Tishk International University
Faculty of Nursing

GENETICS
Nursing Department

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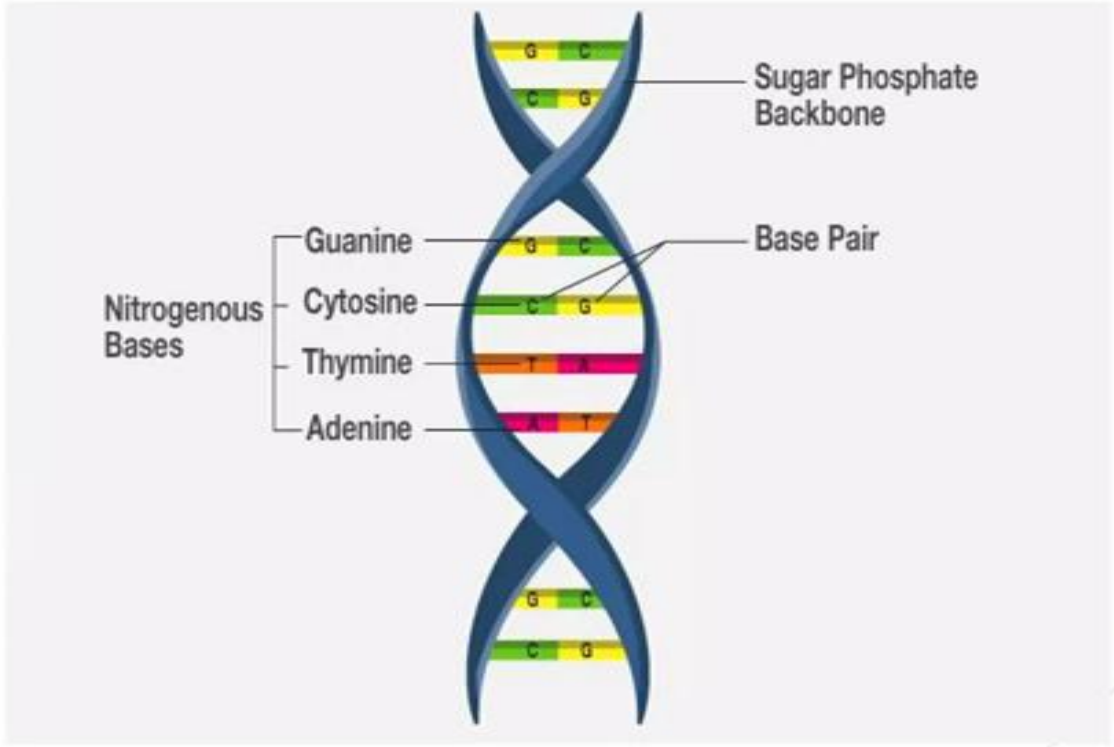
PhD in molecular Biology

