2018/9/24

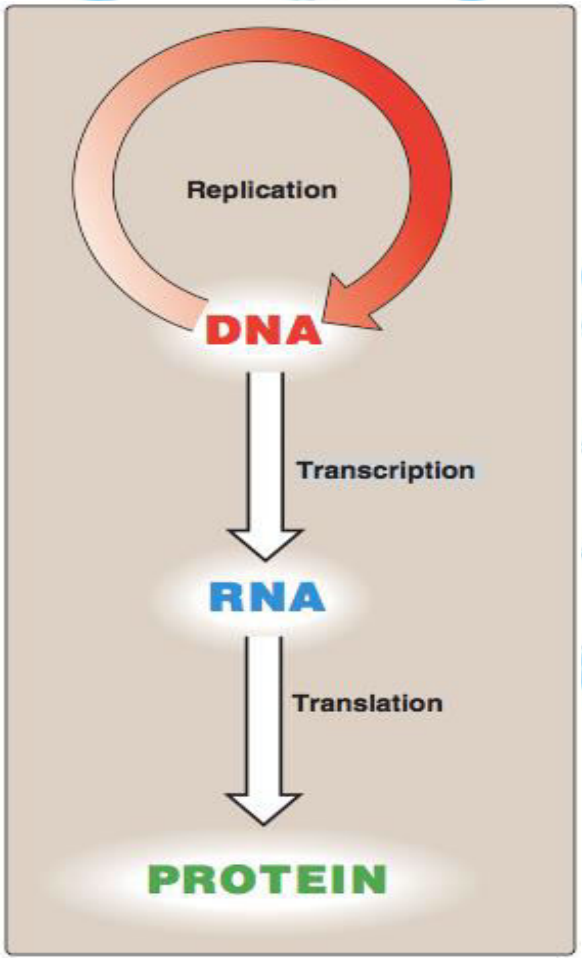
Molecular biology (1)

- Color Index:
  - Important.
  - 436 Notes
  - Original slides.
  - 438 notes
  - Extra information

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



– A portion of DNA, called a **gene**, is transcribed into RNA.

– RNA is translated into **proteins**

– Human genome contains about 35,000 genes

Notice:
Replication : DNA > DNA
Transcription : DNA > RNA
Translation : RNA > protein

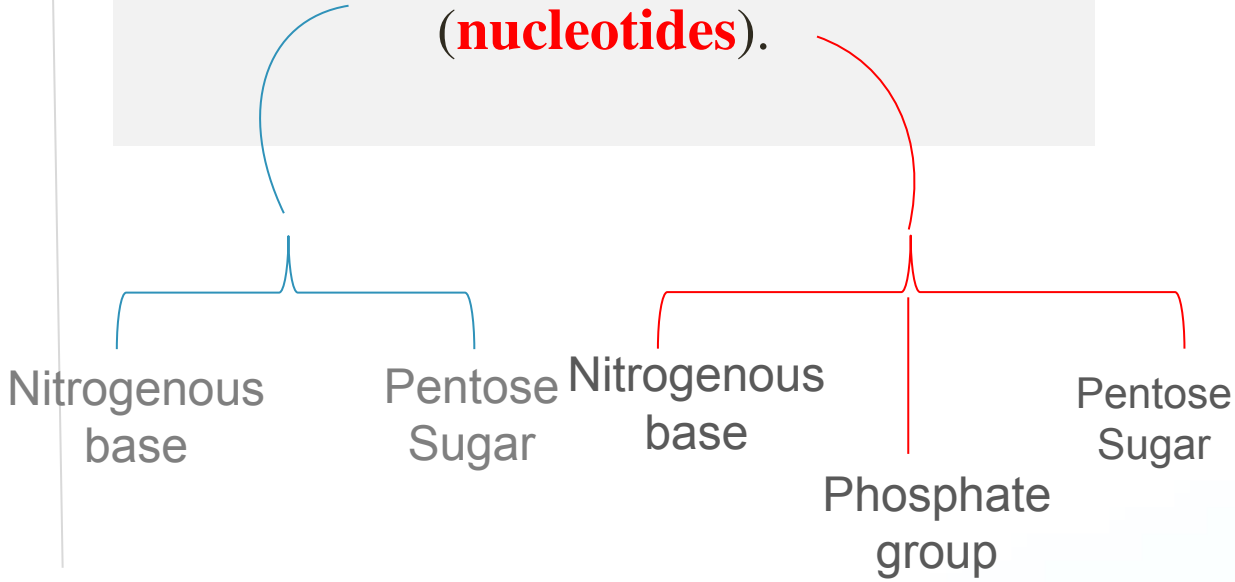
Nucleic acids

Required for the storage and expression of genetic information.

Two types

- DNA (Deoxyribonucleic acid)
- RNA (Ribonucleic acid)

Building block of nucleic acids are : Nucleoside triphosphates (**nucleotides**).



