Oxford Cambridge and RSA

AS Level Biology A

H020/02 Depth in biology

Question Set 7

1 **(a)** Fig. 1.1 shows the general structure of an amino acid.

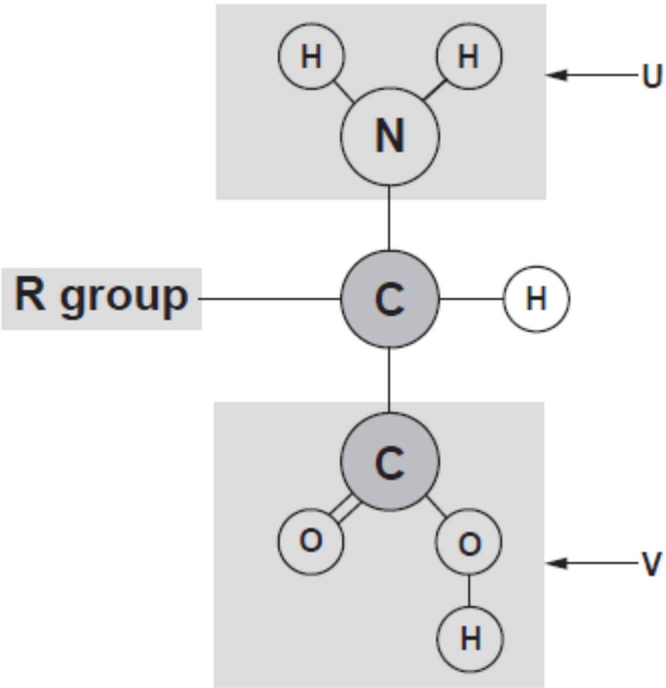

Fig. 1.1

(i) State the names of the groups labelled **U** and **V**.

U Amino group ....

V Carboxyl group ....

[1]

(ii) Fig. 1.2 shows a representation of a short polypeptide chain made from three aminoacids.

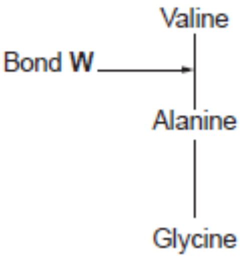

Fig. 1.2

Name bond **W and** state what type of reaction takes place to form this bond.

Name of bond **W**…Peptide bond ....

Type of reaction Condensation reaction .... **[1]**

(b) Pepsin is a protease enzyme with a polypeptide chain containing 327 amino acids. Titin is the largest known protein. It has a polypeptide chain containing at least 92 times more amino acids than pepsin.

(i) DNA sequences in genes code for polypeptide molecules such as pepsin and titin.Explain why a process known as transcription is necessary for polypeptide synthesis. **[2]**

Transcription is necessary to produce mRNA from a section of the template strand of DNA corresponding to a gene. DNA is too large to leave the nucleus via nuclear pores in order to reach the ribosomes where translation takes place. mRNA, which is small enough to pass through, must be produced instead.

(ii) Calculate the minimum length of the DNA base sequence required to code for titin. Show your working.

$327 \times 92 \times 3 = 90252$

Answer.....90252..................... **[2]**

(iii)* Titin is a fibrous protein. Pepsin is a globular protein.

Compare the properties and functions of fibrous proteins and globular proteins in the human body. **[6]**

Fibrous proteins are made up of long, thin, insoluble filaments which form strong but flexible elongated fibres. They are not folded into complex 3D structures. They are made up of a limited number of amino acids which generally form a fairly repetitive sequence. Fibrous proteins have organised structures which links to their structural functions. Collagen is a connective tissue protein found in skin, tendons, ligaments, blood vessels and the nervous system. It has a rope-like structure consisting of three wound polypeptide chains. This gives collagen its flexibility. Collagen provides strength to tissues, preventing tearing or separation from neighbouring tissues. Fibrous proteins also have protective roles. Keratin is present in hair, skin and nails, and protects epithelial cells from stress or damage. It provides a barrier to pathogen entry into the body. Elastin is a fibrous protein found in elastic fibres which provides elasticity to structures such as blood vessels and alveoli, enabling them to expand and recoil back to normal size, for contraction. Actin/Myosin in muscle forming microtubules in cytoskeleton.

Unlike fibrous proteins, globular proteins are water soluble, more compact and rounded. They possess specific, complex 3D structures with hydrophobic amino acid R groups positioned on the inside of the protein and hydrophilic groups on the outside. Conjugated proteins are a form of globular protein that contain a non-protein prosthetic group. Whereas fibrous proteins have structural roles, globular proteins have functional roles. Some globular proteins serve as enzymes which lower the activation energy of specific chemical reactions. For example, catalase increases the rate of breakdown of hydrogen peroxide, a toxic byproduct of metabolism. Some globular proteins serve as hormones (e.g. insulin regulates blood glucose concentration) whilst others may function as receptors, protein channels or transport proteins (e.g. haemoglobin). Similarly to fibrous proteins, globular proteins may serve protective roles in terms of defending the body against infection. Antibodies, antitoxins and opsonins are all examples of globular proteins.

→ Thus temperature sensitive, specific/complementary

(iv) Another protease enzyme is HIV1 protease, which is essential for the life cycle of the human immunodeficiency virus (HIV). Inhibition of this protease prevents HIV from maturing.

In 1995, saquinavir was the first HIV1 protease inhibitor drug to be approved by the US Food and Drug Administration (FDA).

The data in Fig. 1.3 show the number of acquired immune deficiency syndrome (AIDS) diagnoses and deaths between 1981 and 2007 in the US.

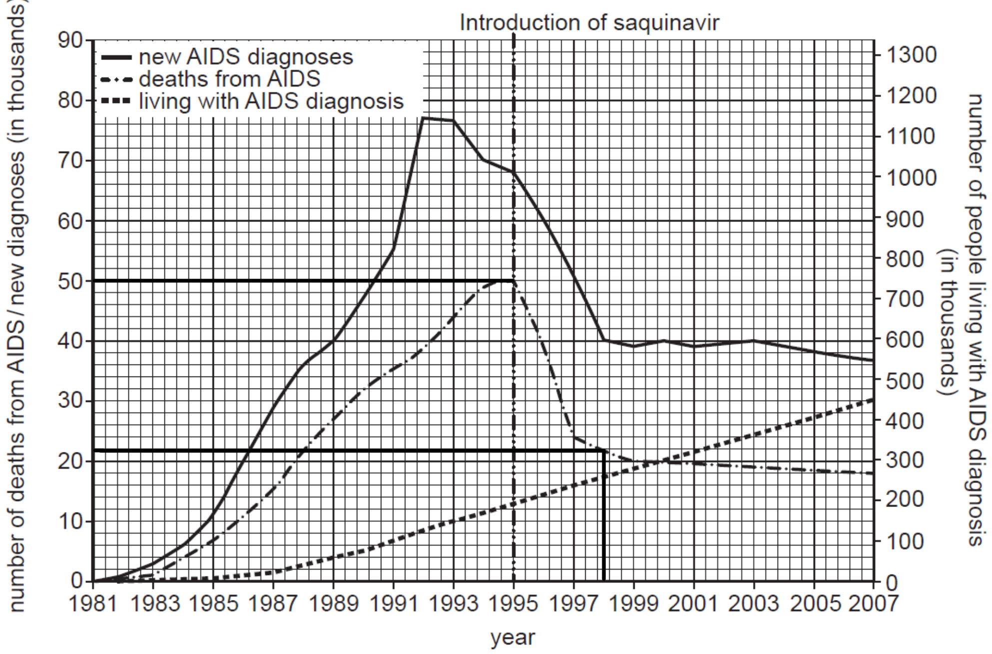

Fig 1.3

Calculate the rate of decrease in deaths from AIDS between 1995 and 1998.

Give your answer to **two significant figures**.

Show your working.

$$\frac{50000 - 22000}{3} = 9333.\dot{3} = 9300 \text{ deaths yr}^{-1}$$

Answer ....9300.......... Units deaths yr^{-1}

[2]

(v) A student looking at the data in Fig. 1.3 made the following conclusion:

> "The decrease in deaths from AIDS after 1995 is because of the use of saquinavir by HIV patients."

Suggest why this conclusion may be invalid based on the data in Fig. 1.3. **[2]**

Before 1995, there was already a decrease in the number of new AIDS diagnoses which may have contributed to the reduction in deaths. The plateau in the number of deaths also began before the drug was introduced in 1995, suggesting another factor may be responsible.

(c) A group of students wanted to use thin layer chromatography to identify four amino acids.

To produce the chromatogram, the students:

- drew a pencil line 1 cm from the bottom of the chromatography plate and put solvent into the beaker to a height of approximately 0.9 cm
- held the chromatography plate firmly in the middle with their hands and lowered it into the beaker
- left the apparatus to stand as shown in Fig. 1.4.

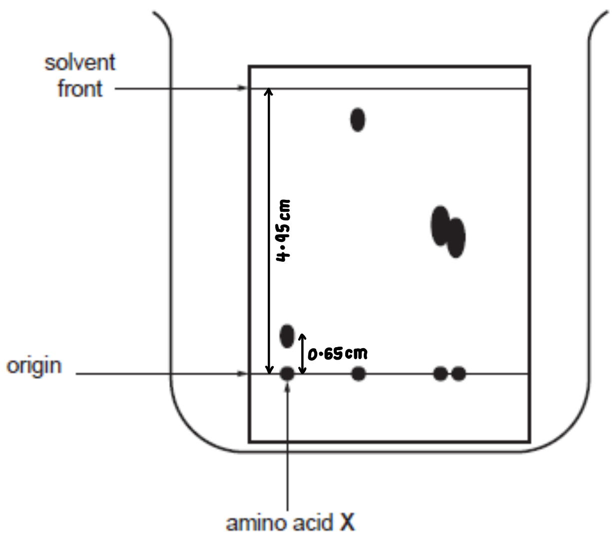

Fig. 1.4

(i) Describe **four** ways you would refine the method used by the students. For each change you suggest, give a reason why this would improve the results of the experiment. **[4]**

Add less solvent to ensure that it does not wet the amino acid spots on the pencil line. Place a watch glass over the beaker to prevent the solvent evaporating away. Wear gloves when handling the chromatography paper to prevent the transfer of oils from the hands. Place the amino acid spots further apart to prevent them from merging.

(ii) Table 1 shows the R_f values of some amino acids.

Name of amino acid	R_f value
Alanine	0.31
Cysteine	0.40
Glutamine	0.13
Phenylalanine	0.59

Table 1

Using the information in Table 1 and Fig. 1.4, identify amino acid **X** by calculating its R_f value.

Show your working.

$\frac{0.65}{4.95} = 0.1\dot{3}$

R_f value of amino acid **X** ......0·13......

Name of amino acid **X** ......Glutamine...... **[2]**

Total Marks for Question Set 7: 22

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