DNA Structure and Function



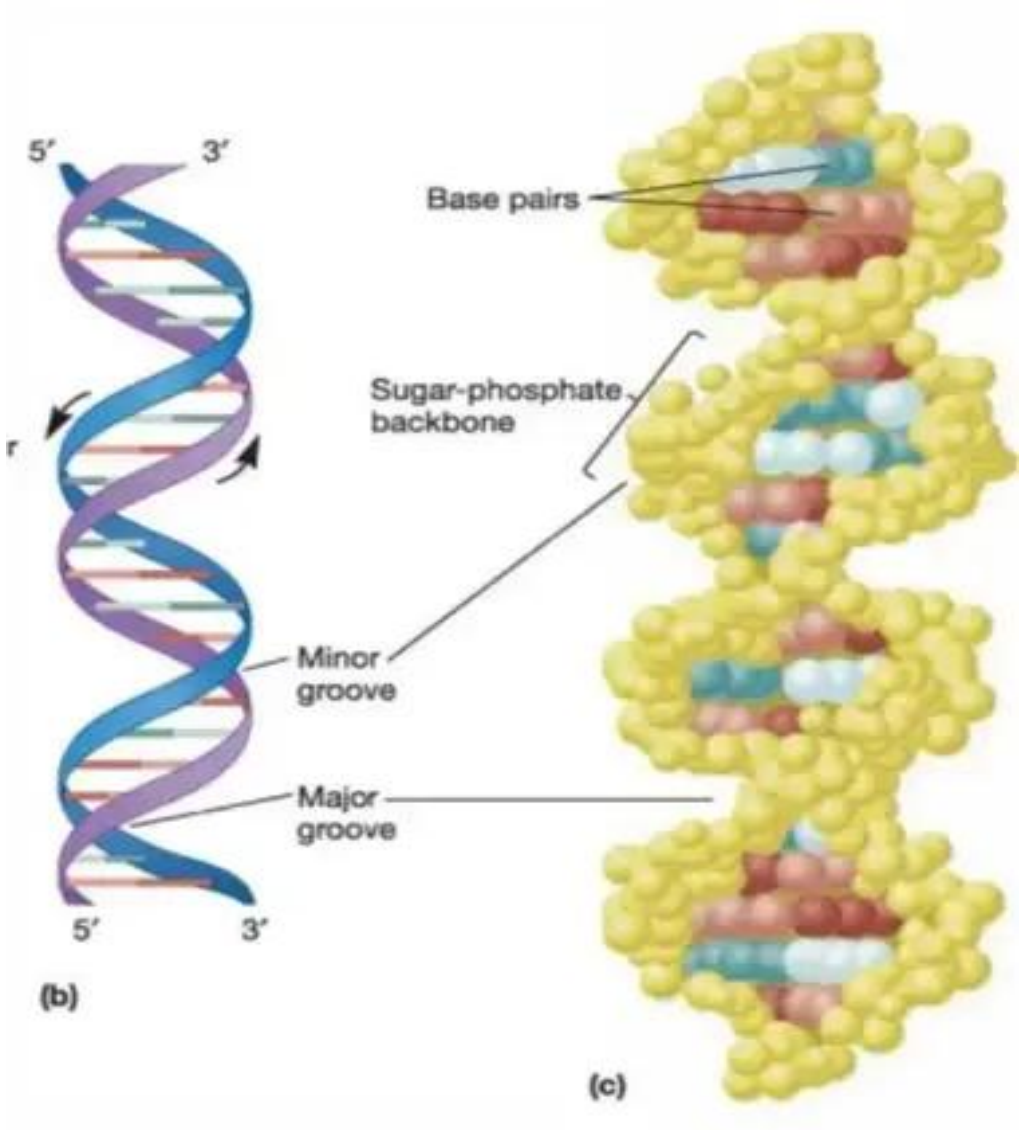
Objectives

- To provide students with a comprehensive understanding of DNA structure and its functions.

❖ DNA Structure:

- The structure of DNA is a **complex, highly organized arrangement that allows it to store and transmit genetic information**.

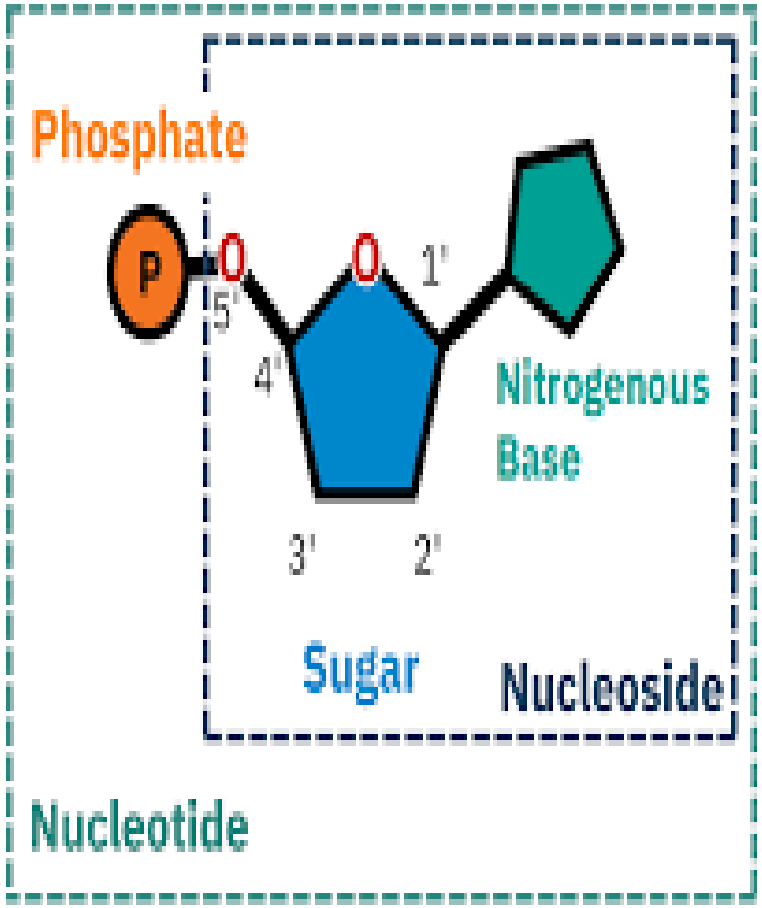
- The DNA double helix structure, first described by **James Watson and Francis Crick in 1953**.
- They got Noble prize for their work in 1962.

