	5 min	Do now: agree or disagree	
5–15	10 min	The amino acid shelf	
15–30	15 min	Protein doodles	
30–45	15 min	Heat and acid	
45–55	10 min	A written question	
55–60	5 min	Exit and homework	
	60 min	One lesson	

STARTER

- 5 min** **Do now: agree or disagree**
- “Essential amino acids are more important than non-essential ones.” Students write one sentence to say why. Do not correct yet.

ON THE BOARD, FROM THE GUIDE

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03 Some amino acids you must eat

CHAPTER 03 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.

- Twenty jars feed the line, and the chain grows in **one order**, set by the gene.
- Eleven jars are filled by a pipe from the cells: **non-essential** amino acids, which your cells can make from other amino acids.
- Nine jars are filled only from the plate: **essential** amino acids, which must come from food.
- A varied plant plate: grain runs a little low in one jar and pulses in a different one, and together they fill every jar. A **vegan** diet covers all nine with **variety**.
- A day of rice only: one jar runs low.

Predict box: You eat plenty of protein, but it lacks one essential amino acid. What happens to the proteins that need it? Hands up or mini whiteboards first.

Answer A: They cannot be completed, because no other amino acid can take its place in the sequence

04 Twenty amino acids, endless chains

CHAPTER 04 IN THE SLIDES

Switch the figure through 2, 10, 51, 62, 100 and 146, 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.

1. Type **ROSALIND FRANKLIN**: each letter is the code for one amino acid (the O is skipped: no amino acid has that letter). Its 15 amino acids are joined by 14 peptide bonds: one of 20^{15} (about 3×10^{19}) 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.

Predict box: How many different dipeptides can be made from the 20 amino acids? Hands up or mini whiteboards first.

Answer D: 400, because there are twenty choices at each of the two positions

05 Heat and pH unfold a protein

CHAPTER 05 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. Raw egg white: clear and runny. Magnified, the proteins are **folded**, each on its own among the water molecules.
2. **Heat** makes the molecules jiggle harder and breaks the bonds that hold the folds.
3. The chains **unfold**: with the bonds gone, their shape is gone.
4. Unfolded chains **tangle** together and the egg white sets, white and solid. The proteins are **denatured**.

Play the animation, Heat it, change the pH. It loops; pause it on each moment below and ask what is happening (in the lesson slides it is a video).

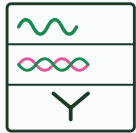
1. A new chain of amino acids among water molecules: as yet it has **no shape**.
2. A small molecule **fits** its pocket: one precise shape, one job.
3. Cooled again, it does not refold: the unfolded chains **tangle** together instead.

Predict box: When an egg sets in a hot pan, which bonds break? Hands up or mini whiteboards first.

Answer C: The weak bonds that hold the fold, while the peptide bonds stay intact

THE LESSON

10 min	The amino acid shelf Chapter 3's figure. Pairs then plan a day of vegan meals that covers all nine essential amino acids, without naming any. Rice and lentils, or hummus and bread, make a good start.
15 min	Protein doodles Students pick three proteins and make two drawings each: how does its shape suit its job? (activity below). Use chapter 4's examples as the fact cards.
15 min	Heat and acid The egg white demonstration (optional, below), or chapter 5's figure. Then the folding scene under it, Heat it, change the pH: let the film run once, then take the temperature past 65 °C and back to 37 °C (the chain stays unfolded and tangles), press Fresh protein and move the pH to 1.5 and to 12.5. Then the predict box: which bonds break?
10 min	A written question Set an SL written question from the B1.2 exam maker (in Practise and revise), such as drawing a dipeptide or explaining essential amino acids, and peer-mark it. Point out that the markscheme has more points than marks.

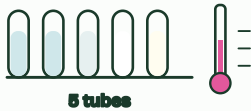


DRAWING

Protein doodles

Each student picks three proteins from lysozyme, insulin, antibodies, rhodopsin, collagen, spider silk, glucagon and a snake venom toxin. For each they write five keywords and make two drawings answering “how does its shape suit its job?” Finish with a gallery walk.

Needs: A4 paper, and a short fact card for each protein written by the teacher.



