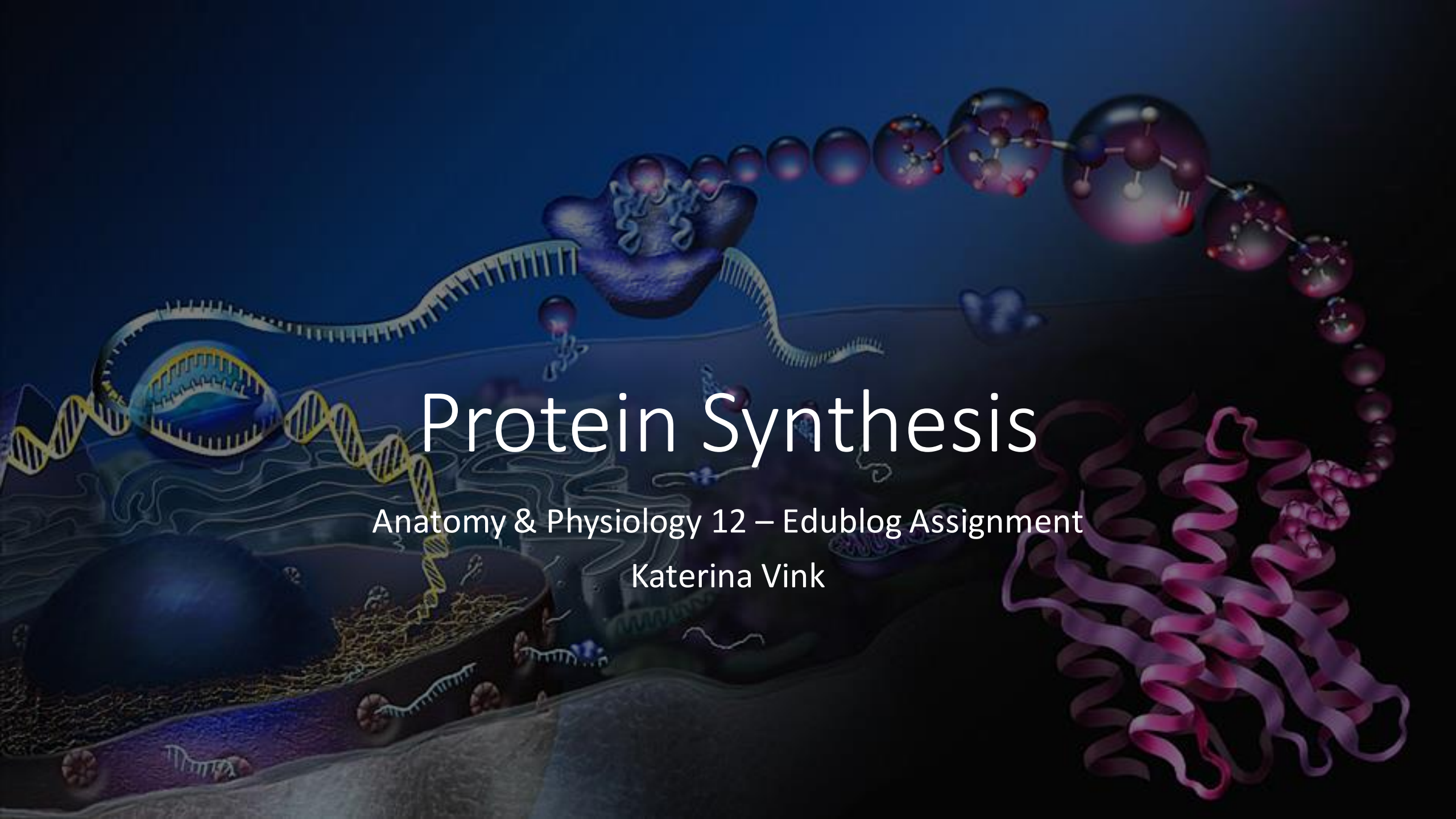
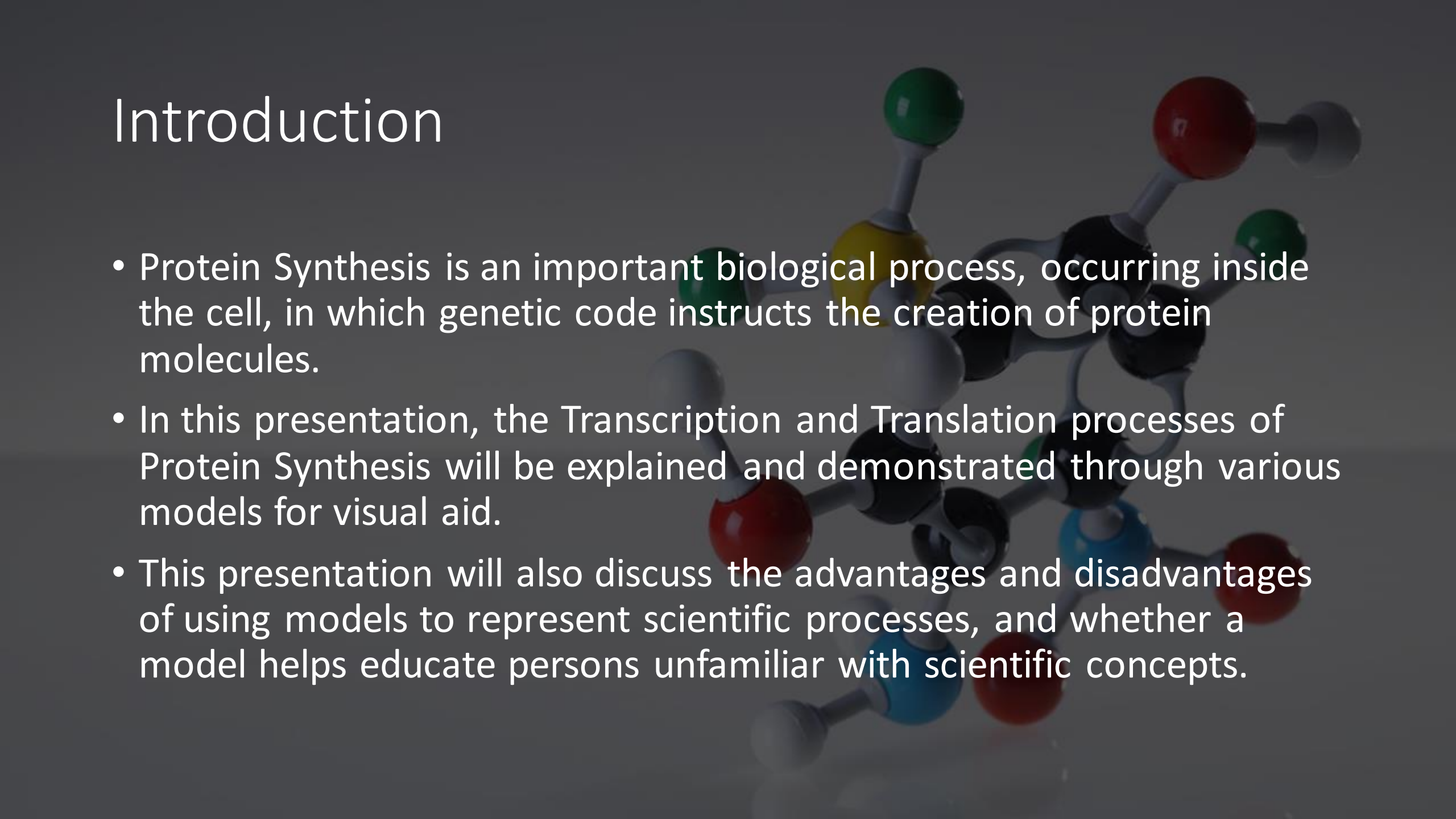


Protein Synthesis

Anatomy & Physiology 12 – Edublog Assignment

Katerina Vink

Introduction

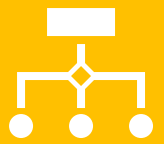


- Protein Synthesis is an important biological process, occurring inside the cell, in which genetic code instructs the creation of protein molecules.
- In this presentation, the Transcription and Translation processes of Protein Synthesis will be explained and demonstrated through various models for visual aid.
- This presentation will also discuss the advantages and disadvantages of using models to represent scientific processes, and whether a model helps educate persons unfamiliar with scientific concepts.

