






Theme:
Structure and function of DNA
(primary and secondary)

Lesson objectives:

- **Establish the connection between DNA structure and its function;**
- **Describe the chemical structure of nucleotides and explain their bonding and location in DNA molecules;**



**Creating an information
scheme that should describe
the structure and function of
DNA**



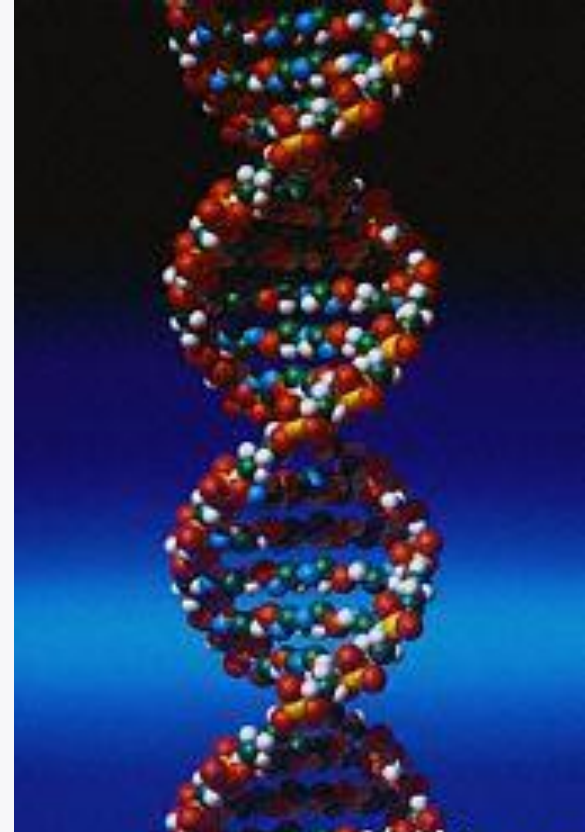
Compare your schema with video info

- https://www.youtube.com/watch?v=o_-6JXLYS-k

Why do we study **DNA**?

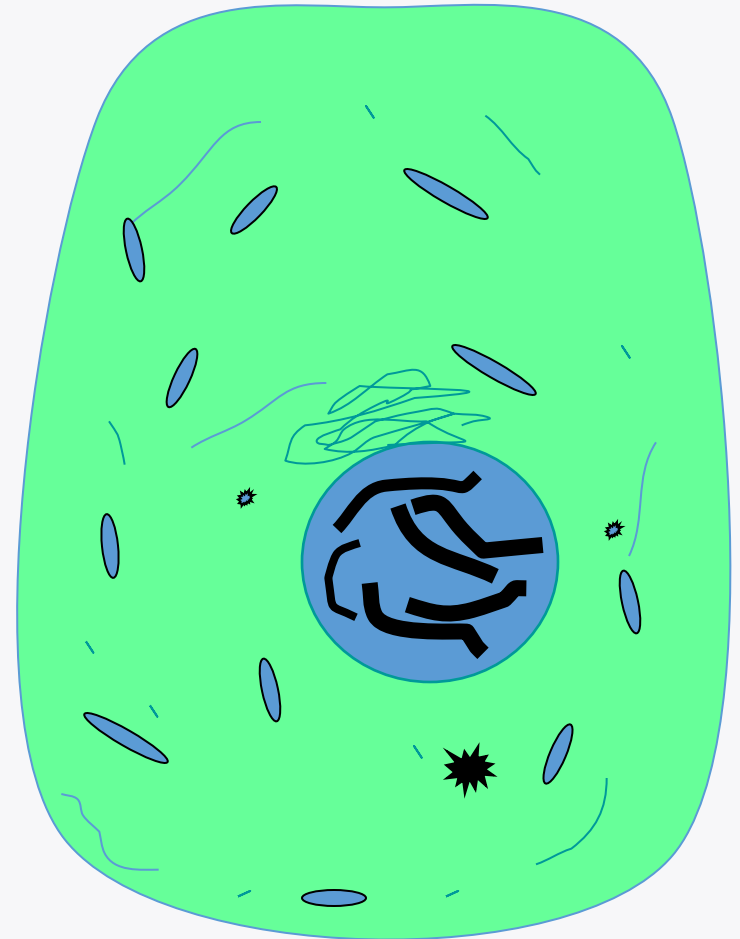
We study DNA for many reasons, e.g.,

- **its central importance to all life on Earth,**
- **medical benefits such as cures for diseases,**
- **better food crops.**



Chromosomes and DNA

- Our genes are on our chromosomes.
- Chromosomes are made up of a chemical called DNA.



