

## Summary

3D models were printed and used to help students understand protein synthesis. Use of models can increase the understanding of chemical representations (Wu et. al, 2001). Working in groups, students will manipulate the moving pieces of microscopic processes making the learning experience more impactful (Blatchford et. al, 2003). Through hands on learning students achieve a level of understanding surpassing that of only lecturing.

## Goals achieved

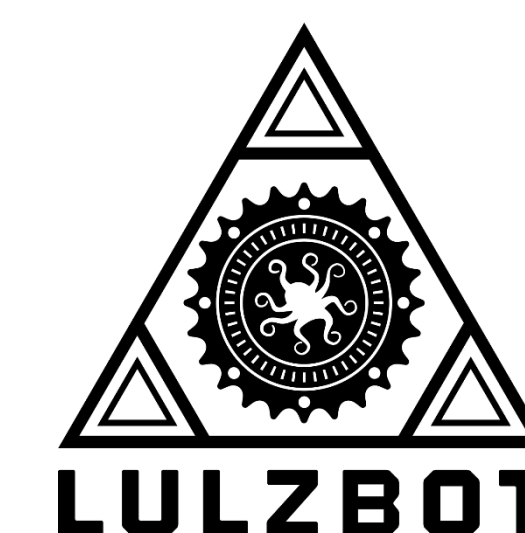
- To increase student understanding and comprehension of protein synthesis in which DNA is used to make RNA and proteins.
- To make lesson plans and model sets for human karyotyping.
- To increase faculty awareness of 3D printing as a tool for instruction.

## Learning Objectives

1. Compare the molecules involved and organize and explain the sequence of events of protein synthesis.
2. Explain the roles different parts of ribosome structure play in protein synthesis.
3. Describe the post-transcriptional modifications that occur with eukaryotic RNA and relate their role in protein synthesis.
4. Demonstrate understanding of protein synthesis by building an example protein given a specific set of DNA as a code for that protein



Lulzbot TAZ 6 3D printer



Student completed protein synthesis model showing final mRNA and resulting amino acid sequence.



Students practicing protein synthesis



Students arranging paired chromosomes



Students matching paired chromosomes

## Student opinions

- “This project made visualizing proteins synthesis easier.”
- “This exercise was actually pretty fun, by actually working hands-on with the pieces it allowed me to have a better understanding of the topic.”
- “RNA processing was hard for me to comprehend but after doing this experiment it made more sense”

## Continued evaluation

Essay and exam scores from previous semesters will be compared with exam and essay scores from the current semester.

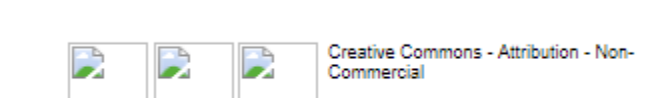
## References

- Hsin-Kai Wu, Jos Hsin-Kai Wu, Joseph S. Krajcik, Elliot Soloway. Promoting understanding of chemical representations: Students' use of a visualization tool in the classroom *Journal of research in Science Teaching*, 38:7 (2001) 821-842.
- Peter Blatchford, Peter Kutnick, Ed Baines, Maurice Galton. Toward a social pedagogy of classroom group work. *International Journal of Educational Research* 39 (2003) 153–172.

Karyotype Laboratory Exercise by  
haciark  
Published on March 20, 2017  
www.sharingview.com/sharing/2121145



DNA / RNA Manipulatives by Eagleknot  
Published on January 11, 2016  
www.sharingview.com/sharing/129952



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