Functions of Proteins

After eating foods rich in proteins, your body breaks down the protein into amino acids. These amino acids are sent to the different parts of the body to perform specific functions, and are recombined to create new proteins. Typically, animal-based proteins are similar to human proteins and may be used more rapidly compared to plant proteins.

Fig. 5.19 Protein-rich foods that are good to consume after a workout

Your body uses proteins to build and repair tissues. Proteins are also used to make hormones, enzymes, and other chemicals in your body. They are important components of cells and building blocks of muscles, cartilage, skin, bones, and blood.

Protein is considered a macronutrient, which provides calories and energy. Your body requires large amount of proteins, at least 60 grams per day, for normal functioning. If your diet is enriched with proteins, your body benefits a lot. These benefits include fast recovery after an exercise, building of lean muscles and reducing muscle loss, maintaining a healthy weight, and curbing hunger (fig. 5.19). Eggs, meat, milk, fish, and legumes are good sources of proteins.

Classes of Proteins and Their Functions

Proteins are the most diverse group of biological molecules, both chemically and functionally. There are different classes of proteins.

Do you know that if microorganisms enter into your body, the B lymphocytes (fig. 5.20) or white blood cells of your immune system will produce antibodies to destroy these microorganisms? These antibodies are proteins (*defensive proteins*) defending you from foreign invaders.

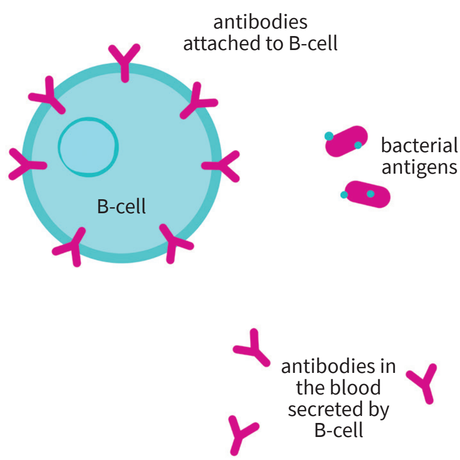

Fig. 5.20 The B lymphocytes are capable of producing antibodies (represented in the figure as Y molecule). Antibodies are also called *immunoglobulins*. These are proteins that help fight against foreign substances called *antigens*.

[redacted]

Other proteins are responsible for movement (*motor and contractile proteins*). Motor proteins are responsible for the movement of cilia and flagella. The contraction of the muscles is made possible because of actin and myosin proteins.

There are also proteins that act as hormones (*hormonal proteins*). An example would be insulin, which facilitates or regulates the entrance of glucose into the cell. Without insulin, glucose level in the blood remains high. Imagine the effect on an individual who has diabetes and cannot produce insulin. Glucose cannot enter into the cell and be utilized as a source of energy.

Proteins can play regulatory roles (*regulatory proteins*) within the cell. They may turn on or off genes needed during development.

Proteins can also act as cell surface receptors (*receptor proteins*). These are proteins called *major histocompatibility complex* found on the surface of the cell that can recognize whether a tissue is foreign or not. Take for example a kidney transplant procedure where a donor donates a kidney to a patient. In many cases, the donated kidney is rejected by the body after a few years. The differences in the receptor proteins in the cell of the donor and the patient could lead to kidney rejection. The recipient's immune system recognizes that the kidney is from a different individual so it rejects the kidney.

