5.4.2 Explain amino-acid charge and polymer formation

Name: _____ Class: _____ Date: _____ **Total: 22 marks**

KEY WORDS evidence • conditions

Objective

Explain amino-acid charge and polymer formation. All questions and marking guidance are original.

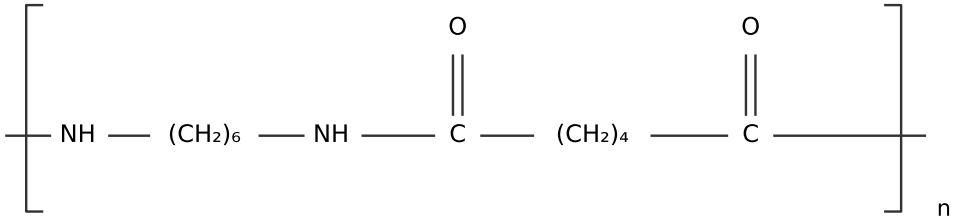
1 Key knowledge and worked examples

Amino acids contain acidic and basic groups. Glycine is achiral; most other α-amino acids have four different groups around the central carbon. The zwitterion has NH_3^+ and COO^- groups, with zero net charge. In acid it becomes NH_3^+/COOH; in alkali NH_2/COO^-.

■ Worked method

For glycine, acid form is $^+H_3NCH_2COOH$; zwitterion is $^+H_3NCH_2COO^-$; alkaline form is $H_2NCH_2COO^-$. Joining an amino and carboxyl group forms –C(=O)–NH– plus water. Poly(propenamide) instead opens C=C bonds by addition: its amide side groups do not make its backbone a condensation polymer.

Condensation polymer repeat unit



Nylon-6,6: open bonds continue through the brackets; amide links lie in the backbone.

2 Practice

2.1 Give the principal glycine form in acid, at zwitterion conditions and in alkali, with charges. [3]

2.2 Explain why glycine is achiral but alanine $H_2NCH(CH_3)COOH$ is chiral. [2]

2.3 Give the linkage formed when two amino acids condense and identify the small molecule lost. [2]

3 Exam-style questions

3.1 Give condensed formulae for both ordered dipeptides formed from one glycine and one alanine, ignoring zwitterion charges for this question. [4]

3.2 Identify the monomer of [–CH_2–CH($CONH_2$)–] and classify polymerisation. Explain why the side group does not change the classification. [3]

3.3 Explain how poly(ethenol) can be used for a water-soluble laundry bag, and how polyamide hydrogen bonding can strengthen fibres. [3]

3.4 Describe a controlled optical-activity comparison of two pure alanine enantiomers and glycine. Explain why a zero result for an unknown amino-acid solution does not prove it contains a racemate. [5]

Solutions

Original marking guidance: M1 method, A1 accuracy, B1 explanation.

2.1 $^{+}H_3NCH_2COOH$; $^{+}H_3NCH_2COO^{-}$; $H_2NCH_2COO^{-}$.

2.2 Glycine central carbon has two H atoms; alanine has four different groups at its central carbon.

2.3 –C(=O)–NH– peptide/amide linkage; water.

3.1 $H_2NCH_2CONHCH(CH_3)COOH$. $H_2NCH(CH_3)CONHCH_2COOH$.

3.2 CH_2=CHCONH$_2$, propenamide; addition, because C=C opens without eliminating a small molecule.

3.3 Many OH groups hydrogen-bond to water, supporting dissolution. Polyamide N–H and C=O groups hydrogen-bond between chains, requiring energy to separate them/holding chains together.

3.4 Zero a polarimeter with solvent and use plane-polarised monochromatic light. Match concentration/path length and temperature/wavelength. Pure alanine enantiomers give equal opposite rotation; glycine is inactive. Zero can mean achiral glycine or cancellation in a racemate, so it is not unique evidence.