

October 2023

# Protein Factory Game

By Ingeborg Van der Neut, ABE The Netherlands



**AMGEN**® Biotech Experience

Scientific Discovery for the Classroom

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# AMGEN<sup>®</sup> Biotech Experience

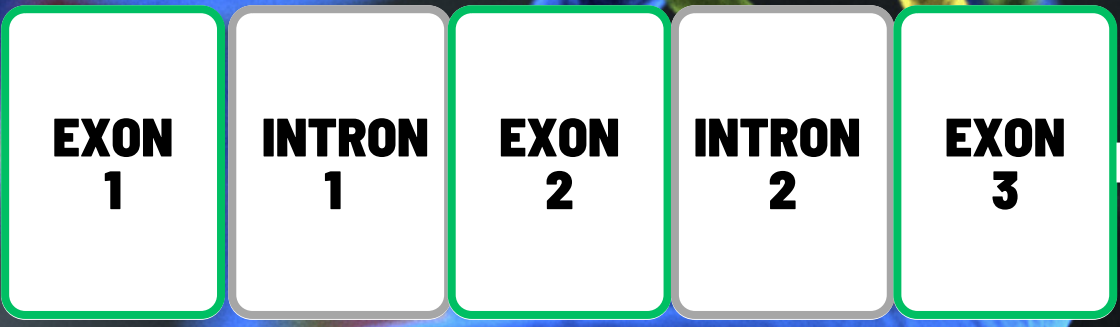
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## Scientific Discovery for the Classroom

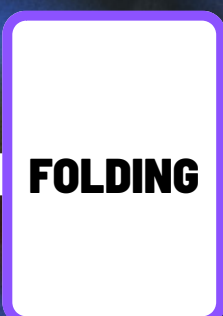
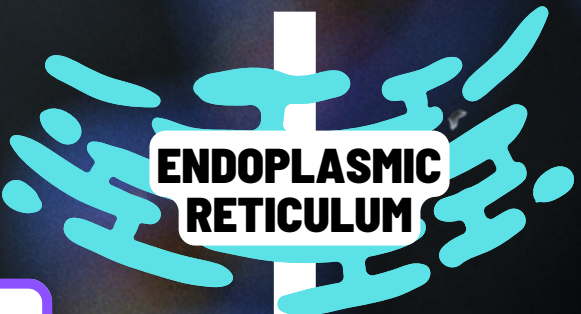
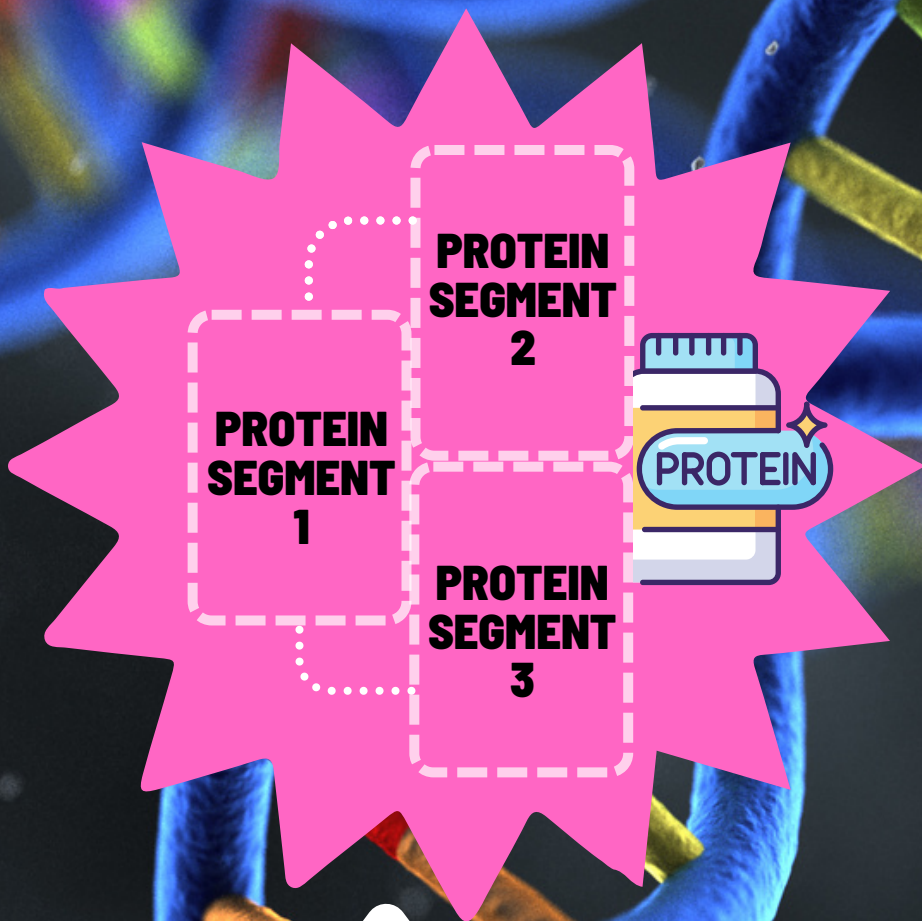
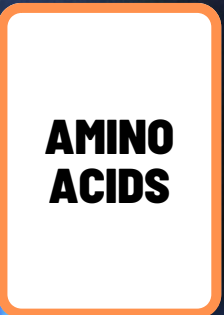
The projects designed by the 2022–23 ABE Master Teacher Fellows are a compilation of curricula and materials that are aligned with Amgen Biotech Experience (ABE) and prepare students further in their biotechnology education. These projects were created over the course of a 1-year Fellowship in an area of each Fellow’s own interest. Each is unique and can be adapted to fit the needs of your individual classroom. Objectives and goals are provided, along with expected outcomes. Projects can be used in conjunction with your current ABE curriculum or as an extension.

