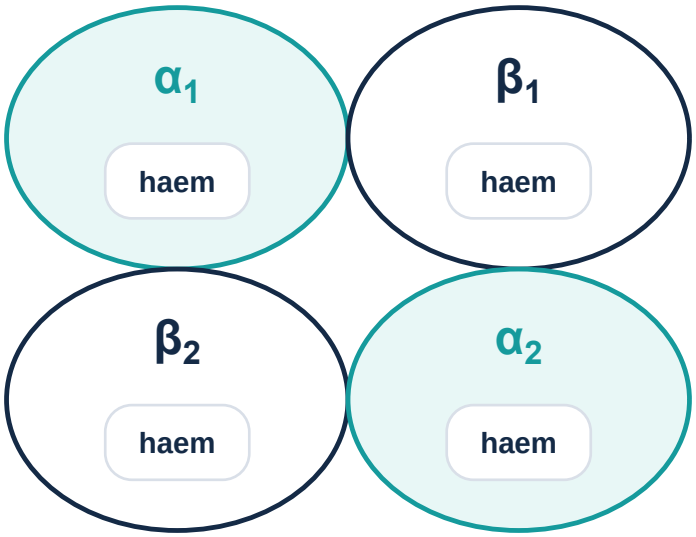
Four chains make one molecule

The main adult human haemoglobin, HbA, is a soluble globular protein in red blood cells. Its four polypeptide chains assemble into a compact molecule with quaternary structure.

HbA: TWO ALPHA CHAINS + TWO BETA CHAINS



Each labelled lobe is one folded globin chain with one haem group.

Composition schematic, not a scale model. The small 1 and 2 labels distinguish copies of the same chain type; they are not protein-structure levels.

1. TWO TYPES, FOUR POLYPEPTIDES

Alpha-globin and beta-globin have different amino acid sequences. HbA contains two copies of each. The notation $\alpha_2\beta_2$ describes the number of chains of each type.

2. QUATERNARY MEANS A MULTI-CHAIN ASSEMBLY

Contacts between the folded chains stabilise the assembly. The four chains are not one continuous polypeptide joined end-to-end. Each chain retains its own amino acid sequence.

Scope note: this lesson uses HbA. Other haemoglobins can have a different combination of globin chain types.

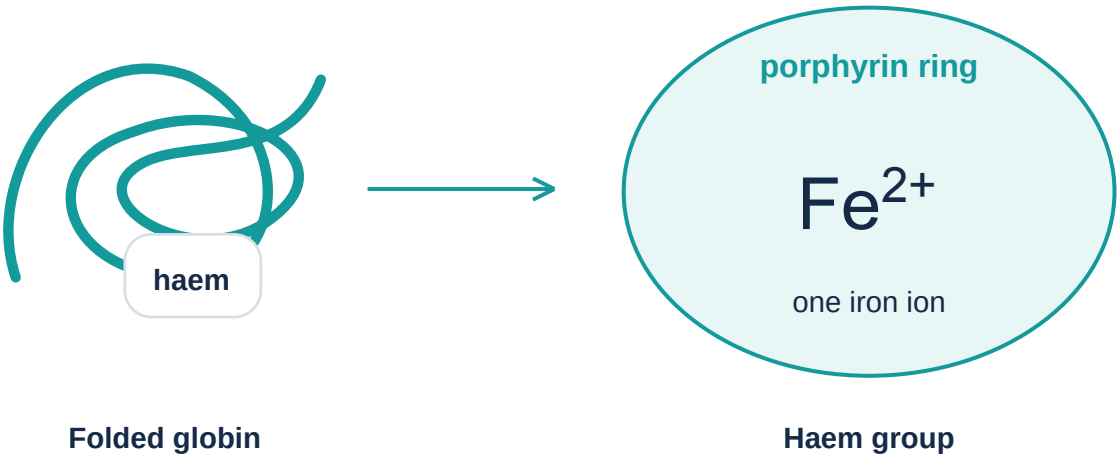
Supporting reading: RCSB PDB-101, Molecule of the Month: Hemoglobin.

Scope: Cambridge Biology 9700 syllabus, section 2.3, outcome 5, p. 18.

Globin and haem are different parts

Globin is the polypeptide component. Haem is a tightly associated non-protein prosthetic group. A protein with a non-protein component is called a conjugated protein.

ONE HAEM GROUP IN EACH GLOBIN CHAIN



Folded globin **Haem group**

The oval represents a ring system surrounding iron, not the chemical bond pattern. Haem is held in a pocket within globin; it is not another polypeptide chain.

1. COUNT THE NON-PROTEIN COMPONENTS

Each of the four chains carries one haem group, and each haem contains one iron ion. Therefore one HbA molecule contains four haem groups and four iron ions.

2. KEEP THE PARTS DISTINCT

An iron ion is part of haem, not an amino acid. Haem is a prosthetic group, not a fifth subunit. The presence of multiple polypeptide chains is what gives haemoglobin quaternary structure.

Next-lesson connection: oxygen binds reversibly at the haem iron. The detailed link between this structure and oxygen transport follows in Lesson 2.3.6.

Supporting reading: RCSB PDB-101, Molecule of the Month: Hemoglobin.

Scope: Cambridge Biology 9700 syllabus, section 2.3, outcome 5, p. 18.

Read the same molecule at each level

The structure levels describe different aspects of haemoglobin. Separate what belongs to one globin chain from what describes the whole four-chain assembly.

1. PRIMARY

The amino acid sequence of each alpha- or beta-globin chain. Peptide bonds join successive residues within that chain.

2. SECONDARY

Local alpha helices occur in both types of globin chain. The name "beta-globin" does not mean that the chain is a beta pleated sheet.

3. TERTIARY

Each globin chain folds into a three-dimensional shape, creating a pocket that accommodates its haem group.

4. QUATERNARY

Two alpha and two beta chains associate in a specific arrangement. Interactions between their surfaces hold the assembly together.

ONE-MOLECULE CHECK

2 alpha + 2 beta = 4 globin chains

4 haem groups | 4 iron ions | 1 HbA molecule

Supporting reading: Alberts et al., Molecular Biology of the Cell, protein structure.

Scope: Cambridge Biology 9700 syllabus, section 2.3, outcome 5, p. 18.