our Genetic Code

Assist. prof. Dr. Mujahid Kh. Ali

General Objectives:

1. To define the genetic code and understand its function as a dictionary linking the language of nucleotides to the language of amino acids.
2. To know that the genetic code is a triplet code (a codon composed of 3 bases).
3. To identify the start codon (AUG) and stop codons (UAA, UAG, UGA) and their functions.
4. To explain the key properties of the genetic code (triplet, non-overlapping, comma-less, degenerate, nearly universal).
5. To differentiate between a codon and an anticodon in terms of location and function.

What is Genetic code

- Genetic code: is a dictionary that corresponds with sequence of nucleotides and sequence of amino acids.
- Genetic code is a set of rules by which information encoded in genetic material (DNA or RNA sequences) is translated into proteins by living cells.
- Term given By " George Gamow "

DISCOVERY

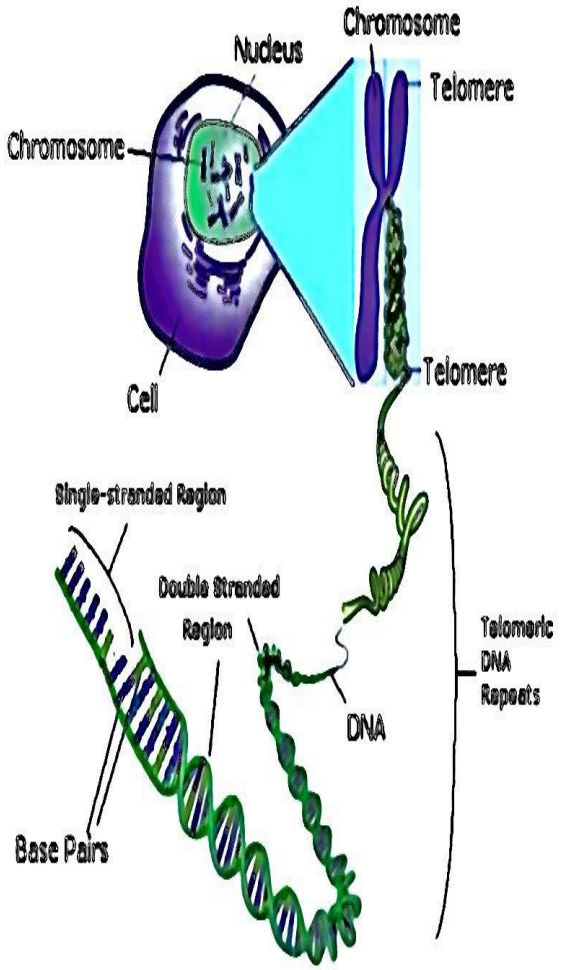
- To understand how proteins are encoded began after the structure of DNA was discovered by James Watson and Francis Crick.

