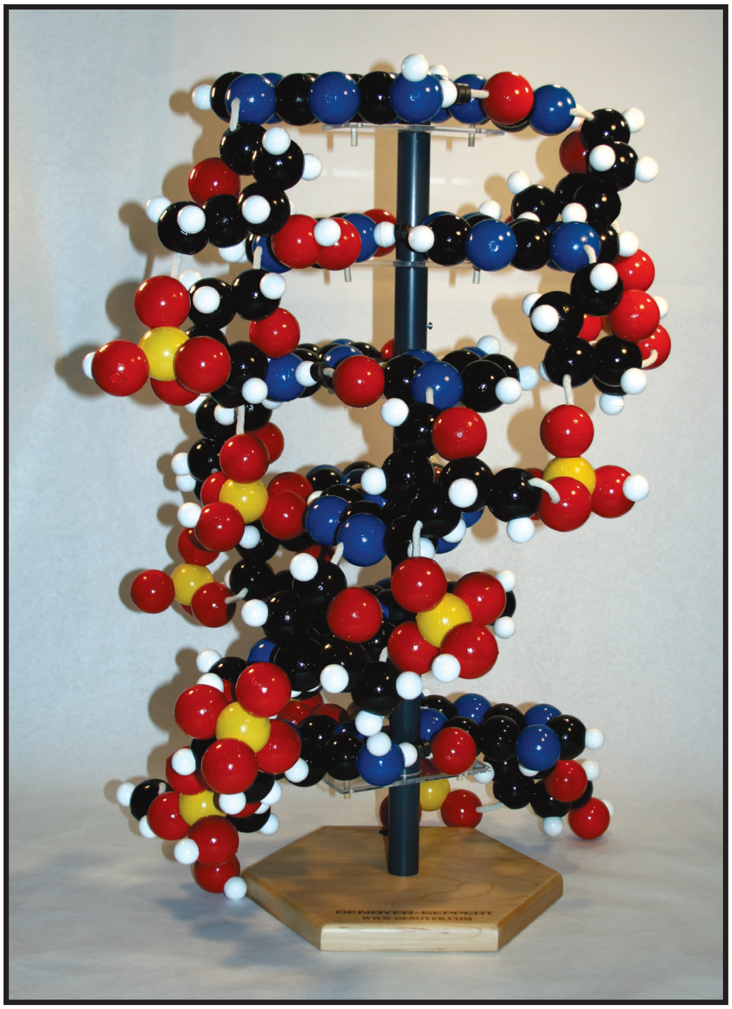
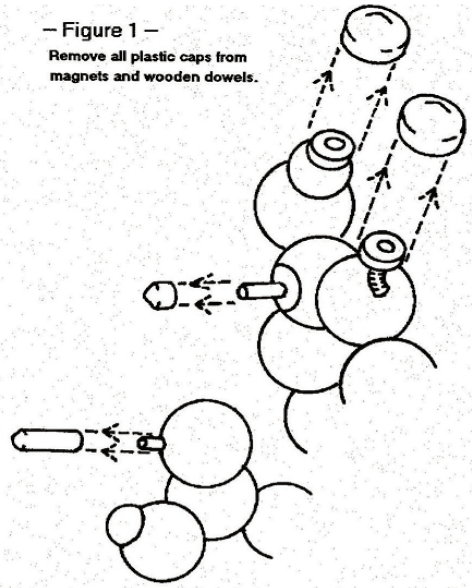
DENOYER-GEPPERT