Transcription

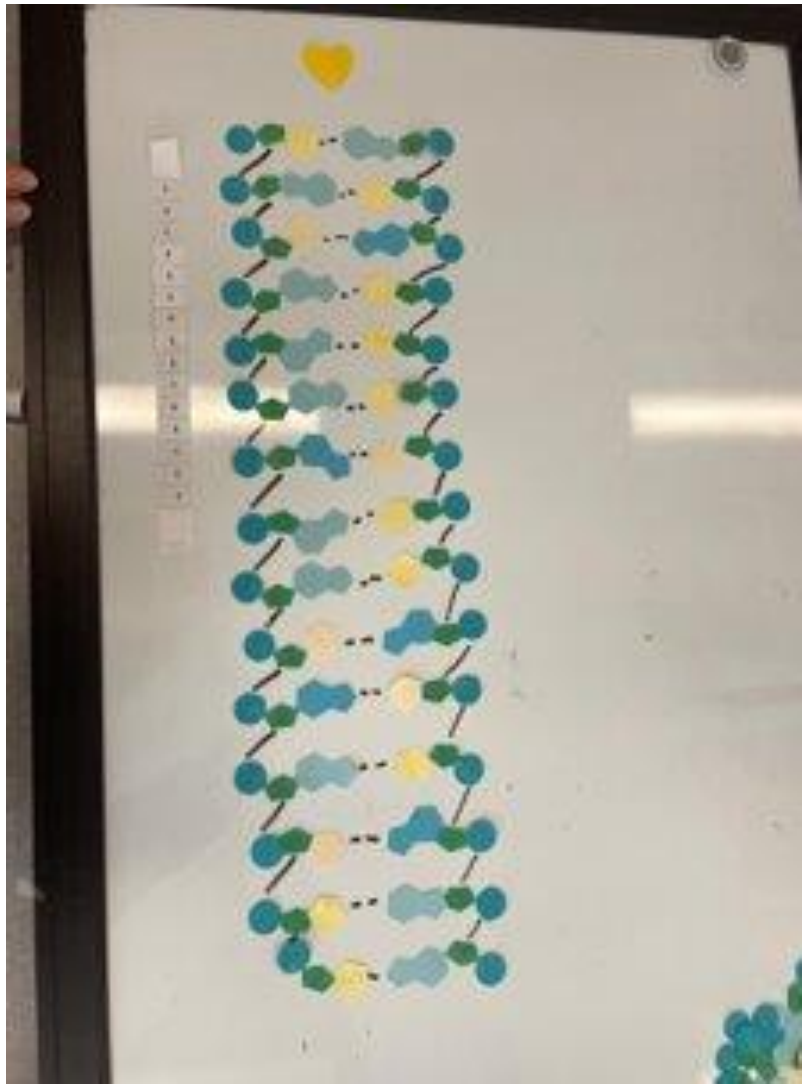
RNA Transcription is the process by which the building instructions spelled out by DNA are transferred to mRNA.[1]

There are 3 steps: DNA separates, mRNA bonds complimentary base pairs, mRNA separates from DNA.

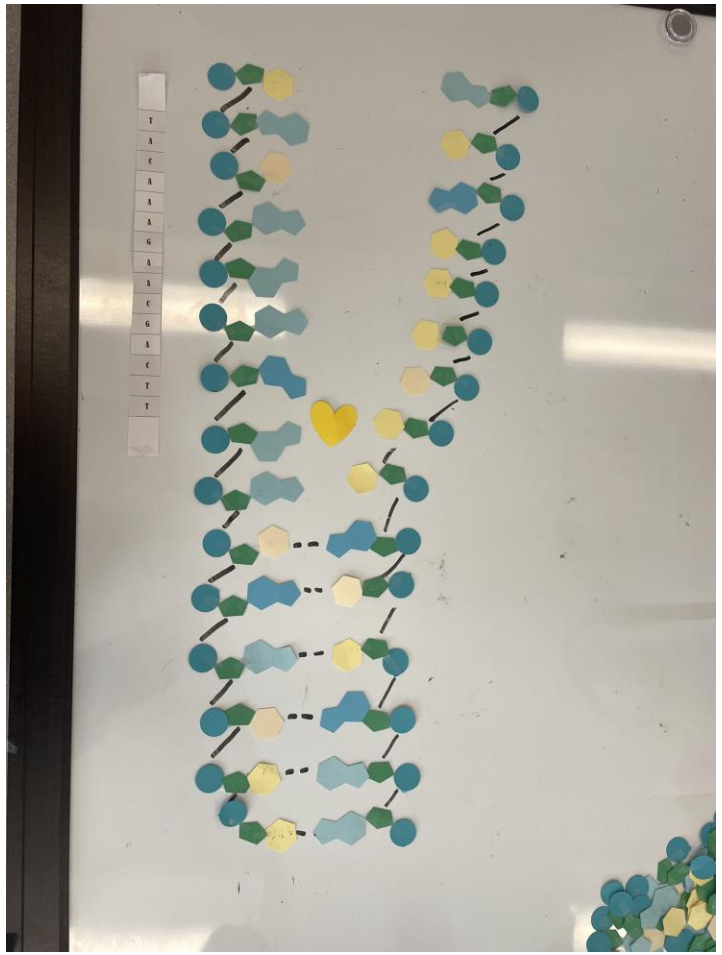


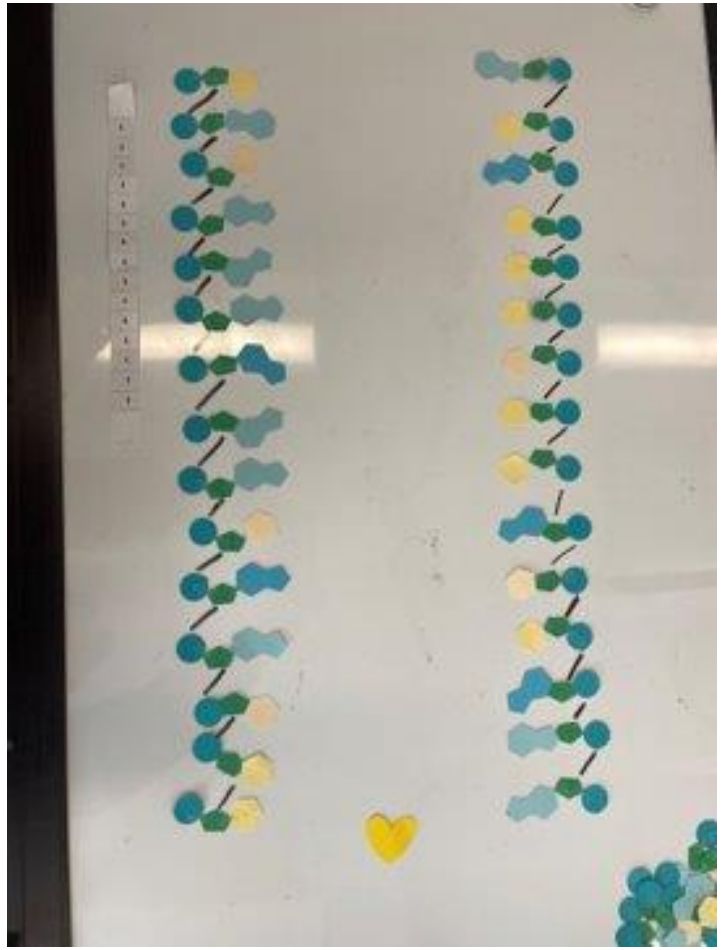
The molecules involved in this process are DNA and mRNA.

- A strand of DNA is usually in a double helix shape. The first step of transcription is the unwinding and unzipping of DNA.
- This model shows a strand of DNA after it has unwinded from its spiral, now resembling a ladder. The heart represents the RNA polymerase that activated this action.