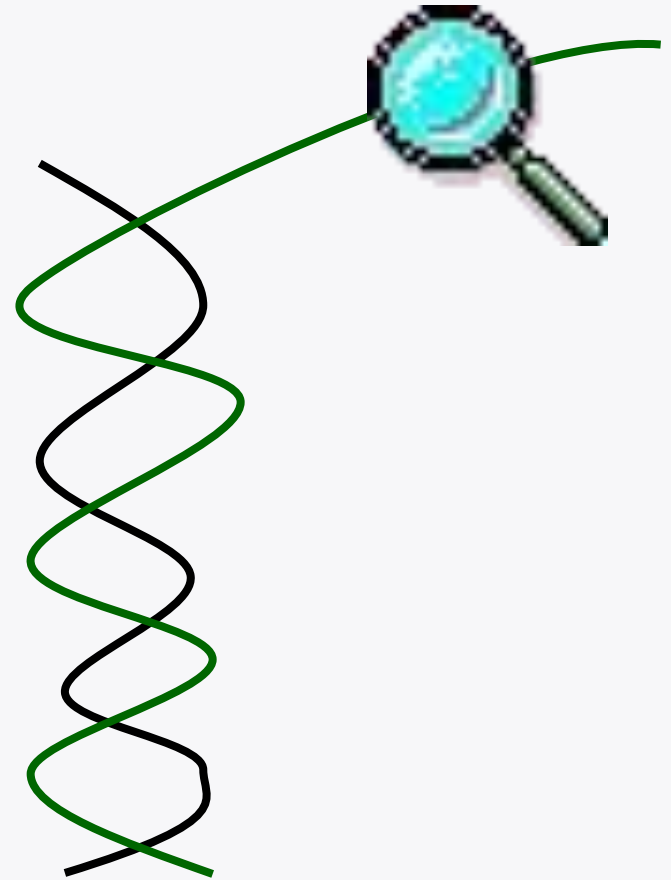
▶ The Shape of the Molecule

- DNA is a very long polymer.
- The basic shape is like a twisted ladder or zipper.
- This is called a *double helix*.



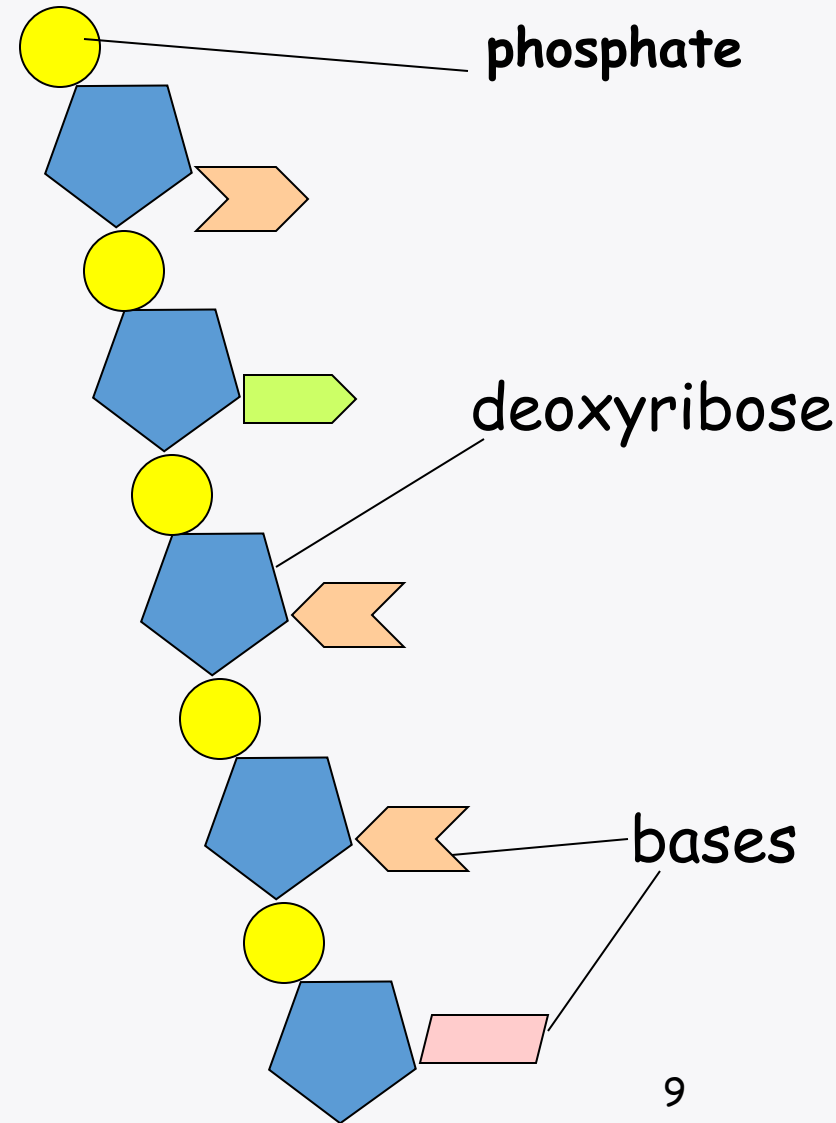
The Double Helix Molecule

- The DNA double helix has two strands twisted together.

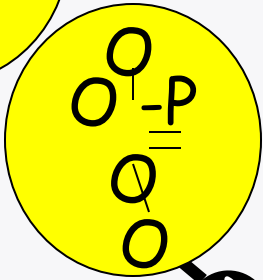
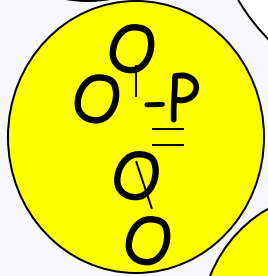
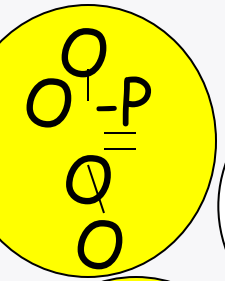


One Strand of DNA

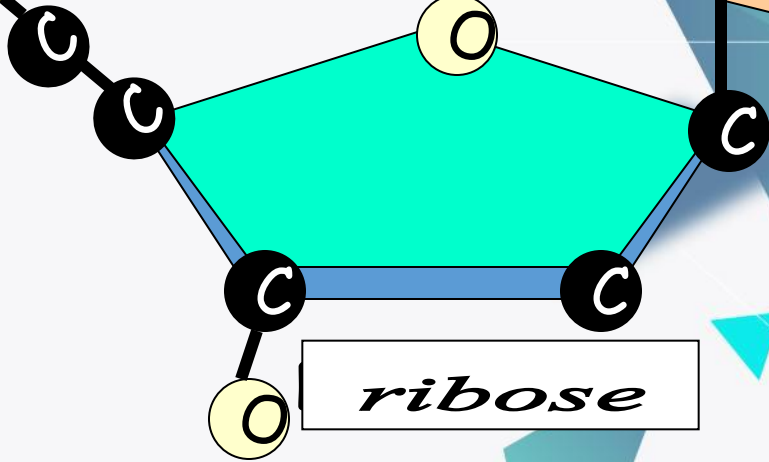
- The backbone of the molecule is alternating **phosphates** and **deoxyribose sugar**
- The teeth are nitrogenous **bases**.



