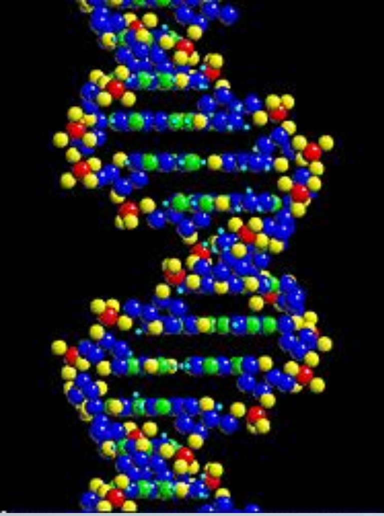
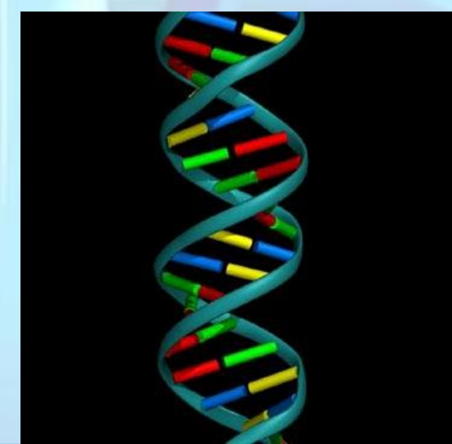


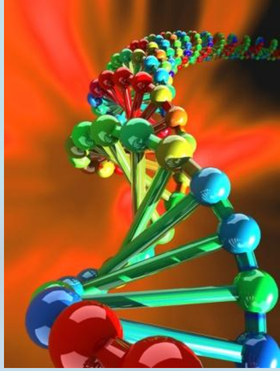
BIOLOGY I

Lab Exercise 12: **DNA to Protein**

Evelyn I. Milian

Instructor





Activities for this Lab Exercise

1. Brief introduction to Interactive online DNA tutorial – **Students are strongly encouraged to use this and other websites for review**

2. Conclusion of Lab Exercise 12 from lab manual

3. Building a DNA molecule using a kit provided by the instructor

4. Building your own DNA double helix from scratch

   – This will be fun!!! ☺ ☺ ☺

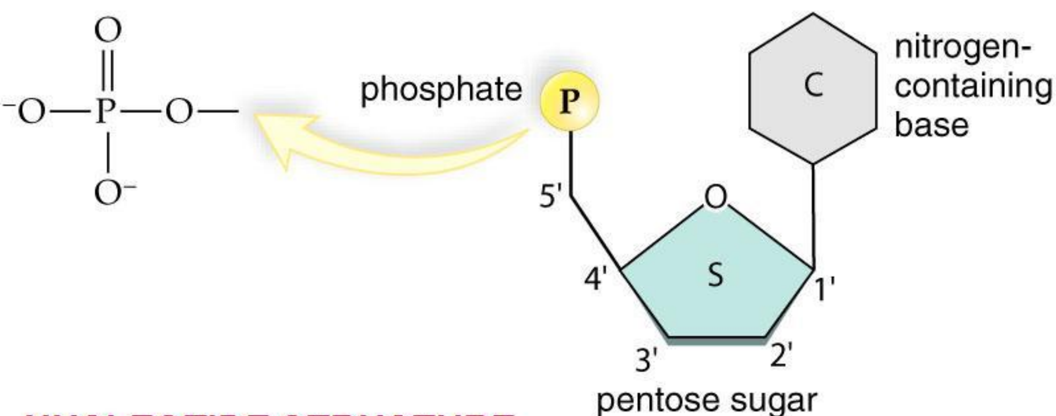
DNA STRUCTURE AND REPLICATION: **Some Websites for Review**

- DNA structure interactive tutorial: http://www.umass.edu/molvis/tutorials/dna/
- DNA replicating song (creative and funny!): http://www.youtube.com/watch?v=dIZpb93NYlw
- DNA structure: http://www.youtube.com/watch?v=qy8dk5iS1f0
- Molecular visualization of DNA: http://www.youtube.com/watch?v=4PKjF7OumYo
- DNA replication brief videos:
  - http://www.youtube.com/watch?v=teV62zrm2P0&feature=related
  - http://www.youtube.com/watch?v=AGUuX4PGlCc&feature=related
  - http://www.youtube.com/watch?v=z685FFqmrpo&feature=related

REVIEW OF DNA STRUCTURE

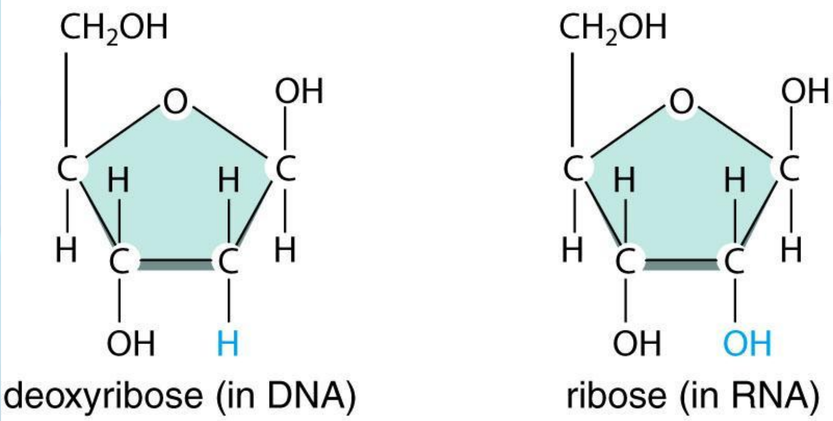
- Review all the **figures** in your book and the figures discussed in class before working in the lab activities.

