

Chromosome

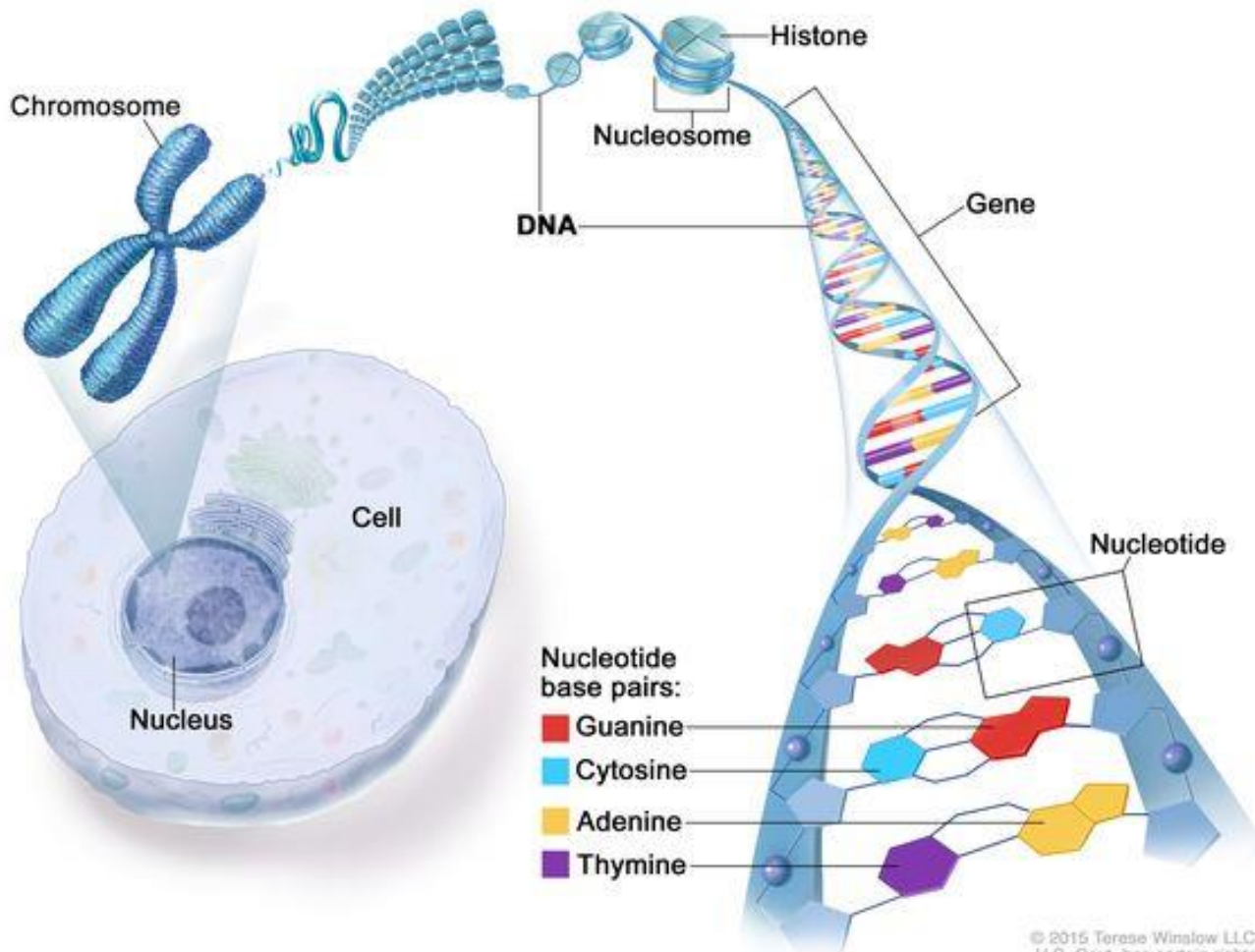
GENETIC CODE

Gene

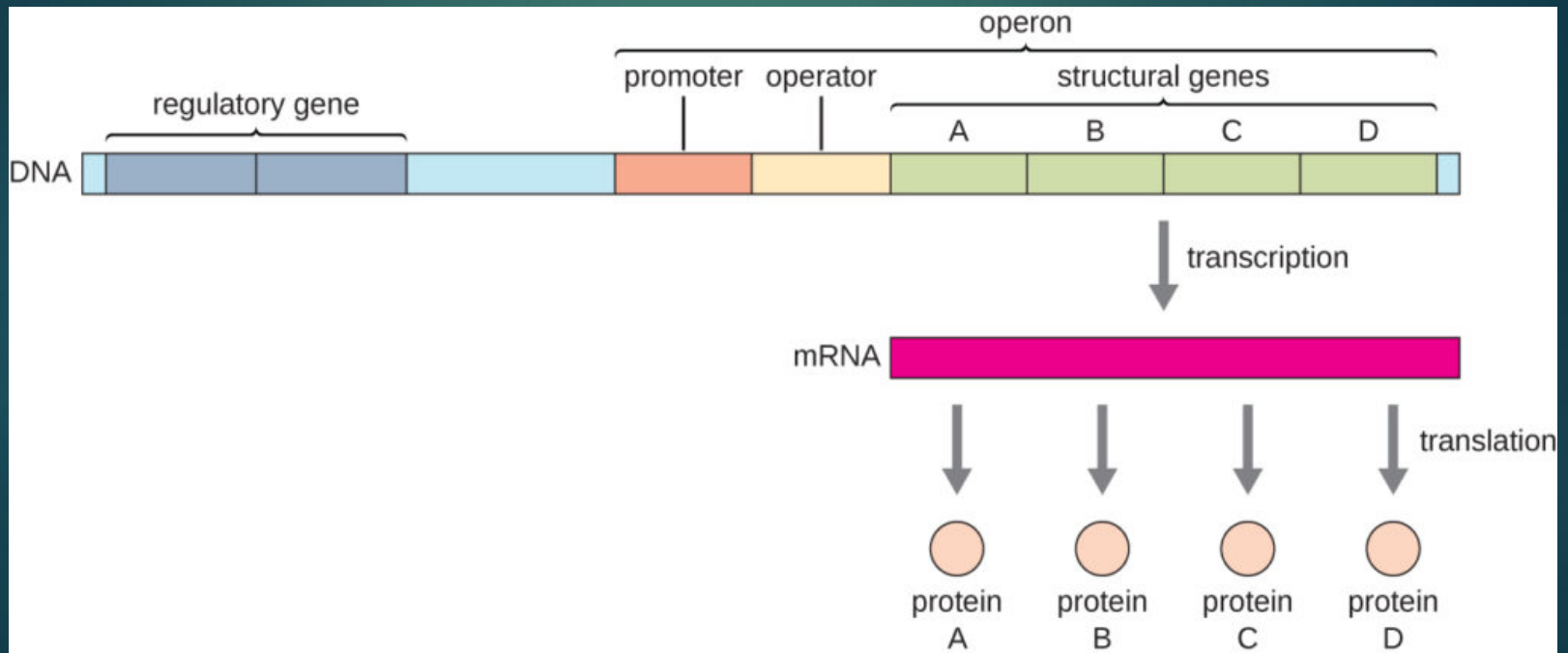
DEFINITION OF THE GENE

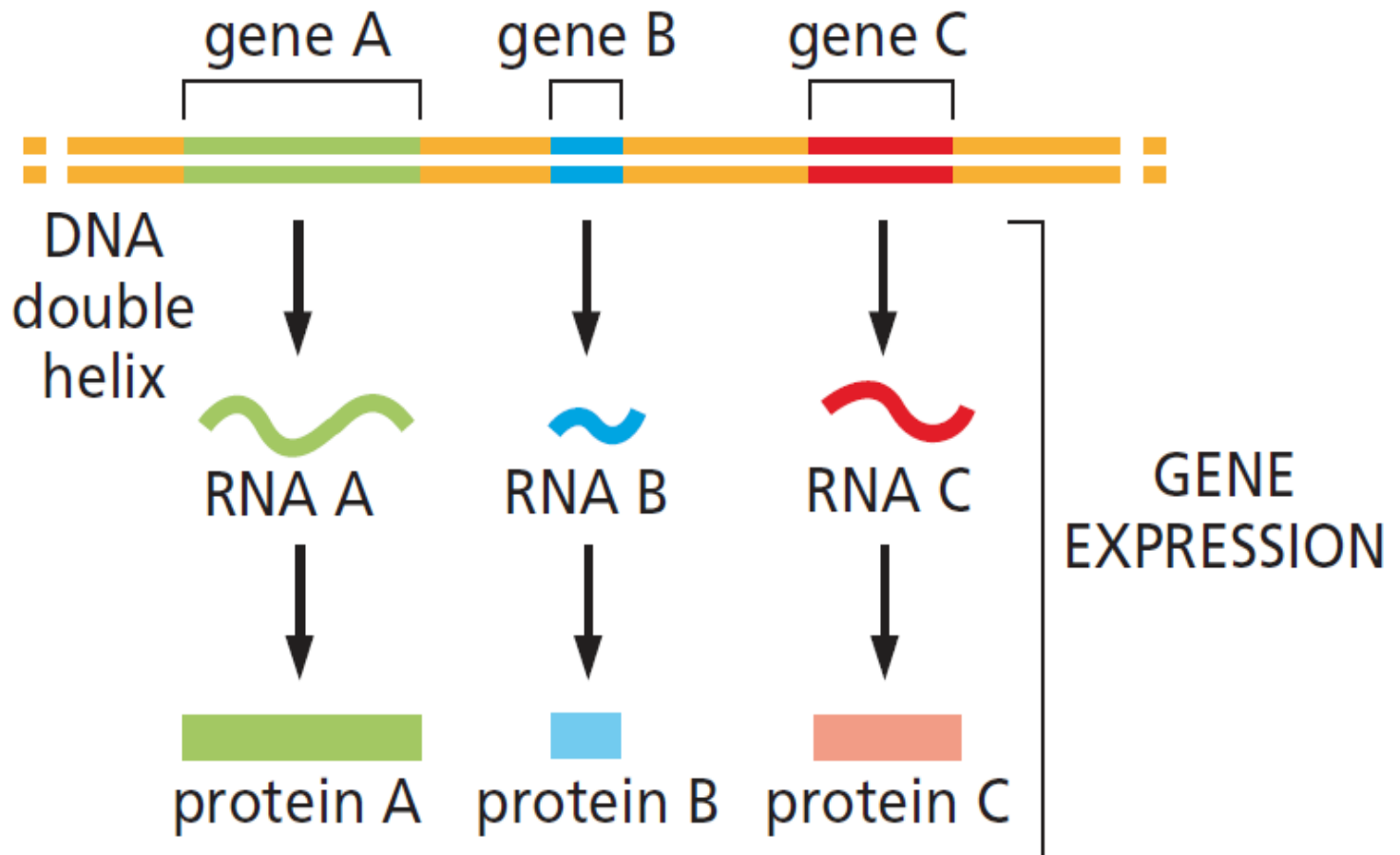
- ▶ The gene is to genetics what atom is to chemistry
- ▶ Unit of genetic information; synthesis of one polypeptide
- ▶ Fractions or part of DNA molecule; regarded as the genetic material
