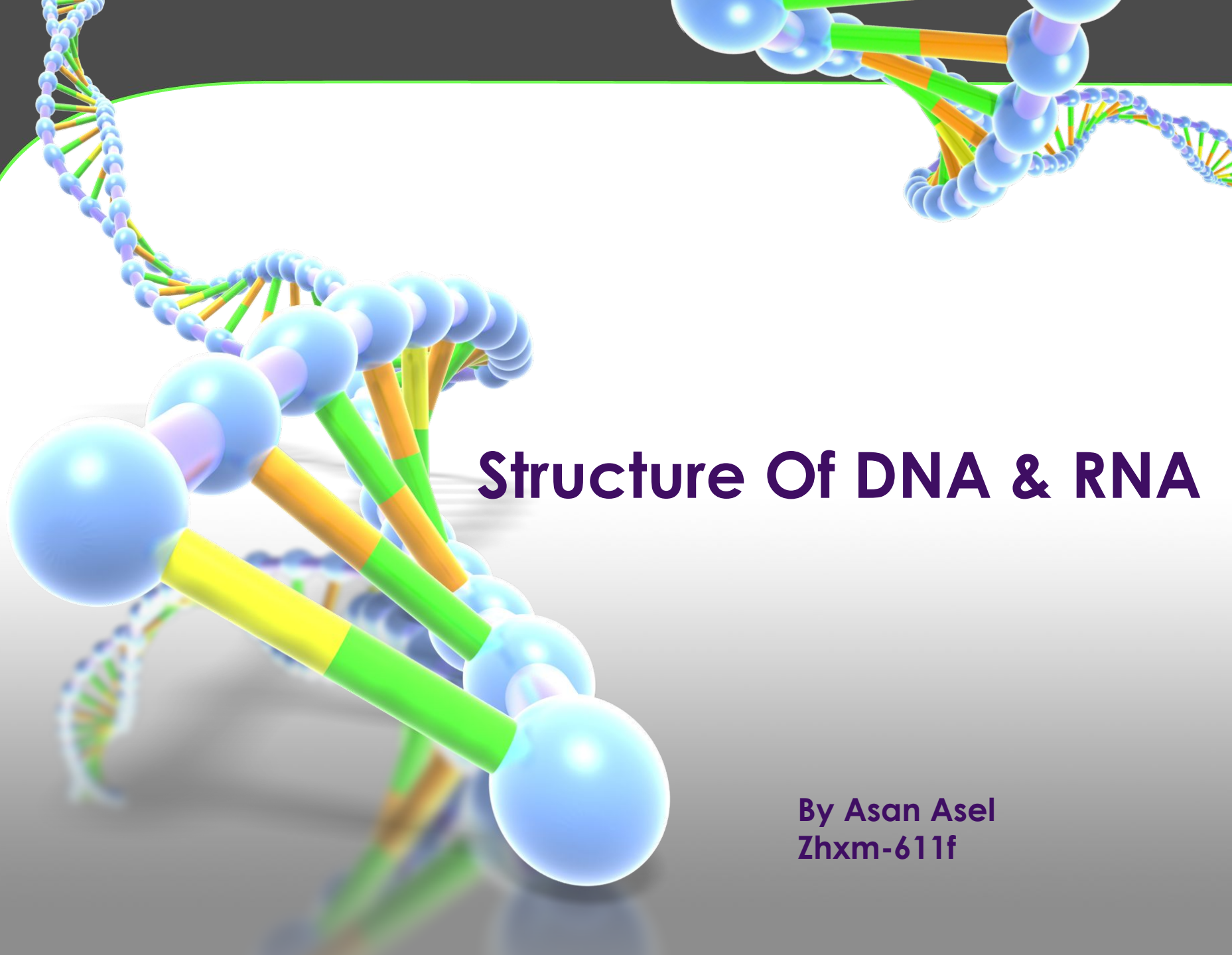


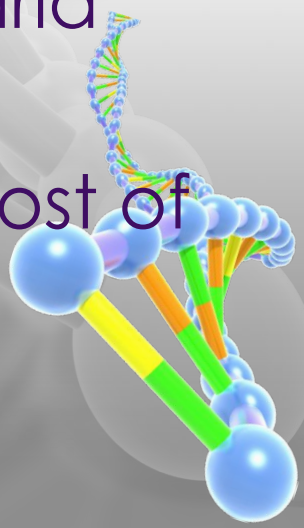
Structure Of DNA & RNA

By Asan Asel
Zhxm-611f

DNA

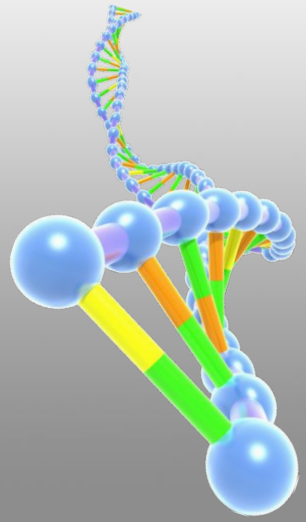
DNA

- Deoxyribonucleic acid
- DNA - a polymer of deoxyribo-nucleotides.
- Usually double stranded.
- And have double-helix structure.
- found in chromosomes, mitochondria and chloroplasts.
- It acts as the genetic material in most of the organisms.
- Carries the genetic information



A Few Key Events Led to the Discovery of the Structure of DNA

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



Friedrich Meischer

- In 1953 , ***James Watson and Francis Crick***, described a very simple but famous ***Double Helix*** model for the structure of DNA.

