Chapter 21 Biochemistry

21.1 Introduction to Proteins

Key Terms

biochemistry	biotechnology	essential elements
trace elements	cell	proteins
fibrous proteins	globular proteins	alpha-amino acids
side chain (R group)	dipeptide	peptide linkages
polypeptide	primary structure	secondary structure
alpha-helix	pleated sheet	tertiary structure
disulfide linkage	denaturation	enzymes
lock-and-key model	substrate	active site

Summary

Proteins are natural polymers. They make up about 15% of the human body. *Fibrous proteins* strengthen and support many types of tissues, such as muscle, hair, and cartilage. Ball-shaped *globular proteins* are the body's worker molecules.

All proteins are made up of *alpha-amino acids.* They are made up of an amino group ($-NH_2$) attached to the alpha-carbon, which is the one next to the carboxyl group (–COOH). Amino acids are classified as polar or nonpolar depending on whether the *side chain,* also known as the *R group,* attached to the alpha-carbon is hydrophilic (attracted to water) or hydrophobic (repellent to water). A protein polymer is built by reactions between amino acids that produce *peptide linkages.* Further reactions create a longer chain called a *polypeptide* and eventually a protein.

There are about 20 different amino acids. They can be put together in any order. The order of amino acids in a protein is called the *primary structure.*

A protein's *secondary structure* is the arrangement of the chain of amino acids in space. The particular job that a protein does in the body determines its shape.

The *tertiary structure* of a protein is its overall shape, for example, whether it is long and narrow, globular, or tube-shaped. Some amino acids get their tertiary structure by bending back on themselves. A particular type of bond called a *disulfide linkage* can fasten together two parts of a protein chain to form and hold a bend in the chain.

Denaturation is the process of breaking down a protein's three-dimensional structure. Any source of energy can cause denaturation of proteins. Ultraviolet radiation, X-ray radiation, nuclear radioactivity, lead, and mercury can damage protein structure.

Enzymes are proteins that catalyze (speed up) specific biologic reactions. Without enzymes, life would be impossible because important biochemical reactions would happen too slowly. Scientists believe that enzymes work according to the *lock-and-key model.* This model states that the shapes of the reacting molecule and the enzyme fit together as a key fits a lock.

21.2 Carbohydrates, Nucleic Acids, and Lipids

Key Terms

carbohydrates
monosaccharides (simple sugars)
disaccharide
sucrose
glycoside linkage
polysaccharides
starch
cellulose
glycogen
DNA (deoxyribonucleic acid)
RNA (ribonucleic acid)
nucleotide
protein synthesis
gene
lipids
mRNA (messenger RNA)
tRNA (transfer RNA)
fats
fatty acids
saponification
micelles
surfactant
phospholipids
waxes
steroids
cholesterol
sex hormones
adrenocorticoid hormones
bile acids

Summary

Carbohydrates serve as food sources for most living things and as support materials for plants. There are almost countless types of carbohydrates. Many carbohydrates are polymers. They are made up of molecules called *simple sugars,* or *monosaccharides.* Fructose is a monosaccharide. More complex carbohydrates are formed by combining monosaccharides. Two monosaccharides can combine to form a *disaccharide.* Common table sugar, *sucrose,* is a disaccharide. Large polymers containing many monosaccharide units are called *polysaccharides.* Three of the most important polysaccharides are *starch, cellulose,* and *glycogen.*

Deoxyribonucleic acid (DNA) is a huge polymer that stores and transfers genetic information. Together with other similar, but smaller, nucleic acids called *ribonucleic acids (RNA),* DNA carries the information needed for the creation of proteins. The basic unit in DNA and RNA polymers is called a *nucleotide.* Each nucleotide has three parts: a nitrogen-containing organic base, a five-carbon sugar, and a phosphate group. To form DNA and RNA polymers, nucleotides are hooked together into a shape that resembles a twisted ladder. This structure is called the double helix. During cell division the double helix unwinds and new strands of nucleotides are formed on each original strand.

Protein synthesis (creation) is the other major job of DNA. The information for constructing the proteins needed by the body is stored in the organism's DNA. A section of DNA, called a *gene,* contains the code for a particular protein. Various types of RNA molecules help in protein synthesis.

Topic	Protein synthesis
First	Using a gene as the pattern, a messenger RNA (mRNA) molecule is constructed in the cell's nucleus.
Next	mRNA moves from the nucleus to the cytoplasm.
Next	Using mRNA as a pattern and with the help of a cell structure called a *ribosome,* a transfer RNA (tRNA) molecule attaches itself to amino acids.
Last	tRNA puts amino acids into place on the growing protein chain.

Lipids are substances that are found in cells and that do not dissolve in water. There are four types of lipids. *Fats* are esters made up of glycerol and *fatty acids* that are long-chain carboxylic acids. *Phospholipids* are also esters of glycerol. *Waxes* are esters that include alcohols instead of glycerol. *Steroids* are made up of a basic four-ring structure. *Cholesterol*, certain hormones, and *bile acid* are all types of steroids.

Additional Active Reading Questions

1. What is the function of fibrous proteins?
2. What is the name of the units that make up proteins?
3. What is the primary structure of a protein? the secondary structure? the tertiary structure?
4. Define *denaturation.*
5. How do scientists think enzymes work?
6. Name three polysaccharides.
7. What does DNA stand for, and what does it do?
8. What is the basic unit in the DNA and RNA polymer?
9. List the four types of lipids.