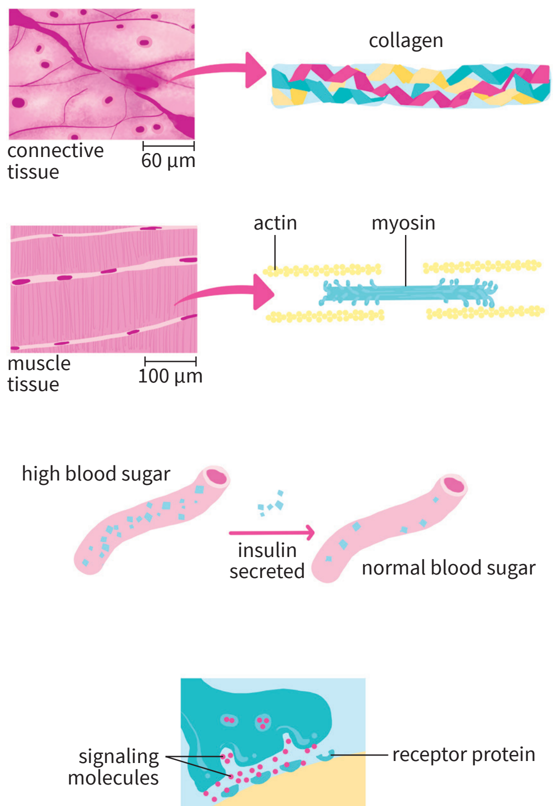

Fig. 5.22 Proteins can perform several functions: structural like elastin and collagen for the muscles, contractile like myosin and actin for muscle movement, or as a hormone such as insulin in the blood. Receptor proteins of nerve cells receive signals from other nerve cells in order to effect a response.

Proteins also function as storage of amino acids (*storage proteins*). The protein in milk (fig. 5.23) known as casein is the major source of amino acids for baby mammals. *Ovalbumin* is the egg white protein used as amino acid source of a developing embryo. All seeds contain one or more groups of proteins present in high amount. These proteins provide a store of amino acids that are used during germination and seedling growth. In the case of wheat, gluten forms the storage proteins whose properties are important so that the wheat flour can be used to make bread, baked goods, and pasta.

Fig. 5.23 Proteins are good storage of amino acids. Casein is the storage protein in milk, and ovalbumin is the egg white protein in the eggs.

Refer to table 5.3 for a quick look at the importance of proteins.

Table 5.3 Classes of proteins, their functions, some examples, and uses of the examples

Classes of Proteins	Function	Examples	Use of the Examples
enzymes	enzyme catalysis	[redacted]	[redacted]
immunoglobulins	defense	[redacted]	[redacted]
toxins		[redacted]	[redacted]
cell-surface antigens		[redacted]	[redacted]
circulating transporters	transport	[redacted]	[redacted]
membrane transporters	transport	[redacted]	[redacted]
fibers	support	[redacted]	[redacted]

Table 5.3 continued

Classes of Proteins	Function	Examples	Use of the Examples
[redacted]		actin	contraction of muscle fibers
		myosin	contraction of muscle fibers
		serum albumin	maintains osmotic concentration of blood
		lactose repressor	regulates transcription
		insulin	controls blood glucose levels
		vasopressin	increases water retention by kidneys
		oxytocin	regulates uterine contraction and milk production
		ferritin	stores iron, especially in the spleen
		casein	stores iron in milk
		calmodulin	binds calcium ions

Enzymes as Catalysts of Metabolic Reactions

One important function of proteins is acting as enzymes (*enzymatic proteins*). An *enzyme* is an organic molecule that catalyzes or speeds up a chemical reaction without being consumed. Enzymes speed up reactions by lowering the amount of *activation energy*, or energy required to start a reaction (fig. 5.24). The enzyme facilitates the contact of the reactants with one another, leading to less energy required to start the reaction. The less activation energy is required, the faster the reaction becomes. In the absence of an enzyme, higher activation energy is needed to start the reaction.