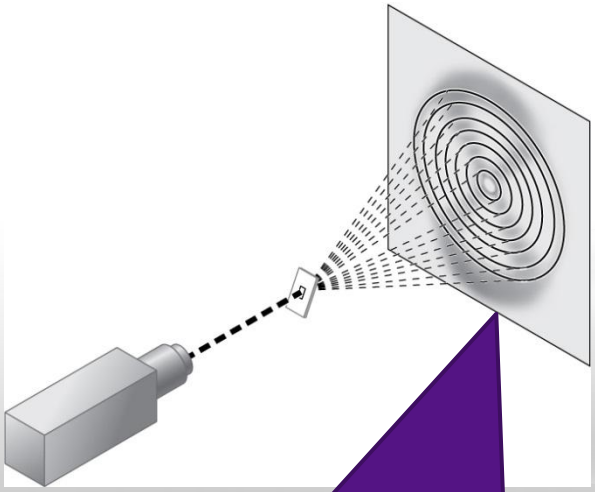
FRANCIS CRICK AND JAMES WATSON

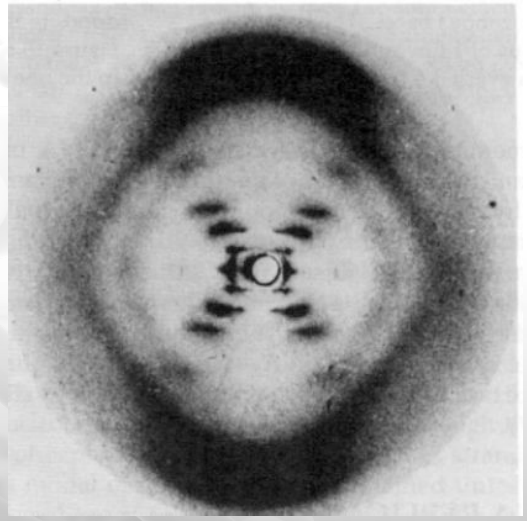
- The scientific framework for their breakthrough was provided by other scientists including
  - Linus Pauling
  - Rosalind Franklin and Maurice Wilkins
  - Erwin Chargaff

Rosalind Franklin

- She worked in same laboratory as Maurice Wilkins.
- She study X-ray diffraction to study wet fibers of DNA.

X-ray diffraction of wet DNA fibers



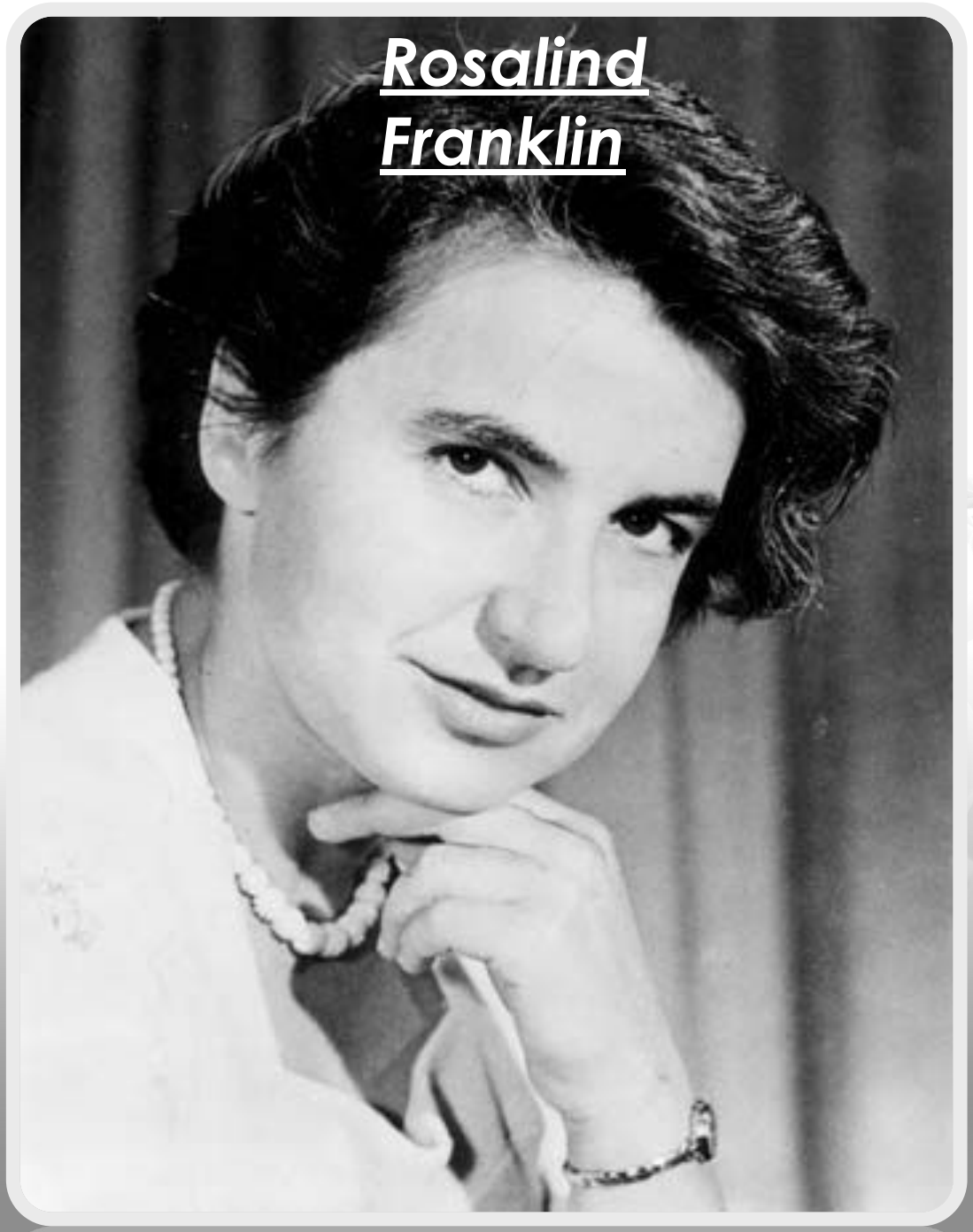


The diffraction pattern is interpreted (using mathematical theory)

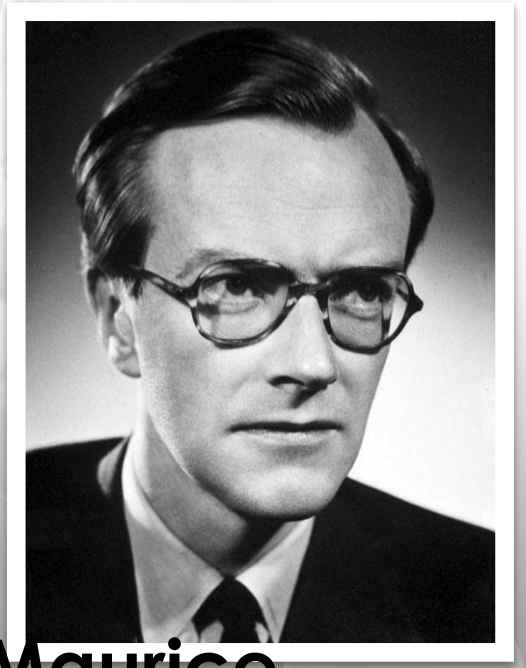
This can ultimately provide information concerning the structure of the molecule