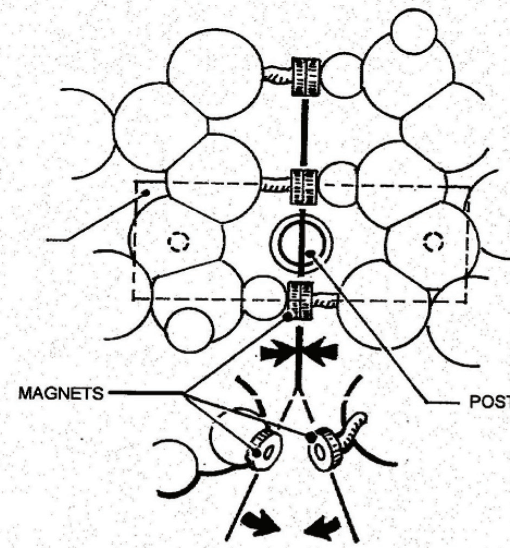
FLEX-O-MODELS™



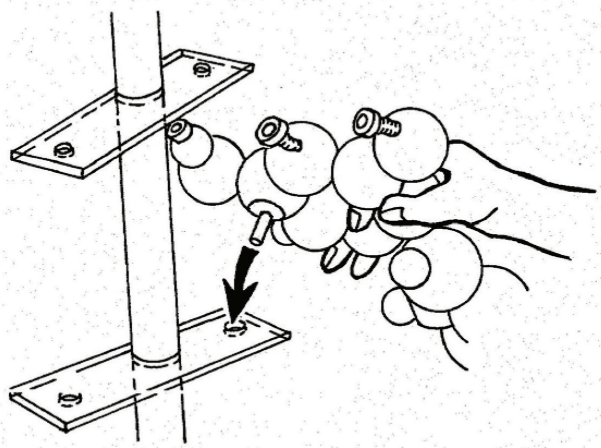
BIOCHEMISTRY: DNA MOLECULE

Instructional Sheet   0611

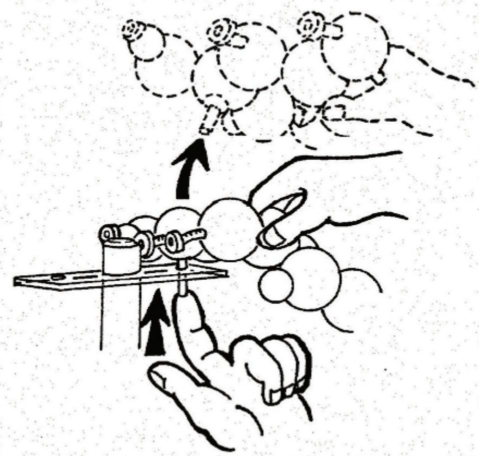




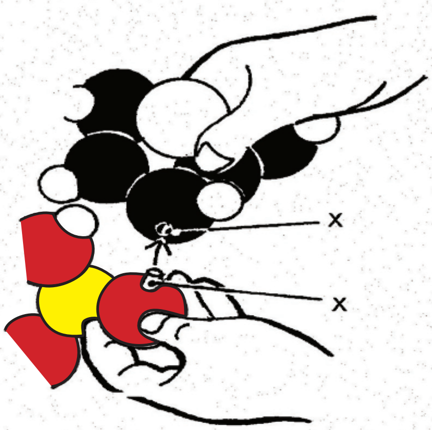
– FIGURE 2 –



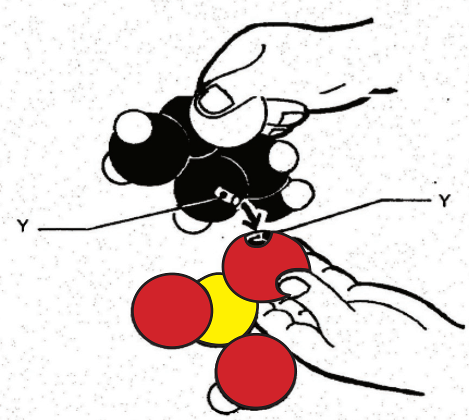
– FIGURE 3 –
TO ASSEMBLE DNA



– FIGURE 4 –
TO REMOVE ASSEMBLED DNA



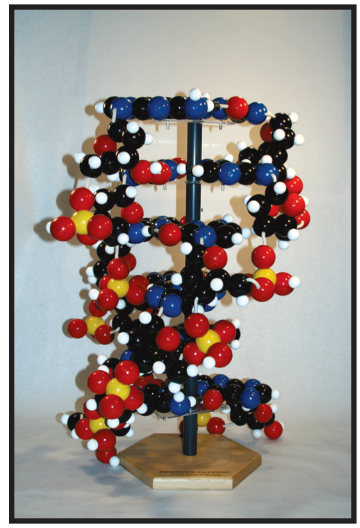
– FIGURE 5 –



– FIGURE 6 –

BIOCHEMISTRY: DNA MOLECULE

Instructional Sheet 0611



INTRODUCTION

Thank you for choosing the Giant Hands-On DNA Model. We hope that this model will assist you and your students gain a deep appreciation for one of the most elegant examples of form and function in nature. The twentieth century was the century of the genome. Now, in the twenty-first century, knowledge of the structure and basic functions of the DNA molecule is essential for any student. From genetic modifications to the food supply to gene therapies that aim to combat diseases, everyone's life is touched by the study and manipulation of the DNA molecule. The following pages will provide assembly instructions and get you started with a basic overview of some activities that you can do with this model.