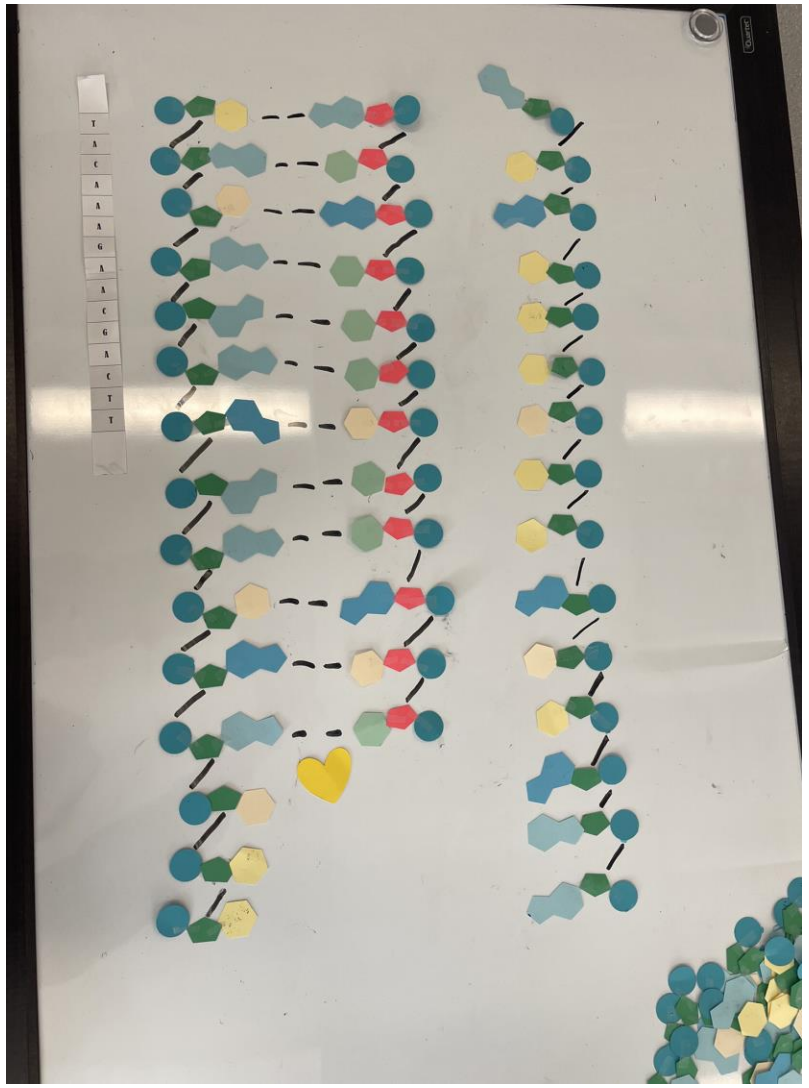


These models depict the unzipping of the DNA strand. The RNA polymerase separates the two backbones by breaking the H-bonds that hold them together. What remains are two separate backbones of DNA, one containing a genetic code.

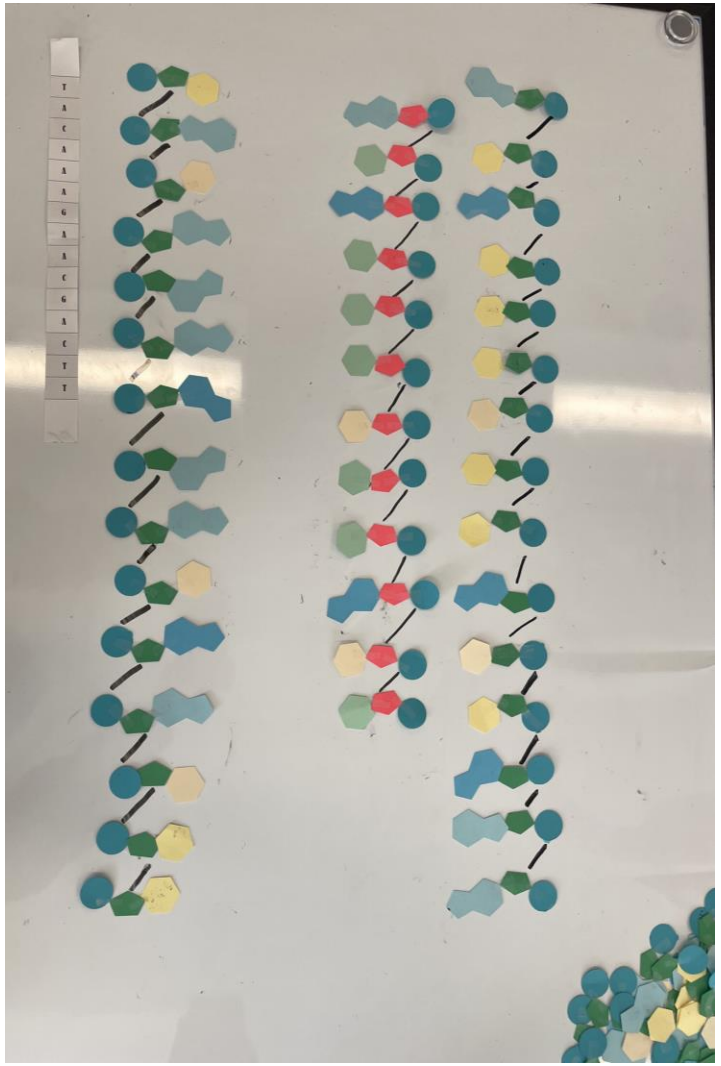


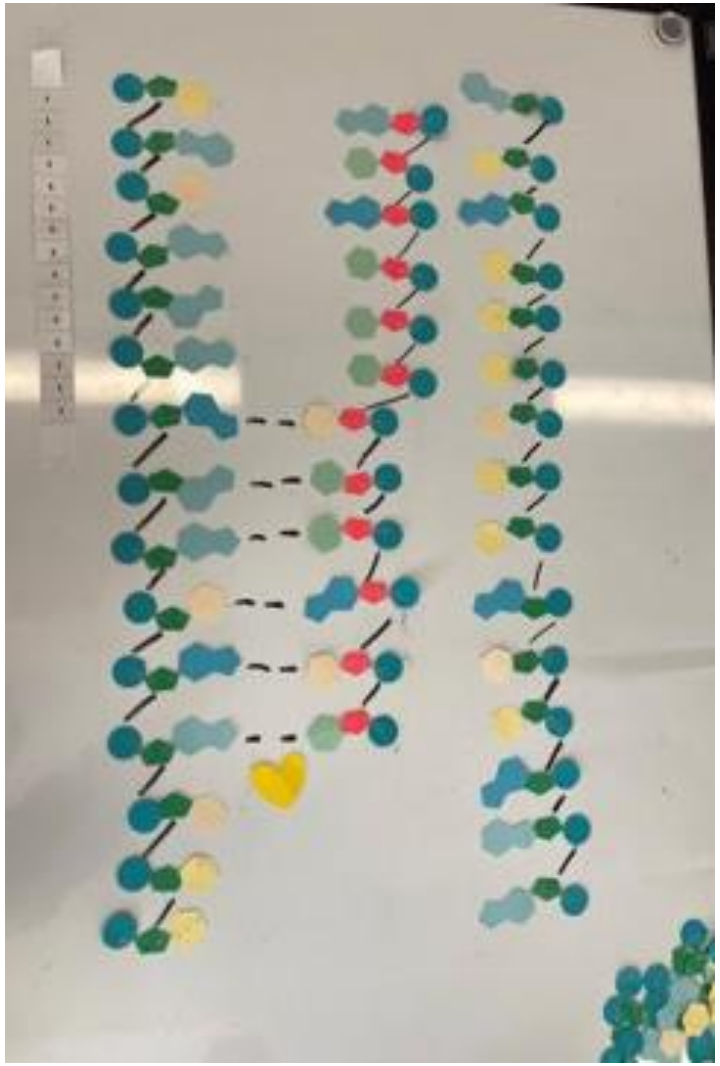


- This model represents the complete second step, the complimentary base pairing of RNA to DNA.
- The RNA strand is not bonding to the gene, but to the compliment of the gene, so that the RNA's code is exactly that of the gene.
- The RNA polymerase helps form H-bonds between the bases of the nonsense strand and corresponding RNA nucleotides. Then the enzyme helps form the mRNA backbone by bonding adjacent nucleotides.
- When the entire gene is transcribed, an mRNA is formed.