X Ray Crystallography Rosalind Franklin's photo

- 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



Rosalind Franklin

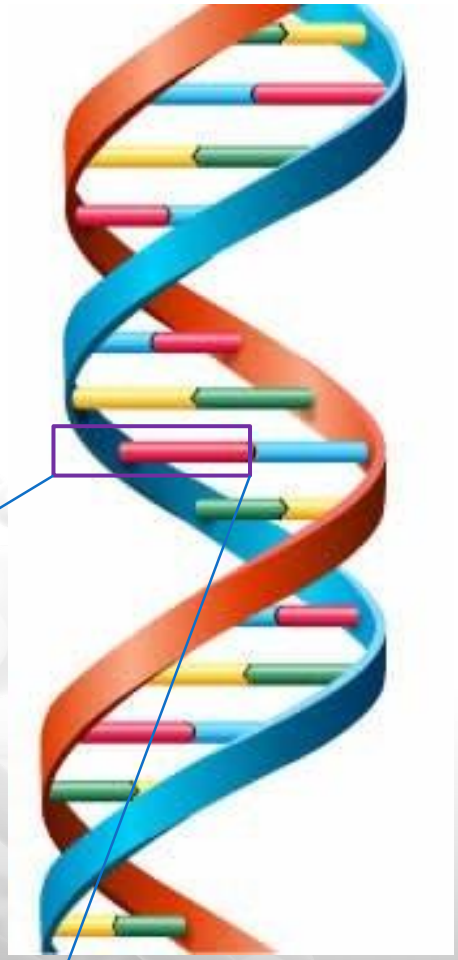


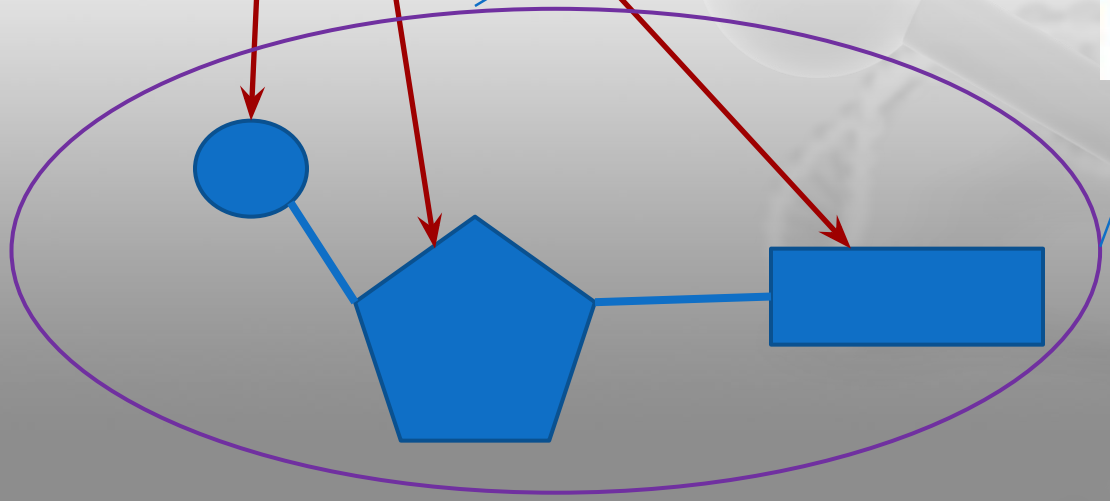
Maurice Wilkins

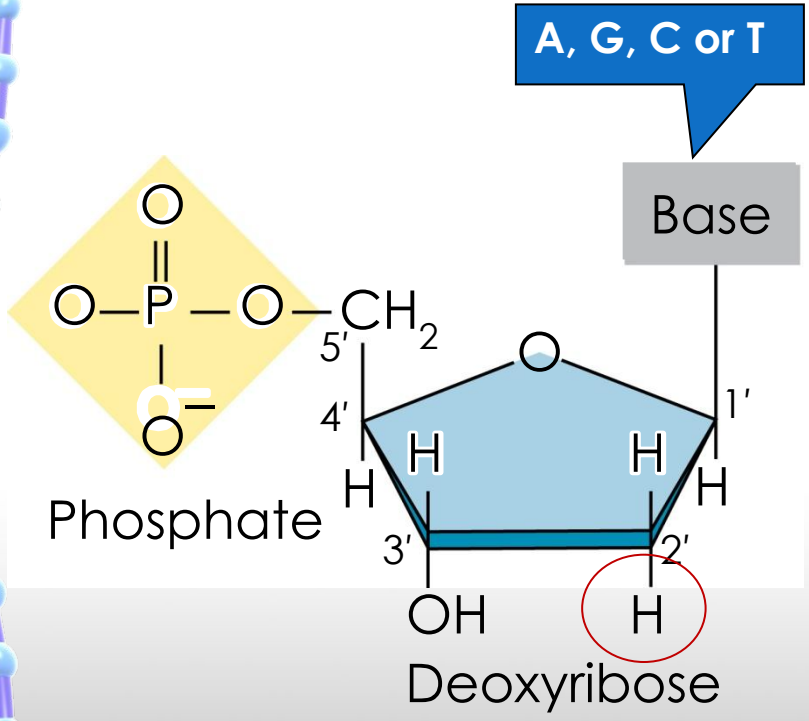
DNA Structure

- DNA structure is often divided into four different levels primary, secondary, tertiary and quaternary.