ATP



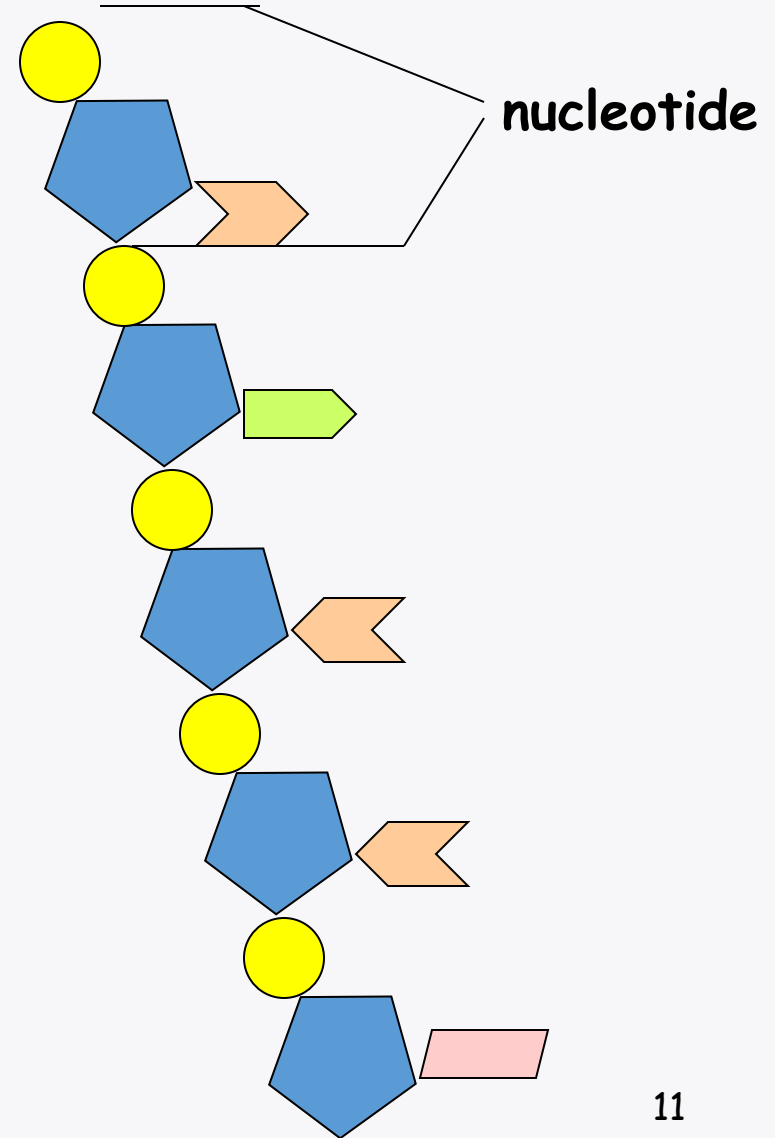
Phosphate



Nitrogenous base

One Strand of DNA

- One strand of DNA is a polymer of nucleotides.
- One strand of DNA has many millions of nucleotides.





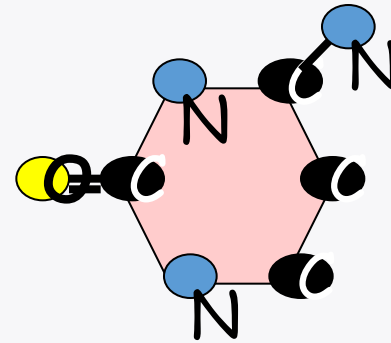
Four nitrogenous bases

DNA has four different bases:

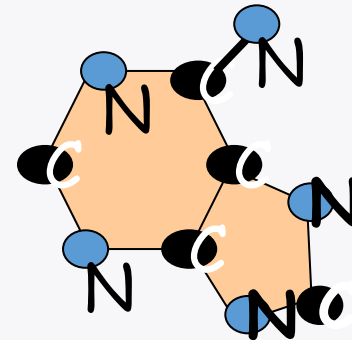
- Cytosine **C**
- Thymine **T**
- Adenine **A**
- Guanine **G**

Two Kinds of Bases in DNA

- *Pyrimidines* are single ring bases.

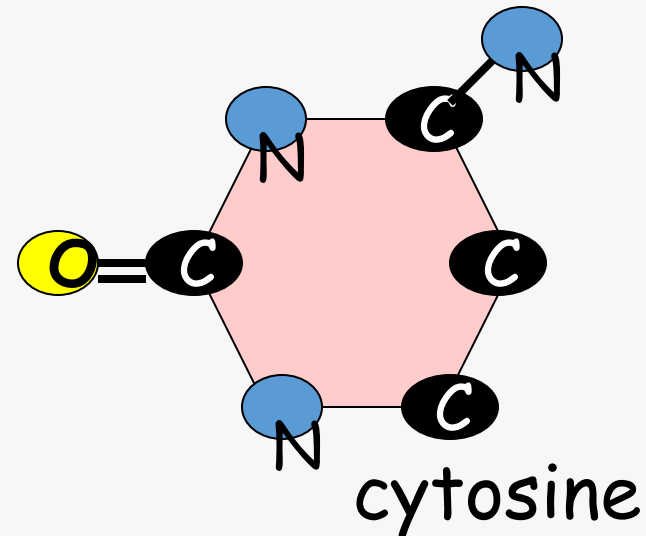
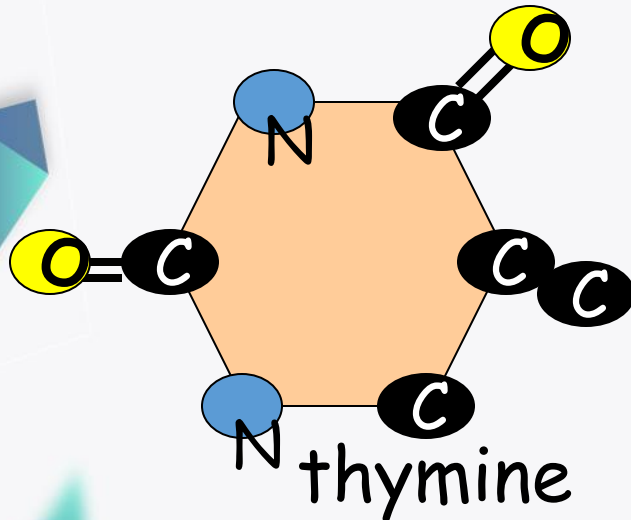