NUCLEIC ACIDS: **Nucleotide Structure**



NUCLEOTIDE STRUCTURE

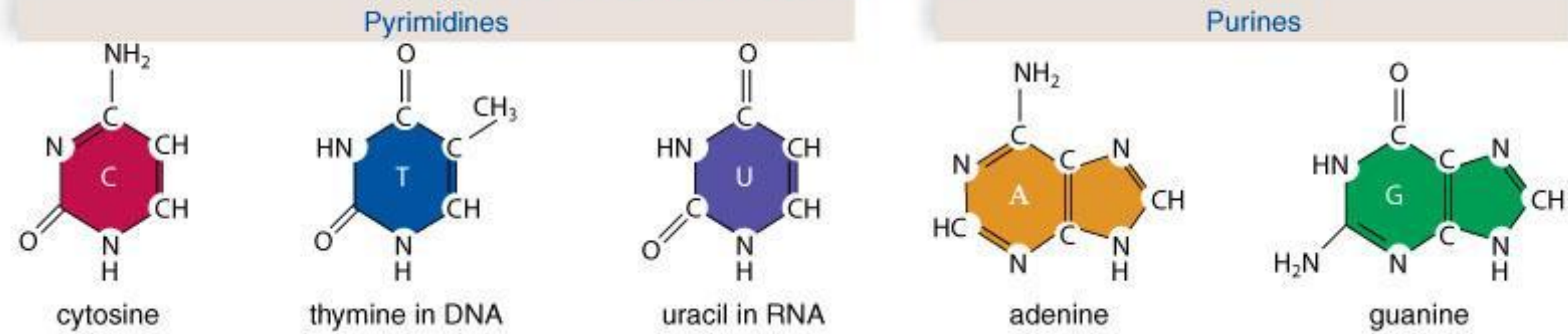
Figure 3.19 (Mader)



DEOXYRIBOSE VERSUS RIBOSE

Figure 3.19 (Mader)

Nitrogenous Bases



c. Pyrimidines versus purines

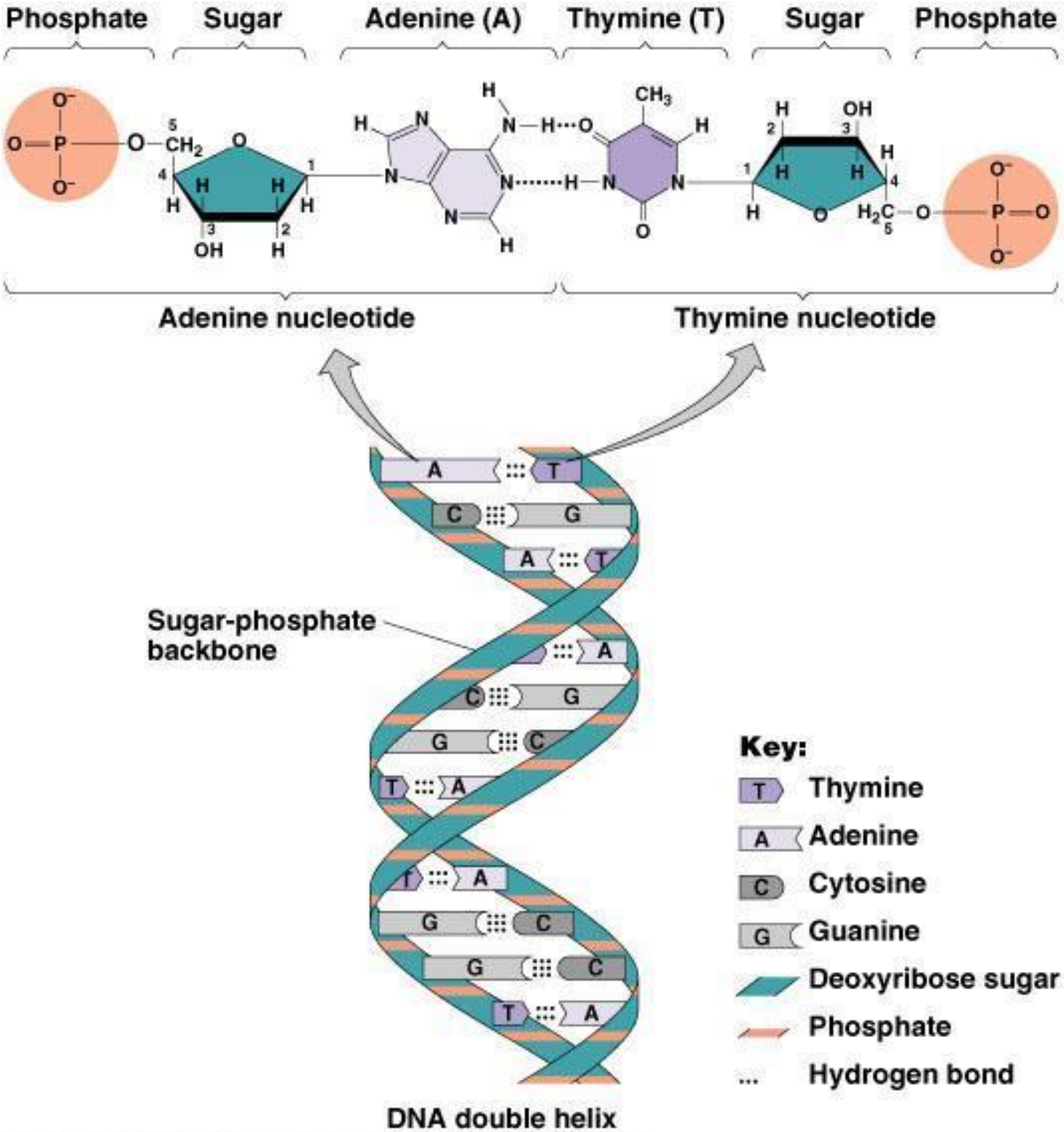


FIGURE 2.16 - The structure of DNA.

NUCLEIC ACIDS: DNA

- **Nucleotides** (top) are composed of a **deoxyribose** (in DNA) sugar molecule linked to a **phosphate group** and to a **nitrogenous base**. The two nucleotides shown here are linked by **hydrogen bonds** between their complementary bases.
- The ladderlike form of **DNA's double helix** (bottom) is made up of many nucleotides, with the repeating sugar-phosphate combination forming the **backbone** and the complementary bases the rungs.

FIGURE 3.21 - DNA Structure.

NUCLEIC ACIDS: DNA

- DNA is a **double helix** in which the two polynucleotide strands twist about each other.

a) **Hydrogen bonds** (dotted lines) occur between the complementarily paired bases: **A** is always paired with **T**, and **G** is always paired with **C** (a purine with a pyrimidine).

b) Space-filling model of DNA.

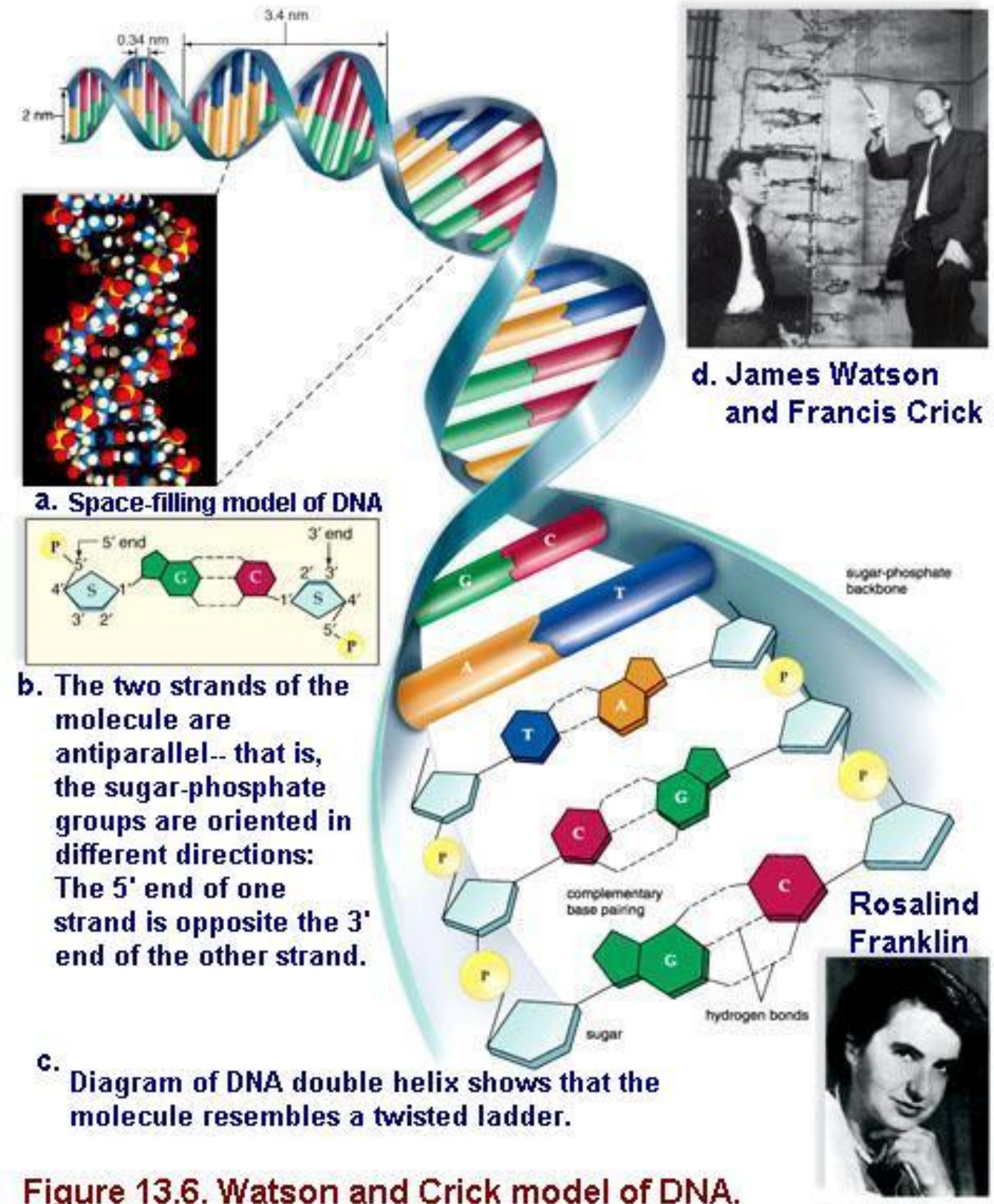


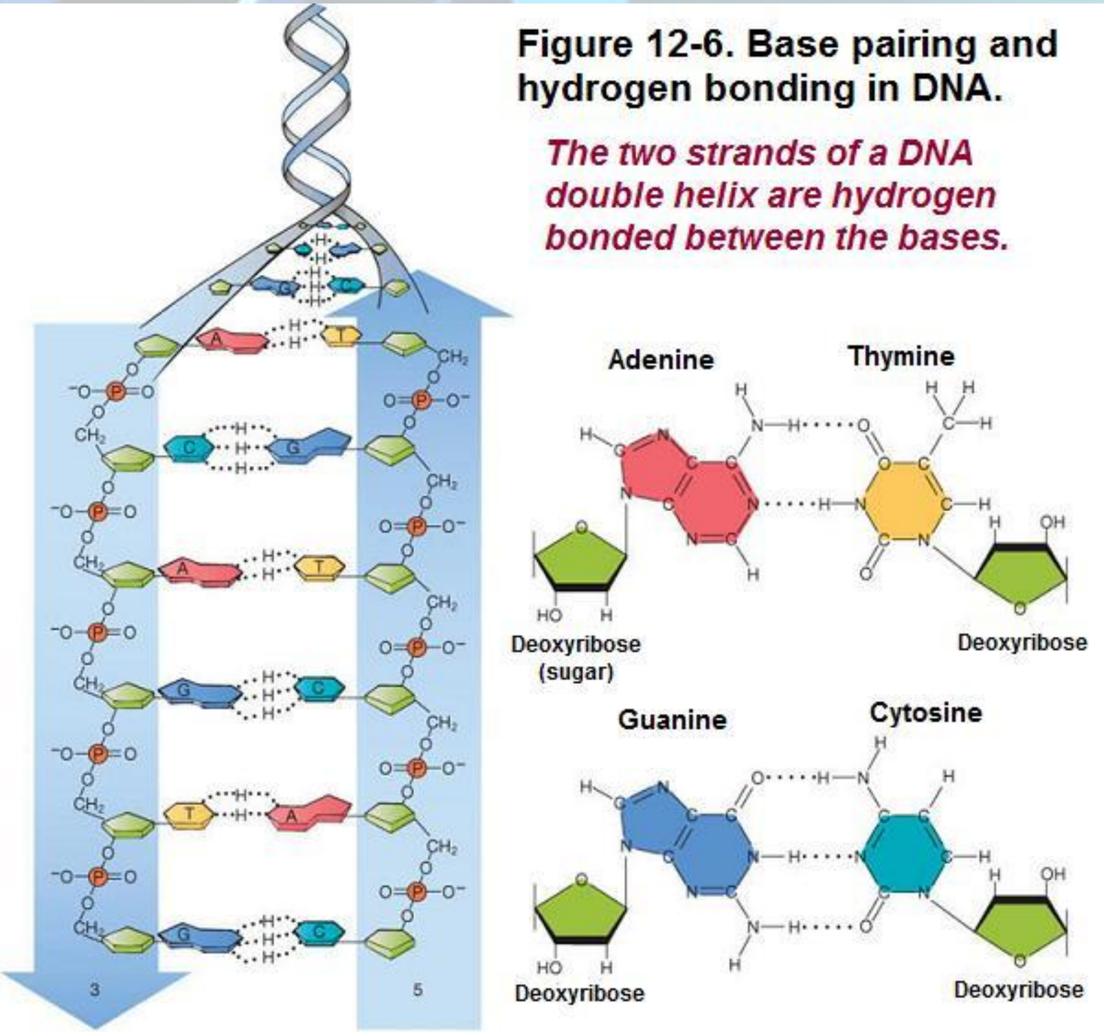
Figure 13.6. Watson and Crick model of DNA.

Watson and Crick's Model of DNA

a. A space-filling model of DNA.

b. The two strands of the molecule are *antiparallel*—that is, the sugar-phosphates are oriented in different directions: The 5' end of one strand is opposite the 3' end of the other strand.

c. Diagram of ***DNA double helix*** shows that the molecule resembles a twisted ladder or a spiral. The bases are joined by hydrogen bonds.



(a) The two sugar–phosphate chains run in opposite directions. This orientation permits the complementary bases to pair.

(b) Hydrogen bonding between base pairs adenine (A) and thymine (T) (*top*) and guanine (G) and cytosine (C) (*bottom*). The AT pair has two hydrogen bonds; the GC pair has three.

The Structure of DNA: **The Watson and Crick Model**

- The two sugar-phosphate chains run in ***opposite directions***. This orientation permits the complementary bases to pair.
- The pairs of nitrogenous bases in a DNA double helix are held together by **hydrogen bonds**, as shown here.
- **Adenine (A)** pairs with **thymine (T)**, and **guanine (G)** pairs with **cytosine (C)**.
- The A-T pair has two hydrogen bonds, the G-C pair has three.

