



## Review Article

# Physiological Role of Proteins and their Functions in Human Body

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Proteins are large, complex molecules that play many critical roles in the body. They responsible for various functions in cells and are required for the structure, function, and regulation of the body's tissues and organs. Proteins are made up of thousands of smaller units called amino acids, which are attached to one another in long chains. There are 20 types of amino acids that can be combined to make a protein. The sequence of amino acids determines each protein's unique 3-dimensional structure and its specific function. Proteins are macromolecules, composed of amino acid subunits called monomers. These amino acids are covalently attached to one another to form long linear chains called polypeptides, which then fold into a specific three-dimensional shape. The folded polypeptide chains are functional by themselves. Sometimes they are combining with additional polypeptide chains to form the final protein structure. Occasionally the non-polypeptide groups are also required in the final protein. For example, the blood protein hemoglobin is made up of four polypeptide chains, each of which contains a heme molecule, which is ring structure with an iron atom in its center.

**Keywords:** Protein, Amino acid, Monomers, Polypeptide chain and Enzyme.

## 1. INTRODUCTION

Proteins are macronutrients that support the growth and maintenance of body tissues. Amino acids are the basic building blocks of proteins and are classified as essential or non-essential. Essential amino acids are obtained from protein-rich foods such as meat, legumes and poultry, while non-essential ones are synthesized naturally in your body. According to the Centers for disease control and prevention,

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you should obtain 10 percent to 25 percent of your daily calorie needs from proteins.

Proteins are large, complex molecules that play many critical roles in the body. They do most of the work in cells and are required for the structure, function, and regulation of the body's tissues and organs. Proteins are made up of hundreds or thousands of smaller units called amino acids, which are attached to one another in long chains. There are 20 different types of amino acids that can be combined to make a protein. The sequence of amino acids determines each protein's unique 3-dimensional structure and its specific function<sup>1-2</sup>.

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## 2. PHYSIOLOGY OF PROTEINS

Proteins are macromolecules composed of amino acid subunits called monomers. These amino acids are covalently attached to one another to form long linear chains called polypeptides, which then fold into a specific three-dimensional shape. Sometimes these folded polypeptide chains are functional by themselves. Sometimes they may combine with additional polypeptide chains to form the final protein structure. Sometimes the non-polypeptide groups are also required in the final protein. For instance, the blood protein hemoglobin is made up of four polypeptide chains, each of which contains a heme molecule, which is ring structure with an iron atom in its center<sup>4-5</sup>.

Proteins perform essential functions throughout the systems of the human body. These long chains of amino acids are critically important for:

- Catalyzing chemical reactions
- Synthesizing and repairing DNA
- Transporting materials across the cell
- Receiving and sending chemical signal
- Responding to stimuli
- Providing structural support

Proteins have different shapes and molecular weights, depending on the amino acid sequence. For example, hemoglobin is a globular protein, which means it folds into a compact globe like structure contain collagen, found in our skin. It is a fibrous protein, folds into a long extended fiber-like chain<sup>6-8</sup>.

### Enzymes

Enzymes are proteins that catalyze biochemical reactions. These enzymes are essential for chemical processes like digestion and cellular metabolism. Without enzymes, most of the physiological processes would proceed very slow or not at all, so that life could not exist.

Each enzyme is specific to its substrate. The substrates are the reactants that undergo the chemical reaction catalyzed by the enzyme. The location where substrates bind to or interact with the enzyme is known as the active site, because that is the site where the chemistry occurs. When the substrate binds to its active site at the enzyme, the enzyme may help in its breakdown, rearrangement, or synthesis. By placing the substrate into a specific shape and microenvironment in the active site, the enzyme encourages the chemical reaction to occur.

### Enzymes are essential for digestion:

The processes of breaking of larger food molecules into subunits, which are small in structure, diffuse through a cell membrane and to be used by the cell.

