miniPCR DNA Structure LARP (Live Action Role Play)

Summary

In this activity, students will role play to make a double stranded molecule of DNA. Students will represent individual nucleotides, with their left arm representing the phosphate group, their body representing the 5-carbon sugar, while holding a nitrogenous base card in their right hand. Here we list directions to follow, but we encourage teachers to experiment with this activity and to modify it to their needs and class. This LARP is focused on DNA structure, but with simple modifications could be used as part of a lesson on DNA replication or transcription.

Materials

Instructions

Step by step instructions to follow while directing your students.

Teacher Questions

Use these questions throughout the activity to challenge students and to assess their understanding. The questions are meant as suggestions to expand upon.

Group 1 and 2 Scripts

For optional use. We recommend encouraging students to use the script as sparingly as possible. Words in parentheses must be chosen by the student depending on the nitrogenous base card they are holding. We recommend printing one copy and having the teacher or student facilitator use the script as a prompt when necessary.

Formative Assessment/Exit ticket

At the end of the activity or class, use to assess student understanding.

Nitrogenous Base Cards

Printed two per page. Cut pages in half prior to use. Print at least one card per student. We recommend printing extra. If you print the exact number needed for your class, the total number of adenine cards handed out to group one must equal the number of thymine cards distributed to group two and vice versa. Likewise, the number of guanine cards distributed to group one must be equal to the number of cytosine cards distributed to group two and vice versa.

Directions

Overview

This activity can be used for a wide range of groups sizes, but we recommend a minimum of eight students involved. Students will be given "Nitrogenous Base Cards" identifying them as adenine, thymine, guanine or cytosine. They will then introduce themselves to the group as their respective nucleotide, describing their chemical properties and bonding with the person next to them to make a DNA strand. They will also describe what they are looking for in a complementary base. Complementary base pairs will then introduce themselves to the group, making hydrogen bonds with their partner, creating double stranded DNA.

Step by Step

- Split you class in to two groups.
- You may wish to nominate one or two students (one if you have an odd number of students in your class, two if you have and even number) to act as student facilitators.
- Distribute "Nitrogenous Base Cards" to students in group 1.
- Students should hold the card with the hydrogen bonds (dotted lines) facing away from them.
- Have students with nitrogenous base cards line up side by side with about a two-foot space between them. Students should place their left hand on the right shoulder of the student standing next to them.
- Students holding a Purine (adenine or guanine) should stand with their right arm outstretched, signifying the larger double ring structure. Students holding a pyrimidine (thymine or cytosine) should stand with their right arm bent at the elbow, signifying the smaller single ring structure.
- Start with the student on the right-hand end of the line. Have the student introduce themselves to the group by describing their structure and chemical properties. If stuck, use the following script as a prompt. "My left hand is a phosphate group. My body is a 5-carbon sugar. My right hand is a nitrogenous base. I am (adenine, thymine, guanine, cytosine) and I am a (purine, pyrimidine) because I have a (double, single) ring structure. I can make (two, three) hydrogen bonds."
- Have one student from group 2 step forward. They must choose the nitrogeneous base card that will bind correctly bind to the student who just introduced themselves.
- Have the student stand directly in front of the student from group 1. The two students should hold their nitrogenous base card so that the hydrogen bonds meet. Students holding a Purine (adenine or guanine) should stand with their right arm outstretched, signifying the larger double ring structure. Students holding a pyrimidine (thymine or cytosine) should stand with their right arm bent at the elbow, signifying the smaller single ring structure.

- Have the student from group 2 introduce themselves to the group by describing their structure and chemical properties. If stuck, use the following script as a prompt. "I am (adenine, thymine, guanine, cytosine). I bind with (adenine, thymine, guanine, cytosine) because I also make (two, three) hydrogen bonds, and unlike my complementary base, I am a (purine, pyrimidine) because I have a (single, double) ring structure. My left hand is a phosphate group. It binds to the 5-carbon sugar of the nucleotide next to me."

- Have the next student in line from group one recite the group 1 script. Have a second student from group 2 choose a nitrogenous base card and stand across from the student in group 1.

- They should place their left hand on the right shoulder of the student next to them and recite the group 2 script.

- Repeat this process until you have made two complementary strands of DNA.

Notes on implementing.

It is fun to introduce this as a "line dance" and students introduce themselves to the group and describe the features they would find attractive in a partner.

