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Molecular biology (1)

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IMPORTANT

Extra Info

Drs Notes

Foundation Block - Biochemistry Team

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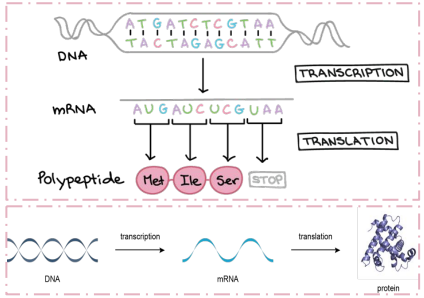
MED439

Objectives:

- Know the central dogma of molecular biology
- Understand the composition, types and structure of DNA and RNA
- Describe the organization of DNA in the chromosome and the role of histone proteins

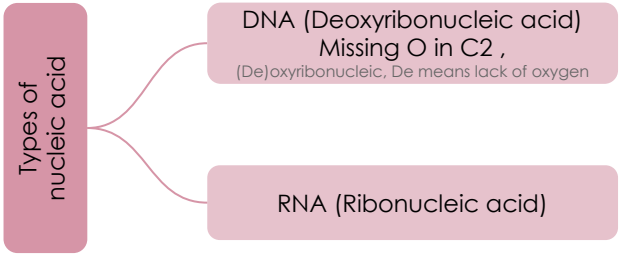
The central dogma of molecular biology

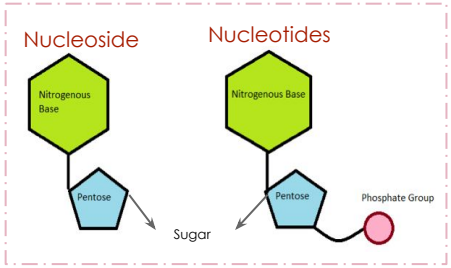
- The **central dogma** of molecular biology describes the two-step process, transcription and translation, by which the information in genes flows into proteins:
  DNA → RNA → protein. in other meanings, understand the concept of **molecular biology**
- A portion of DNA, called a gene,is transcribed into RNA.
- RNA is then translated into proteins.
- Human genome contains about 35,000 genes.
- Replication: DNA → DNA , Transcription: DNA → RNA and translation: RNA → Protein.
- The location of the **Replication** and **transcription** in the nucleus while **Translation** in cytoplasm



Nucleic acid

- Required for the storage and expression of genetic information.
- Building blocks of nucleic acids are nucleoside triphosphate (nucleotides).

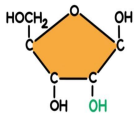


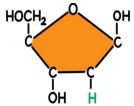


Nucleotides

Nucleotides are composed of:

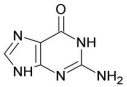
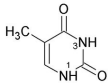
- Nitrogenous base
  - Purines: Adenine (A), Guanin (G)
  - Pyrimidines : Cytosine (C) Thymine (T) and Uracil (U)
- Pentose: (sugar with 5 carbon ring):
  - Ribose (with -OH at C2)
  - Deoxyribose (with only H at C2)
    oxygen is missing in C2
- Phosphate groups





★ Dr : You don't have to memorize the structure. However,, you have to know the **3 names of each one**.

Nucleotides , contd..

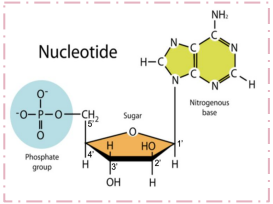
Base formula	Base (X = H) if an H was in X place it would be a base and ending in "ine".	Nucleoside (x = ribose[a]) if a ribose was in X place it would be a bucleoside and ending in "osine" for **pruriens** and "idene" for **pyrimidenes** .	Nucleotide[b] (x = ribose phosphate[a]) if a ribose phosphate (ribose with a phosphate connected to it) was in place of X it would be a nucleotide and ending with "ylic acid"
 Adenine	Adenine Ade A	Adenosine Ado A	Adenylic acid Adenosine monophosphate AMP
 Guanine	Guanine Gua G	Guanosine Guo G	Guanylic acid Guanosine monophosphate GMP
 Cytosine	Cytosine Cyt C	Cytidine Cyd C	Cytidylic acid Cytidine monophosphate CMP
 Uracil	Uracil It doesn't have the suffix ine " exception " Ura U	Uridine Urd U	Uridylic acid Uridine monophosphate UMP
 Thymine	Thymine Thy T	Deoxythymidine dThd dT	Doxythymidylic acid deoxythymidine monophosphate dTMP

Purines
2 rings 4 nitrogens

Pyrimidines
1 ring 2 nitrogens

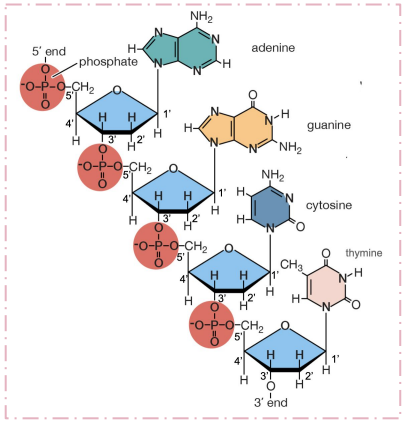
The phosphate group

- The sugar carbon numbers are primed (1'2'3' etc) while the nitrogenous bases are unprimed.
- The nitrogenous base is bonded to C1' of sugar.
- The phosphate group is bonded to C3' or C5' of sugar.