As a condition of the Fellowship, these classroom resources may be downloaded and used by other teachers for free. The projects are not edited or revised by the ABE Program Office (for content, clarity, or language) except to ensure safety protocols have been clearly included where appropriate.

We are grateful to the ABE Master Teacher Fellows for sharing their work with the ABE community. If you have questions about any of the project components, please reach out to us at [ABEInfo@edc.org](mailto:ABEInfo@edc.org), and we will be happy to connect you with the author and provide any assistance needed.



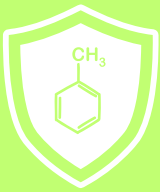
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**NUCLEUS**



TRANSLATION  
CYTOPLASM



**METHYL CAP**



**NEEDED FOR  
TRANSPORT TO  
THE CYTOPLASM**

**POLY-A TAIL**



**NEEDED FOR  
TRANSLATION**

**TEMPERATURE  
TOO HIGH**



**ENZYMES  
DISABLED**

**TEMPERATURE  
TOO HIGH**



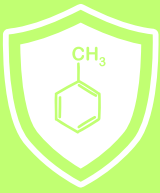
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TRANSLATION**

**TEMPERATURE  
TOO LOW**



**PROCESSES  
SLOW DOWN**

**TEMPERATURE  
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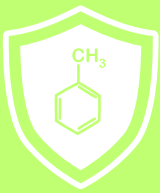
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**NEEDED FOR  
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**NEEDED FOR  
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**LACK OF  
AMINO ACIDS**



**TRANSLATION  
STOPS**

**LACK OF  
AMINO ACIDS**



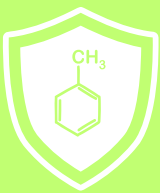
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**TRANSLATION  
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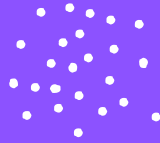
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**POLY-A TAIL**



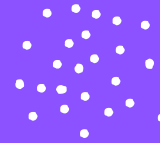
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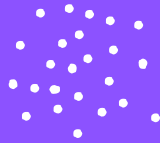
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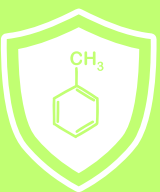
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**POLY-A TAIL**



**NEEDED FOR  
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**RNA  
POLYMERASE**



**ENZYME TO  
PRODUCE RNA**

**RNA  
POLYMERASE**

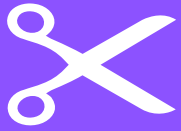


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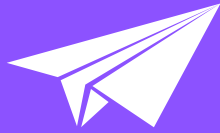
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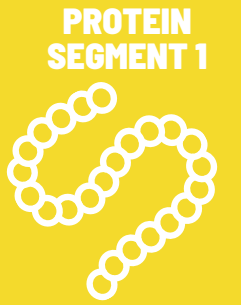
**ENZYME TO  
PRODUCE RNA**



