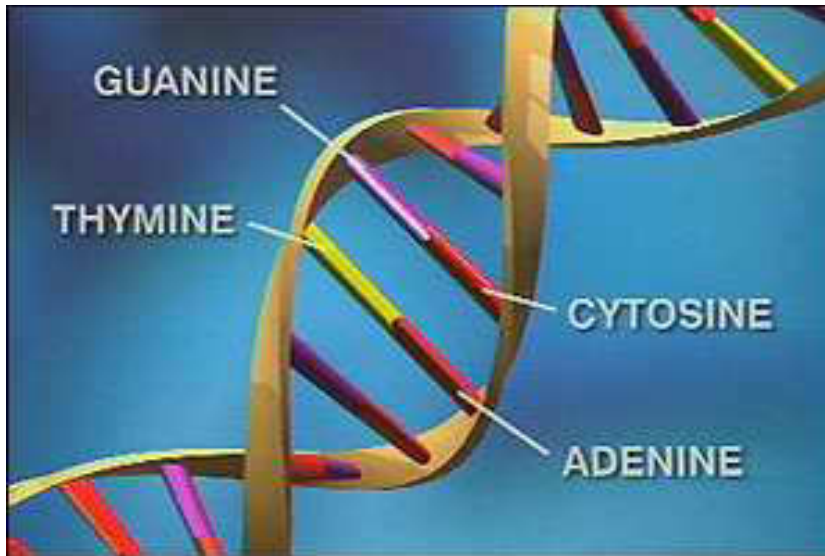


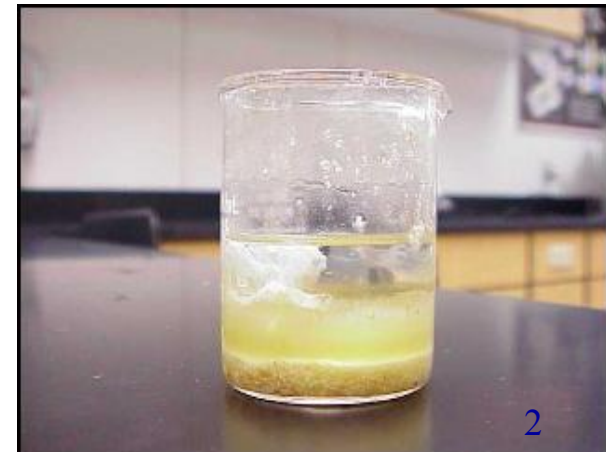
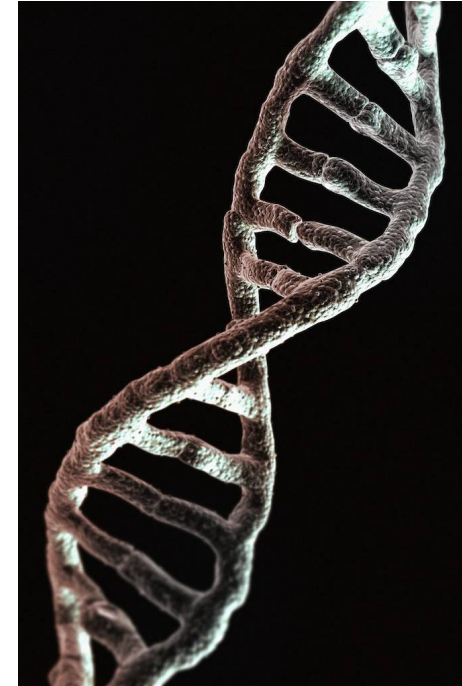
# DNA

## Molecular Genetics Booklet 1



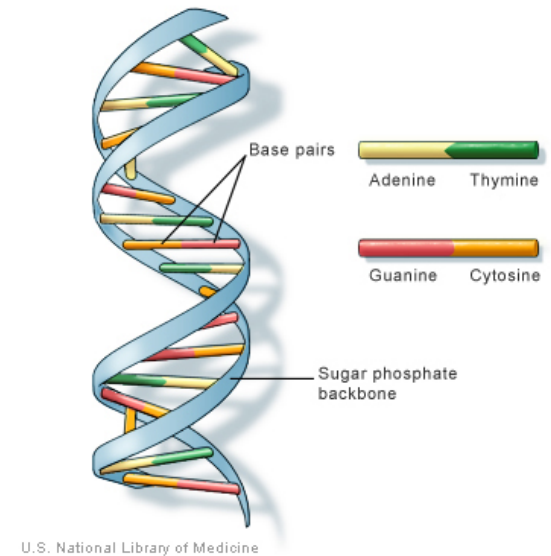
# INTRODUCTION TO DNA

- Genome of human cell has ~50,000-100,000 more genes (segments of DNA that encode for traits) than a bacterial cell and contains far more DNA per gene.
- The genetic information of a cell is contained in its **DNA** in the nucleus
- DNA unique to each individual



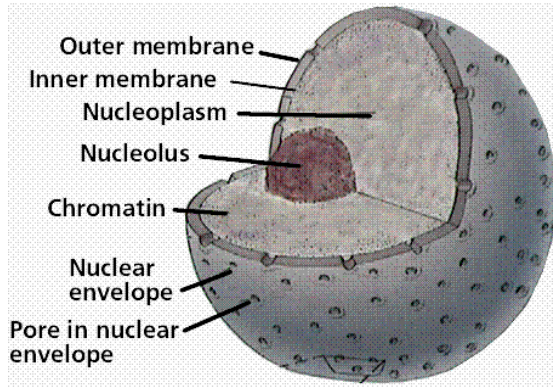
# INTRODUCTION TO DNA

- DNA stands for **DeoxyriboNucleic Acid**
- **Deoxyribose** is the sugar that makes up the backbone of DNA
- Named nucleic because it was initially found in the **nucleus**
- Acid - the **phosphates** in the backbone cause DNA to be acidic
- DNA is universal - it is the **genetic code for all living cells** whether they be plant, animal, bacteria or fungus



# DNA Location

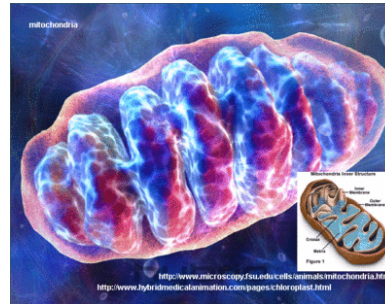
## IN THE NUCLEUS



## Nuclear DNA

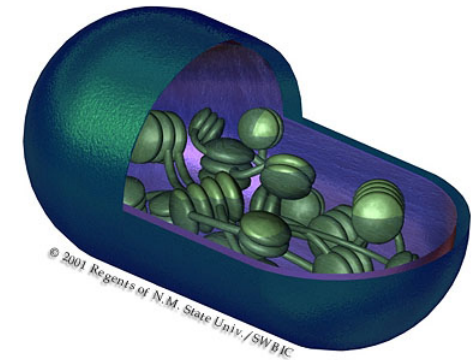
In The Nucleus. Long strands of chromatin... then chromosomes

## OUTSIDE THE NUCLEUS



## Mitochondrial DNA (mtDNA)

- a circular chromosome
- In plants and animals

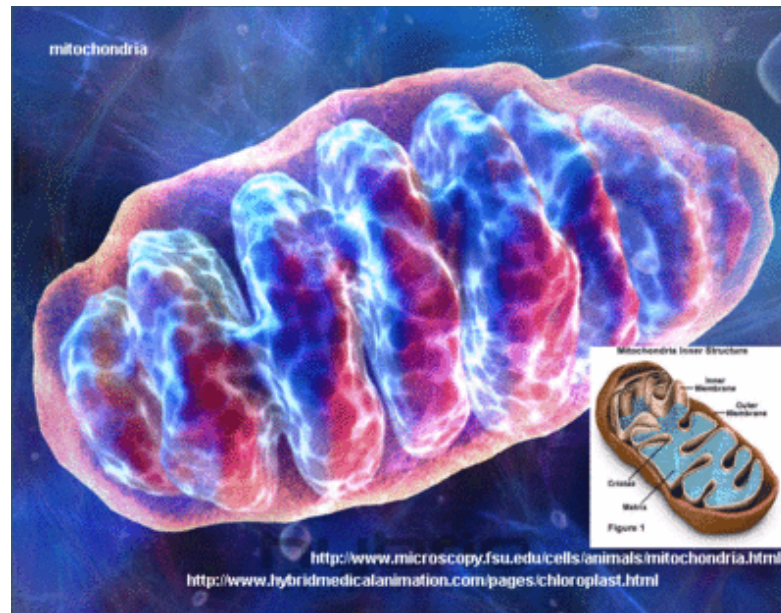


## Chloroplast DNA (cpDNA)

- a circular chromosome
- in plants

# DNA Location

- An individual's mtDNA is identical to their **mother's** (unlike nuclear DNA which is from both mother and father)

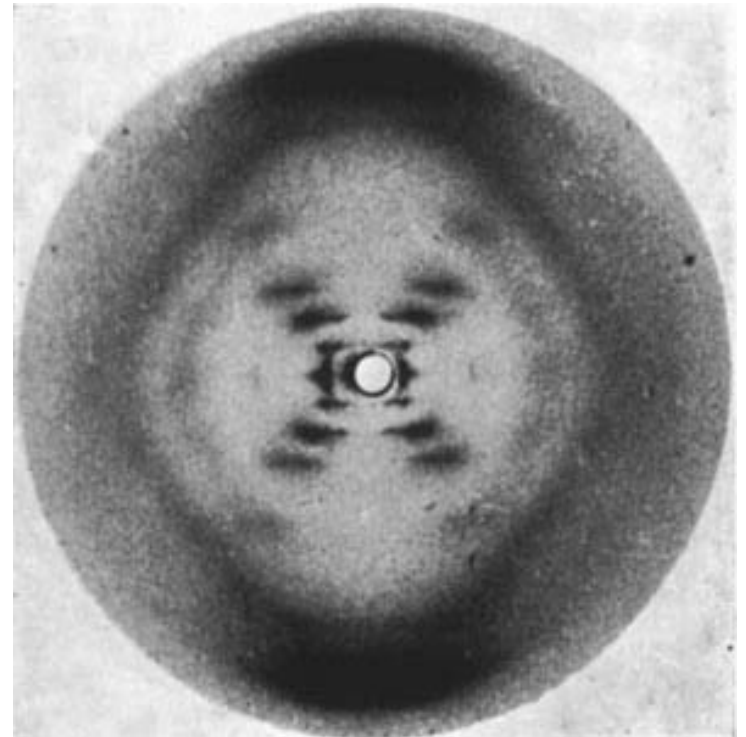


This enables us to trace ancestry because you inherited your mitochondrial DNA from your mom who inherited it from her mom and so forth...



