

The Importance Of Proteins And Protein-Containing Medicinal Products In Medicine

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Abstract

This article analyzes the biological and physiological significance of proteins, their main functions in the human body, as well as protein-based drugs and their fields of application in medicine. Proteins are the principal structural components of every living cell and play an essential role in metabolism, immune defense, enzymatic processes, and the maintenance of cellular integrity. The article also provides a broad overview of pathological conditions associated with proteins and the medical need for protein substances in clinical practice. It serves to strengthen theoretical knowledge and foster clinical thinking among students studying in the field of medicine.

Keywords: proteins, protein-based preparations, insulin, enzymes, interferon, immunoglobulin, albumin.

Аннотация

В данной статье анализируется биологическое и физиологическое значение белков, их основные функции в организме, а также лекарственные препараты на основе белков и области их применения в медицине. Белки являются основным компонентом каждой живой клетки и имеют большое значение в метаболизме, иммунологической защите, ферментативных процессах и поддержании клеточной структуры. В статье также подробно рассматриваются вопросы патологических состояний, связанных с белками, и необходимость белков в медицинской практике. Статья служит для закрепления теоретических знаний и формирования клинического мышления у студентов медицинских специальностей.

Ключевые слова: белки, белковые препараты, инсулин, ферменты, интерферон, иммуноглобулин, альбумин.

Introduction:

Proteins, also known as protein molecules, are complex substances composed of amino acid residues linked through amino and carboxyl groups. Based on their solubility in water and saline solutions, proteins are classified into seven groups: albumins, globulins, glutelins, histones, prolamins, protamines, and scleroproteins. In addition, proteolytic enzymes such as pepsin, trypsin, chymotrypsin, and papain are also classified as proteins. The term *protein* is often used synonymously with *oqsil* (protein substance) [1].

Proteins are nitrogen-containing organic compounds that are fundamental components of all living organisms and are indispensable for life. Each cell contains thousands of different proteins, each of which performs a specific function. For this reason, they are called *proteins* (from the Greek *protos* – first, primary, most important). Proteins make up approximately three-quarters of the cell's dry mass.

It is well known that the proteins of all organisms, despite their wide variety of biological activities, are composed of the same 20 standard amino acids. These amino acids do not possess specific biological activity individually. The chemical diversity of proteins depends on the sequence of amino acids within them. Amino acids can be considered the “alphabet” of protein structure; by arranging them in different sequences, an almost limitless number of combinations can be created, resulting in an immense diversity of proteins.

For example, each organism contains several thousand different proteins, and the total number of possible protein varieties is estimated to approach 10 million. Mathematical studies suggest that the total possible number of protein isomers formed from 20 amino acids may exceed even the mass of the Earth in theoretical combinations. Proteins are macromolecules, and their molecular weight may range from several thousand to several million daltons.

Amino acids serve as the fundamental building blocks of protein molecules. Each amino acid contains one carbon atom (the α -carbon atom) bonded to an amino group and a carboxyl group. Twenty different amino acids are found in proteins, and they differ from one another by their R-groups, which may be hydrophilic or hydrophobic, basic, acidic, or neutral. In proteins, amino acids are linked together by peptide bonds, which are formed between the α -carboxyl group of one amino acid and the α -amino group of another amino acid [2]. Modern scientific research is increasingly focused on understanding the role of proteins in the treatment and prevention of diseases. Historically, major scientific breakthroughs have been achieved in protein research. For example, in 1958, scientist Frederick Sanger determined the amino acid sequence of insulin and was awarded the Nobel Prize in Chemistry for this work [3]. In the history of diabetes treatment, insulin preparations extracted from animal pancreas were first used in 1922. Later, in 1982, recombinant human insulin marketed under the name *Humulin* began to be used in medical practice [4]. In 1986, the first monoclonal antibody, *OKT3*, was approved for the treatment of immune system disorders.

Today, protein-based pharmaceuticals represent one of the fastest-growing sectors of the pharmaceutical industry. More than 170 types of protein preparations are currently used worldwide, accounting for a substantial proportion of newly developed biologic drugs. These agents are widely used in the treatment of cancer, diabetes, infectious diseases, and immune system disorders

Structure and Functions of Proteins:

Proteins are among the most important biomolecules essential for life. They participate in numerous physiological processes in the body, including cellular function, metabolism, immune system activity, maintenance of tissue structure, and the expression of genetic information. Proteins are present in every cell of the body and are composed of amino acids. They are considered one of the most important organic substances in living organisms.

