

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.

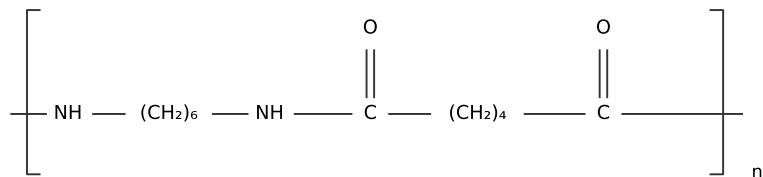
1 Key knowledge and worked examples

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 $\text{NH}_3^+/\text{COOH}$; in alkali NH_2/COO^- .

■ Worked method

For glycine, acid form is $^+\text{H}_3\text{NCH}_2\text{COOH}$; zwitterion is $^+\text{H}_3\text{NCH}_2\text{COO}^-$; alkaline form is $\text{H}_2\text{NCH}_2\text{COO}^-$. Joining an amino and carboxyl group forms $-\text{C}(=\text{O})-\text{NH}-$ plus water. Poly(propenamide) instead opens $\text{C}=\text{C}$ 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 $\text{H}_2\text{NCH}(\text{CH}_3)\text{COOH}$ 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 $[-\text{CH}_2-\text{CH}(\text{CONH}_2)-]$ 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 $^+\text{H}_3\text{NCH}_2\text{COOH}$; $^+\text{H}_3\text{NCH}_2\text{COO}^-$; $\text{H}_2\text{NCH}_2\text{COO}^-$.

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

2.3 $-\text{C}(=\text{O})-\text{NH}-$ peptide/amide linkage; water.

3.1 $\text{H}_2\text{NCH}_2\text{CONHCH}(\text{CH}_3)\text{COOH}$. $\text{H}_2\text{NCH}(\text{CH}_3)\text{CONHCH}_2\text{COOH}$.

3.2 $\text{CH}_2=\text{CHCONH}_2$, propenamide; addition, because $\text{C}=\text{C}$ 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.