The Structure of DNA: **The Watson and Crick Model**

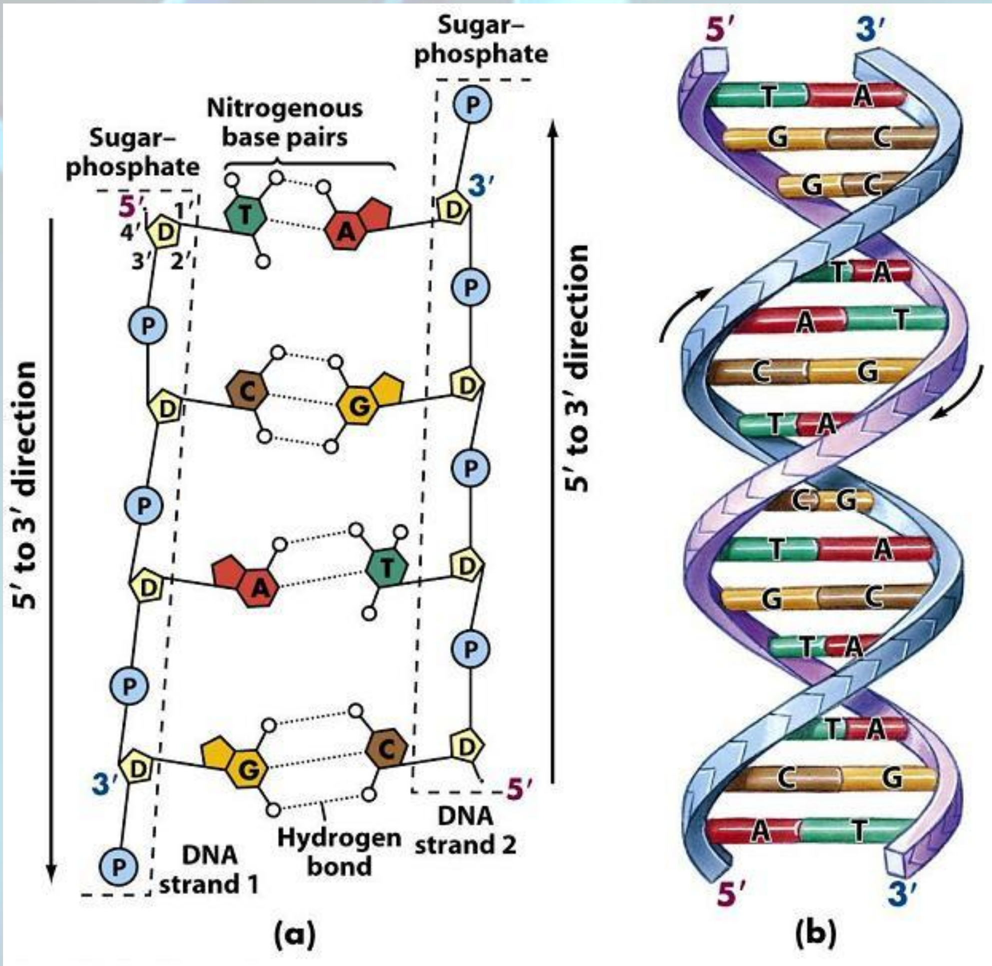


FIGURE 7.1 - The structure of DNA.

- The two upright strands, composed of the sugar **deoxyribose (D)** and **phosphate groups (P)**, are held together by **hydrogen bonds** between complementary bases. ***Adenine (A)*** always pairs with ***thymine (T)***, and ***guanine (G)*** always pairs with ***cytosine (C)***. Each strand can thus provide the information needed for the formation of a new DNA molecule.
- The DNA molecule is twisted into a **double helix**. The two sugar-phosphate strands run in *opposite* (antiparallel) directions. Each new strand grows from the 5' ("five prime") end toward the 3' end.

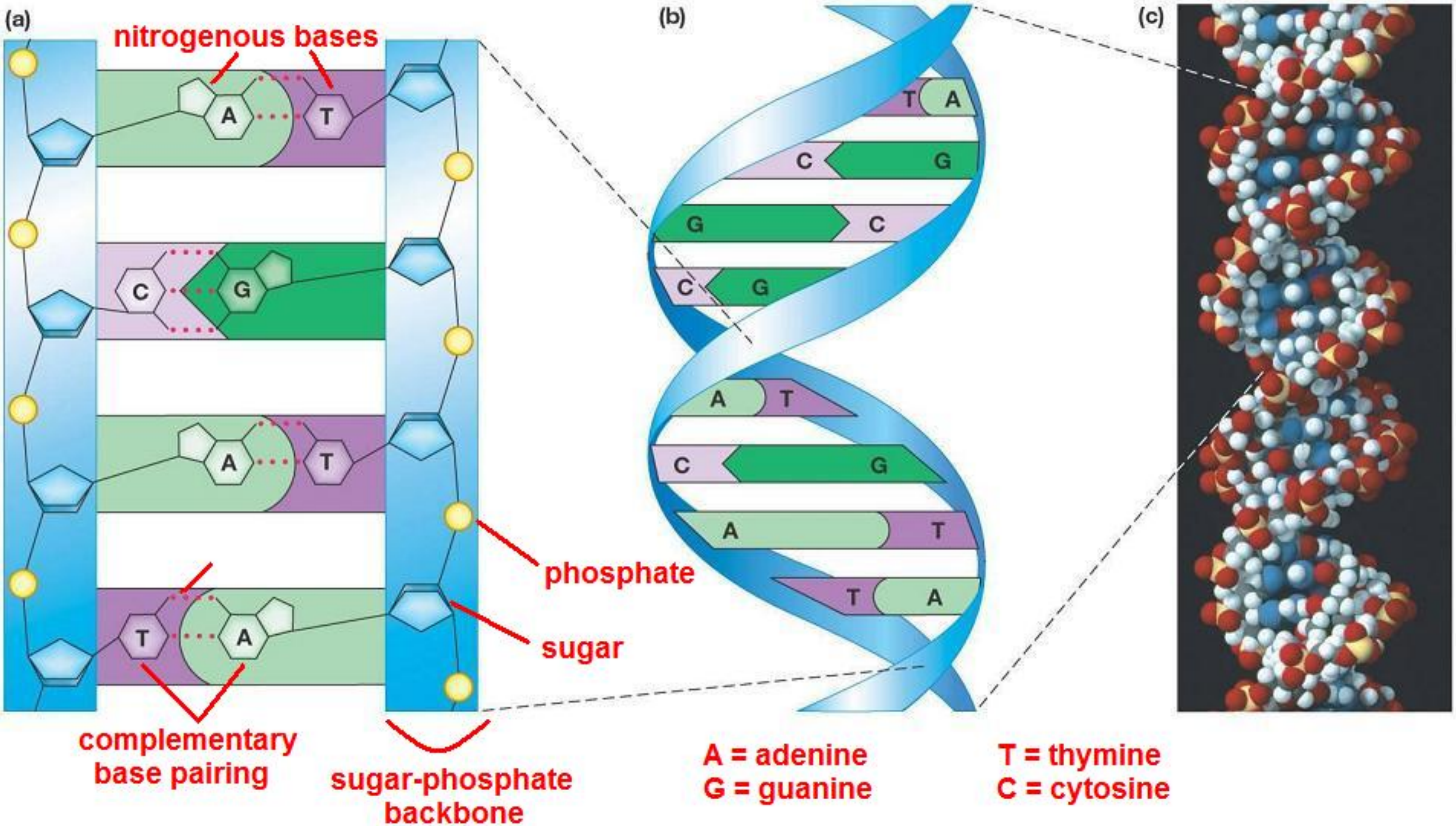
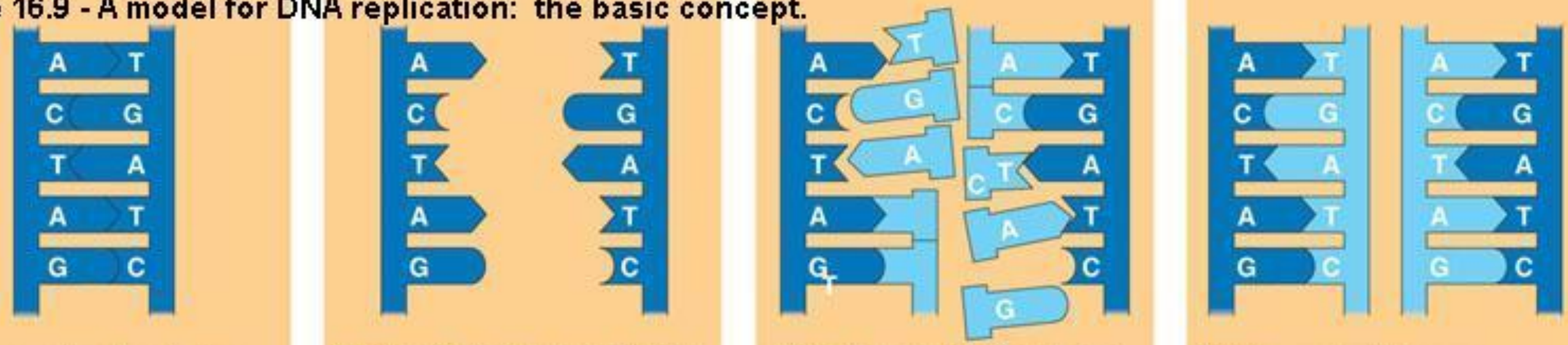