James Watson & Crick

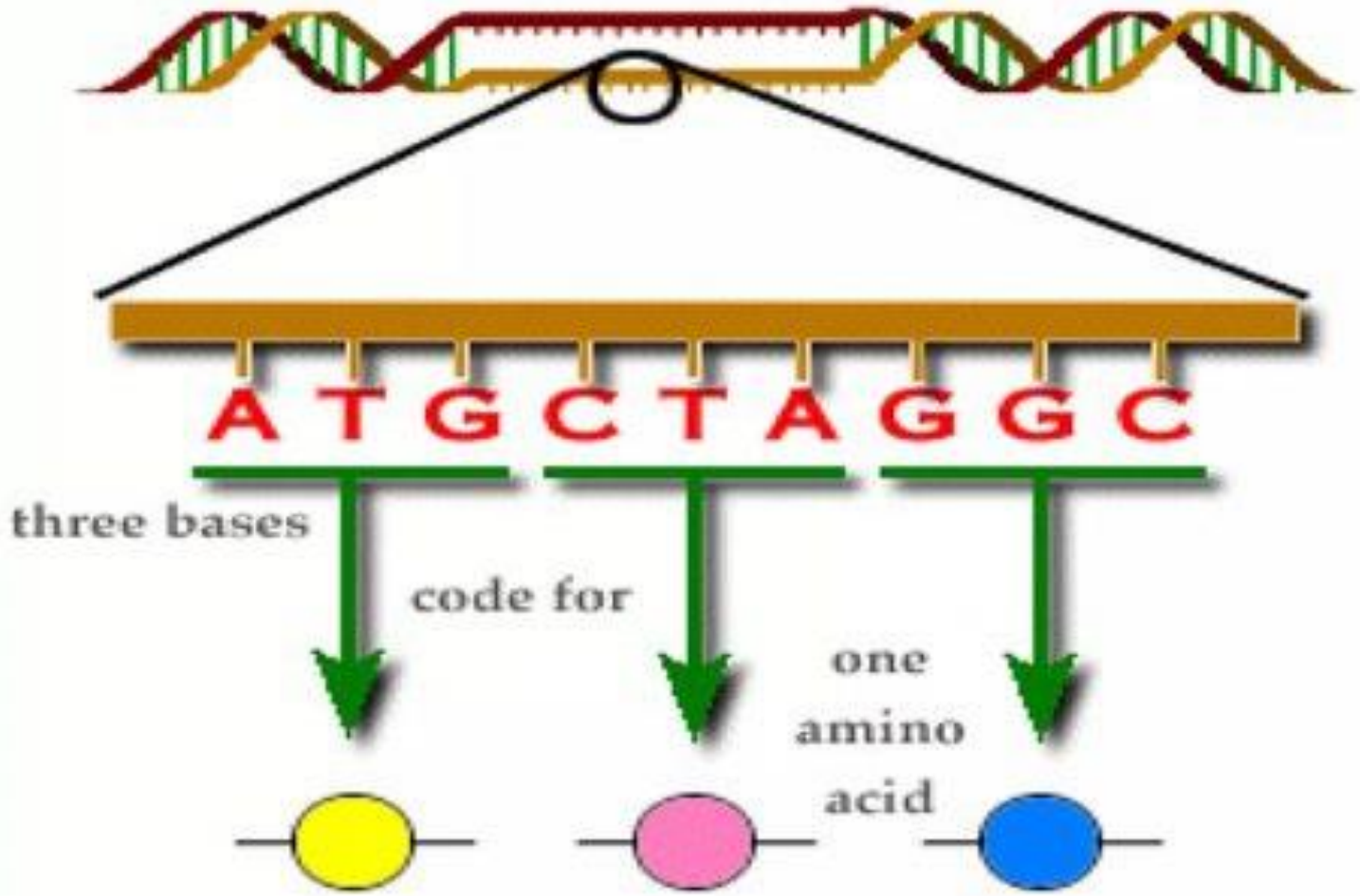
- George Gamow postulated that a three-letter code must be employed to encode the 20 standard amino acids used by living cells to build proteins.

Introduction of genetic code

- The letters A, G, T and C correspond to the nucleotides found in DNA. They are organized into codon.
- The collection of codons is called Genetics code.
- For 20 amino acids there should be 20 codons.
- Each codon should have 3 nucleotides to impart specificity to each of the amino acid for a specific codon.
- I nucleotide - 4 combinations
- 2 nucleotide-16 combinations
- 3nucleotide- 64 combinations most suited for 20 amino acids)