While scripts have been provided, encourage students to describe themselves and their prospective bonding partner in their own words as much as possible, only using the script when they are stuck.

Example Questions

Which is your 5 prime end? Which is your 3 prime end?

- *5 prime end is the left side of the body. # prime end is the right side of the body.*

What type of bond did you just form?

- *A hand on a shoulder represents a covalent bond. Bonds between paper represent hydrogen bonds.*

There are two type of bases that make the correct number of bonds. Why do you match with a purine/pyrimidine?

- *Both guanine and cytosine can make three hydrogen bonds. Both adenine and thymine can make two hydrogen bonds. A purine must bind with a pyrimidine to maintain the correct width of the molecule. Two outstretched arms would be too wide. Two bent arms would be too narrow.*

Why are you holding your arm out straight/bent?

- *A straight arm represents the larger double ring structure of a purine. The bent arm represents the smaller single ring structure of a pyrimidine.*

You have many bonds holding everything together. Bonds hold the pieces of one nucleotide together, your phosphate group, 5-carbon sugar, and nitrogenous base. A bond holds your phosphate group to the five carbon sugar of the person next to you. The nitrogenous base is bonded to the person across from you. Which of these bonds seems the easiest to break? Which bonds seem the most difficult?

- *The bonds between the two nitrogenous bases (pieces of paper) are the weakest bonds. The bonds holding a single nucleotide together (bonds within a single person) are least likely to break in a cell. Bonds between the phosphate group and the 5-carbon sugar of the next nucleotide (the hand of one person and shoulder of the next) are more stable than the bonds between complementary bases but break more readily than the bonds within a nucleotide. It's easiest to separate the two pieces of paper. It is next easiest to remove the hand from someone's shoulder. It is hardest to remove a person's hand from their body.*

Who can name a way that our two strands of DNA could be separated in a cell?

- *Inside the cell the DNA strands are separated intermittently by DNA helicase or by RNA polymerase. DNA does not remain single stranded for any extended period of time in the cell.*

What about outside the cell? How could an investigator separate the two strands of DNA?

- *Heat or high pH could separate the strands of DNA.*

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Now that both strands are made, what would happen if everyone in group 1(or 2) took a step to the left (or right)? What types of problems do you now encounter?

- *If students are in front of a non-complementary base there may be an incorrect distance between nucleotides, the incorrect number of bonds between nucleotides or both.*

Group 1 Script

My left hand is a phosphate group. My body is a 5-carbon sugar. My right hand is a nitrogenous base. I am *(adenine, thymine, guanine, cytosine)* **and I am a** *(purine, pyrimidine)* **because I have a** *(double, single)* **ring structure. I can make** *(two, three)* **hydrogen bonds.**

Group 2 Script

I am *(adenine, thymine, guanine, cytosine).* **I bind with** *(adenine, thymine, guanine, cytosine)* **because I also make** *(two, three)* **bonds, and unlike my complimentary base, I am a** *(purine, pyrimidine)* **because I have a** *(single, double)* **ring structure. My left hand is a phosphate group. It bands to the 5-carbon sugar next to me.**

Exit Ticket Name:_____

In your own words describe how the structure of DNA nucleotides in one sequence determines the sequence of DNA nucleotides in the other strand.

