

MINISTRY OF PUBLIC HEALTH
ZAPOROZHYE STATE MEDICAL UNIVERSITY
DEPARTMENT OF ORGANIC AND BIOORGANIC CHEMISTRY

LECTURE: NUCLEIC ACIDS.



Lecturer:

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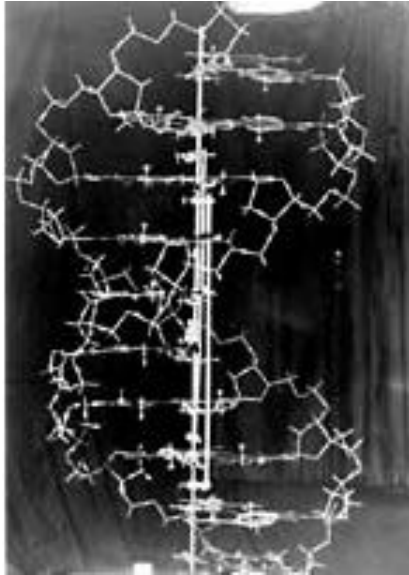
Plan.

1. First isolation of DNA (deoxyribonucleic acid).
2. Pirimidine and purine bases.
3. Minor bases.
4. Structure of nucleosides and nucleotides.
5. Types of bonds in 2'-deoxycytidine-5'-diphosphate.
6. Watson-Crick model of a DNA.
7. Base pairing.
8. Chargaff principles.
9. Different levels of DNA structure.
10. Interesting facts about DNA.
11. Nicotinamide adenine dinucleotide's structure.
12. Bial's test.
13. Mutations.
14. Antiviral drugs.

DNA (deoxyribonucleic acid) was firstly isolated by the Swiss physician Friedrich Miescher in 1869.

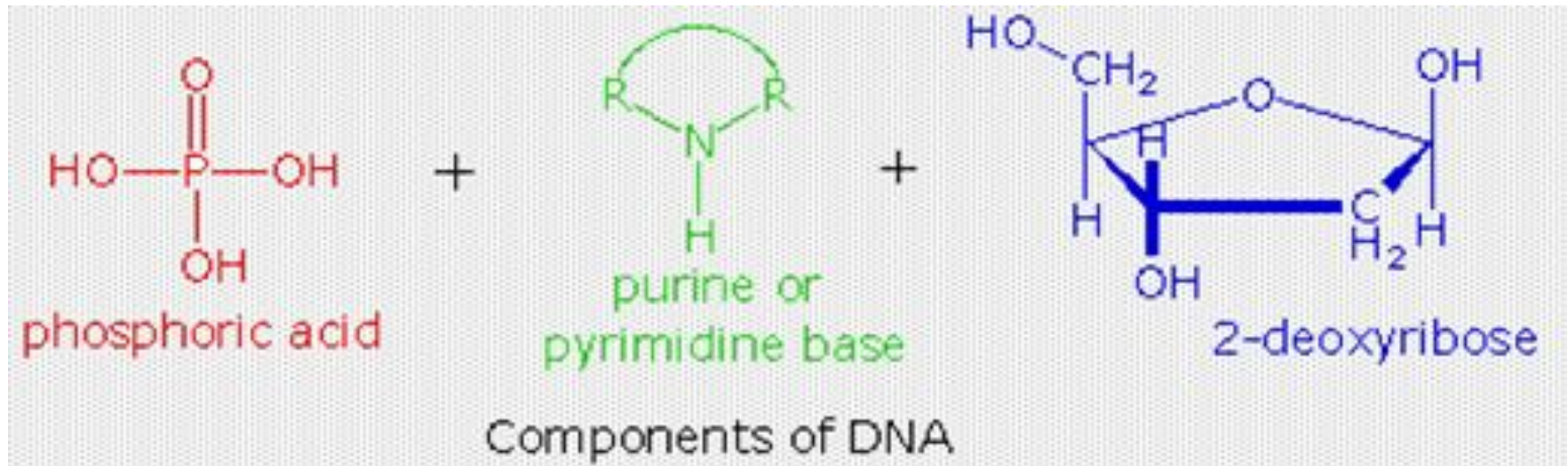
Actually it was Rosalind Franklin's discovery (X-ray diffraction picture of structure of DNA) that led to Crick and Watson's double helix model in 1953. She died from cancer at the age of 37 in 1958.

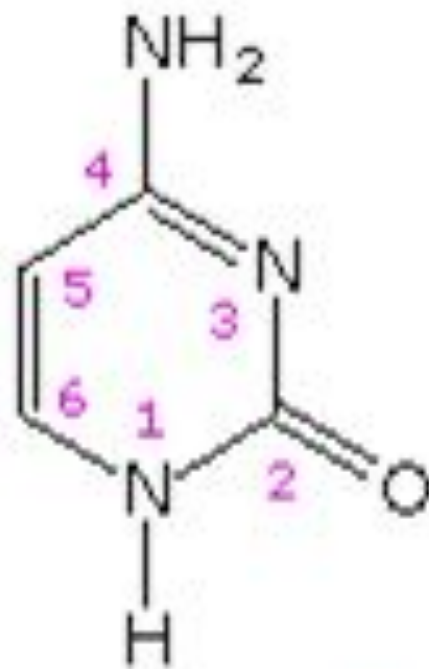
Professor Maurice Wilkins received the Nobel Prize with Crick and Watson for three-dimensional structure of DNA in 1962.



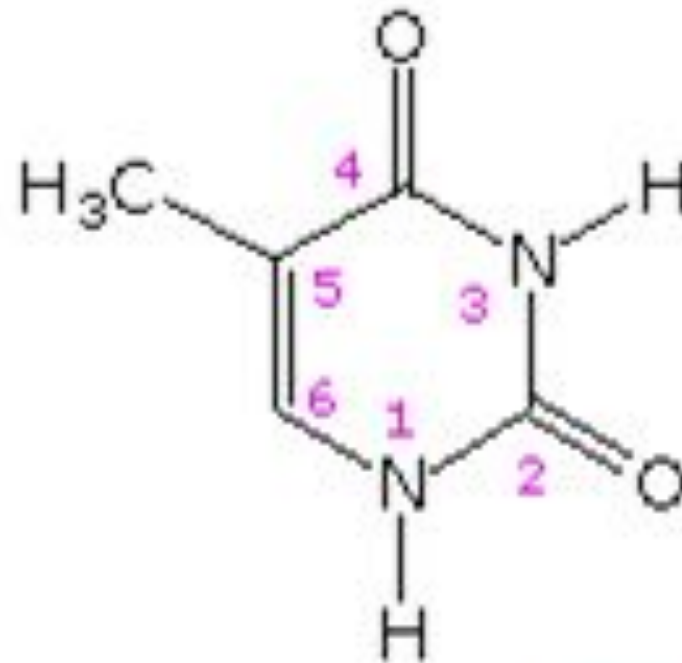
The polymeric structure of DNA may be described in terms of monomeric units of increasing complexity.

The three relatively simple components are.