- ▶ Mendel was the first scientist who proposed genes as particulate units and called them hereditary elements or factors
- ▶ Concept of gene has undergone a considerable change since Mendel's time






DNA Structure



STRUCTURAL AND REGULATORY GENES





Species	<i>Escherichia coli</i>	<i>Gallus gallus</i>	<i>Homo sapiens</i>	<i>Daphnia pulex</i>	<i>Oryza sativa</i>
Number of Genes	~4,200	~17,000	~21,000	~31,000	~38,000
Common Name	 <p>Bacteria</p>	 <p>Chicken</p>	 <p>Human</p>	 <p>Water flea</p>	 <p>Rice</p>

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 " Goerge 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.

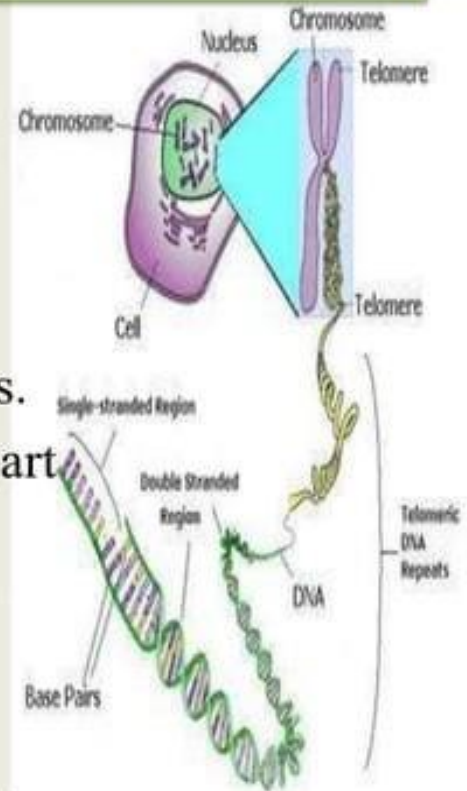
For 20 amino acids there should be 20 codons.