1- فائدته انه يربط بين nucleotides
2- يحافظ على شحنة سالبه

Nucleotides
Are composed of:

Nitrogenous base

Purines:
Adenine (A) & Guanine (G)

Pyrimidines:
Cytosine (C) & Thymine (T) & Uracil (U)

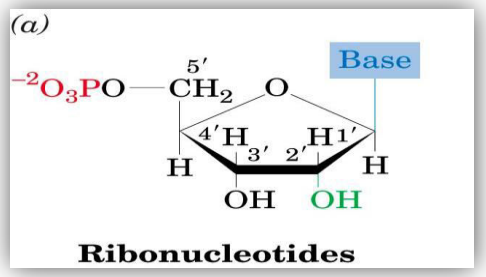
Pentose:
(sugar with 5 carbon ring)

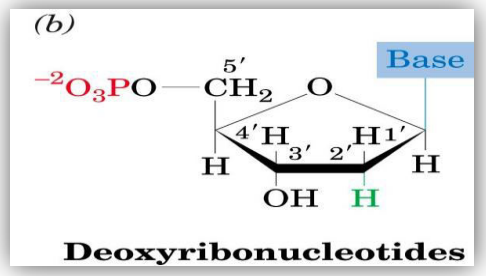
Ribose
with OH at C2

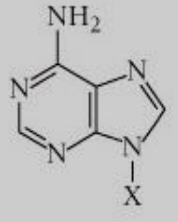
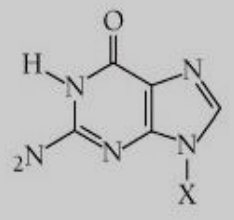
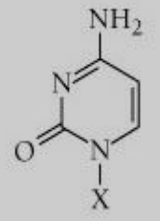
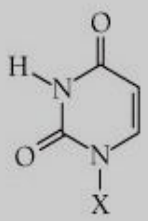
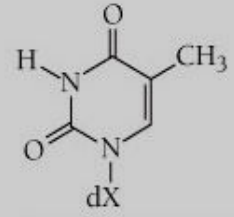
Deoxyribose
With only H at C2

De: not (missing)
Oxy: oxygen

Phosphate groups





Base Formula	Base (X = H)	Nucleoside (X = ribose[a])	Nucleotide[b] (X = ribose phosphate[a])
	Adenine Ade A	Adenosine Ado A	Adenylic acid Adenosine monophosphate AMP
	Guanine Gua G	Guanosine Guo G	Guanylic acid Guanosine monophosphate GMP
	Cytosine Cyt C	Cytidine Cyd C	Cytidylic acid Cytidine monophosphate CMP
	Uracil Ura U	Uridine Urd U	Uridylic acid Uridine monophosphate UMP
	Thymine Thy T	Deoxythymidine dThd dT	Deoxythymidylic acid Deoxythymidine monophosphate dTMP

Notes 436:

Purines : 2 rings and 4 nitrogen inside the rings.
Pyrimidines : 1 ring and 2 nitrogen inside the the ring.

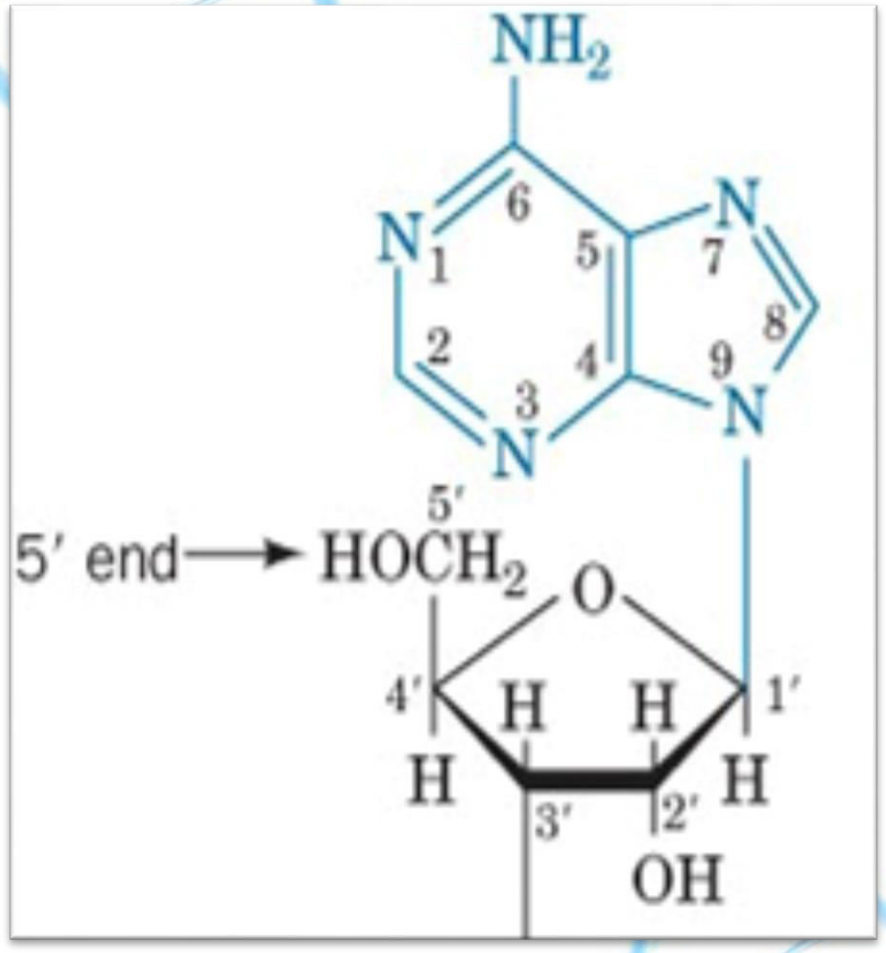
- if an H was in X place it would be a base and ending in "ine".

- if a ribose was in X place it would be a Nucleo**side** and ending in "osine" .

- if a ribose phosphate (ribose with a phosphate connected to it) was in place of X it would be a nucleo**tide** and ending in "ylic acid".