Cytosine **C**

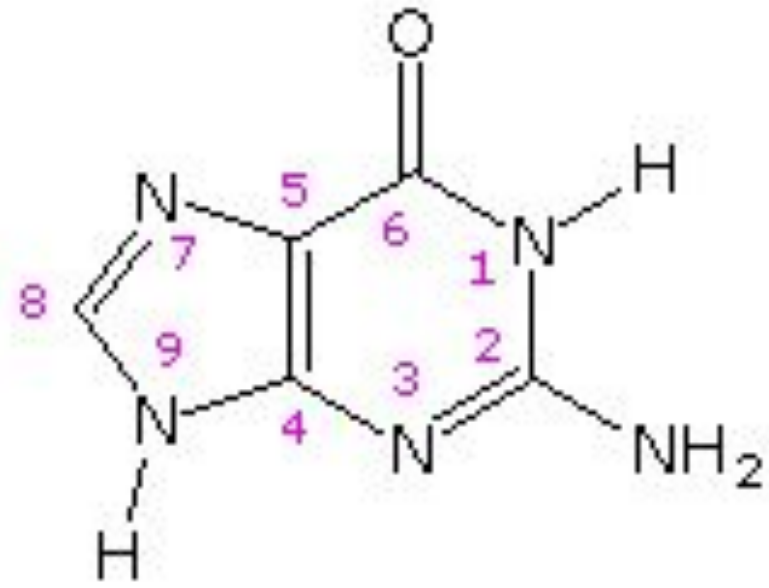


Thymine **T**

pyrimidine bases



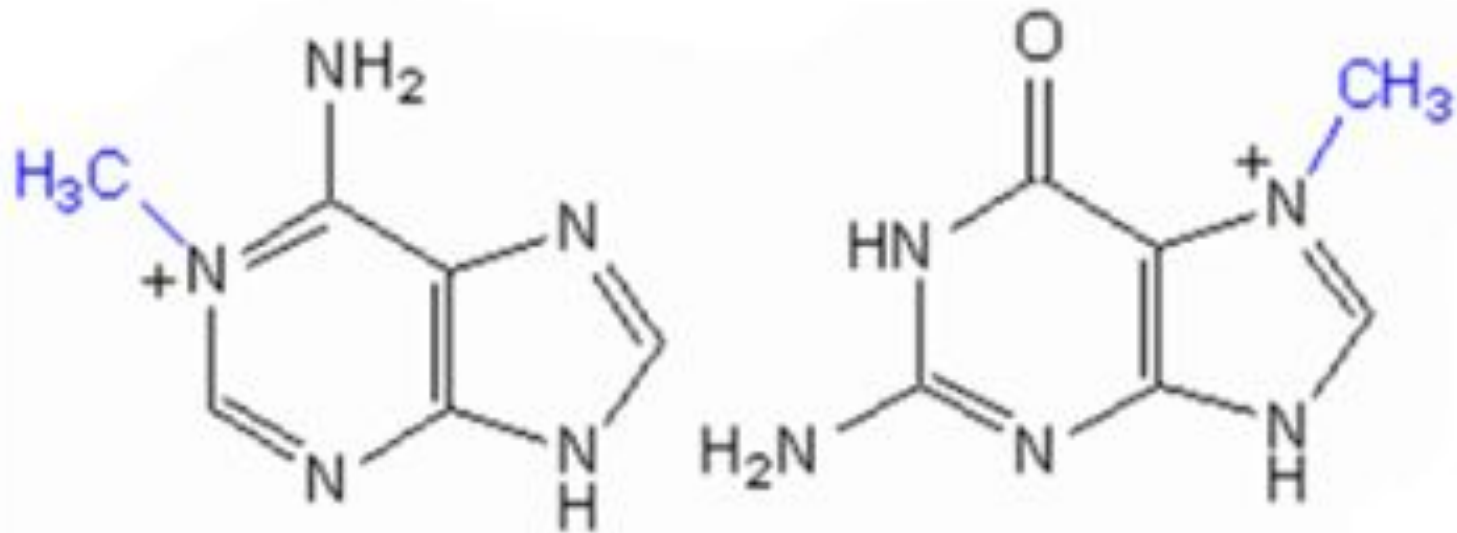
Adenine **A**



Guanine **G**

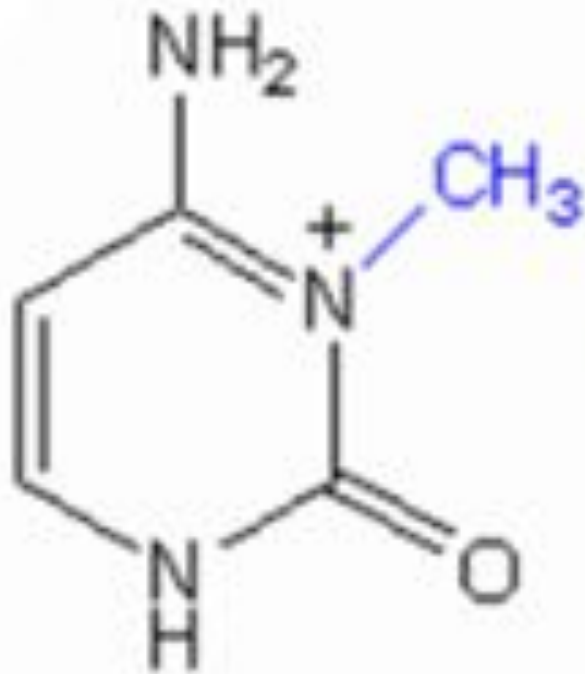
purine bases

Examples of modified bases found in tRNA:

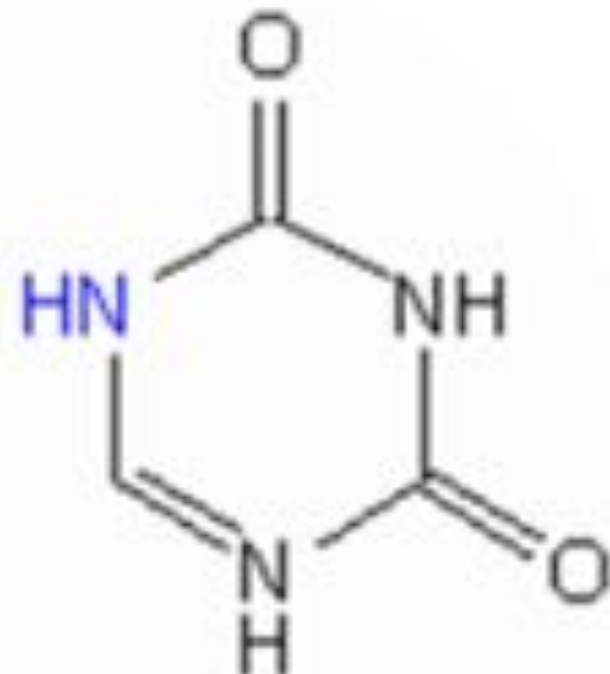


1-methyladenine (m¹A) 7-methylguanine (m⁷G)

Examples of modified bases found in tRNA:



3-methylcytosine (m³C)



pseudouracil (Ψ)

Bases attached to a sugar is called **nucleoside**.

Sugar + phosphate + base = **nucleotide**.

