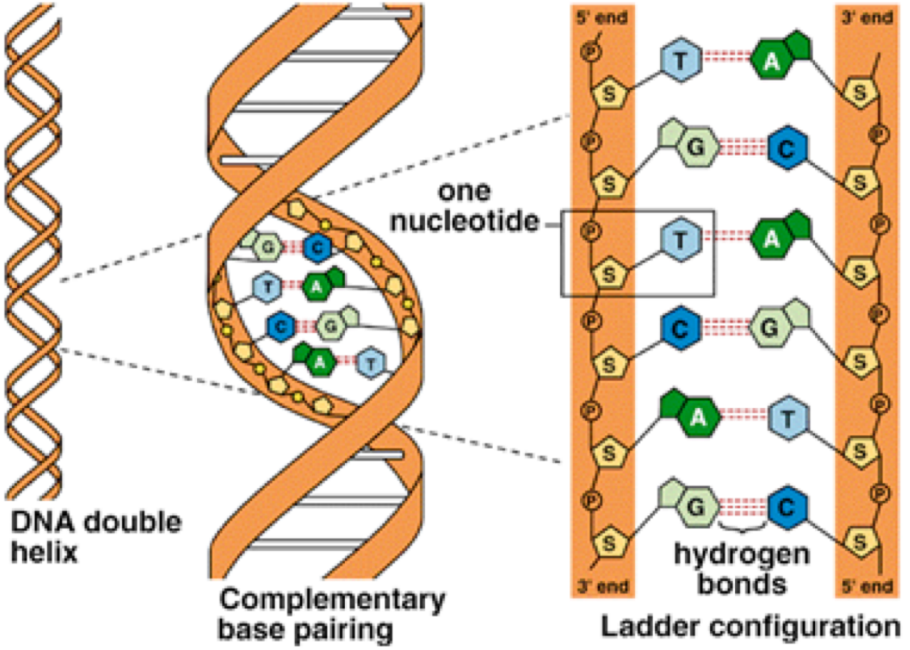
What is DNA????

1. The structure of DNA and RNA

- DNA = deoxyribonucleic acid
- DNA is the control molecule of cells (and, hence life)



- DNA has three major functions!

1. DNA controls cellular activities including reproduction

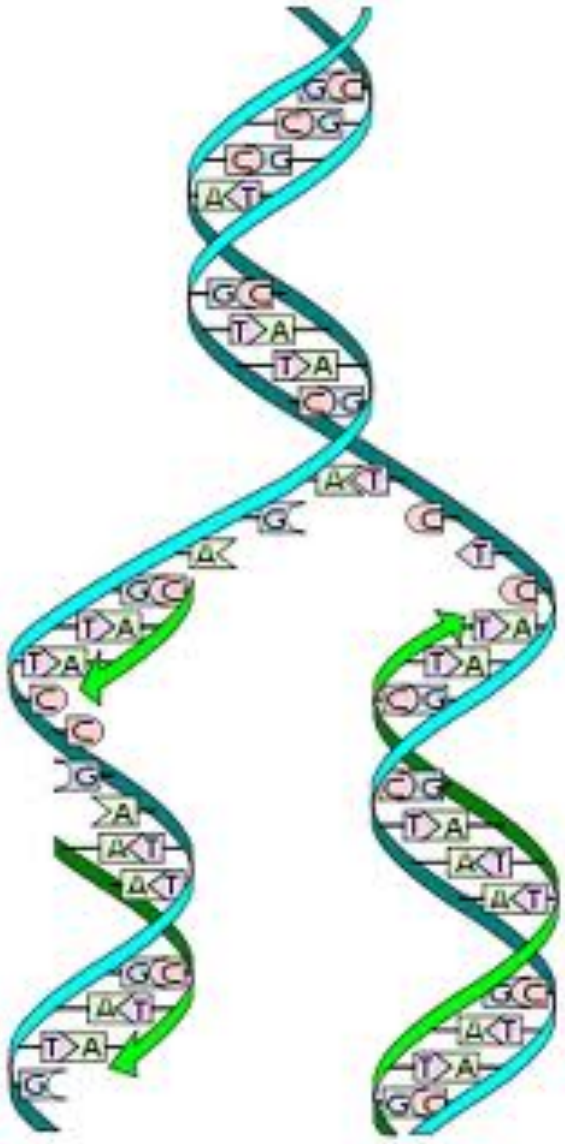
- DNA carries a code. Genetic instructions are encoded in the sequence of bases strung together in DNA.

- DNA from male and DNA from female together become the **genetic information of offspring** in sexual reproduction.

- **RNA** molecules function in the processes by which those DNA instructions are used in building the **proteins** on which all forms of life are based.

2. **<u>DNA MAKES EXACT COPIES OF ITSELF</u>** to pass onto other cells.

- DNA does this through a process called "**replication**."



