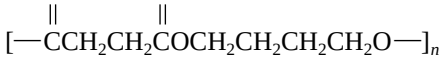
2.2 SYNTHETIC CONDENSATION POLYMERS

PRACTICE

(Page 111)

Understanding Concepts

1. 

2. Two functional groups that can undergo condensation reactions, e.g., carboxyl group, hydroxyl group, amino group must be present.
3. Intrachain bonding (within a polyamide chain): covalent bonds; interchain (between adjacent polyamide bonds): van der Waals attractions, electrostatic forces; hydrogen bonding if N—H bonds are present.

Try This Activity: Diaper Dissection

(Page 112)

(a) The addition of table salt causes some of the water to come out of the gel, as the presence of sodium ions reduces the absorbency of the polymer. The addition of sucrose or calcium chloride does not produce any change as no sodium ions are added.

PRACTICE

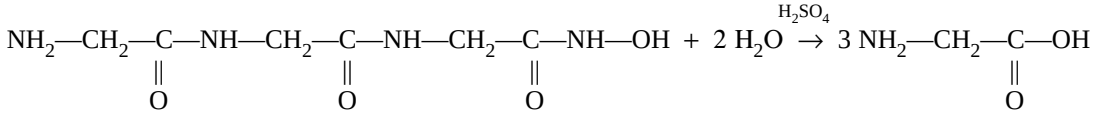
(Page 113)

Applying Inquiry Skills

4. First, obtain two samples of sodium polymethylacrylate of equal mass. Add a known excess volume of distilled water to one sample, and to the other sample, add the same volume of distilled water, into which is dissolved a known mass of NaCl, e.g., to 0.10 mol/L. Allow both samples to sit at the same temperature for the same period of time. Pour off unabsorbed liquid from each sample and find the mass of polymer and absorbed liquid. Calculate and compare the mass of each liquid absorbed per unit time, e.g., mL/min. An example of an approximate decrease in absorption rate would be 10–20%, depending on concentration used.

Making Connections

5. Amides can be hydrolyzed under acidic or basic conditions, similar to hydrolysis of esters. However, the reaction is much slower as the C(O)–NH bond is more stable than the ester bond.

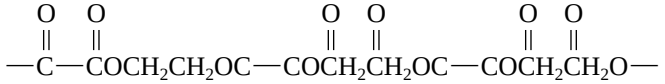


6. Advantages of nylon toothbrushes: controlled degree of rigidity or flexibility, water-resistant and thus dry readily, durable. Drawbacks of nylon toothbrushes: made from nonrenewable resources, nonbiodegradable.

SECTION 2.2 QUESTIONS

(Page 113)

Understanding Concepts

1. A polyester is linked by functional groups that form esters: carboxyl groups and hydroxyl groups (e.g., polymer of a dicarboxylic acid and a diol). A polyamide is linked by functional groups that form amides: carboxyl groups and amines (e.g., polymer of a dicarboxylic acid and a diamine).
2. $H_2NCH_2CH_2CH_2CH_2CH_2NH_2$ 1,5-diaminopentane
   $HOOCCH_2CH_2CH_2CH_2CH_2CH_2CH_2CH_2COOH$ decanedioic acid
3. 

4. $H_2NCH_2CH_2CH_2CH_2CH_2COOH$

6-aminohexanoic acid

$[—(H)NCH_2CH_2CH_2CH_2CH_2CON(H)CH_2CH_2CH_2CH_2CH_2CO—]$

5. $HOOCCH_2CH_2CH_2CH_2COOH$ and $H_2NCH_2CH_2CH_2CH_2NH_2$

hexanedioic acid and 1,6-diaminobutane

6. (a) Covalent bonds: intrachain bonds joining C, H, O, and N atoms.
   (b) Amide bonds: the linkage between the N of the amino group of the amine and the C of the carbonyl group of the acid.
   (c) Hydrogen bonds: interchain attractions between the NH groups and the carbonyl groups.

Applying Inquiry Skills

7. (a) An ideal polymer would be able to do the following: absorb sufficient water to sustain a plant for several weeks, absorb nutrients dissolved in water, would not be harmful to plants, and could be tailored to specific types of application (houseplants, outdoor plants). Also, ideal polymers would degrade after several months into harmless products (e.g., high or low pH), and would be inexpensive.

   (b) Test for absorption: place samples of equal mass of each polymer in equal excess volumes of water and water with dissolved nutrients, and determine mass of liquid absorbed. Test for release of liquid: mix equal swelled mass of each polymer with equal masses of a variety of soil types, measure moisture content over a test period. Examine soil and polymer mixture samples at selected time intervals, and test for pH. Store mixture samples over several months and determine amount of degradation. As a safety precaution, test pH. An appropriate test period would be two weeks.

   Sample answer:

   A.

polymer; mass of polymer; mass of water added; mass of polymer + absorbed water			
polymer A	50.0 g	100.0 g	70.0 g
polymer B	50.0 g	100.0 g	80.0 g

   B.

polymer; mass of nutrient solution absorbed; % change in concentration of nutrients in excess solution		
polymer A	70.0 g	+ 10%
polymer B	80.0 g	0%

   C.

polymer; mass before degradation; mass after degradation (8 weeks); pH			
polymer A	50.0 g	25.0 g	pH 5.5
polymer B	50.0 g	40.0 g	pH 6.5

Analysis

Polymer A absorbs less fluid than polymer B, and does not absorb nutrients as well as polymer B; polymer A also degrades to produce acidic substances. Polymer B allows all nutrients to be absorbed but does not degrade as quickly as polymer A.

Making Connections

8. (Sample answers) As potting soil additive for moisture; as a filter for removing traces of moisture from gasoline, oil; as time-release drug delivery system; as material for "grow a dinosaur" type toys.
9. (Sample answers)
   The term "natural" is used to describe products made by plants or animals, such as natural fruit juice. Some molecules made by plants are synthesized in laboratories, e.g., acetylsalicylic acid; others are made by plants but are treated chemically, e.g., decaffeinated coffee contains caffeine which is made by a plant, but has been treated in a chemical process. Should they be classified as synthetic?

   "Organic" produce in supermarkets indicates that the item is grown without use of "chemical" substances such as fertilizers, antibiotics, etc. In scientific terminology, all plants and animals, and thus most foods, are organic in nature as they contain molecules such as carbohydrates, proteins, and fats, all of which contain carbon atoms.

   The terms "organic" and "natural" denote substances that are not grown using synthetic materials. However, they may require synthetic materials in their use, e.g., cloth diapers need synthetic detergents for washing, plastic for packaging.

   The term "chemical" denotes ingredients of chemical compounds with chemical formulas. Are there compounds that are not made of chemical elements?