STAGES OF PROTEIN BIOSYNTHESIS

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https://doi.org/10.5281/zenodo.8045722

Abstract. *The cells are continuously undergoing metabolic processes — the processes of synthesis and decomposition of substances. Each cell synthesizes the substances it needs. This process is called biosynthesis.*

Biosynthesis is the process of creating complex organic substances during biochemical reactions that occur with the help of enzymes. Biosynthesis is necessary for survival — without it, the cell will die.

One of the most important processes of biosynthesis in a cell is the process of protein biosynthesis, which includes special reactions that occur only in a living cell — these are matrix synthesis reactions. Matrix synthesis is the synthesis of new molecules in accordance with the plan laid down in other already existing molecules.

Protein synthesis in the cell proceeds with the participation of special organelles — ribosomes. These are non-membrane organelles consisting of rRNA and ribosomal proteins.

Keywords: *genetic code, initiation stages, elongation, termination.*

The sequence of amino acids in each protein is determined by the sequence of nucleotides in the gene — the DNA region encoding this particular protein. The correspondence between the sequence of amino acids in a protein and the sequence of nucleotides in its coding DNA and mRNA is determined by a universal rule — the genetic code. Protein information can be recorded in nucleic acid in only one way — in the form of a sequence of nucleotides. DNA is constructed from 4 types of nucleotides: adenine (A), thymine (T), guanine (G), cytosine (C), and proteins — from 20 types of amino acids. Thus, there is a problem of translating a four-letter record of information in DNA into a twenty-letter record of proteins. The genetic code is the ratio of nucleotide sequences and amino acids on the basis of which such a translation is carried out.

The process of protein synthesis in a cell can be divided into two stages: transcription and translation.

Transcription (from Lat. transcription - rewriting) occurs in the cell nucleus with the participation of enzymes, the main work of which is carried out by transcriptase. In this process, the DNA molecule is the matrix. A special enzyme finds a gene and unwinds a section of the DNA double helix. The enzyme moves along the DNA chain and builds a chain of informational RNA in accordance with the principle of complementarity. As the enzymes move, the growing RNA chain of the matrix moves away from the molecule, and the DNA double chain is restored. When the enzyme reaches the end of the copying site, that is, it reaches the site called the stop codon, the RNA molecule separates from the matrix, that is, from the DNA molecule. Thus, transcription is the first stage of protein biosynthesis. At this stage, the information is read by the synthesis of informational RNA.

Copying information, although it is already contained in the DNA molecule, is necessary for the following reasons: protein synthesis occurs in the cytoplasm, and the DNA molecule is too large and cannot pass through the nuclear pores into the cytoplasm. And a small copy of its site — mRNA — can be transported into the cytoplasm.

After transcription, the bulky DNA molecule remains in the nucleus, and the mRNA molecule undergoes "maturation" — the mRNA processing takes place. A CAP is suspended on its 5’ end to protect this end of the mRNA from RNase enzymes that destroy RNA molecules. At the 3’ end, the poly(A) tail is completed, which also serves to protect the molecule. After that, splicing takes place — cutting out introns (non-coding sections) and stitching exons (information sections). After processing, the prepared molecule is transported from the nucleus to the cytoplasm through the nuclear pores.

Step-by-step transcription:

1. RNA polymerase sits on the 3’ end of the transcribed DNA chain.
2. Elongation begins — the polymerase "slides" along the DNA towards the 5' end and builds a chain of mRNA, complementary DNA.
3. The polymerase reaches the end of the gene, "flies off" the DNA and releases the mRNA.
4. After that, the RNA maturation process takes place — processing.

Translation is a direct process of building a protein molecule from amino acids. Translation takes place in the cytoplasm of the cell. Ribosomes, enzymes and three types of RNA participate in translation: mRNA, tRNA and rRNA. The main energy supplier during translation is the ATP molecule — adenosine triphosphoric acid.

Translation is the second stage of protein biosynthesis. During translation, the nucleotide sequences of the informational RNA are translated into the sequence of amino acids in the molecule of the polypeptide chain. This process takes place in the cytoplasm on ribosomes. The formed informational RNAs exit the nucleus through the pores and are sent to the ribosomes. Ribosomes are a unique assembly apparatus. The ribosome slides along the mRNA and builds a long polymer chain of protein from certain amino acids. Amino acids are delivered to ribosomes using transport RNAs. Each amino acid requires its own transport RNA, which has the shape of a trefoil. It has a site to which an amino acid and another triplet anticodon are attached, which binds to a complementary codon in the mRNA molecule.

A chain of informational RNA provides a certain sequence of amino acids in the chain of a protein molecule. The lifetime of information RNA ranges from two minutes (as in some bacteria) to several days. Then the informational RNA is destroyed by the action of enzymes, and the nucleotides are used to synthesize a new molecule of informational RNA. Thus, the cell controls the amount of synthesized proteins and their type.

Broadcast step by step:

- The ribosome recognizes the CAP, sits on the mRNA.
- The R-site of the ribosome receives the first tRNA with an amino acid.
- A second tRNA with an amino acid arrives at the ribosome A-site.
- AK form a peptide bond.
- The ribosome takes a step with a length of one triplet.
- The next tRNA arrives at the vacated A-site.
- AK form a peptide bond.

• Processes 5-7 continue until the ribosome meets the stop codon.

The ribosome is disassembled, releases the polypeptide chain. Biosynthesis is necessary for survival — without it, the cell will die. The process of protein biosynthesis involves special reactions that occur only in a living cell — these are matrix synthesis reactions.

Protein synthesis consists of two stages: transcription (the formation of information RNA on the DNA matrix, takes place in the cell nucleus) and translation (this stage takes place in the cytoplasm of the cell on ribosomes). These stages replace each other and consist of sequential processes.

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