3. DNA Undergoes Mutations

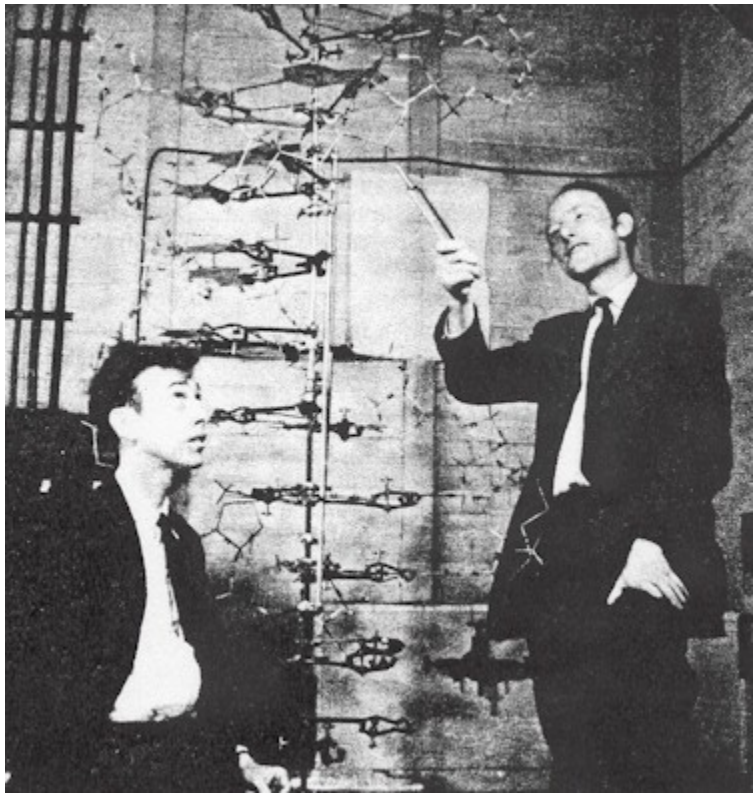
- **Mutations** and **recombinations** in the structure and number of DNA molecules are the source of life's **diversity**.
- **Evolution**, in essence, proceeds from the level of DNA.
- Different combinations of DNA sequences due to mutations and sexual reproduction explain the existence of all the different species that have lived on this Earth.

- ***Furthermore...***
- DNA is the source of the **unity of life**
- **Life most likely began as a nucleic acid.** (recall that there are **TWO** Types of Nucleic acids: **DNA** & **RNA**).
- The first form of life on this planet is thought by many biologists to be a **self-replicating strand** of **RNA**

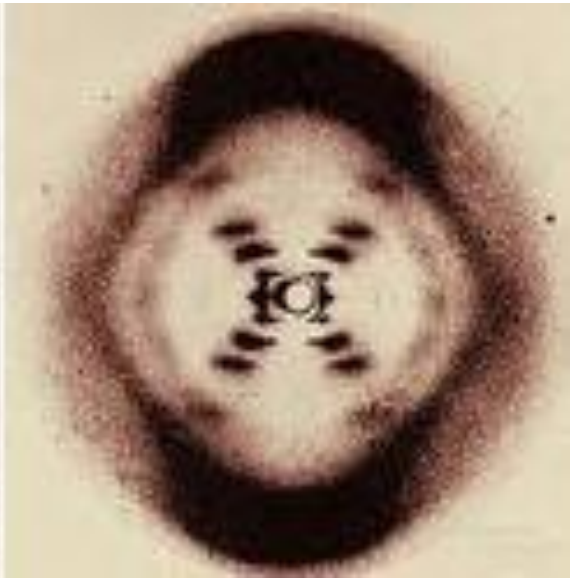
A BRIEF HISTORY OF DNA RESEARCH (no, this is not on the test!)

DNA was first isolated by the Swiss biochemist JOHANN FRIEDRICH **MIESCHER** n **1869**. Because DNA molecules are acidic and are found in the nucleus, Miescher called them nucleic acids. Over 80 years passed, however, before scientists understood that DNA contains the information for carrying out the activities of the cell. How this information is coded or passed from cell to cell was unknown. To break the code, scientists first had to determine the structure of DNA..

During the 1950's, a fierce competition to determine the three dimensional structure of DNA took place. The race was won in **1953** by **JAMES WATSON**, an American biologist, and **FRANCIS CRICK**, a British physicist.



Working together at Cambridge University in England, Watson and Crick solved the puzzle using scale modes of nucleotides. Their success depended a great extent on evidence collected by other biologists, especially X-ray data from British biochemists **ROSALIND FRANKLIN** and **MAURICE WILKINS**. Ted-Ed



In 1958, the mechanism for DNA replication was determined by **MESELSON** and **STAHL**. In the **GENETIC CODE** of **3 DNA nucleotides for 1 amino acid** was worked out by **Crick** and his coworkers