- AMP,GMP, is just an abbreviation
- You don't have to memorize the structure

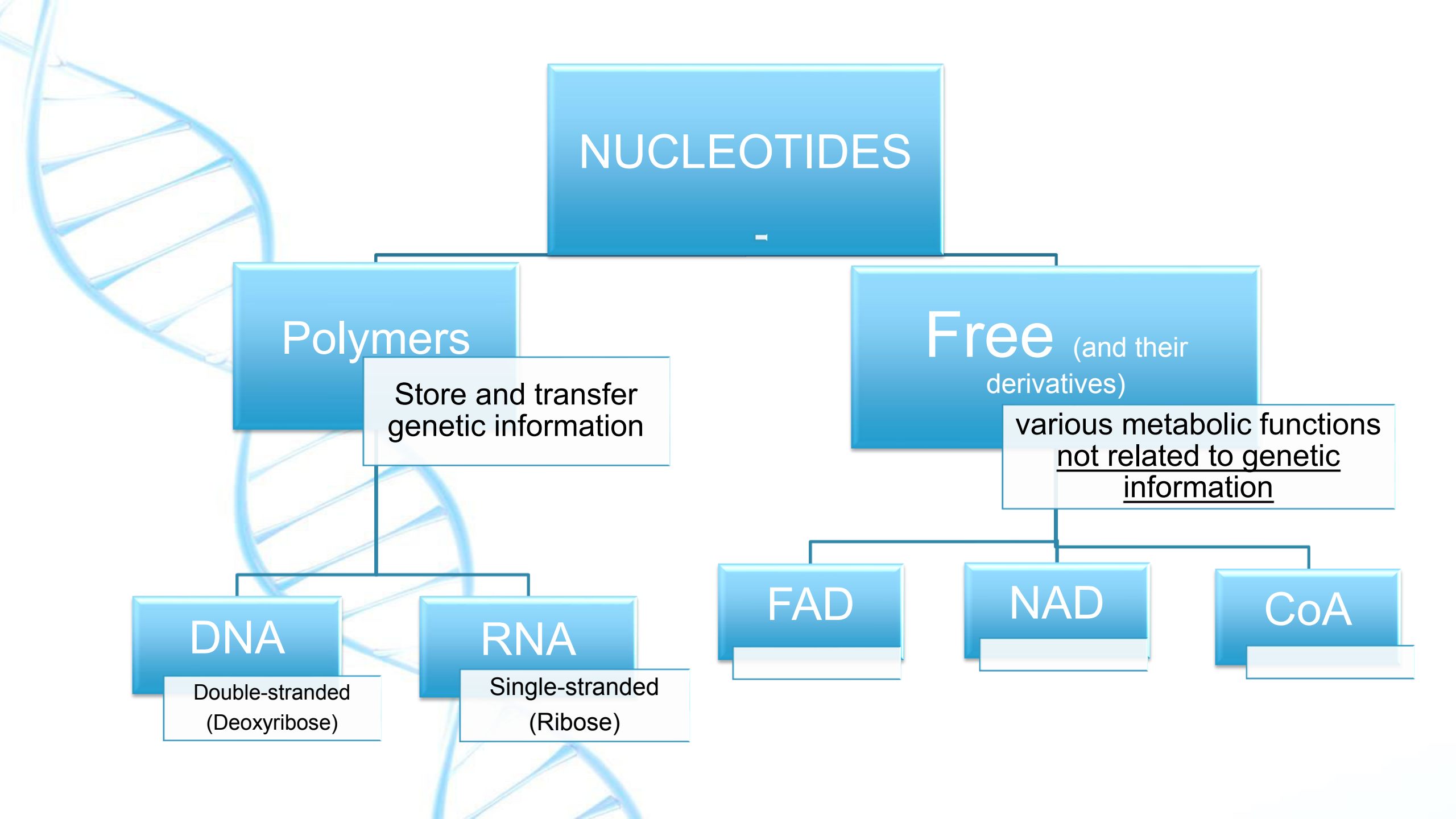
Phosphate groups :



- The **sugar carbon** numbers are primed (1’ 2’ 3’ etc.), while **the nitrogenous base atoms** are unprimed.

- The **nitrogenous base** is bonded to **C_1’** of sugar.

- The **PO_4 group** is bonded to **C_3’** or **C_5’** of sugar.


NUCLEOTIDES
-
Polymers
Store and transfer genetic information
DNA
Double-stranded (Deoxyribose)
RNA
Single-stranded (Ribose)
Free (and their derivatives)
various metabolic functions not related to genetic information
FAD
NAD
CoA

RNA

mRNA (messenger RNA)

Transcription process (from DNA to mRNA).

tRNA (transfer RNA)

