Protein Structure

Organic compounds are substances made of **carbon (**C), **hydrogen (H),** and usually **oxygen (O)**. They often contain nitrogen (N), phosphorus (P) and sulfur (S), and sometimes traces of metals such as iron (Fe) and magnesium (Mg). Organic compounds make up the structures of cells, tissues and organs of living things. Many of them regulate and coordinate the life activities of organisms as well. Still others are the “fuel” that cells break down to obtain energy. There are 4 kinds of organic molecules found in living things: ***proteins, carbohydrates, lipids (aka “fats”)***, and ***nucleic acids*** (DNA and RNA). All are vital but none are more essential and varied in their functions than proteins. Proteins regulate all chemical activities of life and are also the key structural components of cells. Without proteins there is no life.

A protein is a gigantic molecule that is really just a chain of many small molecules (called amino acids) linked together. There are 20 amino acids, each different from the others in some way, but all of which have some basic features in common. What makes each of the thousands of proteins needed by an organism unique is the specific sequence and number of amino acids in its chain. The long chain of amino acids in a protein does not just dangle in space – it folds into a specific 3-dimensional shape determined by its sequence of amino acids. This shape in turn determines what the protein can do - in other words, the job a protein does in an organism depends upon its shape. This is why it is so important to understand protein structure – structure determines shape and shape determines function.

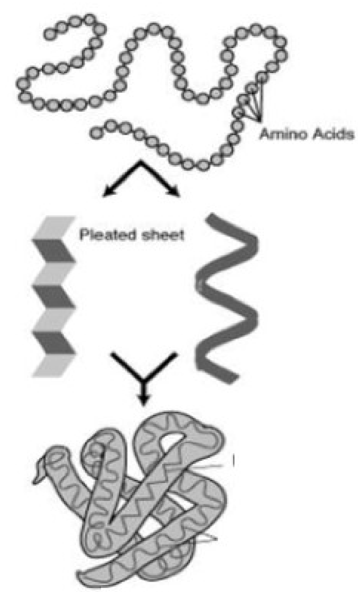
Building a protein requires bonding amino acids together into a long chain. Each amino acid has two identical “functional groups”: at one end is the **amino** group (N and two H) and at the other is the carboxylic **acid** group (C with an -OH and an =O). The amino group of one amino acid bonds to the acid group of another. In the process the first loses an –OH from its acid group and the second loses an H from its amino group. The result is a molecule of water and the beginnings of an amino acid chain: two amino acids bonded together. More amino acids can now be attached at either end. As the chain grows longer it is called a **polypeptide**. Only when all amino acids needed for that particular protein are attached is it called a protein.

The specific order of amino acids in a protein is referred to as its **primary structure** (see diagram below). As the chain grows it bends and folds in a very precise pattern that depends upon the positioning of the amino acids in the chain. Folding is affected by factors such as: a) weak attractive forces between parts of some amino acids and others and b) the fact that some amino acids are hydrophobic (repelled by water) and seek the inside of the 3-dimensional blob. Most important for you to understand is that *primary structure determines the protein’s shape,* and *shape (much like the shape of a key) determines what it can do*. Changing a protein’s shape, like changing the shape of a key, may mean it no longer functions the way it is supposed to. Since it is the sequence of amino acids that determines shape, anything that changes the sequence of amino acids in a protein may change its shape and, in turn, its ability to do its job.

Primary structure (order of amino acids)

Causes specific pattern of twisting and folding.

Final folded shape (determines function)



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