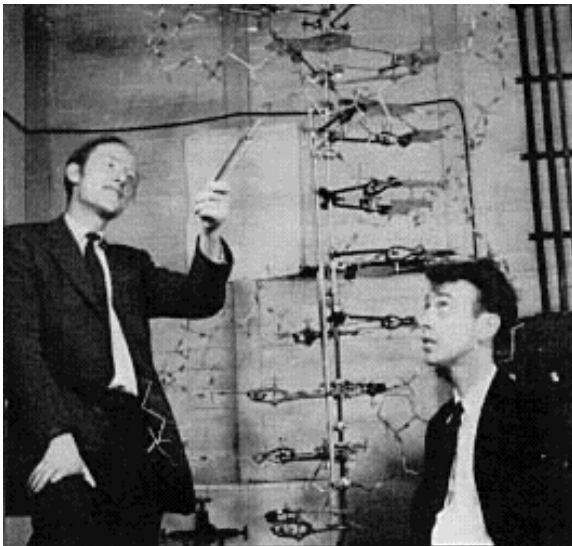
# The Structure of DNA

- Rosalind Franklin was using X-Ray Diffraction to study DNA
- DNA is a **helix**, it is **double stranded** and the distance between DNA strands is constant.
- Her work allowed Watson and Crick to come up with model of DNA
  - Findings presented in 1953
  - Visually confirmed in 1969



# The History of DNA

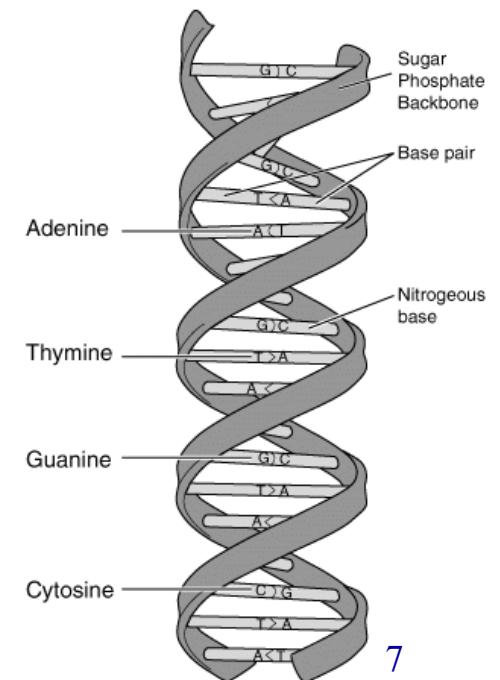
- Watson and Crick **determined the 3-D structure of DNA**
  - Watson entered university at 15 .....in Chicago
    - He ended up at Cambridge University with Crick, a physicist
- Scientists don't work alone, Watson and Crick relied on work done by **Rosalind Franklin**

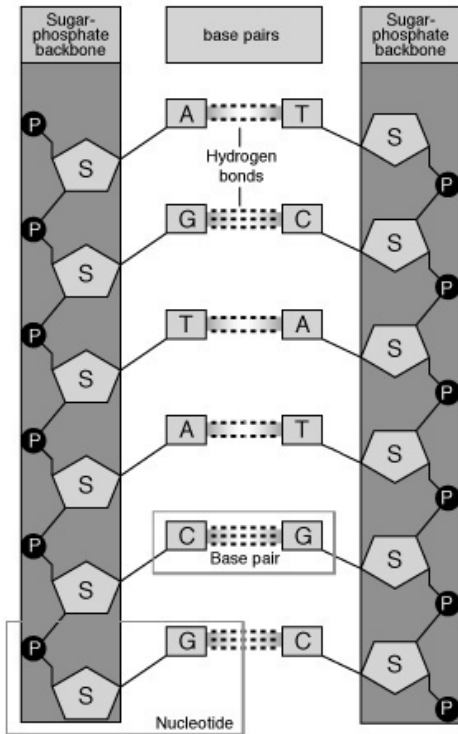


+



=





# DNA looks like a twisted ladder

Structure: 2 complimentary strands

Backbone = phosphate(outside) + deoxyribose (sugar) –  
(inside the phosphate)

Rungs = 2 nitrogen bases

- Adenine pairs with Thymine
- Guanine pairs with Cytosine

Bases held together by hydrogen bonds (between A & T or C & G)

**How to  
remember?**



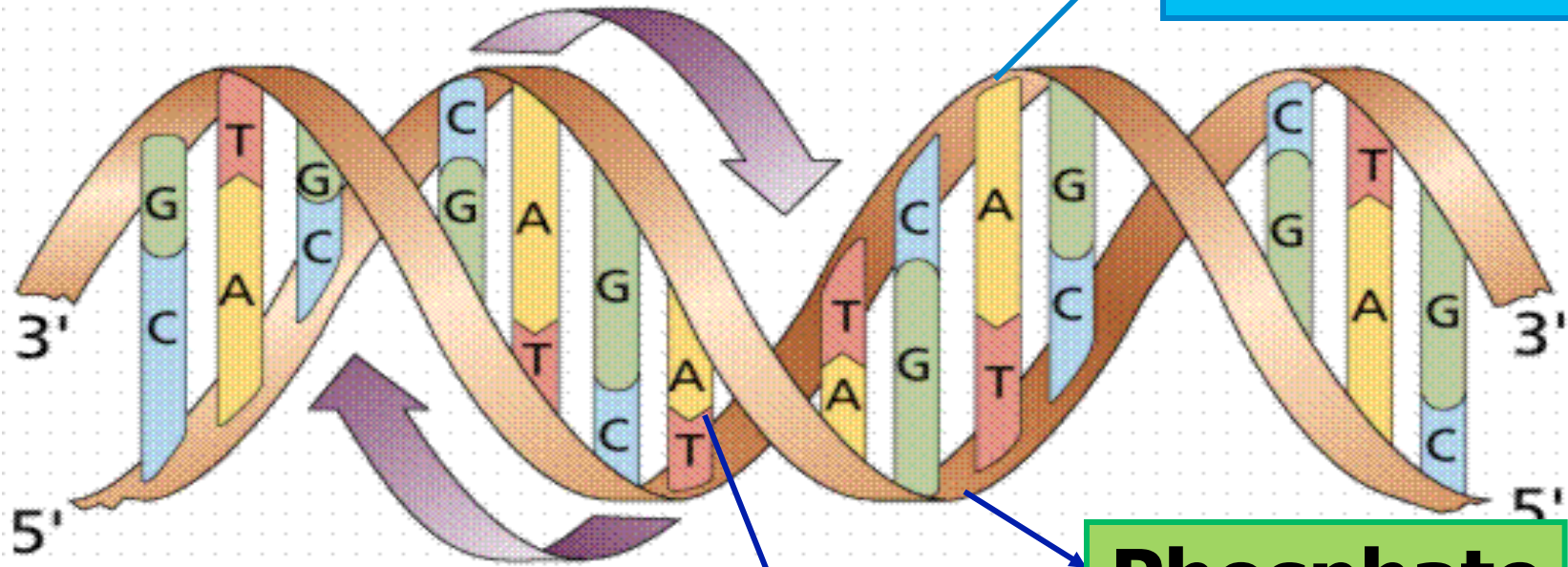
**Straight letters go together A-T  
Curvy letters go together C-G**



# Deoxyribonucleic acid

**Nitrogen Base**

**Deoxyribose**



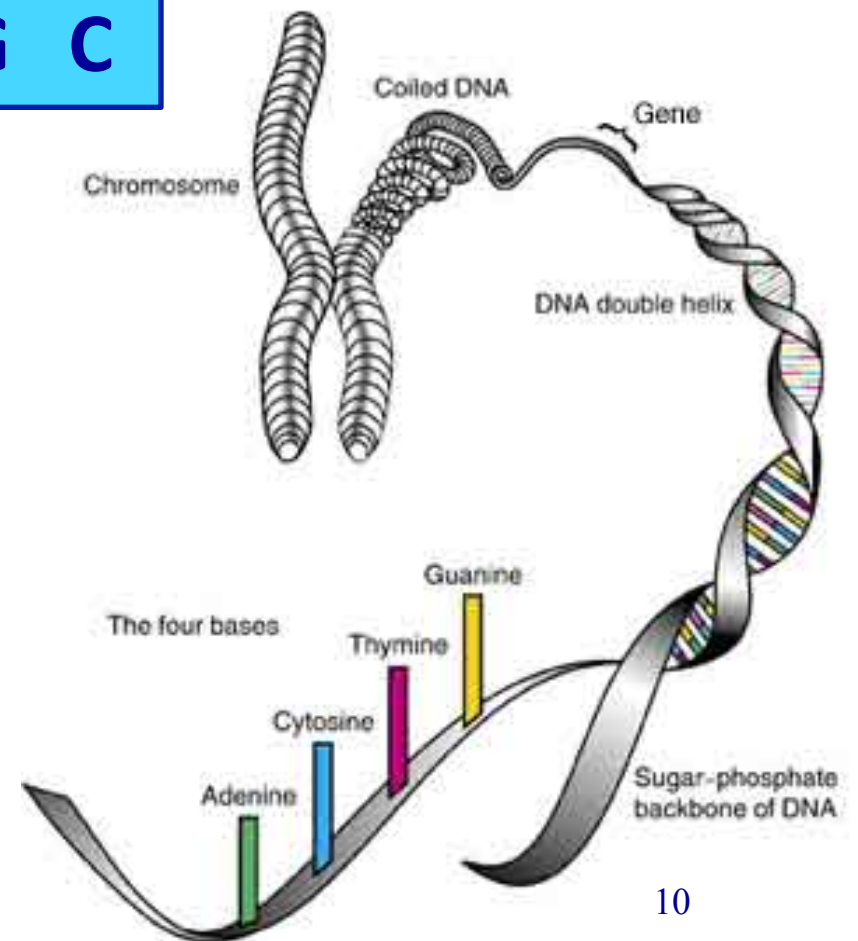
**Phosphate**

**Hydrogen bond**

If one strand of DNA has the following nucleotide bases, what **complementary bases** would the other strand have?