The Genetic Code



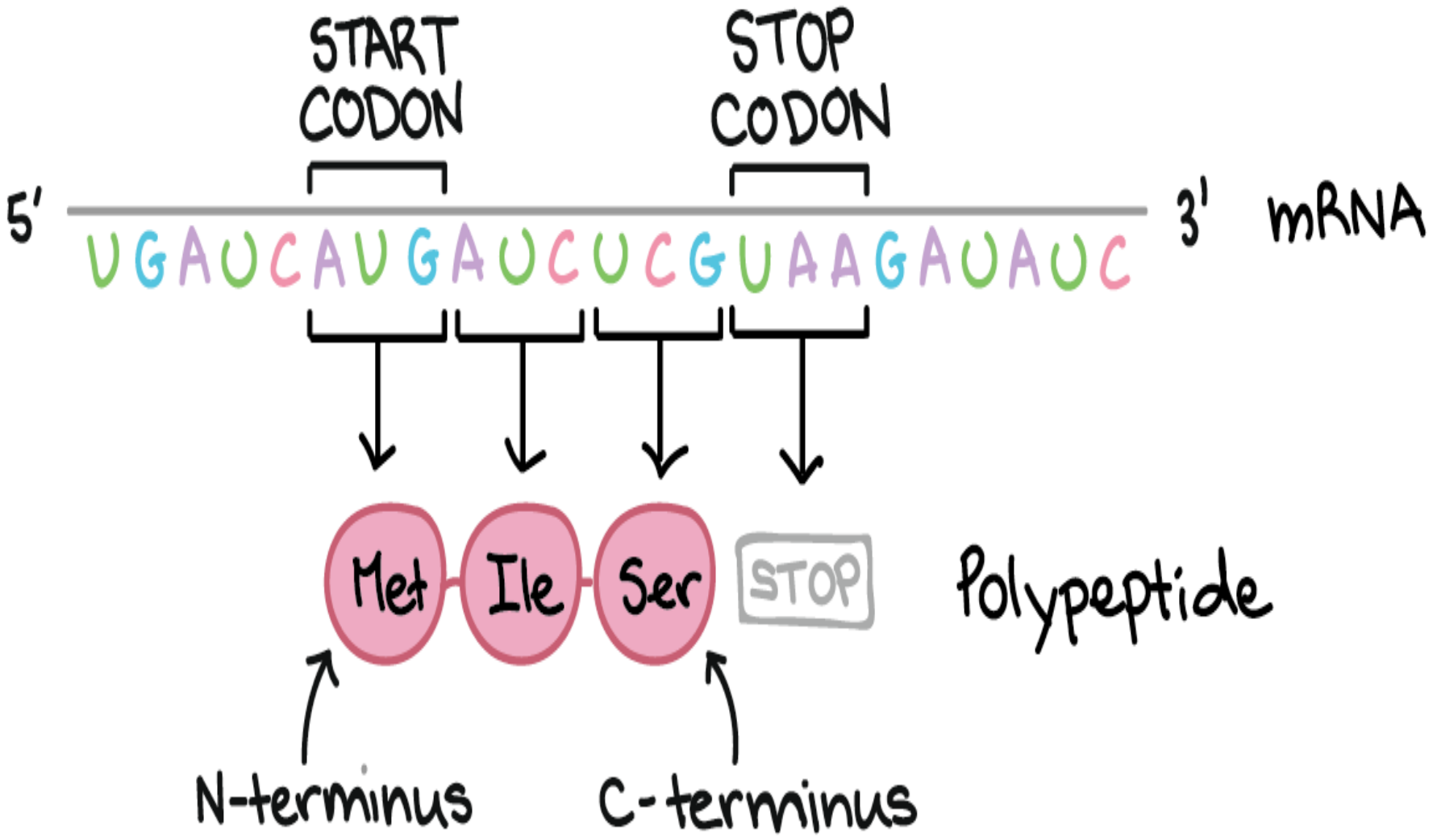
The genetic code is triplet code (i.e. composed of 3 bases), these triplets are called codons. Genetic code consists of 64 triplets of nucleotides. These codons encode for the 20 amino acids used in the synthesis of proteins. Each triplet codon specifies only one amino acid, but an individual amino acid may be specified by more than one codon.

CODON

Genetic code is a Dictionary consists of "Genetic words" called CODONS. Cells decode mRNAs by reading their nucleotides in groups of three, called codons.

