International Scholars Journals

Global Journal of Plant and Soil Sciences Vol. 4 (3), pp. 001-003, March, 2020. Available online at www.internationalscholarsjournals.org © International Scholars Journals

Review

Understanding of protein synthesis in a living cell

Y. Mustapha[1] and S. Muhammad[2]

[1]Department of Biological Sciences, Bayero University, Kano, Nigeria.
[2]Department of Biological Sciences, Usmanu Danfodiyo University, Sokoto, Nigeria.

Accepted 20 October, 2019

The assembly of proteins takes place in the cytoplasm of a cell. There are three main steps. In initiation, far left, all the necessary parts of the process are brought together by a small molecule called a ribosome. During elongation, amino acids, the building blocks of proteins, are joined to one another in a long chain. The sequence in which the amino acids are added is determined by messenger, messenger ribonucleic acid RNA (mRNA), a transcribed copy of the cell's deoxyribonucleic acid DNA. Termination, far right, takes place when the mRNA sequence contains one of several "stop" codons. At these, the ribosome-mRNA complex binds a release factor that causes release of the completed (protein) chain of amino acids. The released chain is called the primary structure of a protein. This paper outlines simple methods for students and teachers alike to help in understand the mechanism of protein synthesis in a living cell.

Keywords: deoxyribonucleic acid DNA, messenger ribonucleic acid (mRNA), amino acids codons.

INTRODUCTION

A story on protein synthesis

A person (1) wants to make a machine (2) He first goes into the library (3) and selects the book (4) that describes how to make this machine. He cannot take the book out of the library, so he makes photocopies (5) of the pages he needs and takes them home (6) with him. While at the library he has also been able to get some of the tools (7) required to make the machine. When he gets home he gathers the parts (8) he needs, reads the photocopies and uses the tools in the process (9) of making the machine works as soon as it is made (10) . If he wants to make a machine to give to others (11), he does the same thing except that he has a problem in building the machine. The tools and instructions must be used inside the house, but the machine will be too big to fit through the door or windows of the house. So, as he adds one piece at a time to the machine, he pushes the small bit he has finished outside the window into the compound (12). He then adds some finishing touches in the compound (13). The machine is now ready to be given away.

*Corresponding author. E-mail: samdiri@yahoo.co.uk. Tel: 234843116092.

This is a story to help you understand the mechanism of protein synthesis in a living cell. If you cannot figure out the connection, use the following to help you understand better: (1) The cell; (2) a protein; (3) the nucleus; (4) the gene (DNA); (5) makes mRNA transcripts; (6) the cytoplasm; (7) rRNA, tRNA; (8) amino acids; (9) translation; (10) self-assembly, the spontaneous folding of a protein into its proper, functional shape; (11) secretion; (12) rER lumen; (13) rER and Golgi.

FOUR IMPORTANT STAGES OF PROTEIN SYNTHESIS FOR SECRETION

Transcription

The gene remains in the nucleus so that the first step is to copy DNA information in a way that it can be taken into the cytoplasm; the DNA is transcribed (re-written) as RNA (RNA has a very similar structure to DNA). There are three types of RNA:

(i) Ribosomal RNA (rRNA) the nucleic acid component of the ribosome rRNA transcripts are first seen in the nucleolus.

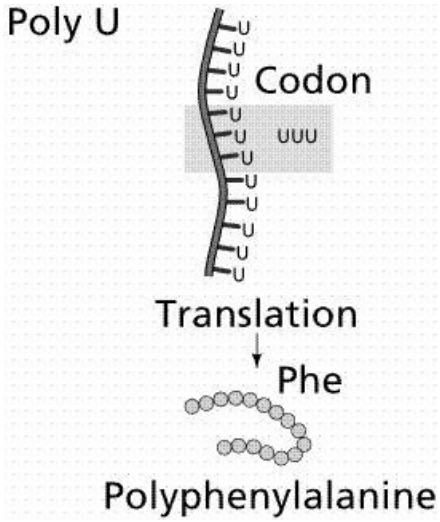

Figure 1. Steps in breaking the genetic code: the deciphering of a poly-U mRNA. Image adopted from Purves et al. (1992), Life: The Science of Biology, 4th Edition, by Sinauer Associates and WH Freeman used with permission.