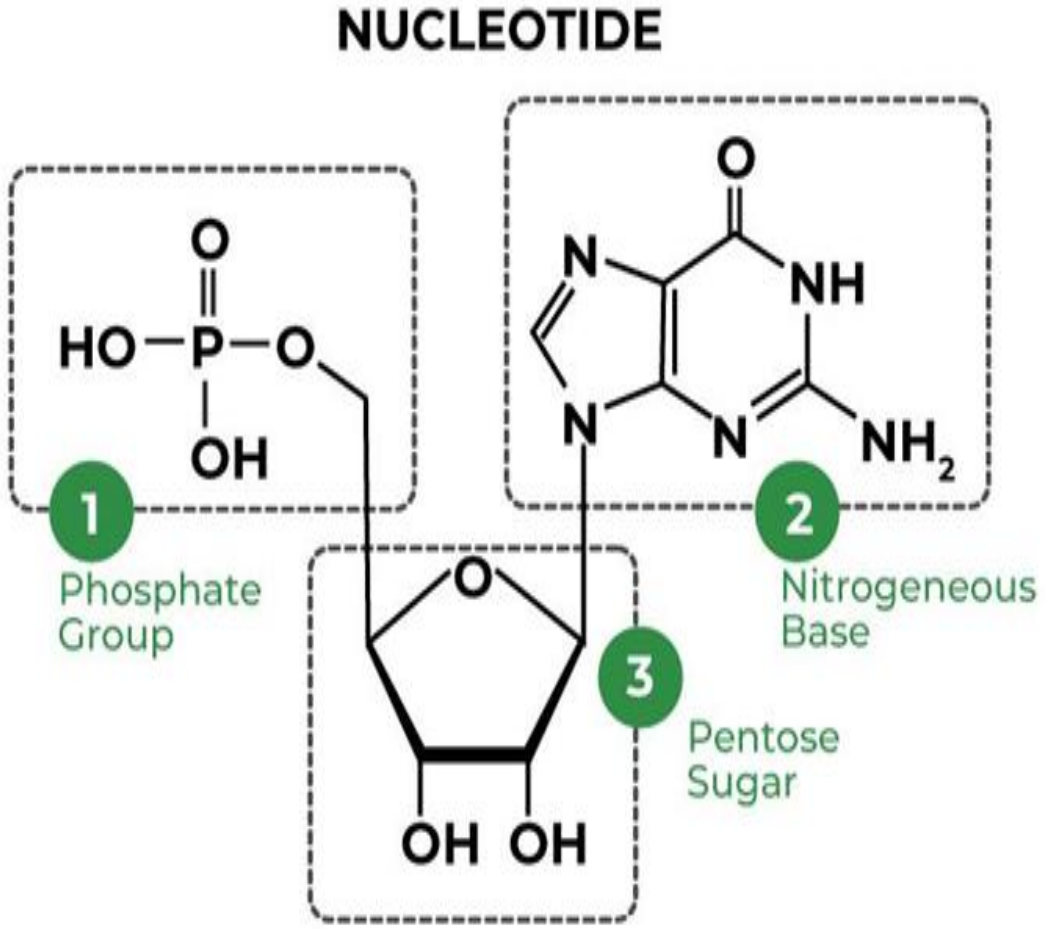


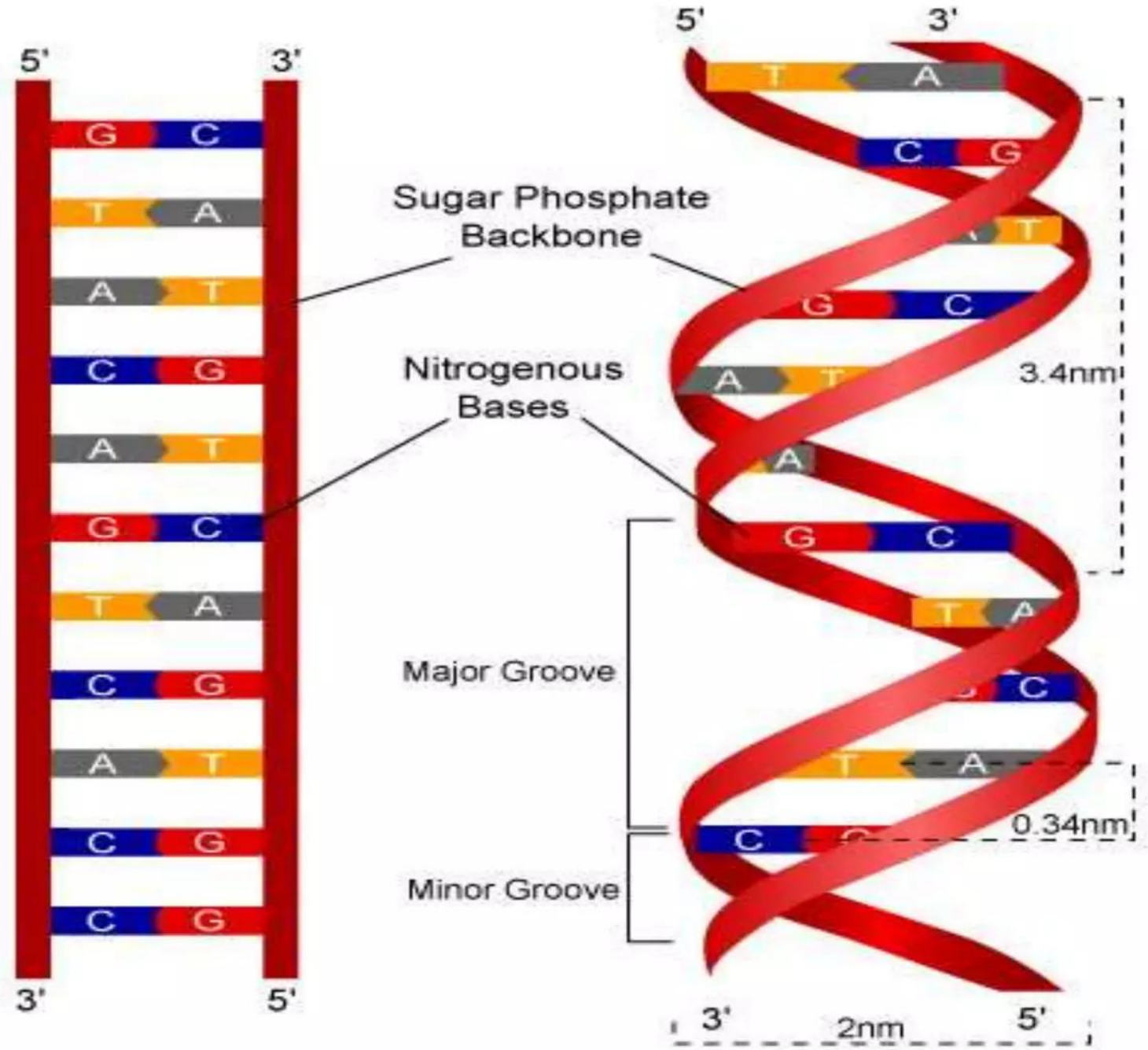
NUCLEOTIDES

- Each DNA (and also RNA) strands consists of chain of nucleotides.