Proteins are highly diverse in both structure and function. According to their structure, they can be divided into two major groups: **globular proteins** and **fibrous proteins**. Globular proteins are generally spherical or ellipsoidal in shape and may contain additional non-protein components known as prosthetic groups. For example, hemoglobin is formed by the combination of globin and heme, and is therefore also referred to as a hemoprotein. Proteins containing lipids are called **lipoproteins**, those containing carbohydrates are called **glycoproteins**, and those containing metals are called **metalloproteins**. Proteins consist of amino acid chains and perform a wide range of functions in the body [5].

The structure of proteins is critically important for their functions. In order to understand how proteins acquire their final shape and function, it is necessary to recognize the different levels of protein structure: **primary**, **secondary**, **tertiary**, and **quaternary** structures.

The **primary structure** of a protein is the simplest level of protein organization and refers to the linear sequence of amino acids in a polypeptide chain. The next level, the **secondary structure**, refers to the folded arrangement formed within the polypeptide chain due to interactions between backbone atoms. The overall three-dimensional structure of a polypeptide is known as the **tertiary structure**, which mainly depends on interactions between the R-groups of the amino acids. Many proteins consist of more than one polypeptide chain; when these subunits combine, they form the **quaternary structure** of the protein [6].

Proteins are involved in the formation of cells and tissues and also play an important role in regulating metabolic processes in the body. Based on their biological functions, proteins can be classified into several groups. For example, certain hormone preparations are of great importance in the treatment of diseases such as diabetes mellitus. Enzyme-based medicinal products are used to improve digestion, reduce inflammation, and accelerate the regeneration of certain tissues. Immunological preparations are considered effective in strengthening the body's defense mechanisms and combating various infectious diseases [7].

Protein Deficiency:

Protein deficiency slows the growth process, weakens the immune system, and reduces the body's capacity to produce energy. It can cause serious health problems, especially among children and elderly individuals. This condition may also lead to disorders of the urinary system and deterioration of liver function.

Excess Protein:

An excessive amount of protein can also have harmful effects on the body. In such cases, surplus protein may accumulate in the body and place an additional burden on vital organs such as the kidneys, liver, and heart. Excessive protein intake may contribute to the development of kidney disease.

Another important feature of protein-containing medicinal products is that they exert effects closely resembling the body's natural biological processes. For this reason, such preparations are often highly effective and are widely used in medical practice. In particular, a new generation of protein-based drugs developed through biotechnology is gaining increasing importance in the treatment of many severe diseases [8].

Medical Importance of Proteins:

Hormones:

Insulin is an essential protein hormone that regulates glucose metabolism. The primary cause of **type 1 diabetes mellitus** is insulin deficiency, which results in the failure of glucose uptake signaling to reach cells. Recombinant insulin preparations (such as *Humulin*) have significantly improved the treatment of diabetes. In addition, **recombinant erythropoietin (EPO)** is used in the treatment of anemia caused by kidney disease.

Enzymes:

Protein-based enzymes play an important role in digestion and tissue repair. For example, **pancreatin** preparations containing pancreatic enzymes such as **lipase, amylase, trypsin, and chymotrypsin** improve digestion in patients with **exocrine pancreatic insufficiency** [9]. In addition, **trypsin–chymotrypsin complexes** help reduce wounds and inflammatory processes and promote faster tissue healing.

Immunoproteins:

Interferons and **immunoglobulins** are proteins of the immune system. Interferons are used in the treatment of viral infections and certain cancers. For example, **interferon- α** is used in the treatment of **hepatitis C** and some types of **lymphoma**. **Intravenous immunoglobulin (IVIG)** is used in cases of immunodeficiency and certain autoimmune diseases. These preparations strengthen the body's defense system and help fight viral infections [10].

Blood Proteins:

Albumin is one of the main proteins of blood plasma and plays an important role in maintaining osmotic pressure and transporting various substances. It is used to stabilize vital signs in patients with **shock, cardiovascular diseases, and hypoproteinemia**. In addition, the antioxidant and anti-inflammatory properties of albumin are also being actively investigated in scientific research.

Conclusion:

Protein-based drugs are of great importance in modern medicine. **Insulin therapy** helps preserve the lives of patients with diabetes mellitus. **Erythropoietin** and **interferons** are effectively used in the treatment of anemia and viral diseases. **Immunoglobulins** play an important role in controlling autoimmune disorders. Likewise, **albumin infusion** helps save lives in severe shock conditions.

According to statistical data, the global market size of recombinant protein drugs reached **168.5 billion US dollars in 2020**, and stable growth in this sector is expected in the coming years. In the future, the development of **recombinant DNA technology** and **synthetic biology** will further improve the efficacy and safety of protein-based drugs and create new opportunities for the development of novel biological preparations.

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