Important Dates in Early DNA Research

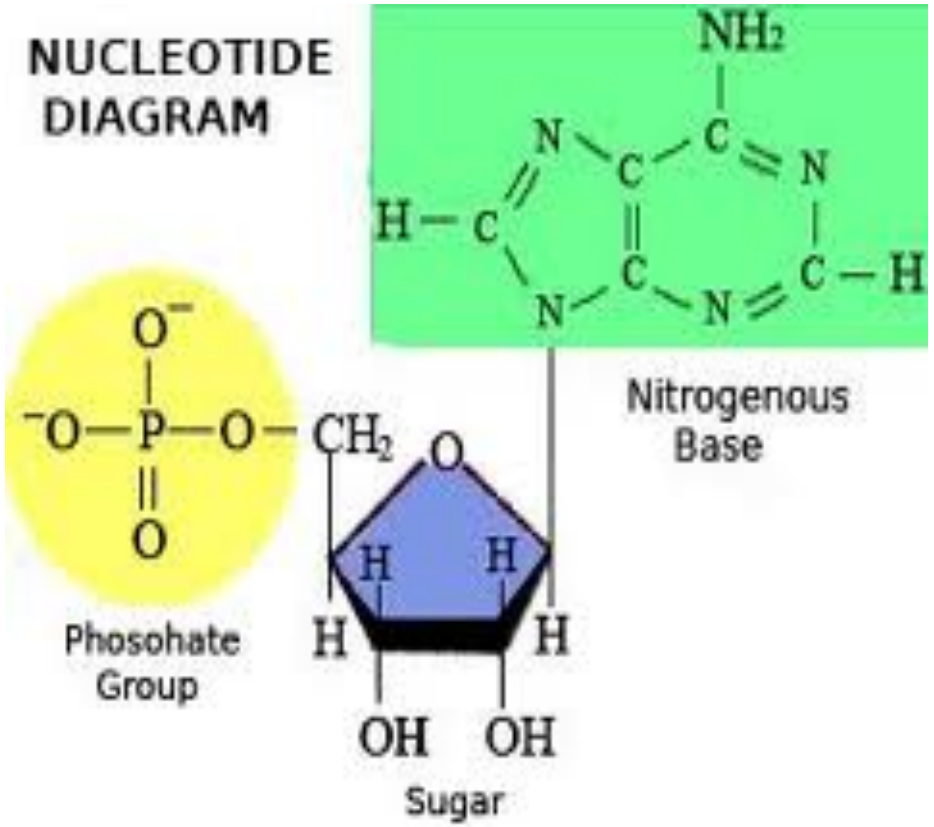
Date	Discovery
1869	Nucleic Acids identified
1928	Transfer of genetic material between bacteria observed (Frederick Griffith)
1944	DNA carries genetic code (Oswald Avery and coworkers)
1950	Protein chains sometimes helical; DNA structure similar (Linus Pauling)
1951	X-ray data for DNA structure produced (Franklin, Wilkins)
1951	Nitrogen base ratio related to genetic code (Chargaff)
1953	DNA double helix discovered (James Watson, Francis Crick)
1958	Mechanism for DNA replication determined (Matthew Meselson, Franklin Stahl)
1961	3 DNA nucleotide code for 1 amino acid (Crick and coworkers)

The Structure of Nucleic Acids

DNA AND RNA ARE POLYMERS OF NUCLEOTIDES

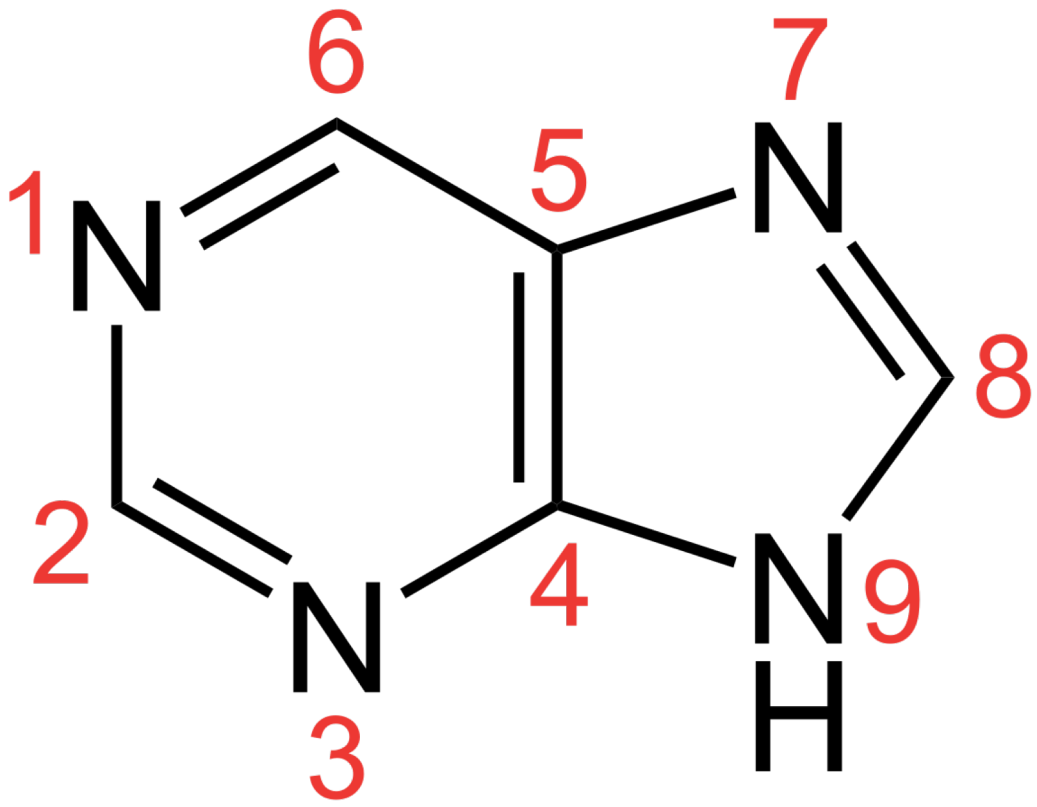
- **Each nucleotide** is composed of three parts:

1. a **pentose** (5 carbon) **SUGAR**
2. a **PHOSPHATE group**
3. a **nitrogenous BASE**