Recognition

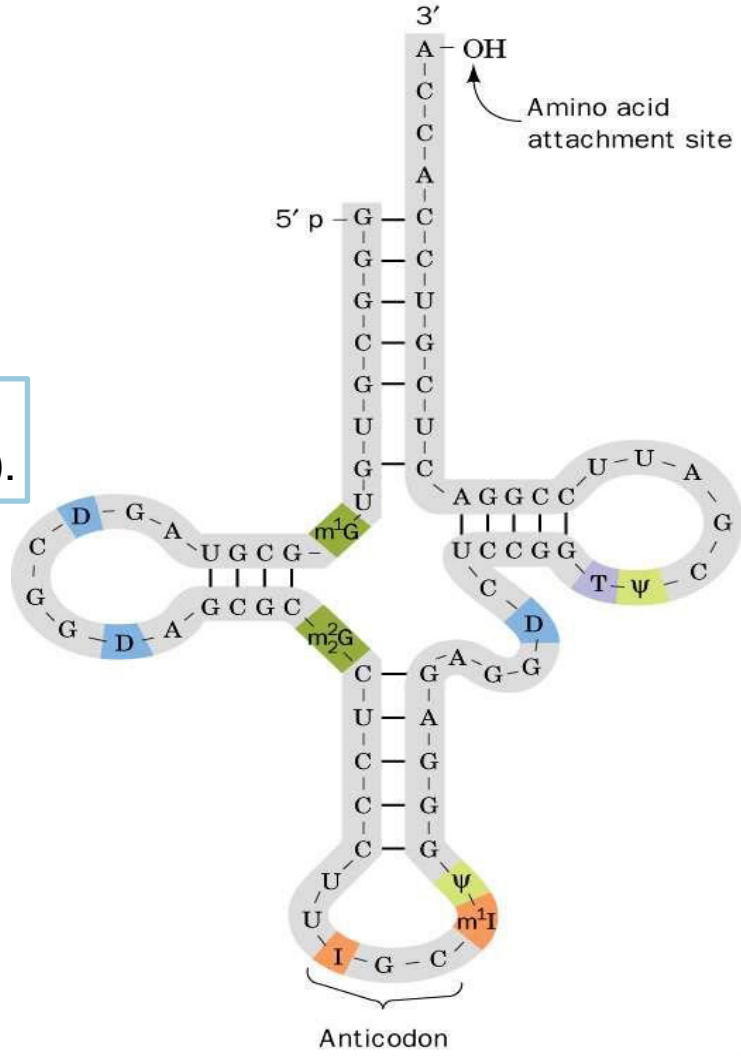
Recognizes amino acid's codon

transferring

Transfer the amino acids to the growing protein chain

rRNA (ribosomal RNA)

Site of protein synthesis (factory).



Structure of a tRNA

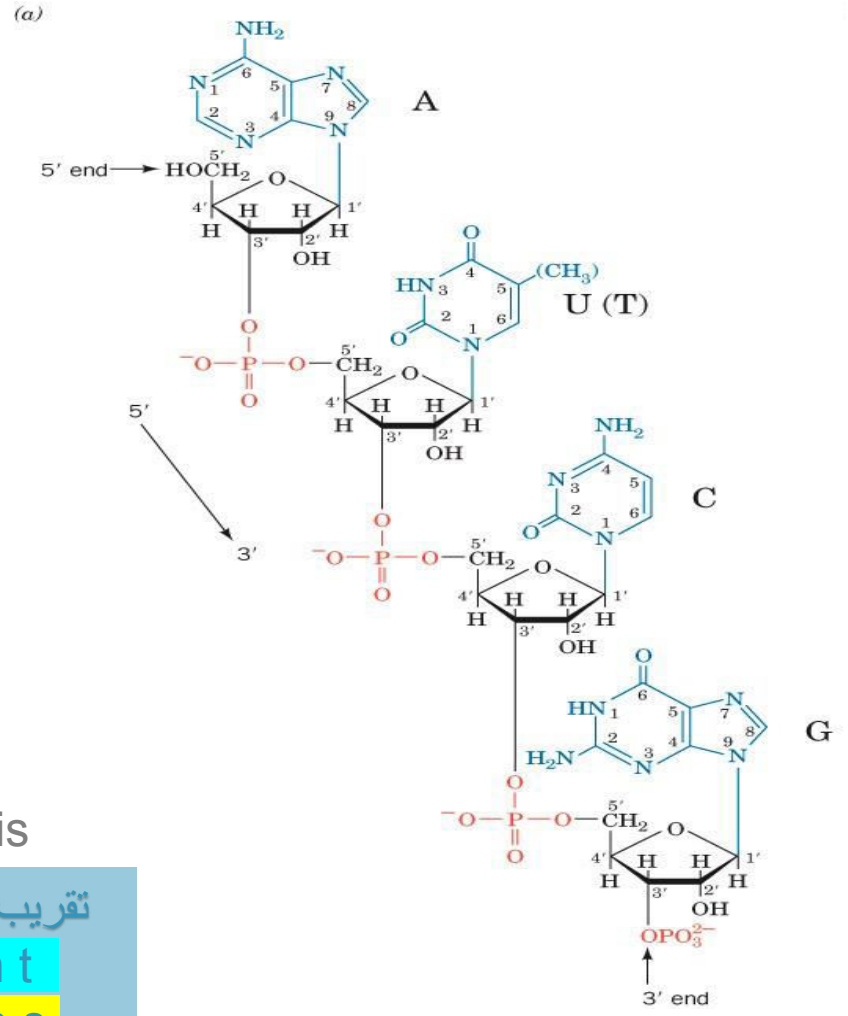
- مهم : معرفة اسم الرابطة التي تربط nucleotides & رقم الكربونة و اللي مرتبط فيها EX: القاعدة النيتروجينية < مرتبطة بكربونة رقم ١

Chemical structure of DNA & RNA

- 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 linkage between nitrogen bases and ribose sugar is glycosidic linkage.