Here are some **features** of codons:

- • Most codons specify an amino acid
- • Three "stop" codons mark the end of a protein
- • One "start" codon, AUG, marks the beginning of a protein and also encodes the amino acid methionine


START CODON
STOP CODON
5'
3'
mRNA
UGAUCAUGAUCUCGUAAGAUAUC
Met
Ile
Ser
STOP
Polypeptide
N-terminus
C-terminus

A start codon, AUG, sets the reading frame, and signals the start of translation of the genetic code, the code is read in a 5’ to 3’ direction. Translation continues in a non-overlapping fashion until a stop codon (UAA, UAG, UGA) is encountered in frame. The nucleotides between the start and stop codons encode for the subsequent protein produced.

The genetic code can be expressed as either RNA codons or DNA codons. RNA codons occur in messenger RNA (mRNA) and are the codons that are actually “read” during the synthesis of polypeptides in the proses of “translation”. But each mRNA molecule acquires its sequence of nucleotides by transcription from the corresponding gene in DNA.

Amino acids

Ala; Alanine
Arg; Arginine
Asn; Asparagine
Asp; Aspartic acid
Cys; Cysteine
Leu; Lucien
Lys; Lysine
Met; Methionine
Phe; Phenylalanine
Pro; Proline
Gln; Glutamine
Glu; Glutamic acid
Gly; Glycine
His; Histidine
Ile; Isoleucine
Ser; Serine
Thr; Threonine
Trp; Tryptophan
Tyr; Tyrosine
Val; Valine

RNA codon table

1st position	2nd position U	2nd position C	2nd position A	2nd position G	3rd position
U	Phe	Ser	Tyr	Cys	U
	Phe	Ser	Tyr	Cys	C
	Leu	Ser	stop	stop	A
	Leu	Ser	stop	Trp	G
C	Leu	Pro	His	Arg	U
	Leu	Pro	His	Arg	C
	Leu	Pro	Gln	Arg	A
	Leu	Pro	Gln	Arg	G
A	Ile	Thr	Asn	Ser	U
	Ile	Thr	Asn	Ser	C
	Ile	Thr	Lys	Arg	A
	Met	Thr	Lys	Arg	G
G	Val	Ala	Asp	Gly	U
	Val	Ala	Asp	Gly	C
	Val	Ala	Glu	Gly	A
	Val	Ala	Glu	Gly	G

Start codon:

is the first codon of a messenger RNA (mRNA) transcript translated by a ribosome. The start codon always codes for methionine in eukaryotes and a modified Met (fMet) in prokaryotes. The most common start codon is AUG. Stop codons are sequences of DNA and RNA that are needed to stop translation or the making of proteins by stringing amino acids together.

There are **three** RNA stop codons: UAG, UAA, and UGA

Types of codons

1. Sense Codons

2. Signal Codons:

A. Start codons

B. Stop codons

- Sense codon: - The codon that code for amino acid is called sense codon.
- Signal codon: - Those codons that code for signal during protein synthesis is called signal codons. For Example: - AUG, UAA, UAG &UGA
- There are Two types of signal codons

✓ Terminating Codon

✓ Initiating Codon.

"Terminating Codons"

