IRB BARCELONA

INSTITUTE FOR RESEARCH IN BIOMEDICINE

COMPLEMENTARY INFORMATION

Basic questions about the genomes and components of the genetic code

What is the genome?

It is the set of genetic instructions of each organism. These genetic instructions (genes) are found in cellular DNA, a large string of nucleotides formed by: Adenine (A) Thymine (T), Guanine G), Cytosine (C). The genome is a very long combination of only 4 letters: ACGGTGATTCTCCAATT…

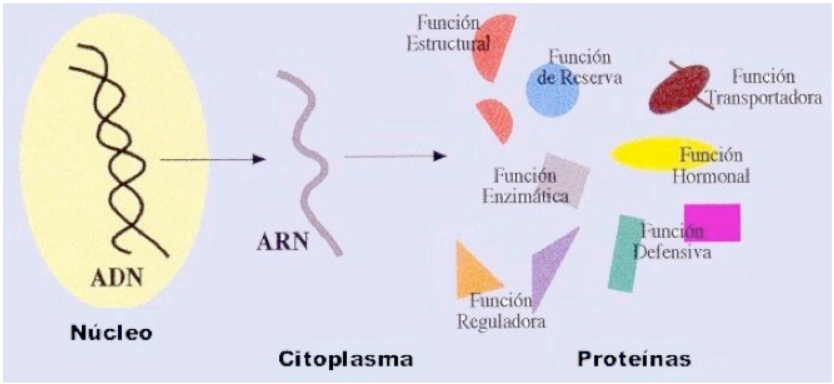
What is the genetic code?

It is the set of regulations that allows the conversion of nucleic acid sequences (DNA or RNA) into proteins inside cells of living beings, in a process called protein synthesis.

What are proteins?

They are the "cell workers" and they are responsible for vast majority of cell functions. Cells synthesize proteins on the basis of requirements and the functions that the organism must undertake. Organisms are more successful if cells show efficient and reliable cellular production of proteins. Genomes have evolved to optimize their activity and to produce the largest amount of proteins possible with the minimum number of errors.

How is DNA converted into proteins?



NUCLEÒTIDS:	NUCLEÒTIDS:	AMINOÀCIDS:
A-T-G-C	**A-U-G-C**	**20 DIFERENTS**

From DNA to RNA

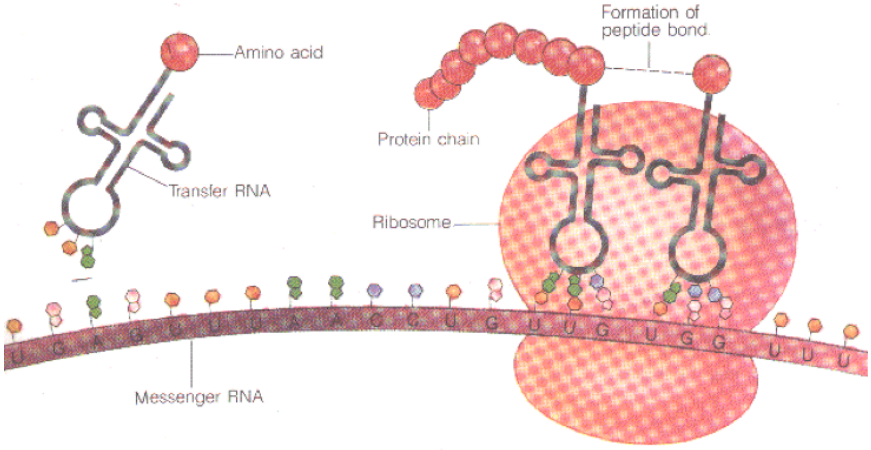
First it is necessary to translate the information of the 4 letters of DNA into another language, that of RNA, which also comprises 4 nucleotides (or letters): Adenine (A), Uracyl (U), Guanine (G), Cytosine (C). This first translation produces a chain of nucleotides that group into series of threes (base triplets or codons), for example: UUU GUU UGG UUG CUG CGA etc….

From RNA to proteins

All proteins are formed by amino acids. In general, 20 different amino acids are used to make a protein and the proteins comprise long chains of combinations and repetitions of these 20 molecules. To make a protein, it is necessary to translate the series of three (messenger RNA) mRNA bases into the corresponding amino acids. Each combination of RNA triplets corresponds to an amino acid. Example: GUU: valine; CGA: argenine, etc…

Correspondence between codons and amino acids

There is a maximum of 61 combinations of triplets or codons that code for only 20 amino acids. Therefore more than one codon codes for the same amino acid. It is known that these codons are not equally represented in all genomes, that is to say, each organism has a preferential codon for a specific amino acid. But until now the reason for this distribution was not known. The study explains the reason for this deviation.



tRNAs, the molecules that translate RNA to amino acid

Transfer RNA (aminoacyl-tRNA synthetases) is involved in the process of translating codons to amino acids. tRNAs are the key pieces in the translation of the genetic code and allow an amino acid chain to be built from an RNA chain. Each tRNA is designed to transport one of the 20 amino acids to the ribosome, where proteins are synthesized. All tRNAs have the same form: at one end they have a unique combination of codons and at the other the amino acid that corresponds to that combination (see picture). Once inside the ribosome, the tRNA codon joins the complementary codon of the mRNA chain while above the amino acid carried by the tRNA is released and it then joins the previous amino acid, thus making the chain grow slowly until the "reading" of the gene corresponding to that protein ends (as shown in the picture).

Modification enzymes
Some enzymes modify tRNAs to allow them to read more than one codon, thus generating "joker-like" tRNAs, making protein translation faster if gene X has more codons that can be read by modified tRNAs.

The scientists have discovered that the presence of these enzymes has been an evolutionary pressure factor that has contributed to the initial separation of the different groups of species (eucaryotes, bacteria and archaebacteria). This finding allows better understanding of the differences observed between the genomes of these organisms and paves the way to improve proteins production in all fields of biotechnology.