An examination of the fully assembled model reveals how the double helix is formed because two strands of nucleotide bases pair up. The pairing is important when the DNA molecule replicates or transcribes itself. Allow students to ponder upon, "why the molecule would take the double-helix shape?" "Why not just a pair of straight, parallel strands?" "Which is stronger?" The overall structure of the DNA is made up of nucleotide bases that are attached to the one above and below by a sugar-phosphate backbone. One nucleotide is the building block of the strand. Within each nucleotide, you will find a nitrogenous base, a deoxyribose or sugar group, and a phosphate group. You can have the students locate the backbone on this model and identify the two alternating parts, phosphate and sugar. The nitrogenous bases are oriented toward the center of the molecule and they form the connection between the two strands by pairing with a particular base on the other strand. Adenine will always pair with Thymine and Guanine will always pair with Cytosine.

This model contains six base pairs, which can easily be unzipped. It revolves manually on the stand. Both sides are removable from the stand. The Adenine nucleotide, which is 2nd from the bottom on the fixed side, is separable from the chain on the fixed side. The sugar and phosphate units of this separable Adenine nucleotide are attached together with connections that can rotate freely, but do not separate. All connections, which are separable, are magnetically held together. All other connections between sugars and phosphates and between sugars and bases are connected with rope.

PARTS & ASSEMBLY

Your model will contain:

(A) Strand of six connected nucleotides, one end (Guanine) is in a red bag.

(B) Strand of six nucleotides:

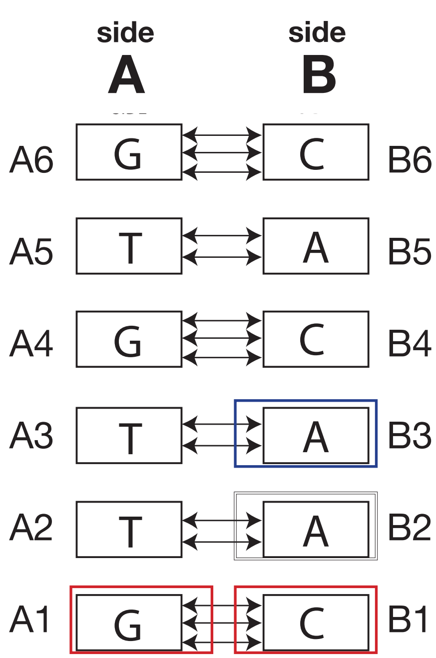
Four-connected with one end (Adenine) in a blue bag.
A removable nucleotide (Adenine) in a white bag.
A removable nucleotide (Cytosine) in a red bag.

(C) Molecular units for ATP hydrolysis (four molecules) in a black bag:

Two HO pegs
One H_2PO_3 with removable H
One H_3PO_4 with removable HO

(D) Post-base: A post with a bag of screws and a wooden base.

Note: Remove all plastic caps from the magnets and wooden dowels (see figure 1). When attaching a nucleotide to a platform of the post, make sure the magnets are facing toward the post. The magnets simulate the Hydrogen bonding between the nucleotide base-pairs and should line up (see figure 2).



This schematic shows how the nucleotides will fit together once the model is assembled. The rectangles indicate where the packaging bags are when you receive the model. If your model was purchased after January 1, 2008, there should be a code written near the dowel that inserts into the plastic support. If you no longer have the bags on your model and your model does not have the code, don't worry, you will still be able to assemble the model. However, it will require a little more effort because you will have to learn to identify the the nuitrogenous bases by sight. You can find illustrations of the four nitrogenous bases on page 7.

PARTS & ASSEMBLY

ASSEMBLY INSTRUCTIONS

STEP 1: ASSEMBLE THE BASE AND SUPPORT POST

Assemble the Post-base (D) using the picture instructions on page 5. Note that the six flat supports spiral counterclockwise from the bottom to the top; also, the assembled post can be rotated in the base.

STEP 2: ADD THE "A-SIDE"- 6-NUCLEOTIDE STRAND

Lay out the six-nucleotide strand (A) next to the post-base with the red bag (containing Guanine) next to the post-base. Remove the bag and insert the dowel under the Guanine nucleotide (labeled A1) into the hole on the bottom of one side of the post support, (see figure 3 for assembly and figure 4 for disassembly). Continue placing the rest of the connected nucleotides by turning the post counterclockwise to the next platform, inserting the dowel into the hole, and stepping upward like a spiral staircase.

STEP 3: ADD "B-SIDE" - CYTOSINE NUCLEOTIDE

Now that one side of this DNA strand is on the post, begin the other side by placing the Cytosine nucleotide (in a Red bag) onto the bottom support, opposite its base pair Guanine. The Cytosine will be labeled B1 and will have three disc magnets that should pair with Guanines three magnets at the center post area.

STEP 4: ADD "B-SIDE" - ADENINE NUCLEOTIDE

Next, the Adenine nucleotide (in a White bag) needs to be placed on the stand just above Cytosine. Once the dowel (labeled B2) is securely inserted into the platform, take the Phosphate (yellow and red group) connected to the bottom nucleotide and connect the red ball (labeled X containing a dowel with magnet) to the black ball (labeled X containing a hole with magnet) of the sugar connected to this Adenine nucleotide (see figure 5).

STEP 5: ADD "B-SIDE" - 4-NUCLEOTIDE STRAND

Finally, the end of the four-nucleotide strand, Adenine (in a Blue bag), can be placed onto the third level from the bottom. The dowel under Adenine should be labeled B3. Continue placing the other three nucleotides onto the stand by stepping upward.

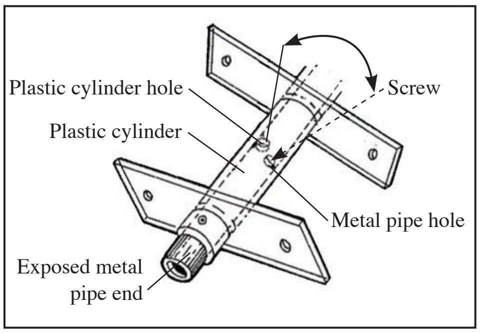
Now go back to the 2nd nucleotide from the bottom (Adenine). Rotate the atom units of the sugar and phosphate so that the red ball (Labeled Z containing a hole with magnet) of the phosphate will easily connect to the black ball (Labeled Z containing a dowel with magnet) of the sugar of the 3rd nucleotide from the bottom (see figure 6).

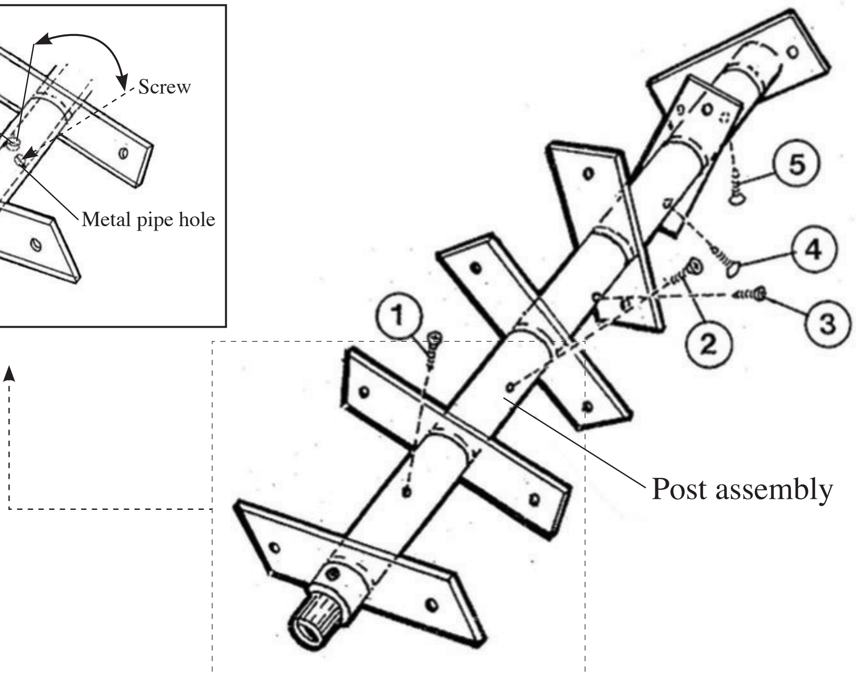
Now that the model is complete, it demonstrates a six base-pair strand of DNA, which can be "unzipped" by removing one side from the post.

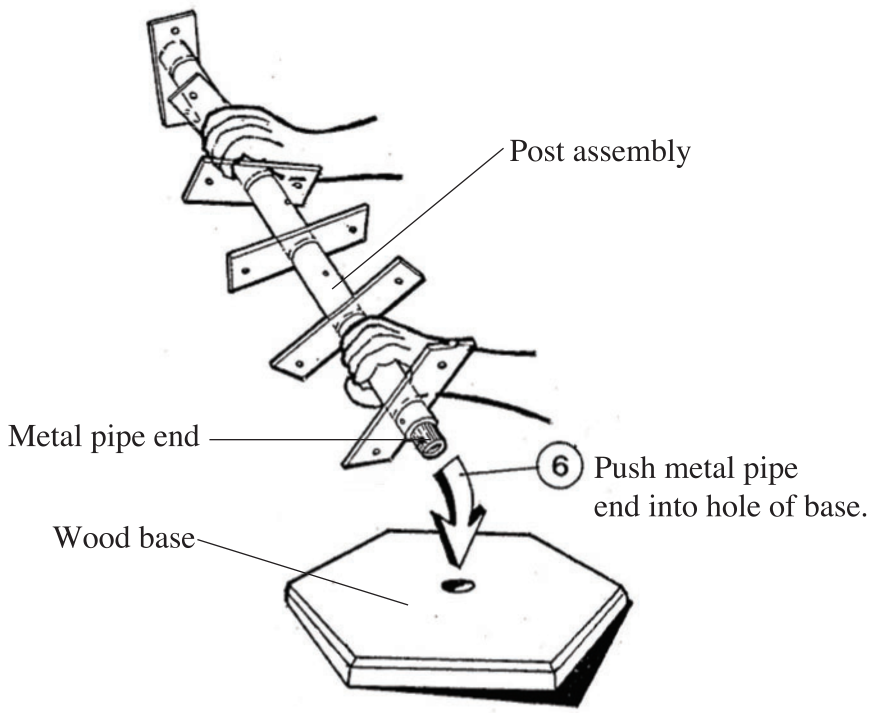
NOTE: Assembley of molecular units for ATP Hydrolysis (Black Bag) is in the instructional sheets.

DNA MODEL POST and BASE ASSEMBLY INSTRUCTIONS

Rotate plastic cylinder of segment one around metal pipe until holes are in alignment. Screw into aligned holes with provided screw. Repeat this process for segments 2-5.

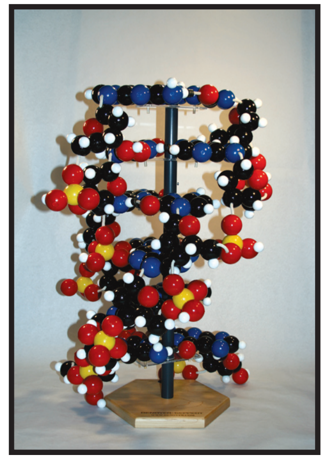






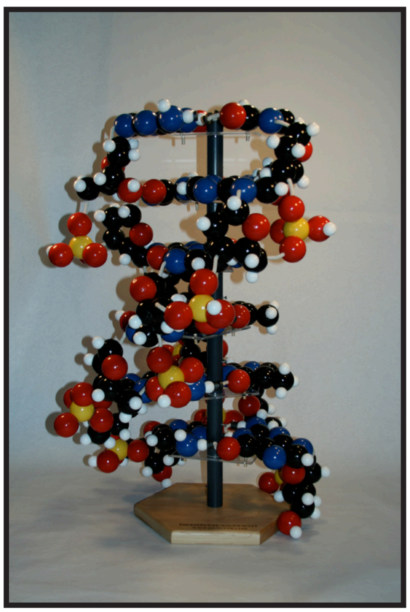
BIOCHEMISTRY: DNA MOLECULE

Instructional Sheet 0611

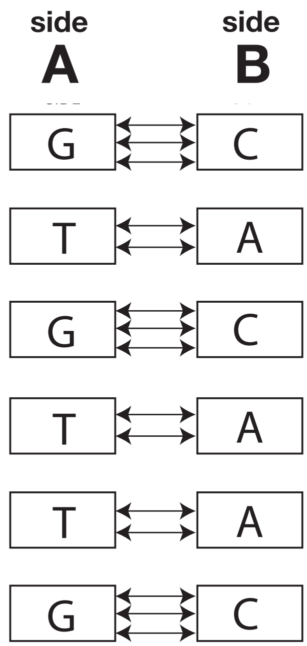


OVERVIEW

This model contains 6 base pairs which can easily be unzipped. It revolves manually on the stand. Both sides are removable from the stand.

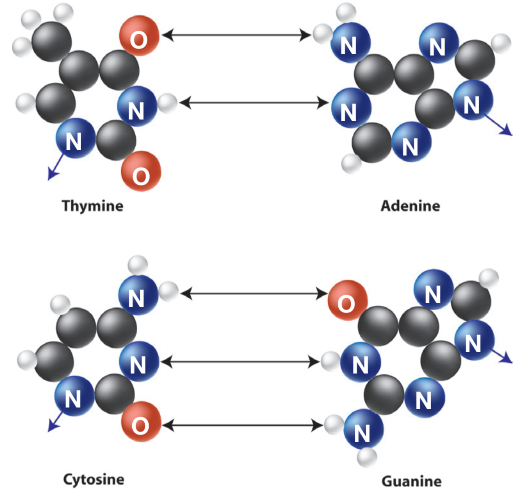


DNA Molecule

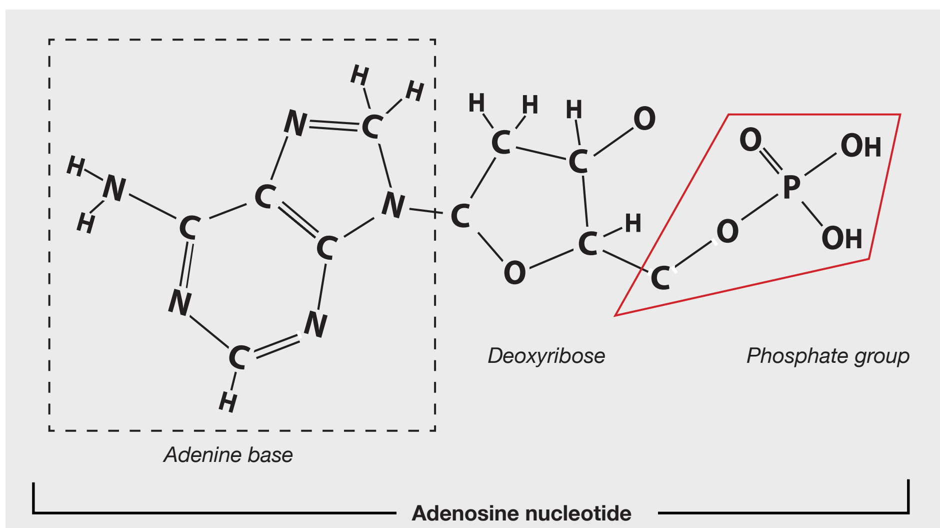


Nitrogenous base pairs

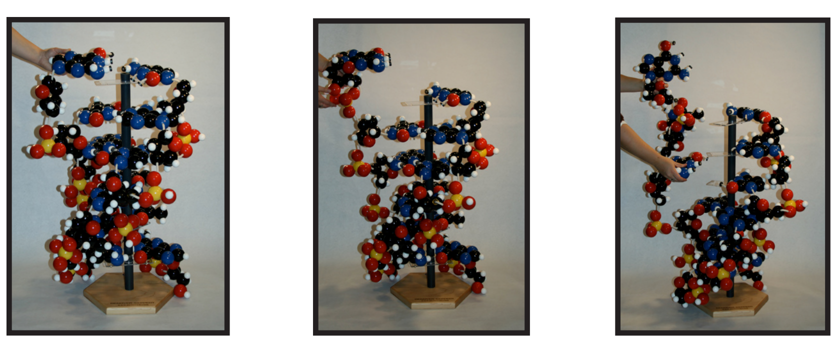
Unzipping the DNA chain will allow you to simulate how DNA duplicates. As the DNA model unzips you can demonstrate the points where new nucleotides would come in and fill the positions This is a good time to show why Guanine will only pair with Cytosine and Adenine will only pair with Thymine. The Guanine and Cytosine bases meet because they both have three hydrogen bond sites (shown by the disc magnets), and the Adenine and Thymine only have two hydrogen bond sites.



Nitrogenous base pairs



The nucleotide Adenosine, which is separable from the other side, can be changed into a nucleotide unit of RNA by replacing the “removable” hydrogen on the ribose with an “OH” group. Now, instead of a deoxyribose sugar, it is a ribose sugar. At this point you may want to discuss a few types of RNA. The messenger RNA strand can exit the nucleus and deliver its message to the ribosmal RNA in the ribosomes.

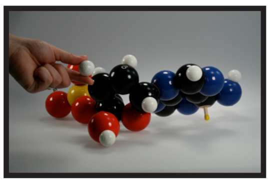


Process of DNA unzipping

HYDROLYSIS OF ATP

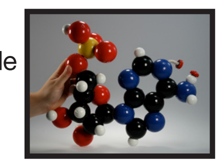
$$-C-O-\underset{\underset{OH}{|}}{\overset{\overset{O}{\|}}{P}}-O-\underset{\underset{OH}{|}}{\overset{\overset{O}{\|}}{P}}-O-\underset{\underset{OH}{|}}{\overset{\overset{O}{\|}}{P}}-OH + H_2O \rightleftharpoons -C-O-\underset{\underset{OH}{|}}{\overset{\overset{O}{\|}}{P}}-O-\underset{\underset{OH}{|}}{\overset{\overset{O}{\|}}{P}}-OH + H_3PO_4$$

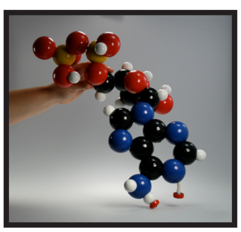
Once the nucleotide is removed out of the double helix,



1. Replace "removable" hydrogen with "OH" group on sugar ring.

2. Add another "OH" group to other carbon atom on sugar ring. This makes the Adenosine nucleotide now AMP, Adenosine Monophosphate.





3. Add a "H_2PO_3" unit on it at the Oxygen atom that contains the magnet. (Remove magnetically attached Hydrogen from H_2PO_3). This makes ADP, Adenosine Diphosphate.

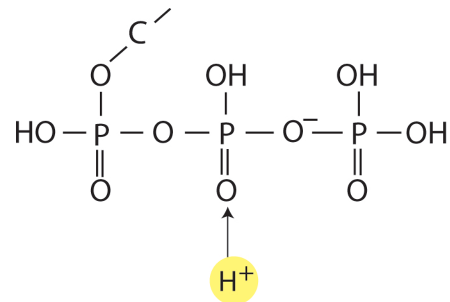
4. Add last "H_2PO_3" unit, from the H_3PO_4 molecule (remove OH group) This makes it ATP, Adenosine Triphosphate.

ATP can be hydrolyzed by the H_2O molecule. Show the H_2O molecule breaking apart into H+ and OH- units. The ATP will be hydrolyzed when the hydrogen ion (H+) is attached (becomes bonded) to the connecting oxygen atom between the last two phosphate units. Hydrogen will become attached (attracted) to oxygen, because the H+ is positively charged and the connecting oxygen atom is negatively charged (has high electronegativity value – has strong pull for electrons). Hydrogen will also be attracted to the other oxygen atoms of the PO_4 units; this is where an enzyme comes in. The enzyme brings the H+ to the connecting oxygen atom between the last to phosphate units.

HYDROLYSIS OF ATP

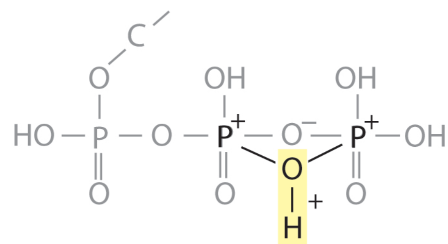
STEP 1

The hydrogen ion will be attacted to the oxygen atom, which is negative due to its large pull for electrons.



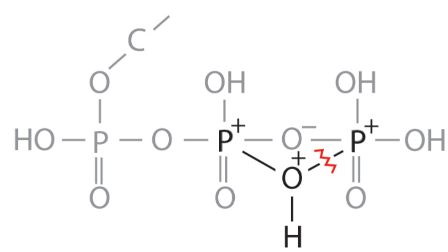
STEP 2

The oxygen atom becomes slightly positive as electrons are pulled away from it by the positive hydrogen ions.



STEP 3

Since all three atoms are postively charged, then the bond between the phosphorus and oxygen (either side) will break due to the force of repulsion between the positively charged atoms.



STEP 4

The OH- ion from the water molecule will be attracted to the other positive phosphorus atom of the other phosphate unit.