

# BUILDING A PROTEIN

## Primary Learning Outcomes:

Students will understand the process of protein synthesis. Students will practice and learn the process of decoding DNA. Students will learn how genetic mutations can occur.

## High School Georgia Performance Standards

- SB1 Students will analyze the nature of the relationships between structures and functions in living cells.
- SB2 Students will analyze how biological traits are passed on to successive generations.
- SCSh5 Students will demonstrate the computation and estimation skills necessary for analyzing data and developing reasonable scientific explanations.
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## Middle School Georgia Performance Standards

- S7CS5 Students will use the ideas of system, model, change and scale in exploring scientific and technological matters.
- S7CS3 Students will have the computation and estimation skills necessary for analyzing data and following scientific explanations.
- S7L2 Students will describe the structure and function of cells, tissues, organs, and organ systems.
- S7L3 Students will recognize how biological traits are passed on to successive generations.
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**Materials (provided in kit):**

- Colored beads (Please try to retrieve all beads and return to the kit.)
- Fishing line

**Advance Preparation:**

- Pair up all the desks, so that the students will be paired in their original explorative groups.
- You will need to assign which recipe you want the student pairs to follow
- Provide the following materials to each group:
  - a. Key to the genetic code (attached)
  - b. Recipe for a protein (attached)
  - c. Large beads in 7 different colors
  - d. 50 cm length of fishing line
  - e. Stop-watch

Give the student groups only 25 minutes to construct their protein, and 25 minutes to answer the analysis questions.

**Safety Information:**

Immediately pick up any dropped beads to prevent possible accidents.

**Evaluation Strategies:** Genetic codes are "read" in groups of three nucleotides. Three nucleotides are referred to as a codon. Each codon corresponds to a different amino acid. In this evaluation each codon refers to a specific color of bead. The beads represent amino acids. The string of beads represents a protein. Each student simulates the action of a ribosome. Use the attached Rubric to evaluate each student's performance.

## RNA Templates

### Recipe 1

**AUGUUAGACGAUCCUCUAGCUAUCUUAUCGCGUUCUUCCCGGAAGAGUGA**

### Recipe 2

**AUGGCGGCUAUCUUAAGAGCUCGCACUAUUCGCUAUCUUAACUGCCUCCGUGA**

### Recipe 3

**AUGAUCGCUAUCUUAAGCGUUCUUCUUCGCUAUCUUAACUGAUCUUAUUCUGA**

### Recipe 4

**AUGGCGGCUUUCUCCUGAUCUUAAGCUAUCGCUAUCUUAUUAGCUAUCUGA**

## The Genetic Code

UUU dark blue

UUC dark blue

UUA light blue

UUG light blue

GAU green

GAC green

GAA green

GAG green

AUU orange

ACU orange

AUA orange

AUG start, white

CUU red

CUC red

CUA red

CUG red

CCU black

CCC black

CCA black

CCG black

GCU yellow

GCC yellow

GCA yellow

GCG yellow

UGA stop, white

## Student Performance Assessment

You've learned about DNA, genes, and gene technology. Now you will have a chance to simulate the action of a ribosome! In this activity you will use the key provided and a sample of genetic code (the "RNA template") as a recipe to assemble your protein.

### Procedure

1. Compare the "RNA template" you've been given with the genetic code, and string the first bead onto the thread.
2. Have a partner time how long it takes you to add 3 amino acids to your chain. Divide the time by 3 and record the result here. \_\_\_\_\_  
This is the average amount of time it takes you to add one amino acid to the chain.
3. Continue stringing until your protein is complete.

**Analysis:**

1. Double-check your completed protein with the genetic key. How many errors, if any, were there? \_\_\_\_\_
2. Explain the correct way to read the genetic "recipe"
3. What does each group of bases code for?
4. It takes your ribosomes about 0.001 seconds to assemble one amino acid. If the average protein consists of 300 amino acids, how long does it take your ribosomes to make a protein? Give your answer in seconds.
5. Using the time you recorded in step 4, calculate how long it would take you to make a protein with 300 amino acids out of beads. Convert your answer to minutes.
6. Your body translates RNA copies of DNA into protein with amazing accuracy. Based on your answer to step 5, how accurate was your translation?
7. What would happen if you skipped one nucleotide in your recipe? What do we call this when it happens inside your body?