

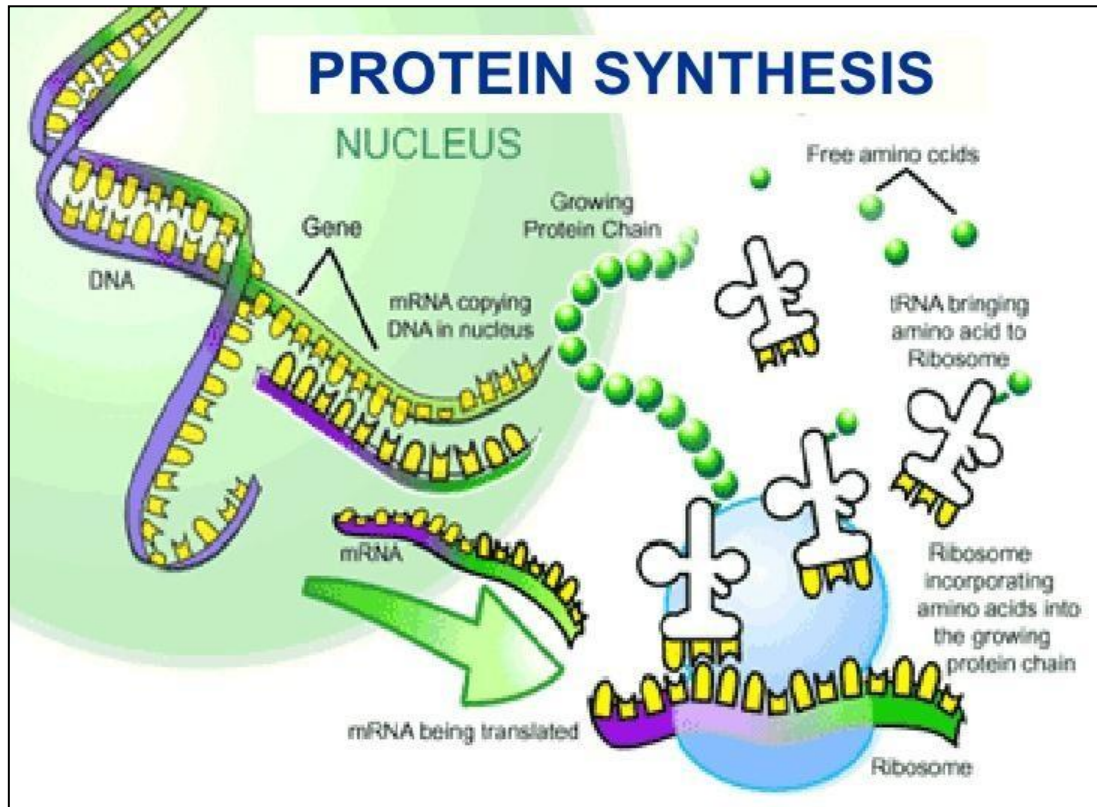
19. PROTEIN SYNTHESIS

The genetic information for the synthesis of proteins and other enzymes resides in DNA and the actual synthesis takes place in cytoplasm. Two French scientists of pasture institute, F. Jacob and J. Monod proposed about the existence of a messenger for communication between DNA and the protein synthesizing machinery in the cytoplasm and later this was called the mRNA (messenger RNA).

A particular segment of DNA, that is a gene, which becomes active, in a manner similar to the replication of DNA during cell division, serves as a template for the formation of RNA, which contains a sequence bases of that is complementary to one strand of DNA (antisense strand, which serves as its template) and identical to the other strand of DNA (sense strand). This process of production of mRNA from DNA is called transcription. The RNA polymerase which catalyses the synthesis of RNA from the DNA template is known as transcriptase. Actually, in eukaryotic cells, it was found that the RNA molecule immediately after transcription is many times longer than the RNA that enters cytoplasm. Hence, this RNA was named as heterogeneous RNA (hnRNA). This hnRNA is processed in the nucleus itself by deleting intervening sequences called introns and the expressed sequences that are retained are known as exons. This hnRNA is further processed by capping with methyl guanosine at the 5' end and by addition of a number of adenines (poly -A) at 3' end. This capping and addition of poly A tail is supposed to protect the mRNA from degradation by cytoplasmic enzymes.

The process of protein synthesis where amino acids are brought by the tRNA and sequentially arranged based on the codons of the mRNA is known as translation (i. e. the nucleotide sequence is translated into the amino acid sequence). The translation process requires mRNA, rRNA, ribosomes, 20 kinds of amino acids and their specific tRNAs and many translation factors. The process of translation (protein synthesis) consists of five major steps viz., (1) activation of amino acids (2) transfer of amino acids to tRNA (3) chain initiation (4) chain elongation and (5) chain termination. Each step is governed by specific enzymes and cofactors.

In the cytoplasm, the amino acids are activated in the presence of ATP and linked to their respective tRNAs by a process called charging of tRNA in the presence of an enzyme aminoacyl synthetase. Thus, a number of tRNA molecules, pick up amino acids freely floating in the cytoplasm and forms aminoacyl-tRNAs.



The processed mRNA enters the cytoplasm and binds to ribosomes, which serve as work benches for protein synthesis. The ribosome consists of rRNAs and different proteins. Ribosome contains two subunits; the large subunit and the small subunit. The process of translation starts when an initiating aminoacylated tRNA base pairs with an initiation codon of an mRNA molecule that has been located by the small subunit of ribosome. Then the larger subunit joins. Two separate and distinct sites are available in the ribosome to which the tRNAs can bind; A (acceptor or aminoacyl attachment) site and P (peptidyl) site. An aminoacyl-tRNA first attaches to site A (acceptor site or aminoacyl attachment site) the kind of aminoacyl t-RNA being determined by the sequence of mRNA (codon) attached to site A. The peptide bonds are formed between the aminoacids which is catalysed by the enzyme peptidyl transferase. The peptidyl tRNA along with the mRNA codon moves to the P (peptidyl) site making the A site available for the attachment of a new aminoacyl-tRNA. Thus, the translation proceeds and at the end a releasing factor binds to the stop codon terminating the translation. The ribosome releases the polypeptide and mRNA and subsequently dissociates into two subunits. Further processing of polypeptide chain into proteins and enzymes is done in the cytoplasm itself and depends upon the bonding properties of the amino acids joined in them.

Most of the mRNA molecules are unstable and degraded after the release of polypeptide chain, but some mRNAs such as those coding for hemoglobin may be stable. When the cell needs large quantities of a particular enzyme or protein, more number of mRNA molecules coding for the same protein are produced to meet the demand.

Polyribosomes or polysomes: Many ribosomes read one strand of mRNA simultaneously, helping to synthesize the same protein at different spots on the mRNA.

Cistron: A sub division of gene which acts as a unit of function with a gene.

Muton: A sub division of gene which is the site of mutation.

Recon: The smallest subunit of gene capable of undergoing recombination or a sub unit of gene which is the site of recombination