

# Mission Protein

## Teacher's Guide

### IDENTIFICATION DU JEU

**Title :** Mission Protein

**Subject :** Biology

**Target course :** Cellular biology (101-SNI-RE) or other

**Program :** Science 200.B1 or other

**Objective :** Apply mechanisms leading to the synthesis of a functional protein.

**Content covered :** Protein synthesis (protein transcription, translation and folding).

**Average length of play :** 20 to 40 minutes

**Average time for all activities in the pedagogical scenario :** 2 hours

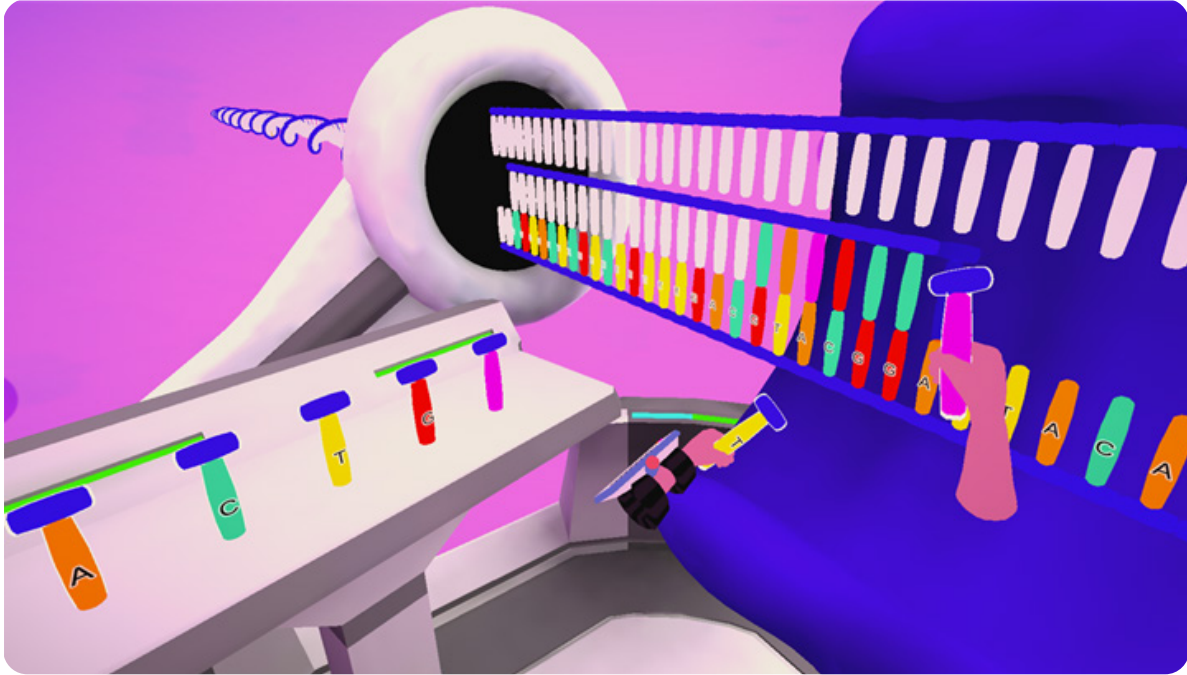
### Description of the game (mechanics and purpose)

**The purpose of the game** is to **perform protein synthesis processes**, in the form of an escape game in a cell, to cure a patient with hemophilia.

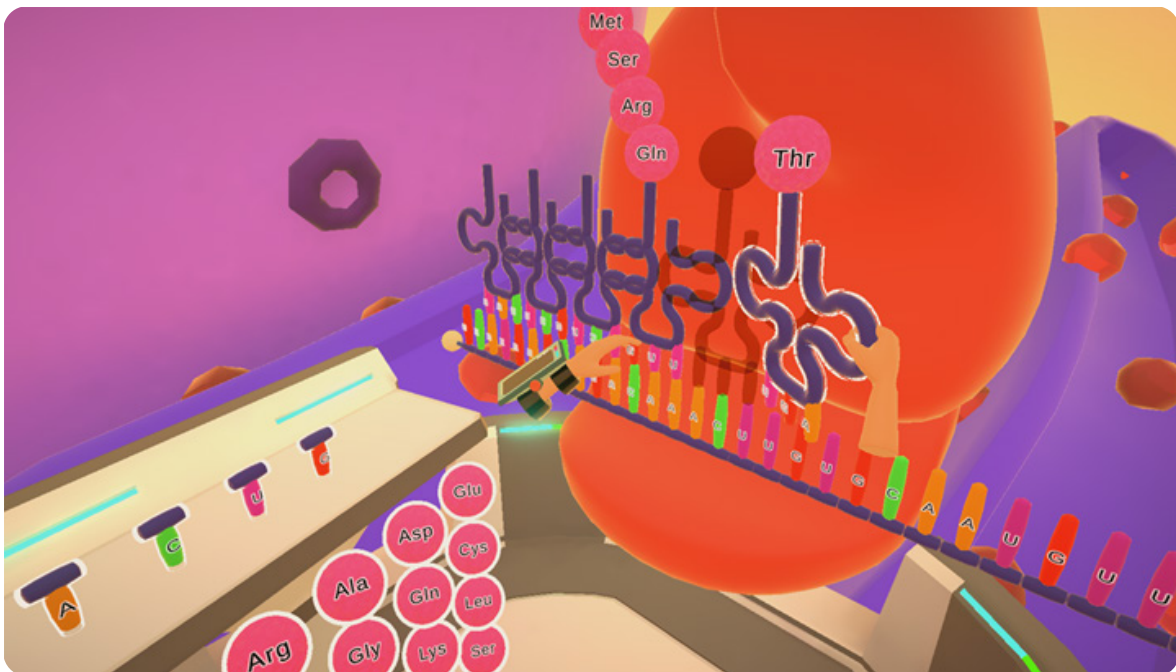
When the students first arrive in the preparation room, they are given the opportunity to get used to the controllers and the 3D immersive virtual reality environment. **The participants will have to use the controllers to pick up magnetized identifiers and place them on the right organelles on the cell diagram** and then use the controllers to teleport from one place to another and **pick up a key that will shrink them so they can enter the cell nucleus**.



The participants will enter the cell nucleus in order to transcribe the “corrected” gene and introduce it into the patient using the **CRISPR-Cas9 method**. They will then have to **choose the right nucleotides** to synthesize a strand of RNA, **splice the gene** and **remove it from the nucleus through the nuclear pore**.



Then the students will return to the cytoplasm to complete the translation by **matching the correct nucleotides in the tRNA anticodon** and **choosing the right amino acid**, with the help of the genetic code. Once the protein is synthesized, it will be folded before being sent to the Golgi apparatus.



The steps for advancing through the game are described in detail and illustrated in Appendix 1

# MATERIALS AND TECHNICAL ASPECTS

## Materials required

Each game requires the use of a **Meta Quest 2 or 3 headset and a tablet or computer** mirroring the image viewed in the headset. The game is designed for teams of two.

The students will also need the *Practice Guide* and the *Support File* to play the games.

The following information can be found in the *Practice Guide* :

- How to adjust and turn on the headset
- How to define the play zone
- How to mirror the game on a computer or tablet (mirroring means casting the virtual reality headset's content to a computer or tablet screen in real time)
- How to start the game
- How to exit the game
- How to turn off the headset

The following information can be found in the *Support File* :

- Context of the game
- Explanation of how to use the controllers to pick up and place objects and to teleport
- Information required to advance through the game: The game requires communication between the partner (the person with the *Support File* who is watching the game on the computer or tablet) and the player, who is wearing the headset. The partner guides their classmate during the game, and also has certain required information, such as the genetic code. It is important for the player to wait for instructions from the partner before advancing, in order to facilitate learning and the completion of all the steps of the game.

The game documentation can be found (<https://novascience.github.io/VR/#Jeux>).

## Technical aspects and logistics

Using virtual reality in a course requires several preparatory logistical steps, including configuring the required accounts, headsets and WiFi, and setting up a space where the game can be played. It is strongly recommended that you read the “Logistics planning for the deployment of immersive virtual reality in a college” appendix.

## Safety measures

Using an immersive virtual reality headset entails a low risk of cybersickness, a feeling similar to motion sickness. To minimize the potential discomfort and other risks, **we recommend following these instructions :**

1. A member of the teaching staff must be present at all times when the headsets are being used.
2. The play zones must be clearly marked and free of obstacles. They must remain free of obstacles for the entire duration of play.
3. The headsets should never be used for more than 30 minutes at a time.
4. We recommend removing the headset as soon as any discomfort occurs (headache, nausea, dizziness, for example). In this situation, the player can change places with the partner who is not using the headset.
5. A virtual reality headset should not be used by anyone with any of the following conditions: **heart or blood pressure problems, anxiety, post-traumatic stress, pregnancy, epilepsy**. In these cases, the participant should play the role of the partner so they can continue to take part in the pedagogical activity. The same precaution applies to people who tend to suffer from motion sickness.

If minor symptoms occur, encourage the student to remain in the room and rest for a while, until the symptoms subside. A chair should be provided quickly to anyone who starts to feel ill.

**If more serious symptoms appear, immediately contact security, which will contact the educational institution’s first aid workers or emergency services, if necessary.**

# PEDAGOGICAL PLANNING

## Outline of the activity

To optimize learning, it is important for the game to be part of a complete pedagogical scenario. Time to review the game afterward should also be provided.