Chemical structure of RNA & DNA

- The PO_4 bridges the **3'** and **5'**; positions of ribose sugar.
- The PO_4 and sugar bonding is the backbone of DNA structure.
- The linkage between the nucleotides is called phosphodiester bond.
- the linkages that forms nucleosides (linkage between nitrogenous bases and ribose) is called glycosidic linkage. So keep in mind Nucleotides : Phosphodiester bond and Nucleosides : Glycosidic linkage



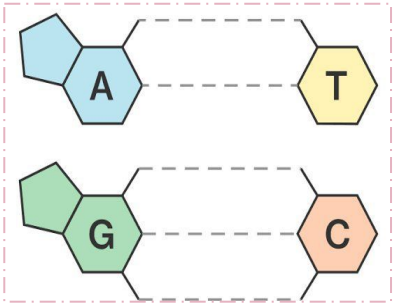
Function of nucleotides

1. Polymers of nucleotides (as DNA or RNA) store and transfer genetic information.
2. Free nucleotides and their derivatives perform various metabolic functions not related to genetic information.
3. Other nucleotides: FAD, NAD, CoA.

The double helix DNA

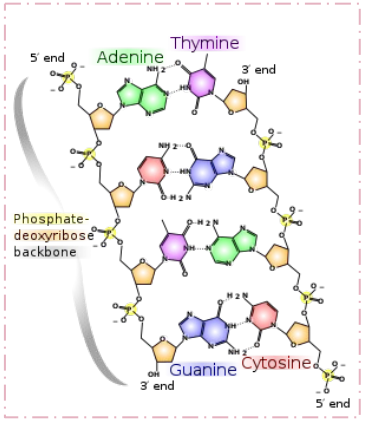
- The structure of DNA was first determined by James Watson and Francis Crick in 1953 and it is commonly known as Watson-Crick structure.
- Watson -Crick base pairs :
  - A is double bonded to T
  - G is triple bonded to C .

  So, it is more difficult to break G-C bonds



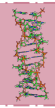
Features of Watson-Crick DNA structure

1. Two polynucleotide chains wind around a common axis to form a double helix.
2. The two strands are anti-parallel (run in opposite direction). 5 → 3 and 3 → 5.
3. Each strand is a right-handed helix.
4. The nitrogenous bases are in the center of the double helix and the sugar-phosphate chains are on the sides.
5. The surface of the double helix contains 2 grooves, major and minor.(places for binding proteins that help in replication and translation).
6. Each base is hydrogen bonded to a base in the opposite strand to form a base pair (A-T and G-C) known as Complementary base pairing.
7. The helix has 10 base pairs (bp) per turn.



★ Dr : Make sure you know **the directions** , **major** an **minor grooves** and the **Base pair for each one.**

Types of DNA structure

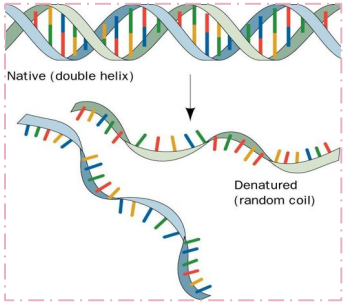
Types of DNA	A-DNA 	B-DNA (Watson & Crick) 	Z-DNA 
direction	Right-handed They are clockwise	Right-handed They are clockwise	Left-handed They are anti-clockwise
Helix length	Short	Elongated "long"	More elongated
Major groove	Deep and narrow	Wide	Not a real groove
Minor groove	wide	Narrow	Narrow
Placements of bp	Displaced away from the helical axis	Centered over the helical axis	Zig-zag pattern (nearly perpendicular to the helical axis)
Bp per turn	11	10	12
Conformation of deoxyribose (the carbon where oxygen is removed)	C3	C2	G (C2) or C (C3)
Seen in	Seen in: - DNA replication - Non coding RNA	Most common in human body	Seen in the sites DNA is copied

DNA Supercoiling

- The chromosomes of many bacteria and viruses contain circular DNA which is supercoiled in order to take a smaller place, and to give it more protection because they don't have nucleus

Melting temperature

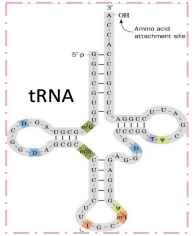
- The temperature at which the double-stranded DNA is separated into two single strands.
- Melting point of DNA depends on nitrogenous base content (A-T and G-C). G-C has 3 hydrogen bonds, so it is stronger than A-T which only has 2.



