Year 13 Science: Polyesters, polyamides, proteins and fats

Name: _____ Date: _____

Try these without your notes first, then check the answer key.

Practice

1. What small molecule is lost when ethane-1,2-diol and benzene-1,4-dicarboxylic acid form PET?

2. Give the products when nylon-6,6 is heated under reflux with HCl(aq).

3. How many different dipeptides can be made from one glycine and one alanine?

4. Give the products when glyceryl tristearate (a fat) is heated with NaOH(aq).

5. Which amino acid is not chiral?

Exam-style question: PLA and nylon

PLA cups are made from lactic acid, $CH_3CH(OH)COOH$. Nylon-6,6 can be made from hexane-1,6-diamine and hexanedioyl dichloride, $ClOC(CH_2)_4COCl$.

6. Name the type of polymerisation that forms PLA, and the type of link in it.

7. Explain why lactic acid exists as enantiomers.

8. Give the organic product when PLA is heated under reflux with NaOH(aq).

9. Name the small molecule released when nylon-6,6 is made from the dichloride.

10. Explain why the dichloride route is faster than using hexanedioic acid.

Fix the mistake

11. Correct this statement: "The repeating unit of a polyester is just the ester link -COO-."

12. Correct this statement: "Glycine and alanine can only make one dipeptide."

13. Correct this statement: "Saponification of a fat gives glycerol and three fatty acids."

14. Correct this statement: "Condensation polymers form when C=C bonds break open."

Answer key (for parents and tutors)

1. What small molecule is lost when ethane-1,2-diol and benzene-1,4-dicarboxylic acid form PET?
   Water, H_2O.
2. Give the products when nylon-6,6 is heated under reflux with HCl(aq).
   Hexanedioic acid and the hexane-1,6-diammonium ion, $^+H_3N(CH_2)_6NH_3^+$.
3. How many different dipeptides can be made from one glycine and one alanine?
   Two: Gly-Ala and Ala-Gly.
4. Give the products when glyceryl tristearate (a fat) is heated with NaOH(aq).
   Glycerol (propane-1,2,3-triol) and sodium stearate (sodium octadecanoate), three per fat molecule.
5. Which amino acid is not chiral?
   Glycine: its C2 carries two H atoms, so it has no asymmetric carbon.
6. Name the type of polymerisation that forms PLA, and the type of link in it.
   Condensation polymerisation; ester links (Achieved).
7. Explain why lactic acid exists as enantiomers.
   C2 is bonded to four different groups, H, OH, CH_3 and COOH, so the molecule has two non-superimposable mirror images that rotate plane-polarised light in opposite directions (Merit).
8. Give the organic product when PLA is heated under reflux with NaOH(aq).
   The 2-hydroxypropanoate (lactate) ion, $CH_3CH(OH)COO^-$, as sodium 2-hydroxypropanoate: every ester link is hydrolysed and OH^- removes the acid proton (Achieved for the product, Merit for the explanation).
9. Name the small molecule released when nylon-6,6 is made from the dichloride.
   HCl, hydrogen chloride (Achieved).
10. Explain why the dichloride route is faster than using hexanedioic acid.
    The C of -COCl is bonded to two electronegative atoms, O and Cl, so it is strongly δ+ and is attacked quickly by the N lone pair of the amine. The reaction is not reversible, so it goes to completion at room temperature; the acid reacts slowly and reversibly (Excellence).
11. Correct this statement: "The repeating unit of a polyester is just the ester link -COO-."
    A repeating unit contains one of each monomer, with an open bond at each end, so it shows both carbon chains and one link.
12. Correct this statement: "Glycine and alanine can only make one dipeptide."
    They can join in either order, giving Gly-Ala and Ala-Gly, which are different compounds.
13. Correct this statement: "Saponification of a fat gives glycerol and three fatty acids."
    In NaOH the acids end up as their sodium salts (soap); free fatty acids form only in acid hydrolysis.
14. Correct this statement: "Condensation polymers form when C=C bonds break open."
    That is addition polymerisation; condensation joins two different functional groups and releases a small molecule.