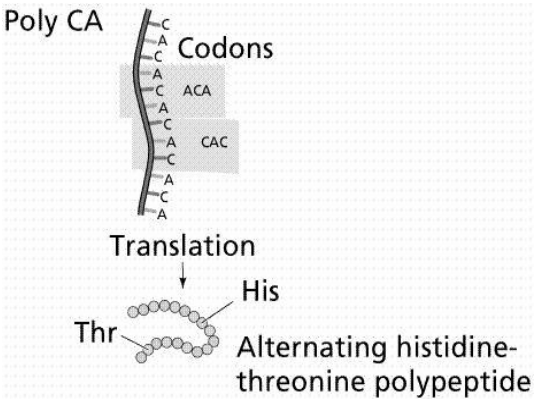

Figure 2. Deciphering the code: poly CA. Image above was adopted from Purves et al. (1992) *Life: The Science of Biology,* 4th Edition, by Sinauer Associates The genetic code consists of 61 amino-acid coding codons and three termination codons, which stop the process of translation. The genetic code is thus redundant (degenerate in the sense of having multiple states amounting to the same thing), with, for example, glycine coded for by GGU, GGC, GGA, and GGG codons. If a codon is mutated, say from GGU to CGU, is the same amino acid specified.

(ii) Messenger RNA (mRNA) carries the specific code for a protein or peptide. That is there are different (mRNA) for different proteins.

(iii) Transfer RNA (tRNA) brings amino acids to proteins synthesis completed (RNA) transcripts leaves the nucleus through the nuclear pore.

40S in eukaryotic cells and 30S in prokaryotic cells are called S protein. The proteins associated with the larger ribosomal subunits 60S in eukaryotic cells and 50S in prokaryotic cells are called L protein. (Allen and Baker 2001).

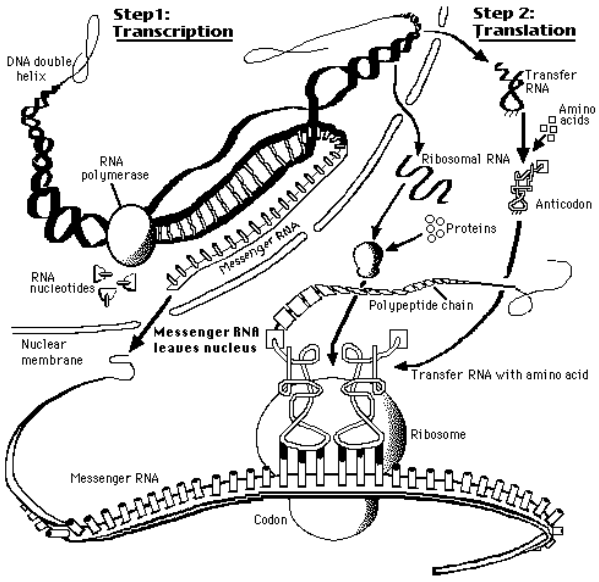

Figure 3. Protein synthesis. Adopted from Purves et al., (1992) Life: The Science of Biology, 4th Edition, by Sinauer Associates and WH Freeman.

Translation

The genetic code consists of at least three bases. To code for the 20 essential amino acids, a genetic code must consist of at least a 3-base set (triplet) of the 4 bases. If one considers the possibilities of arranging four things 3 at a time (4X4X4), we get 64 possible code words, or codons (a 3-base sequence on the mRNA that codes for either a specific amino acid or a control word).

The genetic code was broken by Marshall Nirenberg and Heinrich Matthaei, a decade after Watson and Crick's work (Ausuber, 1988). Nirenberg discovered that RNA, regardless of its source organism, could initiate protein synthesis when combined with contents of broken *Escherichia coli* cells. By adding poly-U to each of 20 test-tubes (each tube having a different "tagged" amino acid) Nirenberg and Matthaei were able to determine that the codon UUU (the only one in poly-U) coded for the amino acid phenylalanine (Figure 1) . Likewise, an artificial mRNA consisting of alternating A and C bases would code for alternating amino acids histidine and threonine. Gradually, a complete listing of the genetic code codons was developed (Figure 2 and 3).

Modification

The newly formed protein passeses from rER to Golgi and the protein may be modified along the way. For example, sugar groups are added in the Golgi to make glycoproteins. Vesicles containing finished protein bud off from the Golgi and become secretory vesicles.

Secretion

During secretion the vesicles release their contents by exocytosis.

REFERENCES

Allen GE, Baker JJW (2001). Biology Scientific Process and Social Issues. Fitzgerald Science Press, Inc., Bethesda, Maryland.

Ausuber PM (1988). Current protocols in Molecular Biology, John Willey and Sons, New York. A continuously updated volume published in loose leaf form giving detailed protocols methods and Review on protein synthesis

Purves WK, Orians GH, Heller HC (1992). Life: The Science of Biology, 3rd edition. Sinauer Associates, Inc., W. H. Freeman and Company, Sunderland, Mass.