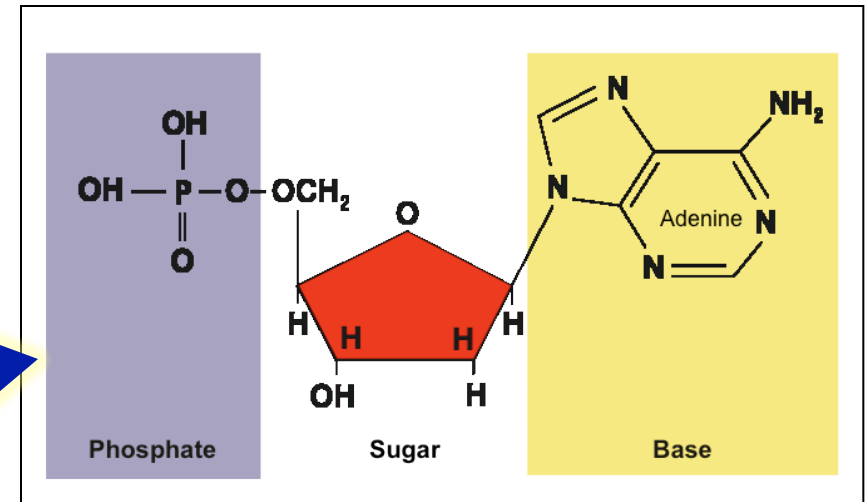
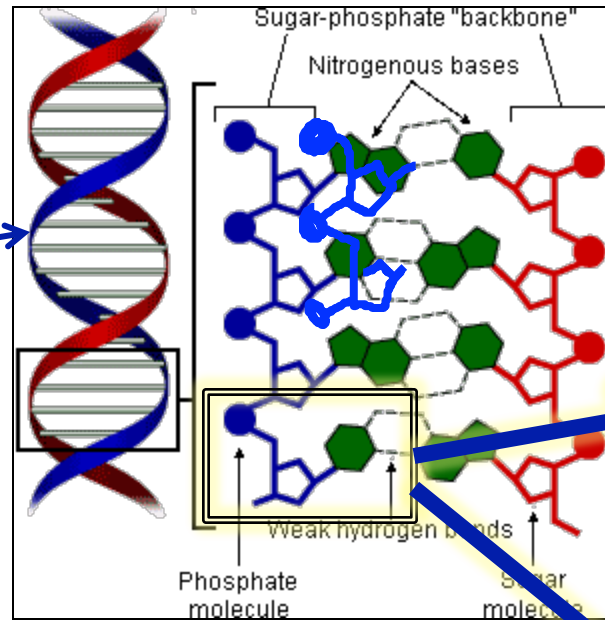
A T C G A A T C G

T A G C T T A G C



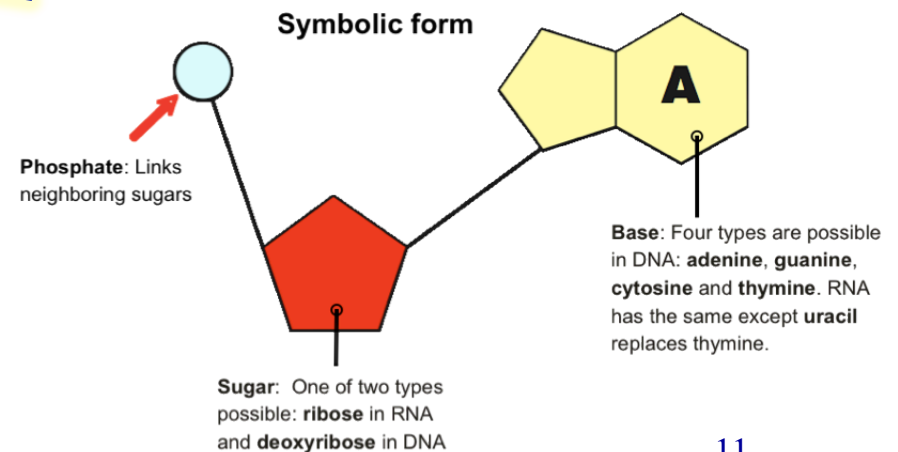
# Nucleotide

Like a  
twisted  
ladder, made  
up of  
nucleotides



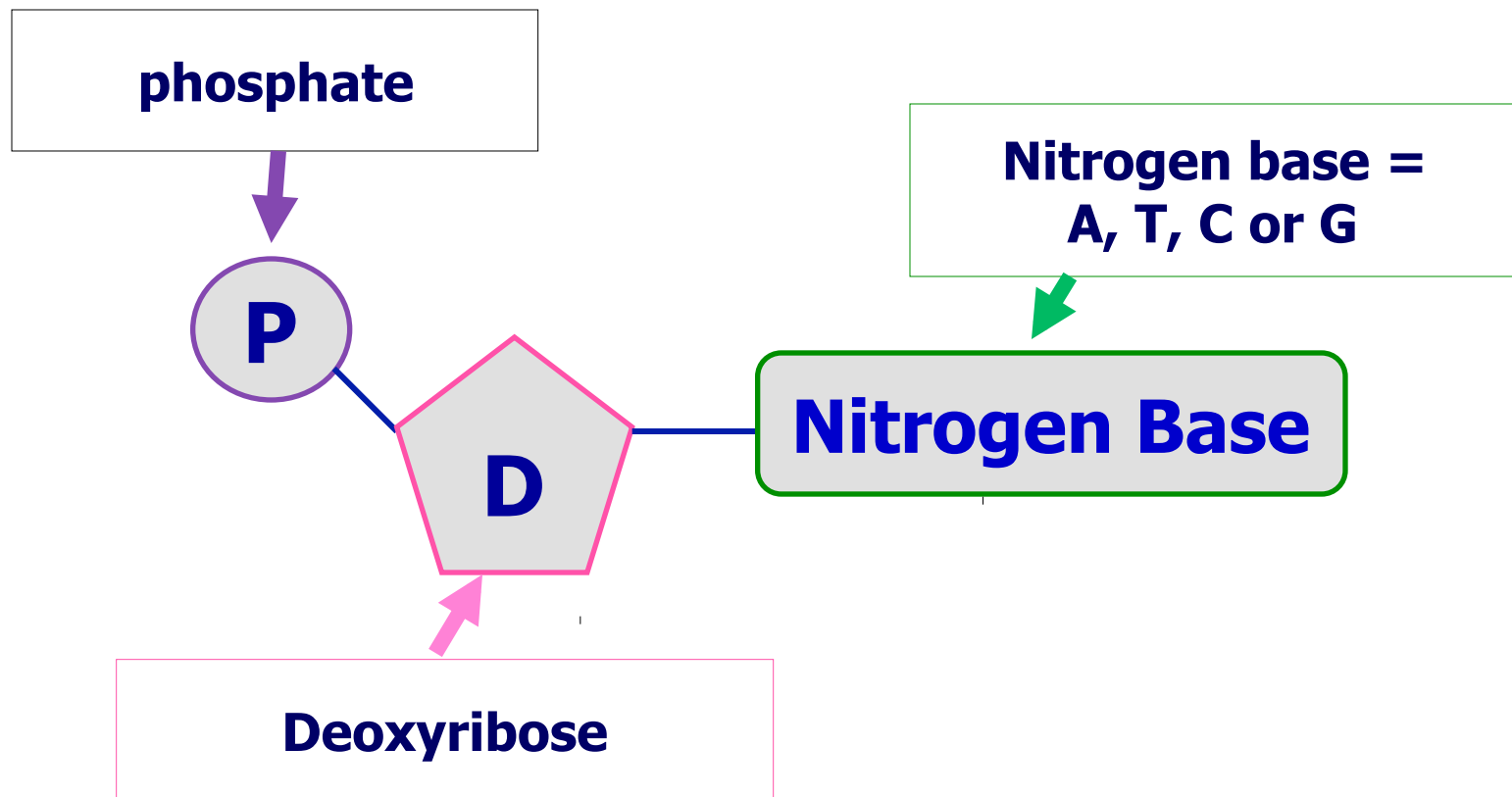
**A Nucleotide**

- The functional unit of DNA is called a nucleotide
- Each nucleotide is made up of deoxyribose, phosphate & nitrogen base
- DNA is made up of many nucleotide monomers



# Nucleotide

1 base(A,T,C,G) + 1 phosphate + 1 sugar(deoxyribose)