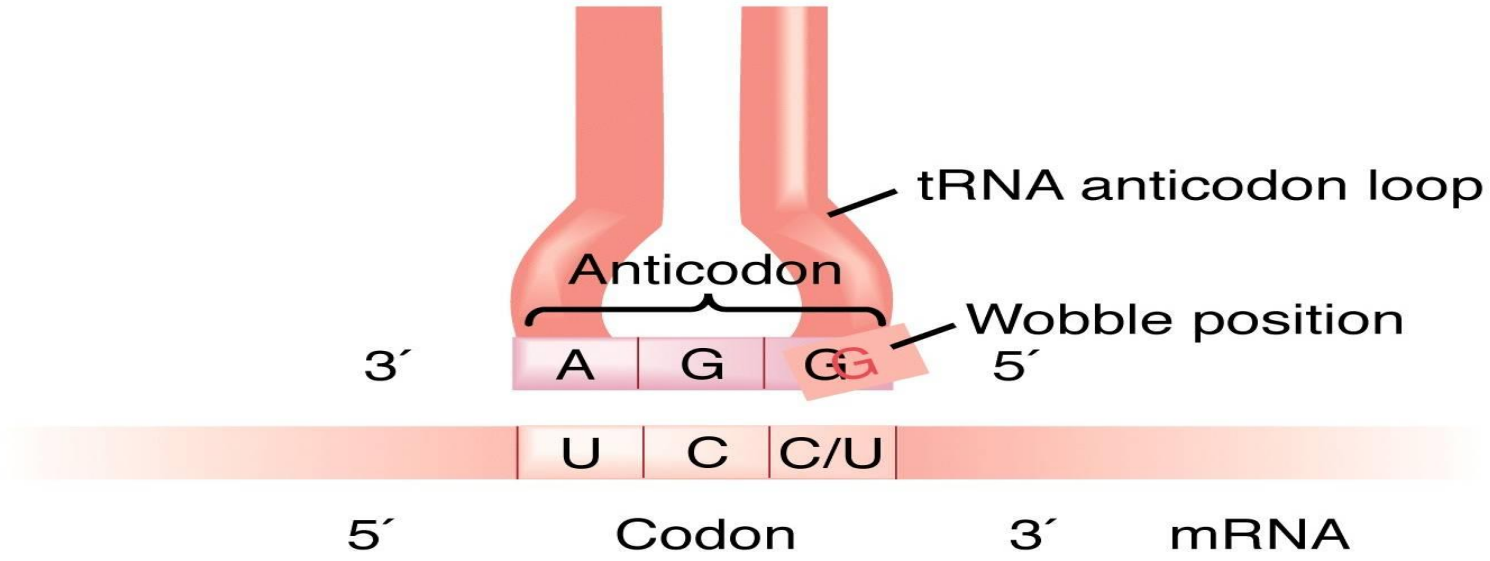
UAA, UAG & UGA are termination codons or nonsense codons & are often referred to as amber, ochre & opal codons.

"Initiating codon"

AUG is the initiation codon. It codes for the first amino acid in all proteins.

At the starting point it codes for methionine in eukaryotes & formyl methionine in prokaryotes.

The anticodons: are trinucleotide units in the transport RNAs (tRNAs), that are complementary to the codons in messenger RNAs (mRNAs). They allow the tRNAs to supply the correct amino acids during the protein production.



Differences between codon and anticodon

1. Definition

Anticodon: Anticodons are trinucleotide units in the tRNAs, complementary to the codons in mRNAs. They allow the tRNAs to supply the correct amino acids during the protein production.

Codon: Codons are trinucleotide units in the DNA or mRNAs, coding for a specific amino acid in the protein synthesis.

2. Function

Anticodon: The anticodons are the link between the nucleotide sequence of the mRNA and the amino acid sequence of the protein.

Codon: The codons transfer the genetic information from the nucleus where the DNA is located to the ribosomes where the protein synthesis is performed.

3. **Location**

Anticodon: The anticodon is located in the Anticodon arm of the molecule of tRNA.

Codon: The codons are located in the molecule of DNA and mRNA.

4. Complementarity

Anticodon: The anticodon is complementary to the respective codon.

Codon: The codon in mRNA is complementary to a nucleotide triplet from a certain gene in the DNA

5. Numbers.

Anticodon: One tRNA contains one anticodon.

Codon: One mRNA contains a number of codons

Properties of genetic codes

Several properties of the genetic code become apparent as follows;

1- The genetic code is composed of nucleotide triplets. In other word, three nucleotides in mRNA (a codon) specify one amino acid in a protein.