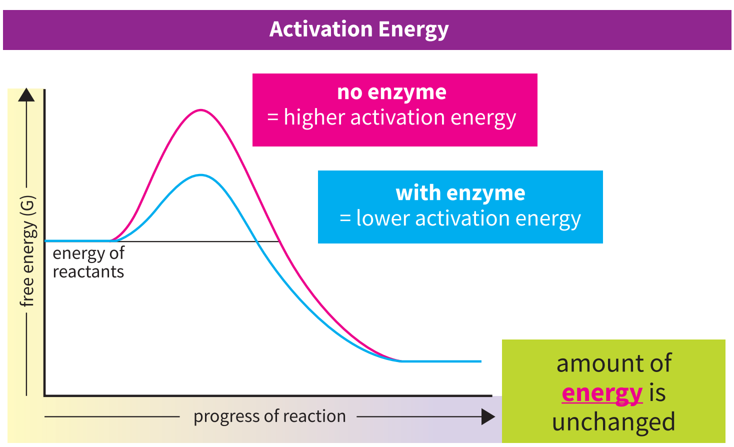

Fig. 5.24 Enzymes do not change the amount of energy in the reaction. The reaction also does not consume or alter the enzyme.

An enzyme has an active site, or a region to which substrates bind. An *active site* has its own specific shape. A substrate that has a shape similar to that of the active site of the enzyme can bind to the enzyme easily. Once the reaction happens, the products are released. Enzymes are not consumed and the active site is ready to interact with another substrate again.

Enzymes are *catalysts*, or molecules that make chemical reactions proceed much faster. In living organisms, there are metabolic pathways that are enzyme-mediated reactions by which a cell builds, rearranges, or breaks down organic substances. There are also metabolic pathways to build molecules from smaller ones. This is called *biosynthetic* or *anabolic*. The metabolic pathways that break molecules apart are *degradative* or *catabolic*.

Factors Affecting Enzyme Activity

The rates of all chemical reactions occurring in the cell are precisely controlled. The metabolic pathways must be highly regulated so that important compounds will not be in excess or limited in supply. One mechanism to regulate a metabolic pathway is by negative feedback or feedback inhibition (fig. 5.25). This means that the product of the reaction itself inhibits the enzyme that controls its formation. It works two ways: competitive and noncompetitive inhibition. Enzyme inhibitors are involved. In competitive inhibition, an inhibitor physically blocks the active site of the enzyme, preventing the binding of the substrate to the active site. The product competes with the substrate to occupy the active site, hence *competitive inhibition*. For noncompetitive inhibition, a noncompetitive inhibitor binds to an enzyme other than the active site. The enzyme changes its shape, preventing the binding of the substrate to the active site.

The physical and chemical conditions where a protein is present may affect its structure. Changes in pH level, salt concentration, and temperature may destroy the interactions between the proteins. The hydrogen bonds that maintain the protein's secondary and tertiary structures may be disrupted.

[redacted]

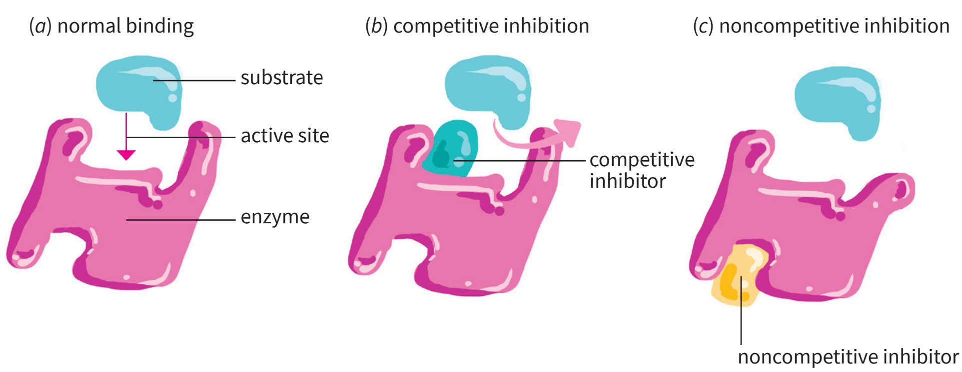

Fig. 5.25 Most enzymes can catalyze only one or few chemical reactions. (*a*) For normal binding of the substrate and enzyme, the shape of the substrate must fit in the shape of the enzyme's active site. (*b*) For competitive inhibition, the reaction product binds to the enzyme's active site. (*c*) For noncompetitive inhibition, the product binds to the enzyme at a location other than the active site, changing the enzyme's shape so that the substrate can no longer bind.