# Label this diagram with these words:

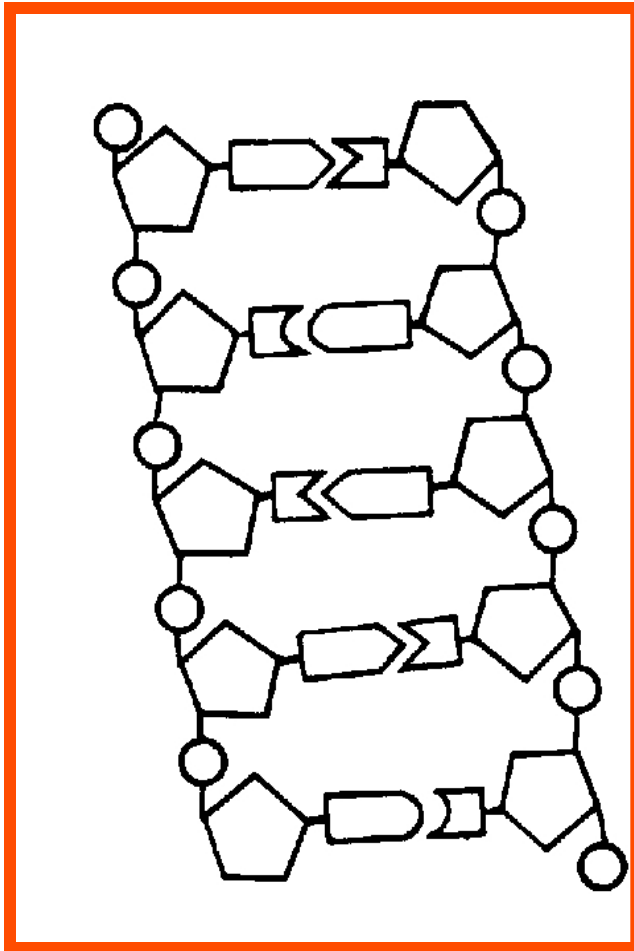
**Deoxyribose**

**Hydrogen bond**

**Nucleotide**

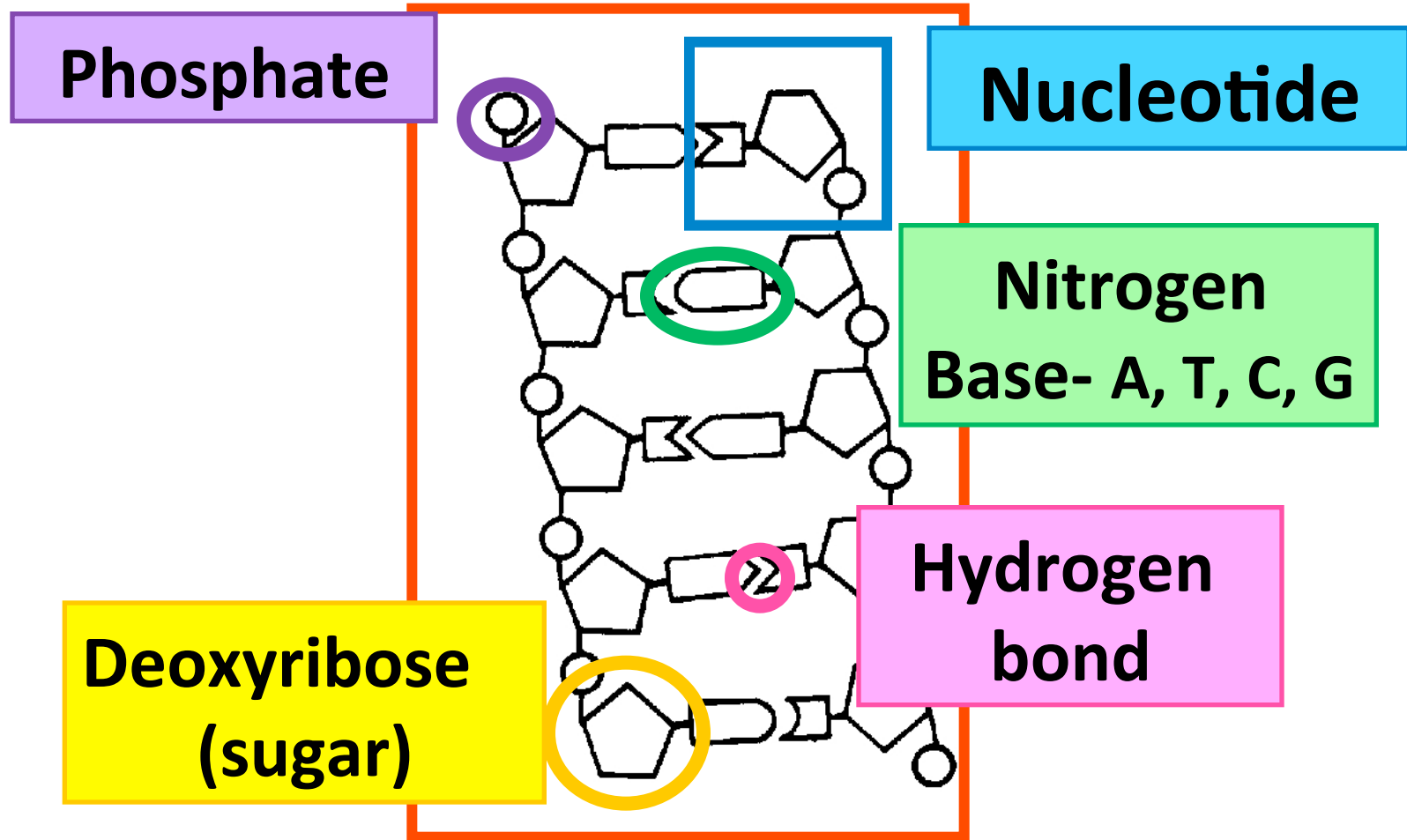
**Phosphate**

**Nitrogen  
Base- A, T, C, G**





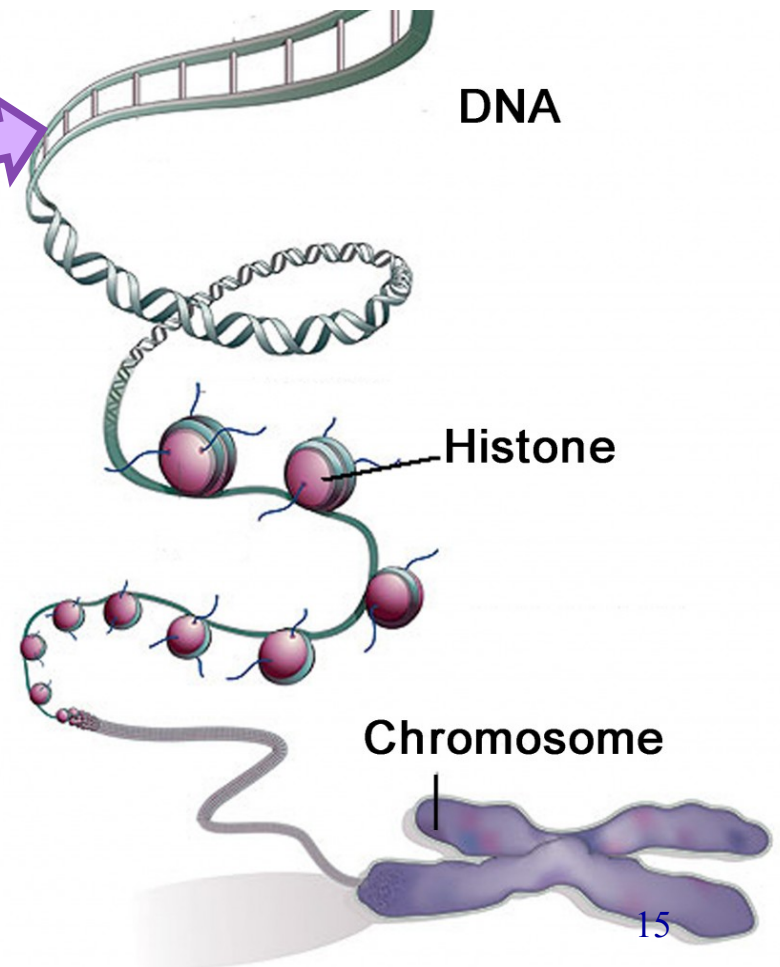
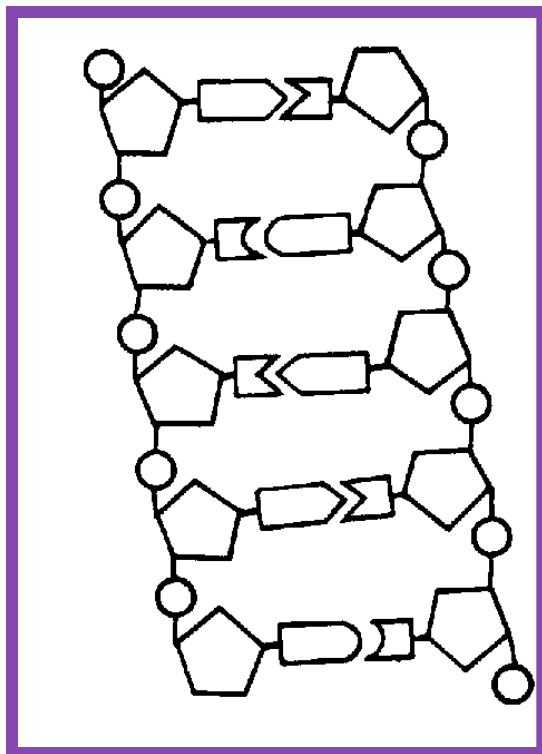
# DNA Structure