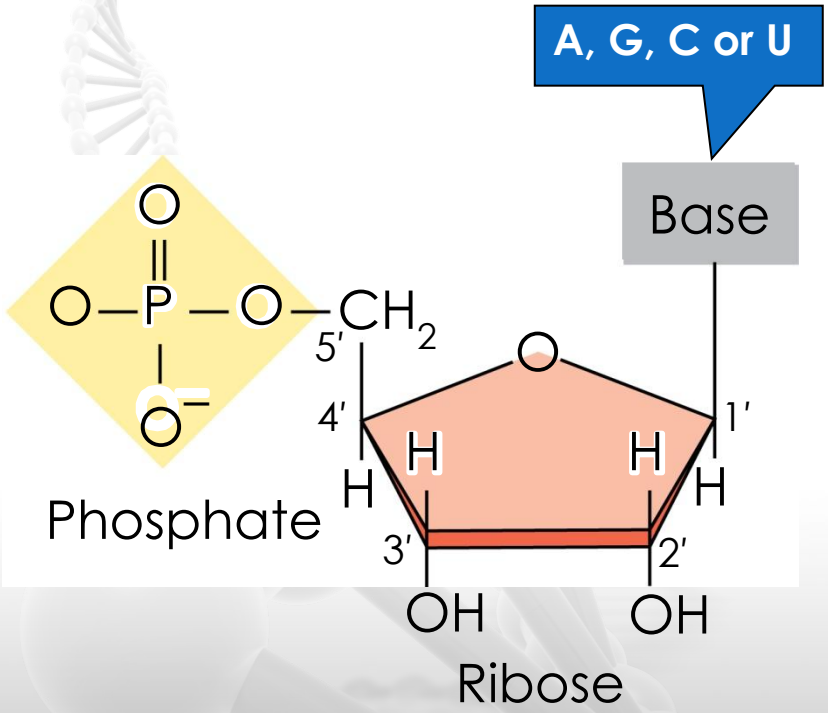
- DNA has three main components
  - 1. Deoxyribose (a pentose sugar)
  - 2. Base (there are four different ones)
  - 3. Phosphate







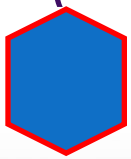
DNA Nucleotide



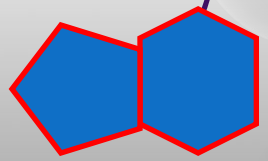
RNA Nucleotide

❖ ***The Nitrogenous Bases***

- THEY ARE DIVIDED INTO TWO GROUPS
  - Pyrimidines and purines
- PYRIMIDINES (MADE OF ONE 6 MEMBER RING)
  - Thymine
  - Cytosine

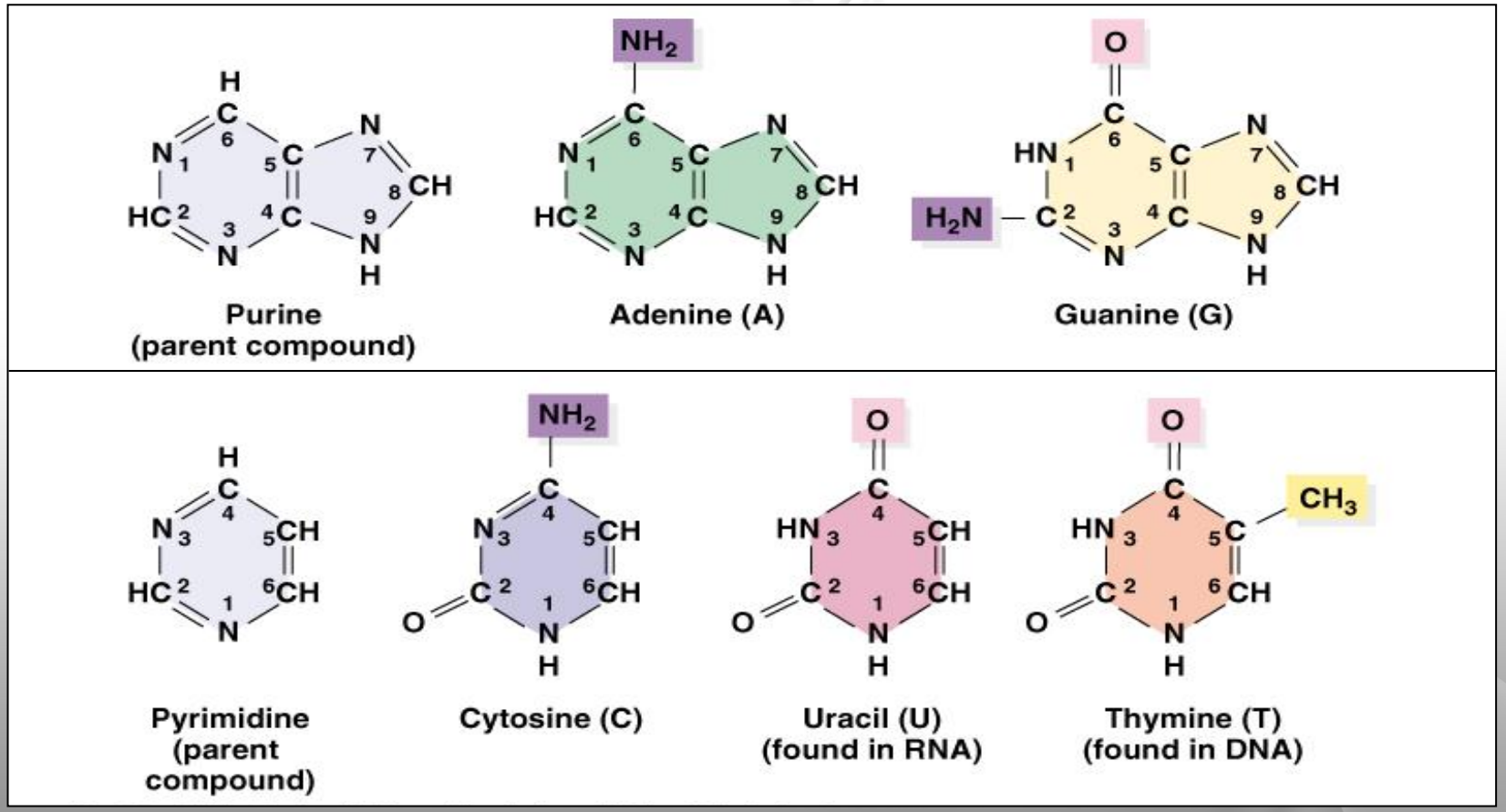


- PURINES (MADE OF A 6 MEMBER RING, FUSED TO A 5 MEMBER RING)
  - Adenine
  - Guanine