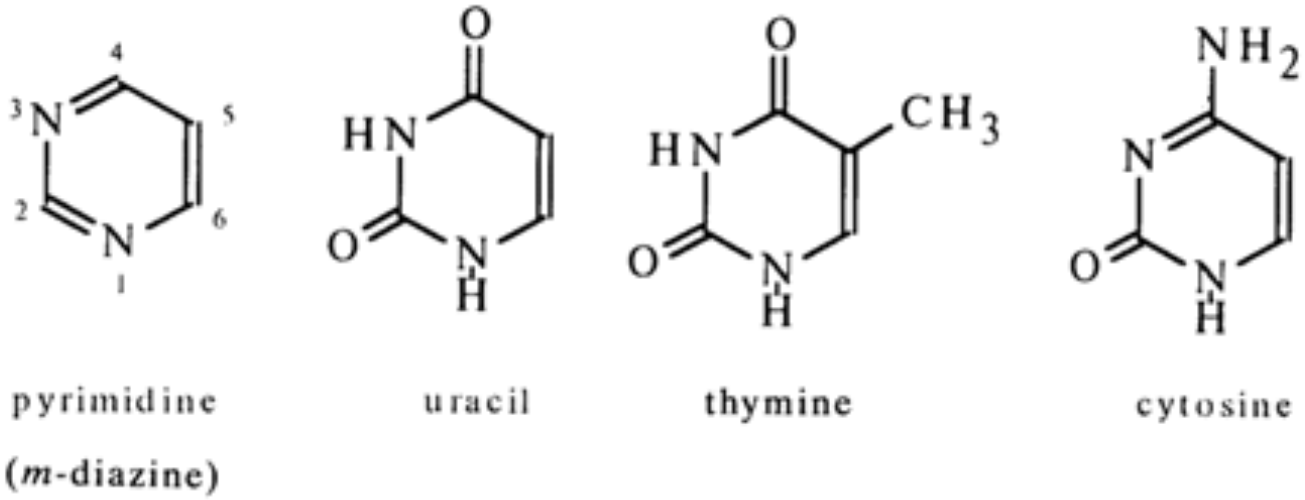


There are two types of bases

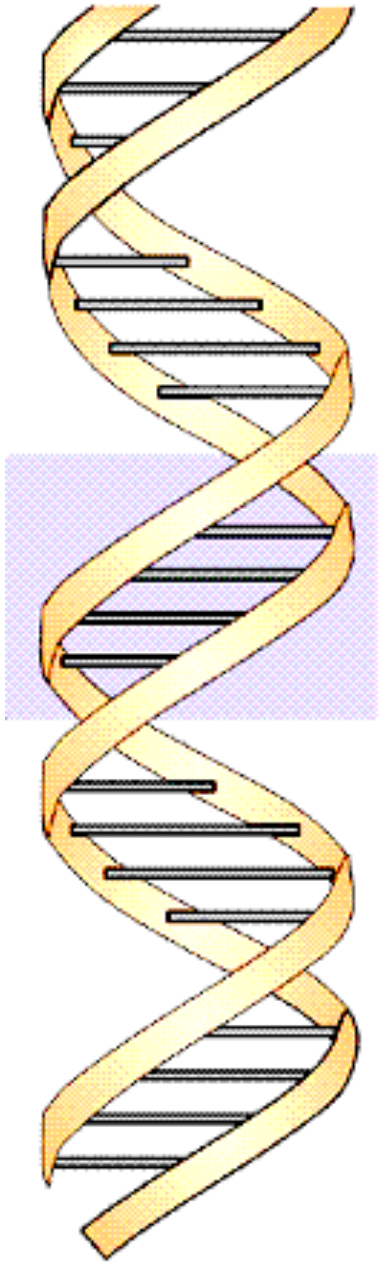
- i) **<u>PURINES</u>** - have a ***double ring structure*** (adenine & guanine)



ii) **PYRIMIDINES** - have a ***single ring structure*** (thymine, cytosine, uracil)