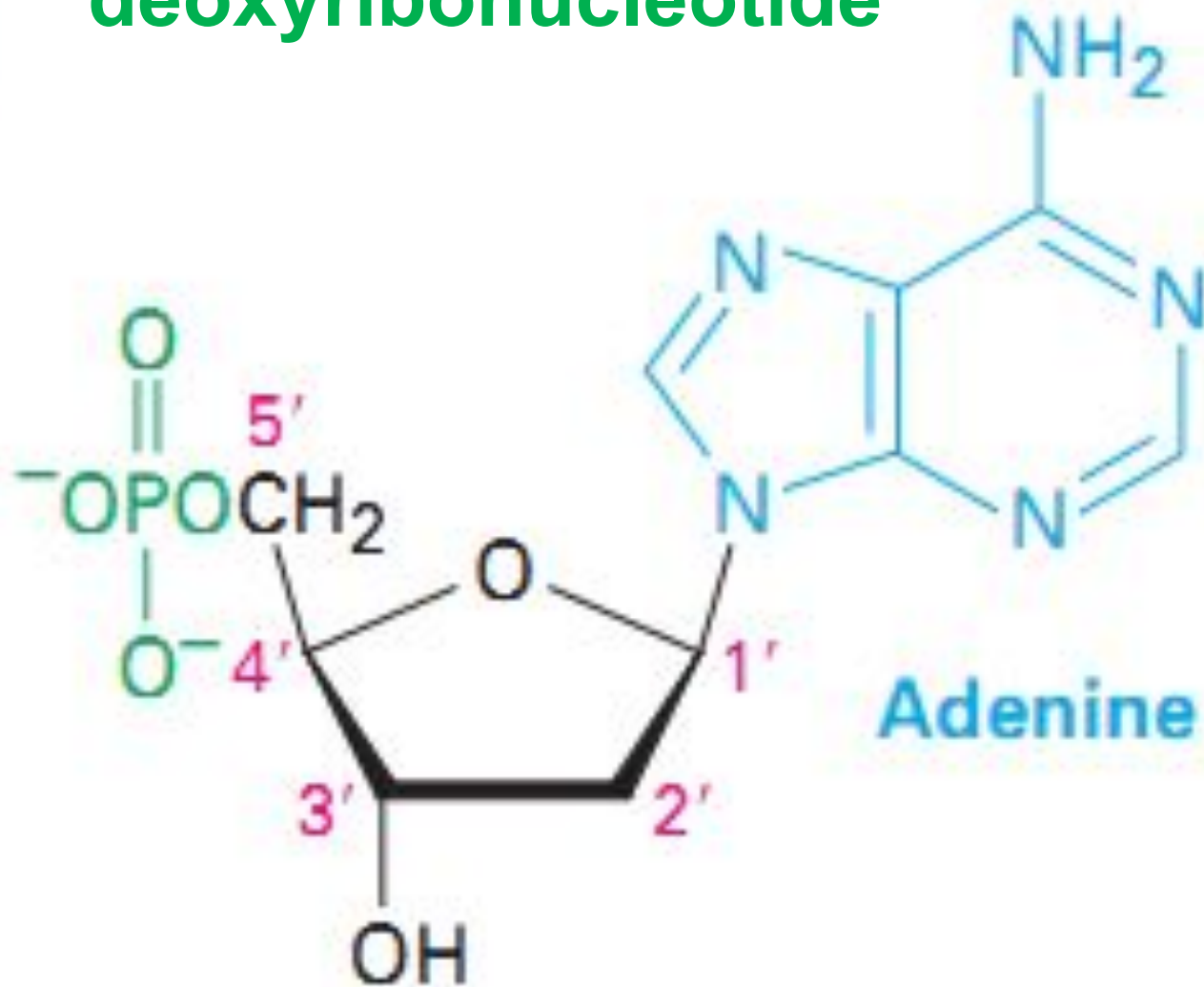
DNA only : Thymine, 2-deoxyribose

RNA only : Uracil, ribose

DNA and RNA : adenine, guanine, cytosine

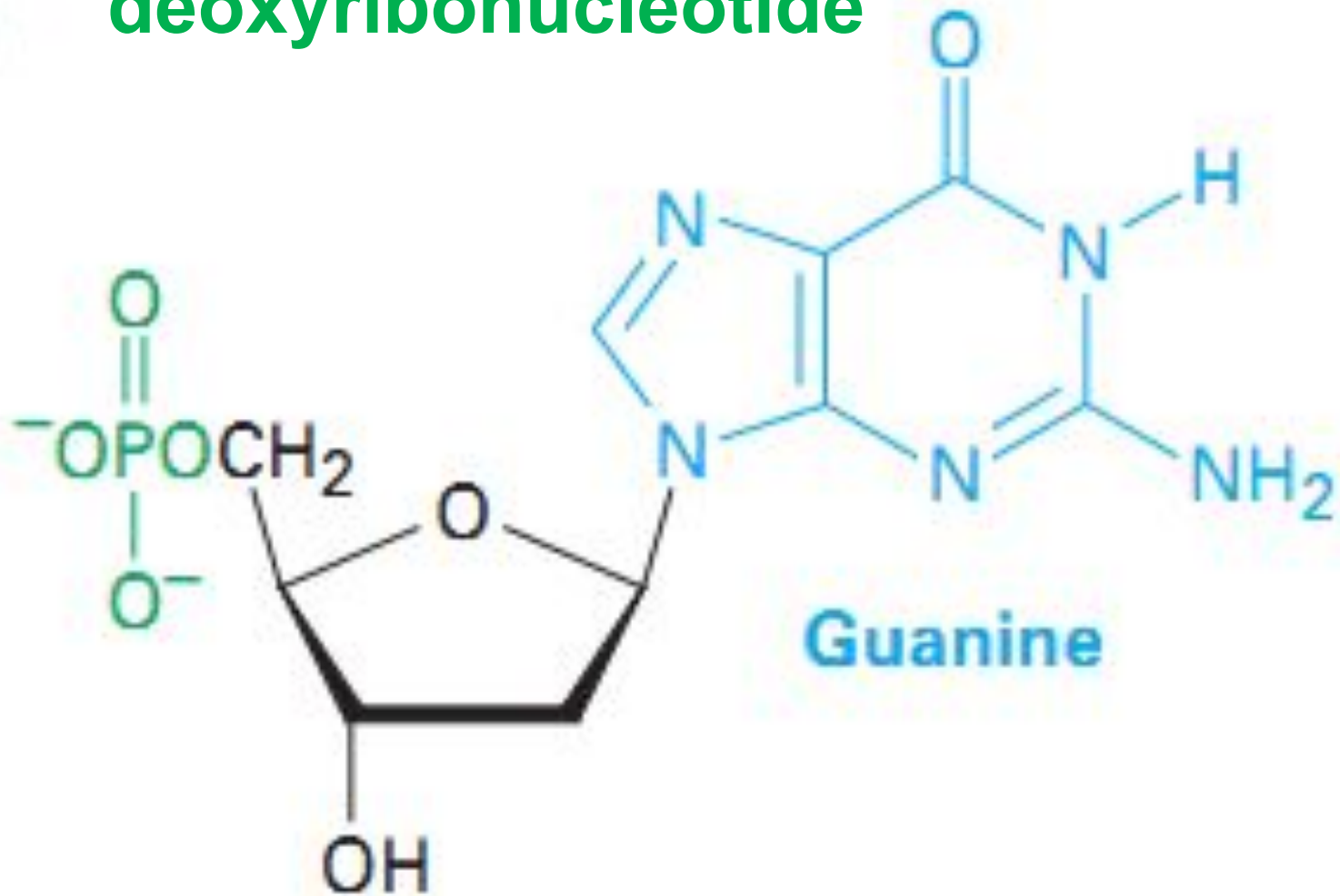
A

deoxyribonucleotide



2'-Deoxyadenosine 5'-phosphate

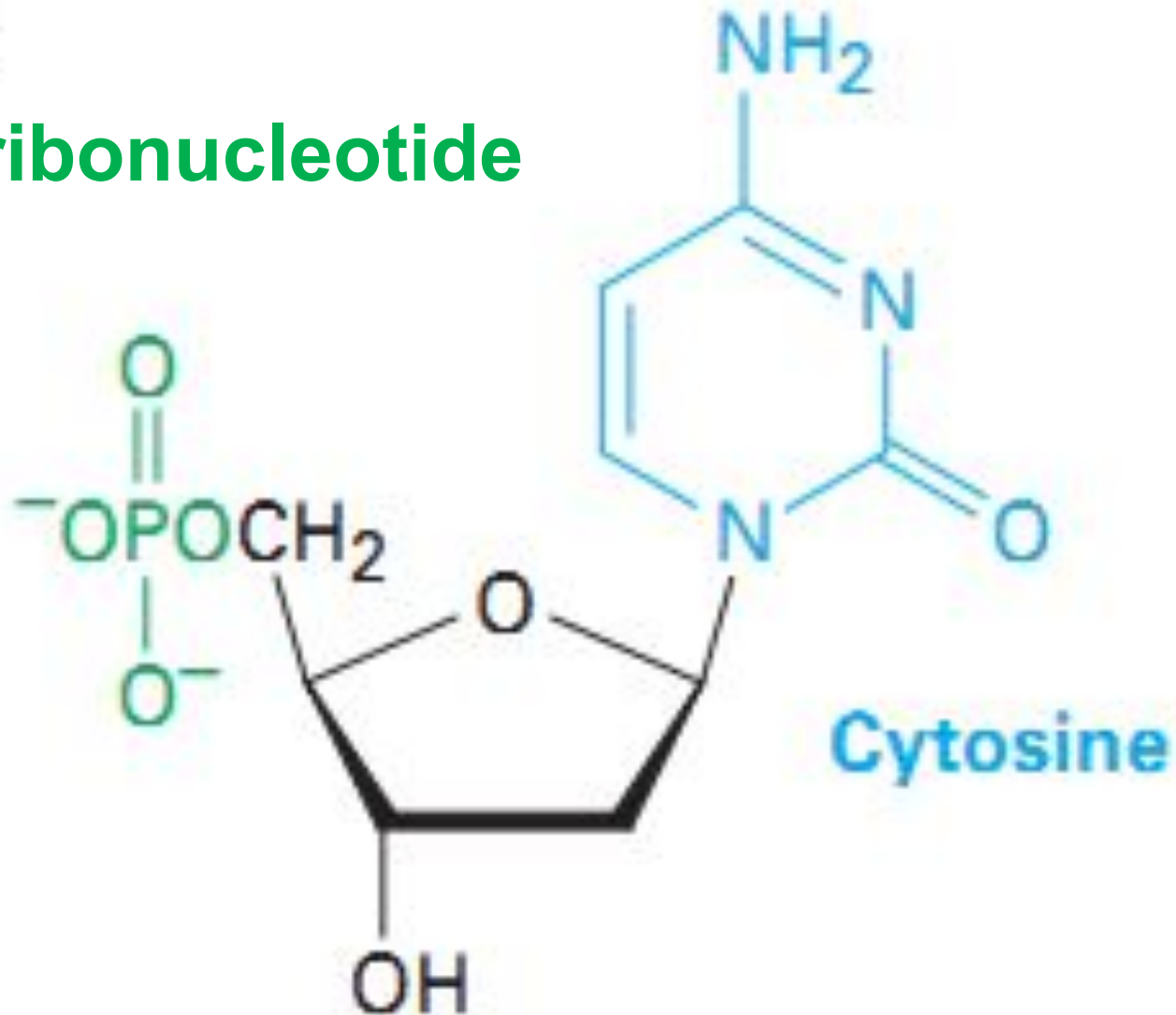
G deoxyribonucleotide