These enzymes include

**Amylase:** This catalyzes the digestion carbohydrates in the mouth and small intestine

**Pepsin:** This catalyzes the digestion of proteins in the stomach

**Lipase:** Which catalyzes reactions need to emulsify fats in the small intestine; and

**Trypsin:** This catalyzes the further digestion of proteins in the small intestine<sup>9-10</sup>.

### Enzymes are essential for biosynthesis:

The process of making new complex molecules from the smaller subunits that are generated by the cell. These biosynthetic enzymes include DNA Polymerase, which catalyzes the synthesis of new strands of the genetic material before cell division; fatty acid synthetase, which the synthesis of new fatty acids for fat or membrane lipid formation; and components of the ribosome, which catalyzes the formation of new polypeptides from amino acid monomers.

### Hormones

Some proteins working as chemical signaling molecules called hormones. These proteins are secreted by endocrine cells that act to control or regulate specific physiological processes, which include growth, development, metabolism, and reproduction. For example, insulin is a protein hormone that helps to regulate blood glucose levels. Other proteins act as receptors to detect the concentrations of chemicals and send the signals to respond. Some types of hormones, such as estrogen and testosterone, are lipid steroids, not proteins.

Proteins perform essential functions throughout the systems of the human body. In the respiratory system, hemoglobin (composed of four protein subunits) transports oxygen for use in cellular metabolism. Additional proteins in the blood plasma and lymph carry nutrients and metabolic waste products throughout the body. The proteins actin and tubulin form cellular structures, while keratin forms the structural support for the dead cells that become fingernails and hair. Antibodies, also called immunoglobins, help recognize and destroy foreign pathogens in the immune system. Actin and myosin allow muscles to contract, while albumin nourishes the early development of an embryo or a seedling<sup>11-13</sup>.

### Amino Acids

An amino acid contains an amino group, a carboxyl group, and an R group, and it combines with other amino acids to form polypeptide chains.

#### Amino Acid Structure:

Amino acids have a central asymmetric carbon to which an amino group, a carboxyl group, a hydrogen atom, and a side chain (R group) are attached. This amino acid is utilized, but if it were placed in water at pH7, its amino group would pick up another hydrogen and a positive charge and the hydroxyl in its carboxyl group would lose a hydrogen and gain a negative charge.

#### Types of Amino Acids

The name "amino acid" is derived from the amino group and carboxyl-acid-group in their basic structure. There are 21 amino acids present in proteins, each with a specific R group or side chain. Ten of these are considered essential amino acids in humans because the human body cannot produce them and they must be obtained from the diet. Examples are glycine, alanine, valine, leucine, methionine and isoleucine. All organisms have different essential amino acids based on their physiology<sup>14-16</sup>.

#### Characteristics of Amino Acids

- The chemical composition of the side chain determines the characteristics of the amino acid. Amino acids such as valine, methionine, and alanine are nonpolar (hydrophobic), while amino acids such as serine, threonine, and cysteine are polar (hydrophilic).
- The side chains of lysine and arginine are positively charged so these amino acids are also known as basic amino acids. Proline is an exception to the standard structure of an amino acid because its R group is linked to the amino group, forming a ring-like structure.
- Amino acids are represented by a single upper case letter or a three-letter abbreviation. For example, valine is known by the letter V or the three-letter symbol Val.
- The sequence and the number of amino acids ultimately determine the protein's shape, size, and function. Each amino acid is attached to another amino acid by a covalent bond, known as a peptide bond. When two amino acids are covalently attached by a peptide bond, the carboxyl group of one amino acid and the amino group of the incoming amino acid combine and release a molecule of water.
- Any reaction that combines two monomers in a reaction that generates H<sub>2</sub>O as one of the products is known as a dehydration reaction, so peptide bond formation is an example of a dehydration reaction<sup>17-20</sup>.

#### Polypeptide Chains

The resulting chain of amino acids is called a polypeptide chain. Each polypeptide has a free amino group at one end. This end is called the N terminal, or the amino terminal, and the other end has a free carboxyl group, also known as the C or carboxyl terminal. When reading or reporting the amino

acid sequence of a protein or polypeptide, the convention is to use the N-to-C direction. That is, the first amino acid in the sequence is assumed to be one at the N terminal and the last amino acid is assumed to be the one at the C terminal.