**ENZYMES TO CUT OUT THE INTRONS**



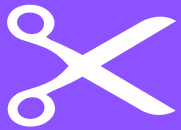
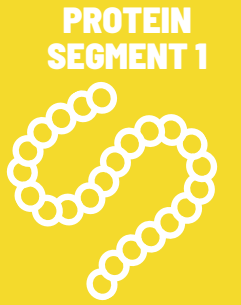
**ENZYMES TO FINISH THE PROTEIN**



**ENZYMES TO CUT OUT THE INTRONS**



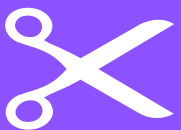
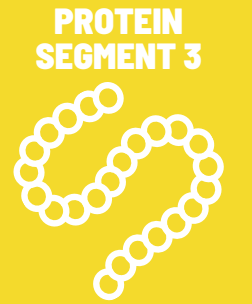
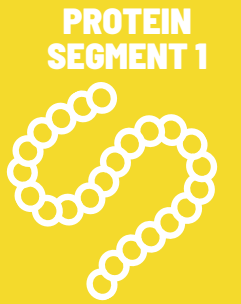
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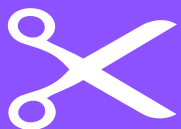
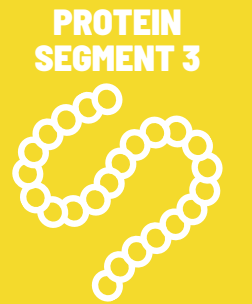
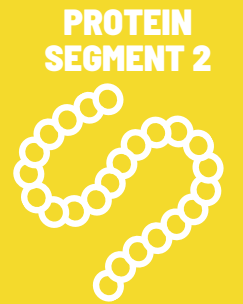
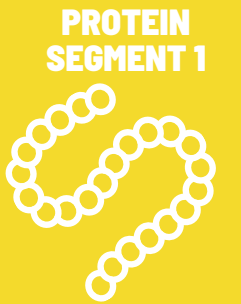
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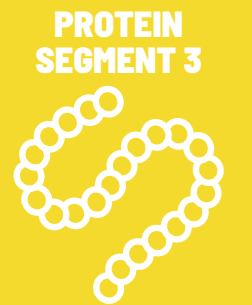
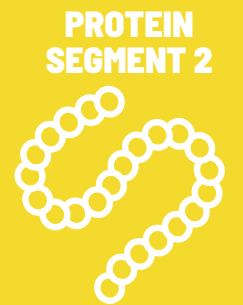
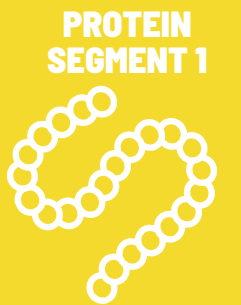
**ENZYMES TO FINISH THE PROTEIN**



**ENZYMES TO CUT OUT THE INTRONS**



**ENZYMES TO FINISH THE PROTEIN**





**PROTEIN**  
FACTORY



**PROTEIN**  
FACTORY



**PROTEIN**  
FACTORY



**PROTEIN**  
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**PROTEIN**  
FACTORY



## Rules for the Protein Factory

### Aim of the game:

In this card game the goal is to make a finished protein, starting from DNA! The team that is the first to have a finished protein in their Golgi apparatus wins!

### Materials:

- Two game boards
- Green cards for RNA
- Yellow cards for protein segments
- Purple cards for actions
- Red cards for obstruction of the other team (to be left out in a first game)

### Preparation:

The game is played with two teams of two players. A and C work together, and B and D are a team.

Each team has its own board to place its cards.

Each player is given an RNA polymerase card.

Shuffle all the other cards and give each player another 4 cards, that makes it a total of 5 cards at hand.

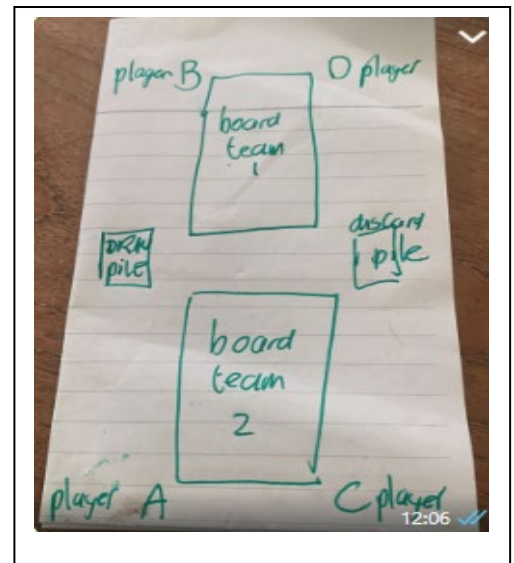
The player who has last eaten proteins is player A. The players take turns from A to D.