2'-Deoxyguanosine 5'-phosphate

C

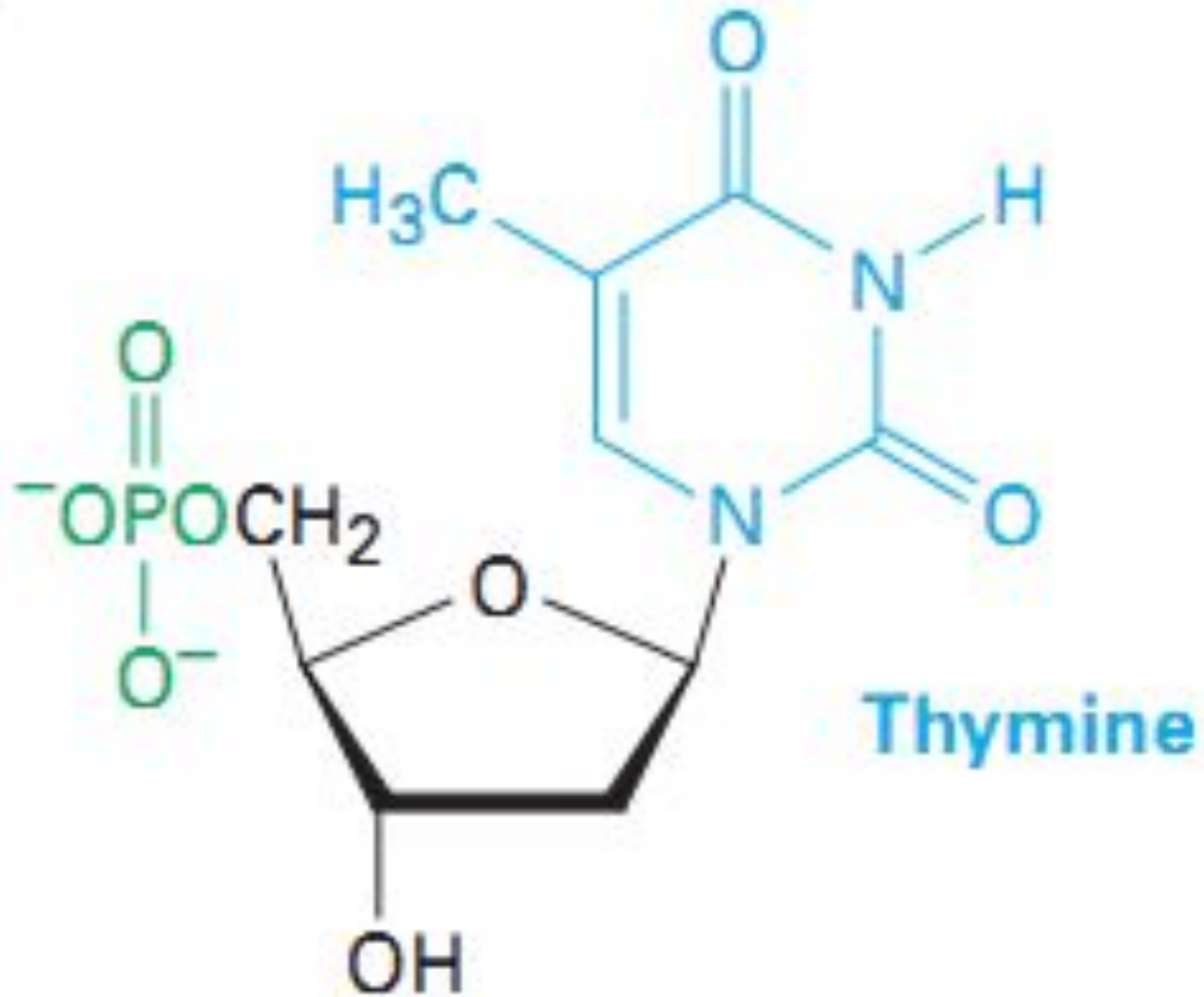
deoxyribonucleotide



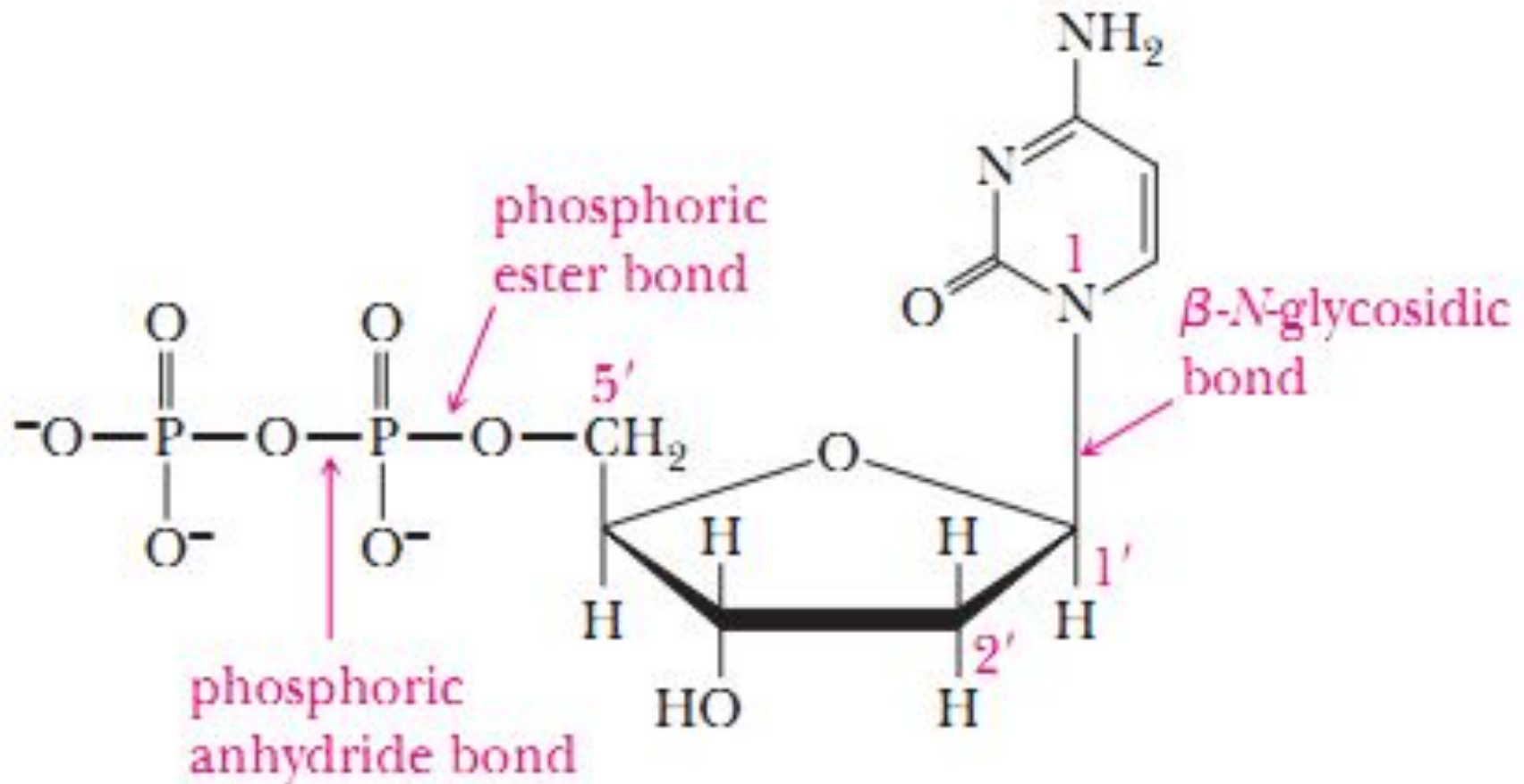
2'-Deoxycytidine 5'-phosphate

deoxyribonucleotide

T



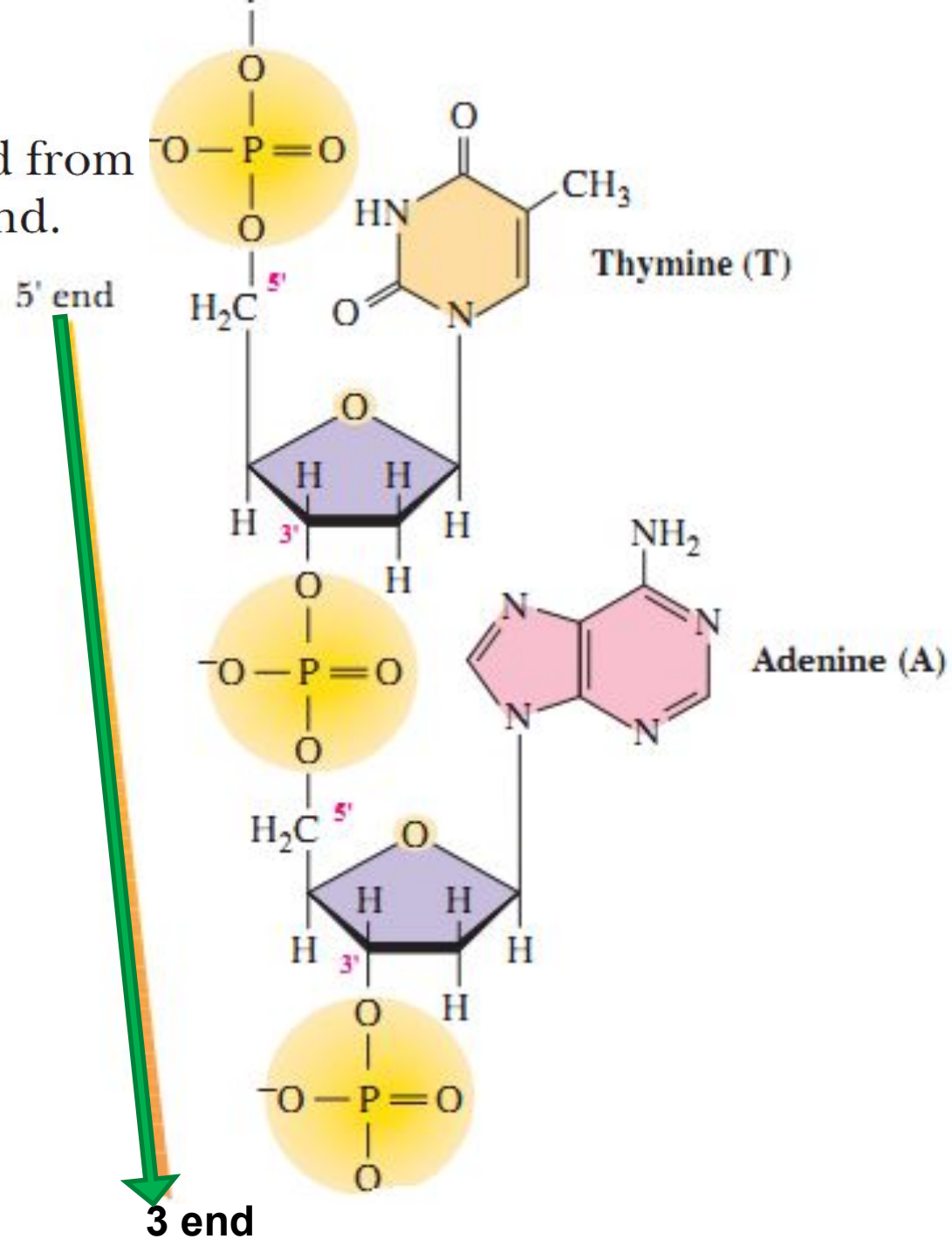
Types of bonds in 2'-deoxycytidine-5'-diphosphate