Each codon should have 3 nucleotides to impart specificity to each of the amino acid for a specific codon.

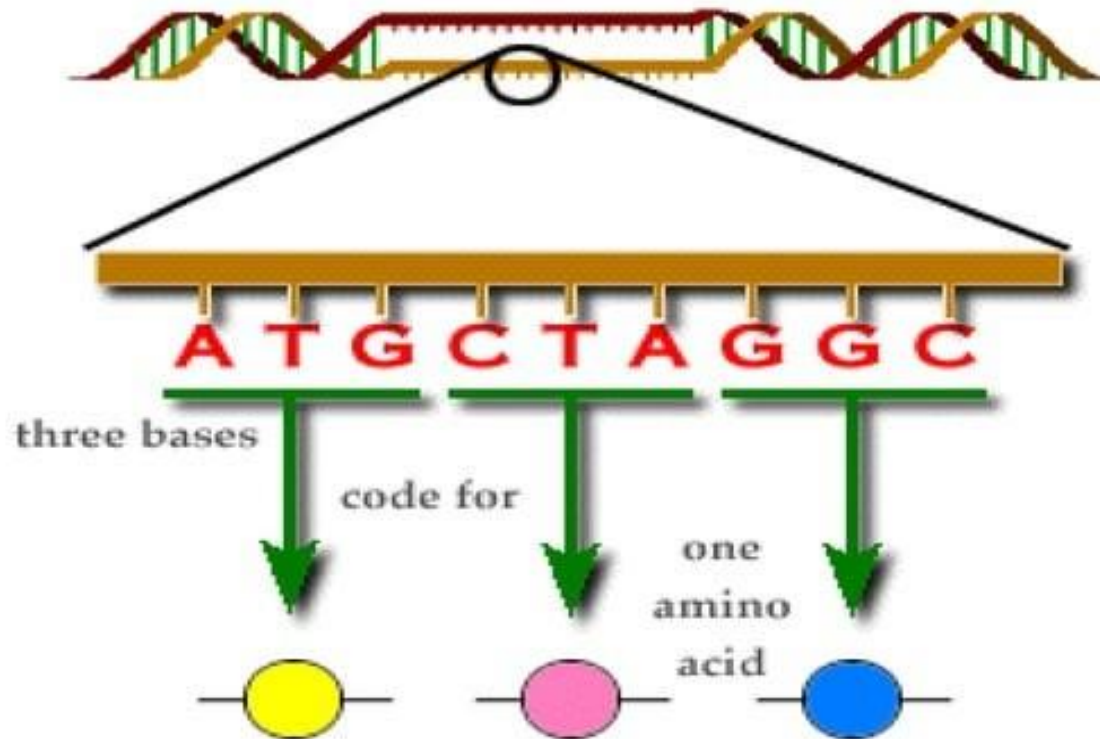
1 nucleotide – 4 combinations

2 nucleotide-16 combinations

3nucleotide- 64 combinations(most suited for 20 amino acids)



The Genetic Code



Genetic code can be expressed
in a simple table with 64 entries

		Second Position									
		U		C		A		G			
		code	Amino Acid	code	Amino Acid	code	Amino Acid	code	Amino Acid		
First Position	U	UUU	phe	UCU	ser	UAU	tyr	UGU	cys	U	Third Position
		UUC		UCC		UAC		UGC		C	
		UUA	leu	UCA		UAA	STOP	UGA	STOP	A	
		UUG		UCG		UAG	STOP	UGG	trp	G	
	C	CUU	leu	CCU	pro	CAU	his	CGU	arg	U	
		CUC		CCC		CAC		CGC		C	
		CUA		CCA		CAA	gln	CGA		A	
		CUG		CCG		CAG		CGG		G	
	A	AUU	ile	ACU	thr	AAU	asn	AGU	ser	U	
		AUC		ACC		AAC		AGC		C	
		AUA		ACA		AAA	lys	AGA	arg	A	
		AUG	met	ACG		AAG		AGG		G	
	G	GUU	val	GCU	ala	GAU	asp	GGU	gly	U	
		GUC		GCC		GAC		GGC		C	
		GUA		GCA		GAA	glu	GGA		A	
		GUG		GCG		GAG		GGG		G	

Codon and its type

- Genetic code is a Dictionary consists of “Genetic words” called CODONS.
- Each codon consists of three bases (triplet)
- There are 64 codons.
- 61 codons code for 20 amino acids found in protein.
- 3 codons do not code for any amino acid.

Type of codon

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

conti.....