FIGURE 9-3. The Watson-Crick Model of DNA Structure.

A Simplified View of DNA Replication: ***The Basic Concept***

- In this simplification, a short segment of DNA has been untwisted into a structure that resembles a ladder. The rails of the ladder are the **sugar-phosphate backbones** of the two DNA strands; the rungs are the **pairs of nitrogenous bases**. Simple shapes symbolize the four kinds of bases. Dark blue represents DNA strands present in the parent molecule; light blue represents free nucleotides and newly synthesized DNA.

Figure 16.9 - A model for DNA replication: the basic concept.

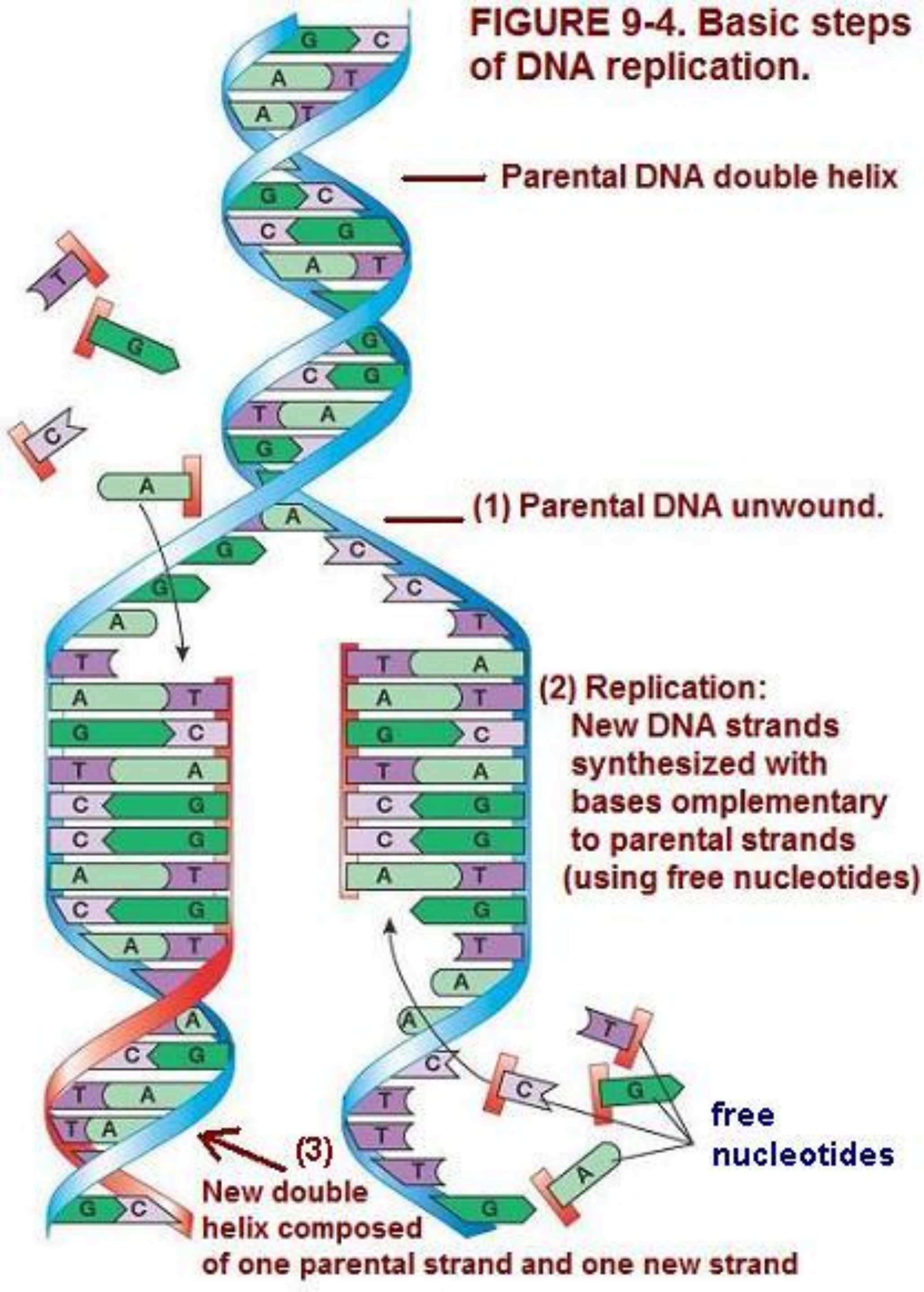


(a) The parent molecule has two complementary strands of DNA. Each base is paired by hydrogen bonding with its specific partner, A with T and G with C.