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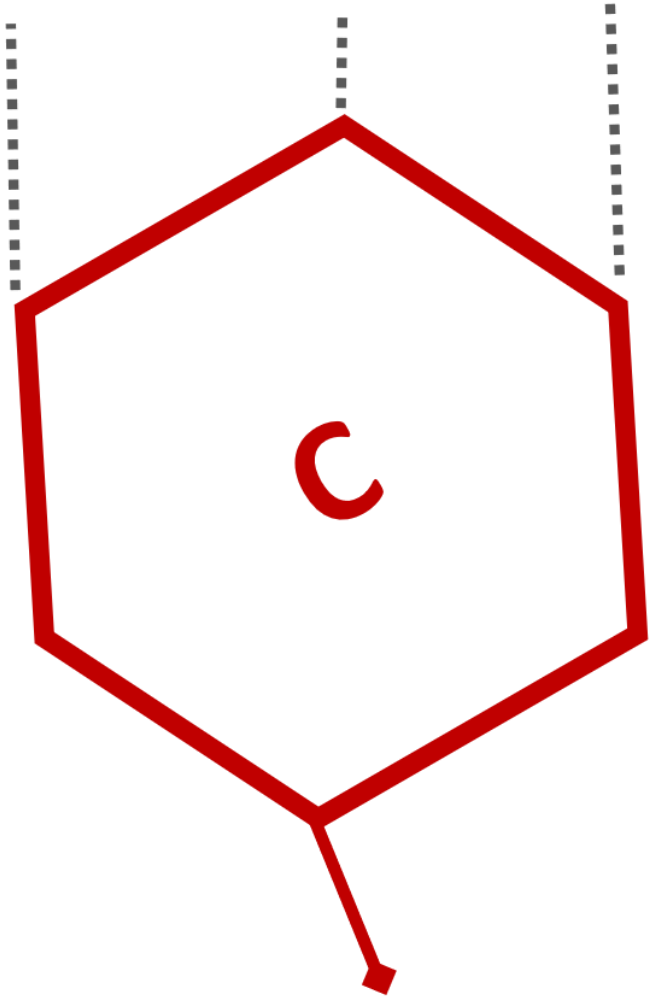
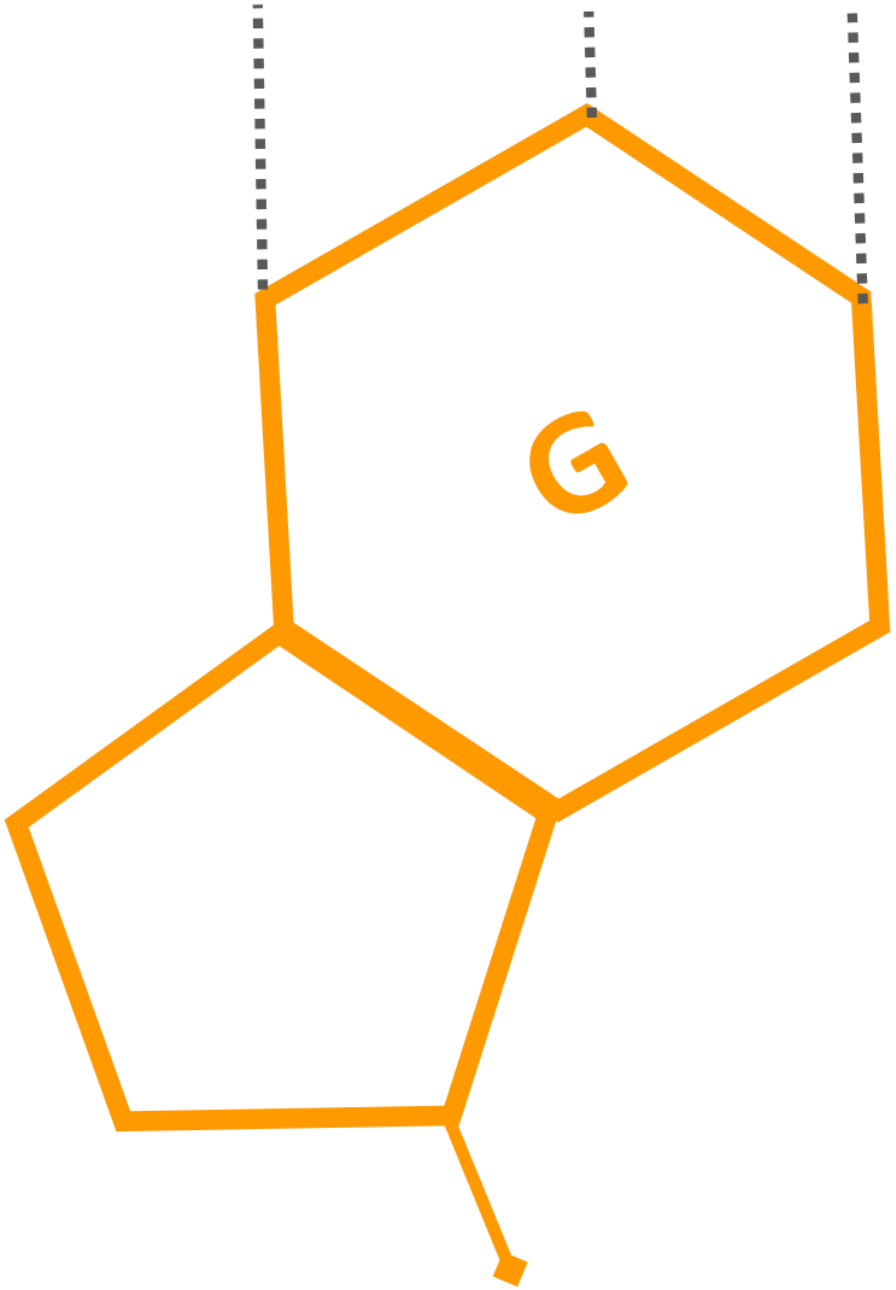