nucleoside

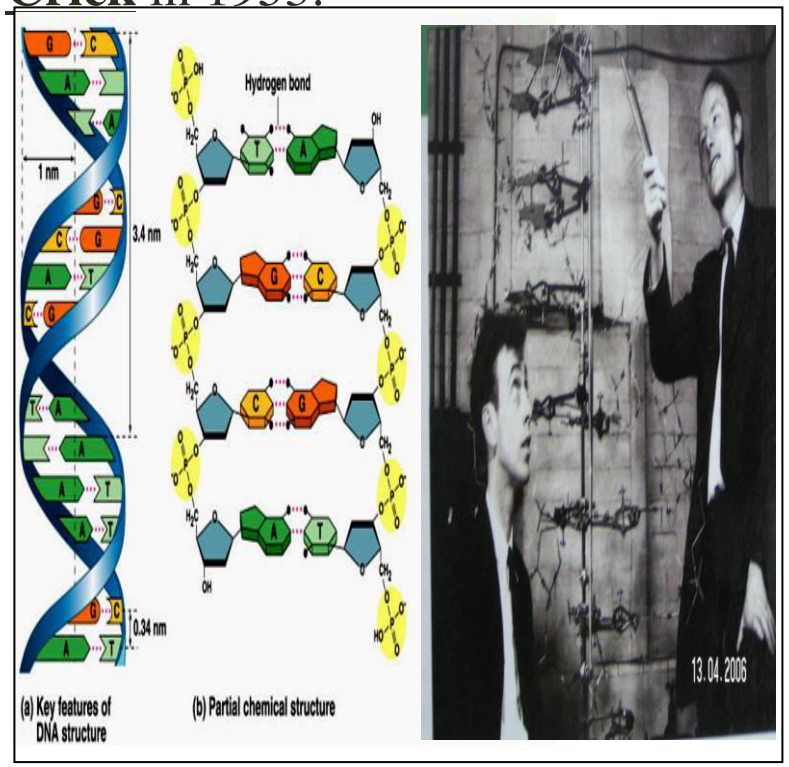


تقريب للتذكر
T with t
S with s

THE DOUBLE HELIX DNA

- The structure of DNA was first determined by James **Watson** and Francis **Crick** in 1953.

Commonly known as Watson-Crick structure.



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). From 5 ----------3
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: the major and minor grooves. Places for bonding of the protiens to regulate transcription or replication.

6- complementary base pairing , Each base is hydrogen bonded to a base in the opposite strand to form a base pair (A-T and G-C)

7-The helix has 10 base pairs (bp) per turn.

In RNA, Thymine is replaced by Uracil (U)

Adenine (A) — Thymine (T)

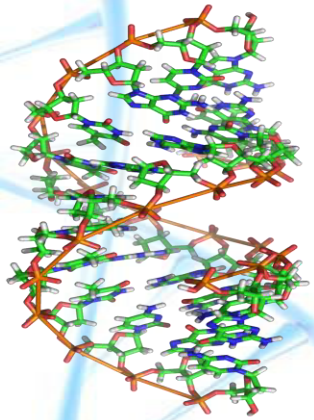
Guanine (G) ≡ Cytosine (C)

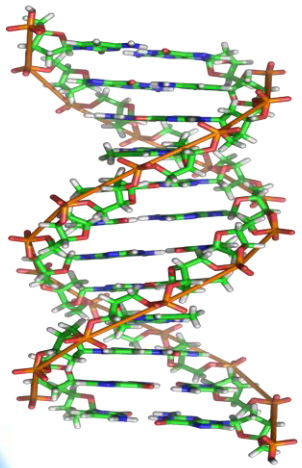
Types of DNA structure

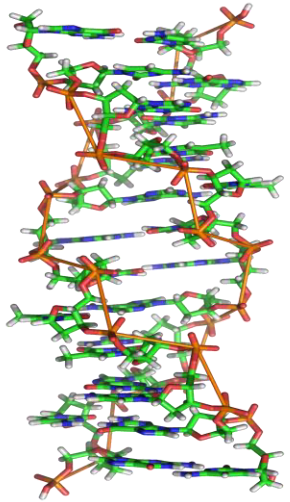
	A-DNA	B-DNA Watson-Crick model	Z-DNA
Direction	Right-handed	Right-handed	Left-handed
Helix length	Short	Elongated	More elongated
Major groove	Deep and narrow	Wide	Not real groove
Minor groove	Wide	Narrow	Narrow
Placement of bp	Displaced away from the helical axis	Centred over the helical axis	Zig-zag pattern (nearly perpendicular to the helical axis)
bp per turn	11	10	12
Conformation of deoxyribose	C_3	C_2	G (C_2) ; C (C_3) مرة يمسك في رقم 3 ومرة في 2
Notes	يوجد في حالتين : 1- نسخ الDNA 2- Non coding RNA	غالبية الموجود في الجسم على هذا الشكل Most common	-

Med437:

The carbon where the oxygen is removed







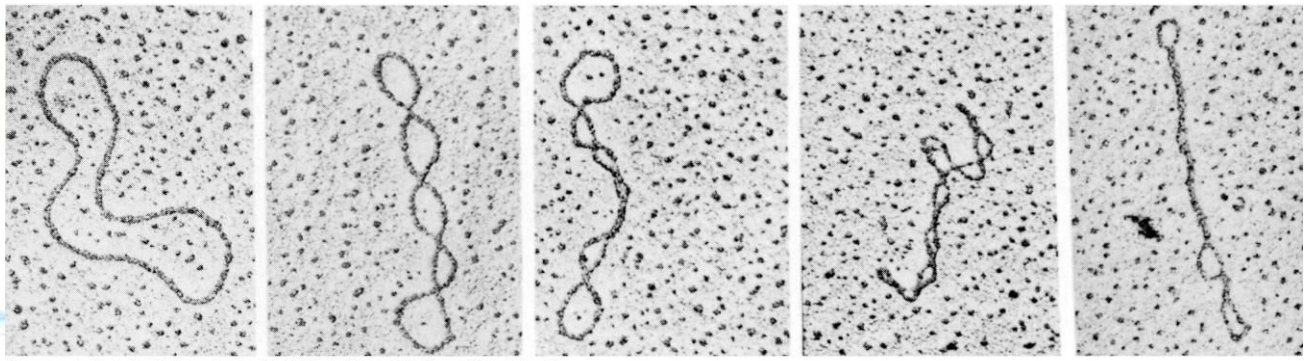
Major groove
Minor groove

DNA supercoiling

- The chromosomes of many bacteria and viruses contain circular DNA which is supercoiled.
- The end of DNA of human is not connected like bacteria، It is separated.