(b) The first step in replication is separation of the two DNA strands.

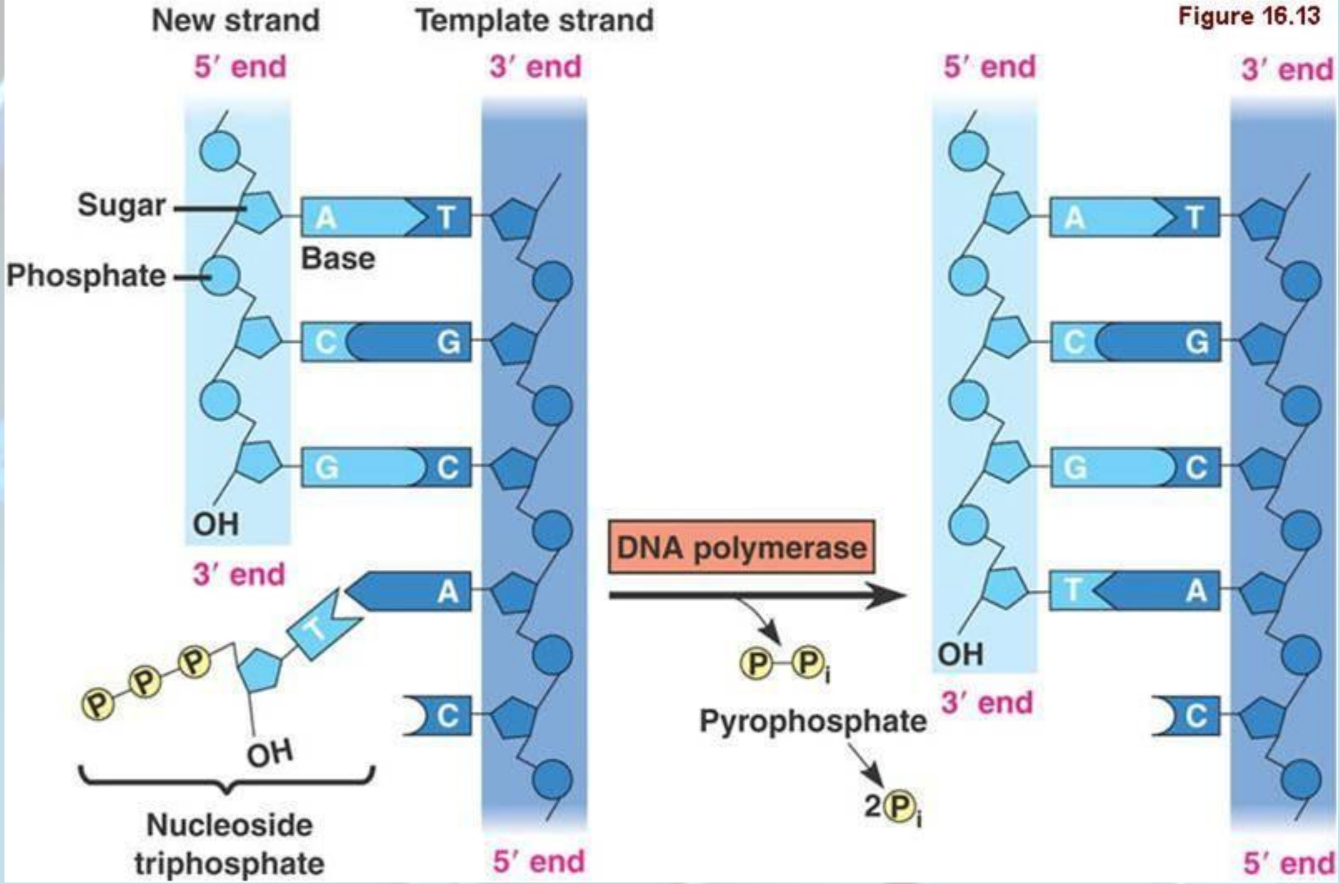
(c) Each parental strand now serves as a template that determines the order of nucleotides along a new, complementary strand.

(d) The nucleotides are connected to form the sugar-phosphate backbones of the new strands. Each "daughter" DNA molecule consists of one parental strand and one new strand.



DNA Replication: ***Basic Steps***

- After the DNA double helix unwinds (by *helicase*), each old strand serves as a template for the formation of the new strand.
- Complementary nucleotides available in the cell pair with those of the old strand and then are joined together to form a new strand.
- After replication is complete, there are two daughter DNA double helices. Each one is composed of **an old strand and a new strand**.
- Each daughter double helix has the same sequence of base pairs as the parental double helix had before unwinding occurred.