Nitrogenous Base Card

minipcr



Nitrogenous Base Card

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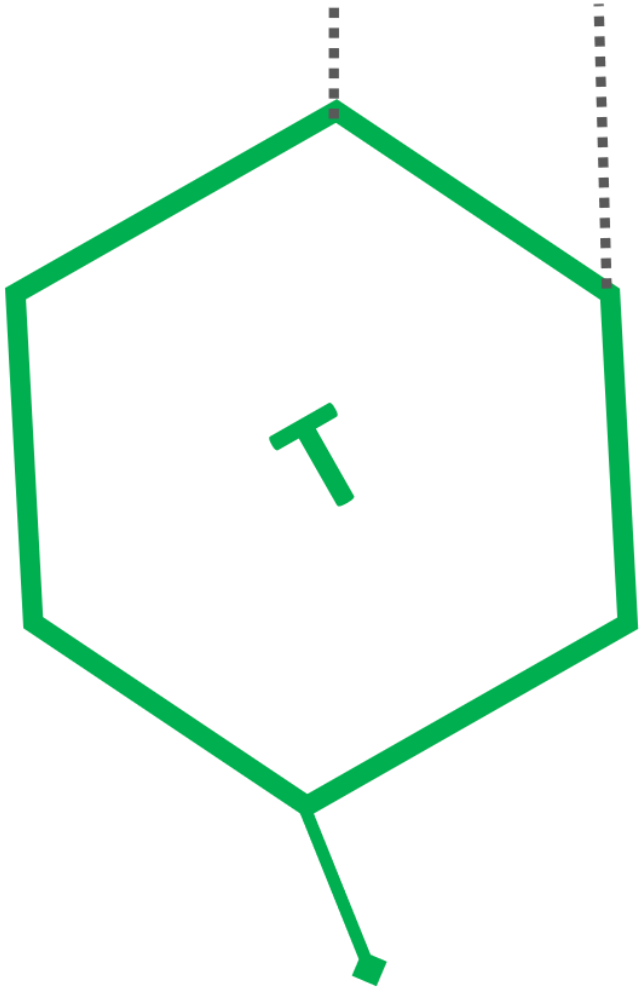