Names of DNA Base Derivatives

Base	Nucleoside	5'-Nucleotide
Adenine	2'-Deoxyadenosine	2'-Deoxyadenosine-5'-monophosphate Adenylic acid
Cytosine	2'-Deoxycytidine	2'-Deoxycytidine-5'-monophosphate Cytidylic acid
Guanine	2'-Deoxyguanosine	2'-Deoxyguanosine-5'-monophosphate Guanidylic acid
Thymine	2'-Deoxythymidine	2'-Deoxythymidine-5'-monophosphate Thymidylic acid

Base sequence is read from the 5' end to the 3' end.



RNA are easily hydrolyzed under mild alkaline conditions to **nucleotides** which is cleaved in alkaline medium the phosphoric acid to form **nucleosides**, that are hydrolyzed in acidic medium to the **heterocyclic base** and the **sugar**.

The secondary structure of DNA is determined by the spatial organization of the polynucleotide chain.

. The orientation of the **heterocyclic base** on each nucleotide residue is **perpendicular** to the axis of the double helix.



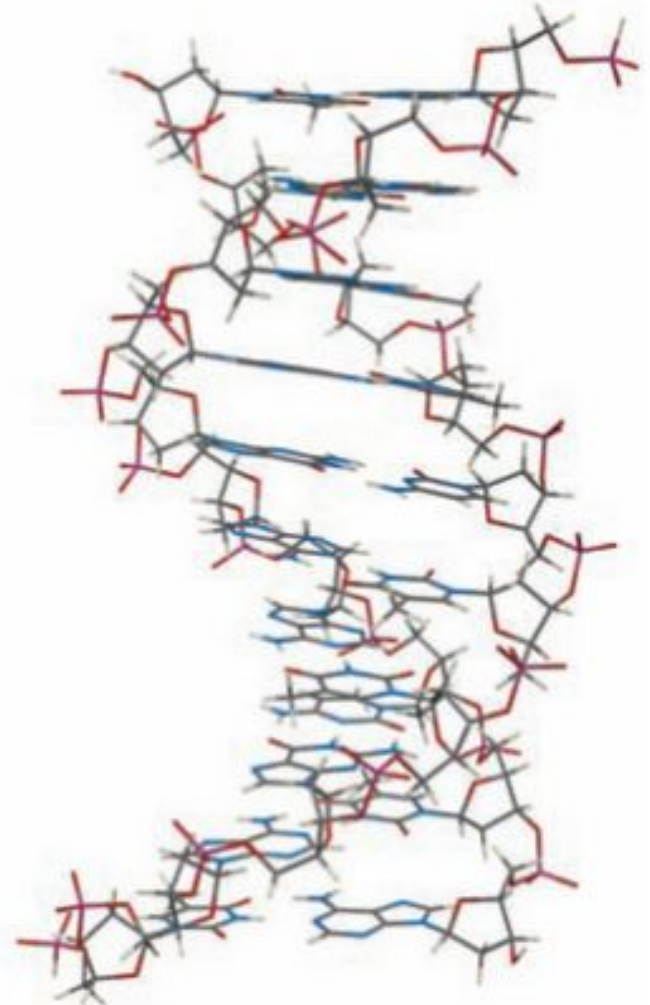
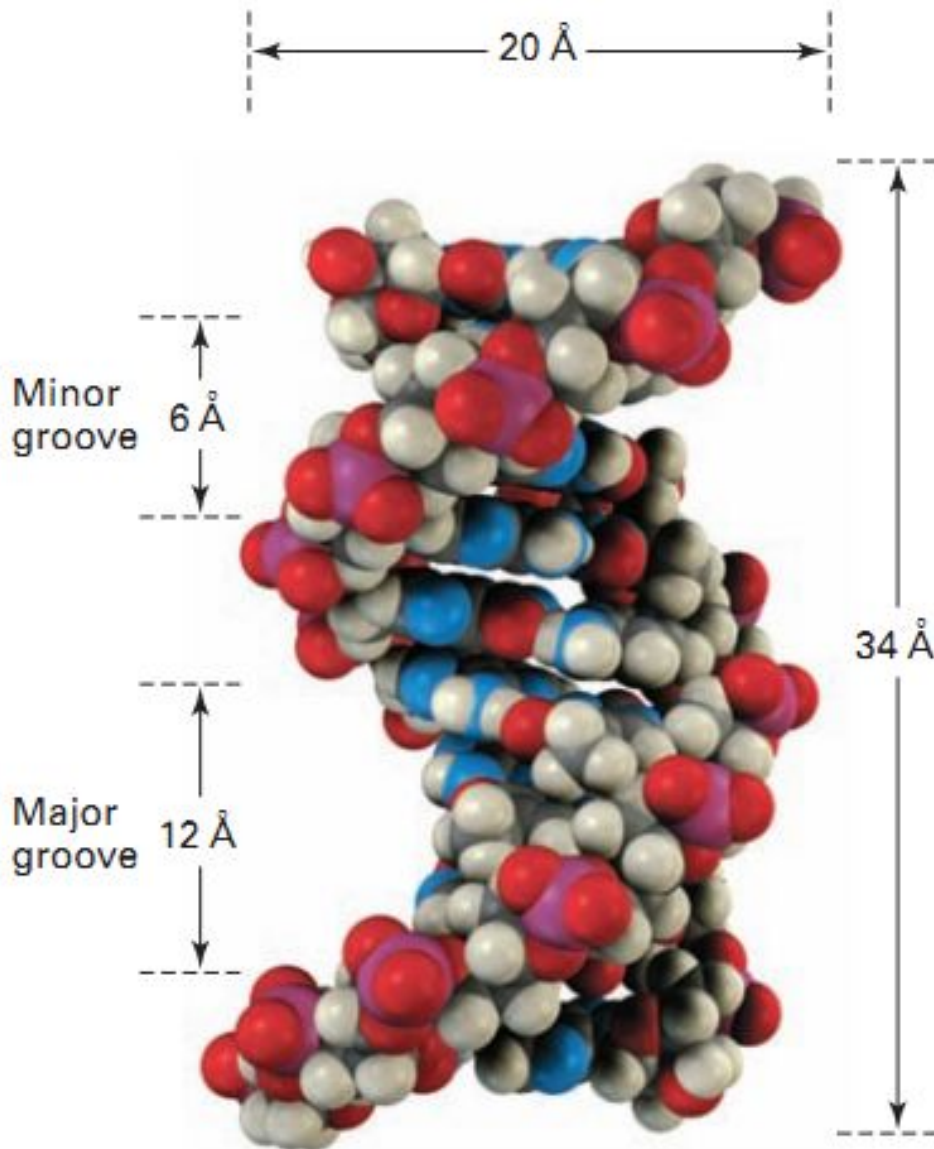
*Watson and Crick with their
model of DNA.*

According to the Watson-Crick model of a DNA molecule consists of **two** polynucleotide chains forming a **double helix** with diameter of 1.8 - 2.0 nm. At **each turn** of the helix are **ten base pairs**.