PRACTICAL (OPTIONAL)

Egg white, heat and acid

Put egg white in five tubes: room temperature, and 40, 60 and 80 °C water baths for five minutes, plus one with vinegar or lemon juice. Record clear or cloudy and runny or set, then cool the hot ones. Which change came back on cooling?

Needs: one egg, test tubes, water baths or a kettle and beakers, thermometers, vinegar.

PLENARY

5

min

Exit and homework

Homework: [the Check step](#). The [amylase home lab](#) (C1.1) makes good optional homework: denaturation you can time.

WHAT STUDENTS GET WRONG

“Essential” means more important. It means “must be eaten”.

Denaturation breaks the chain, or is caused by cold, or means the protein “dies”. It is the shape that goes.

Twenty amino acids, so twenty proteins. The order makes the protein.

STRETCH AND SUPPORT

Support: use the four Remember it tiles as starters.

Support: cut the figures’ captions up for students to put in order.

Stretch: why are there more possible proteins of 62 amino acids than atoms in the observable universe?

Stretch: how do the proteins of hot-spring microbes stay folded at temperatures that would denature ours?

IN THE GUIDE

- 3 [Some amino acids you must eat](#)
- 4 [Twenty amino acids, endless chains](#)
- 5 [Heat and pH unfold a protein](#)
- A11 [The whole guide, with the figures that play](#)
- PPTX [This lesson’s slides, in the order of this plan](#)

PRACTISE AND REVISE

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- [B1.2 Proteins](#)

EXAM PRACTICE

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



R groups and the levels of structure HL

60 minutes • B1.2.6 to B1.2.9 • Chapters 6, 7, 8, 9

Sorting R groups, then the primary, secondary and tertiary structure and the bonds that hold each

BY THE END, STUDENTS CAN

- ☐ Classify R groups and explain how they set the properties of a polypeptide B1.2.6
- ☐ Explain how the sequence of amino acids gives every copy of a protein the same precise shape B1.2.7
- ☐ Describe the alpha helix and beta-pleated sheet and the hydrogen bonds that hold them B1.2.8
- ☐ 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

TIMING

0-5	5 min	Do now: sort six R groups	
5-25	20 min	Pipe-cleaner polypeptide	
25-35	10 min	Helix and sheet	
35-50	15 min	What holds the fold	
50-60	10 min	An HL written question	
	60 min	One lesson	

STARTER

- 5 min** **Do now: sort six R groups**
- Print [chapter 6's](#) six R group cards and sort them into hydrophobic, polar, acidic and basic, then turn over the Hungry Pandas Ate Bamboo tiles.

ON THE BOARD, FROM THE GUIDE

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06 The R groups decide how a chain behaves

CHAPTER 06 IN THE SLIDES

Show the figure: Six R groups, drawn as condensed formulas, and four bins. Which bin does each belong in, and what tells you?

Predict box: An R group contains a carboxyl group. Inside a cell, at about pH 7, it is: Hands up or mini whiteboards first.

Answer B: Negatively charged, because it has lost a hydrogen ion

Remember it: Hungry Pandas Ate Bamboo (Hydrophobic, Polar, Acidic, Basic).

07 The sequence sets the shape

CHAPTER 07 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.

- Primary** structure: a sequence of amino acids, each joined to the next by a peptide bond.
- Secondary** structure: one stretch coils and another pleats beside itself, held by dashed hydrogen bonds.
- Tertiary** structure: the whole chain folded into a compact shape.
- Quaternary** structure: two or more folded chains together. Not every protein has one.
- A second copy of the same sequence folds into the same shape: same sequence, **same shape**, every time.

Predict box: Two people make insulin from the same gene sequence. Do their insulin molecules have the same shape? Hands up or mini whiteboards first.

Answer A: Yes, exactly: the same sequence folds the same way every time

08 Coils and pleats held by hydrogen bonds

CHAPTER 08 IN THE SLIDES

Switch the figure through Helix, Sheet and In a protein, and have the class say what will change before each.

Predict box: Which groups form the hydrogen bonds that hold an alpha helix? Hands up or mini whiteboards first.