2- The code is non- overlapping. This means that successive triplets are read in order (i.e. one after another). Each nucleotide is part of only one triplet codon.

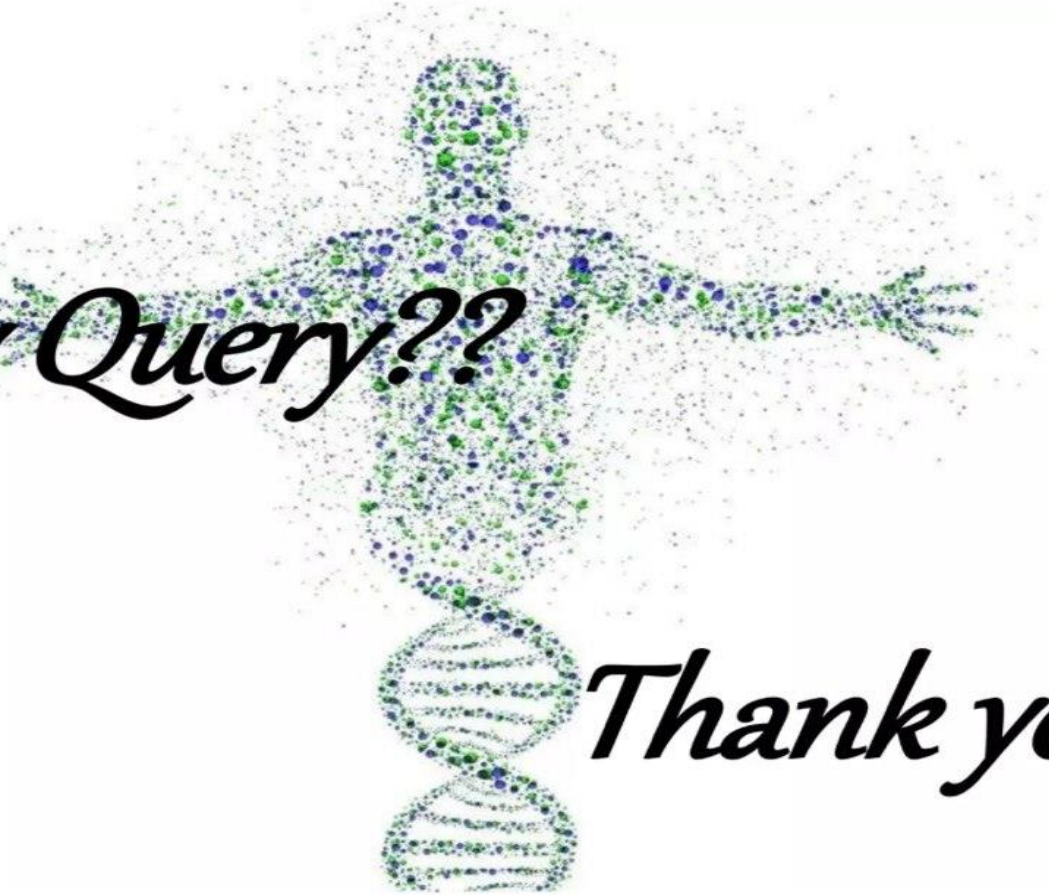
3- The genetic code is unambiguous. Each codon specifies a particular amino acid, and only one amino acid. In other word, the codon AGG codes for the amino acid threonine, and only threonine.

4- The Genetic is considered as comma less. There is no gap or space between the triplet codons on the m-RNA molecule, which is why genetic information is considered to be comma less.

An open reading frame is formed from many codons arranged in an array. Genetic information is represented as a continuous sequence.

5- The genetic code is degenerate. In contrast. Each amino acid can be specified by more than one codon.

6- The code is nearly universal. Almost all organisms in nature (from bacteria to human) use exactly the same genetic code. The rare exceptions include some changes in the code in mitochondria, and in few protozoan species.



Any Query??

Thank you!!