

gas-permeable lenses, and research is ongoing to develop new organic compounds with desired properties for use in improving vision and eye care.

Making Connections

2. (Sample answer)

Drug delivery systems, e.g., nicotine patches, estrogen patches.

Problem to be solved: Patients quitting smoking need a bridging program to relieve withdrawal from nicotine; patients requiring estrogen to relieve symptoms due to surgery.

Existing solution: nicotine gum; estrogen capsules. Problems: Patients may forget to take medication. As well, a low but continuous dosage most effective.

Improved solution: Polymers used to provide an adhesive patch on the skin, allowing the nicotine or estrogen to be absorbed through the skin on a continuous basis.

2.4 PROTEINS—NATURAL POLYAMIDES

Try This Activity: Making Chiral Molecules

(Page 117)

(a) L-alanine

(b) D-alanine

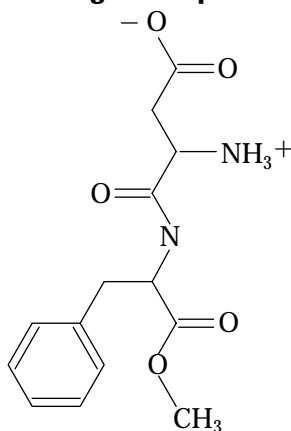
(c) They do not have the same properties because they are structurally different, and are isomers.

PRACTICE

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Understanding Concepts

1. (a)



aspartame

(b) $M_{\text{aspartame}} = 294.34 \text{ g/mol}$

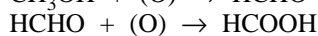
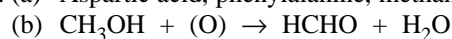
The portion in the aspartame molecule attributable to methanol is CH_3O .

$$m_{\text{CH}_3\text{O}} = 31.04$$

$$\% \text{CH}_3\text{O} = \frac{31.04 \text{ g}}{294.34 \text{ g/mol}} \times 100\%$$

$$\% \text{CH}_3\text{O} = 10.55\%$$

2. (a) Aspartic acid, phenylalanine, methanol (which is further oxidized to formaldehyde and formic acid)



$$\begin{aligned}
 3. (a) \quad m_{\text{CH}_3\text{OH}} &= 200 \text{ mg} \times \frac{M_{\text{CH}_3\text{OH}}}{M_{\text{aspartame}}} \\
 &= 200 \text{ mg} \times \frac{32.05 \text{ g/mol}}{294.34 \text{ g/mol}} \\
 m_{\text{CH}_3\text{OH}} &= 21.8 \text{ mg} \\
 (b) \quad \text{LD}_{50(70 \text{ kg})} &= 0.07 \text{ g/kg} \times 70 \text{ kg} \\
 \text{LD}_{50(70 \text{ kg})} &= 4.9 \text{ g} \\
 (c) \quad \text{number of cans of diet pop} &= \frac{4.9 \text{ g}}{21.8 \text{ mg/can}} \\
 &= 220 \text{ cans}
 \end{aligned}$$

Explore an Issue: Take a Stand: Will That Be “Regular” or “Diet”?

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- (a) Aspartame:
Reasons for its use: reducing caloric intake, to counter obesity; for sugar-reduced or sugar-free diets, e.g., for diabetic patients; reduce incidence of tooth decay.
Reasons against its use: may have undesirable side effects such as headaches; no nutritive value, may contribute to lower than required intake of minerals and vitamins.
- (b) Factors to consider: experimental design, e.g., use of controlled variables; type of system tested, e.g., test done on mice, information transferred to human applications; size of population tested; number of independent research groups reporting findings; funding of the research group, e.g., funded by the manufacturer of the product.
- (c) (Sample answer) Risks are still uncertain and debatable; in some cases, benefits outweigh the risks, e.g., sugar-free diets prescribed by doctor; in other cases, should reduce possible risk by keeping daily use of aspartame to a minimum.

Try This Activity: Identifying Fibres by Odour

(Page 123)

- (a) Silk and wool fabrics are protein; cotton, linen, and hemp are cellulose; polyester, lycra, and nylon are synthetic.
(b) Matches contain sulfur, which, when burned, confuses the odour of the fabric burning.

PRACTICE

(Page 124)

