Concept of Genetic Code

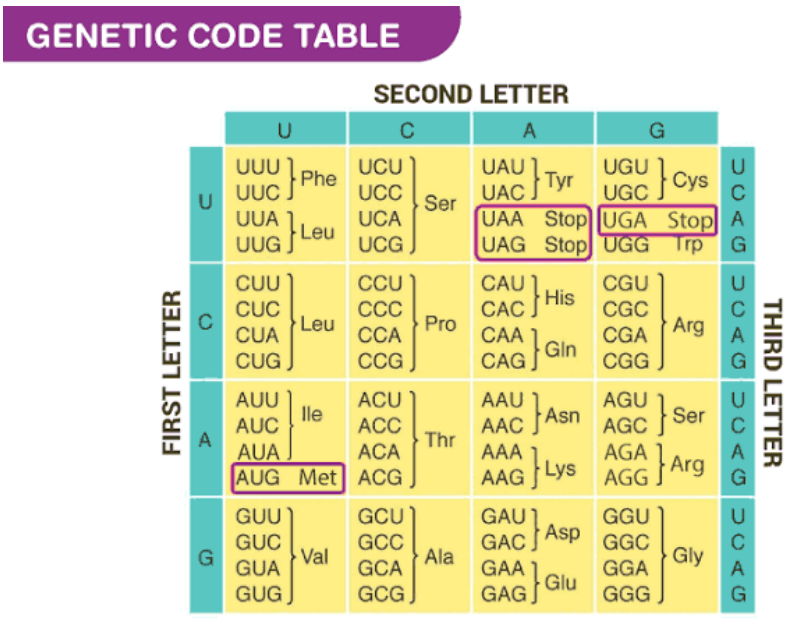
Introduction

The genetic code is a set of rules used by living cells to translate information encoded within genetic material (DNA or mRNA sequences) into proteins. Proteins are essential molecules responsible for various functions in an organism, such as catalyzing metabolic reactions, DNA replication, and transporting molecules. The process by which DNA is transcribed into mRNA and then translated into protein is known as gene expression. Understanding the genetic code is fundamental to understanding how organisms function at the molecular level.

Structure of the Genetic Code

The genetic code consists of nucleotide triplets called codons. Each codon specifies a particular amino acid. The main features of the genetic code include:

• **<u>It is a triplet code</u>**: A codon or a code word is defined as a group of bases that specify an amino acid. There is strong evidence, which proves that a sequence of three nucleotides codes for an amino acid in the protein, i.e., the code is a triplet**.** The four bases of nucleotide i.e, (A, G, C, and U) are used to produce three-base codons. The 64 codons involve sense codons (that specify amino acids). Hence, there are 64 codons for 20 amino acids since every codon for one amino acid means that there exists more than



code for the same amino acid.

• **It is universal**: With few exceptions, all known organisms use the same genetic code. The genetic code is non-ambiguous which means a specific codon will only code for a particular amino acid.

• **It is degenerate**: More than one codon may code for the same amino acid. Every amino acid except tryptophan (UGG) and methionine (AUG) is coded by various codons, i.e, a few codons are synonyms and this aspect is known as the degeneracy of genetic code. For instance, UGA codes for tryptophan in yeast mitochondria.

• **It is non-overlapping**: Codons are read one after another, without overlapping. The code is read sequentially in a group of three and a nucleotide which becomes a part of triplet never becomes part of the next triplet.

For example

5'-UCU-3' codes for Serine

5'-AUG-3' codes for methionine

• **It includes start and stop signals**: Generally, **AUG codon** is the initiating or start codon. The polypeptide chain starts either with eukaryotes (methionine) or prokaryotes (N-formylmethionine).On the other hand, **UAG, UAA** and **UGA** are called as termination codons or stop codons. These are not read by any tRNA molecules and they never code for any amino acids.

Decoding the Genetic Code

Decoding the genetic code involves transcription and translation:
1. Transcription: DNA is copied into messenger RNA (mRNA).
2. Translation: The mRNA is read by ribosomes in the cytoplasm. Transfer RNA (tRNA) molecules bring amino acids corresponding to each codon, and the ribosome links them together to form a protein.

Importance of the Genetic Code

The genetic code is crucial for the synthesis of proteins which determine the structure and function of cells. Understanding the code helps in:
• Diagnosing genetic disorders
• Genetic engineering and biotechnology
• Evolutionary studies
• Developing gene therapies and vaccines

The concept of the genetic code lies at the heart of molecular biology. It provides insight into how genetic information is translated into functional proteins, enabling life processes. With advances in genomics and biotechnology, decoding the genetic code continues to be central to many scientific and medical breakthroughs.