- *Purines* are double ring bases.



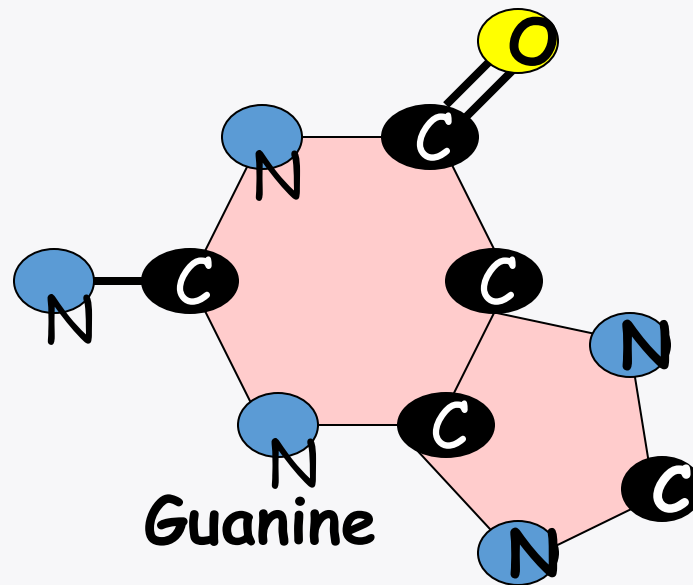
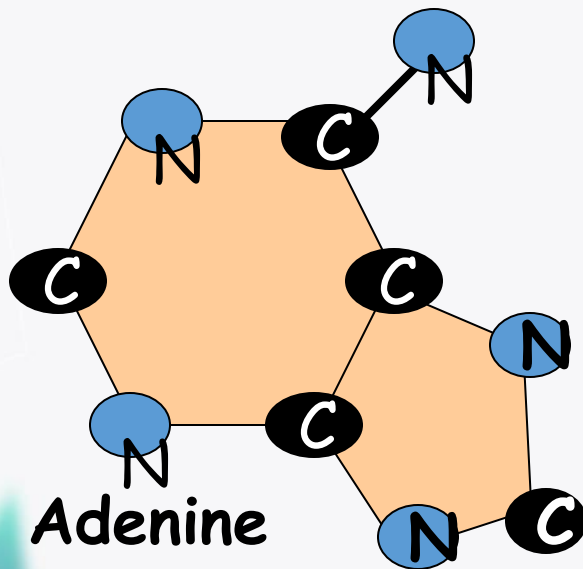
Thymine and Cytosine are pyrimidines

- Thymine and cytosine each have one ring of carbon and nitrogen atoms.