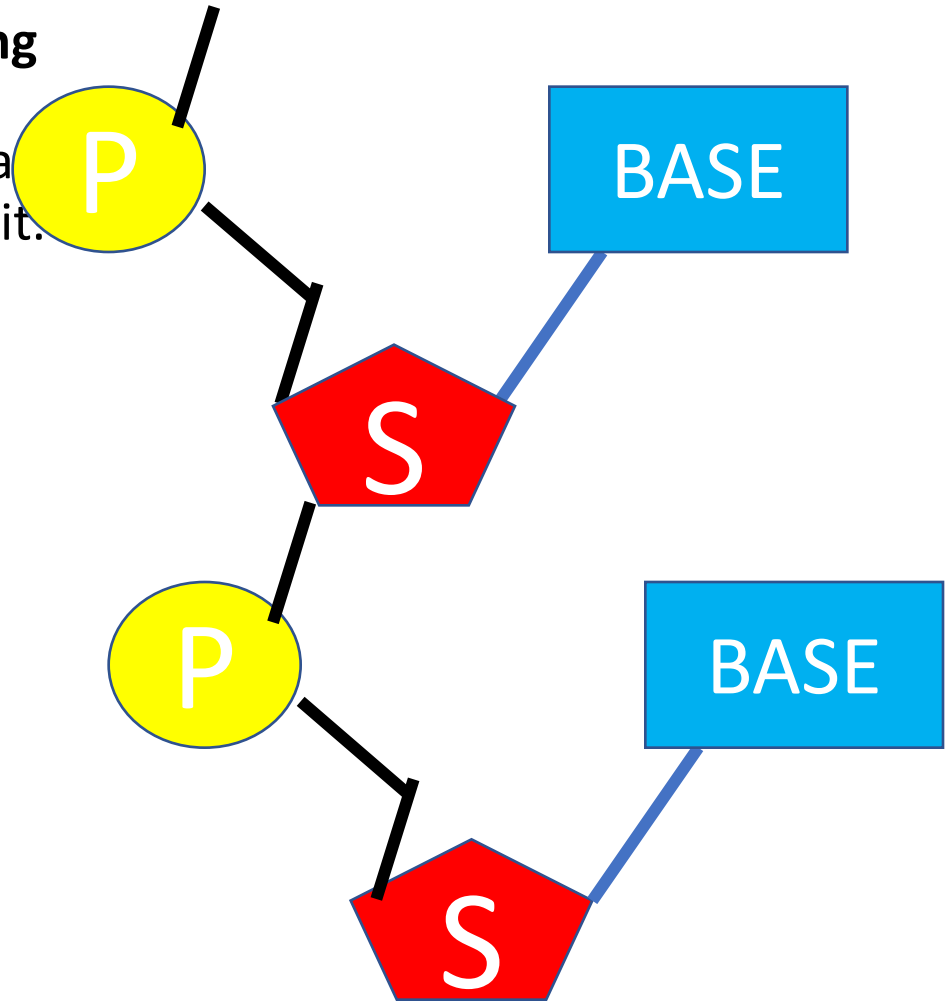


- The DNA strand consists of a sequence of nucleotides linked together to form a **DOUBLE HELIX** that can be visualized as an immensely **long, twisted ladder**

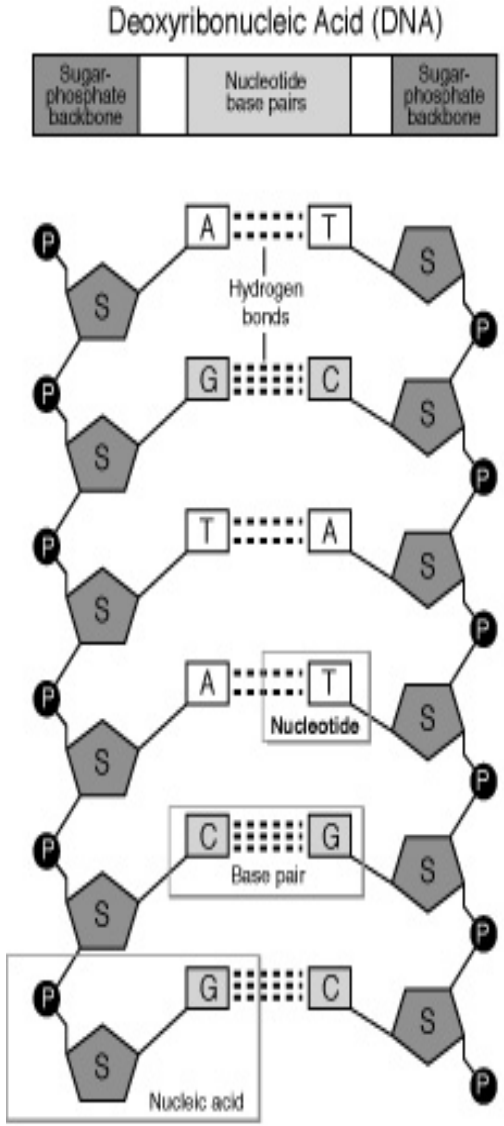


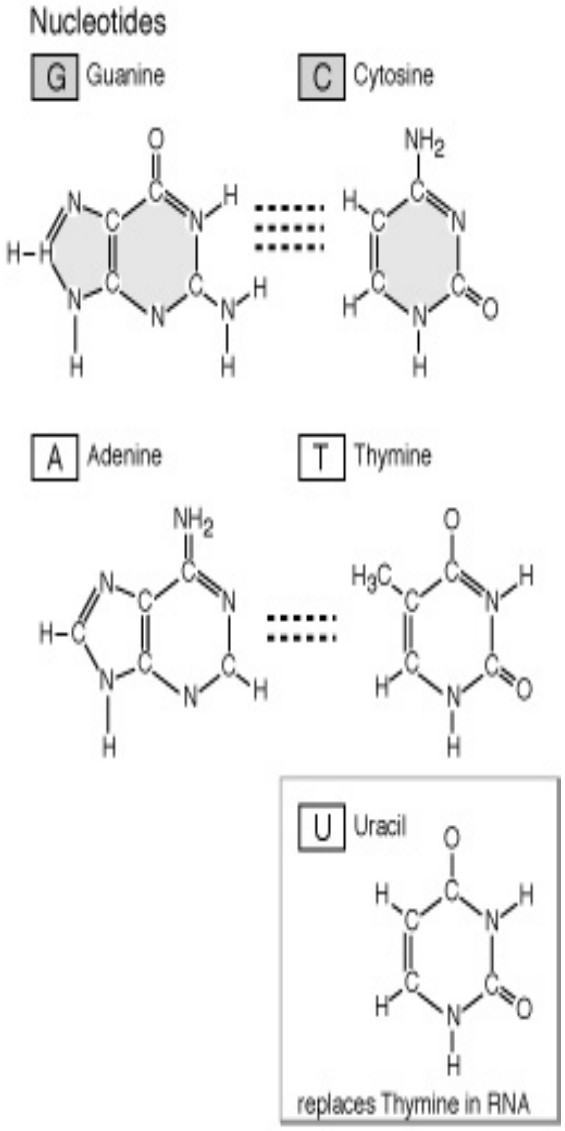
Phosphate – Sugar backbone

Each strand, or one side of the ladder, is composed of **alternating molecules of deoxyribose and phosphate** with a nitrogenous ba attached to each deoxyribose unit.