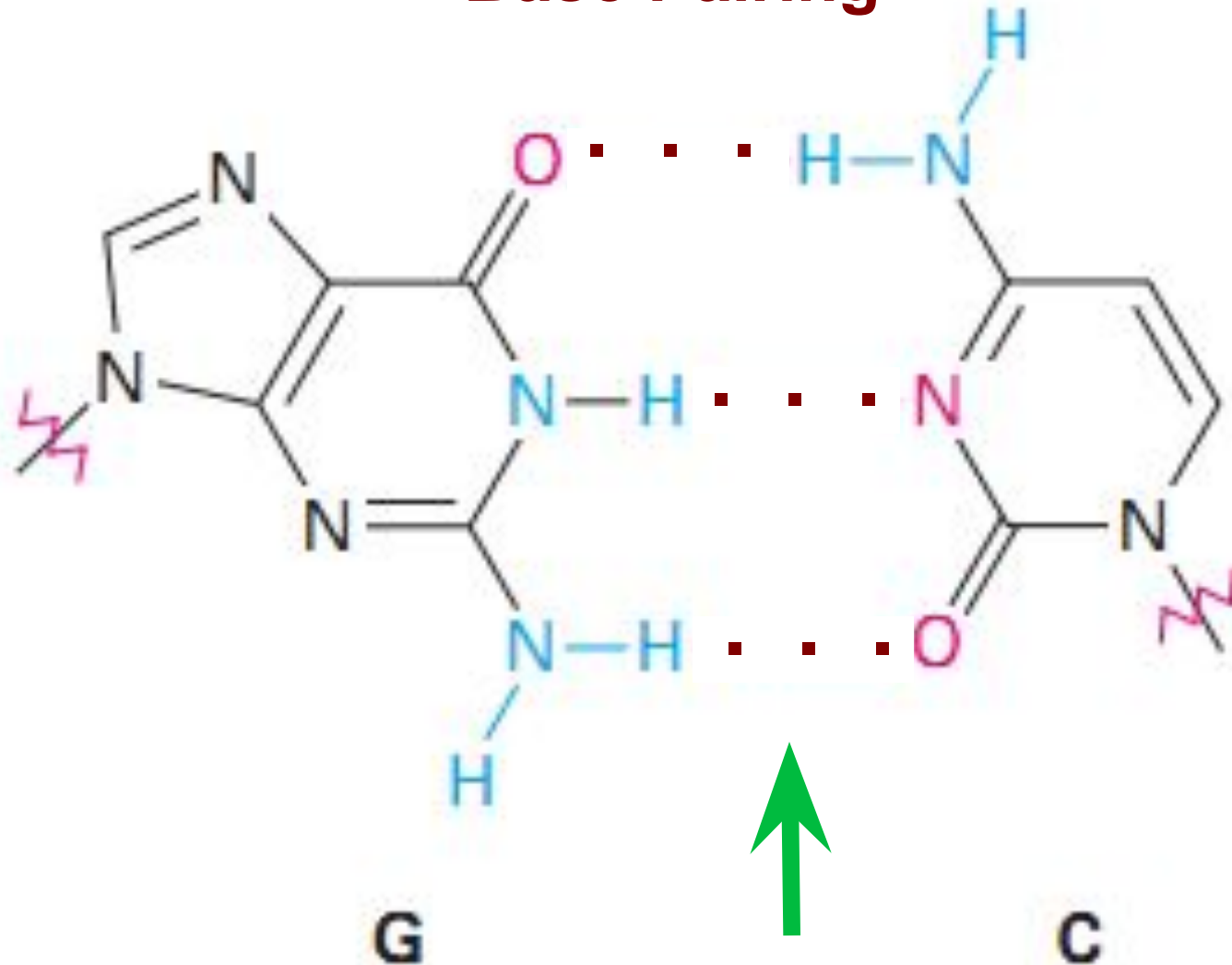
The **sugar– phosphate** backbone runs along the **outside** of the helix, and the **amine bases** hydrogen bond to one another on the **inside**. Both major and minor grooves are visible.

Two polynucleotide strands are **antiparallel** to each other, so direction of phosphodiester formation is opposite: **one chain is 5' - 3' end** and the other of 3' – 5' end.