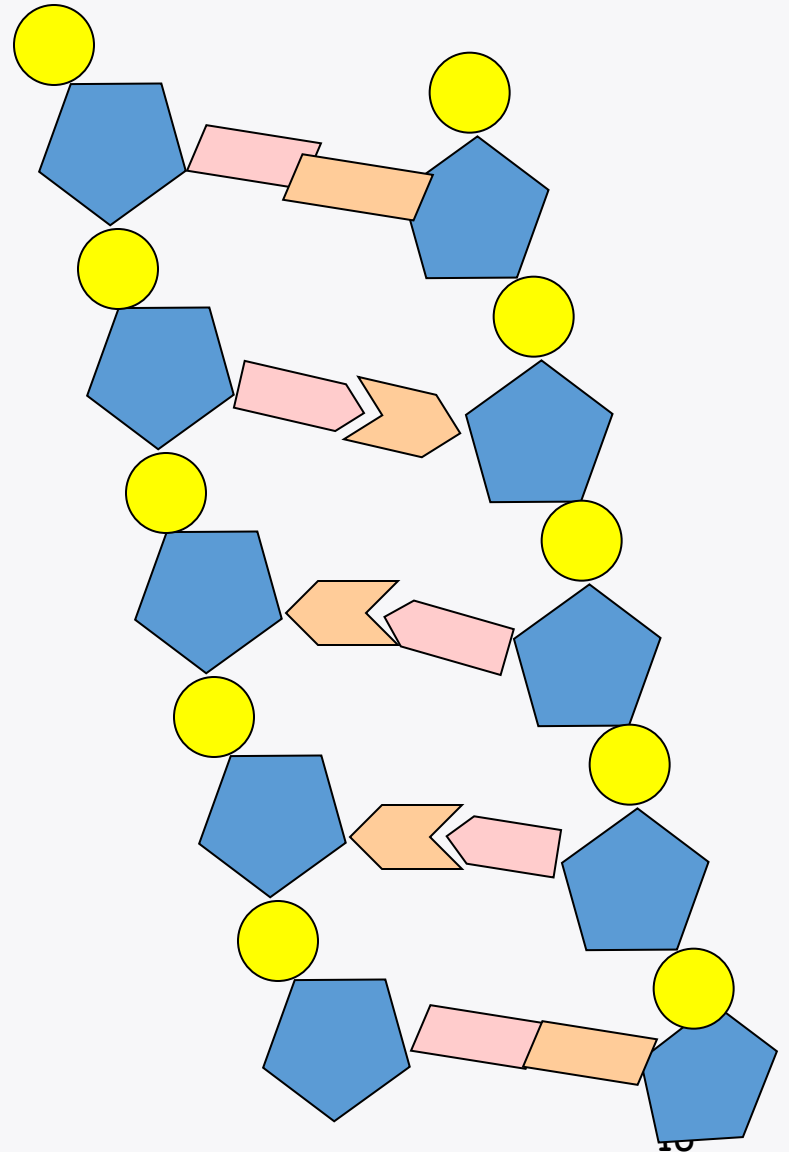
Adenine and Guanine are purines

- Adenine and guanine each have two rings of carbon and nitrogen atoms.



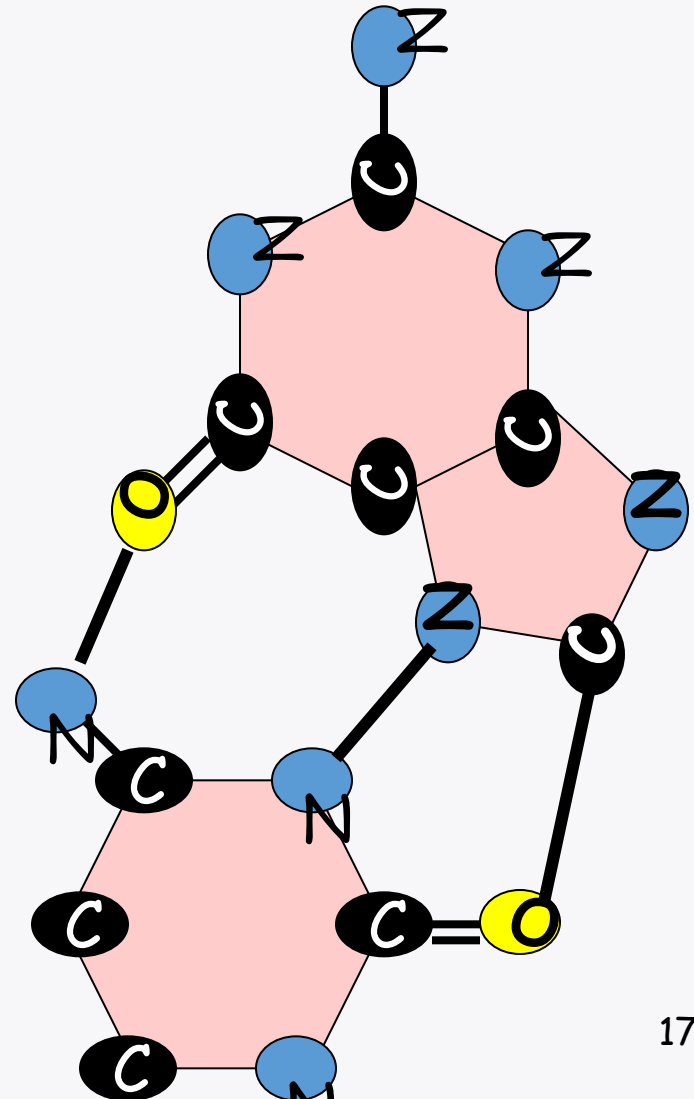
Two Stranded DNA

- Remember, DNA has two strands that fit together something like a zipper.
- The teeth are the nitrogenous bases but why do they stick together?