To take smaller space

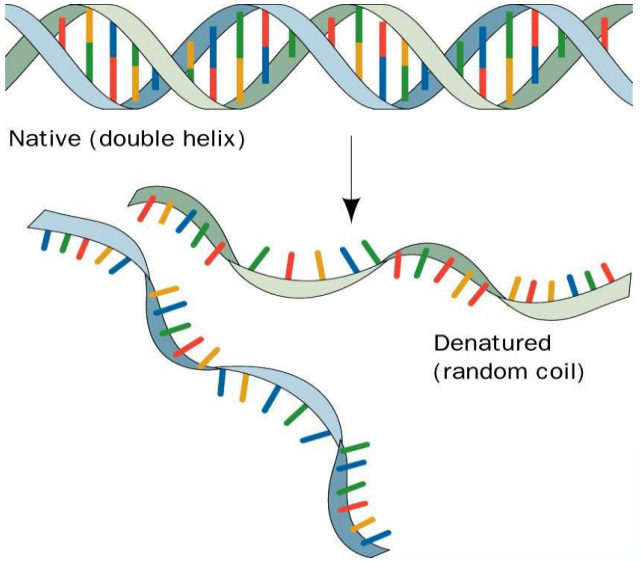
To give it more protection (cause it doesn't have a true nucleus)



Electron micrographs by Laurien Polder. From Kornberg, A. and Baker, T.A., DNA Replication (2nd ed.), p. 30, W.H. Freeman (1992). Used with permission

Melting temperature

- The temperature at which the double-stranded DNA is separated into two single strands.



MT of DNA depends on nitrogenous base:

G-C has 3 hydrogen bonds ➔ stronger than A-T (2 hydrogen bonds ➔ needs more energy (heat) to break

Med436

* Note ; positively charged means (polar basic) – histidine is not included because it is a weak base

-

How DNA is organized in a chromosome

1- Each chromosome is a complex of a single linear DNA molecule and protein called chromatin.

2- The DNA from single 23 human chromosomes have a length of 1 meter.

3- 50% of chromatin consists of protein called "Histones".

4- The human genome contains 3.5 billion base pairs and more than 95% is non-coding or “junk” DNA.

Nucleosomes

What are they?

- Nucleosomes are the individual units of chromatin.

(particles consisting of DNA and histones connected by thin strands of naked DNA = like beads on a string "مثال السبحة")

- They consist of a segment of DNA wrapped around a core called histone octamer (eight).

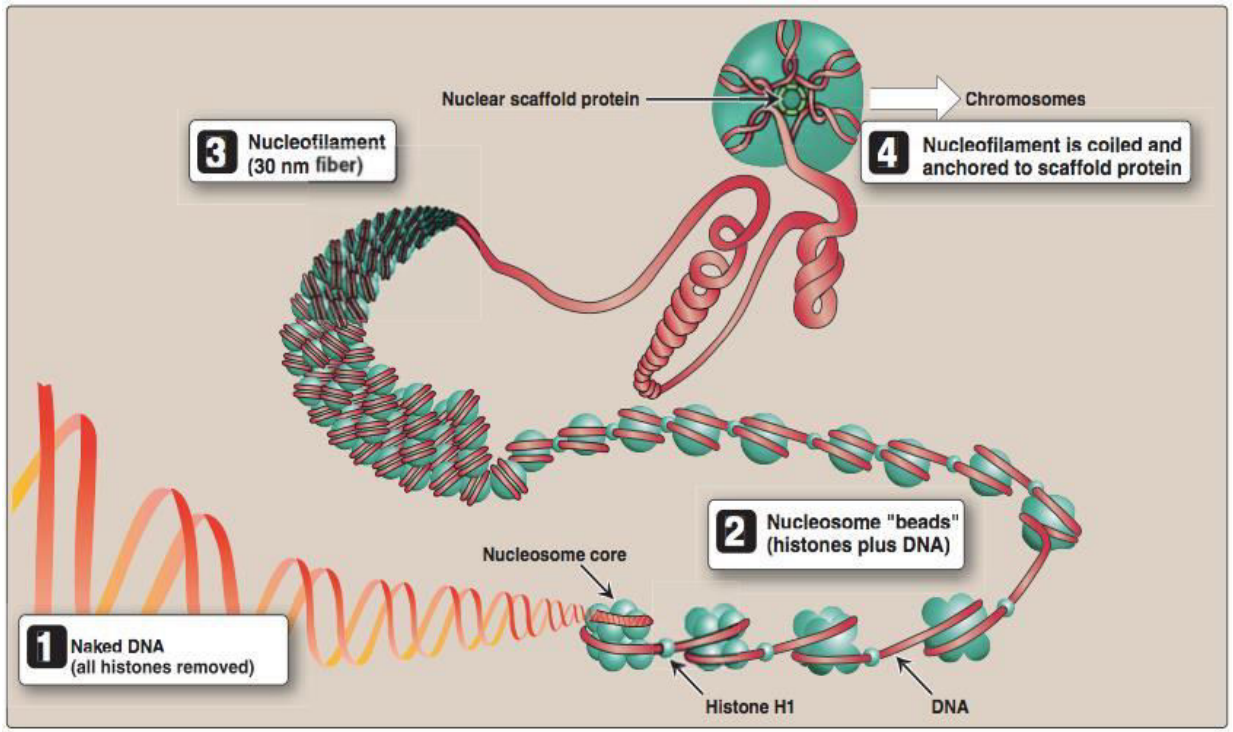
- Octamer:

نبه عليها الدكتور

(8 particles of histone protein)
Two particles of each histone (H2A, H2B, H3 and H4) assemble to form the core