Although the terms polypeptide and protein are sometimes used interchangeably, a polypeptide is technically any polymer of amino acids, whereas the term protein is used for a polypeptide or polypeptides that have folded properly, combined with any additional components needed for proper functioning, and is now functional<sup>21-22</sup>.

### 3. PROTEIN STRUCTURE

Each successive level of protein folding ultimately contributes to its shape and therefore its function.

- Protein structure depends on its amino acid sequence and local, low-energy chemical bonds between atoms in both the polypeptide backbone and in amino acid side chains.
- Protein structure plays a key role in its function; if a protein loses its shape at any structural level, it may not function.
- Primary structure is the amino acid sequence.
- Secondary structure is local interactions between stretches of a polypeptide chain and includes  $\alpha$ -helix and  $\beta$ -pleated sheet structures.
- Tertiary structure is the overall three-dimensional folding driven largely by interactions between R groups.
- A Quaternary structure is the orientation and arrangement of subunits in a multi-subunit protein.
- **antiparallel:** The nature of the opposite orientations of the two strands of DNA or two beta strands that comprise a protein's secondary structure
- **disulfide bond:** A bond, consisting of a covalent bond between two sulfur atoms, formed by the reaction of two thiol groups, especially between the thiol groups of two proteins
- **-pleated sheet:** secondary structure of proteins where N-H groups in the backbone of one fully-extended strand establish hydrogen bonds with C=O groups in the backbone of an adjacent fully-extended strand
- **-helix:** secondary structure of proteins where every backbone N-H creates a hydrogen bond with the C=O group of the amino acid four residues earlier in the same helix.

Protein structures are very complex, and researchers have determined the structure of complete proteins down to the atomic level. Early structural biochemists conceptually divided protein structures into four "levels" to make it easier to handle the complexity of the overall structures. To determine how the protein gets its final shape or conformation, need to understand these four levels of protein structure: primary, secondary, tertiary, and quaternary<sup>23-26</sup>.

### Primary Structure

A protein's primary structure is the unique sequence of amino acids in each polypeptide chain that makes up the protein. Really, this is just a list of which amino acids appear in which order in a polypeptide chain, not really a structure. But, because the final protein structure ultimately depends on this sequence, this was called the primary structure of the polypeptide chain. For example, the pancreatic hormone insulin has two polypeptide chains, A and B.

The A chain of insulin is 21 amino acids and B chain consists of 30 amino acids long and each sequence is unique to the insulin protein. The gene or sequence of DNA, ultimately determines the unique sequence of amino acids in each peptide chain. A change in nucleotide sequence of the gene's coding region is lead to a different amino acid being added to the growing polypeptide chain, causing a change in protein structure and involved infuction<sup>27-30</sup>.

### Functions

Protein is an important substance found in every cell in the human body. In fact, except for water, protein is the most abundant substance in the body. This protein is manufactured by body utilizing the dietary protein. It is used in many vital processes and thus needs to be consistently replaced. This can achieve by regularly consuming foods that contain protein.

### Repair and Maintenance

Protein is termed the building block of the body. It is called this because protein is vital in the maintenance of body tissue, including development and repair. Hair, skin, eyes, muscles and organs are all made from protein. This is why children need more protein per pound of body weight than adults; they are growing and developing new protein tissue.

### Hormones

Protein is involved in the creation of some hormones. These substances help control body functions that involve the interaction of several organs. Insulin, a small protein, is an example of a hormone that regulates blood sugar. It involves the interaction of organs such as the pancreas and the liver. Secretin is another example of a protein hormone. This substance assists in the digestive process by stimulating the pancreas and the intestine to create necessary digestive juices<sup>31-33</sup>.

### Enzymes

Enzymes are proteins that increase the rate of chemical reactions in the body. In fact, most of the necessary chemical reactions in the body would not efficiently proceed without enzymes. For example, one type of enzyme functions as an aid in digesting large protein, carbohydrate and fat molecules into smaller molecules, while another assists the creation of DNA.