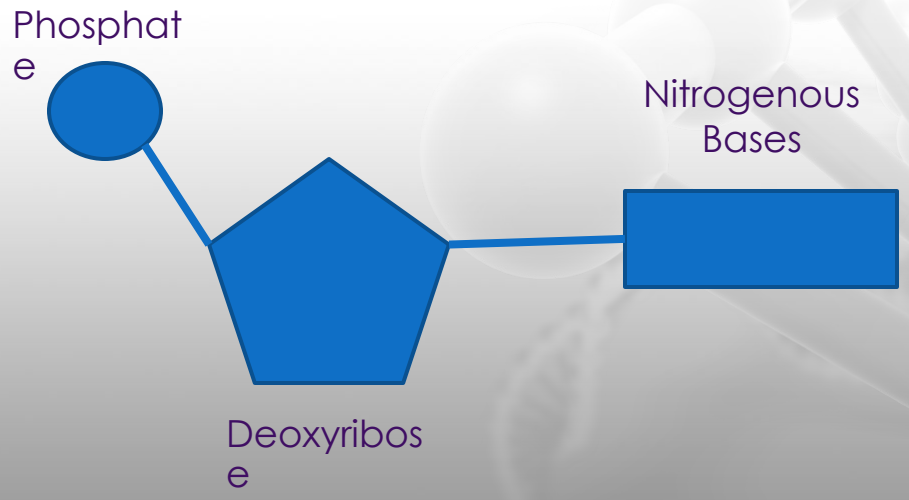
- THE RINGS ARE NOT ONLY MADE OF CARBON

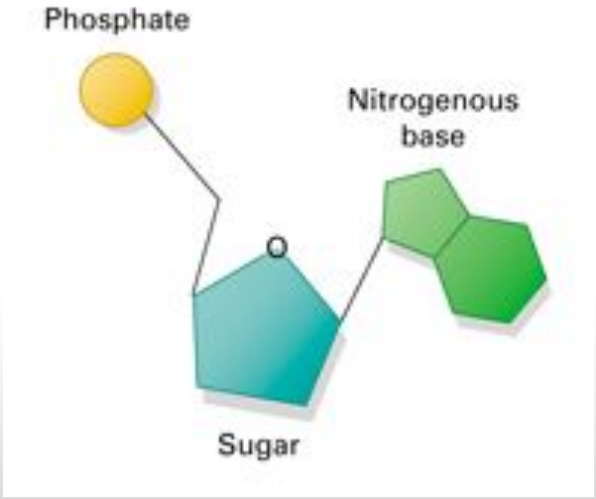
❖ Nitrogenous bases of DNA & RNA

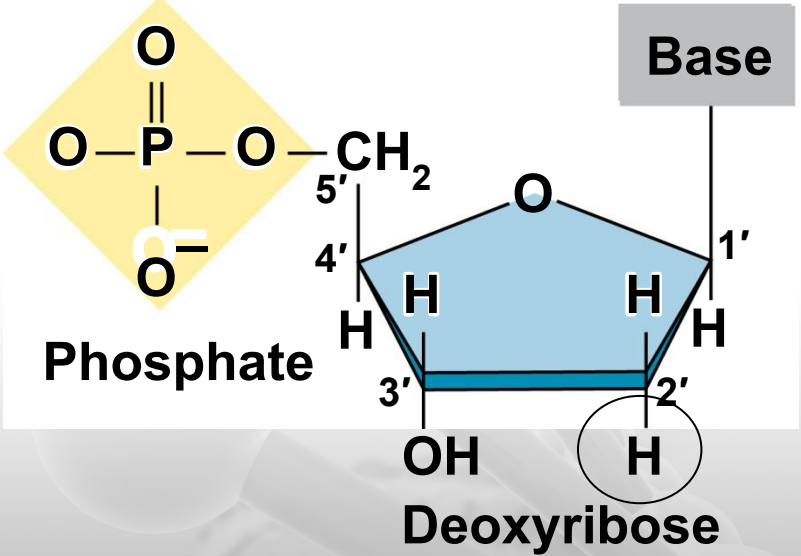


Nucleotide Structure

- Nucleotides are formed by the condensation of a sugar, phosphate and one of the 4 bases
- The following illustration represents one nucleotide



