

**Table 9.4** Average number and size of erythrocytes and the average hemoglobin concentration in blood in man and some domestic animals

Species	Man	Cattle	Goats	Sheep	Pigs	Horses	Dogs	Poultry
Number ( $\cdot 10^{-12}/L$ )	5	7	15	11	7	7a 10b	7	3
Size (fL <sup>c</sup> )	95	52	20	34	60	45 <sup>b</sup>	70	130
Hb (g/L)	150	110	100	118	127	110 <sup>a</sup> 145 <sup>b</sup>	150	90

a: cold-blooded horses, b: warm-blooded horses, c: fL = femtoliter =  $10^{-15}$  L

passage through the systemic capillaries at rest. Therefore, venous blood is considerably darker than arterial blood.

Each iron atom can have six covalent (p. 8) bindings. In hemoglobin, four nitrogen atoms in the heme ring are covalently bound to iron. There is also a covalent binding between iron and the peptide chain. It is the sixth binding that is used for the loose and reversible binding of  $O_2$ . The binding of  $O_2$  does not result in iron itself being oxidized (Fig. 9.3b). When  $O_2$  is not bound to heme, the sixth covalent binding is free.

The four peptide chains in the hemoglobin molecule forms two pairs, and within each pair, the peptide chains are identical (Fig. 9.3a). The amino acid composition of the peptides determines the

oxygen affinity of the hemoglobin molecule. Two of the peptide chains are called  $\alpha$ -chains and consist of 141 amino acids. The other two consist of 146 amino acids, which may be beta-, gamma-, delta-, or epsilon chains ( $\beta$ ,  $\gamma$ ,  $\delta$ ,  $\epsilon$ ).

Blood releases about 25 % of its oxygen when it passes through the tissues

The iron atom in each heme group can covalently bind one  $O_2$  molecule

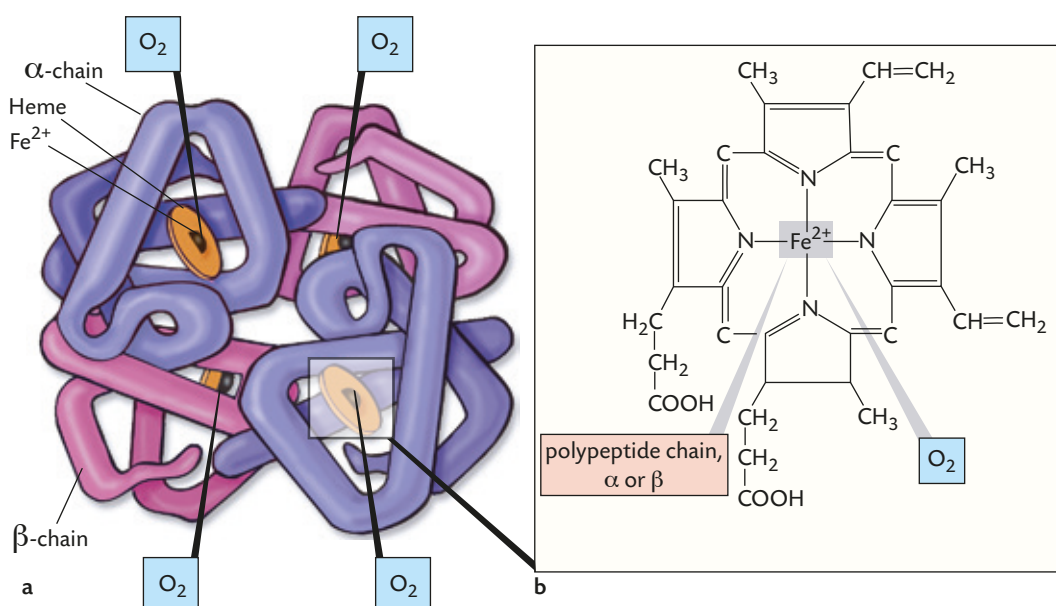
Globin consists of four peptide chains, forming two pairs, within which the chains are identical

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**11** How much of the oxygen bound to hemoglobin is released during passage through the systemic capillaries?

**12** How much of the erythrocyte mass is hemoglobin?

**13** Describe the structure of hemoglobin.



**Figure 9.3** The hemoglobin molecule. **a** Each hemoglobin molecule is composed of four subunits. The subunits form two pairs, each with identical peptide chains. Two of the chains are  $\alpha$ -chains, and the other two may be  $\beta$ -,  $\gamma$ -,  $\delta$ -, or  $\epsilon$ -chains. Each polypeptide chain forms a pocket that contains a heme group (shown as disks). **b** Each heme group has an ionic iron atom ( $Fe^{2+}$ ) at its center.  $O_2$  binds to  $Fe^{2+}$ .