Research paper on proteins

Health & Medicine, Body

Background

Early scientists and nutritionists believed that the most vital nutrient in living organisms, for building and maintaining the body was the protein. The role of proteins as enzymes came into existence several years later. This was around 1926 when experiments showed that enzymes were proteins. Insulin was the first protein to be sequenced. Hemoglobin was the first structure of proteins to be resolved. Myoglobin was then resolved later.

X-ray diffraction analysis (X-ray crystallography) led to the determination of the structure of the proteins (three-dimensional structure). The purification of proteins can be made possible from cellular compounds. Several methods have also been put in place to study the structures and functions of proteins. They include mass spectrometry, site-directed mutagenesis among others.

Proteins form an important part of an organism. The participation of the proteins in the cell processes are great as most of the proteins are enzymes that are involved in several reactions as they catalyze the reactions. This makes the proteins to be very important in metabolism. Other than catalyzing biochemical reactions, proteins also have some structural duties. These proteins include the myosin which are found in muscles and helps in the contraction of the muscles, and the actin which are present in all cells and muscle tissues and are very crucial in contraction and cell movement. Others include those found in cytoskeleton and are responsible for the maintenance of the cell shape. Some proteins are very useful in provision of immune responses, others are crucial in cell signaling, some in cell adhesion, while others in cell cycle.

INTRODUCTION

Polypeptides or proteins fall under the organic compounds category. The proteins are made up of amino acids which forms the building blocks of the body. The amino acids have two groups joined together. The groups are the carboxyl and the amino. Between these groups are the peptide bonds that bind them together in a linear chain.
The gene sequence defines the sequence of the amino acids in the protein. This sequence is determined in the genetic code, which specifies twenty standard amino acids.

Proteins, being in the category of polypeptides, can fold into a globular structure. The rate and extent of this folding depends on several factors that make the folding differ widely. Some proteins are considered as single structures because the extent of their folding results into highly rigid structures with little or no fluctuations. Some proteins, on the other hand, go through great reorganizations, creating great difference from one to the other. The signaling event is what normally leads to the conformational changes.

The function of the protein depends largely on the structure of the protein. The enzyme activities also depend on the protein structure. The protein structure acts as the regulator.
Some proteins require a folding process so as to function while others do not require any folding as they function in the non-folded state.

The essential amino acids, which are highly needed by the body, cannot be synthesized by animals. This calls for the inclusion of these essential amino acids in the animals' meal. These amino acids are obtained from the digestion of proteins. The digestion process results into the breakdown of proteins into free amino acids. These amino acids are later used in metabolism. All amino acids have common features in terms of the structure. The structure of amino acids includes the amino group, the variable side chain and the carboxylic group which are bonded to the α-carbon. The only family of amino acids that possess different structural features is the proline. The proline contains a ring to the N-end amine group which is unusual. The CO-NH amide moiety is forced into a fixed conformation by this unusual ring. For a standard amino acid, the side chains have numerous structures and chemical properties. These side chains combine to form the structure with three dimensions, and also account for the chemical reactivity.

Difference between Proteins, Polypeptides and Peptides

Proteins, polypeptides and peptides are often used to mean the same thing but in real sense, they are not. It is therefore important for us to distinguish them in order to avoid the overlap in meaning and the resulting ambiguity.

Protein -

Protein is normally a complete molecule (biological molecule) in a stable

conformation.

Peptide -

peptide is used to refer to amino acid oligomers without a stable structure (three-

dimensional structure)

Polypeptide -

polypeptide refers to any single chain (linear chain) of amino acids. The

polypeptide has no definite conformation.

LITERATURE REVIEW

The information that is fixed in the genes (the genetic code) is used to assemble the proteins from amino acids. Every protein has a unique sequence of amino acids.

In the genetic code, there is a set of three nucleotides (codons) which allocates an amino acid. An example of the genetic code for methionine which is the adenine-uracil-guanine (AUG).

Some amino acids are specified with more than one codon in DNA due to the redundancy in the genetic code. This redundancy results from the limited possible number of codons (64) from the four nucleotides present in the DNA. In the DNA, the coded genes are transcribed into pre-messenger ribonucleic acid (pre-mRNA) or the primary transcript by use of several forms of post-transcriptional modification which leads to the formation of mature messenger ribonucleic acid. The mRNA is then used for protein synthesis by the ribosome as an outline (pattern or template).

Protein Synthesis

The protein is synthesized from the messenger ribonucleic acid pattern by a process known as translation. In this process of synthesis, the mRNA is sent to the ribosome and translated three nuclides at a time. This is done by matching every codon to its base-pairing-anticodon on a transfer molecule. The transfer molecule carries the amino acid that corresponds to the codon it identifies. The biosynthesis of proteins takes place from N-terminus to the C-terminus. The number of the amino acids contained in a protein and the molecular mass of the protein is used to measure the size of the protein. Averagely in length, proteins have approximately four hundred and sixty six amino acids, while the molecular mass of proteins is 53kDa. Titins are the largest known proteins in existence and have a molecular mass of approximately three thousand kDa with a total of approximately twenty seven thousand amino acids. This protein is a component of muscle sacromere.