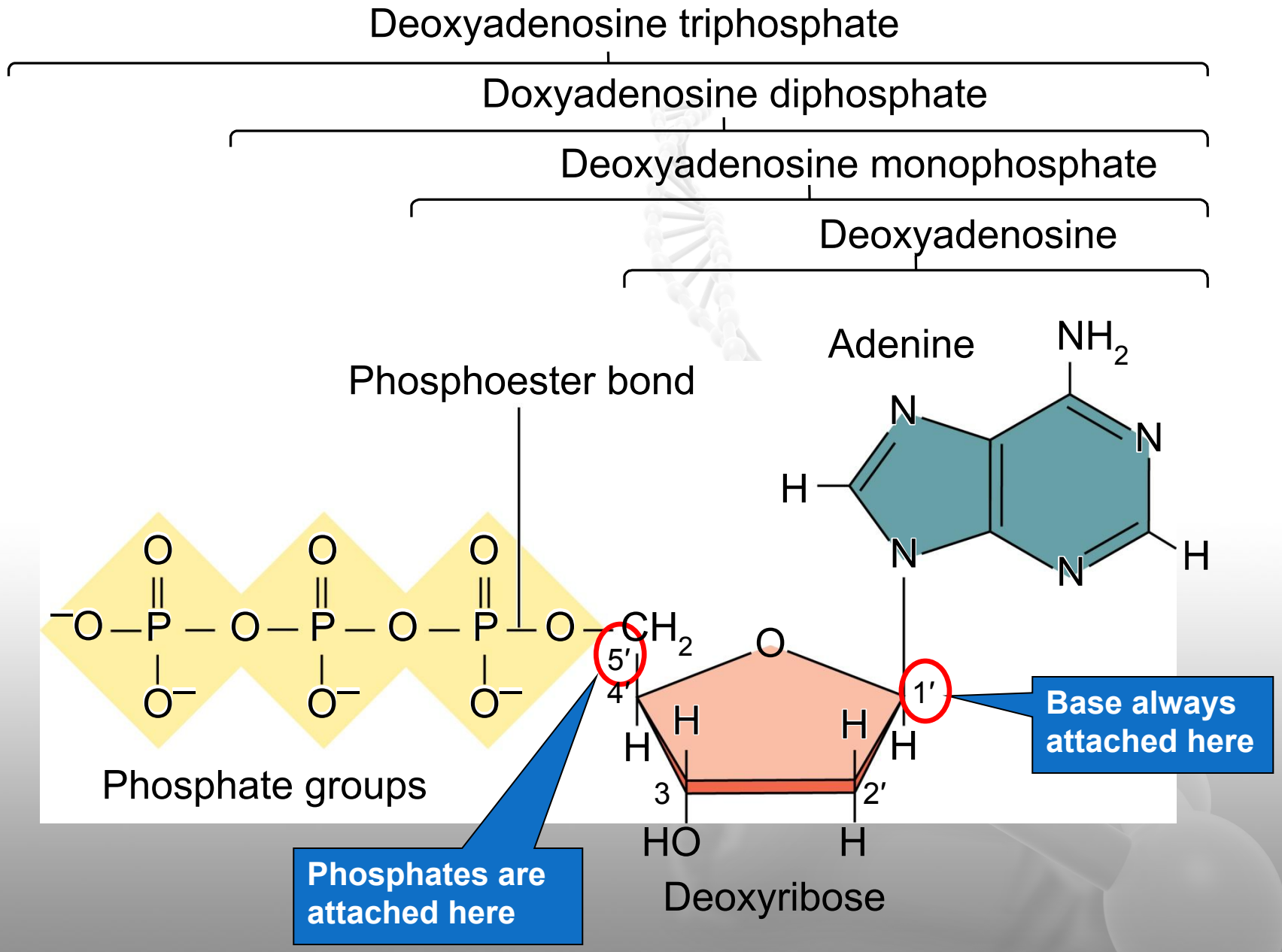




DNA nucleotide

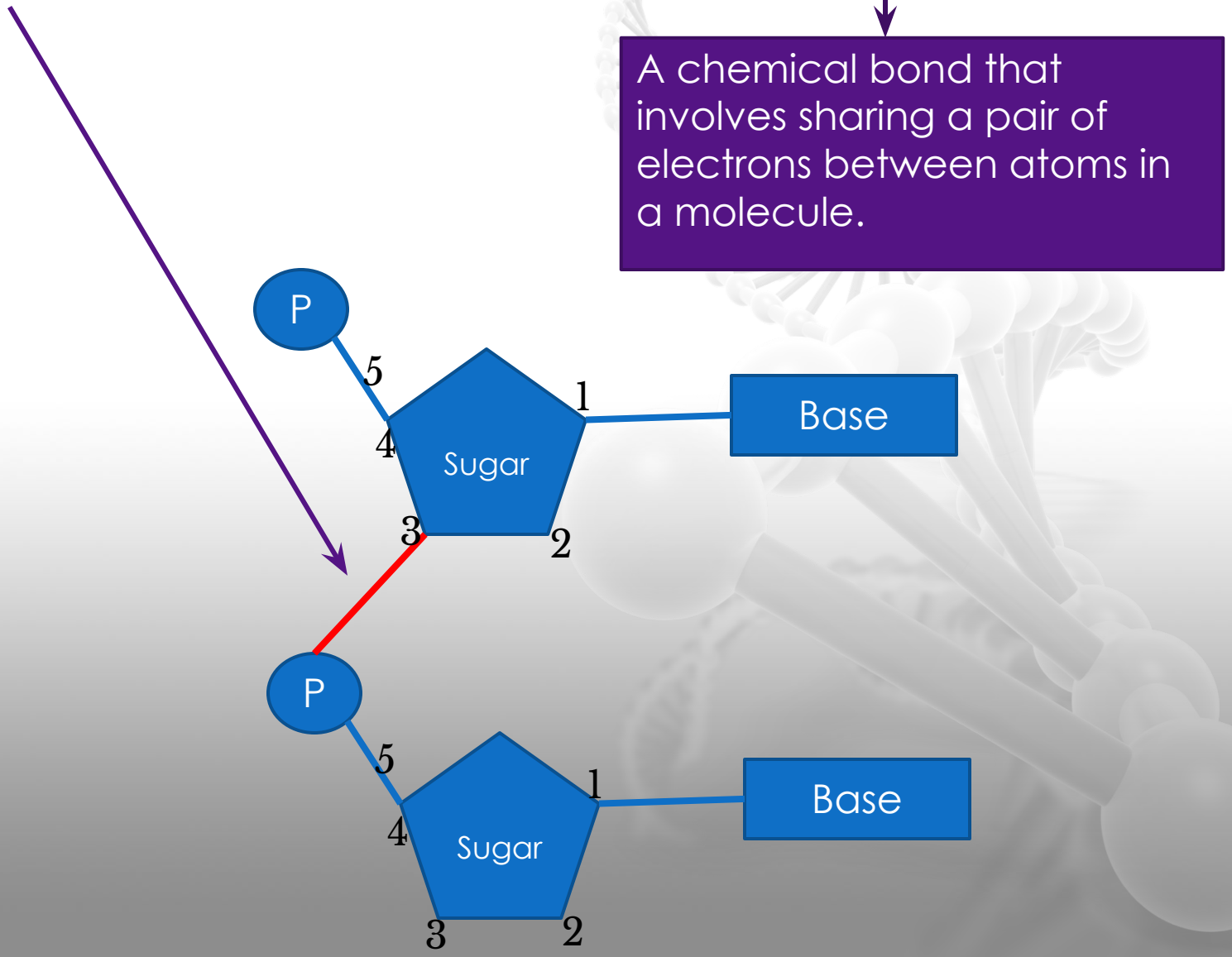
- Base + sugar → nucleoside
  - Example
    - Adenine + ribose = Adenosine
    - Adenine + deoxyribose = Deoxyadenosine