- Each nucleotide chain is made up of three main components –
  1. Nitrogenous base – These bases are classified into two types –
     1. Purines – The purines bases are Adenine (A) and Guanine (G).
     2. Pyrimidines – The pyrimidine bases are Thymine (T), Cytosine (C) and Uracil (U) (Uracil takes place of Thymine in RNA).
  2. Deoxyribose Sugar – It is a pentose sugar with 5 carbon atoms
  3. Phosphate molecules


Phosphate
P
O
O
1'
5'
4'
3'
2'
Nitrogenous
Base
Sugar
Nucleoside
Nucleotide


NUCLEOTIDE
HO
P
O
OH
O
N
NH
N
N
NH2
O
OH OH
1
Phosphate
Group
2
Nitrogeneous
Base
3
Pentose
Sugar


5'
3'
G C
T A
A T
C G
A T
G C
T A
C G
A T
C G
C G
3'
5'
Sugar Phosphate Backbone
Nitrogenous Bases
Major Groove
Minor Groove
5'
3'
3.4nm
0.34nm
3'
2nm
5'

BONDS BETWEEN NUCLEOTIDES

- The two nucleotides chain of DNA are held together by two types of molecular forces.

Hydrogen Bonds

- These are formed between the nitrogenous bases on opposite nucleotide strands.
- They are always between a purines and pyrimidine nitrogenous base only.
- Adenine base on one strand always pairs with thymine on the other strand (A-T or T-A)
- Guanine base on one strand pairs with cytosine on the other hand. (G-C or C-G)

PHOSPHATE DIESTER BONDS

- These bonds are between sugar molecules

CLASSIFICATION OF DNA

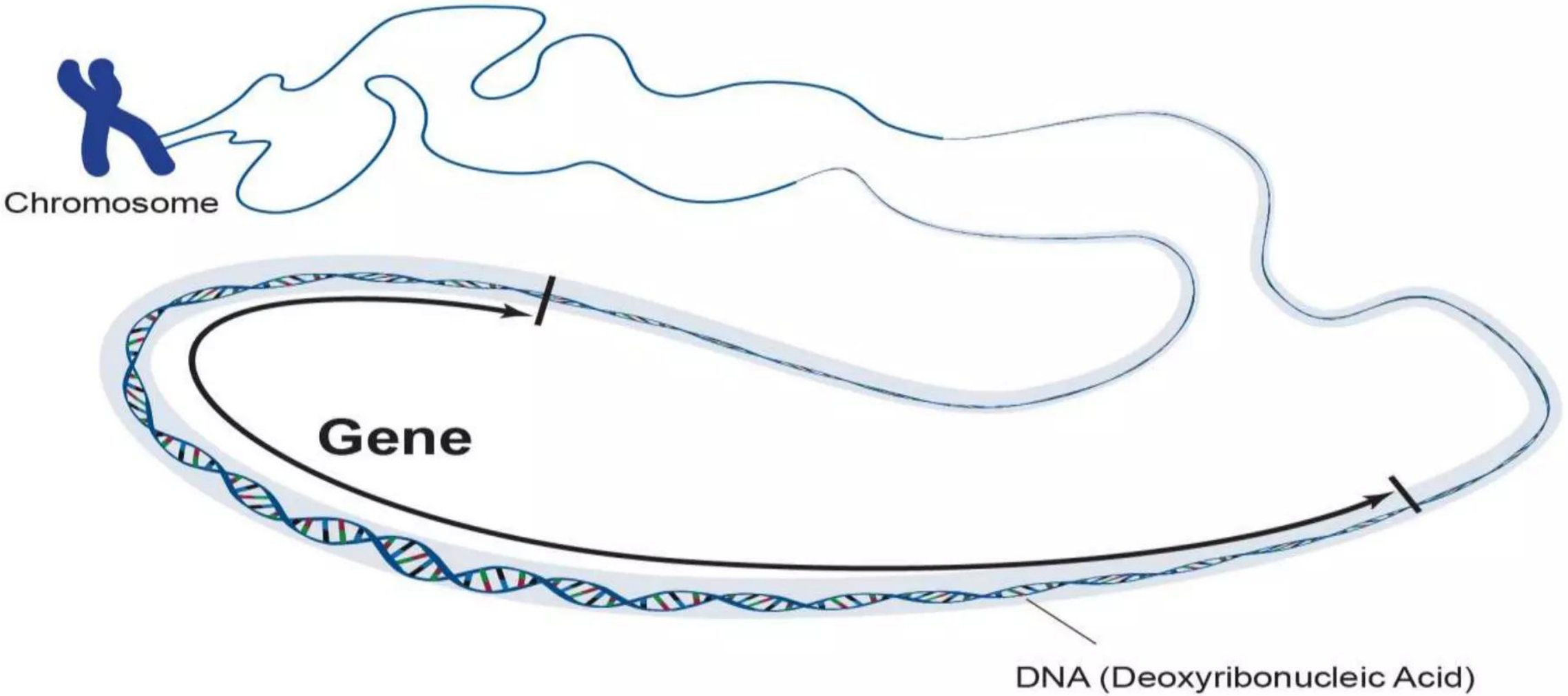
- Depending on the types of DNA Sequence