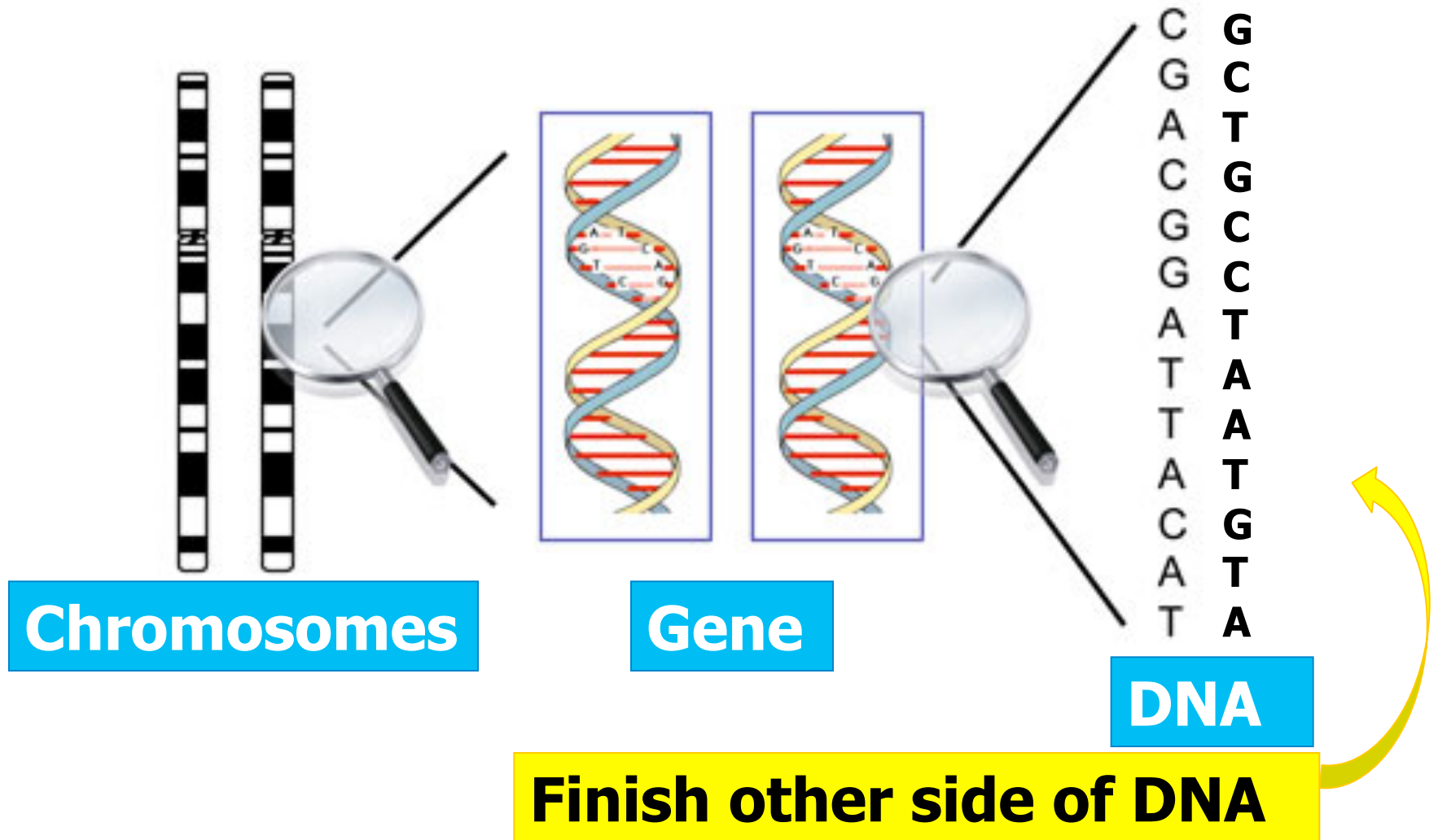
# DNA Structure

Segment of DNA or gene

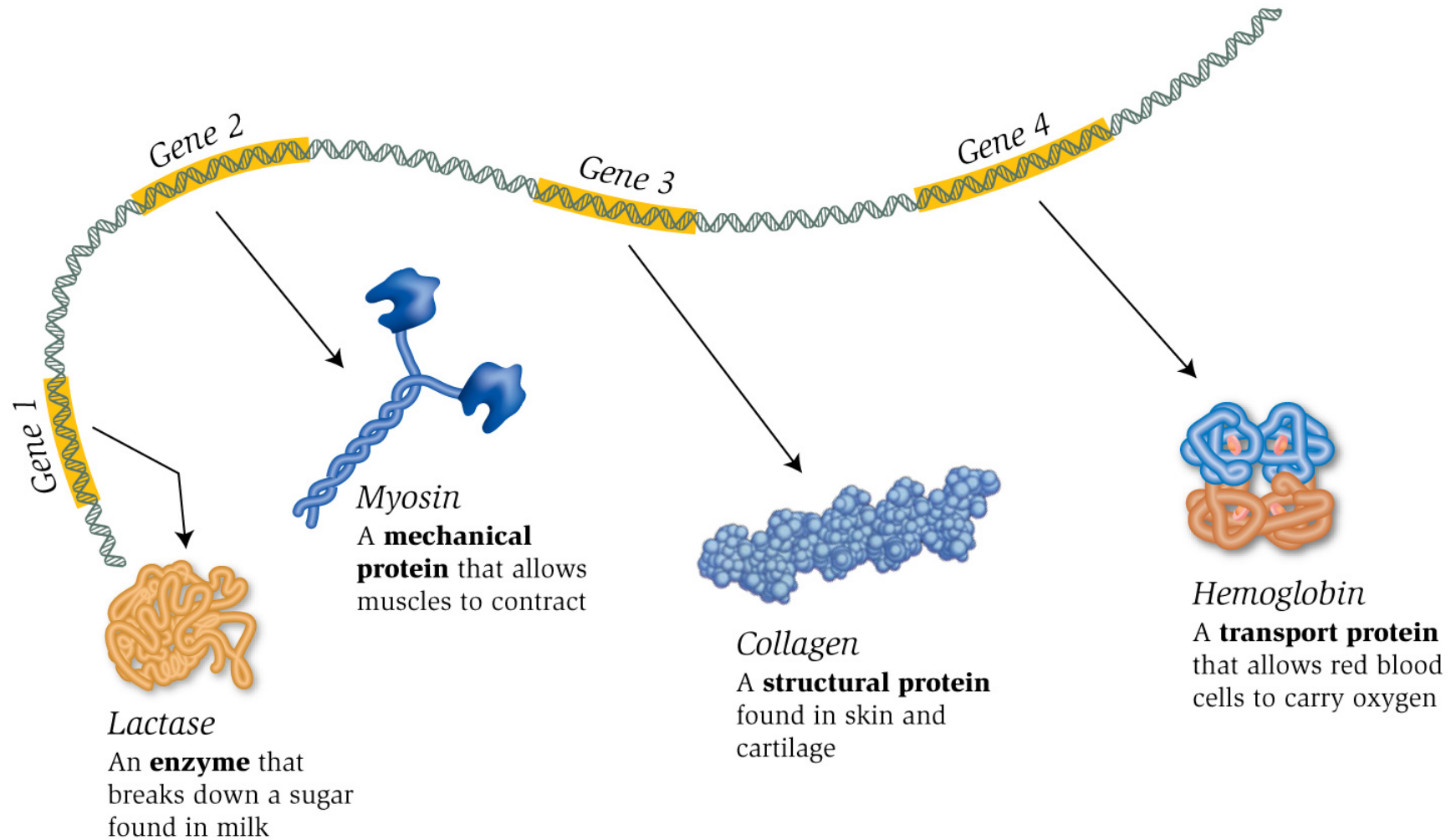
Chromosomes are made up of DNA



**Gene = segment of a chromosome (DNA)**  
**that codes for a specific trait**



# Each protein carries out a unique function



# DNA Bases

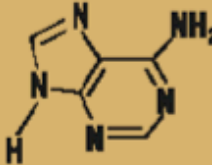
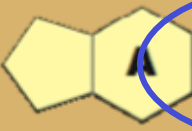
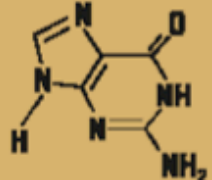

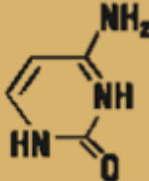

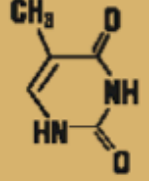

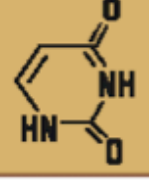

These are on your DATA sheet.

**Purines:  
Big ones!!**

“Pure As Gold”  
(Adenine and  
Guanine are Purines)

**Pyrimidines:  
Smaller**

“CuT Py” (Cytosine and  
Thymine are Pyrimidines)

<b>Purines</b>			Adenine
• Double-ringed structures			
• Always pair up with pyrimidines			Guanine
<b>Pyrimidines</b>			Cytosine
• Single-ringed structures			
• Always pair up with purines			Thymine
			Uracil



# DNA Base Pairs

Remember that adenine and thymine are complementary base pairs.

This means that  $A = T$

Also, guanine and cytosine pair together, so

$$G = C$$

---

**When added together, all the base pairs = 100%.**

---

Question: If a DNA molecule were comprised of 30% adenine, how much guanine would be present?

Solution: If  $A = 30\%$ , then  $T = 30\%$ . Added together,  $A + T = 60\%$  of the DNA molecule.

That means that the other 40% of the molecule is made up of G and C. Since  $G = C$ , then each is  $\frac{1}{2}$  of 40, or  $40 \div 2 = 20$ .

$G = 20\%$

# DNA Base Pairs



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**Practice:** If a DNA molecule is 40% Guanine, then how much Thymine will there be in the molecule?

# DNA and Uniqueness

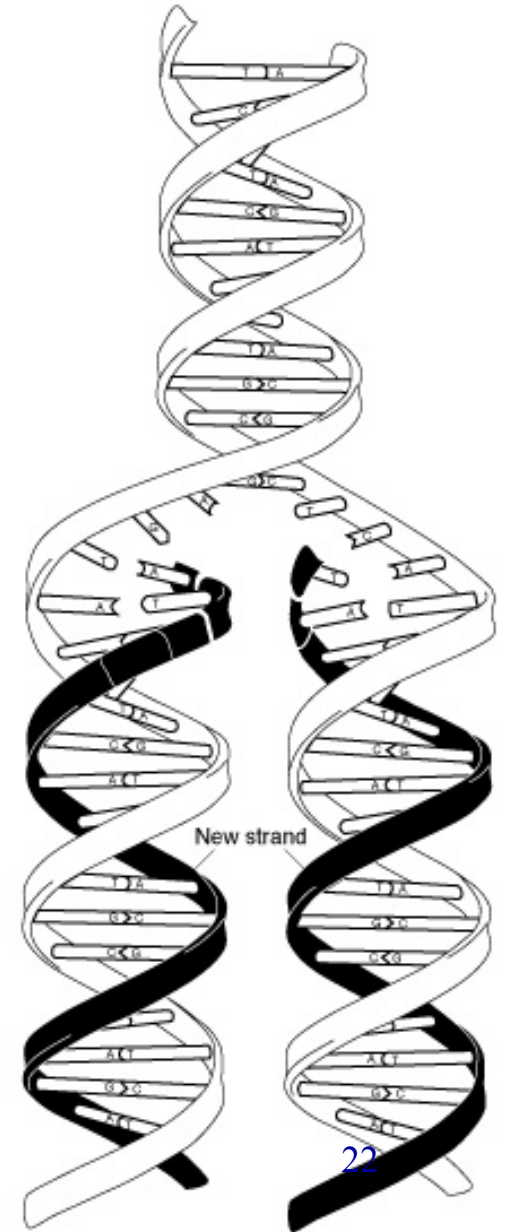
- Our DNA is like a **cookbook** of instructions
- The sequence of DNA bases determine the type of proteins produced
- Proteins are unique for each life form
- Offspring look similar to parents but not exactly the same...why?
  1. **New gene combinations (when sperm and egg fuse to form zygote)**
  2. **Mutations (changes in DNA)**
  3. **Crossing over**



If all the DNA in your body were uncoiled and stretched out, it would reach to the sun and back approximately **3000** times!!