Understanding Concepts

4. Proteins are condensation polymers: The carboxyl group of one amino acid reacts with the amino group of another amino acid, forming a peptide bond and eliminating a water molecule.
5. They are mirror images of each other and are not superimposable on each other.
- 6.
- $$\begin{array}{ccccccc}
 \begin{array}{c} \text{H} \quad \text{O} \\ | \quad || \\ \text{H}_2\text{N}-\text{C}-\text{C}-\text{OH} \\ | \\ \text{R}' \end{array} & + & \begin{array}{c} \text{H} \quad \text{O} \\ | \quad || \\ \text{H}_2\text{N}-\text{C}-\text{C}-\text{OH} \\ | \\ \text{R}'' \end{array} & \rightarrow & \begin{array}{c} \text{H} \quad \text{O} \quad \text{H} \quad \text{O} \\ | \quad || \quad | \quad || \\ \text{H}_2\text{N}-\text{C}-\text{C}-\text{N}-\text{C}-\text{C}-\text{OH} \\ | \quad | \quad | \quad | \\ \text{R}' \quad \text{H} \quad \text{R}'' \end{array} & + & \text{H}_2\text{O}
 \end{array}$$
7. Primary structure: the sequence of the amino acids in a polypeptide chain. Secondary structure: the three-dimensional organization of segments of a polypeptide chain; alpha helix or pleated sheet. Tertiary structure: the three-dimensional folding of the alpha-helices and pleated-sheet structures of polypeptide chains. Quaternary structure: several protein subunits may join together. See page 122 in this section for diagrams.
8. Fibrous protein: collagen, function: for structure and strength; structure: long helical chains packed closely together and form crosslinkages. Globular protein: enzymes; function: for mobility throughout the organism; structure: sections of helices and pleated sheets within the same protein attract each other and form a globular shape.

SECTION 2.4 QUESTIONS

(Page 124)

Understanding Concepts

1. The carbon atom in an amino acid has the following attached to it: an amino group, a carboxyl group, a hydrogen, and another substituted group, R. Thus, this carbon atom is attached to four different atoms or groups, making it a chiral molecule. Glycine has two hydrogen atoms attached, and no R group; it is therefore not chiral.
2. Each protein is over hundreds of amino acids in length, arranged in its unique sequence; millions of combinations are possible from 20 amino acids in any sequence.
3. Fibrous proteins are made up of long linear polypeptide chains that can be packed closely together. Interchain attractions such as hydrogen bonding and van der Waals forces are strong and numerous, and, in addition, there may be crosslinkages such as disulfide bonds.
4. A change in primary structure changes the sequence of amino acids, and thus the interactions of amino acids within the same chain. This results in changes in secondary structure, which then changes the tertiary structure.
5. Several protein molecules may join together as a larger unit, e.g., insulin, hemoglobin.
6. (a) covalent bonds: intramolecular linkages; form the peptide bonds. Strong bonds account for the stability of protein molecules.
(b) hydrogen bonds: form between amine groups and carbonyl groups, within different sections of the same protein molecule, or between adjacent molecules. These bonds produce the secondary, tertiary, and quaternary structure of the protein.
(c) van der Waals forces: between sections of the same protein molecule or adjacent molecules. Weaker than the other attractions, but contribute to secondary, tertiary, and quaternary structures.
(d) disulfide bonds: crosslinking between polypeptide chains; gives added strength to the protein.

Applying Inquiry Skills

7. (a) Amount of saccharin fed, percentage of body weight, duration of test, number of rats tested.
(b) Control rats given placebos, researchers are “blind” to identity of test rats, all other conditions identical for test and control rats (food, water, temperature, stress level).
(c) Inconclusive as to health risk to humans: Tests might not have same effects on humans as on rats, as the dosage and body weight of rats and humans not comparable.

Making Connections

8. Enzymes are proteins. When immersed in boiling water, the heat denatures the proteins by disrupting the interchain bonds and altering the secondary, tertiary, and any quaternary structure. Enzyme action and specificity is generally related to protein shape and structure, and a denatured protein loses its enzyme function.
9. Collagen functions as a structural protein, forming tendons and sheets that support soft tissues such as skin and internal organs. The secondary structure of collagen is a triple helix – three chains wound tightly together. Each chain is over 1400 amino acids long, consisting of a primary structure of a repeating sequence – every third amino acid is a glycine that fits perfectly inside the helix.
There are different kinds of collagen molecules, with different tertiary structures. For example, some collagen molecules align side by side to form tough fibrils, like fibres in a rope. These molecules can crisscross cells and serve as pathways for cellular movement during development. Others have a globular head at one end and a tail at the other end; several of these molecules associate at the tails, forming an X-shaped complex. This structure in turn forms an extensive network that suits the function of strong but flexible sheets for supporting internal organs.
10. (Sample answer)
 - (a) Thalidomide was first prescribed as a sedative in 1957, to help combat morning sickness in pregnant women. After the birth of children with deformed limbs and other side effects, the drug was banned. In 1965, a doctor prescribed the drug to a leprosy patient as a sedative, and found surprisingly that it alleviated the swelling. Thalidomide has since been proven effective as an anti-inflammatory drug. The drug also acts to stop the development of blood vessels, thus arresting the development of fetal limbs. This property is tested as a treatment for cancer, AIDS, and other diseases. Other drugs are also being tested as replacements for thalidomide.
 - (b) Thalidomide is a chiral molecule and thus exists as two optical isomers. Laboratory tests showed that one of the isomers was an effective sedative, but the other isomer caused the harmful side effects. It appears that even if only the effective isomer is used, the changes in pH in the body may cause racemizing; that is, the single isomer changes to become a mixture of both isomers. The risk of using thalidomide as a sedative for pregnant women is too high, compared with the cost of developing alternative medications, or with the cost of having no medications available. Proper testing of new medications is essential, at any cost.
 - (c) (Points to include) brief history of use of thalidomide; chemical structure (optical isomers); risks of use; benefits in other treatments; rigour of testing and government control; financial and human cost.