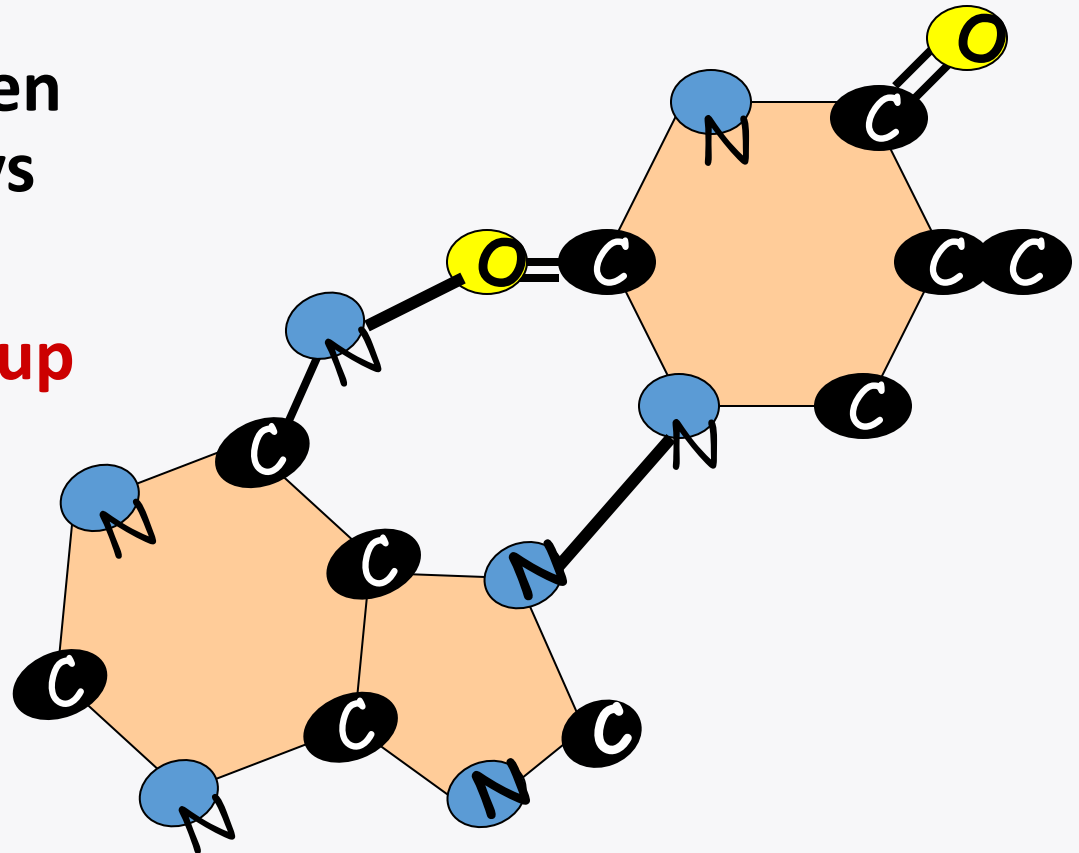
Hydrogen Bonds

- The bases attract each other because of hydrogen bonds.
- **Hydrogen bonds are weak but there are millions and millions of them in a single molecule of DNA.**
- The bonds between cytosine and guanine are shown here with dotted lines



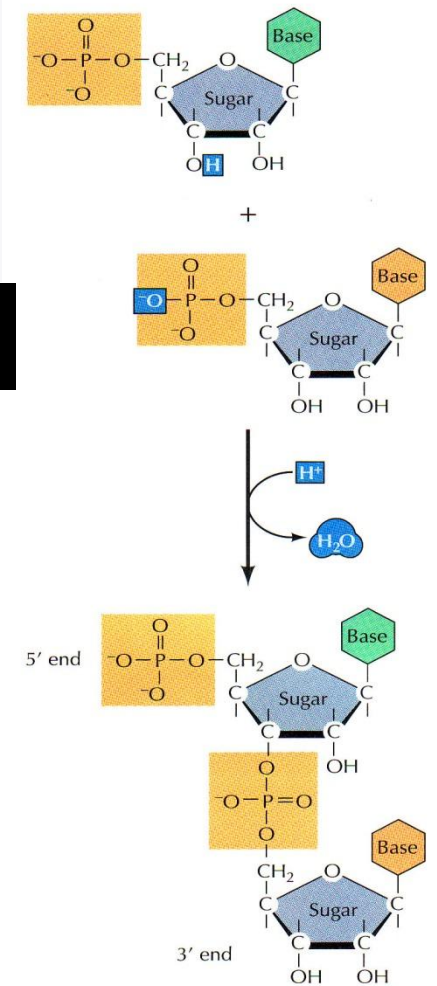
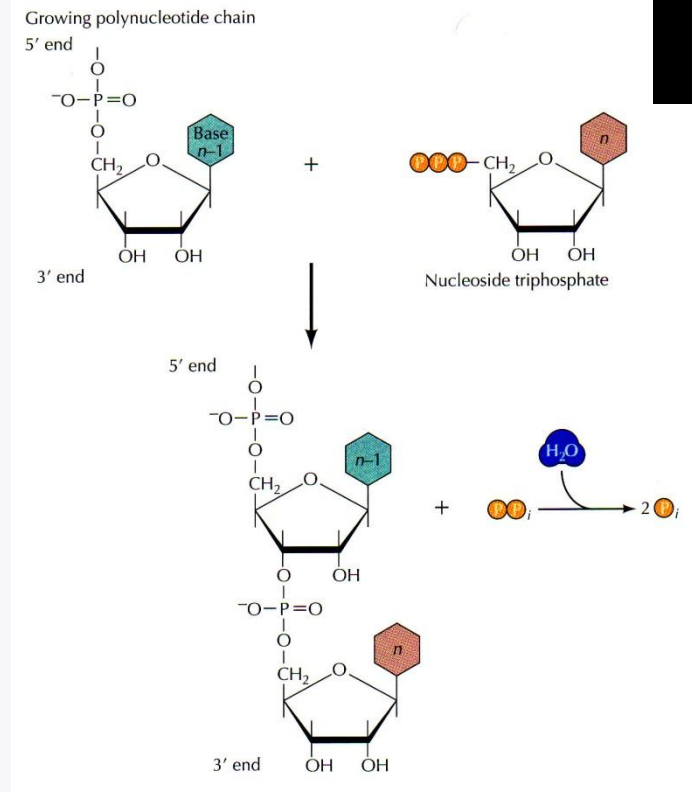
Hydrogen Bonds, cont.

- When making hydrogen bonds, cytosine always pairs up with guanine
- Adenine always pairs up with thymine
- Adenine is bonded to thymine here