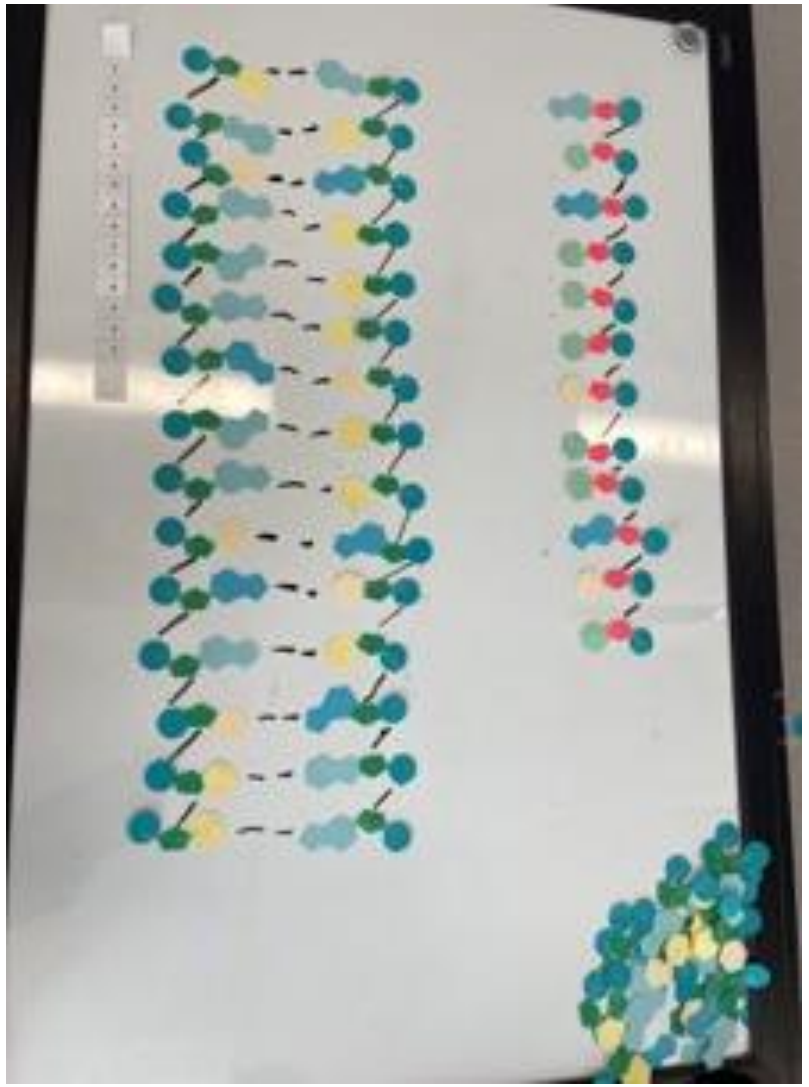


The final step of transcription is the separation of the mRNA strand from the DNA strand. When the entire gene is transcribed, the RNA polymerase again goes through the bonds and breaks the H-bonds. The two DNA strands will then start to reconnect.





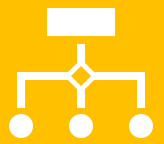
- This model represents the final product of the RNA transcription process. Once the DNA has fully reconnected, what remains is a strand of DNA containing a specific gene, and a strand of messenger RNA containing the exact instructions of that gene.
- The mRNA will now exit the nucleus and go into the cytoplasm, searching for a ribosome to start the next step of protein synthesis.



Translation

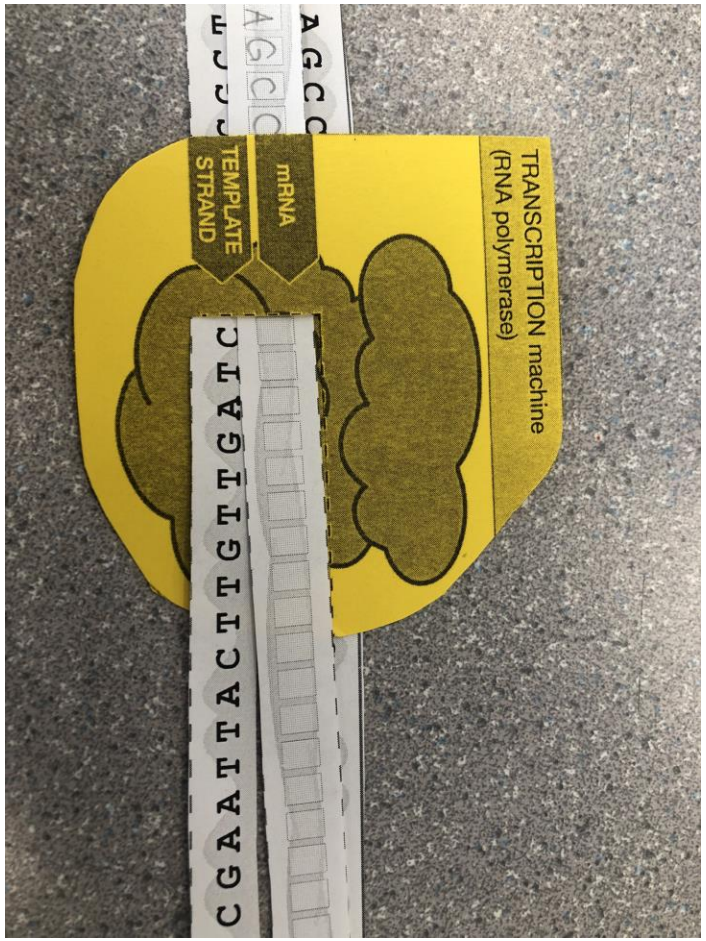
RNA Translation is the process by which the code carried by the mRNA is converted into a polypeptide.[2]

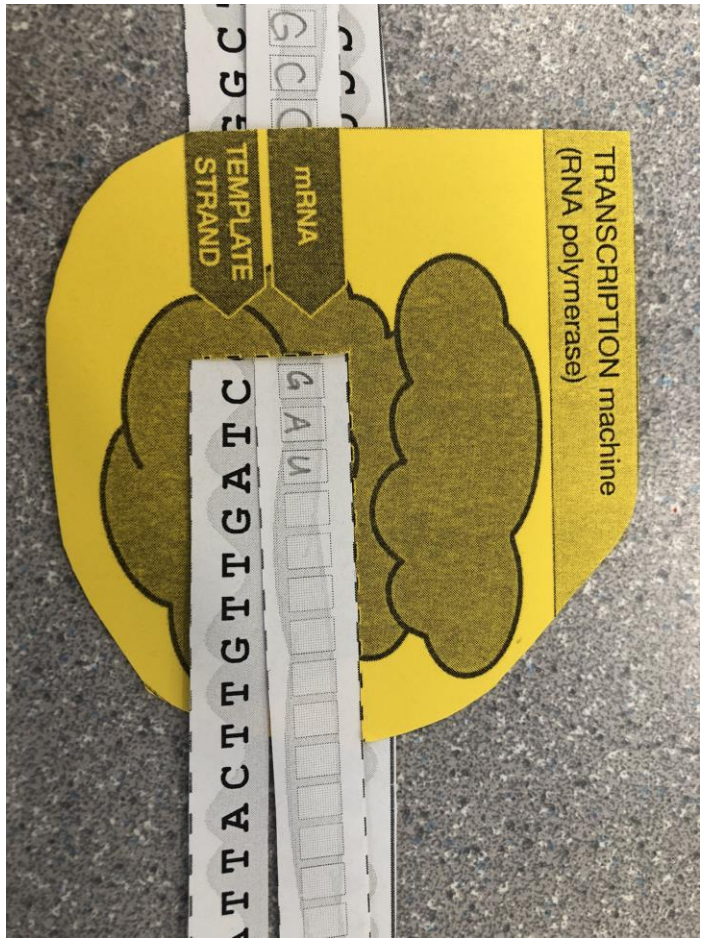
Translation occurs in 3 stages: Initiation, Elongation, and Termination.