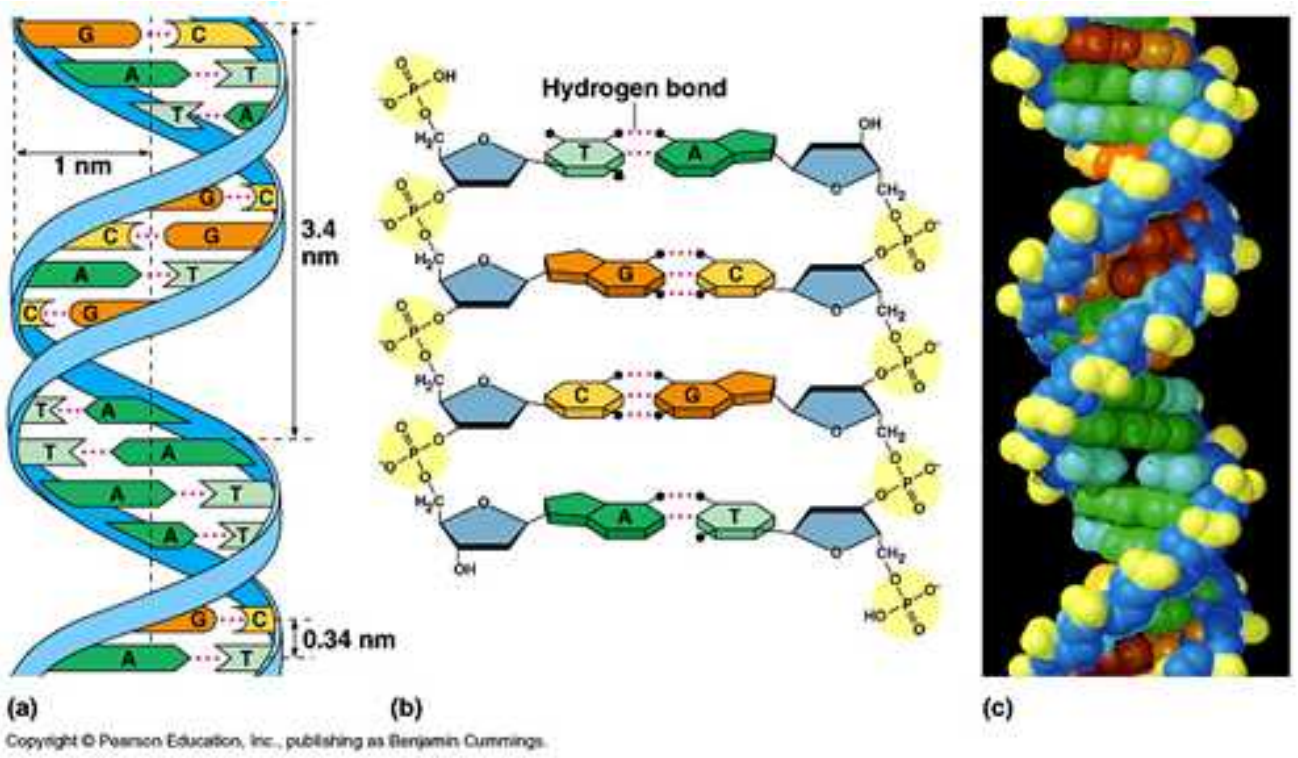


- Nucleotides are connected by joining the bases of one nucleotide to the bases of the adjacent nucleotide (the ‘sugar-phosphate backbone’).





- Pairs of **joined bases project crosswise**, forming the **rungs** of the ladder. The bases stick out the side of the sugar molecules, and are linked to the bases of the other strand by **<u>hydrogen bonds</u>** in a very strict pattern. Always a **purine** with a **pyrimidine**.



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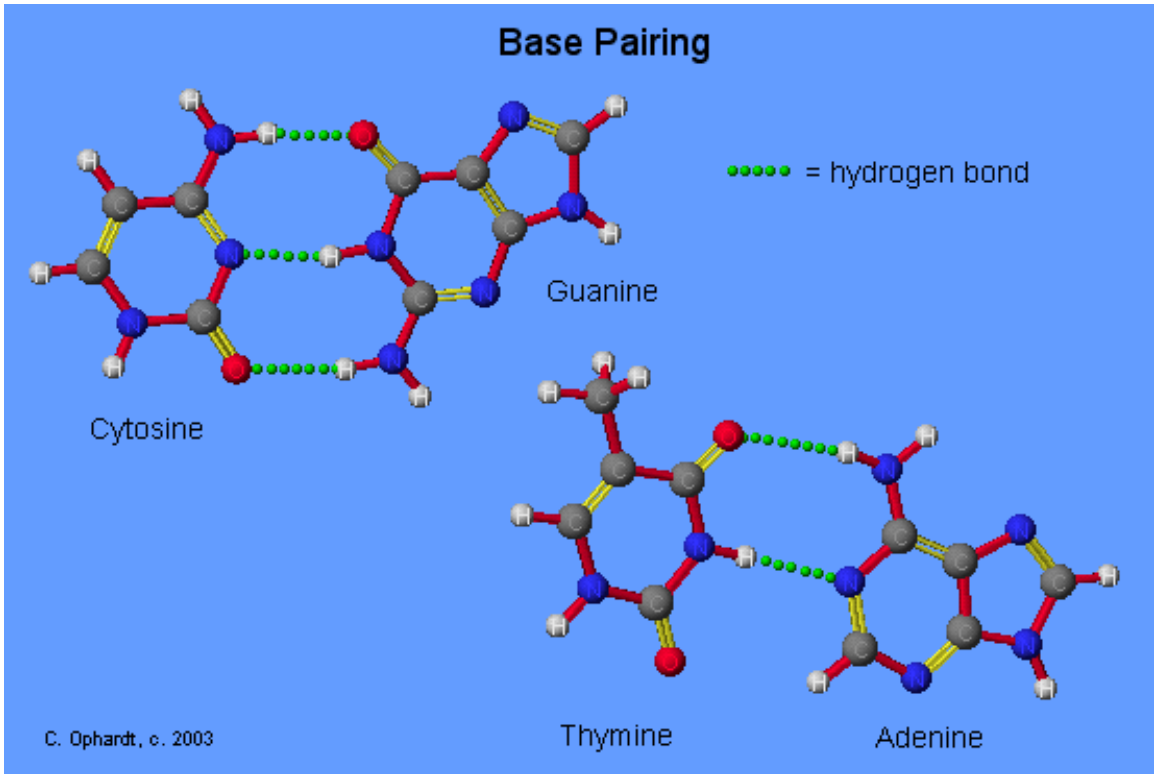
There is <u>COMPLEMENTARY BASE PAIRING</u> BETWEEN STRANDS