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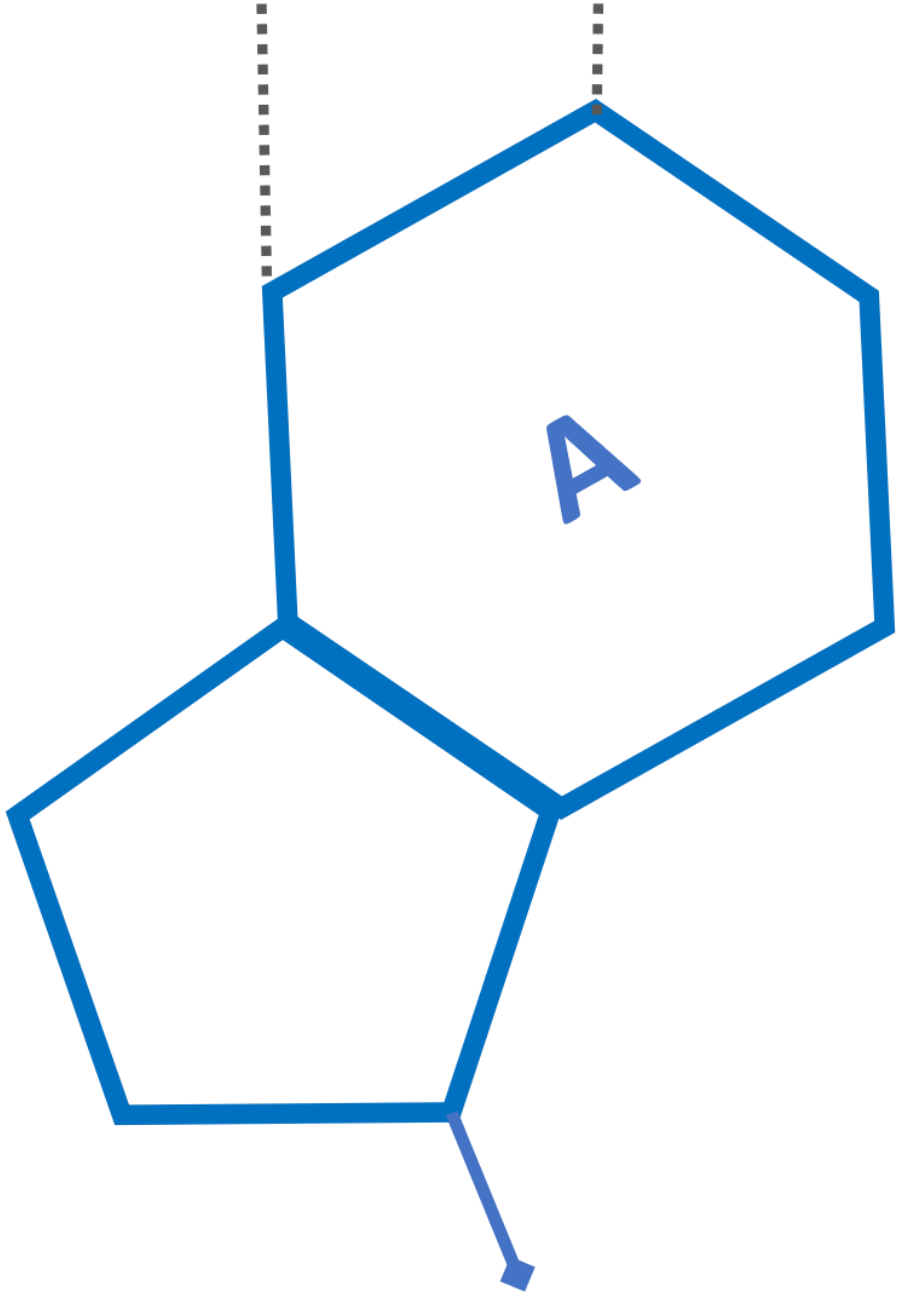

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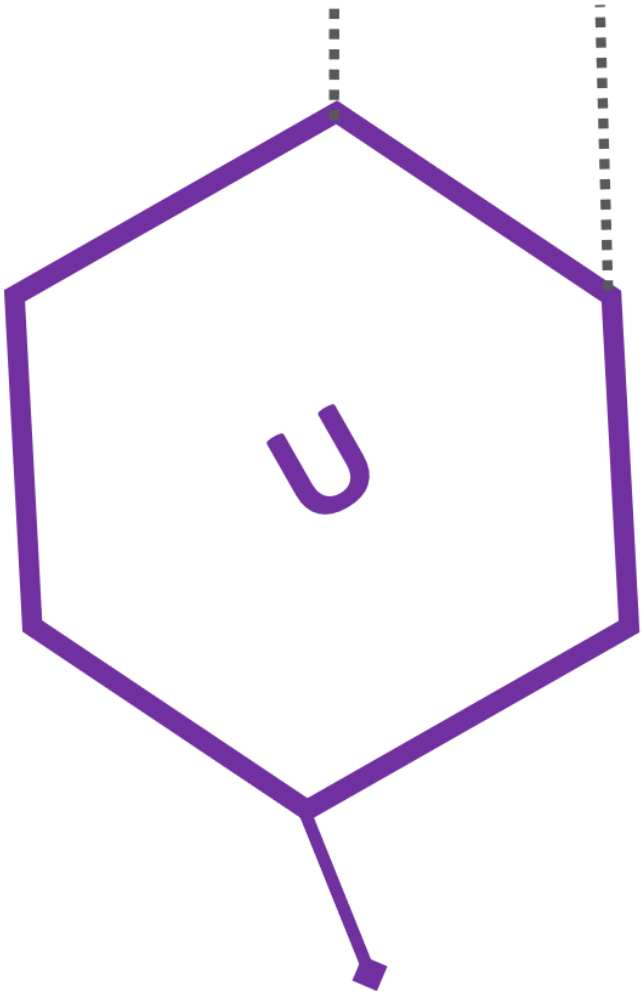

Uracil. For use in optional RNA transcription activities.

Nitrogenous Base Card

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