Other than the biosynthesis, proteins also undergo chemical synthesis. The process involved here includes the peptide synthesis for short proteins. This process depends on organic synthesis methods like chemical ligation. This synthesis introduces amino chains which are non natural into the polypeptide chains.

Protein Structure

Proteins have different shapes depending on the folding pattern. The most common folds result into three-dimensional structures. The native conformation of the proteins determines the shape into which the protein

naturally folds. Most of the proteins do not need any assistance in order to fold: they simply do as a result of the chemical properties of their amino acids. Other proteins require some external assistance in order to fold. The resulting structures are grouped into four categories, each distinct from the rest. They are: the primary structure, the secondary structure, the tertiary structure, and the quaternary structure.

The primary structure represents the amino acid sequence. In the secondary structure, there is regular repeat of the local structures stabilized by hydrogen bonds. This makes the secondary localizes the secondary structure. The tertiary structure represents the general shape of the single molecule of protein. It also gives the partial link of the secondary structures with each other. Here, the stability is due to non-local interactions. This tertiary structure is what is responsible for the basic functions of proteins. The quaternary structure represents several molecules. It is the structure resulting from various protein molecules or subunits that function as one complex unit. This results into the polypeptide chain.

During the functioning of the proteins, there is flexibility of the structures. Proteins can change from one structure to another related structure as they function. This results into the functional arrangements. The structures in the functional arrangement (the tertiary and the quaternary) are called the conformations while the change is referred to as conformational change. These changes are initiated by the substrate molecules which bind to the active site of enzymes. The substrate molecule can also bind to any region (physical region) of the protein that acts as a catalyst in any chemical

reaction. While in solution form, the collision of molecules and the thermal vibration makes the proteins to exhibit variations in their structure.

The main classes of proteins that results are: the membrane, the globular and the fibrous proteins. Most enzymes and the soluble proteins fall in the family of globular proteins. Fibrous proteins are generally structural while the membrane proteins provide channels for polar molecules. They act as receptors.

Functions of Proteins

Proteins have several functions. They are highly important in cellular functions and at the same time act as enzymes.

Cellular Functions

Within the cell, proteins are the principal actors. The duties they discharge are specified by the information in their genetic codes. The ability of the protein molecules to bind with other specific molecules tightly is the key factor towards their functioning. The active site of the protein that is responsible for the binding is always a depression on the molecular surface and is called the binding site. The tertiary structure of the protein is responsible for the binding as it defines the binding depression or pocket. The chemical properties of the side chains of the amino acids in the surrounding also determine the binding.

The binding process is very possible for molecules of proteins themselves. Fibrils are always formed when proteins bind specifically to other sets of same molecule.

Proteins as Enzymes

Enzymes normally catalyze chemical reactions. This is the most common role of proteins. Enzymes are very specific and only acts on specific chemical reactions. Almost all reactions involved in metabolism are conducted by enzymes. They also influence the DNA in the replication of DNA, the repair of DNA and the transcription process. Some enzymes act on proteins to change the chemical groups (they add or subtract the groups) in the post-translation modification. Over four thousand reactions are catalyzed by enzymes. Only a small fraction of the amino acids in the enzymes usually get in contact with the substrate. The active site of the enzyme is the region that binds with the substrate and contains the residue.

Role of Proteins in Cell Signaling

Proteins like insulin are responsible for transmission of signals from the cells of their synthesis to other distant cells. Membrane proteins are receptors and also bind signaling molecules. They induce biochemical response in cells.

Some protein components form antibodies which bind the antigens in the body and aims at destroying them. These antibodies form the adaptive immune system. Antibodies, unlike enzymes, are not specific. The affinity of an antibody to bind to the substrate is extremely high.

METHODOLOGY

In this field of proteins, we have looked at the two forms of study. The first form is the vitro study which deals with the purified proteins and the second is the vivo which majorly concerns the activities of the enzymes. The vitro study is performed in a controlled environment. It is very important in

determining the nature in which proteins perform their duties. On the contrary, the vivo studies reveal the information about the regulation of the functions of the proteins.

For the purification, a protein is separated from other cellular compounds. In this process, the membrane of the cell is disrupted and the components released into a crude lysate solution. The resulting mixture is then purified by ultracentrifugation which disintegrates the cellular components into various soluble proteins, lipids and proteins of membranes, nucleic acids and cellular organelles. Salting out is then done to precipitate the mixture. This process concentrates the proteins. Chromatography is finally used to single out the proteins based on the properties like net charge, molecular weight and binding affinity. Also, isolation of proteins can be done by use of their charge.

CONCLUSION

Proteins are very important in the bodies of living organisms. It is therefore very important that an individual or a scholar have knowledge about the proteins. This research has majored on the structures and the functions of proteins.

Without enzymes, various metabolic processes could not be successful. Proteins play a major and very important role in this case. The structure of the protein has been seen to be very important in the functionality of the proteins.

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