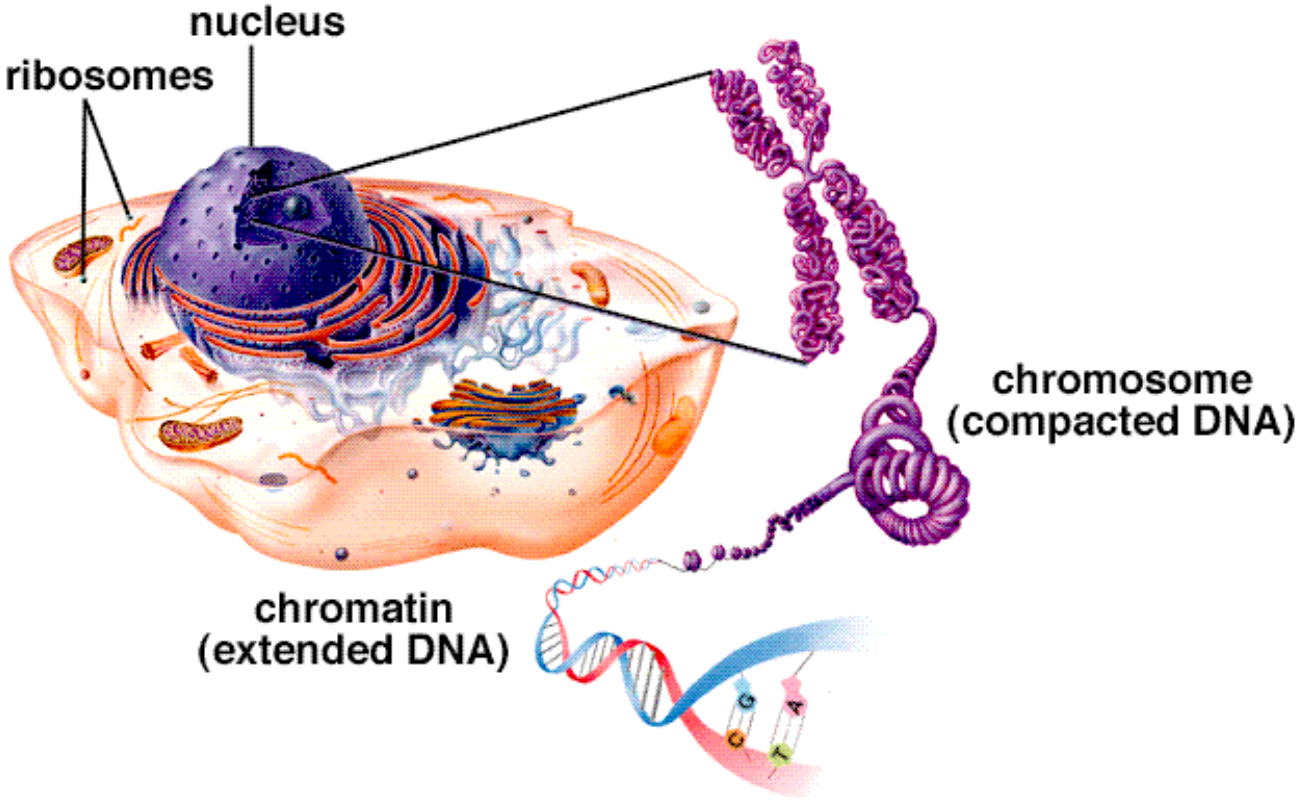
- **ADENINE (A) bonds with THYMINE (T)**
- **GUANINE (G) binds with CYTOSINE (C)**



- Note that the **number** of **purine** bases equals the number of **pyrimidine** bases.
- the bases **<u>can be in any order</u>**, but **always** pair as above
- It is the **<u>SEQUENCE OF BASES</u>** that **codes heredity information** in the genetic code in DNA and RNA.
- Review the rules of complementary base pairing below

