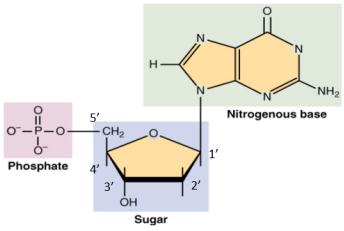
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Modeling DNA Replication

Overview: Students will model DNA structure and DNA replication.

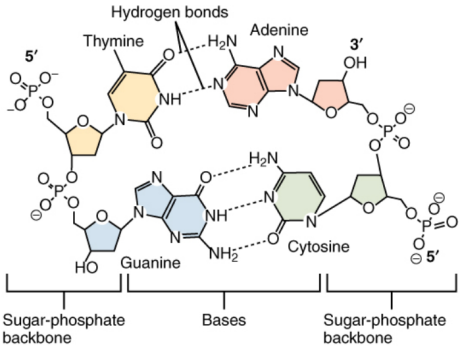
Background/Content Connection:
This activity can be used to introduce or review all these aspects of DNA structure, as well as how DNA replicates during cell division. If students have learned about the different enzymes involved in DNA replication you can also choose to model enzyme function during replication.

DNA is a large macromolecule composed of smaller molecules (monomers) called **nucleotides**. Nucleotides are composed of three molecules: a phosphate group and a nitrogen base attached to a five-carbon sugar, called deoxyribose.

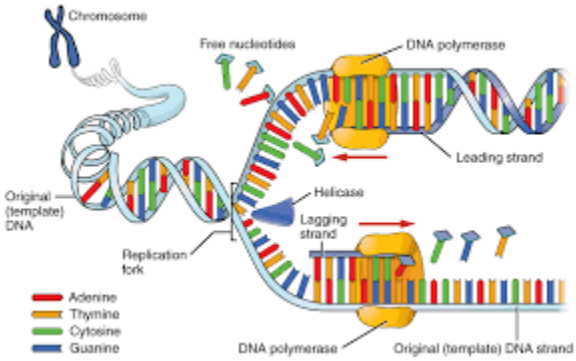


The DNA double helix has several distinguishing features.

- The nucleotides are linked together by covalent bonds between the phosphate group in one nucleotide and the sugar molecule of the next nucleotide to form a **phosphate-sugar backbone**. The bases are on the inside of the spiral.
- The double helix structure is stabilized by hydrogen bonds between the **base pairs** following the **AT/GC rule**. Adenine and thymine form two hydrogen bonds and guanine and cytosine three hydrogen bonds.
- The sequences of the two DNA strands are **complementary**.
- The two strands in the double helix are **antiparallel**. If you look at the orientation of the sugars in the nucleotides, one strand runs 5' to 3' and the other is 3' to 5'

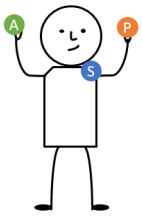


During **DNA replication** the original strands of DNA act as templates for the synthesis of new DNA molecules made up of one parental strand and one daughter strand. Replication begins with the formation of a replication fork at the origin of replication(s) and proceeds in two directions until the entire molecule is copied. In all living organisms, several different enzymes are involved in DNA replication; the functioning of these enzymes explain the mechanism of DNA replication at the molecular level.

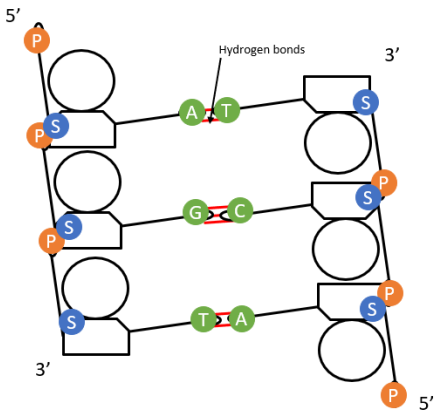


Materials: Students, nucleotide stickers (sugar, phosphate, nitrogen bases) and hydrogen bond paper strips. Large open space in which to work (an empty hall works well). Optional – enzyme cards (helicase, polymerase, etc.), string (to make enzyme lanyards) and scissors.

Basic Procedure:



1. Assign each student in the class to one nucleotide and distribute sugar, phosphate and nitrogen base stickers to each student. Try to make sure that you have equal numbers purines and pyrimidines.
2. Have each student place the phosphate sticker on the back of their left hand, the sugar sticker on their left shoulder and the nitrogen base sticker on the back of their right hand.
3. Have three students stand in a line. Have the students form the sugar-phosphate backbone by placing their left hand on the left shoulder of the person in front of them.
4. Complete the double helix by having the three complementary student nucleotides line up opposite the first students.
5. Create hydrogen bonds between the complementary bases by passing out the "hydrogen bond" paper strips. If you have taught students about the number of hydrogen bonds between the bases (A/T have 2 and C/G have 3), you can have students hold two or three stripes of paper between them.



6. You can choose to extend the length of the double helix to include more students by matching up complementary base pairs or choose to have remaining students join in during replication.
7. Once you have created a short double-stranded molecule, you can walk your students through some of the structural features of the molecule.

Replication

1. Build a short DNA double helix following the protocol given above.
2. Assign one or more students to the roles of enzymes, pass out the enzyme lanyards. Give the helicase a pair of scissors.
3. Talk through the stages of replication as the enzymes work together to replicate the molecule. Encourage your students to use the correct terminology when they explain what's happening. For example:
   - "Helicase breaks the hydrogen bonds between base pairs at the origin of replication to form a replication fork." The Helicase student enzyme uses scissors to cut the hydrogen bonds strips.
   - "DNA polymerase binds to the template DNA and begins to add new complementary nucleotides to the growing strand." The polymerase student enzyme calls for the correct student nucleotide

to join the strand and gives the base pair new hydrogen bond strips.