A Level Biology A

H420/01 Biological Processes

Question Set 20

20 (a) (i) Rubredoxin is a protein found in bacteria. It contains around 50 amino acids. One iron ion is bound by the sulphur atoms of four cysteine amino acids.

The structure of rubredoxin is shown in Fig. 20.1.

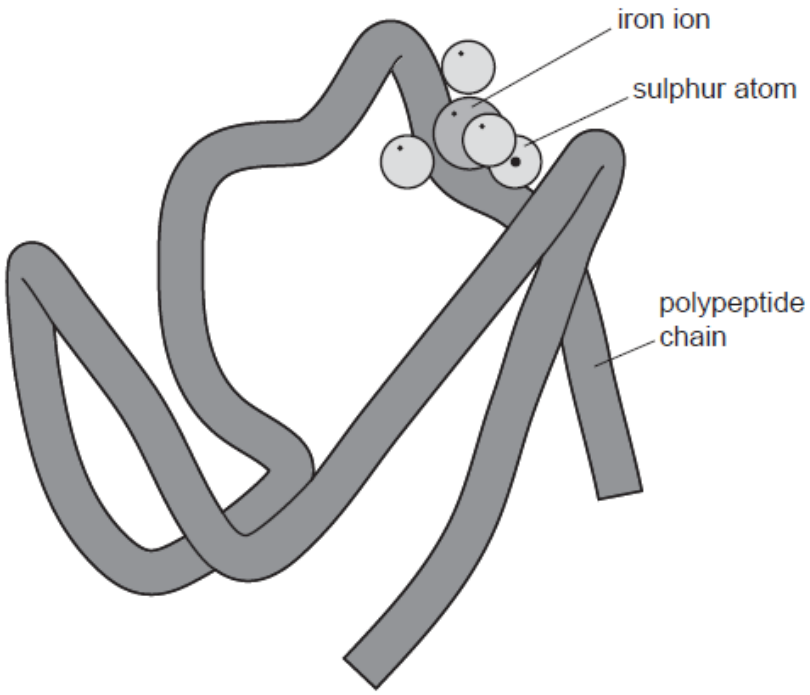

Fig. 20.1

Rubredoxin is known as a **conjugated protein**.

Use Fig. 20.1 to explain what is meant by the term conjugated protein. **[3]**

Conjugated proteins are forms of globular proteins (compact, rounded, water soluble proteins) that contain a non-protein prosthetic group (e.g. Fe^{2+} in rubredoxin) attached by covalent bonding. This group is vital to the biological functioning of the protein.

20 (a) (ii) Using the information provided about rubredoxin, state **two** similarities between thestructures of rubredoxin and haemoglobin.

similarity 1 Both contain Fe^{2+}

similarity 2 Both have a globular protein structure. **[2]**

20 (a) (iii) Rubredoxin and haemoglobin have different secondary and tertiary structures.

Using the information provided about rubredoxin, state **two other** differences betweenthe structures of rubredoxin and haemoglobin.

difference 1 Haemoglobin has a quaternary structure consisting of four polypeptide chains whereas rubredoxin does not have a quaternary structure

difference 2 Rubredoxin contains sulfur whereas haemoglobin does not. **[2]**

20 (b) (i) Ferritin is a protein that is used to regulate iron levels within plant tissues.

It is a large spherical structure which can hold many iron (Fe^{3+}) ions at its centre. Iron can be toxic to plant tissues. Ferritin prevents the build-up of iron.

Fig. 20.2 shows the internal structure of ferritin.

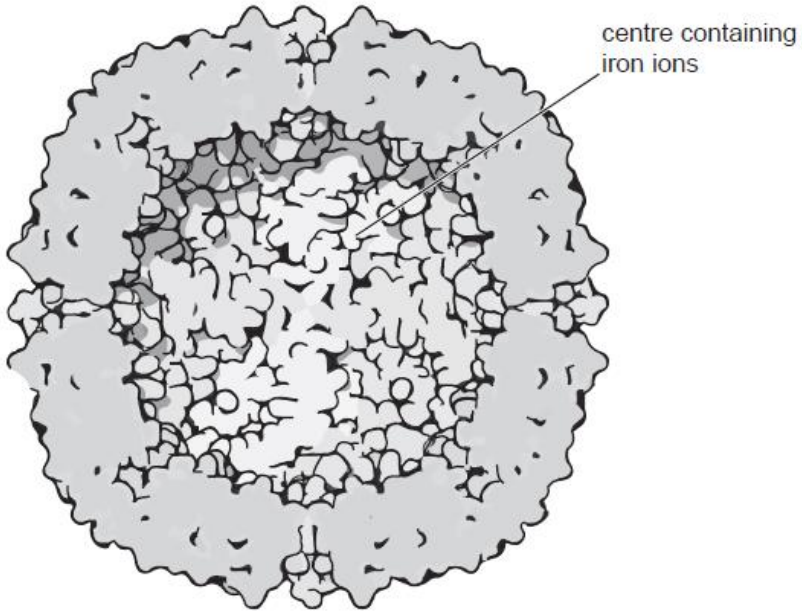

Fig. 20.2

Ferritin molecules can hold 4500 Fe^{3+} ions in the inner sphere.

It is thought that the Fe^{3+} ions are unable to occupy the total available volume of theinner sphere because other molecules are present in the inner sphere.

The volume of the inner sphere of the ferritin molecule is 268 nm^3.The volume of an Fe^{3+} ion is 9.04×10^{-4} nm^3.

Calculate the volume of the inner sphere **not** occupied by Fe^{3+} ions.

Volume of $4500\ Fe^{3+} = 4500 \times (9{\cdot}04 \times 10^{-4}) = 4{\cdot}068\ nm^3$

$268 - 4{\cdot}068 = 263{\cdot}932 = \underline{264\ nm^3}$

volume = ……264……nm^3 **[3]**

20 (b) (ii) Explain how hydrophilic and hydrophobic interactions contribute to the spherical shape of ferritin.

The tertiary structure of ferritin is such that the hydrophobic R groups on the amino acids aggregate and are buried towards the centre of the protein, away from the aqueous environment, whilst the hydrophilic R groups are positioned on the outside of the protein, exposed to the aqueous environment. This creates the spherical shape. **[1]**

Total Marks for Question Set 20: 11