### Transportation and Storage of Molecules

Protein is a major element in transportation of certain molecules. For example, hemoglobin is a protein that transports oxygen throughout the body. Protein is also sometimes used to store certain molecules. Ferritin is an

example of a protein that combines with iron for storage in the liver.

### Antibodies

Protein forms antibodies that help prevent infection, illness and disease. These proteins identify and assist in destroying antigens such as bacteria and viruses. They often work in conjunction with the other immune system cells. For example, these antibodies identify and then surround antigens in order to keep them contained until they can be destroyed by white blood cells.

## 4. CONCLUSION

Protein is an important component of every cell in the body. Hair and nails are mostly made of protein. Our body uses protein to build and repair tissues. A protein makes the enzymes, hormones, and other body chemicals. Protein is an important building block of bones, muscles, cartilage, skin, and blood. Along with fat and carbohydrates, protein is a "macronutrient". Vitamins and minerals are needed in only small quantities are called "micronutrients." But unlike fat and carbohydrates, the body does not store protein, and thus has no reservoir when body needs to supply to the body.

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## 6. REFERENCES

1. Boirie Y, Dangin M, Gachon P, Vasson M P, Maubois JL, Beaufriere B. Slow and fast dietary proteins differently modulate postprandial protein accretion. Proc Natl Acad Sci 1997; 94: 14930-14935.
2. Brenner B M, Lawler E V, Mackenzie H S. thehyper filtration theory: a paradigm shift in nephrology. Kidney Int 1996; 49: 1774-1777.
3. Brinkworth G, Buckley J, Bourdon P, Bulbin J, David A. Oral bovine colostrum supplementation enhances buffer capacity, but not rowing performance in elite female rowers. Int J Sport Nutr Exe 2002; 12: 349-363.
4. Brinkworth G D, Buckley J D, Slavotinek J P, Kurmis A P. Effect of bovine colostrum supplementation on the composition of resistance trained and untrained limbs in healthy young men. Eur J Appl Physiol 2004; 91: 53-60.
5. Buckley J D, Brinkworth G D, Abbott M J. Effect of bovine colostrum's on anaerobic exercise performance and plasma insulin-like growth factor I. Journal of Sport Sciences 2004; 21: 577-588.
6. Counous G. Whey protein concentrate (WPC) and glutathione modulation in cancer treatment. Anticancer Res 2000; 20: 4785-4792.
7. Crouse J R, Morgan T, Terry J G, Ellis J, Vintolins M, Burke G L. A randomized trial comparing the effect of

