

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

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 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

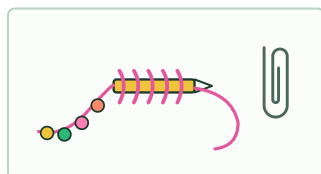
Chapter 8: students sketch an alpha helix and a beta-pleated sheet with their hydrogen bonds, labelling the two groups that form each bond.

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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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**

- [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 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

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.