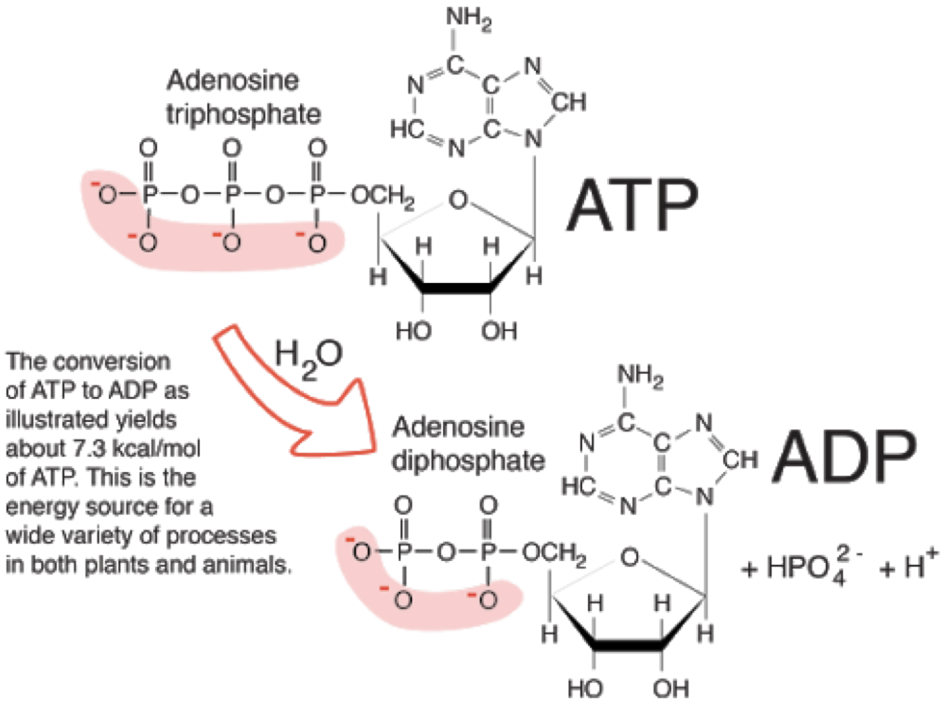
A	T	G	T	G	A	T	C	C	A	C	G	C	G	T
II	II	III	II	III	II	II	III	III	II	III	III	III	III	II

- DNA strands are **extremely long**, each one containing **millions** of atoms. Every human cell contains about one meter of these twisted strands. (this amounts to about **4 billion pairs** of bases).



ATP - Adenosine Triphosphate
- the Molecule of ENERGY

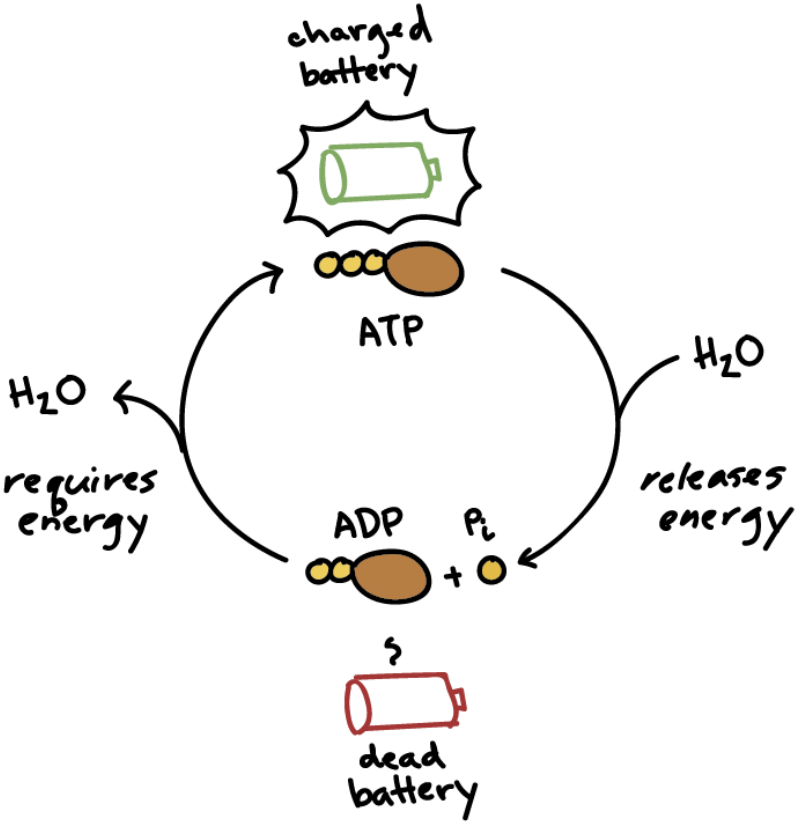
- ATP is a type of **nucleotide** that is used as the **primary CARRIER OF ENERGY** in cells
- Consists of the sugar **Ribose**, the **base Adenine**, and **3 phosphate groups** attached to the ribose.



- The bond between the **outer two phosphates** is **very high in energy**: when it is broken, *much energy is released*, which can be used by the cell (for example, for muscle contraction).

- The bond between the first and second phosphate is also high in energy, but not as high as between the two end phosphates

- ATP is produced mostly inside **<u>mitochondria</u>** during the process of **<u>cellular respiration</u>**.



Compare and Contrast DNA and RNA

	DNA	RNA
Sugar	Deoxyribose (5 C sugar with one less oxygen)	Ribose (5 C. sugar with one more oxygen)
Bases	Adenine, Guanine, Thymine, Cytosine	Adenine, Guanine, Uracil, Cytosine
Strands	Double stranded, with base pairing	Single stranded
Shape	Double helix shaped	Not double helix shaped
Location	Nucleus	Nucleus and cytoplasm
Length	Longer than RNA	Shorter
Kinds	1	3 kinds (messenger - mRNA, transfer - tRNA, ribosomal - rRNA)

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