1. Single copy DNA Sequence – In this type nucleotide sequences are present only once without any repetition of nucleotide. They account for 50-60 % of human DNA.
2. Moderately repetitive DNA Sequence – In these the nucleotide sequences are repeated many times and constitute about 25-40 % of human DNA. Most of them have no function.
3. High repetitive DNA Sequences – It is characterized by repetition of nucleotides several times (Hundreds to millions). These are non coding sequences and constitute about 10-15% of Human DNA.

FUNCTION OF DNA

- It is the genetic material, therefore responsible for carrying all the hereditary information.
- It has property of replication essential for passing genetic information from one cell to its daughters or from one generation to next.
- Crossing over produces recombination
- Changes in sequence and no. of nucleotides causes Mutation which is responsible for all variations and formation of new species.
- It controls all the metabolic reaction of cells through RNAs and RNA directed synthesis of proteins.

GENE



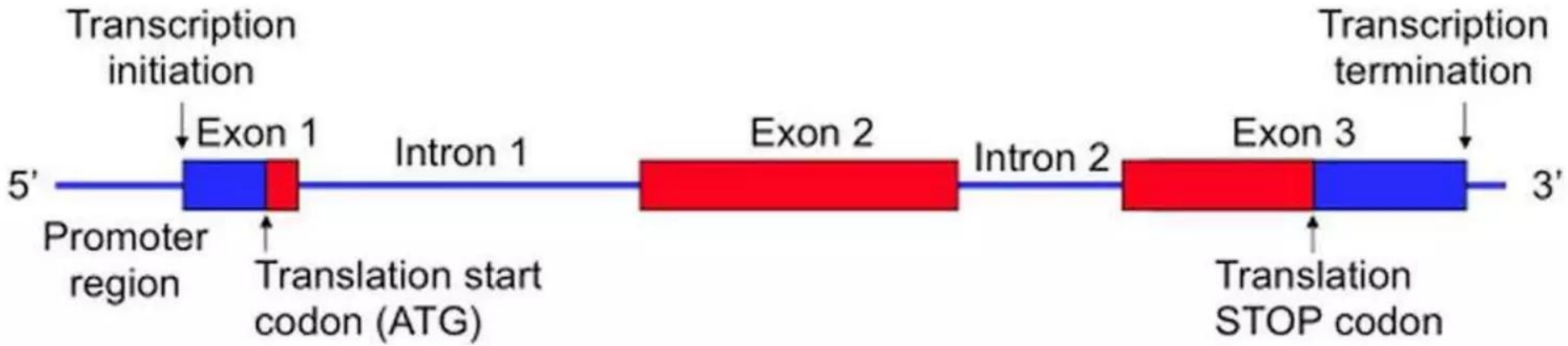
GENE

- The gene is the Functional unit of Heredity.
- Each gene is a segment of DNA that give rise to a protein product or RNA.
- A gene may exist in alternative forms called alleles.
- Chromosome in fact carry genes.
- Each chromosome consists of a linear array of genes.

