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قسم التقنيات الاحيائية الطبية

Molecular Biology

Lec. 2

The nucleic acid DNA & RNA

by

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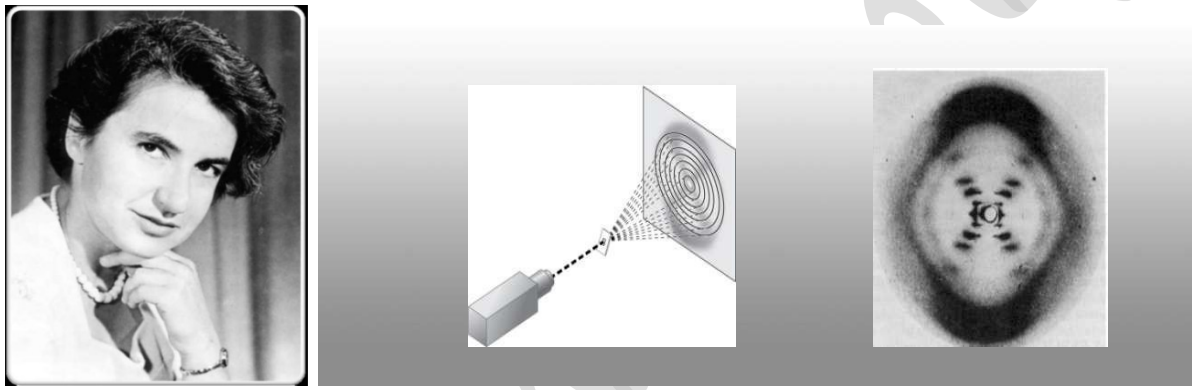
The history of DNA

DNA as an acidic substance present in nucleus was first identified by ***Friedrich Meischer*** in 1868. He named it as **Nuclein.**

Rosalind Franklin in1952 She is study X-ray diffraction to study wet fibers of DNA.



She made marked advances in X-ray diffraction techniques with DNA The diffraction pattern she obtained suggested several structural features of DNA:

- Helical
- More than one strand
- 10 base pairs per complete turn

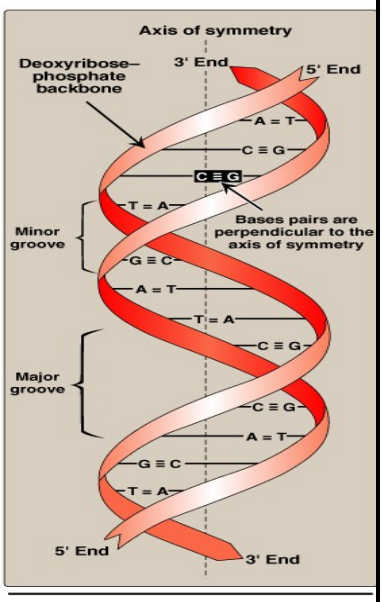
James Watson and Francis Crick in1953 , described a very simple and famous ***Double Helix*** model for the structure of DNA.

Importance of DNA

1- **Storage of genetic material & information (material of GENES)**

2- **Transformation of genetic information to new cells (template for REPLICATION) i.e. synthesis of new DNA for new cells**

3- Transformation of information for protein synthesis in cytosol (template for TRANSCRIPTION) i.e. synthesis of mRNA in nucleus



Structure of DNA molecule

- DNA molecule is formed of double helical strands.
- (Dounble helix)
- The two strands are held together by hydrogen bonds
- Each single strand is formed of polynucleotides
- Polyncleotides are mononucleotides bound to
- each other by phosphodiester bonds

Structure of *Single strand* of DNA

- **Building Units**: **Polynucleotide**
- **sugar**: deoxyribose
- **Base**: **Purine**: A or G OR **Pyrimidine**: T or C
- **Phosphoric acid**
- Mononucleotides are bound together by **phosphodiester bonds**
- In **linear** DNA Strand : **two ends** (**5`** = phosphate & **3`** = OH of deoxyribose)
- In **circular strand**: no ends