# DNA Replication

- DNA was the only known molecule capable of **replicating** itself
  - prions (special proteins) now known to do this too!
- Replication necessary for 1 cell to become **2 identical cells**
- DNA replication occurs when a cell is going to divide

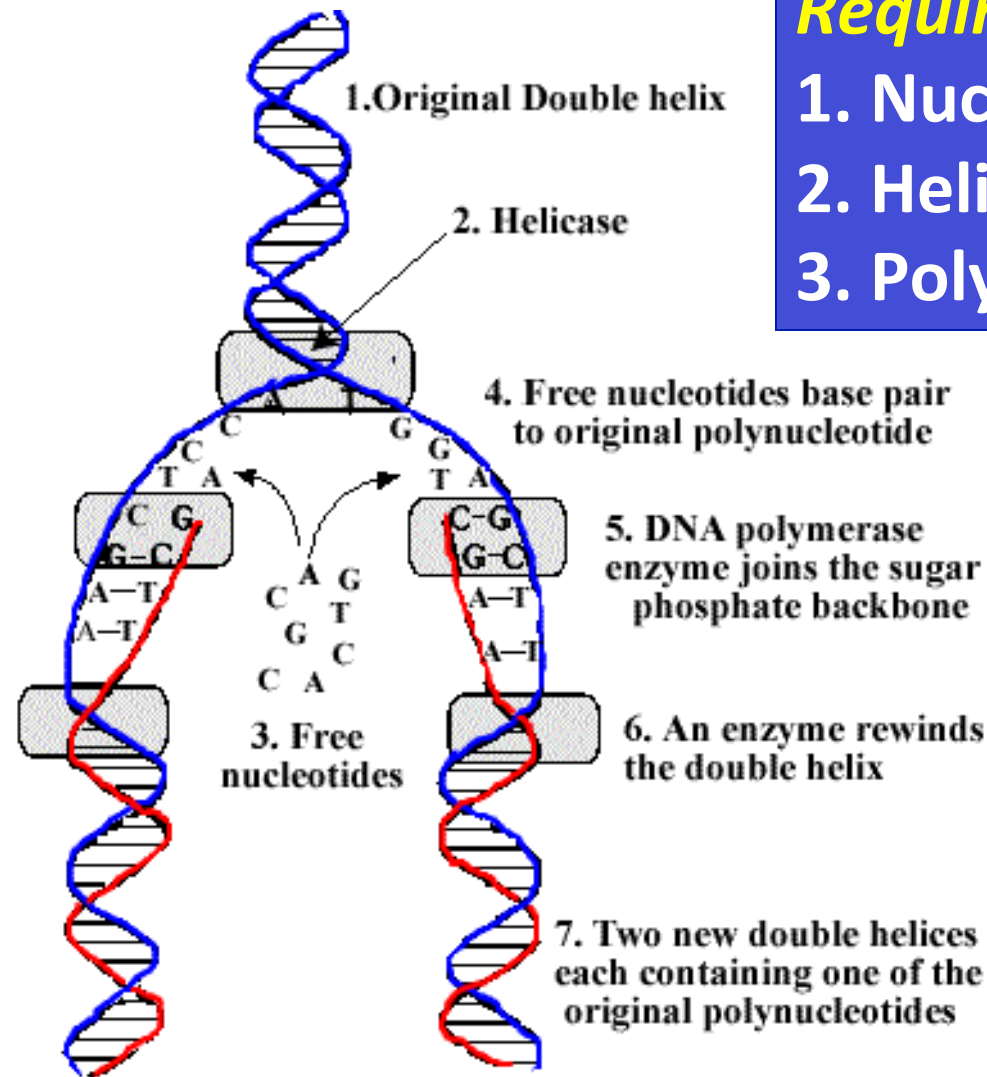


# Semiconservative Replication

## *Requirements*

1. Nucleotides
2. Helicase
3. Polymerase

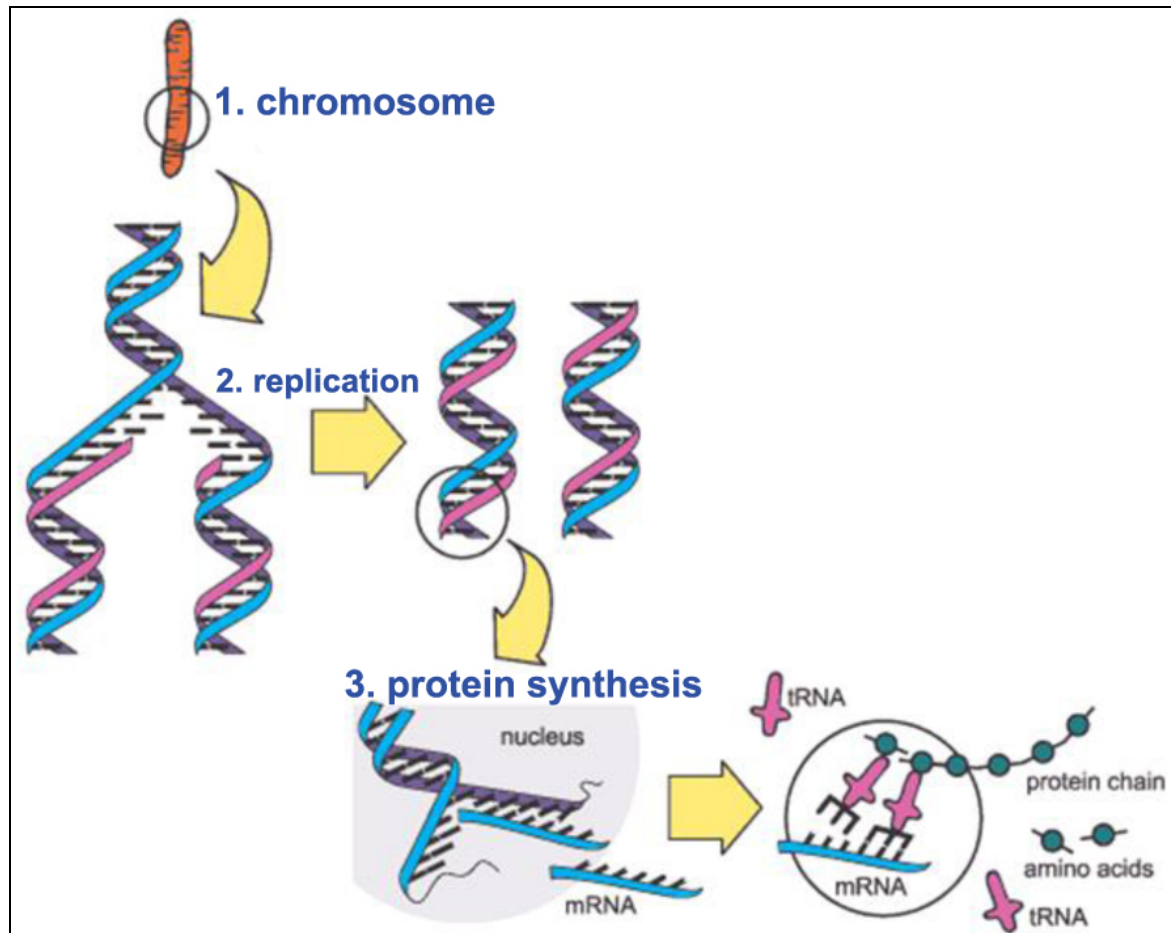
New DNA made  
up of  
1 Parent strand &  
1 Daughter strand





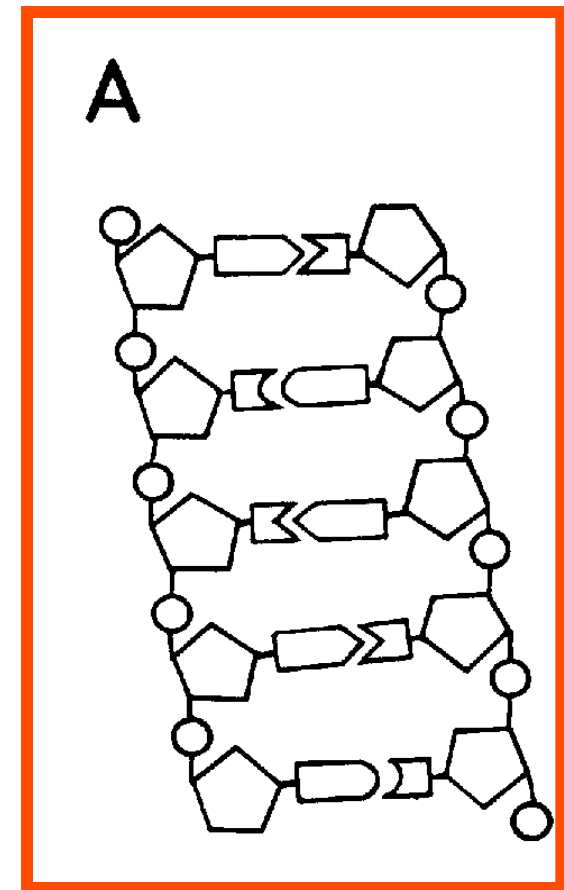
# DNA Unzips for 2 reasons!