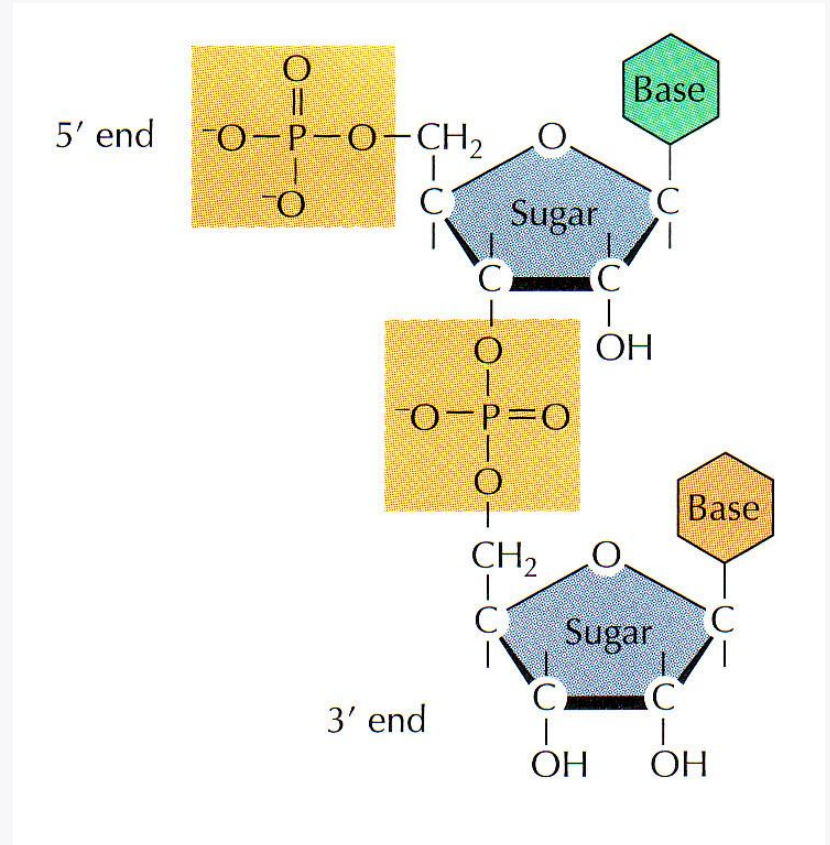
Linear Polymerization of Nucleotides

- Nucleic acids are formed of nucleotide polymers.
- Nucleotides polymerize together by phospho-diester bonds via condensation reaction.
- The phospho-diester bond is formed between:
 - Hydroxyl (OH) group of the sugar of one nucleotide.
 - Phosphate group of other nucleotide



Polymerization of Nucleotides

- The formed polynucleotide chain is formed of:
 - **Negative (-ve) charged Sugar-Phosphate backbone.**
 - Free 5' phosphate on one end (5' end)
 - Free 3' hydroxyl on other end (3' end)
 - **Nitrogenous bases are not in the backbone**
 - Attached to the backbone
 - Free to pair with nitrogenous bases of other polynucleotide chain



Polymerization of Nucleotides

- Nucleic acids are polymers of nucleotides.
- The nucleotides formed of purine or pyrimidine bases linked to phosphorylated sugars (nucleotide back bone).
- The bases are linked to the pentose sugar to form Nucleoside.
- The nucleotides contain one phosphate group linked to the 5' carbon of the nucleoside.

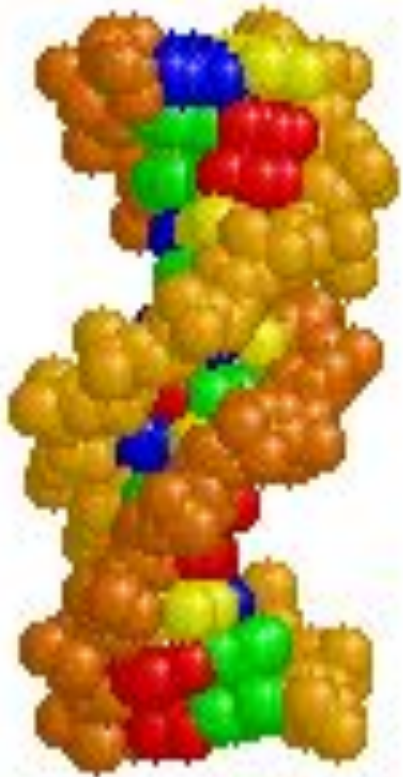
Nucleotide = Nucleoside + Phosphate group

DNA by the Numbers

- Each cell has about 2 m of DNA.
- The average human has 75 trillion cells.
- The average human has enough DNA to go from the earth to the sun more than 400 times.
- DNA has a diameter of only 0.000000002 m.



The earth is 150 billion m or 93 million miles from the sun.



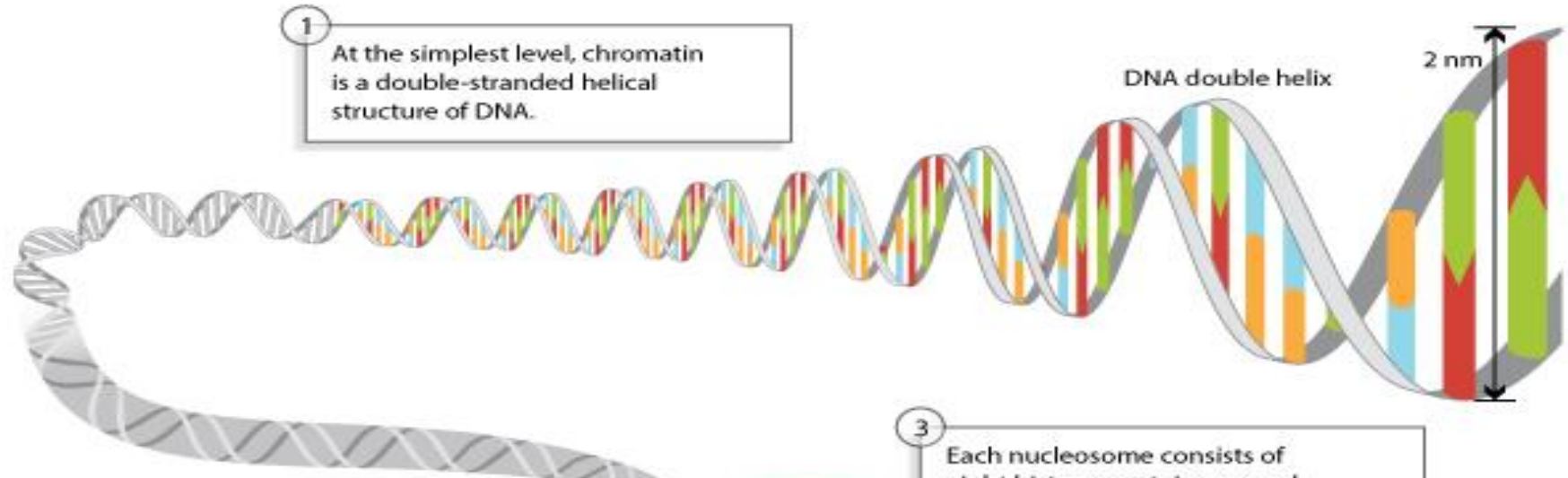
Summary of how DNA Structure is suited to function:

- It is very stable: nucleotides are linked by **covalent** bonds.
- It carries **coded** information.
- It can be replicated: **specific base pairing** means that DNA can be copied when cells divide.
- It is compact: **folding** of the molecule means a great deal of information can be packed into a small volume.

