

LEGO Protein Synthesis

Teacher Notes

Purpose

To understand that different cells build different proteins because they use *different genes* of the *same DNA* molecule.

Overview

Students will work in small groups (4-5 students). Each group will take on the identity of a different cell type. They will use Lego “amino acids” to build a unique “polypeptide” chain.

Materials:

For each student:

- ☐ Photocopy of assignment backed with data sheet.

For each group:

- ☐ Copy of the protein “recipes”
- ☐ Copy of the Lego genetic code

On a shared table, the “cytoplasm” (since the blocks represent amino acids):

- ☐ 30 Green Lego Blocks
- ☐ 40 Yellow Lego Blocks
- ☐ 65 Red Lego Blocks
- ☐ 45 Blue Lego Blocks
- ☐ 40 White Lego Blocks
- ☐ 20 Black Lego Blocks

Posted at the front of the class, the “nucleus”:

- ☐ The DNA molecule which will be used by all groups

Procedure:

1. Pass out the assignment and data sheet.
2. Have the students answer the pre-lab questions (10 minutes)
3. Discuss the answers to the pre-lab questions (5 minutes)
4. Assign each group a cell type.
5. Students go to their groups and copy the recipe on their data sheet:

Recipe	4								2							
DNA																
RNA																
Blocks																

6. Now ONE person goes to DNA molecule and copies the nucleotides for the genes from the DNA molecule, one gene at a time:

Recipe	4									2								
DNA	G	T	T	G	C	G	A	A	T	A	C	C	G	C	G	A	A	T
RNA																		
Blocks																		

7. Back at the lab station, the student reads off the DNA nucleotides while another student transcribes it into RNA codons:

Recipe	4									2								
DNA	G	T	T	G	C	G	A	A	T	A	C	C	G	C	G	A	A	T
RNA	C	A	A	C	G	C	U	U	A	U	G	G	C	G	C	U	U	A
Blocks																		

8. The first person goes back to the DNA molecule to copy the next gene. The second person now uses the Lego Genetic Code to decode the RNA codons into Lego blocks:

Recipe	4									2								
DNA	G	T	T	G	C	G	A	A	T	A	C	C	G	C	G	A	A	T
RNA	C	A	A	C	G	C	U	U	A	U	G	G	C	G	C	U	U	A
Blocks	Green			Yellow			Red			Black			Yellow			Red		

9. The third person now goes to the table and gets the Lego blocks, ONE at a time, and brings them back to the lab station.
10. The second person now takes the block and adds it to the tower.
11. When all the work is done, and the tower is made, each student fills in his/her entire data sheet and colors the boxes on the data sheet, and answer the questions.



Lego “Polypeptide” Recipes

Cell Type	Genes
Liver Cell	4, 2, 4, 2, 3, 3, 4, 4, 3, 3
Nerve Cell	5, 3, 5, 2, 5, 1, 1, 1, 1
Muscle Cell	3, 5, 1, 3, 5, 1, 3, 5, 1, 3
Skin Cell	1, 2, 2, 1, 3, 3, 5, 4
Bone Cell	1, 5, 3, 4, 1, 1
Lung Cell	3, 1, 3, 2, 4, 5, 2, 3, 1, 3
Kidney Cell	2, 5, 2, 4, 3, 2, 4, 2, 3
White Blood Cell	5, 4, 3, 1, 2, 3, 4, 2, 2

Lego “Genetic Code”

RNA	Block
UGG	Blue
CGC	Yellow
UUA	Red
CUA	White
UGC	Black
CAA	Green



Answer Keys:

Pre-Lab Questions

1. If you were looking for DNA in a eukaryotic cell, where would you go to find it?
In the nucleus
2. Which organelle is responsible for making proteins?
ribosomes
3. What is transcription and where does it occur?
DNA is copied into mRNA, it occurs in the nucleus
4. What are the DNA-RNA base-pairing rules?
A → U, T → A, C → G, G → C
5. What is the name of the 3 nucleotide segments of mRNA?
Codons
6. What is translation and where does it occur?
mRNA is used to build proteins, it occurs at the ribosome
7. During translation, what pairs up with the mRNA codons?
Anticodons on tRNA
8. What do tRNAs carry to the ribosome, and what do they form as they link up to form a chain?
Amino acids, a protein

DNA – Block – RNA:

DNA	Block	RNA
ACC	Blue	UGG
GCG	Yellow	CGC
AAT	Red	UUA
GAT	White	CUA
ACG	Black	UGC
GTT	Green	CAA

Gene 1 = AATGATACC = Red, White, Blue
 Gene 2 = ACGGCGAAT = Black, Yellow, Red
 Gene 3 = GTTGATAAT = Green, White, Red
 Gene 4 = GTTGCGAAT = Green, Yellow, Red
 Gene 5 = ACCGCGACC = Blue, Yellow, Blue

Liver Cell	4, 2, 4, 2, 3, 3, 4, 4, 3, 3	GYRBYRGYRBYRGWRGWRGYRGYRGWRGWR
Nerve Cell	5, 3, 5, 2, 5, 1, 1, 1, 1	BYBGWRBYBBYRRWBRWBRWBRWB
Muscle Cell	3, 5, 1, 3, 5, 1, 3, 5, 1, 3, 5, 1	GWRBYBRWBGWRBYBRWBGWRBYBRWBGWRBYBRWB
Skin Cell	1, 2, 2, 1, 3, 3, 5, 4	RWBBYRBYRRWBGWRGWRBYBRWB
Bone Cell	1, 5, 3, 4, 1, 1	RWBBYBGWRGYRRWBRWB
Lung Cell	3, 1, 3, 2, 4, 5, 2, 3, 1, 3	GWRRWBGWRBYRGYRBYBBYRGWRRWBGWR
Kidney Cell	2, 5, 2, 4, 3, 2, 4, 2, 3, 2, 5	BYRBYBBYRGYRBYRBYRBYRGWRBYRBYB
White Blood Cell	5, 4, 3, 1, 2, 3, 4, 2, 2	BYBGYRGWRRWBBYRGWRGYRBYRBYR

1. What does each of the following represent?
 - Front of the classroom: the nucleus
 - Table with the blocks: the cytoplasm
 - Lab station: ribosome
 - Lego blocks: amino acid
 - Lego tower: polypeptide/protein
 - The person in your group building the tower: rRNA (ribosome)
 - The person in your group getting the blocks: tRNA

- The person in your group copying the genes from the front of the class onto his/her paper: mRNA

Look at all the Lego towers made by the different groups:

2. How are they similar? Same colored blocks
3. How are they different? Different order and number of blocks; different sizes
4. Do different cells (liver, nerve, bone, etc.) have the same DNA? yes
5. Why do these different cells have different proteins? They use different genes

What do you think about the process of Protein Synthesis? Answers will vary

CLOSING

I hope you found the activity helpful in teaching Protein Synthesis to your students. Please contact me and let me know how the activity could be improved.

Thank you,

Abram van der Fluit
abram@vanderfluit.com