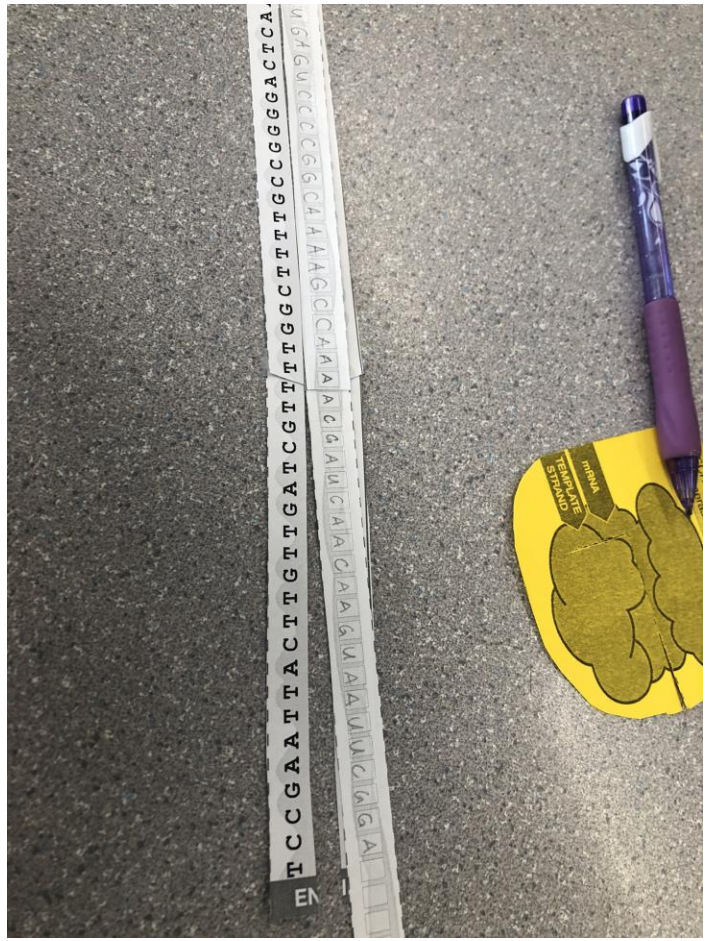


The molecules involved in this process are mRNA, tRNA, rRNA, and amino acids.

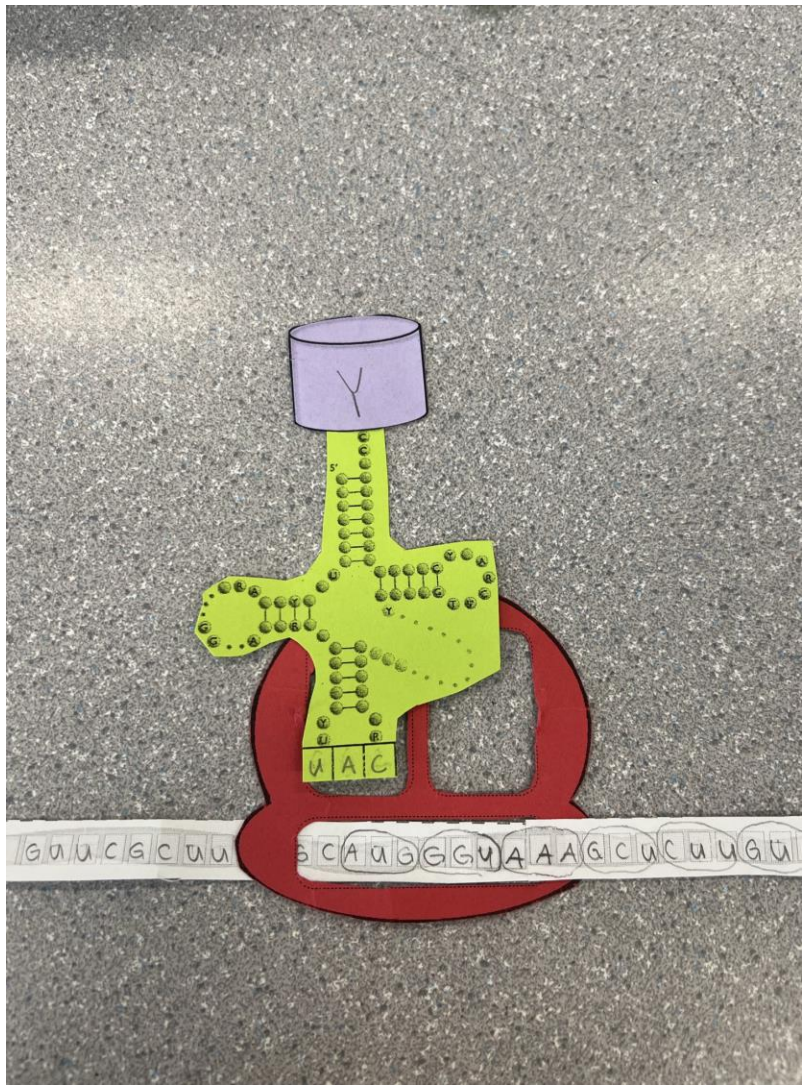
This models represents the RNA Transcription process in a different way, but one that makes the next models easier to understand.