“Terminating Codons”

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

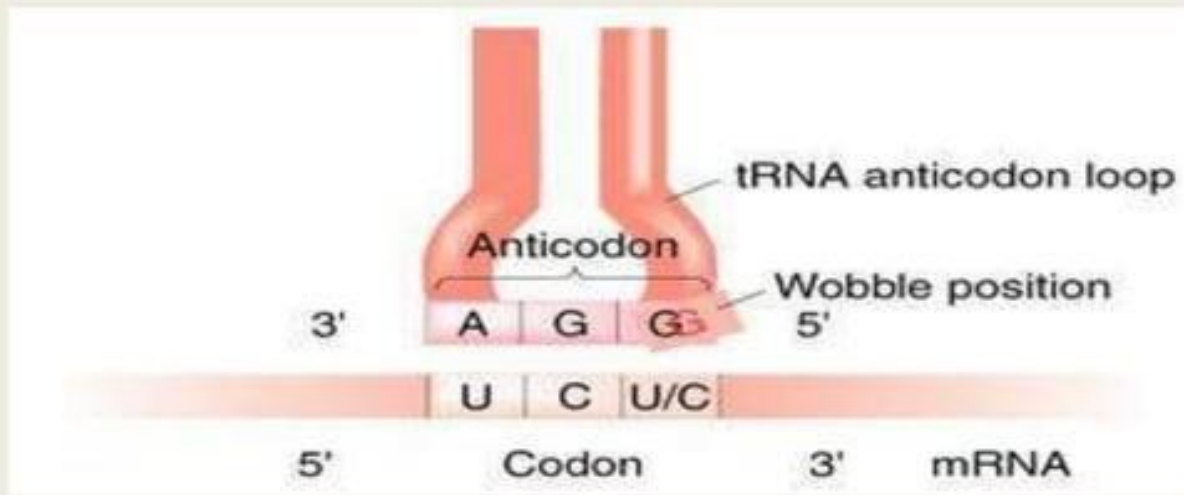
“Initiating codon”

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.

ANTICODON

- The base sequence of t RNA which pairs with codon of mRNA during translation is called anticodon.



Different between codon and anticodon

- Codon could be present in both DNA & RNA, but anticodon is always present in RNA & never in DNA.
- Codons are written in 5 to 3 direction whereas anticodons are usually written in 3 to 5 direction.
- Anticodon of some tRNA molecules have to pair with more than one codon.

CONTI....

- Codons are sequentially arranged in nucleic acid strand while anticodons are discretely present in cells with amino acids attached or not.
- Codon defines which anticodon should come next with an amino acid to create the protein strand.
- Anticodon helps in bringing a particular amino acid at its proper position during translation.

Characteristic of the genetic code

1. Triplet code
2. Comma less
3. Nonoverlapping code
4. The coding dictionary
5. Degenerate code
6. Universality of code
7. Non ambiguous code
8. Chain initiation code
9. Chain termination codons

“Genetic code is triplet”

- The genetic code is triplet. There are 64 codons.

		Second letter					
		U	C	A	G		
First letter	U	UUU } Phe UUC } UUA } Leu UUG }	UCU } UCC } Ser UCA } UCG }	UAU } Tyr UAC } UAA Stop UAG Stop	UGU } Cys UGC } UGA Stop UGG Trp	U C A G	Third letter
	C	CUU } CUC } Leu CUA } CUG }	CCU } CCC } Pro CCA } CCG }	CAU } His CAC } CAA } Gln CAG }	CGU } CGC } Arg CGA } CGG }	U C A G	
	A	AUU } AUC } Ile AUA } AUG Met	ACU } ACC } Thr ACA } ACG	AAU } Asn AAC } AAA } Lys AAG }	AGU } Ser AGC } AGA } Arg AGG }	U C A G	
	G	GUU } GUC } Val GUA } GUG }	GCU } GCC } Ala GCA } GCG }	GAU } Asp GAC } GAA } Glu GAG }	GGU } GGC } Gly GGA } GGG }	U C A G	

“Universality”

- The genetic code is universal.
- AUG is the codon for methionine in mitochondria. The same codon (AUG) codes for isoleucine in cytoplasm. With some exceptions noted the genetic code is universal.

“Non-Ambiguous”

- The genetic code is non-ambiguous.
- Thus one codon can not specify more than one amino acid.

“Non-overlapping”

- One base cannot participate in the formation of more than one codon.
- This means that the code is non-overlapping.