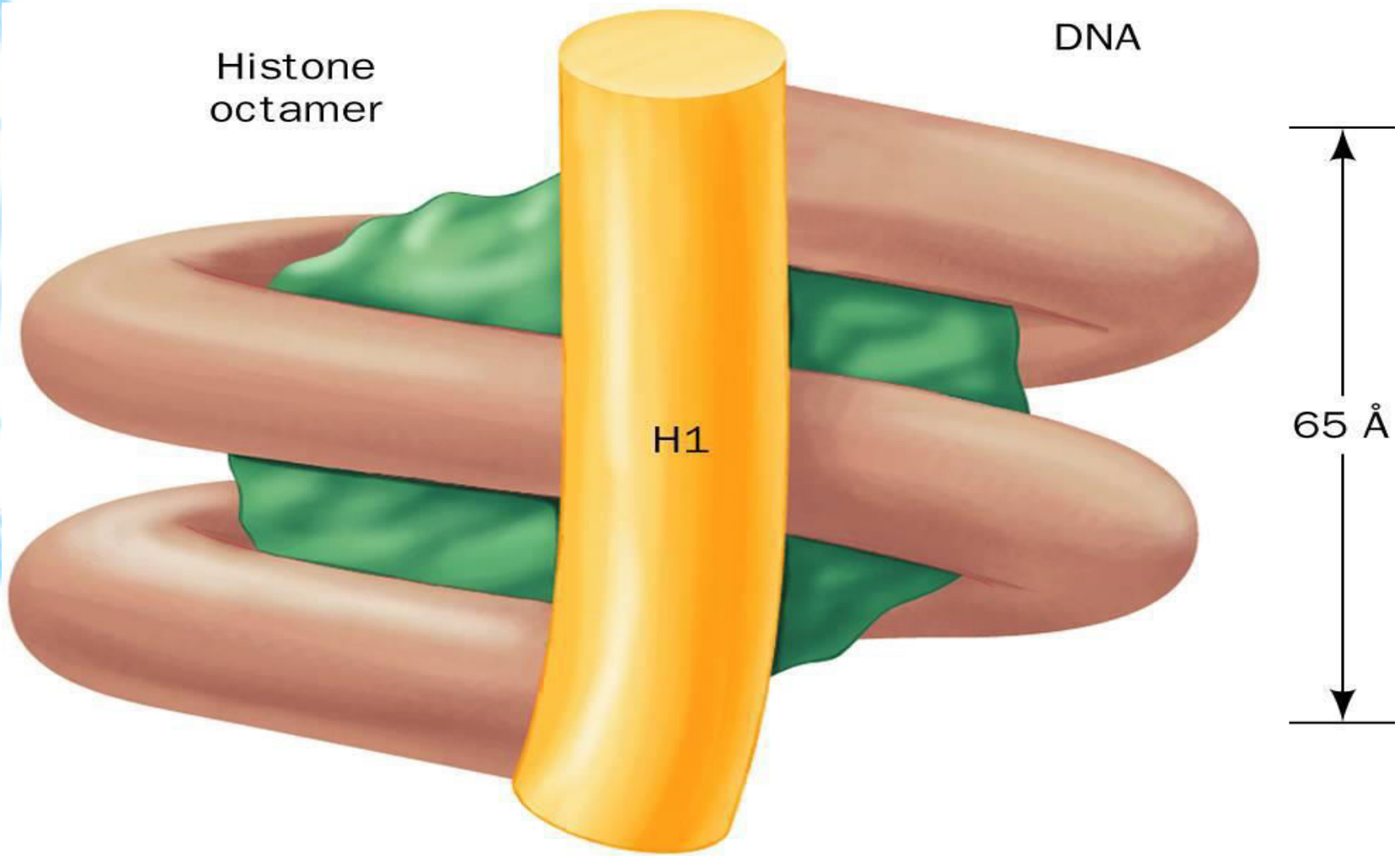
- While the fifth type of histone H1 forms the bond between the core and the DNA.

(H1 binds to 2 complete helical turns of DNA.)



- Major types of Histones: H1, H2A, H2B, H3, and H4.
- They consist of amino acids that are positively charged (arginine and lysine).
- Important: These proteins (+) bind to PO4 (-) groups of DNA, stabilizing the structure of chromatin.