The types and functions of RNA

- RNA is a single- stranded polymer of ribonucleotides

Types of RNA	Messenger RNA	Transfer RNA	Ribosomal RNA
Functions	transcription process. (DNA → mRNA)	**- Recognition:** recognizes amino acids codon. (decode the mRNA). **- Transferring:** transferring the amino acids to the growing protein chain. More details in the next lecture	- Site of protein synthesis (factory). - It is the RNA component of a ribosome

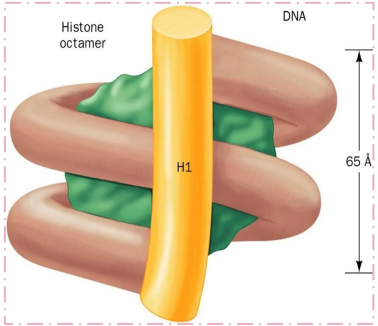


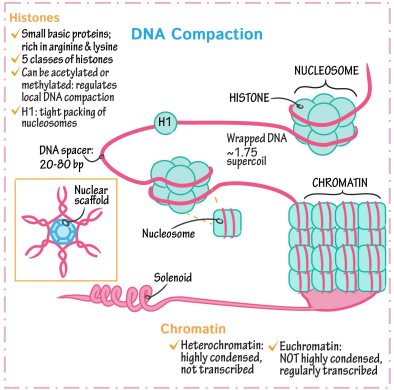
tRNA acts as adopter

Organization of DNA

- The human genome contains 3.5 billion base pairs and more than 95% is non-coding or "junk" DNA.
- The DNA from single 23 human chromosomes have a length of 1 meter.
- Each chromosome is a complex of a single linear DNA molecule and protein called chromatin.
- 50% of chromatin consists of proteins called histones.
  - histones have five major types of
    H1 H2A H2B H3 H4
  - Histones have positively charged amino acids (arginine and lysine).
  - These proteins bind to negatively charged PO_4 groups of DNA to stabilize the chromatin structure.
- Nucleosomes are particles consisting of DNA and histones connected by thin strands of naked DNA (like beads on a string; Sabhah سبحه in Arabic).
- Nucleosomes consist of the histone octamer (eight histones) and DNA.
- Octamer consist of (8 histones) $(H2A)_2(H2B)_2(H3)_2(H4)_2$ except H1
- H1 binds to 2 complete helical turns of DNA.
- H1 binds the octamer with naked DNA

see the pic on the right for a better understanding





Take home messages

- The central dogma of molecular biology involves three components: DNA, RNA and protein.
- There are two chemically distinct types of nucleic acids: DNA and RNA, which perform several crucial functions.
- To package the long sequence of the genomic DNA, it is highly organized into chromosomes.

Quiz

Q1 : A portion of …… called a …… is transcripted into….. ?			
A) Gene, DNA, RNA	B) RNA, DNA, gene	C) DNA, gene, RNA	D) Gene, RNA, DNA
Q2 :What are the types of Pyrimidines nitrogenous base?			
A) Guanine, Thymine, Uracil	B) Thymine, Uracil, Cytosine	C) Cytosine, Guanine,Adenine	D) Thymine, Adenine, Guanine
Q3 : The nitrogenous base is bonded to …….. of sugar.			
A) C1	B) C2	C) C3	D) C4
Q4 : …….. Binds to two complete helical turns of DNA .			
A) H1	B) H2A	C) H2B	D) H3
Q5 : Nucleotides are composed of :			
A) nitrogenous base , hexose & phosphate group	B) nitrogenous base , pentose & phosphate group	C) nitrogenous base , pentose & carboxylic group	D) none
Q6 : The linkage between the nucleotides are called :			
A) phosphodiester bond	B) glycosidic bond	C) Ester bond	D) ether bond

SAQs :

Q1: What are the major types of histones?

Q2: enumerate the types of nucleotides other than DNA,RNA .

★ **MCQs Answer key:**

1) C 2) B 3) A 4) A 5) B 6) A

★ **SAQs Answer key:**

1) H1. H2A. H2B. H3. H4.

2) NAD,FAD.

Girls team:

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Reema Alomar
Reem Alqahtani
Renad Alhumaidi
Shaden Alobaid
Noura Alsalem
Lama Alahmadi
Sadem Alhazmi
Somow Abdulrahman
Budoor Almubarak
Samar Almohammedi
Nuha Alkudsi
Norah Alsheikh
Muneerah Alssdhan
Mayasem Alhazmi
Noura alshathri
Duaa Alhumoudi

Boys team:

Mansour albawardi
Hassan alshuraf
Abdulrahman almbki
Mohammed alsayari
Abdullaziz alomar
Abdulaziz alrabiah
Saud alrasheed
Abdullah almazro
Hamad almousa
Ahmad alkhayat

"Don't study because you need to, study because knowledge is power and they can never take it away from you".

Made by

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