# Assignment Summary

For this assignment, you will first make a model of a DNA strand using pop beads. This DNA strand codes for a protein, which determines a trait in an organism. Next, you will change the base sequence of your model in three ways to show how mutations occur. Then, you will compare the base sequence of the mutated models to sequences on a key provided by your teacher to find out whether the mutated strand creates a protein that is beneficial, harmful, or neutral. Finally, you will answer some questions to summarize what you have done in this project. The Student Worksheet on the last few pages of this document will help you complete your assignment.

Background Information

DNA is the genetic material passed from parent to offspring. It is an important molecule because it carries instructions used for producing proteins. These proteins determine how an organism looks and functions.

DNA is a double-helix molecule. The two sides of the molecule, its backbone, are made of sugar molecules and phosphate molecules. These sides are connected by rungs made of nitrogen bases. The nitrogen bases of DNA are adenine (A), thymine (T), cytosine (C), and guanine (G).

A gene is a segment of DNA that codes for a specific trait. The sequence of nitrogen bases in a gene is copied from DNA into a strand of RNA in the nucleus of a cell. The RNA then moves out of the nucleus to the ribosome. The ribosome uses the information that RNA copies from DNA to produce proteins that have specific shapes and functions. The shapes of proteins help them perform their job. If the shape of the protein is changed, the protein may not be able to perform its function. A mutation, which is a permanent change in the DNA sequence in a gene, may change the shape of the protein it codes for. Types of mutations include substitution, insertion, and deletion. The effects of mutations on organisms may be beneficial, harmful, or neutral.

Safety

* Wear safety goggles to protect your eyes in case pop beads break into pieces.
* The pop beads are to be used only for creating models and are not to be played with.
* All actions while doing this project should be purposeful.
* Wash your hands after completing this project.

Materials

|  |  |  |
| --- | --- | --- |
| * Key from teacher * 37 gray pop beads | * 6 orange pop beads * 6 blue pop beads | * 5 purple pop beads * 5 green pop beads |

# Assignment Instructions

**Step 1 Prepare for the project.**

1. Read steps 2 through 10 so you know what you are expected to do during this project. Pay particular attention to the instructions you need to follow to create your DNA strand and mutated models. If there is anything that is not clear to you, be sure to ask your teacher.

**Step 2: Gather materials for the model.**

1. Collect the resealable plastic bag containing the pop beads from your teacher. Keep the pop beads in the plastic bag; take them out only when you need to use them.

**Step 3: Create a model of DNA.**

1. Use the base sequence below to create a DNA strand. In this sequence, A stands for adenine, T stands for thymine, C stands for cytosine, and G stands for guanine.

A–T–C–G–T–A–G–A–C–G–C–T–T–A–T–G–A–C

1. First, snap together all of the gray beads to make the sugar phosphate backbone of one side of the DNA molecule.
2. Then, attach the nitrogen bases to the sugar phosphate backbone. Remember to use the right color for each nitrogen base.
   * Orange pop beads for adenine
   * Blue pop beads for thymine
   * Purple pop beads for cytosine
   * Green pop beads for guanine

Be sure to leave spaces between the nitrogen bases. A small segment of the DNA strand you are creating is shown to give you an idea of what your strand should look like.



1. After you have completed your DNA strand, show your model to your teacher for grading.

**Step 4: Create a model of the first mutated DNA strand.**

1. Replace the first nitrogen base (adenine) in the sequence with another nitrogen base from the plastic bag.
2. Record the base sequence of the mutated strand in row C of Table 1 on the Student Worksheet.
3. Restore the original DNA strand by replacing the first nitrogen base of the mutated strand with adenine. Make sure to check that the restored DNA strand has the same base sequence as the original DNA strand.

**Step 5: Create a model of the second mutated DNA strand.**

1. Replace the second nitrogen base (thymine) in the sequence with another nitrogen base from the plastic bag.
2. Record the base sequence of the mutated strand in row C of Table 2 on the Student Worksheet.
3. Restore the original DNA strand by replacing the second nitrogen base of the mutated strand with thymine. Make sure to check that the restored DNA strand has the same base sequence as the original DNA strand.