“Continuous Translation”

- The gene is transcribed & translated continuously from a fixed starting point to a fixed stop point.
- Punctuations are not present between the codons.

“The code has polarity”

- The code has a definite direction for reading of message which is referred to as polarity.
- Reading of message from left to right & right to left will specify for different amino acids.
- For Example UUG stands for leucine, & from right to left it is GUU which stands for valine.

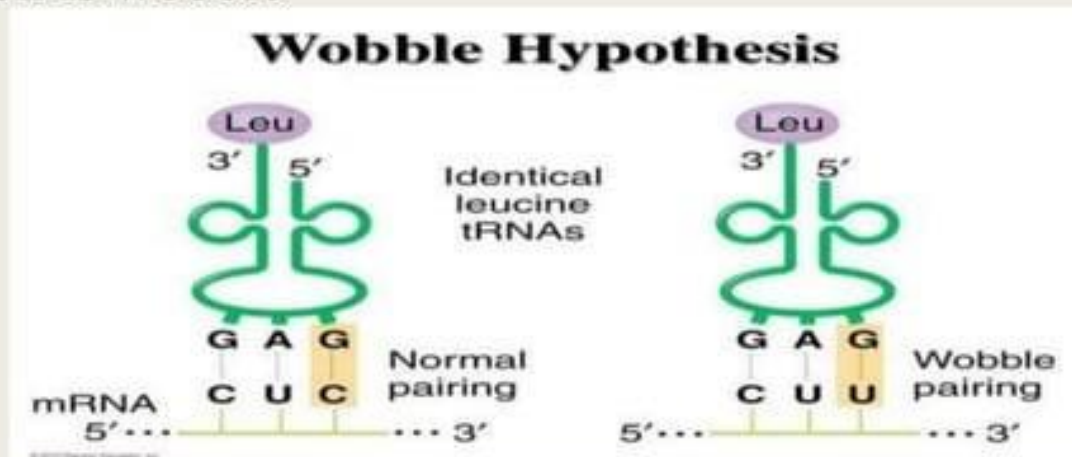
Degeneracy of genetic code

- An amino acid can be coded for by more than one codon. This is called degeneracy of genetic code.

		Second nucleotide					
		U	C	A	G		
First nucleotide	U	UUU Phe	UCU	UAU Tyr	UGU Cys	Third nucleotide	U
		UUC	UCC Ser	UAC	UGC		C
		UUA Leu	UCA	UAA STOP	UGA STOP		A
		UUG	UCG	UAG STOP	UGG Trp		G
	C	CUU	CCU	CAU His	CGU		U
		CUC	CCC Pro	CAC	CGC		C
		CUA	CCA	CAA Gln	CGA		A
		CUG	CCG	CAG	CGG		G
	A	AUU Ile	ACU	AAU Asn	AGU Ser		U
		AUC	ACC Thr	AAC	AGC		C
		AUA	ACA	AAA Lys	AGA		A
		AUG Met	ACG	AAG	AGG		G
	G	GUU	GCU	GAU Asp	GGU		U
		GUC	GCC Ala	GAC	GGC		C
		GUA	GCA	GAA Glu	GGA		A
		GUG	GCG	GAG	GGG		G

Wobble hypothesis

- Crick postulated the ‘wobble hypothesis’ to account for the degeneracy of genetic code. According this hypothesis, the first two bases of a codon pair according to the normal base pairing rules with the last two bases of the anticodon. Base-pairing at the third position of a codon is wobble