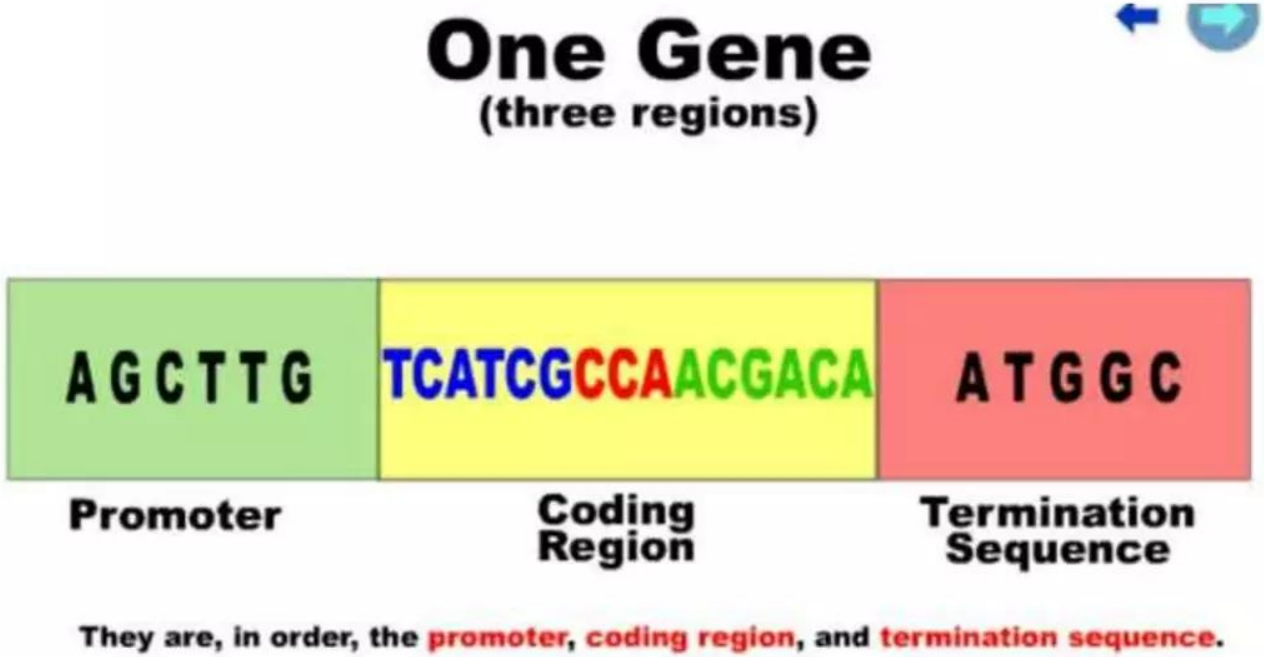
GENE STRUCTURE

- Each gene consist of a specific sequence of nucleotides.
- Gene may be silent or active.
- When active the genes direct the process of protein synthesis.
- Genes do not code for proteins directly but my means of genetic code.
- The genetic code consists of a sequence codeword called codons.
- A codon for an amino acid consists of a sequence of three nucleotides base pairs called triplet codon

Gene Structure



REGION OF GENE



INITIATOR AND STOP CODONS

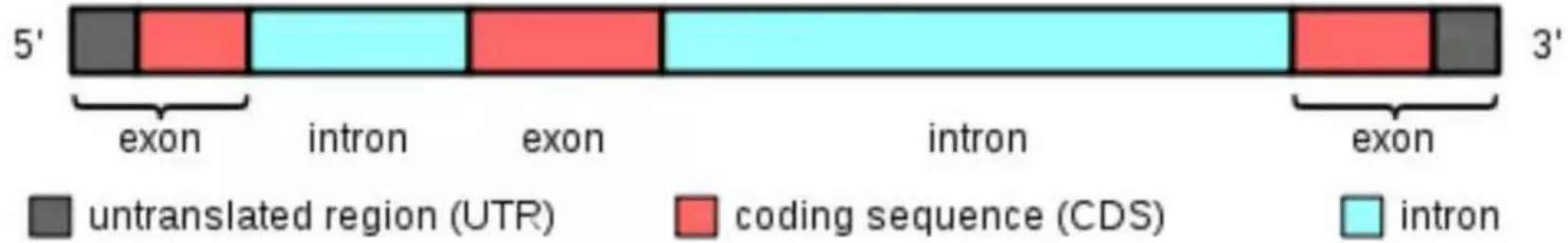
- The boundaries of a gene is known are known as start and stop codons.
- The start codons tells when to begin protein production and stop (termination) codons tells when to end the protein production.