DNA double helix fragment in space-filling and wire-frame format

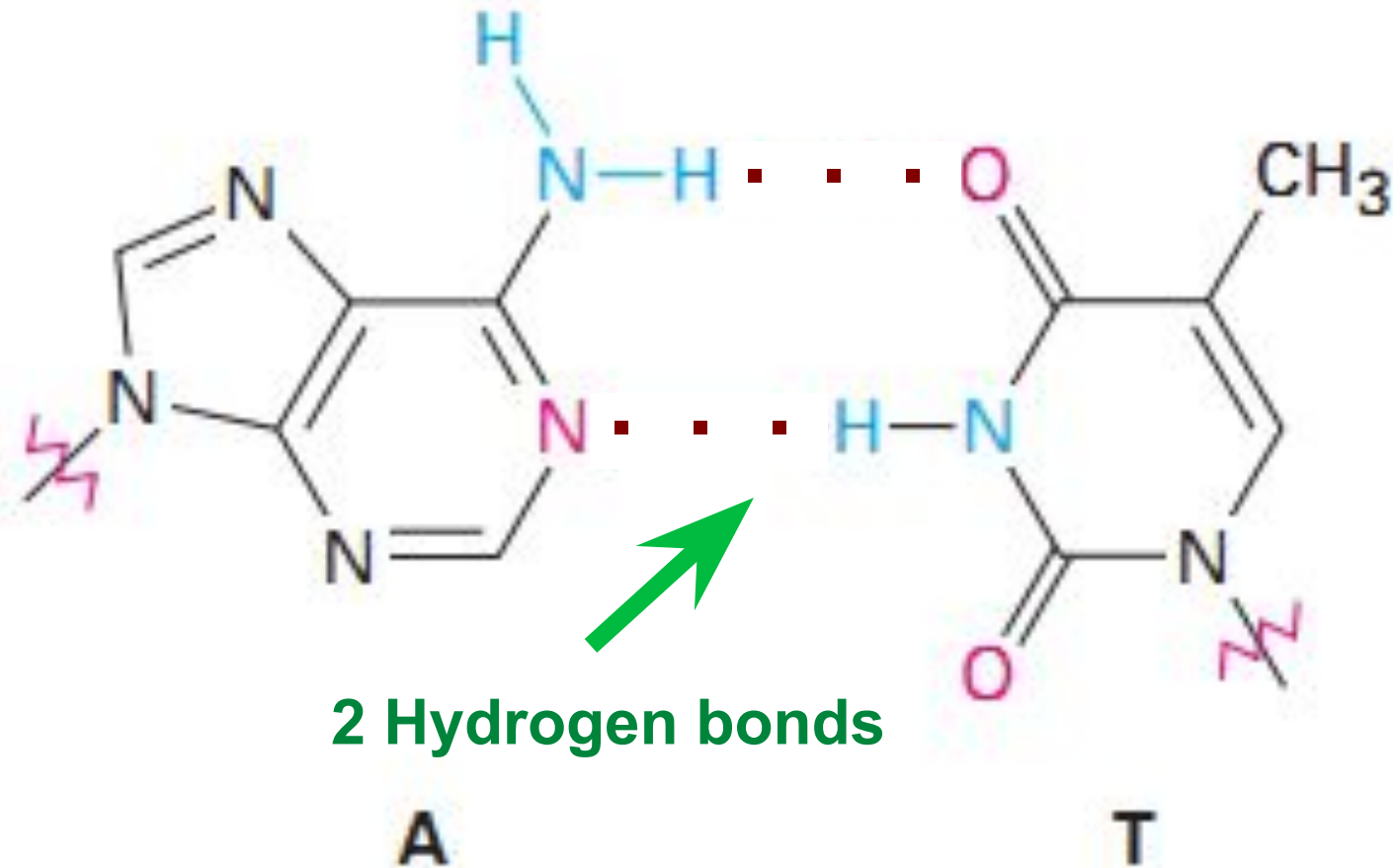


Base Pairing



3 Hydrogen bonds

Base Pairing

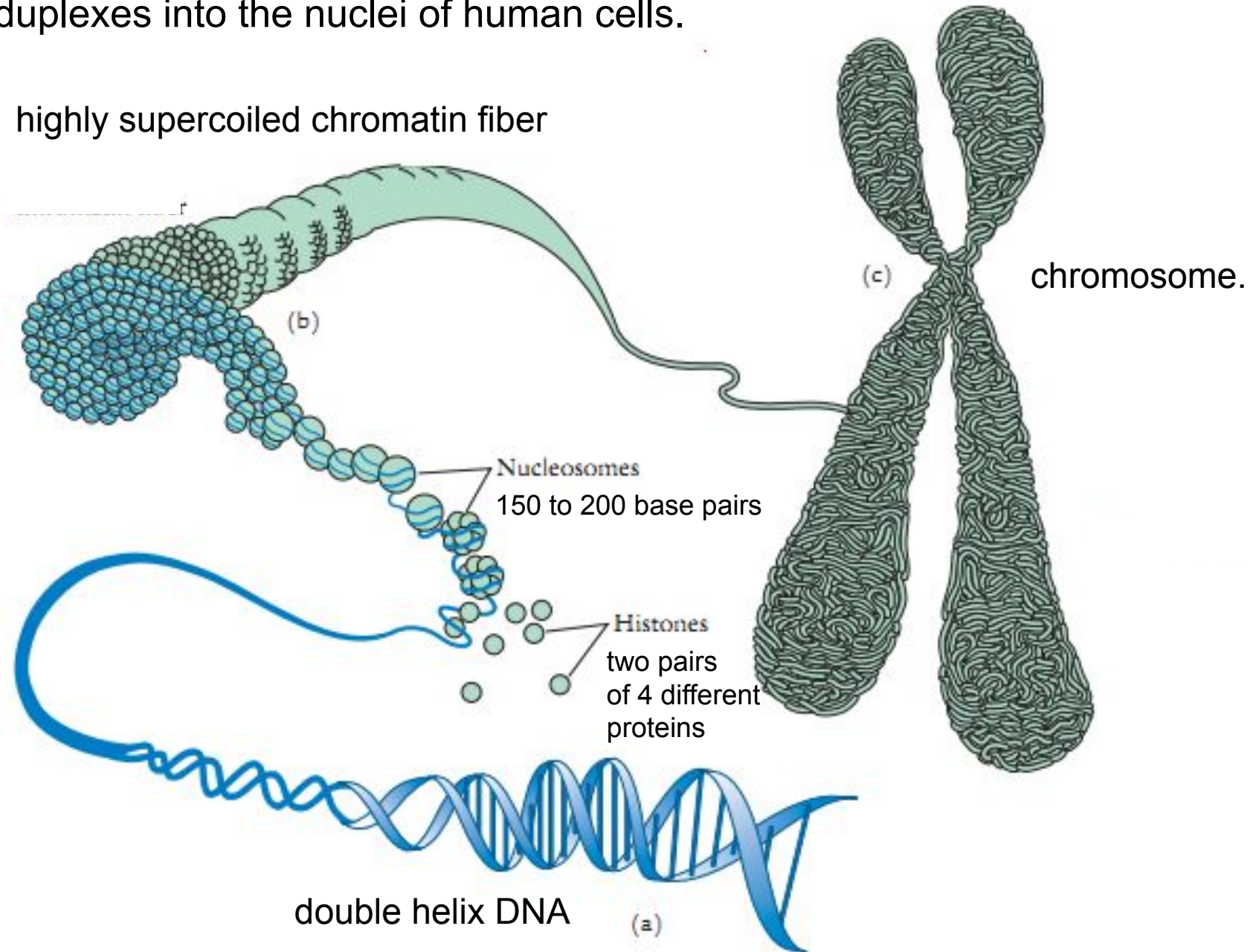


Chargaff principles:

- **A** always pairs with **T** in DNA.
- **C** also pairs with **G** in DNA.
- The amount of **A** is equal to the amount of **T**, same for **C** and **G**.
-
- $A + C = T + G$

Different levels of DNA structure to fit the enormously long DNA duplexes into the nuclei of human cells.

highly supercoiled chromatin fiber





Replication — the process by which identical copies of DNA are made so that information can be preserved and handed down to offspring.

Transcription — the process by which the genetic messages are read and carried out of the cell nucleus to ribosomes, where protein synthesis occurs.

Translation — the process by which the genetic messages are decoded and used to synthesize proteins.

IF YOU UNWRAP ALL OF THE DNA YOU HAVE IN
ALL YOUR CELLS, YOU COULD REACH THE MOON
6000 TIMES.



99.9% OF OUR
DNA SEQUENCE IS
THE SAME AS
OTHER HUMANS'.



This **0.1% DNA DIFFERENCE**
between us may have to do with the number of
nucleotides in a person's DNA.

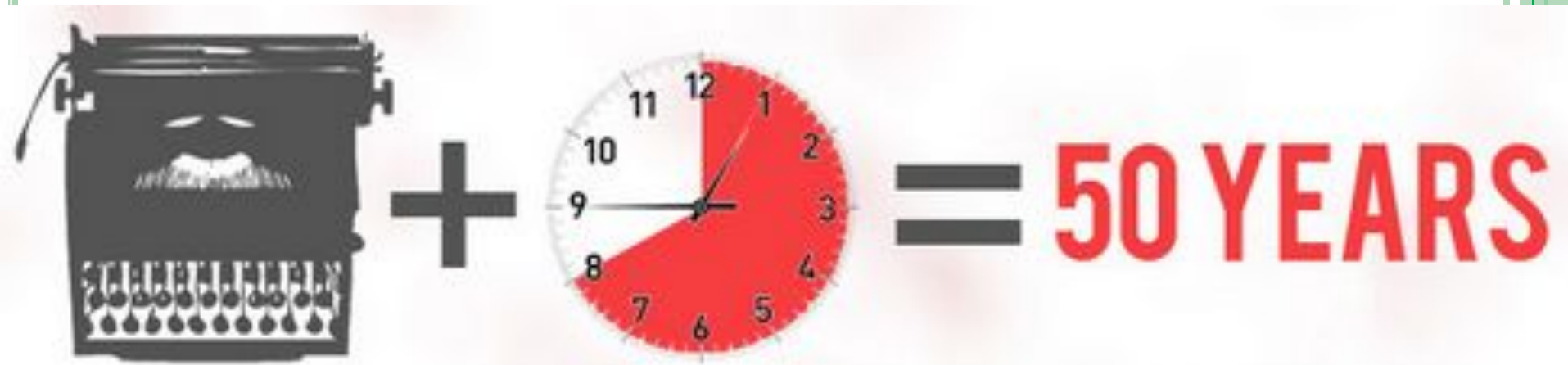


Our entire DNA sequence is
called a genome...
and there's an estimated
3,000,000,000
DNA bases in our genome.



A complete 3 billion
base genome would
take **3 GIGABYTES** OF
STORAGE SPACE.





It would take a person typing 60 words per minute, 8 hours a day, around 50 years to type the human genome.

Almost all the cells in our body have DNA with the exception of red blood cells.



In 2000, a rough draft of a map of the entire human genome (complete DNA sequence) was completed.

**IN 2003, THE FINAL DRAFT
WAS COMPLETED.**

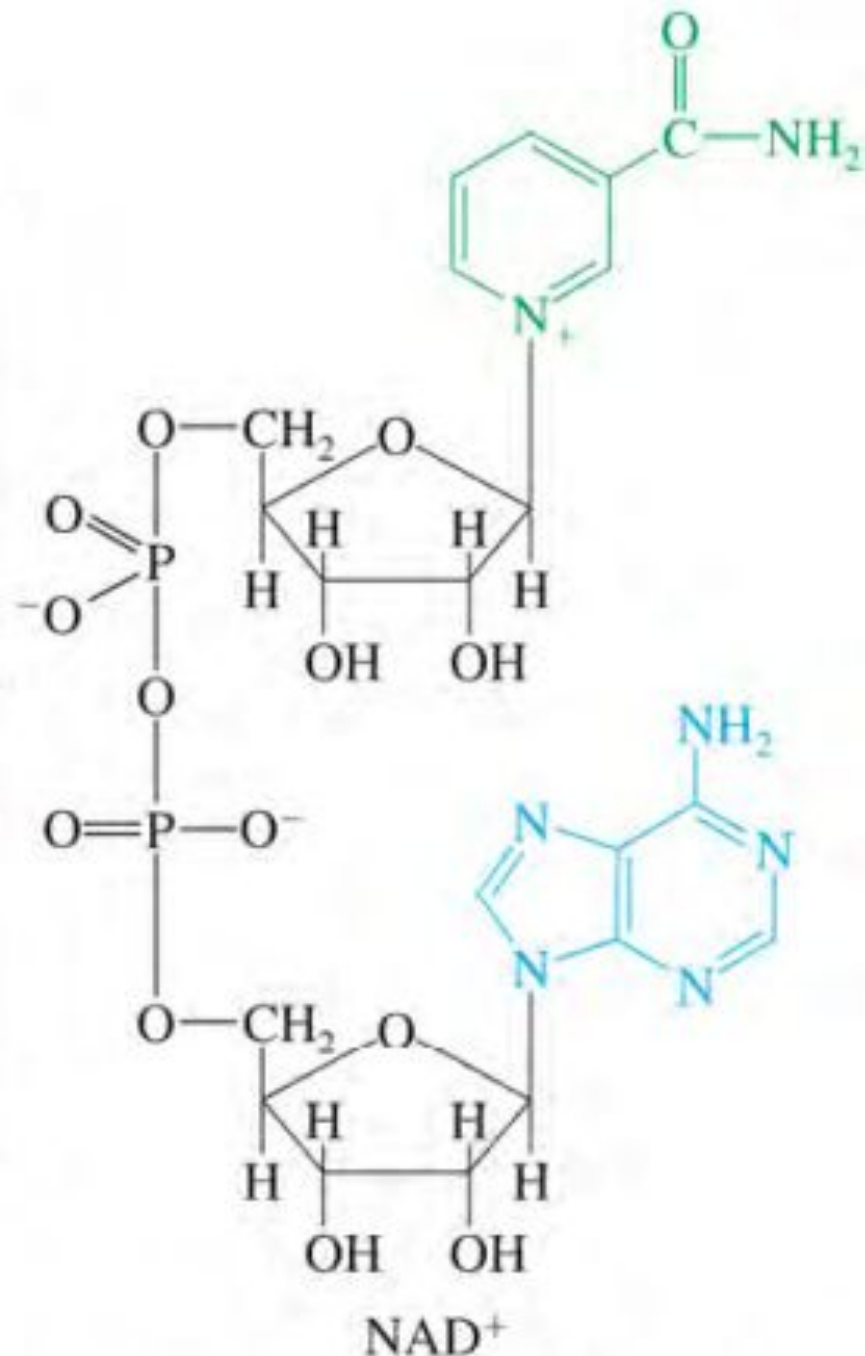


THIS INFORMATION IS BEING USED TO:

+ BETTER UNDERSTAND THE CAUSE AND
FUNCTION OF DISEASE.