**Step 6: Create a model of the third mutated DNA strand.**

1. Replace the third nitrogen base (cytosine) in the sequence with another nitrogen base from the plastic bag.
2. Record the base sequence of the mutated strand in row C of Table 3 on the Student Worksheet.
3. Restore the original DNA strand by replacing the third nitrogen base of the mutated strand with cytosine. Make sure to check that the restored DNA strand has the same base sequence as the original DNA strand.

**Step 7: Determine the effect of each mutation.**

1. Collect the key from your teacher. The key shows the base sequences of the possible mutated DNA strands, the protein produced from each mutated strand, and the effect of the mutation on the organism.
2. Find the base sequence from the key that matches the base sequence of the first mutated DNA strand from row C of Table 1.
3. Note the protein produced from this mutated strand, and record it in row D of Table 1.
4. Note the effect of this mutation on the organism and record it in row E of Table 1.
5. Find the base sequence from the key that matches the base sequence of the second mutated DNA strand from row C of Table 2.
6. Note the protein produced from this mutated strand and record it in row D of Table 2.
7. Note the effect of this mutation on the organism and record it in row E of Table 2.
8. Find the base sequence from the key that matches the base sequence of the third mutated DNA strand from row C of Table 3.
9. Note the protein produced from this mutated strand and record it in row D of Table 3.
10. Note the effect of this mutation on the organism and record it in row E of Table 3.

**Step 8: Complete the Student Worksheet.**

1. Answer the questions on the Student Worksheet to summarize what you have done in this project. Be sure to answer the questions using complete sentences. Recheck your work to make sure that you followed grammar, punctuation, and capitalization rules.
2. Check that all rows in all tables are filled out.

**Step 9: Evaluate the Student Worksheet using this checklist.**

If you can check each criterion below, you are ready to submit your project.

* Are all the rows of Table 1 complete?
* Are all the rows of Table 2 complete?
* Are all the rows of Table 3 complete?
* Do all of the questions in the Student Worksheet have answers?

**Step 10: Revise and submit your project.**

1. If you were unable to check off all of the requirements on the checklist, go back and make sure that your worksheet is complete. Save your worksheet before submitting.
2. When you have completed your worksheet, return to the Virtual Classroom and use the “Browse for file” option to locate and submit your assignment, or turn it in to your teacher if required.

**Step 11: Clean up your workspace.**

1. Unsnap all pop beads and put them back into the plastic bag. Seal the bag and give it to your teacher.
2. Clean up your workspace making sure to throw away any trash. Congratulations! You have completed your project.

Modeling DNA Mutations Student Worksheet

**Table 1.** First mutated DNA strand

|  |  |  |
| --- | --- | --- |
| **Row** | **Description** | **Answers** |
| A | Base sequence of original strand | A–T–C–G–T–A–G–A–C–G–C–T–T–A–T–G–A–C |
| B | Protein produced from original strand | Protein A |
| C | Base sequence of mutated strand |  |
| D | Protein produced from mutated strand |  |
| E | Effect of mutation |  |

**Table 2.** Second mutated DNA strand

|  |  |  |
| --- | --- | --- |
| **Row** | **Description** | **Answers** |
| A | Base sequence of original strand | A–T–C–G–T–A–G–A–C–G–C–T–T–A–T–G–A–C |
| B | Protein produced from original strand | Protein A |
| C | Base sequence of mutated strand |  |
| D | Protein produced from mutated strand |  |
| E | Effect of mutation |  |

**Table 3.** Third mutated DNA strand

|  |  |  |
| --- | --- | --- |
| **Row** | **Description** | **Answers** |
| A | Base sequence of original strand | A–T–C–G–T–A–G–A–C–G–C–T–T–A–T–G–A–C |
| B | Protein produced from original strand | Protein A |
| C | Base sequence of mutated strand |  |
| D | Protein produced from mutated strand |  |
| E | Effect of mutation |  |

Answer these three questions to summarize what you have done in this project.

1. How did you model mutations in this project?
2. How are the three mutated strands similar to each other? (Hint: Think about the type of mutations modeled.)
3. How are the three mutated strands different from each other?