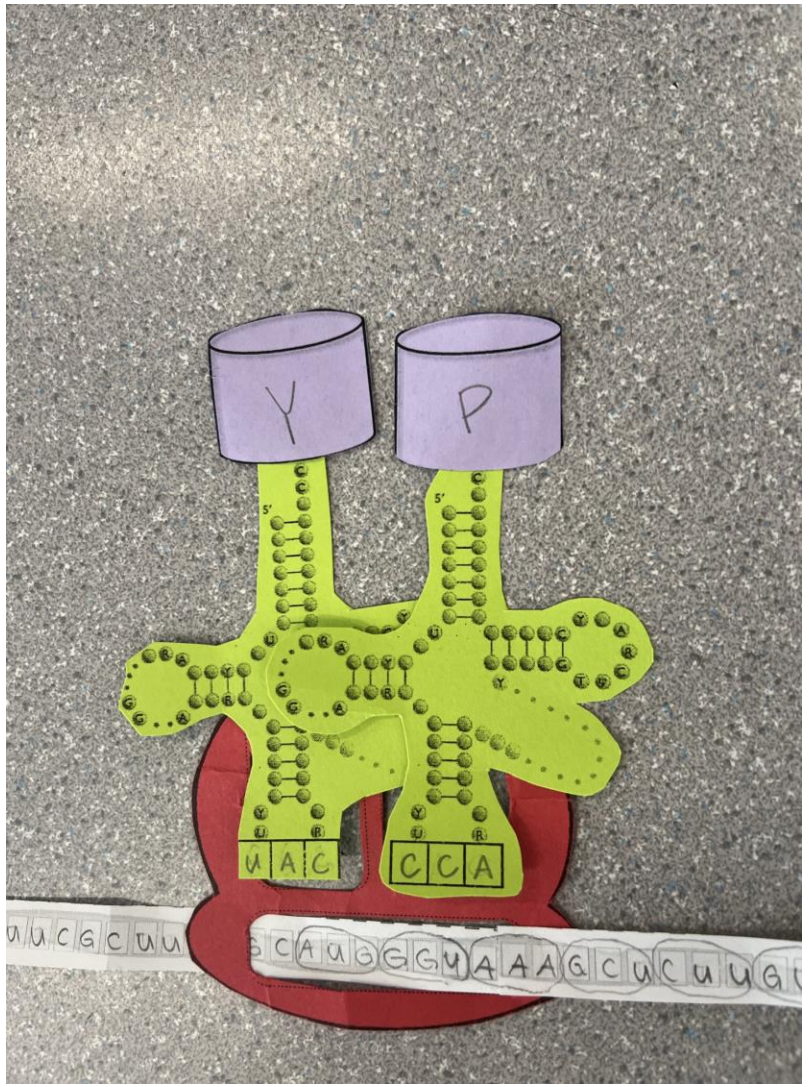




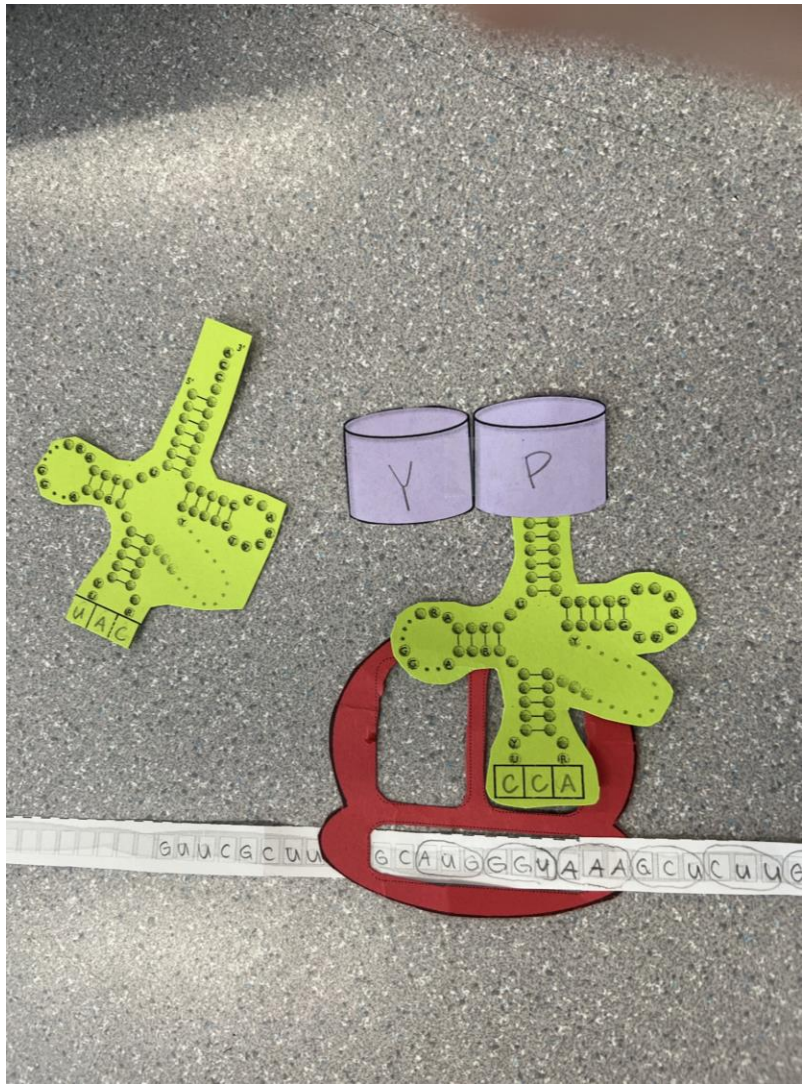
- This model represents the first stage of Translation: Initiation.
- First, the mRNA strand binds to two ribosome subunits. The ribosome begins moving the mRNA strand through itself when the mRNA reads the initiating codon AUG.
- An initiator tRNA occupies the "P" site and binds to the AUG codon. The tRNA brings an amino acid (the amino acid that corresponds to the gene's instructions for building a protein chain).



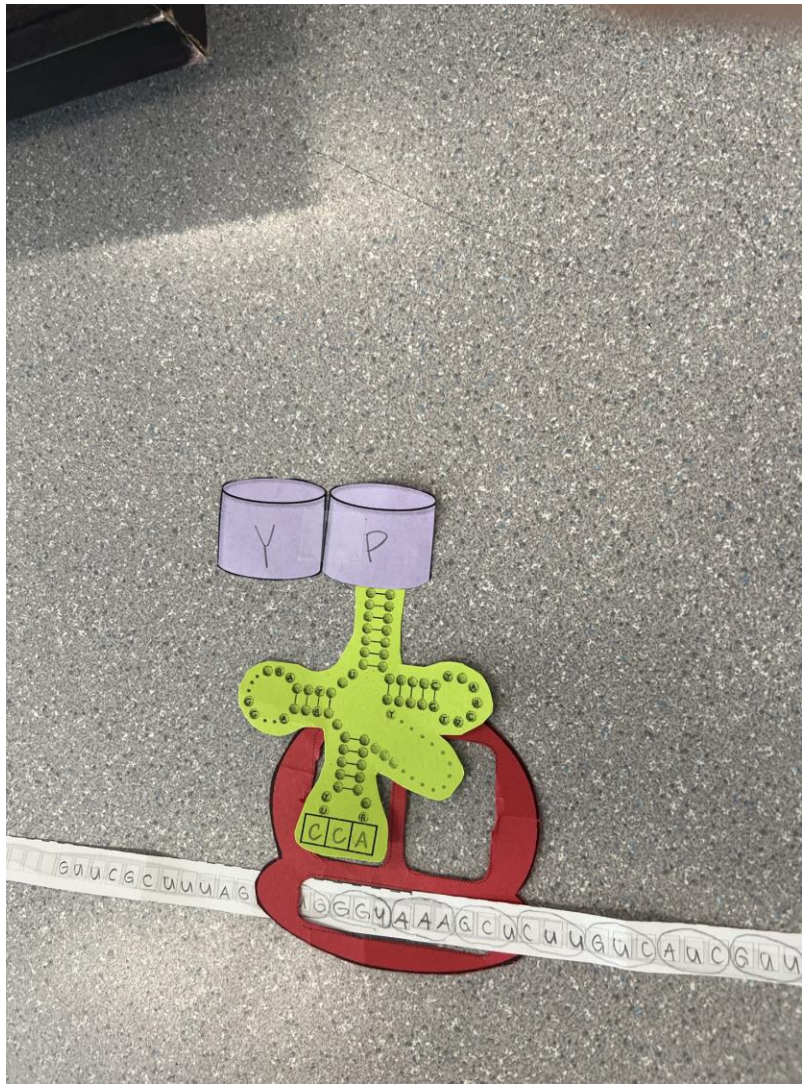
- Next, a second tRNA arrives at the "A" binding site (the tRNA with the complimentary anti-codon to the next codon being read on the mRNA).
- This new tRNA also brings an amino acid with it.



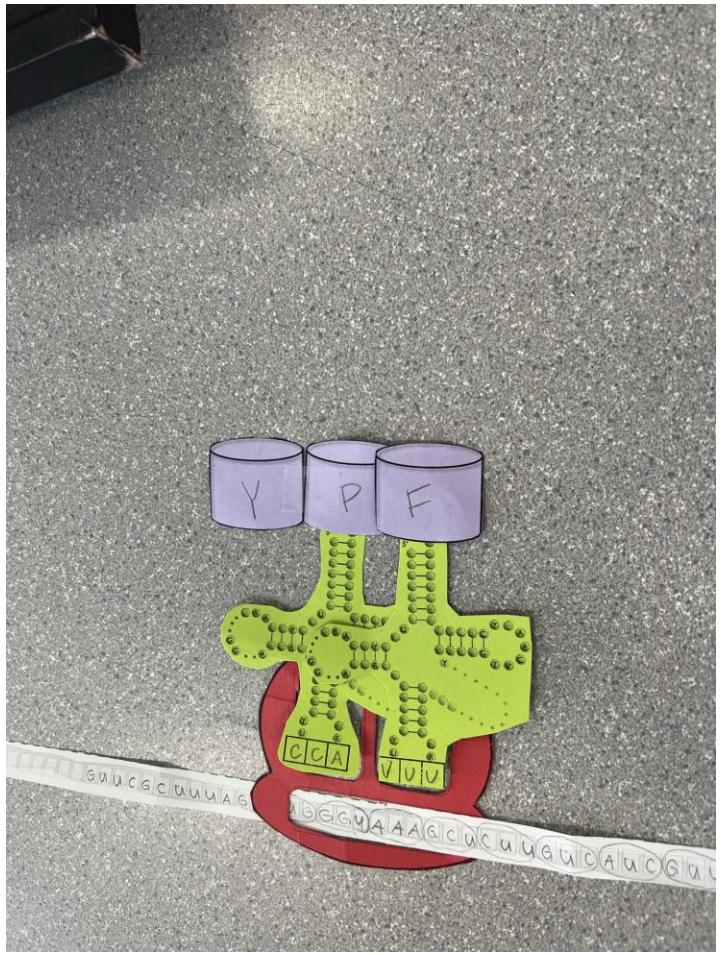
- Next, the adjacent amino acids form peptide bonds and bond together to start a polypeptide chain.
- When the mRNA shifts and the tRNA leaves the "P' site, its amino acid is passed to the tRNA in the "A" site.