1 At the simplest level, chromatin is a double-stranded helical structure of DNA.

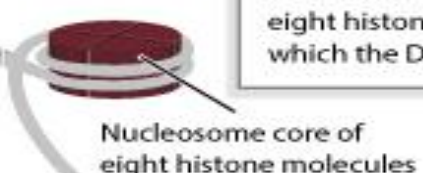
DNA double helix

2 nm



2 DNA is complexed with histones to form nucleosomes.

3 Each nucleosome consists of eight histone proteins around which the DNA wraps 1.65 times.



4 A chromosome consists of a nucleosome plus the H1 histone.



6 ... that forms loops averaging 300 nm in length.

300 nm



5 The nucleosomes fold up to produce a 30-nm fiber...

30 nm



250-nm-wide fiber

700 nm



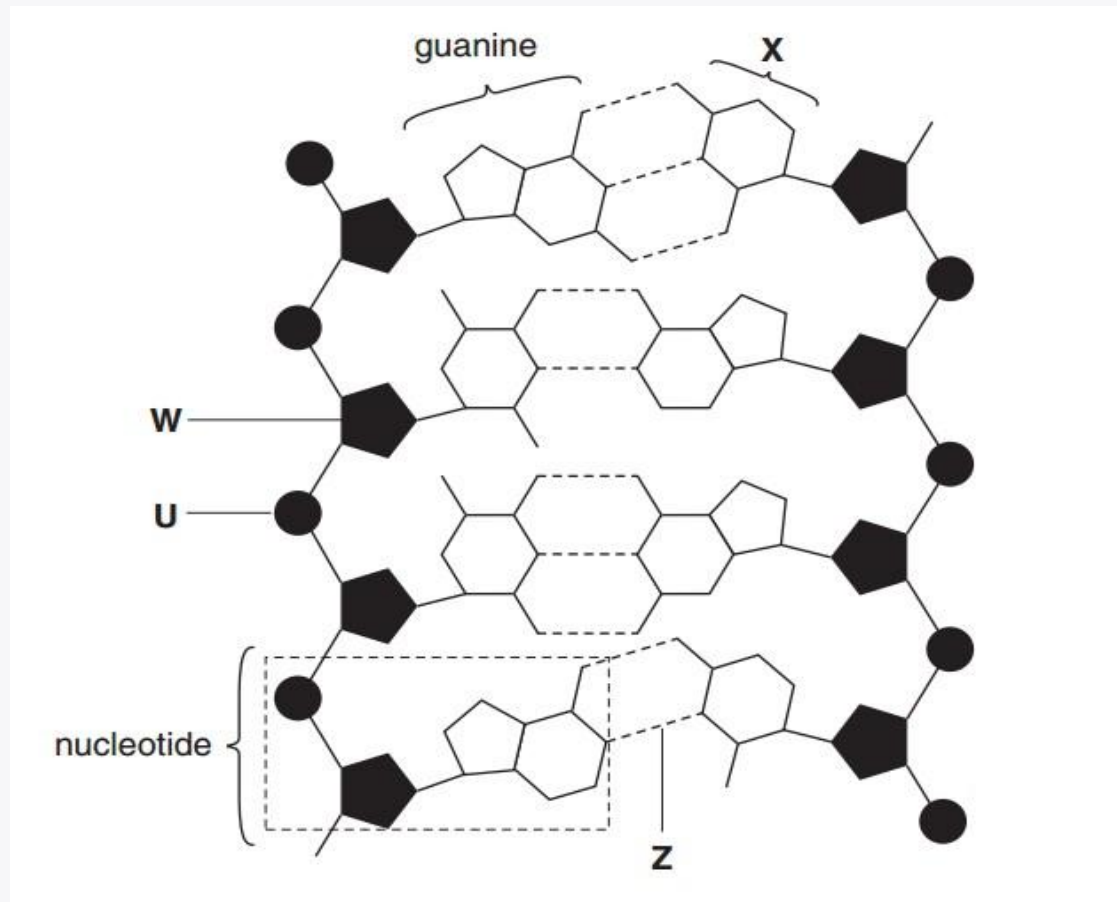
7 The 300-nm fibers are compressed and folded to produce a 250-nm-wide fiber.

8 Tight coiling of the 250-nm fiber produces the chromatid of a chromosome.

1400 nm



Fig. shows part of a DNA molecule.



(a) Name U, W and X.

U, W, X

(b) Name the bonds indicated by Z.

Structure	Link to function
Genes and chromosomes	
DNA molecular structure (polymers)	
the anti-parallel nature of the strands; the asymmetric ends of DNA strands (the <u>5'</u> (<i>five prime</i>) and <u>3'</u> (<i>three prime</i>) ends, with the 5' end having a terminal phosphate group and the 3' end a terminal hydroxyl group);	
Double helix and complementary base pairing	
Sequence of bases making up the genetic code/Codon (covered in detail later); the coding and non-coding strands	
Packaging of DNA molecule-how and why? (protection etc)	
Histones	