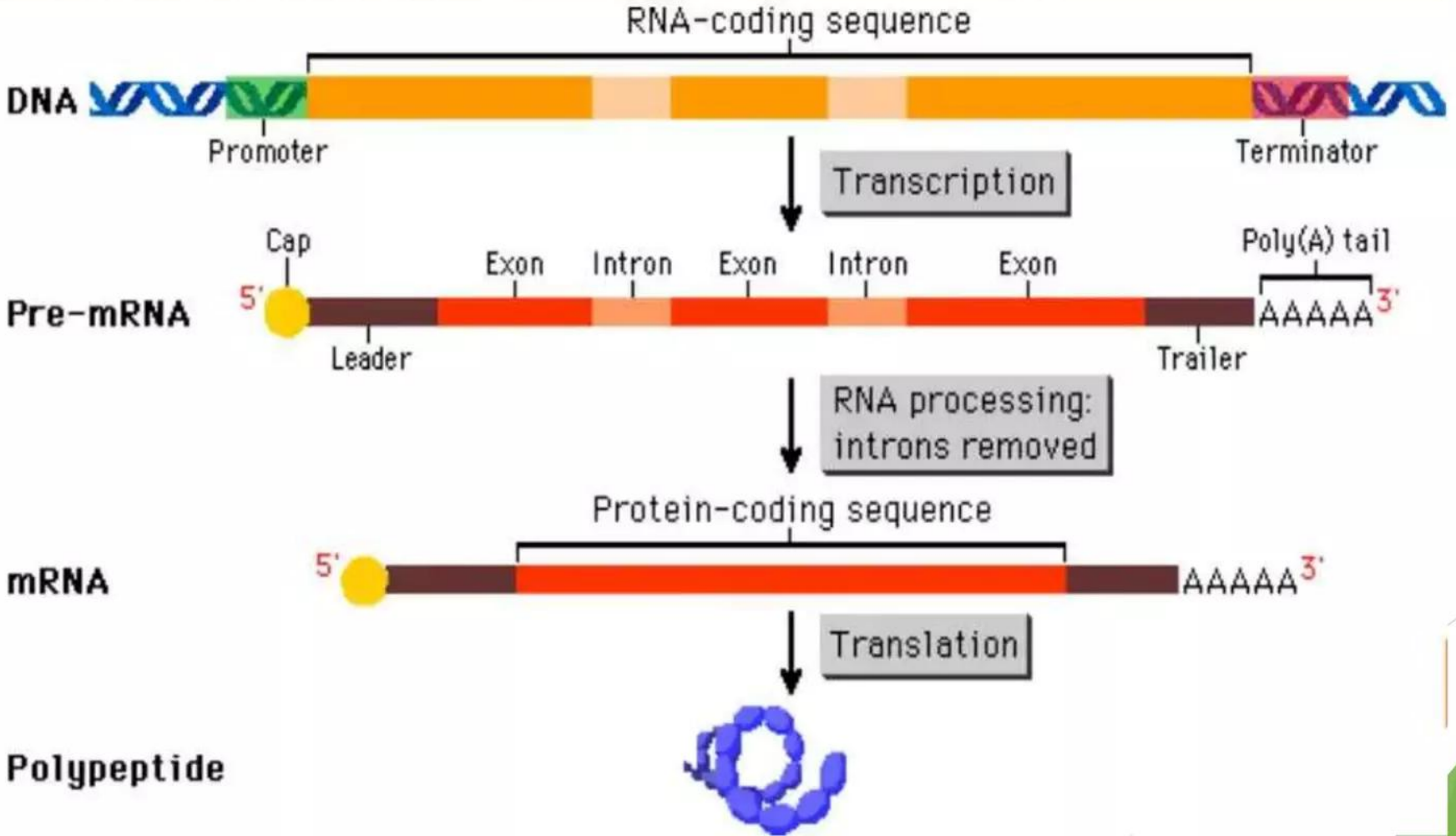
CODING REGION

- The nucleotide sequence between the start and stop codons is the core region known as coding region.
- This region is divided in to two main segment namely exons and introns.

- Exon – This region codes for producing a protein
- Introns – These are the regions between exons and do not code for a protein. (Non coding region)

Eukaryotic gene.





REGULATORY REGION

- These are also non coding regions which control gene expression.
- Promoters – These are the regions which bind to transcription factors either strongly or weakly.
- Enhancers – These are the regions which can enhance the effect of weak promoter.
- Silencers – These are the regulatory regions that can inhibit transcription.

Reference

- Klug, W.S., Cummings, M.R., et al. (2019). Concepts of Genetics. 12th Edition. Pearson.

- Hartl, D. L., & Jones, E. W. (2009). Genetics: Analysis of Genes and Genomes. 7th Edition. Jones & Bartlett Learning
- Snustad, D. P., & Simmons, M. J. (2015). Principles of Genetics. 7th Edition. Wiley.