1. For replication prior to cell division
2. To make mRNA for protein synthesis



# DNA Replication

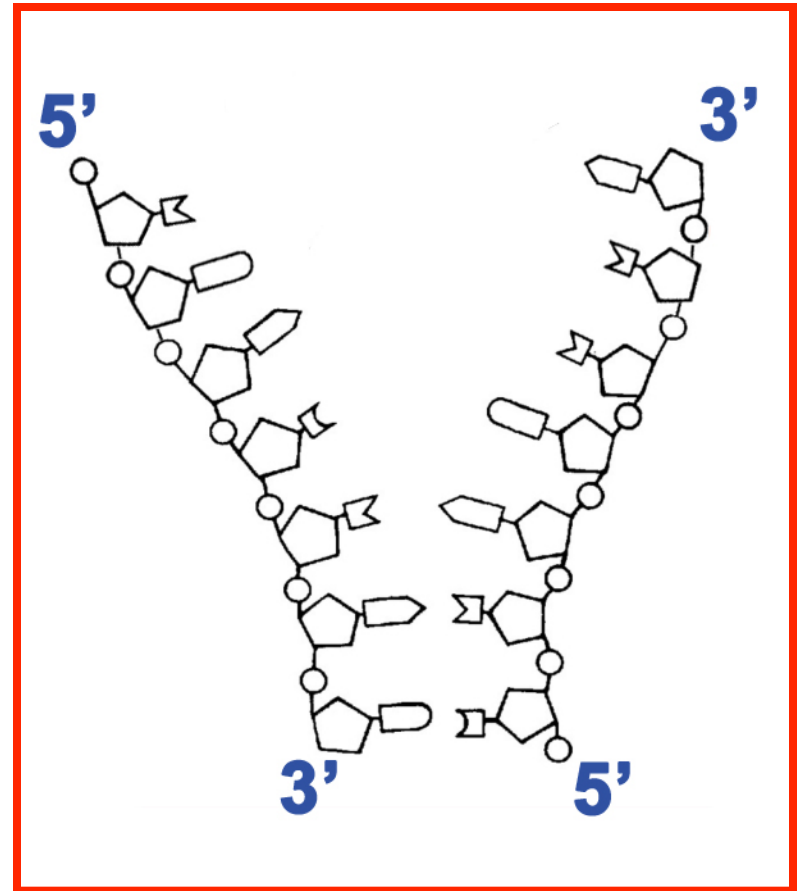
1. **DNA molecule untwists**  
(straightens)
  - initiated by the enzyme **helicase**



# DNA Replication

## 2. DNA 'unzips' (the hydrogen bonds break) with the help of helicase

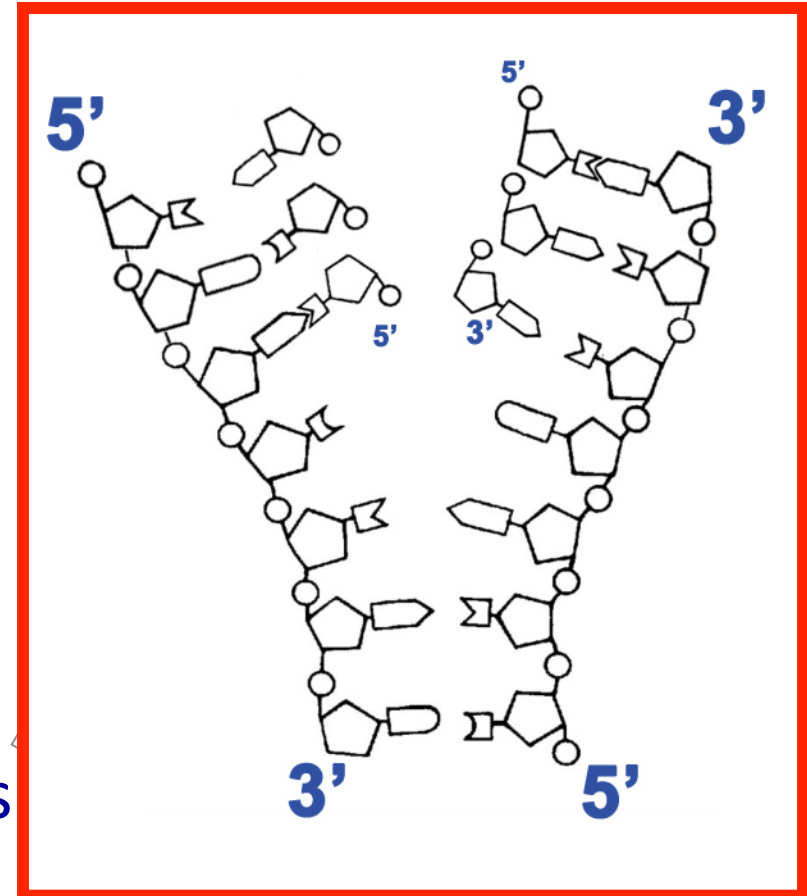
- Helicase acts like a pair of scissors to break the weak H-bonds between nitrogen bases





# DNA Replication

3. The exposed nucleotides **attract their 'partner/complementary' nucleotides.**
- DNA polymerases are involved in the fusing of the free nucleotides.
  - nucleotides start to attach from 3' end of parent strands

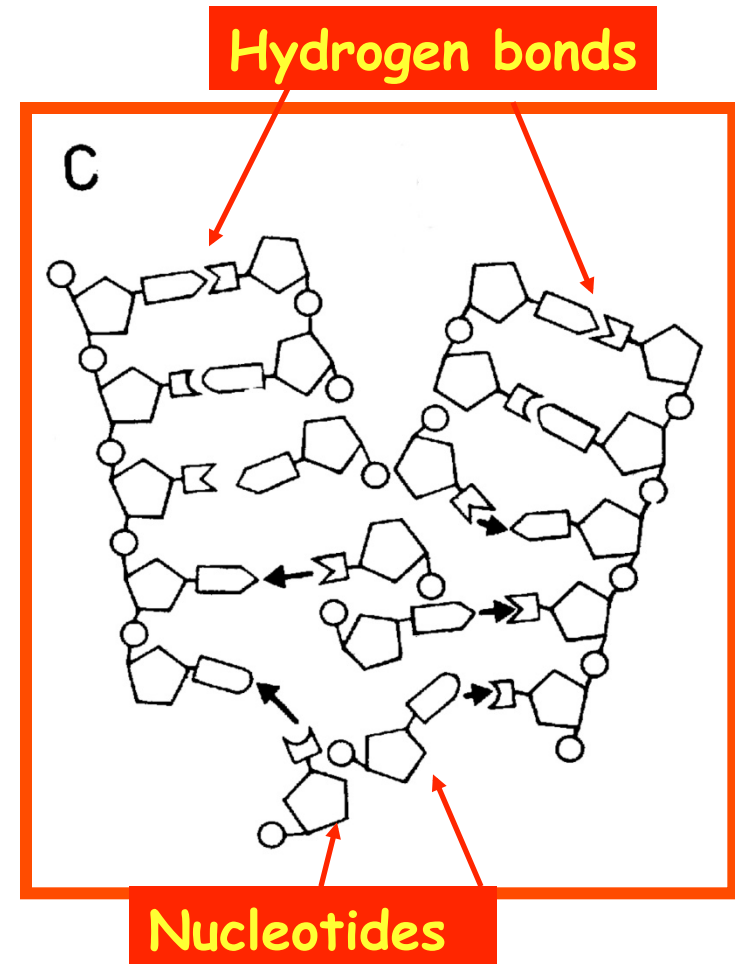


**\*\*FREE FLOATING NUCLEOTIDES IN THE NUCLEOPLASM  
COME FROM FOOD WE EAT!\*\***



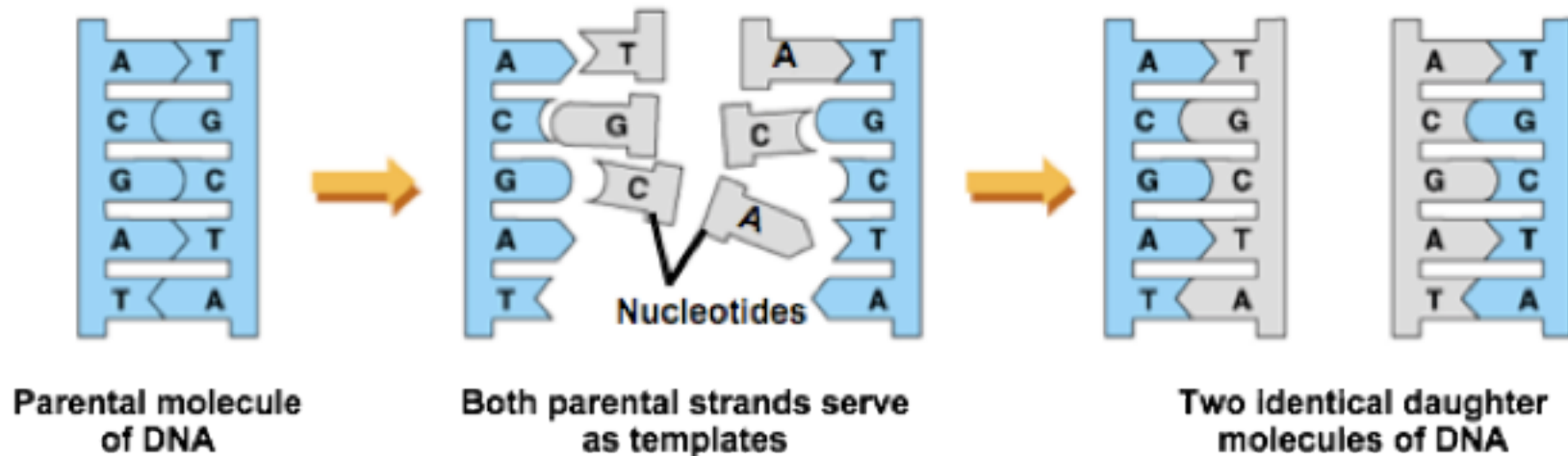
# DNA Replication

4. The sugar and phosphate molecules of adjacent nucleotides join to form **2 ladder-like structures** each identical to the original.



