

9. Making proteins

I am sure that you know how proteins are made. However you might be interested in some details of this process. Manufacturing of proteins is the most essential process of all living organisms. Proteins perform many functions and are essential constituents of the cell. They are used to build bodies, support the skeleton, control processes, digest food and defend against infections. Without them life would be impossible.

Proteins are made from amino acids which are essential building bricks of the cell. The key elements of amino acids are carbon, hydrogen, oxygen, and nitrogen. To form a protein, amino acids are joined with each other in the form of a linear chain. On average a few hundred amino acids join to form one protein, but some muscle proteins can contain up to 30000 amino acids.

Before the cell starts making a protein it has to search for information in DNA. Each gene has at its beginning a label called a promoter corresponding to the specific protein code. Finding the right promoter is not a simple task. To do it are needed helpers called sigma factors. These sigma factors bind to a specific promoter.

The question is: how could these promoters evolve? They do not perform any cell functions. They are simply addresses. The natural selection process could not design them.

For copying information from DNA is responsible very large molecule called RNA polymerase. In bacteria the RNA polymerase is built from about 62,000 atoms.

When the RNA polymerase finds the protein code it starts splitting the DNA strands. Then the RNA polymerase locks to one strand and starts reading the code. At the same time it starts producing messenger RNA. Messenger RNA is a copy of one strand of DNA.

RNA polymerase has remarkable properties. It provides automatic error correction of copied strands. It 'knows' what protein in a given moment is required by the cell. It is still not understood how does it.

In the next stage of making proteins the messenger RNA is sent to the ribosome. Ribosome is a very large complex which works as a factory for proteins. Ribosomes are absolutely essential for life to exist. It converts instructions provided by

messenger RNA into the chains of amino-acids that make up proteins. A ribosome consists of approximately 380,000 atoms.

To make proteins the ribosome needs amino acids which are floating around the cell. However, how does the ribosome recognize the right amino acid? To do this the amino acid needs a label and this label is provided by another nucleotide sequence that exists in the cell and is called transfer RNA (tRNA). Each tRNA has a three letter codon, e.g. AAA for lysine. There are 20 different tRNA labels each corresponding to 20 amino acids. tRNA labels lock to the corresponding amino acids as determined by its three letter codon and now can be identified by the ribosome.

But the key question is, how does tRNA with a specific codon recognize the right amino acid? And here the story gets even more complicated. To identify the right amino acid the help of another compound called aminoacyl tRNA synthetase is required. Again the chemistry is getting much too complicated and we have to stop here.

As you see the process of making proteins is extremely complex. This process works from the beginning of life.