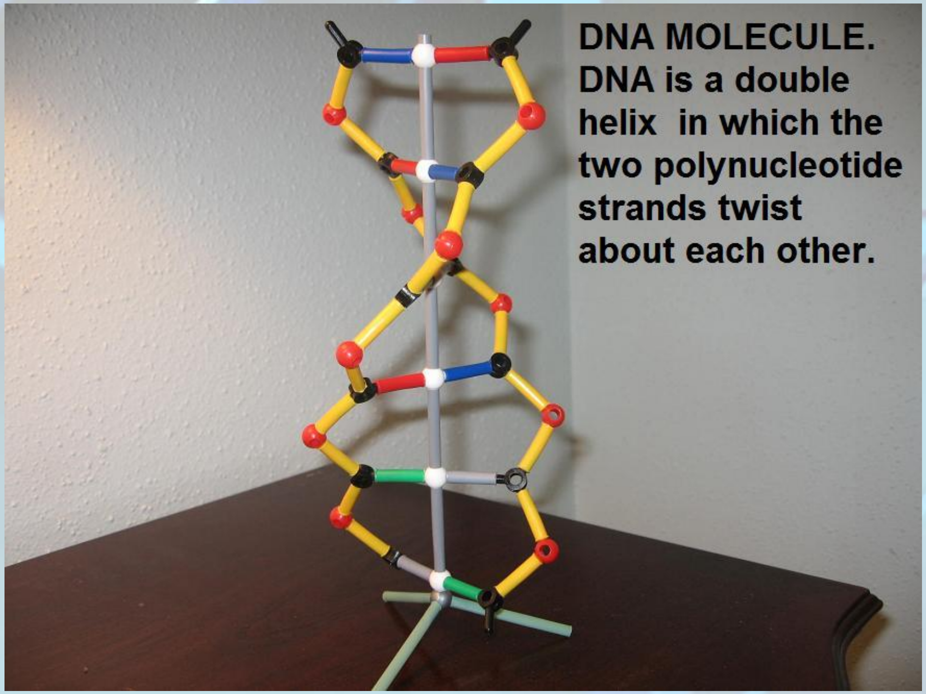
DNA REPLICATION: Incorporation of a Nucleotide into a DNA Strand

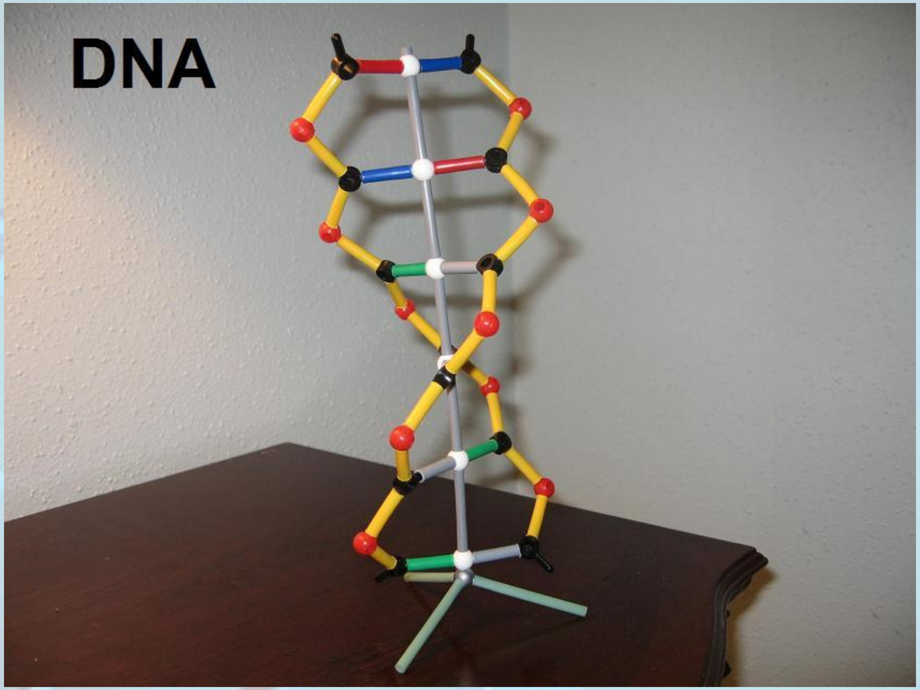
- ***DNA polymerase*** catalyzes the addition of a nucleoside triphosphate to the 3’ end of a growing DNA strand (a nucleoside triphosphate has a nitrogenous base, a pentose sugar, and three phosphate groups).
- When a nucleoside triphosphate bonds to the sugar in a growing DNA strand, it loses two phosphates. Hydrolysis of the phosphate bonds provides the energy for the reaction.

Building a DNA Model Using a Kit

- Use the **kit** provided by your instructor to build a model of the DNA double helix molecule. The kit contains all the parts you will need to build a DNA molecule model.
- **Follow the instructions** provided.
- **Ask** your instructor if you have questions.

Model of the DNA Molecule





Sugar-Phosphate Backbone:

- *Red spheres* = phosphates
- *Black* = deoxyribose (sugar)
- *Yellow straws* = connectors

Bases and Hydrogen Bonds:

- *Red straws* = adenine
- *Blue straws* = thymine
- *Gray straws* = guanine
- *Green straw* = cytosine
- *White spheres* = hydrogen bonds

Build Your Own DNA Double Helix from Scratch!!!

- Work in **small groups** of 4-6 students.
- **Build your own DNA double helix** using the materials supplied by your instructor. * Suggestion: Make your DNA molecule about **6 – 8 nucleotide pairs long,** enough to fit the poster board. **BE CREATIVE!!!**
- You must build and join **ALL the components of the DNA nucleotides**, **clearly labeled**, or write a **legend** identifying them by colors. *The DNA molecule should look like one of the figures we have discussed in class, but please* **do not use a "ribbon" pattern to represent the phosphates and sugars; you must build all the parts and join them together***.*
  - **Sugars (deoxyribose)**
  - **Phosphates**
  - **Nitrogenous bases: adenine, thymine, guanine, cytosine**
  - **Hydrogen bonds** – *You can draw them if they are too difficult to build.*
  - **5' to 3' direction in one strand; 3' to 5' direction in the second strand**
- **Work as a team: ALL** the students in each small group **must** contribute to building the molecule; distribute tasks wisely.
- **Be creative and have fun**!!!
- This activity will probably be considered as a **BONUS** for your LAB TEST #2.

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