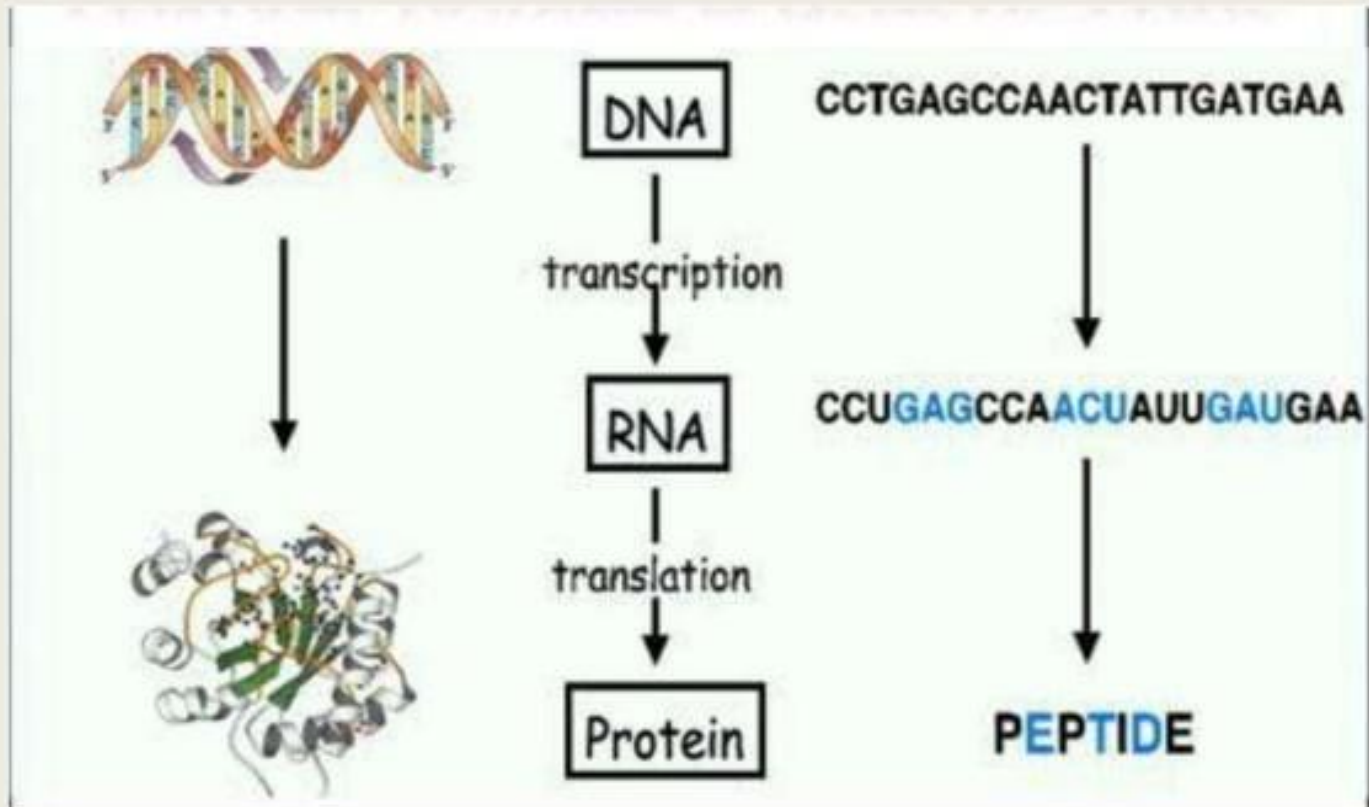
Wobble hypothesis explains degeneracy

- Wobble hypothesis explains the degeneracy of the genetic code, i.e, existence of multiple codons for a single amino acid. Although there are 61 codons for amino acids, the number of tRNA is far less (around 40) which is due to wobbling.

Biological significance of degeneracy of the genetic code

- If the code were not degenerate, 20 codons would designate amino acids and 44 would lead to chain termination.
- The probability of mutating to chain termination would therefore be much higher with a non degenerate code.

FLOW OF GENETIC INFORMATION



CLINIC SIGNIFICANCE

- Mutation can be well explained using the genetic code.
- A) Point Mutations
 - 1) Silent
 - 2) Misense
 - 3) Nonsense
- B) Frame shift mutations

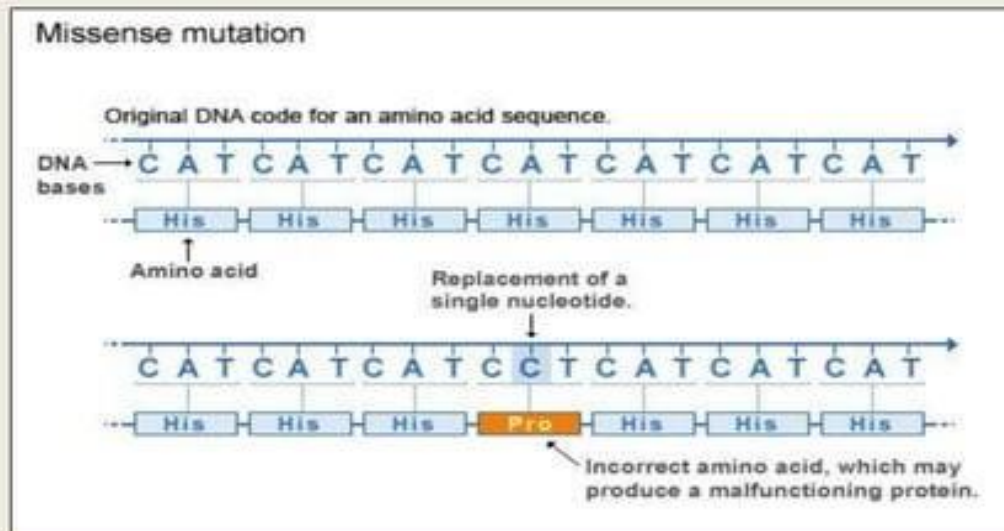
Silent Mutations

- Single nucleotide change-A to G, same amino acid is incorporated. Mutation goes unnoticed.