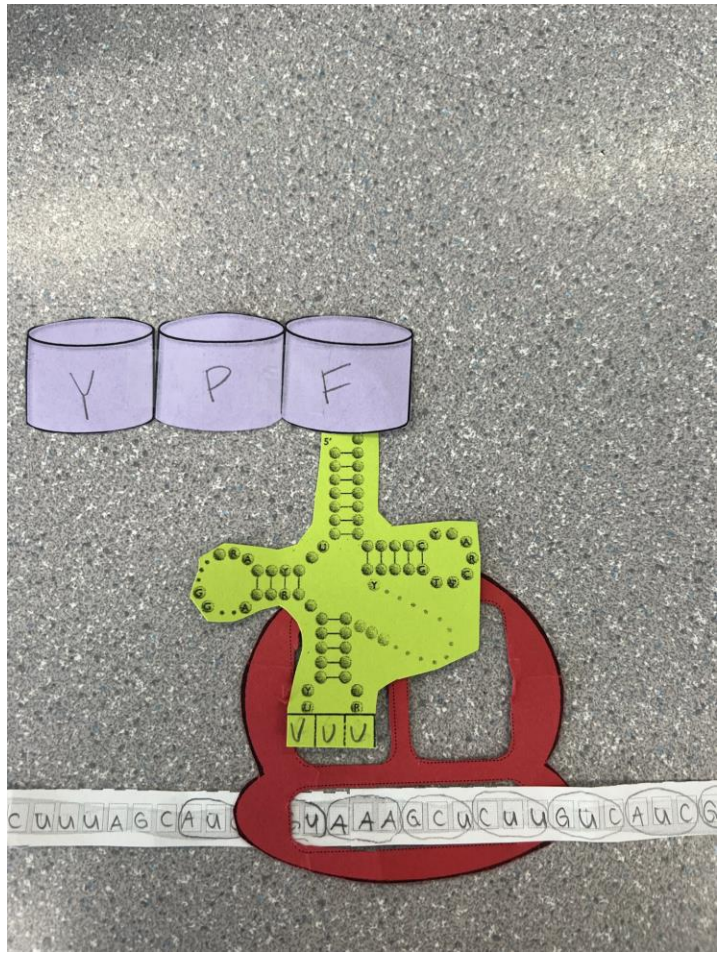


- Once the "P" site is empty, the tRNA and its amino acids shift into the available spot.
- This leaves the "A" site available, which allows a new tRNA to come and bind to the next codon on the mRNA strand, thus adding a new amino acid to the chain, and continuing the cycle of translation.

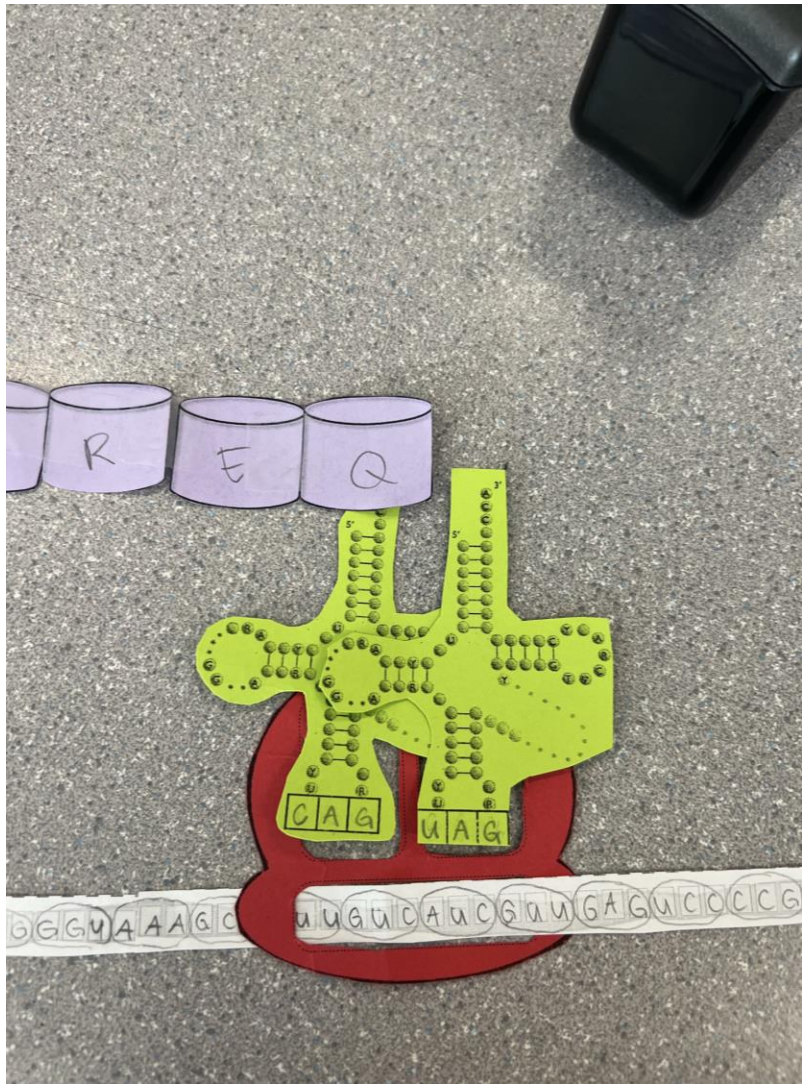


This process continues, the steps repeating as the polypeptide chain elongates. This model represents the second step of Translation: Elongation.

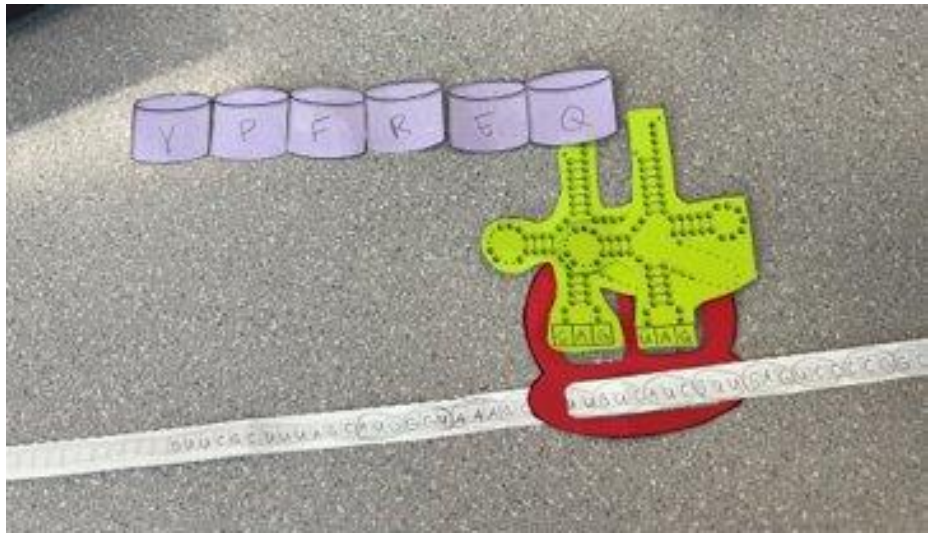


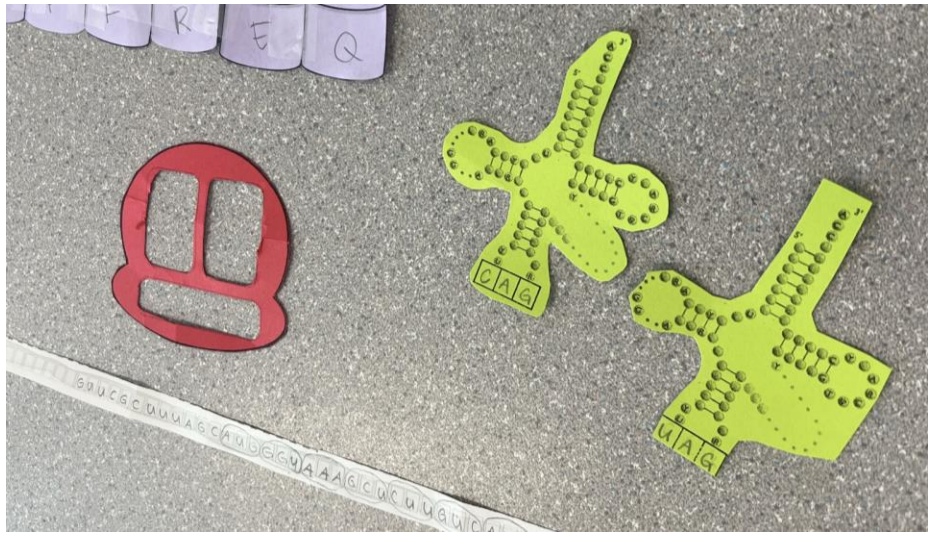


- The model represents the last stage of Translation: Termination.
- The cycle of reading codons and binding to tRNAs repeats until the ribosome reads a STOP codon on the mRNA.
- A STOP codon does not have a corresponding anti-codon or amino acid, so when it is read, no new amino acid is added to the polypeptide chain.
- This terminates the process of translation, and therefore protein synthesis as well.