### How to play:

*First time playing, without the red cards*

At your turn, you place all the cards you can use at that moment on the board. That can be any number of cards between 0 and 5.

Once you are finished you can discard as many cards at the discard pile as you want. Discuss with your teammate, what are good cards to keep, what are cards you don't need. Refill your hand up to 5 cards from the draw pile. When the draw pile is empty, shuffle the discard pile to use again.



# AMGEN® Biotech Experience

## Scientific Discovery for the Classroom

### The Netherlands

The cards can only be placed in the correct sequence.

1. **Transcription:** The RNA polymerase card has to be placed to be able to play the Exon and intron cards, in the right order. (So, you will have to put exon 1 before intron 1, etc.)
2. **Splicing:** The splicing card has to be placed to cut the introns out and move the exons to the right spot on the board.
3. **Transport to the cytoplasm:** The RNA needs a methyl cap and a poly-A tail to be transported to the cytoplasm.
4. **Transcription:** The ribosome can only do its job when the amino acids card is placed, then you can add protein segment 1, 2 and 3 and move it into the endoplasmic reticulum.
5. **Folding:** The enzyme for folding has to be placed to fold the protein in its final shape in the Golgi apparatus.

Your protein is ready! The first team with a finished protein is the winner!

## How to play:

*Next level players, with the red cards*

Add the red cards to the pile, shuffle well.

The game is basically the same but with one new feature: The red cards give you the opportunity to interfere with the process of the opponent!

This is what happens if you play them:

- **Temperature is too low:** The cell processes go too slow: the next player of the opposite team has to skip their turn. *Put the card on the discard pile at the end of your turn.*
- **Temperature is too high:** One of the enzymes denatures: You can take one of the cards: **RNA polymerase, Splicing or Folding** from the opponent's board. They cannot continue with the relevant process until they place a new card with the suitable enzyme. *Put both cards on the discard pile at the end of your turn.*
- **Lack of amino acids:** When there are no amino acids available, the cell cannot continue with translation: You can take the **Amino acids** card from the opponent's board. They cannot continue with translation until they place a new card with **Amino acids**. *Put both cards on the discard pile at the end of your turn.*

## Instructions for the Teacher

### **About the choices I made:**

The reason I picked this subject is because there seems to be a lot of confusion with my students when it comes to the processes of transcription and translation.

By making it into a hands-on simulation, they will store the information in several parts of their brain and that seems to help them remember it better.

By turning it into a game, I hope to get different students engaged compared to a 'regular' lesson. Some kids just seem to wake up when winning is involved!

By making them play in teams, they will have to discuss the process with each other. That will help to develop 'biological language'.

**But: Feel free to adjust it to your students, of course!**

### **What to do to get the students started?**

The students play this game in two teams, each preferably of two students (*but improvise if necessary*)

For each game of four players you need:

- Two boards, one per team (each board is two pages). I would advise to laminate it.
- One set of cards, printed on thick paper and cut out
- One set of rules

The students can play from the rules but I find it easier to show it to them first. I put one board in a central place, let them gather around it and talk them through it in about 5 minutes by showing them which card goes where and in what order. During this instruction I make sure I use the correct biological terms so they are aware of the connection to the theory in their book.

### **After the game:**

This is the most important part of this lesson, here we have to make sure that they use the experience of the game to enhance their knowledge. I would have a discussion with them. Possible questions could be:

- This is a model of protein synthesis. What is simplified in this model?
- What biological processes are involved?
- The board is divided into two parts, what is the difference between these two parts?
- Which organelles are mentioned in this game?
- Are there other organelles involved as well?
- Are the obstruction cards realistic?
- Can you think of another obstruction card?

I hope you and your students have fun with this. Please let me know how it worked and if you see any points of improvement.

Greetz, Ingeborg (Ingeborg.vanderneut@achterhoekvo.nl)