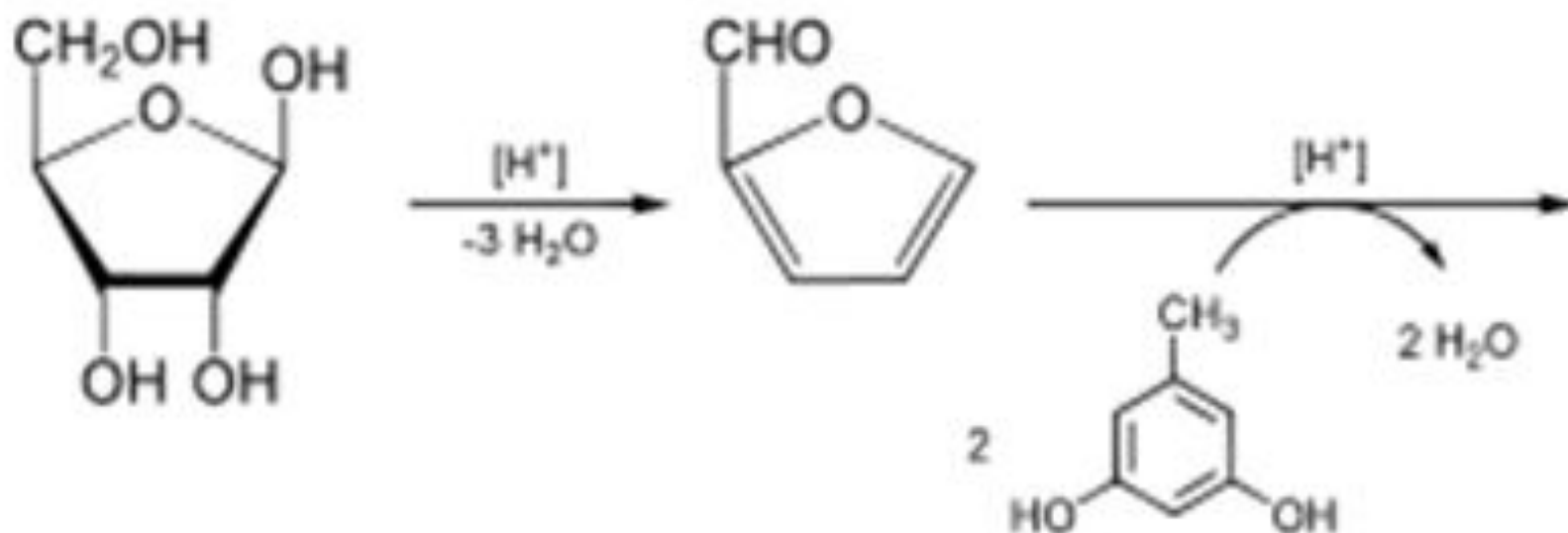
+ CREATE BETTER PREVENTATIVE
MEDICINE.

Nicotinamide adenine dinucleotide (NAD) is one of the principal oxidation-reduction reagents in biological systems.



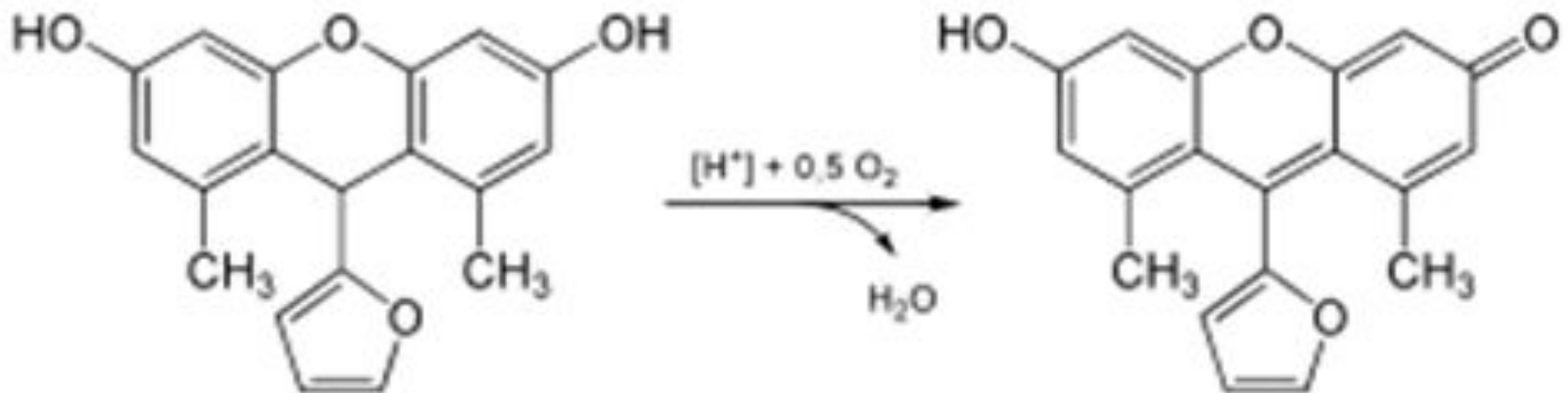
Bial's test

(pentose detection in products of nucleoprotein hydrolysis)



When reacted with concentrated solution of H₂SO₄ or dilute HCl pentoses are dehydrated to form furfural which is condensed with orcinol (3,5-dihydroxytoluene).

Bial's test



Also they gave red products of condensation with thymol (2-isopropyl-5-methylphenol).

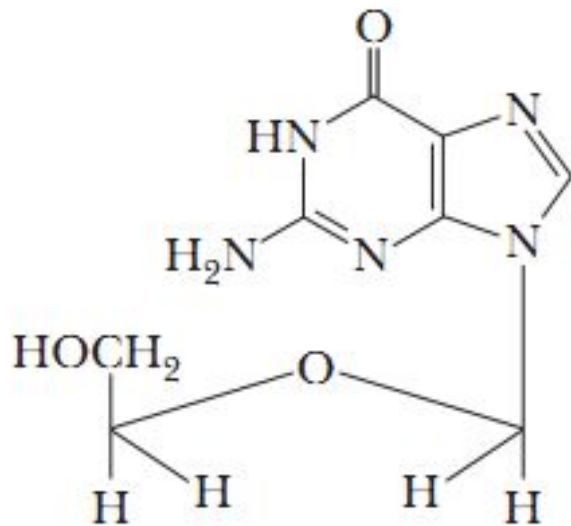
A mutation is an error in the base sequence of a gene.

The end result can be the alteration or cessation of a polypeptide's or protein's functioning because of a change in its α -amino acid sequence.

There are two types of mutations:

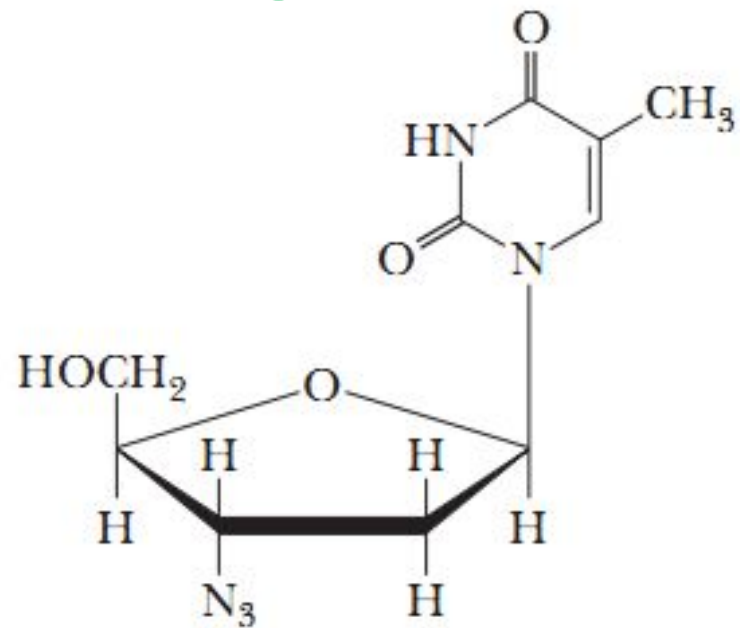
- **Substitution** (point) mutations, in which one base substitutes for another in the normal base sequence: one purine for another, one pyrimidine for another, a purine for a pyrimidine, or a pyrimidine for a purine.
- **Frameshift** mutations, in which a base is inserted into the normal base sequence or is deleted from it.

Antiviral drugs



Acyclovir

(drawn to show its structural relationship to 2-deoxyguanosine)



Zidovudine

(Azidothymidine; AZT)

DNA synthesis terminates whenever AZT is incorporated into the growing DNA strands in the course of reverse transcription.

Protease inhibitors block step 7, the cutting up of the proteins produced by the translation of viral RNA, by inactivating the enzyme protease.

New viruses are not produced.



**Thank You
for Your
attention!**

