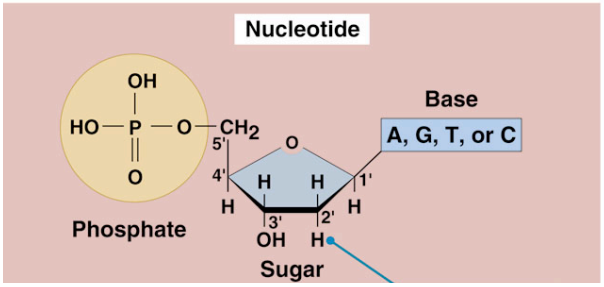
DNA Structure, Replication, Transcription and Translation

Remember the Central Dogma of genetics: DNA→RNA→Protein?
In this activity, we will use some common everyday materials to represent the various components of DNA and RNA in order to study how DNA is transcribed to code for RNA, and how RNA is translated to code for a protein.

Materials
- ✓ A handful of Fruit Loops
- ✓ 4 pentose Honey Combs cereal pieces
- ✓ 2 thin pretzel sticks

If you need help with any of the questions, discuss with another student or ask your TA.



Step One: DNA Structure

1. Construct a nucleotide: To illustrate the structure of DNA, take one piece of pentose Honey Combs cereal and place a **blue** loop at the right arm of the cereal. Break one pretzel stick in half and place one of the pieces on the left arm.
   What do each of the pieces of your structure represent?

2. Assume that the **blue** loop represents thymine. Make three more nucleotides using a **red** loop to represent adenine, **yellow** for cytosine, and **green** for guanine.
   T=blue A=red G=green C=yellow
3. Now, make a dinucleotide (2 nucleotides on the same strand connected by a covalent bond) by attaching the pretzel stick of the **blue** thymidine monophosphate (T) to the left corner of the Honey Comb of **green** deoxyguanosine monophosphate (G).
   Which end of this dinucleotide represents the 3' OH end of the molecule? Which one is the 5' phosphate end?

4. What kind of bond did you just form when you made the dinucleotide?

5. Make a second string of two of nucleotides (dinucleotide).
   One of the nucleotides should be **yellow** deoxycytidine monophosphate (C), and the other, should be **red** deoxyadenosine monophosphate (A).
   The 2 dinucleotides you have made are short single-stranded DNA molecules.
   DNA usually exists as a double-stranded molecule in which 2 strands are bonded together through hydrogen bonds between the bases of each strand.
   Figure out how to bind your two strands together
   Which bases can bond with each other?

Step Two: DNA Replication
Now that you understand the structure of DNA, for the rest of the exercises, you may just use the loops to represent the whole nucleotide.

6. Make a line of loops (in any order of colors you wish) that is 12-15 nucleotides long. Using the base pairing rules you learned above, attach the complementary strand to make a double-stranded DNA molecule.

7. Now that you have a double-stranded DNA molecule in front of you, how would you use this to produce 2 double-stranded DNA molecules exactly like the one you have? Explain what the term "semi-conservative replication" means.

8. At which end of the growing strand do new bases get added?

9. Do the DNA strands completely separate all at once? If not, what happens?

Step Three: Transcription
Organisms don't use the information in DNA directly. It must first be copied into mRNA. This process of taking the information in DNA and converting it into RNA is called transcription. Once transcription takes place, the mRNA can be transported to the cytoplasm of the cell where it is used as a template to make a polypeptide.

10. What are at least 3 differences between DNA and RNA?

11. You may have noticed by now that there are 2 colors of loops left, purple and orange. Because of the relationship in coloration between blue and purple, we will use **p<u>u</u>rple** to represent the base **<u>u</u>racil**. Replicate ONE strand of your DNA using the purple loops when a blue loop would be called for if you were making DNA. Remember: polymerases work by adding to nucleotides to the 3' end of a growing strand.

12. Once you have finished, the RNA strand will separate from the DNA template and the 2 DNA strands will rejoin. The mRNA (messenger RNA) will be moved to the cytoplasm.

Step Four: Translation

Once the RNA is complete and transferred to the cytoplasm, it is transported to the ribosomes where the sequence of bases is read and used to make a polypeptide chain. This process is called translation.

13. A codon is made up of three nucleotides. Each codon "codes" for a particular amino acid that will be added to the polypeptide chain. The RNA is "read" from the 5' end to the 3' end.

14. Explain to your lab partner the process of translation including in your description mRNA, ribosome, tRNA, and amino acids.

15. What is the role of the tRNA?

16. What is the role of the ribosome?

17. Which amino acid do you expect to see at the beginning of a polypeptide? Why?

18. We've just gone through the "Central Dogma" of genetics. Outline this process.

19. What is the function of each of the following, and when in the life of the cell or organism does it take place?

    DNA replication

    Transcription

    Translation