- casein with that of soy protein containing varying amounts of isoflavones on plasma concentrations of lipids and lipoproteins. *Arch Intern Med* 1999; 159: 2070-2076.
8. Dangin M, Boirie Y, Guillet C, Beaufriere B. Influence of the protein digestion rate on protein turnover in young and elderly subjects. *J Nutr* 2002; 132: 3228S-3233S.
  9. Dawson-Hughes B. Calcium and protein in bone health. *Proc Nutr Soc* 2003; 62: 505-509.
  10. Dawson-Hughes B, Harris S S. Calcium intake influences the association of protein intake with rates of bone loss in elderly men and women. *Am J Clin Nutr* 2002; 75: 773-779.
  11. Demling R H, DeSanti L. Effect of a hypocaloric diet, increased protein intake and resistance training on lean mass gains and fat mass loss in overweight police officers. *Ann Nutr Metab* 2000; 44: 21-29.
  12. Deutz N E P., Bruins M J, Soeters P B. Infusion of soy and casein protein meals affects interorgan amino acid metabolism and urea kinetics differently in pigs. *J Nutr* 1998; 128: 2435-2445.
  13. Eisenstein J, Roberts SB, Dallal G, Saltzman E. High-protein weight-loss diets: A review of the experimental and epidemiologic data. *Nutrition Reviews* 2002; 60: 189-200.
  14. Erdman J W, Jr. Soy protein and cardiovascular disease. A statement for healthcare professionals from the Nutrition Committee of the AHA. *Circulation* 2000; 102: 2555-2559.
  15. Fern E B, Bielinski R N, Schutz Y. Effects of exaggerated amino acid and protein supply in man. *Experientia* 1991; 47: 168-172.
  16. Feskanich D, Willett W C, Stampfer M J, Colditz G A. Protein consumption and bone fractures in women. *Am J Epidemiol* 1996; 143: 472-479.
  17. Foster G D., Wyatt H R, Hill J O, Mc Guckin B G, Brill C, Mohammed B S, Szapary P O, Rader D J, Edman J S, Klein S. A randomized trial of a low-carbohydrate diet for obesity. *N Engl J Med* 2003; 348: 2082-2090.
  18. Friedman J E, Lemon P W R. Effect of chronic endurance exercise on the retention of dietary protein. *Int J Sports Med* 1989; 10: 118-123.
  19. Fry A C, Schilling B K, Chiu L Z F, Weiss L W, Kreider R B, Rasmussen C J. Muscle fiber and performance adaptations to resistance exercise with Myo Vive, colostrum or casein and whey supplementation. *Research in Sports Medicine* 2003; 11: 109-127.
  20. Godfrey K, Robinson S, Barker D J P., Osmond C, Cox V. Maternal nutrition in early and late pregnancy in relation to placental and fetal growth. *Br Med J* 1996;312: 410-414.
  21. Ha E, Zemel M B. Functional properties of whey, whey components, and essential amino acids: mechanisms underlying health benefits for active people. *J Nutr Biochem* 2003; 14: 251-258.
  22. Hannan M T, Tucker K L, Dawson-Hughes B, Cupples L A, Felson D T, Kiel D P. Effect of dietary protein on bone loss in elderly men and women: The Framingham Osteoporosis Study. *J Bone Miner Res* 2000; 15: 2504-2512.
  23. Hofman A, Smeets R, Verlaan G, v d. Lugt R., Verstappen P A. the effect of bovine colostrums supplementation on exercise performance in elite field hockey players. *Int J Sport Nutr Exerc Metab* 2002; 12: 461-469.
  24. Hu F B, Stampfer M J, Manson J E, Rimm E, Colditz G A, Speizer F E, Hennekens C H, Willett W C. Dietary protein and risk of ischemic heart disease in women. *Am J Clin Nutr* 1999; 70: 221-227.
  25. Jenkins D J A, Kendall C W C, Vidgen E, Augustin L S A, van Erk M, Geelen A, Parker T, Faulkner D, Vuksan V, Josse R G, Leiter L A, Connelly P W. High protein diets in hyperlipidemia: effect of wheat gluten on serum lipids, uric acid and renal function. *Am J Clin Nutr* 2001; 74: 57-63.
  26. Johnston C S, Tjonn S L, Swan P D. High-protein, low-fat diets are effective for weight loss and favorably alter biomarkers in healthy adults. *J Nutr* 2004; 134: 586-59
  27. Jorda A, Zaragosa R, Portoles M, Baguena-Cervellera R, Renau-Piqueras J. Long-term high-protein diet induces biochemical and ultrastructural changes in rat liver mitochondria. *Arch Biochem Biophys* 1998; 265: 241-248.
  28. Siltberg-Liberles J. Evolution of structurally disordered proteins promotes neostructuralization. *Mol Biol Evol* 2011; 28:59-62.
  29. Williams S G, Lovell S C. The effect of sequence evolution on protein structural divergence. *Mol Biol Evol* 2009;26:1055-1065.
  30. Brown C J, Takayama S, Campen A M, Vise P, Marshall T W, Oldfield C J, Williams C J, Dunker A K. Evolutionary rate heterogeneity in proteins with long disordered regions. *J Mol Evol.*2002; 55:104-110.
  31. Ward J J, Sodhi J S, McGuffin L J, Buxton B F, Jones D T. Prediction and functional analysis of native disorder in proteins from the three kingdoms of life. *J Mol Biol* 2004; 337:635-645.
  32. Brown C J, Johnson A K, Daughdrill G W. Comparing models of evolution for ordered and disordered proteins. *Mol Biol Evol* 2010; 27:609-621.
  33. Goldstein R A. The structure of protein evolution and the evolution of protein structure. *Curr Opin Struct Biol* 2008; 18:170-177.

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