Proteins (chapter 3, 5, and 7)

Proteins

Polymers of amino acids

- Proteins carry out all the tasks needed to keep the cell functioning

  √ Examples: Chemical reactions, import/export of materials

- Each protein specializes in one specific task only

  √ The protein performs the same task over and over

- The task each protein performs is determined by its amino acid sequence

  √ Changes in amino acid sequence can change a protein's function or stop it from doing any function

- There are four major protein types:

Receptors
Channel proteins
Enzymes
Structural proteins

Table 5.1

Receptors

Proteins in the cell membrane that detect molecules outside the cell

- Each receptor is highly specific to detect one and only one type of molecule
- The molecule binds to the receptor's binding site
- When a molecule is bound, the cell is "preprogrammed" to perform some action in response

Binding site

The crevice in a protein where it binds its ligand (the molecule it works on)

- Each protein folds into a unique shape
- The binding site forms when the protein is folded correctly
- The binding site shape exactly fits the ligand’s shape
    - √ This “lock and key” fit makes the protein specific for its ligand molecule and only its ligand molecule
    - √ The protein ignores all other molecules

Channel proteins (also called carrier proteins)

Proteins in the cell membrane that allow solutes to pass through the cell membrane

• Each channel protein is highly specific for only one solute molecule type

√ The protein's binding site gives it specificity

Figs 5.14 and 7.15, Table 5.1

Enzymes

Proteins that carry out chemical reactions ("biological catalysts")

• Some enzyme terms:

√ Active site = The enzyme's binding site

√ Substrate = The reactants of the enzyme's chemical reaction

– The enzyme's ligand

√ Product = The product of the enzyme's chemical reaction

• Each enzyme is highly specific to carry out one and only one chemical reaction

√ Each enzyme is specific for only one reaction because its active site fits only its substrate

• After releasing the product, the enzyme is unchanged and can repeat the reaction on more substrate

• Most enzymes are named after the chemical they react with followed by the ending "ase"

√ Examples: Lipase = An enzyme that reacts with lipids

Sucrase = An enzyme that reacts with sucrose

Figs 8.16 and 8.17, Table 5.1

Cofactors

Non-protein substances that help enzymes bind their substrate

- The cofactor sits in the enzyme's active site
- Metal ions are common cofactors (examples: Fe^{3+}, Mg^{2+}, Zn^{+})
- Coenzymes = Organic (carbon-containing) cofactors
- Most vitamins and minerals are cofactors

Fibrous (structural) proteins

Rope-like proteins that provide strength and framework to cells and tissues

• Examples:

√ Collagen = An extremely strong fibrous protein, abundant in tendons and ligaments

√ Elastin = A stretchable (rubber band-like) fibrous protein

√ Keratin = A hard fibrous protein abundant in nails, hair, and the skin

Table 5.1

Amino acids

Small organic molecules with a backbone of an amine group, a central carbon, and a carboxylic acid.

- There are 20 amino acids. They differ only in the atoms attached to the central carbon (the "side chain" or "R" group)

- R groups can be ionic, polar, or non-polar

- Each amino acid has a three letter abbreviation for its name

  √ Examples: Met, Glu, Pro

Fig 5.17 and page 78

Peptide bond

The covalent bond that joins amino acids together when they polymerize

- The amine of one amino acid joins to the carboxylic acid of another amino acid

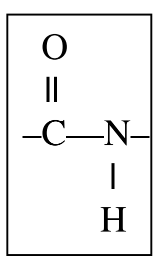

Fig 5.18

Polypeptide chain ("Polypeptide")

Several amino acids joined together by peptide bonds

- Backbone of polypeptide = the chain of linked amino acid backbones

- All backbones have an amine group at one end and a carboxylic acid group at the opposite end

Fig 5.18

Protein

One polypeptide chain (or several polypeptide chains together) that carry out one function

Protein structure (shape or folding) can be described at 4 levels:

Primary structure Secondary structure Tertiary structure Quaternary structure

Fig 5.20

Primary structure (1°)

The sequence of amino acids in the polypeptide chain

• Primary structure controls all other levels of protein folding

√ A change in even one amino acid can cause a protein to fold incorrectly

Fig 5.20

Secondary (2°) structure

Areas of regular (patterned) folding of a polypeptide chain.

- There are two major kinds of 2° structure

  √ Alpha helix = A corkscrew-shaped 2° structure

  √ Beta sheet = A zig-zag (back and forth) 2° structure

- Secondary structures form because of hydrogen bonding along the protein's backbone

Fig 5.20

Tertiary (3°) structure

The folding together of the polypeptide's secondary structures

- Tertiary structure forms because of interactions among the protein's R groups

  √ Hydrophobic R groups clustering at the protein's center

  √ Attraction between oppositely charged ionic R groups

  √ Hydrogen bonding between R groups

  √ Disulfide bridges between R groups (Two sulfur atoms linking R groups together)

Fig 5.20

Quaternary (4°) structure

The folding together of several polypeptide chains into one functional protein.

Fig 5.20

Each protein has an optimum temperature and optimum pH that it functions best in

- Proteins differ from one another in their exact optimum temperature and pH, but generally each protein's optima match its natural environment

Figs 5.22 and 8.18

Denaturation

Making a protein inactive by changing its shape (unfolding it)

Denaturation can be caused by:

- Boiling
- Change in pH
- Change in amino acid sequence

Figs 5.21 and 5.22

Essential amino acids

Amino acids that an organism cannot make for itself and must therefore be obtained in the foods it eats.