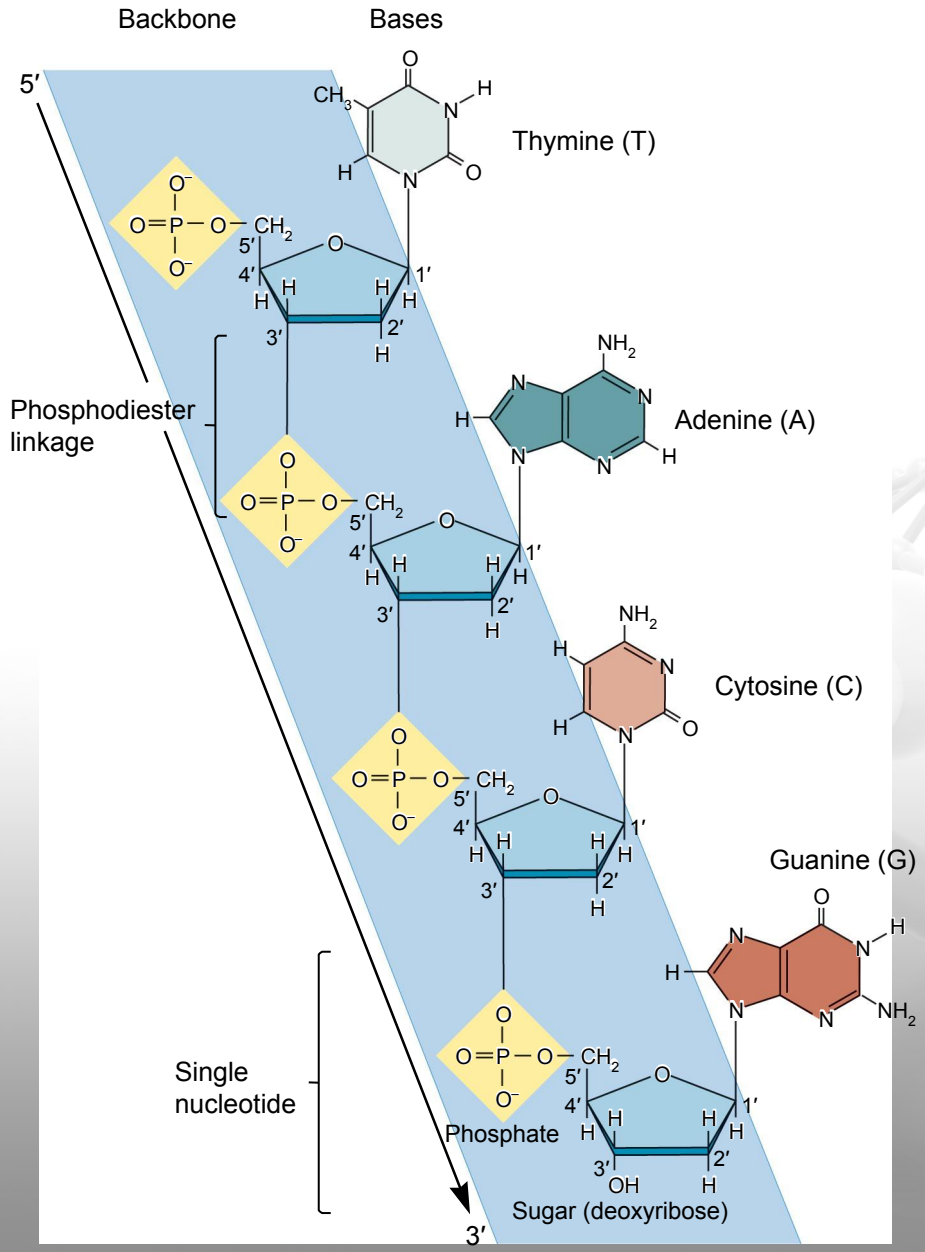
- Base + sugar + phosphate(s) → nucleotide
  - Example
    - Deoxyadenosine monophosphate (dAMP)
    - Deoxyadenosine diphosphate (dADP)
    - Deoxyadenosine triphosphate (dATP)


Deoxyadenosine triphosphate
Doxyadenosine diphosphate
Deoxyadenosine monophosphate
Deoxyadenosine
Adenine
NH2
Phosphoester bond
N
N
H
N
N
H
O
O
O
−O—P—O—P—O—P—O—CH2
O−
O−
O−
5′
4′
1′
H
H
H
H
3
2′
HO
H
Phosphate groups
Deoxyribose
Base always attached here
Phosphates are attached here

- Nucleotides are linked together by *covalent bonds* called *phosphodiester linkage.*

A chemical bond that involves sharing a pair of electrons between atoms in a molecule.