Structure of *double stranded* DNA

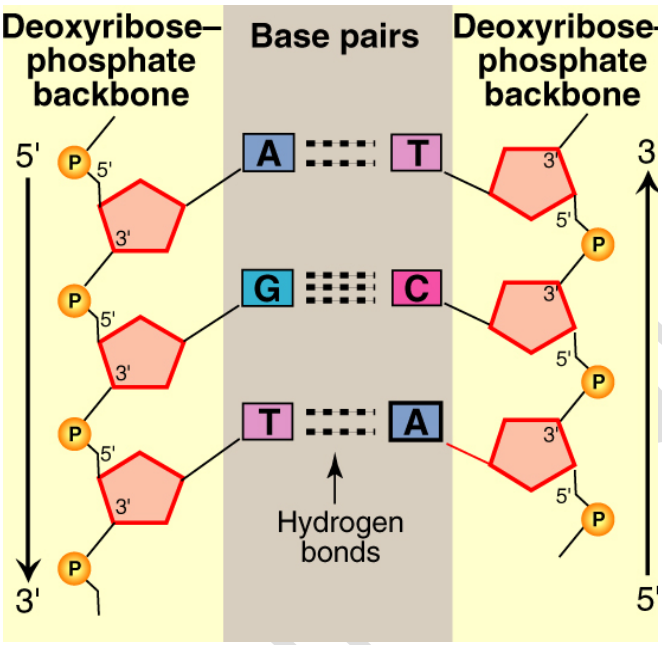
Two strands are anti-parallel (in opposite directions)

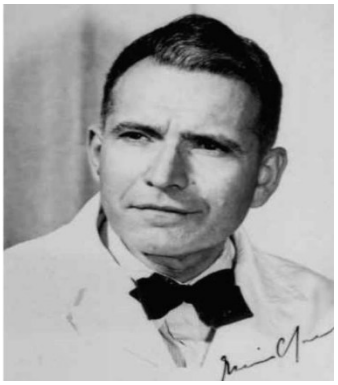
Hydrogen bonds between bases of opposite strands (A & T , C & G)

Denaturation

breakdown (loss) of hydrogen bonds between two strands leading to formation of two separate single strands)

Causes of denaturation : heating or change of pH of DNA

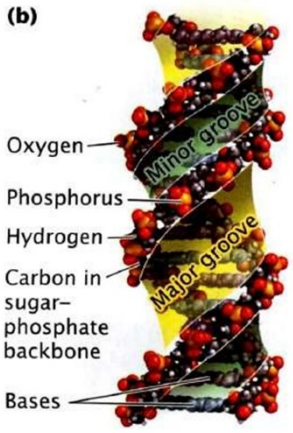




- The compelling observation was that:
- The ratio between **A + G / T + C = 1**
  - ✓ Percentage of adenine=percentage of thymine
  - ✓ Percentage of Cytosine=percentage of Guanine
- This observation became known as a ***Chargaff's Rule.***

Three major forms:

B-DNA
A-DNA
Z-DNA



Property	B-DNA	A-DNA	Z-DNA
Strand	Antiparallel	Antiparallel	Antiparallel
Type of Helix	Right-handed	Right-handed	Left-handed
Overall shape	Long andnarrow	Short and wide	Elongated and narrow
Base pair per turn	10	11	12
Major Groove	Wide & Deep	Narrow & Deep	No discrenible
Minor Groove	Narrow,shallow	Broad, Shallow	Narrow, Deep

Linear & Circular DNA

1- Linear DNA

in nucleus of **eukaryotes** (including human cells)

i.e. DNA of chromosomes

2- Circular DNA

i. in **eukaryotes**: mitochondria

ii. in **prokaryotic** chromosomes (nucleoid of bacteria)

iii. in **plasmids of bacteria** (extrachromosomal element)

iv. in **plant** chroroplasts.

