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Mini Review

Molecular Biotechnology: Protein Synthesis

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Abstract

The clinical topic is a lack of mitochondrial translation and abnormalities in mitochondrial oxidative phosphorylation. Among the additional topics are the following: protein synthesis in the mitochondria, mitochondrial encephalomyopathy with lactic acid and stroke-like episodes, protein synthesis directed by the nucleus, the ribosome, the structure of transfer RNA (tRNA), initiation and amino acid tRNA synthase, elongation and peptidyltransferase ribozyme, termination, inhibitors of protein synthesis, proteins synthesised in the cytoplasm (Carter CG et al., 2001).

INTRODUCTION

The process of making protein molecules is called protein synthesis. It includes amino acid synthesis, transcription, translation, and post-translational activities in biological systems. There are a number of metabolic procedures known as amino acid synthesis that convert carbon sources like glucose into amino acids. The body does not synthesise all amino acids; some must be taken from the food. Proteins are produced within cells through transcription and translation processes. Transcription, in a nutshell, is the process by which the DNA mRNA template is translated into mRNA (Davis HP et al., 1984).

The production of proteins is known as protein synthesis. When applied to biological systems, it happens inside the cell. It takes place in the cytoplasm of prokaryotes. In eukaryotes, the coding section of the DNA is first translated into a transcript (mRNA) in the nucleus. After leaving the nucleus, the transcript travels to the ribosomes where it is translated into a protein molecule with a predetermined amino acid sequence (Crick FH 1958).

Protein synthesis is the process through which cells make proteins using DNA, RNA, and a variety of enzymes. It often comprises protein folding, modifications, and proteolysis as well as transcription, translation, and post-translational processes. The following stage, translation, uses the template. Based on the genetic code, the amino acids are joined during translation in a certain order. The newly created protein goes through further processing after translation, such as proteolysis, post-translational modification, and protein folding (Haselkorn R et al., 1973).

A fundamental biological activity called protein biosynthesis takes place inside of cells and counteracts the loss of existing proteins by producing new proteins. As structural proteins, hormones, or enzymes, proteins serve a variety of important biological purposes. Prokaryotes and eukaryotes both undergo protein synthesis, albeit there are several key distinctions (Moldave K 1985).

Transcription and translation are the two processes that make up protein synthesis. A segment of DNA called a gene, which codes for a protein, is transformed into a template molecule called messenger RNA during transcription (mRNA). In the cell's nucleus, enzymes referred to as RNA polymerases perform this conversion. Eukaryotes make this mRNA prematurely at first (pre-mRNA), which then goes through post-transcriptional changes to produce mature mRNA. Nuclear pores allow the mature mRNA to be evacuated from the cell nucleus and transported to the cytoplasm, where translation may take place. Ribosomes read the mRNA during translation, using its nucleotide sequence to infer the order of the amino acids. To create a polypeptide chain from the encoded amino acids, the ribosomes catalyse the production of covalent peptide bonds (Lucas-Lenard JEAN et al., 1971).

As alterations and faults in this process, caused by underlying

DNA mutations or protein misfolding, frequently constitute the underlying causes of a disease, protein biosynthesis plays a crucial role in illness. DNA mutations modify the mRNA sequence that follows, which then modifies the amino acid sequence that is encoded in the mRNA. By producing a stop sequence that induces early cessation of translation, mutations can shorten the polypeptide chain. Alternately, a change in the sequence of the messenger RNA affects the specific amino acid that is encoded at that location in the polypeptide chain. This alteration in an amino acid can affect how well a protein works or folds. As poorly folded proteins have a propensity to adhere together to create solid protein clumps, they are frequently linked to illness. These clusters have been related to a number of illnesses, many of which are neurological, such as Parkinson's and Alzheimer's disorders (Lengyel P et al., 1969).

Synthesis of Proteins: A Technique

The creation of proteins is a process that occurs in the cells of all living things no post. In reality, transcription and translation are the two steps that make up this procedure, which is known as protein synthesis. Transcription takes place in the nucleus of eukaryotic cells. DNA serves as a template for the production of a messenger RNA molecule during transcription (mRNA). After leaving the nucleus, the mRNA molecule travels to a ribosome in the cytoplasm, where translation takes place. The genetic code contained in the mRNA is read during translation and utilised to create a polypeptide. The core dogma of molecular biology, DNA → RNA → Protein, sums together these two processes.

Transcription: The first element of the fundamental tenet of molecular biology is transcription: DNA → RNA. Transferring genetic information from DNA to mRNA is what it is called. A strand of mRNA is created during transcription to complement a strand of DNA. When the RNA polymerase enzyme attaches to a section of a gene known as the promoter sequence, transcription may start. In order for the enzyme to "read" the DNA bases, this tells the DNA to unwind. Depending on whether or not they will serve as a template for RNA, the two strands of DNA are given different names. The strand that serves as a template is referred to as the template strand or antisense strand. The non-coding or sense strand of DNA refers to the base sequence on the strand across from it. The RNA polymerase proceeds along the DNA once the DNA has opened and the RNA nucleotides are added to the mRNA strand as it grows. Through complementary base pairing, mRNA is produced from the DNA template strand. After the mRNA strand is finished, it separates from the DNA. With the exception of the fact that DNA employs the nucleotide thymine and mRNA utilises uracil in place of thymine, the coding strand of DNA and the resulting strand of mRNA are essentially similar.

mRNA processing: The new mRNA in eukaryotes is not yet prepared for translation. Pre-mRNA at this level requires further processing before maturing into mature mRNA and leaving the nucleus. The procedure might involve polyadenylation, editing, and splicing. The mRNA is altered in various ways by these mechanisms. One gene can now produce several proteins because to these changes.

- Introns, which are areas of the mRNA that do not code for the protein, are removed during splicing. Exons are the only parts of the remaining mRNA that really code for the protein. The ribonucleoproteins in the diagram are tiny proteins that are required for the splicing process and contain RNA in the nucleus.

- Some of the nucleotides in mRNA are altered during editing. For instance, editing has resulted to the development of two distinct variants of the human protein APOB, which aids in the transportation of lipids in the blood. Because of the early stop signal that editing adds to mRNA, one version is smaller than the other.

- The "head" of the mRNA is added a methylation cap during 5′ capping. This cap keeps the mRNA from degrading and enables the ribosomes to locate the mRNA for binding.

- The mRNA gains a "tail" by polyadenylation. There is a string of as in the tail (adenine bases). It indicates that mRNA has ended. Additionally, it aids in the export of mRNA from the nucleus and defends mRNA from enzymes that may degrade it.

Translation: The second component of the fundamental tenet of molecular biology is translation: RNA → Protein. It is a procedure through which mRNA's genetic information is read in order to produce a protein. When mRNA exits the nucleus, it travels to a ribosome, which is made up of proteins and rRNA. The amino acids are delivered to the ribosome in the proper order by tRNA molecules, and the ribosome reads the sequence of codons in the mRNA.

You must learn more about tRNA's structure in order to comprehend its function. The amino acid that each tRNA molecule carries is represented by an anticodon. A codon for an amino acid is complemented by an anticodon. For instance, the anticodon for the amino acid lysine is UUC since it bears the codon AAG. As a result, a tRNA molecule with the anticodon UUC would transport lysine. A UUC anticodon of tRNA momentarily binds to any location where the codon AAG occurs in the mRNA. The amino acid in tRNA is forfeited when it is linked to mRNA. As amino acids are delivered one by one to the ribosome with the aid of rRNA, links between them form, resulting in a polypeptide chain. Until a stop codon is reached, the chain of amino acids continues to develop.

Because rRNA contains enzymatic activity, ribosomes, which are only composed of protein and ribosomal RNA, are referred to as ribozymes. The peptidyl transferase activity, which binds amino acids, depends on the rRNA. Two rRNA and two protein subunits make up ribosomes. Three active sites—the E, P, and A sites—make up the big subunit. These locations are crucial for ribosomes' catalytic activity. Protein

synthesis may be broken down into three phases: initiation, elongation, and termination, just as mRNA synthesis. The process of translation is aided by other molecules in addition to the mRNA template, including ribosomes, tRNAs, and different enzyme components.

Translation occurs in three stages: Initiation, Elongation and Termination.

Initiation: A place upstream (on the 5' side) of the mRNA's start is where the small subunit interacts. In order to find the START codon, it continues to scan the mRNA in the 5'-->3' direction (AUG). The initiator tRNA, which transports the amino acid methionine (Met), binds to the P site on the ribosome as soon as the big subunit is attached. The mRNA leaves the nucleus through a nuclear hole after transcription in the nucleus and reaches the cytoplasm. The small and large subunits of the ribosome attach to the mRNA at the location on the molecule that contains the methylation cap and the start codon. A tRNA that has anticodons that match the start codon on the mRNA is then used to connect these. An initiation complex is made up of the molecules mRNA, ribosomes, and tRNA.

Elongation: The ribosome catalyses each of the three processes by shifting one codon at a time. A charged tRNA enters the complex, the polypeptide gains an amino acid, and an uncharged tRNA leaves at each step (Weissbach H 2012). Each binding between amino acids receives energy from GTP, an ATP-like molecule. Due to the peptide link that develops between each amino acids, the ribosomes work with other RNA molecules to create polypeptide chains, which are chains of amino acids. The A, P, and E sites of the ribosome are three locations that take involvement in translation. Amazingly, each amino acid is added to the E. coli translation machinery in just 0.05 seconds, which means that a 200-amino acid polypeptide may be translated in about 10 second (Loftfield RB et al., 1972). According to complementary base matching between the codons on the mRNA and the anticodons on the tRNA, tRNA continues to add amino acids to the expanding polypeptide. An amino acid from a tRNA is transferred to the developing polypeptide when it enters the ribosome. The tRNA exits the ribosome when this transfer is finished, the ribosome advances one codon length down the mRNA, and a new tRNA with its appropriate amino acid enters. The polypeptide increases when the procedure is repeated.

Termination: When a stop codon (UAA, UAG, or UGA) is found, translation is terminated. With the aid of a number of releasing agents, the developing polypeptide is released when the ribosome comes across a stop codon, and the ribosome subunits separate and leave the mRNA. The mRNA is broken down after several ribosomes have finished translating it so that the nucleotides may be utilised again in a transcription step. A stop codon marks the conclusion of the mRNA coding and the elongation phase. Instead of a tRNA, the stop codon instructs the production of a protein known as a release factor, which will force the complex of the mRNA, ribosome, tRNA, and polypeptide to disintegrate and release all of its constituent parts (Andersen GR et al., 2003).

CONCLUSION

This review's focus is only on microbial protein synthesis. It should go without saying that the understanding gained by studying this pathway in microbes should hasten the advancement of related research in higher creatures. The latter might ultimately help us comprehend a variety of events, including differentiation, hormone action, and antibody production.

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