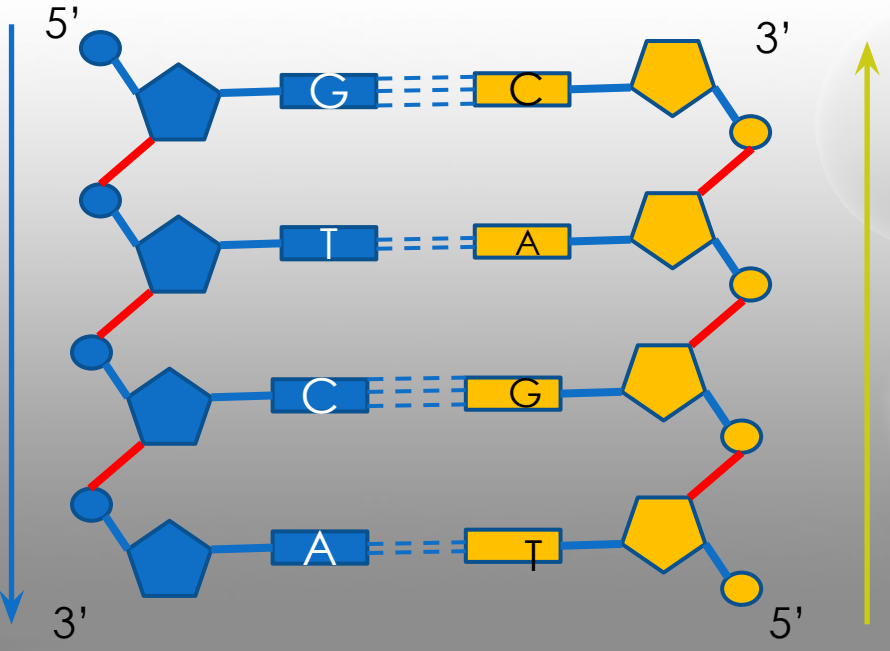


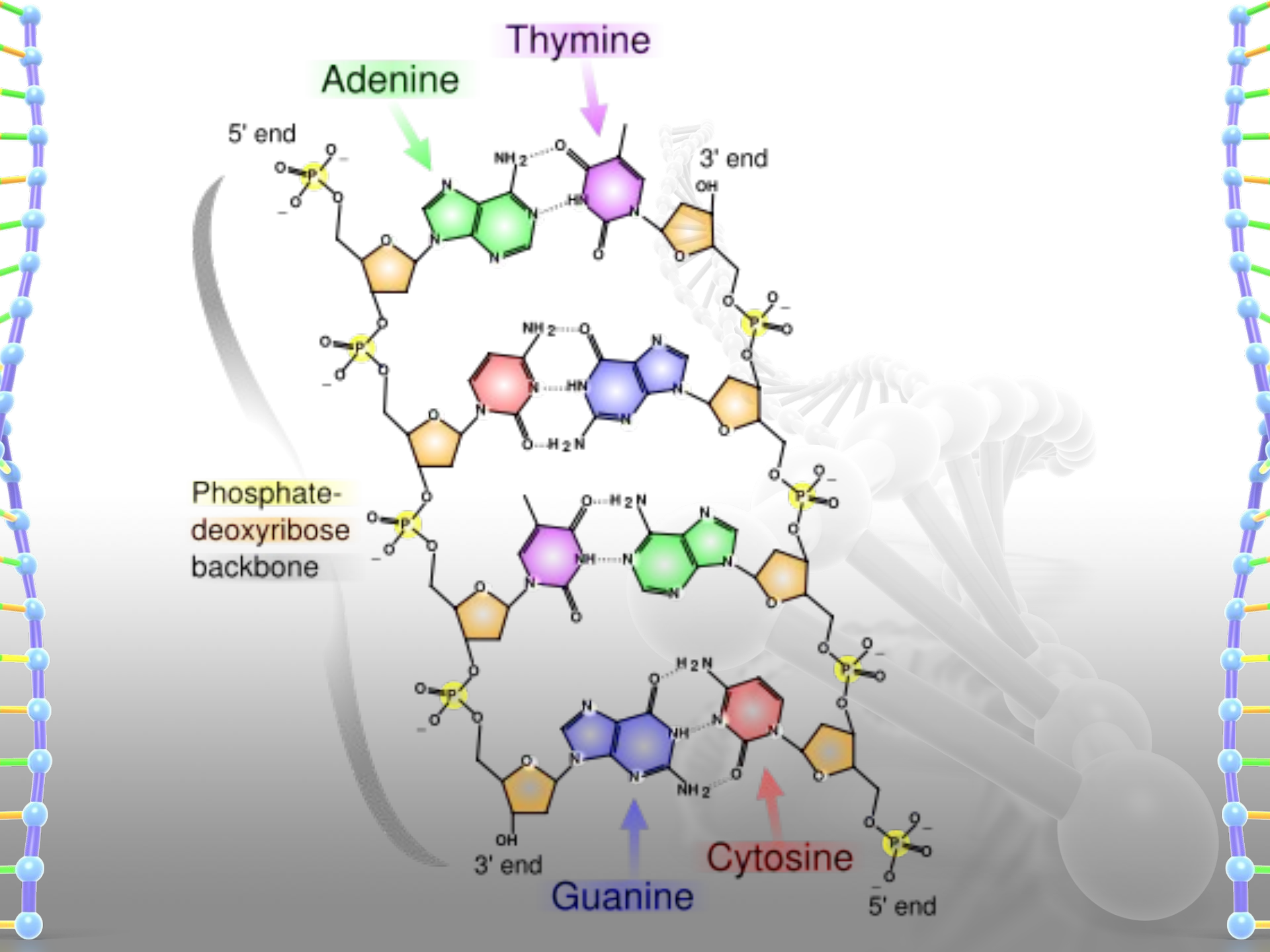

Backbone
Bases
5′
Thymine (T)
Phosphodiester linkage
Adenine (A)
Cytosine (C)
Guanine (G)
Single nucleotide
Phosphate
Sugar (deoxyribose)
3′

DNA Double Helix & Hydrogen bonding

Salient features of the Double-helix structure of DNA:

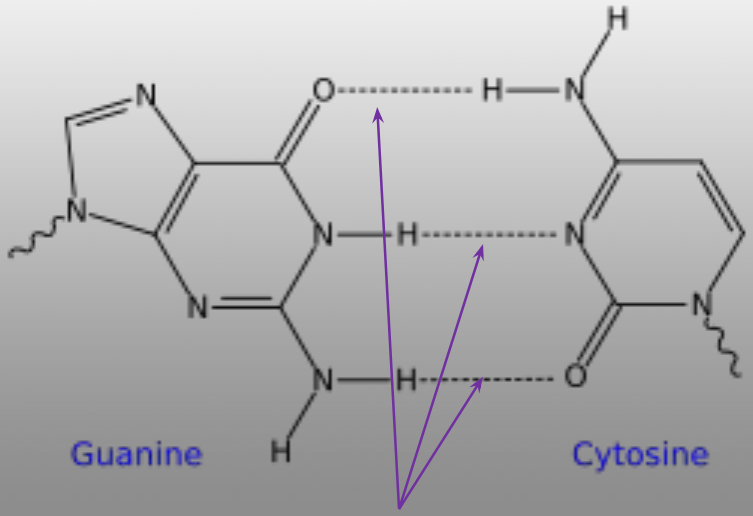
- It is made of two polynucleotide chains, where the backbone is constituted by sugar-phosphate, and the bases project inside.
- The two chains have anti- parallel polarity. It means, if one chain has the polarity 5'→3', the other has 3'→5'.



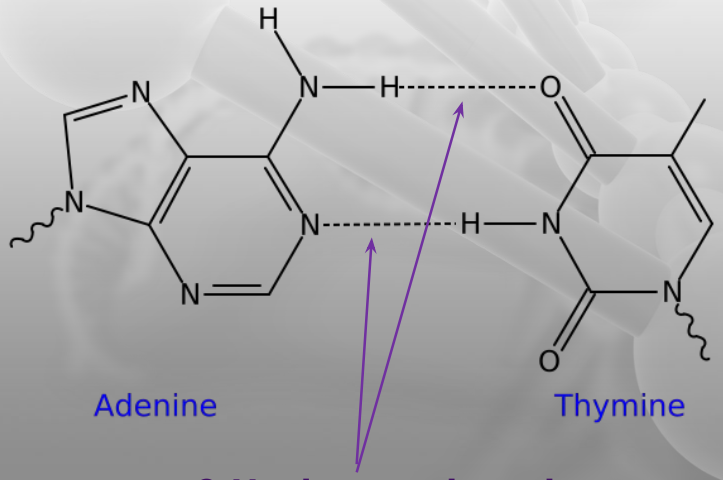

Thymine
Adenine
5' end
3' end
Phosphate-
deoxyribose
backbone
3' end
Cytosine
Guanine
5' end

DNA Double Helix & Hydrogen bonding

- The bases in two strands are paired through hydrogen bond (H-bonds) forming base pairs (bp). ***Adenine*** forms **two** hydrogen bonds with ***Thymine*** from opposite strand and vice-versa. Similarly, ***Guanine*** is bonded with ***Cytosine*** with **three** H-bonds.
- Based on the observation of ***Erwin Chargaff*** that for a double stranded DNA, the ratios between **Adenine** and **Thymine**; and **Guanine** and **Cytosine** are constant and equals one.
- **Hydrogen bond:-**A chemical bond consisting of a hydrogen atom between two electronegative atoms (e.g., oxygen or nitrogen) with one side be a covalent bond and the other being an ionic bond.



3 Hydrogen bonds



2 Hydrogen bonds