# DNA Replication

- **Semi-conservative replication** - because each new molecule is composed of ½ the original strand and ½ the new strand.



Bozeman video (10:10)-skip  
1:25- 2:48

[http://www.youtube.com/watch?v=FBmO\\_rmXxIw&safe=active&safety\\_mode=true](http://www.youtube.com/watch?v=FBmO_rmXxIw&safe=active&safety_mode=true)

Crash Course: DNA structure  
and replication

# Mistakes in Replication – cause of protein mutations!

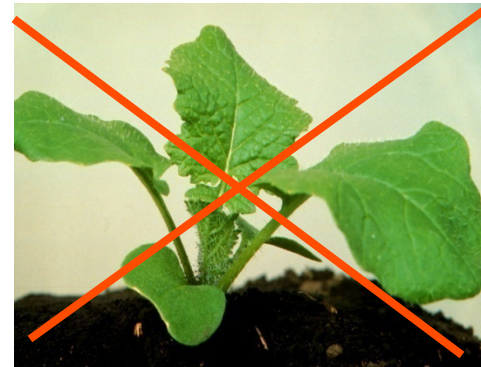
Mistakes in replication can be caused by environmental factors  
such as **hazardous chemicals and radiation**

One change in DNA sequence (mutation) can have a significant effect!

**A** 601 ACGGTGCCCCG CAAAGTGTGG **C**TAACCCTGA ACCGTGAGGG

**B** 601 ACGGTGCCCCG CAAAGTGTGG **A**TAACCCTGA ACCGTGAGGG

**A** + Herbicide **B**



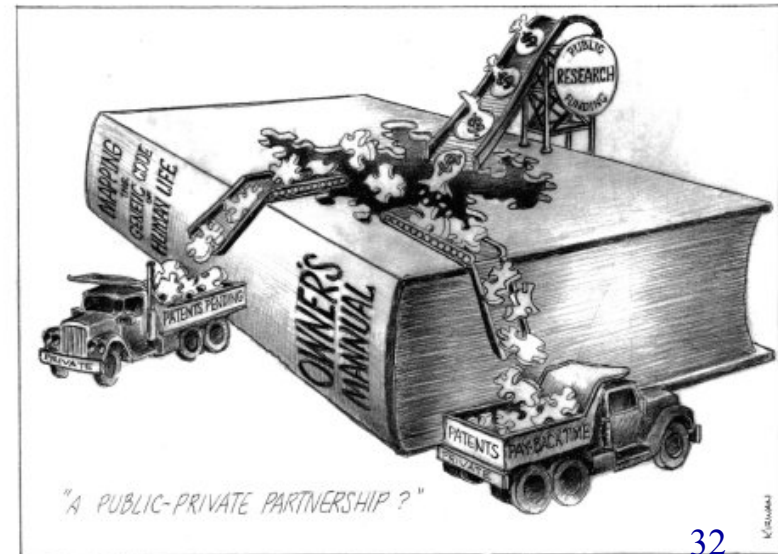
Resistant plant – not  
killed by herbicide due to  
one base pair mutation

# The Human Genome Project

Goals of the project:

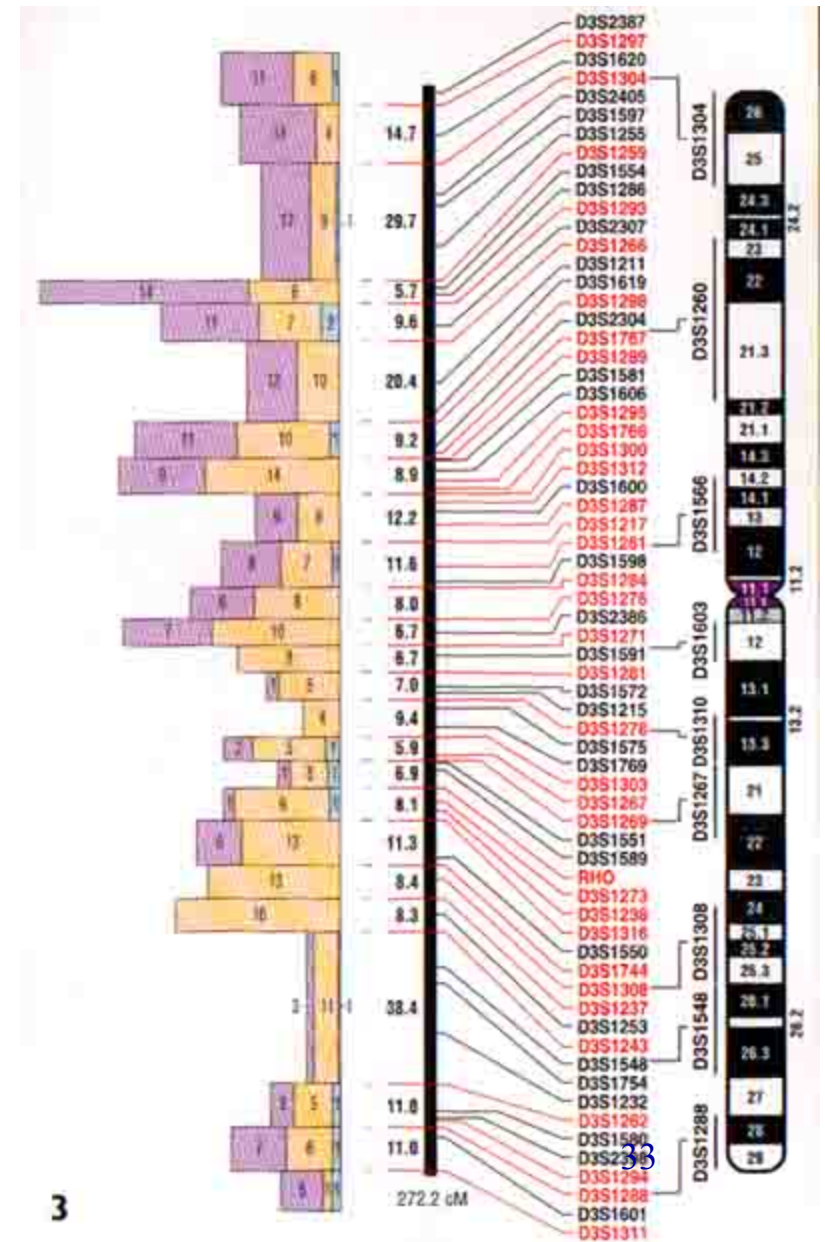
- to **identify all genes** in human DNA.
- To determine the sequences of 30,000 genes which is the **3 billion base pairs** that make up human DNA  
(3 billion is 90 years of seconds)
- Took from **1990 – 2003 to complete**

**Nobel Prize Winner(1980)**  
**Walter Gilbert described**  
**the human genome as**  
**the Holy Grail of biology**  
-helped develop method of identifying base  
pairs (1976)



# Human Genome

- Estimated to contain approx. 3 billion bases
- Mistakes (faulty base pairing) are infrequent and permanent damage prevented by proofreaders
  - Enzymes
- These enzymes run along DNA looking for mismatched pairs
- Some enzymes snip out errors and replace them with correct nucleotide sequences



# Human Genome

## Benefits

- Diagnose and treat genetic disorders (like BRCA gene – the gene for breast cancer)
- Develop new medications
- Prevent disorders
- Study evolutionary relationships
- DNA identification

## Issues

- Who should have access to the information (employers, insurance companies, ‘geneism’ )?
- Who owns the information?
- Reproduction issues – how are we going to use the data?
- Cost to society?



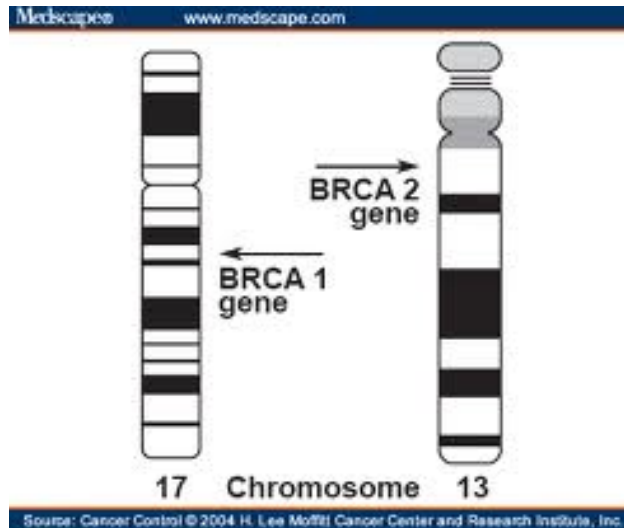


Angelina  
Jolie has  
the  
mutated  
BRCA1  
gene.

## Angelina Jolie Reveals Plans For More Surgery After Double Mastectomy

After having a double mastectomy in 2013, that next stage would likely be to have an oophorectomy, a.k.a. ovary removal surgery. The procedure would combat Angelina's 50 percent risk (the number varies based on the individual) of developing ovarian cancer, the disease her mother, Marchelina Bertrand, died from at the relatively young age of 56. Angelina's risk of developing breast cancer and ovarian cancer was and is so high because she inherited the "faulty gene" known as BRCA1 from her mother.





## BRCA1 and BRCA 2 Genes

*BRCA1* and *BRCA2* are human genes that produce tumor suppressor proteins. These proteins help repair damaged DNA and, therefore, play a role in ensuring the stability of the cell's genetic material. When either of these genes is mutated, or altered, such that its protein product is not made or does not function correctly, DNA damage may not be repaired properly. As a result, cells are more likely to develop additional genetic alterations that can lead to cancer.

# Some More Interesting Genomics Facts

- Humans only have 20% more genes than worms
- Around 99% of our genes have counterparts in mice
- Our genetic overlap with chimpanzees is about 97.5%
- The genetic difference between one person and another is less than 0.1 %  
(1 base pair out of 1000)



## **DNA REVIEW**

DNA stands for...

Describe Parts of DNA molecule:

Nitrogen Bases(4+1):

Purine:

Pyrimidine:

Nucleotide:

Gene:

Helicase:

Polymerase:

Semi-conservative replication: