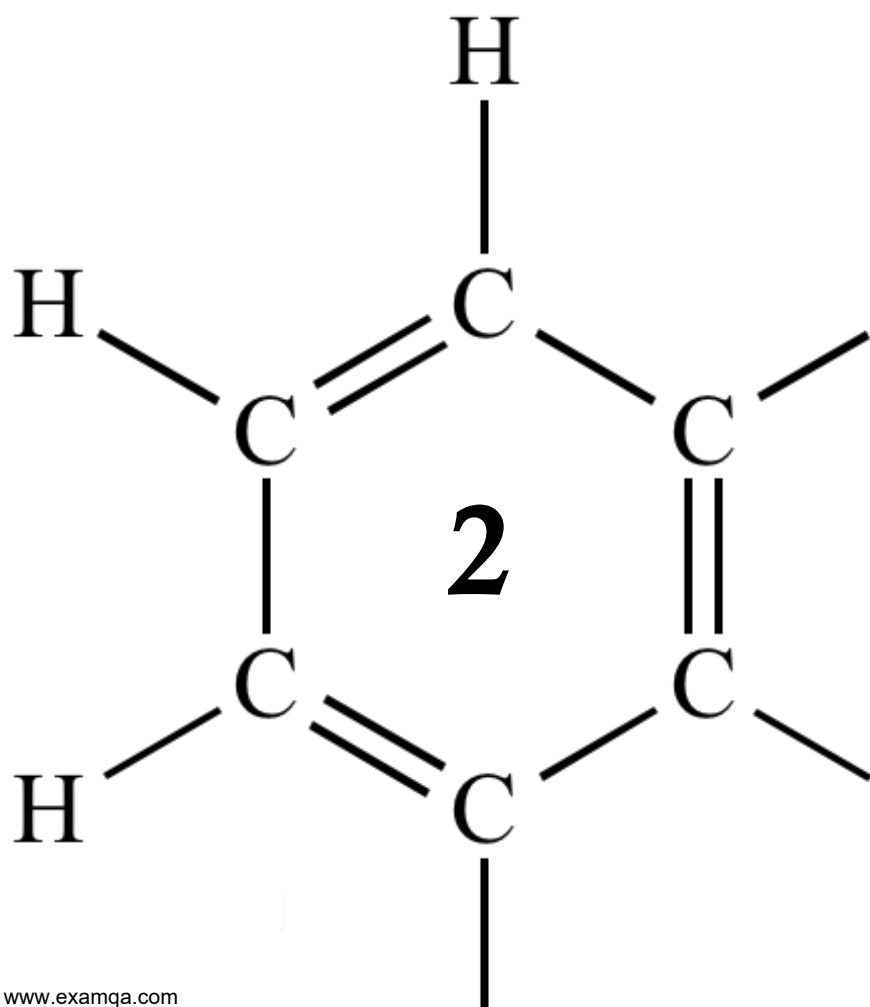


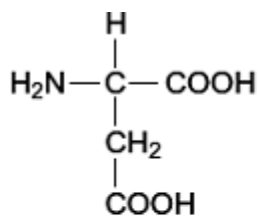
AQA A2 CHEMISTRY

PROTEINS ~ DNA

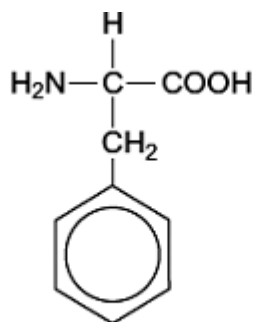


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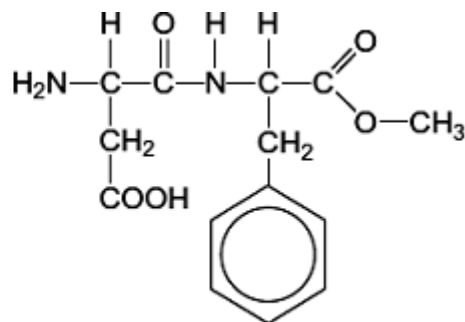
The amino acids aspartic acid and phenylalanine react together to form a dipeptide. This dipeptide can be converted into a methyl ester called aspartame.



aspartic acid



phenylalanine



aspartame

Aspartame has a sweet taste and is used in soft drinks and in sugar-free foods for people with diabetes.

Hydrolysis of aspartame forms methanol initially. After a longer time the peptide link breaks to form the free amino acids. Neither of these amino acids tastes sweet.

- (a) Apart from the release of methanol, suggest why aspartame is **not** used to sweeten foods that are to be cooked.

.....

 (Extra space)

(1)

- (b) Give the IUPAC name of aspartic acid.

.....

(1)

- (c) Draw the organic species formed by aspartic acid at high pH.

(1)

(d) Draw the zwitterion of phenylalanine.

(1)

(e) Phenylalanine exists as a pair of stereoisomers.

(i) State the meaning of the term *stereoisomers*.

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.....
.....

(2)

(ii) Explain how a pair of stereoisomers can be distinguished.

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.....
(Extra space)
.....

(2)

(Total 8 marks)

2

The amide or peptide link is found in synthetic polyamides and also in naturally occurring proteins.

- (a) (i) Draw the repeating unit of the polyamide formed by the reaction of propanedioic acid with hexane-1,6-diamine.

(2)

- (ii) In terms of the intermolecular forces between the polymer chains, explain why polyamides can be made into fibres suitable for use in sewing and weaving, whereas polyalkenes usually produce fibres that are too weak for this purpose.

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(Extra space)

.....

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(3)

(b) (i) Name and outline a mechanism for the reaction of $\text{CH}_3\text{CH}_2\text{COCl}$ with CH_3NH_2

Name of mechanism.....

Mechanism

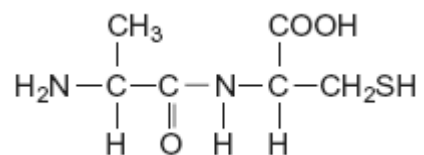
(5)

(ii) Give the name of the product containing an amide linkage that is formed in the reaction in part (b) (i).

.....

(1)

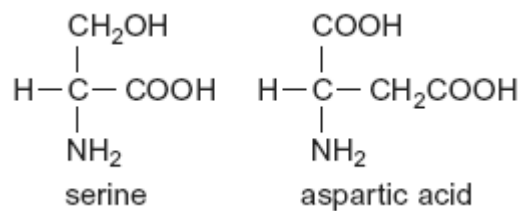
(c) The dipeptide shown below is formed from two different amino acids.



Draw the structure of the alternative dipeptide that could be formed by these two amino acids.

(1)

(d) The amino acids serine and aspartic acid are shown below.



(i) Give the IUPAC name of serine.

.....

(1)

(ii) Draw the structure of the species formed when aspartic acid reacts with aqueous sodium hydroxide.

(1)

(iii) Draw the structure of the species formed when serine reacts with dilute hydrochloric acid.

(1)

(iv) Draw the structure of the species formed when serine reacts with an excess of bromomethane.

(1)
(Total 16 marks)

3

(a) Name compound **Y**, HOCH₂CH₂COOH

.....

(1)

(b) Under suitable conditions, molecules of **Y** can react with each other to form a polymer.

(i) Draw a section of the polymer showing **two** repeating units.

(1)

(ii) Name the type of polymerisation involved.

.....

(1)

(c) When **Y** is heated, an elimination reaction occurs in which one molecule of **Y** loses one molecule of water. The organic product formed by this reaction has an absorption at 1637 cm⁻¹ in its infrared spectrum.

(i) Identify the bond that causes the absorption at 1637 cm⁻¹ in its infrared spectrum.

.....

(1)

(ii) Write the displayed formula for the organic product of this elimination reaction.

(1)

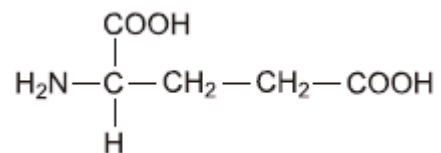
(iii) The organic product from part (ii) can also be polymerised.
Draw the repeating unit of the polymer formed from this organic product.

(1)

- (d) At room temperature, 2-aminobutanoic acid exists as a solid. Draw the structure of the species present in the solid form.

(1)

- (e) The amino acid, glutamic acid, is shown below.



Draw the structure of the organic species formed when glutamic acid reacts with each of the following.

- (i) an excess of sodium hydroxide

(1)

- (ii) an excess of methanol in the presence of concentrated sulfuric acid

(1)

- (iii) ethanoyl chloride

(1)

- (f) A tripeptide was heated with hydrochloric acid and a mixture of amino acids was formed. This mixture was separated by column chromatography. Outline briefly why chromatography is able to separate a mixture of compounds. Practical details are **not** required.

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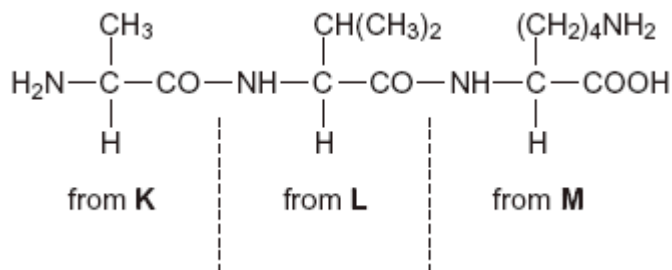
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(3)
(Total 13 marks)

- 4 (a) Consider the tripeptide shown below that is formed from three amino acids, **K**, **L** and **M**.



- (i) Name the process by which the tripeptide is split into three amino acids.

.....

(1)

- (ii) Give the IUPAC name for the amino acid **K**.

.....

(1)

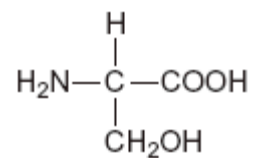
- (iii) Draw the structure of the zwitterion of amino acid **L**.

(1)

(iv) Draw the structure of the species formed by amino acid **M** at low pH.

(1)

(b) Consider the amino acid serine.



(i) Draw the structure of the product formed when serine reacts with an excess of CH_3Br

(1)

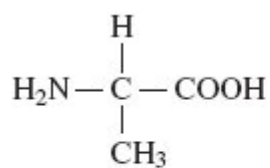
(ii) Draw the structure of the dipeptide formed by two molecules of serine.

(1)

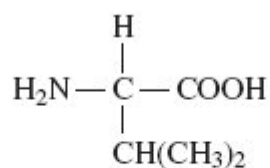
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5

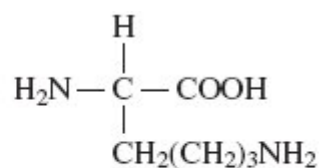
The three amino acids shown below were obtained by hydrolysis of a protein.



alanine



valine



lysine

(a) (i) Draw the zwitterion of alanine.

(1)

(ii) Draw the species formed when valine is dissolved in an alkaline solution.

(1)

(iii) Draw the species formed by lysine at low pH.

(1)

(b) Draw the two dipeptides formed by the reaction of alanine with valine.

(2)

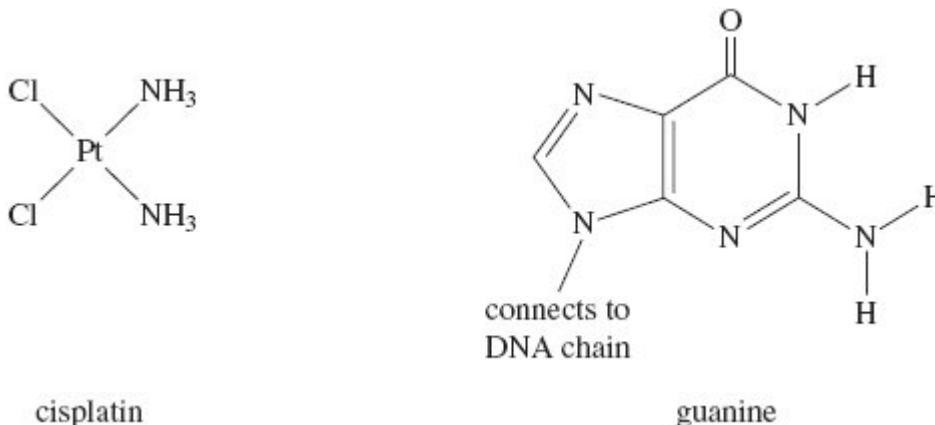
- (c) Name a suitable method by which the mixture of amino acids formed by hydrolysis of the protein can be separated.

.....

(1)
(Total 6 marks)

6

The complex cisplatin acts as an anticancer drug by changing the properties of DNA when it reacts with guanine, a component of DNA.



When cisplatin is absorbed into the human body, it undergoes a ligand substitution reaction and one chloride ligand is replaced by a water molecule forming a complex ion **Q**.

- (a) Write an equation for this substitution reaction to form the complex ion **Q**.

.....

(2)

- (b) The complex ion **Q** can bond to guanine in two different ways.

- (i) The first way involves a hydrogen atom, from one of the ammonia ligands on **Q**, bonding to an atom in a guanine molecule. State the type of bond formed to guanine and identify an atom in guanine that could form a bond to this hydrogen atom.

Type of bond

Atom in guanine

(2)

- (ii) The second way involves a ligand substitution reaction in which an atom in a guanine molecule bonds to platinum by displacing the water molecule from **Q**. State the type of bond formed between guanine and platinum when a water molecule is displaced and identify an atom in guanine that could bond to platinum in this way.

Type of bond

Atom in guanine

(2)

- (c) State and explain **one** risk associated with the use of cisplatin as an anticancer drug.

Risk

Explanation

(2)

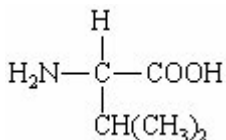
(Total 8 marks)

7

Fibres are made from natural and from synthetic polymers. Both types of polymer have advantages and disadvantages.

- (a) Amino acids are the building blocks of naturally-occurring polymers called proteins.

Consider the following amino acid.



- (i) Draw the structure of the amino acid species present in a solution at pH 12.

- (ii) Use your understanding of amino acid chemistry to deduce the structure of the dipeptide formed from two molecules of this amino acid and illustrate your answer with a sketch showing the structure of the dipeptide.

- (iii) Protein chains are often arranged in the shape of a helix. Name the type of interaction that is responsible for holding the protein chain in this shape.

.....

(3)

- (b) Alkenes are the building blocks of synthetic addition polymers.

Consider the hydrocarbon **G**, $(\text{CH}_3)_2\text{C}=\text{CHCH}_3$, which can be polymerised.

- (i) Draw the repeating unit of the polymer.

- (ii) Draw the structure of an isomer of **G** which shows *E-Z* isomerism.

- (iii) Draw the structure of an isomer of **G** which does not react with bromine water.

(3)

- (c) Draw the repeating unit of the polymer formed by the reaction between butanedioic acid and hexane-1,6-diamine.

(2)

- (d) Two plastic objects were manufactured, one from the polyalkene represented by the repeating unit in part (b)(i) and the other from the polyamide represented by the repeating unit in part (c).

After use it was suggested that both objects be disposed of as landfill.

- (i) Describe an experiment in which you could compare the biodegradability of these two objects.

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(3)

- (ii) Describe an advantage or a disadvantage of a different method of disposal of such objects compared with landfill.

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(3)

(Total 14 marks)