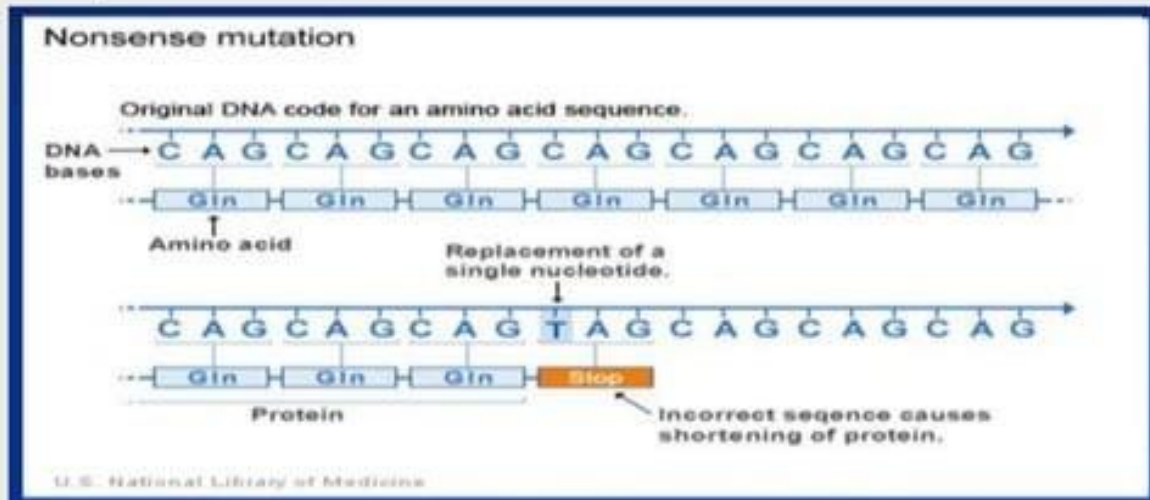
Missense mutations

- Single nucleotide change A to C- different amino acid incorporated. Loss of functional capacity of protein.



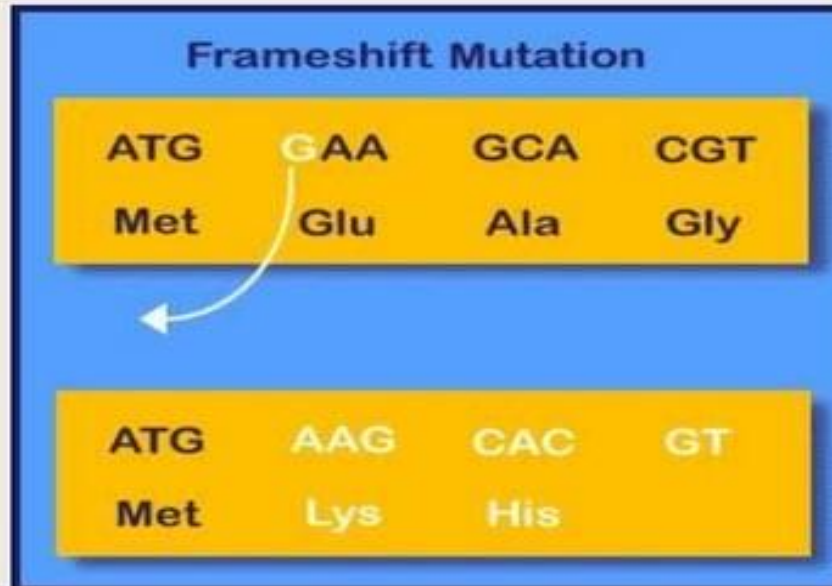
Non sense Mutation

- Single nucleotide change from C to T, stop codon is generated (In m RNA represented by UAG), premature termination of chain, may be incompatible with life.



Frame shift Mutation

- Insertion or removal of a bases can alter the reading frame with the resultant incorporation of different amino acids.





thank you!