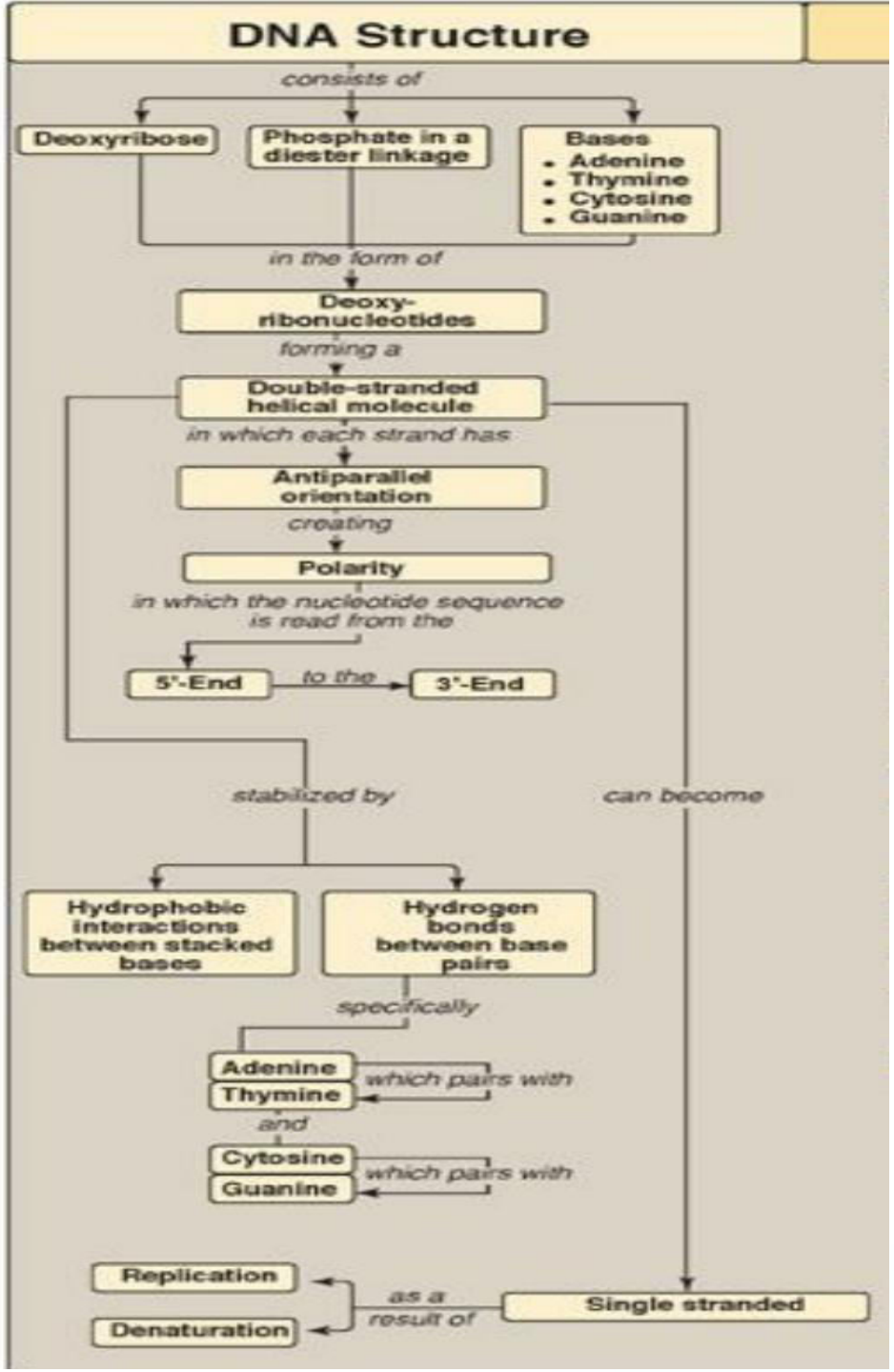
Histone octamer



Take home notes:

- 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.

Review



MCQs

Q1; Which one of the following is the Watson – crick model?

A- A DNA
B- B DNA
C- Z DNA

Q2: RNA is translated into ..... ?

A- Carbohydrates
B- fats
C- proteins

Q3: Nucleotides are composed of :

A- nitrogenous base , hexose & phosphate group
B- nitrogenous base , pentose & phosphate group
C- nitrogenous base , pentose & carboxylic group

Q4: The linkage between the nucleotides are called :

A- phosphodiester bond
B- glycosidic bond
C- Ester bonds

Answer key:

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

SAQs

- Name one benefit of having PO4

.....,.....

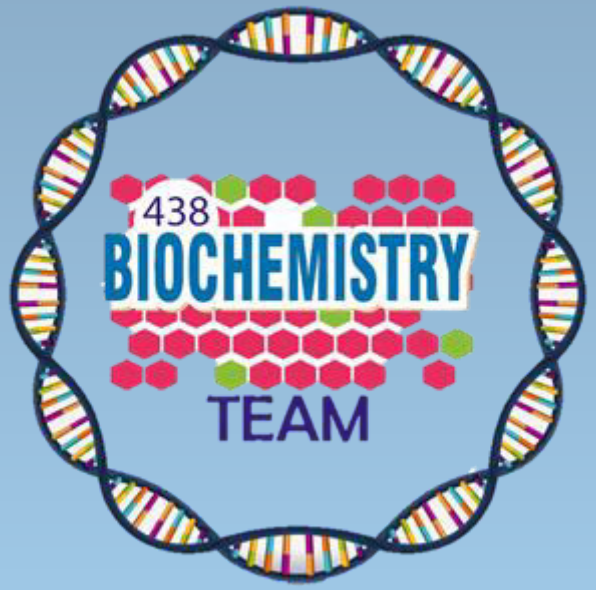
- Name two kinds of nucleotides other than DNA,RNA:

.....,.....

Answer key:

1) Presenting -ev charge.
2) NAD,FAD

➢ Special thanks to:



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- شهد السلامه
- طيف العتيبي
- عبير الخضير
- غيداء البريثن
- لينا العصيمي
- نورة التركي
- نورة المزروع
- نوف الحميضي
- هيفاء الوايلي

❖ Boys team:

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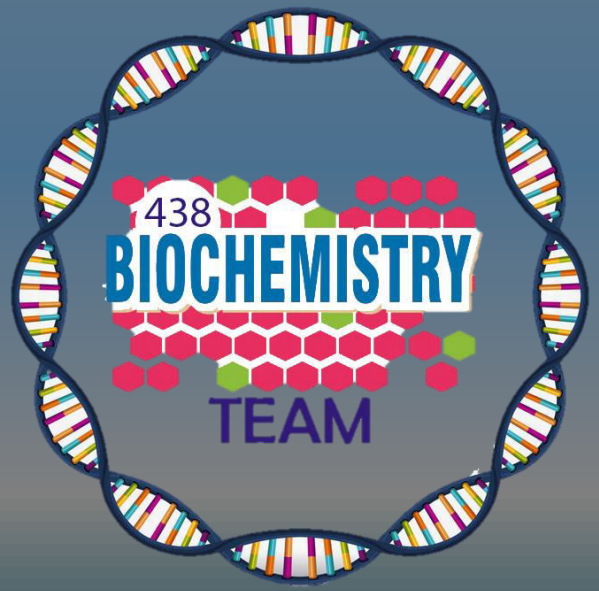
- حميد حميد
- سهيل باسهيل
- عمر الغامدي
- مهند القرني
- نايف السبر



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