Structure of RNA

Building units: Polynucleotides (bound together by PDE)

Single strand

Linear (but may fold into complex structure)

with two ends: 5`(phosphate) & 3`(-OH end)

Sugar: Ribose

Purine bases: Adenine & Guanine

Pyrimidine bases: Cytosine & Uracil

Types of RNA

There are three types of RNA (mRNA , tRNA , rRNA)

1. Messenger RNA (*mRNA*)

- synthesized in the **nucleus** (by *transcription*): DNA (the gene) is used a template for ***mRNA*** synthesis

mRNA is synthesized complementary to DNA but in RNA language i.e. U instead of T

So, if A in DNA it will be U in RNA , if T in DNA it will be A in *mRNA*….etc

- Carries the genetic information from the nuclear DNA (gene) to the

cytosol

- In the **cytosol**, *mRNA* is used as a template for protein biosynthesis by ribosomes (with help of tRNA)…. This is called *Translation or Protein Biosynthesis)*

Transcription + Translation = GENE EXPRESSION

Types of mRNA

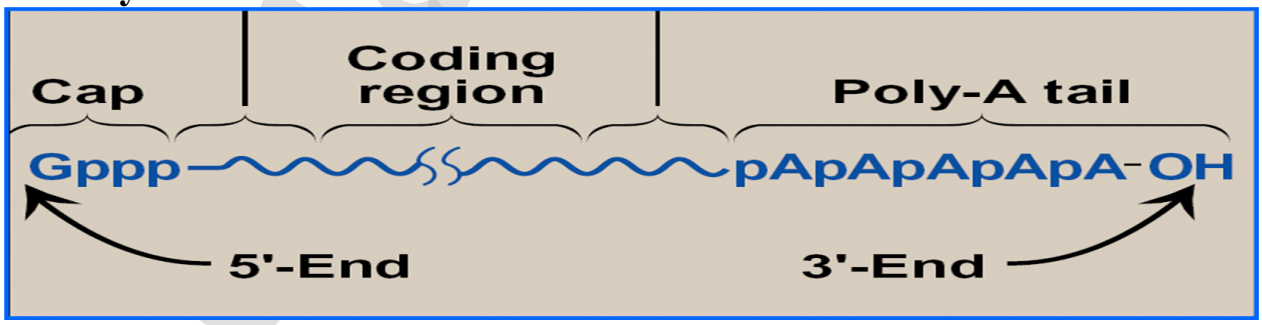
- **Polycistronic *mRNA*:**

One single *mRNA* strand carries information from more than one gene (in ***prokaryotes***)

- **Monocistronic *mRNA:***

one single *mRNA* strand carries information from only one gene (in ***eukaryotes***)

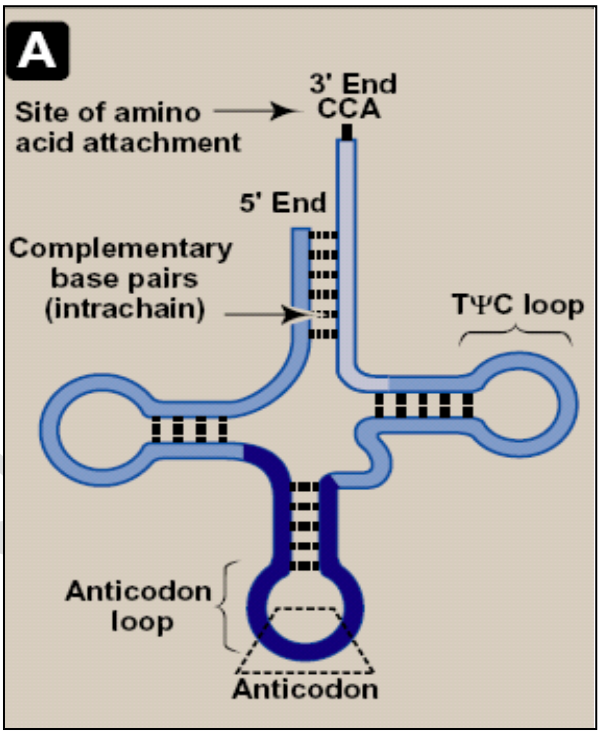
Eukaryotic *mRNA*



5`-end: cap of 7-methylguanosine
3`-end: poly-A tail

2. Transfer RNA (*tRNA*)

Smallest of RNAs in cell: 4S



Location:

cytosol At least one specific tRNA for each of the 20 amino acids found in proteins with some unusual bases with intrachain base-pairing (to provide the folding structure of tRNA)

Function:

1- recognizes genetic code word on mRNA

2- then, carries its specific amino acid for protein biosynthesis

3. Ribosomal RNA (*rRNA*)

80% of total RNA in the cell (most abundant RNA)

Location: cytosol

Function: machine for protein biosynthesis

Types: