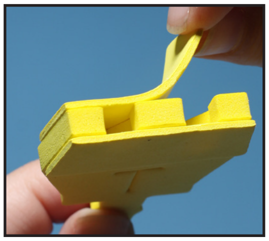
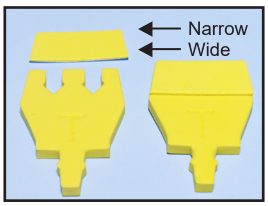
3-D Molecular Designs

...where molecules become real™

Assembly



To complete your pyrimidine bases (blue cytosine, yellow thymine & white uracil) you will attach the sticky-backed foam bands to each side of the base as shown at left. (Please remove the paper backing on the bands first.) The prongs of the pyrimidine bases should be completely covered by the sticky-backed bands. These sticky-backed bands provide stability for the model and reduce confusion between base pairs.

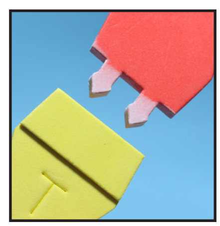


Match the shape of the band to the shape of the base. Note the angle cut on the bands. Place the narrow end at the outside of the prongs. See photo.

Note: ***If over time the bands on the pyrimidines become loose, or are not sticking to the foam base, use super glue to re-attach them.***

Powder Bases Before Using

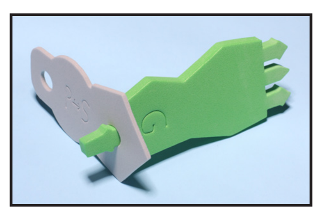
The adhesive on the bands makes joining and separating the base pairs difficult. This stickiness can be eliminated with talcum powder. Dip the purines' exposed prongs into the talcum powder provided. Insert the purine into the complementary pyrimidine. The bases should easily attach and detach.



Care & Maintenance

The foam will tear if too much force is used. Encourage your students to be careful. Wash with a damp cloth or, if necessary, a mild dishwashing detergent.

Misconception Caution



Models are powerful teaching tools, but can cause misconceptions. With this DNA model, students might develop the misconception that DNA is made by simply adding the four DNA bases (A,T,G,C) to a pre-formed sugar-phosphate backbone. To avoid this misconception, we encourage you to explain that a nucleotide consists of a base, deoxyribose sugar and a phosphate group. You can use the individual sugar phosphate pieces joined to the base to help your students visualize the individual nucleotides.

Individual nucleotide units are then joined together by phosphodiester bonds to build up the alternating sugar-phosphate backbone of DNA as it is synthesized by DNA polymerase enzymes in the cell.

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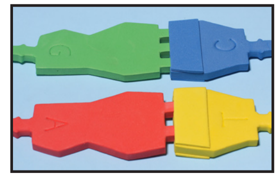
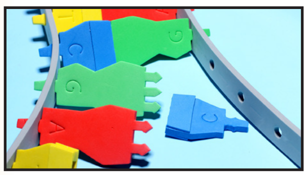
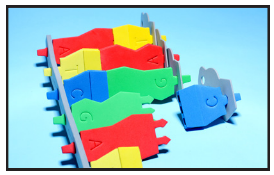
Instructions

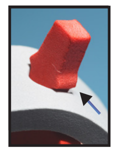
DNA Structure

Build your DNA model with either the long continuous backbone, or the individual sugar-phosphate pieces. Remember, the base always attaches to the sugar (deoxyribose or ribose). Create half of your model by attaching 12 bases to the backbone. Then attach the complementary bases to either the long backbone or individual pieces.

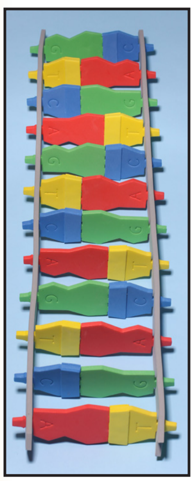






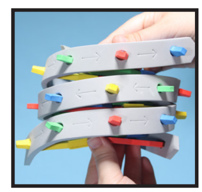


Note: Pull the base through the DNA backbone hole until flared ends pop through. To remove a base from the DNA backbone, squeeze the flared ends until they fit through the hole.

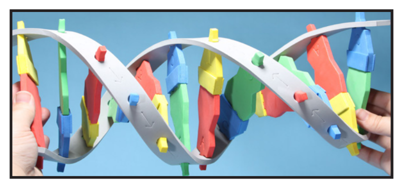


To create the double helix, rotate the bases so that they are vertical instead of horizontal, as shown left.

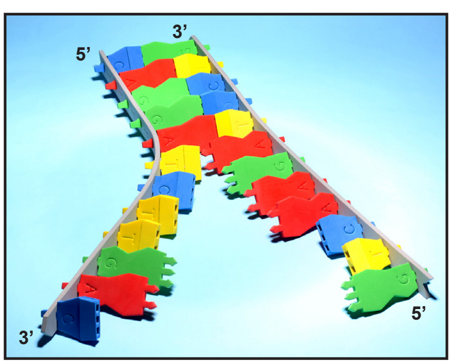
With your right hand on the top base pair and left on the bottom twist your hands in opposite directions. (Your right hand should twist counterclockwise and your left hand clockwise.) Twist until the DNA backbones touch each other in a tight coil.



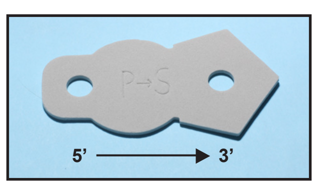
Release the bases and allow the model to relax into its double-helical shape.

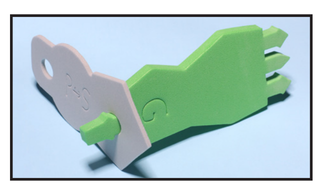


Replication



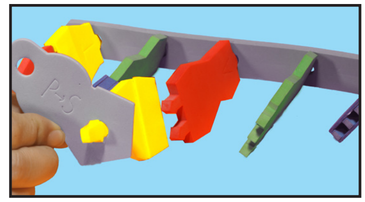
Start with your DNA Starter Kit© model in its ladder shape and unzip the base pairs at one end of the DNA. The two strands of complementary DNA should be *antiparallel*. Begin by adding complementary deoxyribonucleotides to the 3' end of the single-stranded DNA (the end with the point of the arrow).



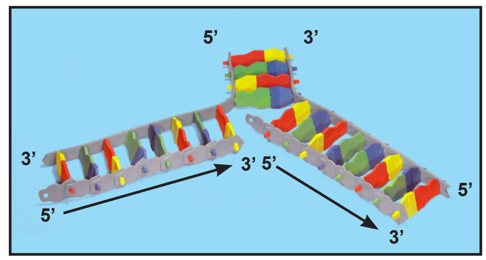


Replication Continued

Each time another nucleotide is added, form the phosphodiester bond to the previous nucleotide by slipping the hole in the remaining phosphate over the peg in the deoxyribose.



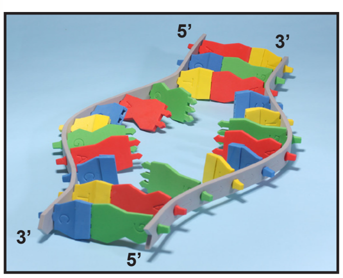
Note that to replicate the opposite strand of DNA, you would have to start at the replication fork – and join complementary nucleotides together as you move along the opposite strand – toward the unzipped end. In this way, both replicated double-stranded DNAs will be anti-parallel. This idea may be too sophisticated for younger students – who could simply replicate one strand of the DNA in an anti-parallel manner – and then replicate the opposite strand once it is completely freed from the original double-stranded DNA.

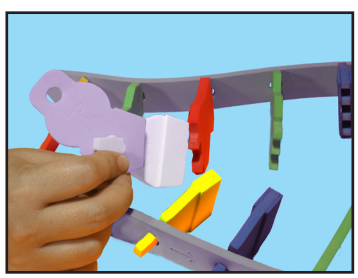


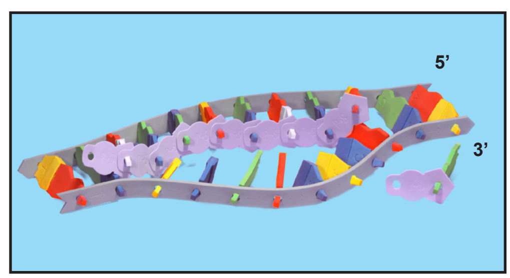
Transcription

RNA can be transcribed from either of the two DNA strands in much the same way as DNA was replicated. But rather than unzipping the DNA from one end, we suggest that you create a transcription bubble by separating several base pairs in the middle of the DNA model.

And then as you begin transcribing one of the two strands of DNA – by adding ribonucleotides together, be sure that the RNA strand that you are making is anti-parallel to the template strand of DNA.





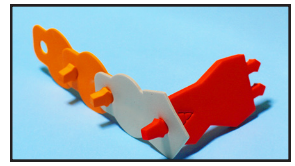


You might also want to point out to students that only one of the two strands of a gene is transcribed into mRNA. Transcription of the opposite strand would result in an RNA that would encode an entirely different sequence of amino acids.

Using Triphosphates with the DNA Starter Kit©

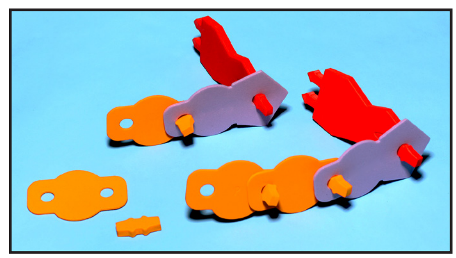
Deoxyribonucleotide Triphosphates (dNTPs)

DNA (RNA) Synthesis



Deoxyribonucleotide triphosphates help students understand that during the process of DNA replication (or RNA transcription) these nucleotide triphosphates serve as the substrates (monomeric subunits) that are joined together by DNA polymerase (or RNA polymerase) to create the complementary strand of DNA (or RNA). A significant fraction of the cell's metabolism is devoted to maintaining an adequate supply of these nucleotide triphosphates for DNA replication and/or RNA transcription. As the nucleotide triphosphate is added to the growing chain, a high energy phosphate bond joining the three phosphate groups together is cleaved by the polymerase – releasing a pyrophosphate (PP_i) and incorporating the nucleotide monophosphate into the growing chain.

Energy Metabolism

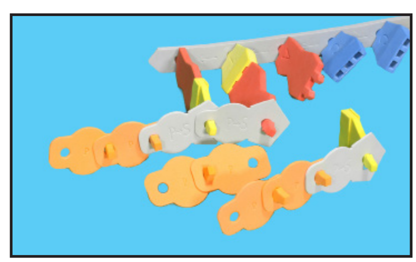


As an added benefit, students can construct models of ATP (adenosine 5'-triphosphate) as they consider this "universal currency of cellular energy". ATP is generated by ATP synthase as it binds both ADP (adenosine 5'-diphosphate) and P_i – and then forms the final high energy phosphate bond to create ATP. This key reaction in the cell is powered by the high proton concentration that is built up in the inter-membrane space of the mitochondria, as a result of oxidative respiration.

Find teacher resources at *3dmoleculardesigns.com/Teacher-Resources/DNA-Starter-Kit.htm*

Upgrade to DNASK Triphosphate Expansion Pack

Triphosphate Expansion Pack



Product Code (DNASK-PEP)

You can turn the nucleotide monophosphate in the basic DNA Starter Kit© into nucleotide triphosphates with the pieces in this expansion pack. The extra phosphates allow your students to model the action of the DNA polymerase as it cleaves the triphosphate and joins the nucleotide monophosphate to the growing DNA strand in replication. Triphosphates can also be used in transcription and to model ATP. Each pack includes 48 phosphate pieces and 48 connectors.

Purchase through our catalog or online at shop3dmoleculardesigns.com.