Answer D: The C=O and N-H groups of the peptide bonds in the backbone

09 Four kinds of bond hold the fold

CHAPTER 09 IN THE SLIDES

Switch the figure through Hydrogen, Ionic, Disulfide, Hydrophobic, All and Lower the pH, and have the class say what will change before each.

Predict box: An ionic bond holds two parts of a protein together. The pH falls to 2. Why might the bond break? Hands up or mini whiteboards first.

Answer B: The negative carboxyl R group gains a hydrogen ion and loses its charge

Remember it: Happy Hippos Ignore Dentists (Hydrogen bonds, Hydrophobic interactions, Ionic bonds, Disulfide bonds).

THE LESSON

20
min

Pipe-cleaner polypeptide

Pairs thread a gene card's coloured pieces onto a pipe cleaner, coil one stretch, pleat another, fold the whole thing and clip the cysteines together (activity below).

10
min

Helix and sheet

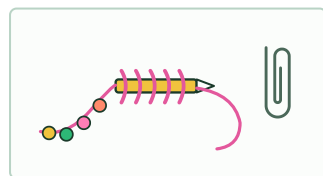
Chapter 8: students sketch an alpha helix and a beta-pleated sheet with their hydrogen bonds, labelling the two groups that form each bond.

15
min

What holds the fold

Chapter 9's figure, one bond at a time, ending with Lower the pH. Start the four levels table, rows 1 to 3.

ACTIVITIES



MODEL · HL

Pipe-cleaner polypeptide

Each pair gets a gene card listing a sequence of colours (yellow hydrophobic, green polar, pink and coral charged, two cysteine colours) and threads short coloured pieces onto a long pipe cleaner in that order: they are the ribosome, and that is primary structure. They twist one stretch round a pencil (helix), zigzag another against itself (sheet), then fold the whole thing so the yellows meet in the middle, clip the two cysteines together (disulfide bond) and join on to another pair's chain (quaternary). Pairs with the same card compare: same shape?

Needs: long pipe cleaners, short coloured pieces (or beads), pencils, paper clips, gene cards.

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—			⊖
—			oo

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.

10
min**An HL written question**

Set an HL written question from the exam maker (the bonds of the tertiary structure, or secondary structure) and peer-mark it.

WHAT STUDENTS GET WRONG

Secondary structure is held by R groups. It is held by the backbone C=O and N-H.

Acidic R groups are positive. They are negative: the carboxyl group has lost a hydrogen ion.

STRETCH AND SUPPORT

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

Stretch: why do all the molecules of one sequence fold the same way, and what did Anfinsen's experiment add?

Stretch: why are disulfide bonds commoner in proteins that leave the cell? (The cytoplasm is a reducing place, so they do not form well inside.)

Stretch: compare an AlphaFold prediction with an experimental structure of the same protein.

IN THE GUIDE

- 6** [The R groups decide how a chain behaves](#)
- 7** [The sequence sets the shape](#)
- 8** [Coils and pleats held by hydrogen bonds](#)
- 9** [Four kinds of bond hold the fold](#)
- 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**

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ALREADY ON THE SITE FOR B1.2

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- Revision map: [B1.2 Proteins](#), to fill in
- Exam questions: [B1.2 in the exam maker](#), a paper with its markscheme

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- [B1.2 Proteins](#)

EXAM PRACTICE**Check yourself**

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



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.

1. 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.
2. 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

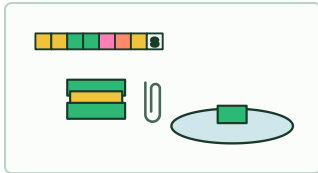
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WRITING · HL

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.

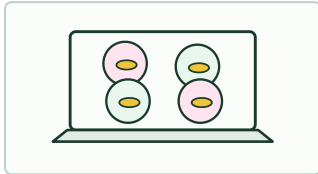


MODEL · HL

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.

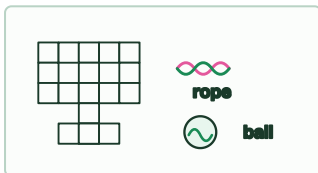


DIGITAL MODEL · HL, OPTIONAL

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