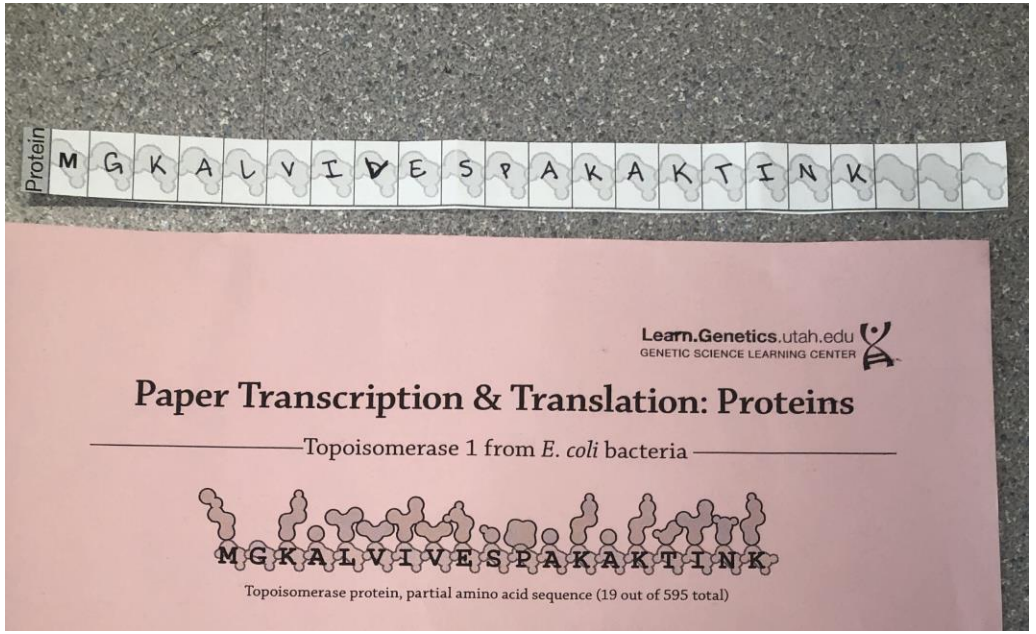


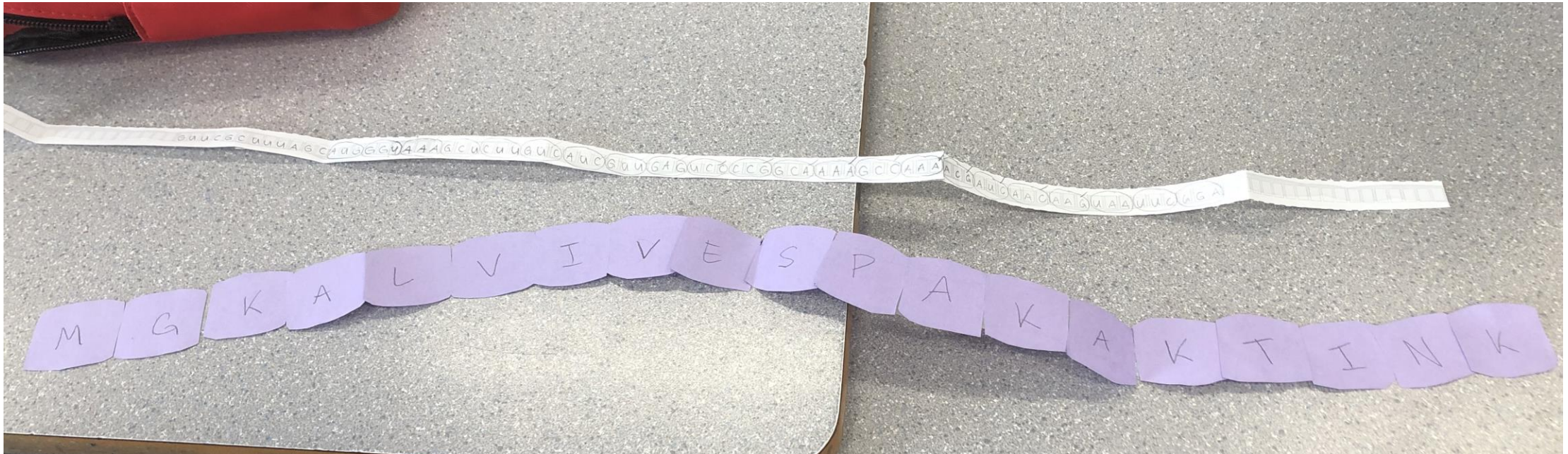
When a STOP codon is read, a release factor takes the tRNA's place and hydrolyzes the H-bonds. All parts separate, and the ribosome disassociates into subunits. All parts then search for other places where they function, and the cycle continues elsewhere in the cell.





The result of protein synthesis is that a polypeptide is created and will become a protein such as Topoisomerase 1 from E. coli bacteria.





Sources of Error

- When conducting this modelling activity, the one big error that me and my group made was:
- When we were supposed to use the genetic code table to read an mRNA's codon and assign the corresponding amino acid, we instead read the tRNA's anti-codon and assigned the amino acid that matched.
- This resulted in an incorrect polypeptide that was too short.
- Once I discerned our error, I went back through the process and made a new polypeptide chain, this time correct (shown in last slide).

What the Models Represented Accurately

- The modelling activities portrayed the basic structures, shapes and movements of DNA during the Transcription process well.
- The models portrayed well the building of a protein, such as how each amino acid is a small block that connects to more and more blocks, showing how amino acids are single building blocks that form large chains of protein.
- The models also represented the fact that a tRNA molecule acts like a taxi, bringing amino acids to the ribosome when needed and leaving to pick up more.

What the Models Misrepresented

- The modelling activities did not clearly show all the details of the basic structures of DNA and RNA, such as the types of bonds or the elements in the nucleotides.
- When modelling the building of the polypeptide chain, all the unique and different amino acids were all represented by the same shape, so the models did not represent the variety of R-groups that make amino acids unique to others.
- The ribosome and the enzymes portrayed were also represented by basic and non-detailed shapes that did not accurately represent their structures' complexities.

How to Improve the Activity

- One problem about the modelling activities that I noticed was that each change we made to the model, each pursuit through the Protein Synthesis process, the model only showed the final result of each movement or change, as the models were stationary.
- One example of the changes that could be made to the modelling activities to make them better represent the actual process is to use an online simulator or programs to animate the stages of the Transcription and Translation processes, so one would be able to see the change happening in real time.

Are Models an Effective Way to Educate the Public About Science?

- I think modelling scientific processes in a visual way is a great way to communicate complex concepts to younger or non-scientific audiences.
- Modelling allows any type of person to connect images and visual structures to the words and instructions they are learning, which helps them visualize and understand concepts better.
- For the individuals who are building the models themselves, the act of going through the instructions and explanations to produce a model, the act of connecting your knowledge to your manual work, lends to the individual's understanding of the processes they are representing.

Sources

[1]: A&P12 YORKE NOTES

[2]: A&P12 YORKE NOTES

CHAPTER 25 MADER TEXTBOOK