In general, the pedagogical scenario should include the following:

Before the game	A preparatory activity can be planned to prepare the students for the content covered in the simulation and to activate their prior knowledge.
During the game	<p>When the students arrive, they should be given information related to :</p> <ul style="list-style-type: none"><li>▪ Game objectives</li><li>▪ Session outline</li><li>▪ Instructions</li></ul> <p>The game is played in teams of two. It is important for the students to be supported (both technologically and conceptually) by a sufficient number of people during play. In the preparation room, which is the first game activity, the students will have the opportunity to get to know the controllers and the 360 gaming environment.</p>
After the game	A debriefing should be held after the game to make sure that the students internalize and absorb the target learning. First, you can gather the participants' impressions by asking them to describe their experience. Then you can go over the mistakes and most difficult concepts. Finally, a summary should be given, ideally by the students, and feedback should be provided by the teacher.

You can view a sample pedagogical scenario in *Appendix 3*

## Practical tips

1. It is crucial for the teacher to be comfortable with the virtual reality headset and the game, to be able to intervene if the students encounter any problems. It is therefore strongly recommended that you familiarize yourself with the headset and the game before holding the activity with the students.
2. The students must receive clear and specific instructions on using the headset and playing the game (for specific manipulations, such as picking up and putting down items and teleporting). Time must be set aside for these instructions. The students should also be encouraged to closely follow the instructions in the *Practice Guide* and the *Support File*.
3. They must learn the protein synthesis process in advance – transcription, translation and use of the genetic code – because the game is a learning consolidation activity.

# APPENDIX 1 – Detailed description of the steps of the game

## The game, step by step

### Emergency exit

#### Restart the level :

- If a problem occurs during the game, you can always restart the level by holding the green button at the bottom of the screen on the player's left arm for 3 seconds.

#### Restart the game :

- If a problem occurs during the game, you can always exit the game or press on the red button at the bottom of the screen on the player's left arm for 3 seconds or press the Oculus button in the player's right hand.



## Task 1 Preparation room

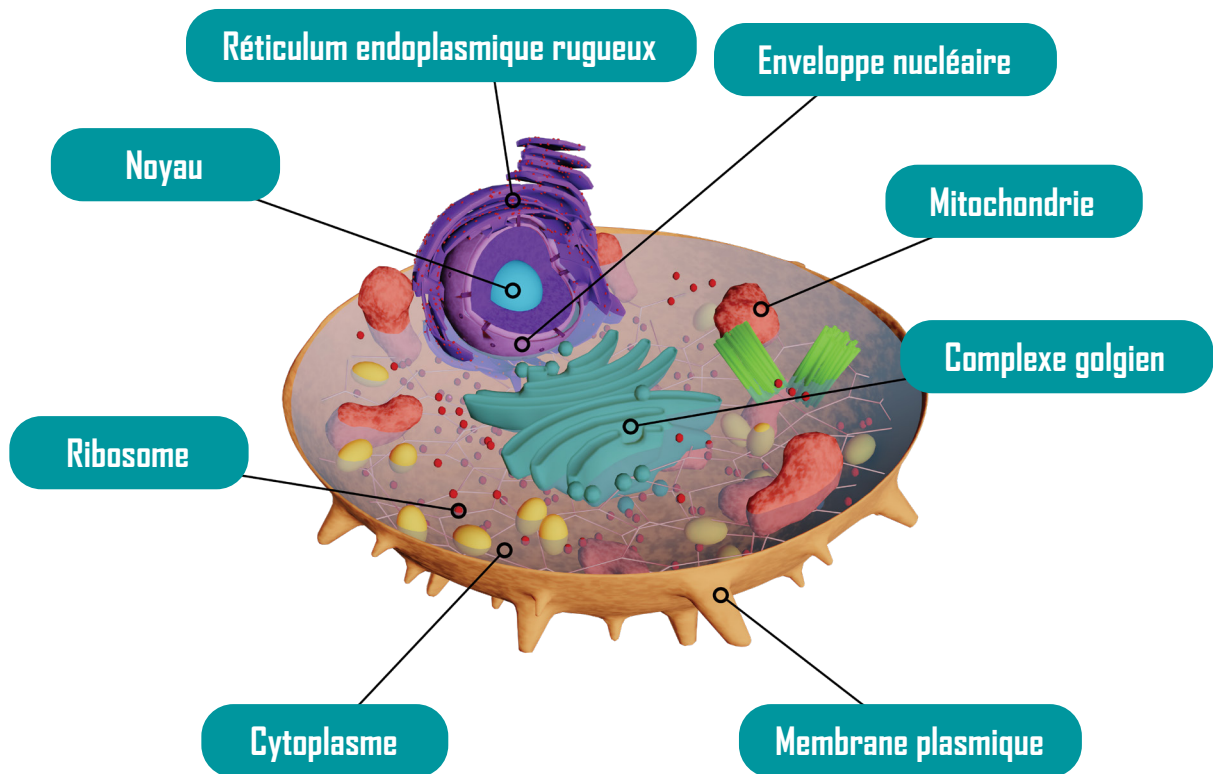
### Step 1.1: Getting to know the game and the controls

- Read the chart on the left describing the mission.
- Refer to the hologram on the table, which describes how to use the controls.
  - To pick up an item, use the button controlled by the middle finger (toward the centre of the hand).
  - To teleport, use the button controlled by the index finger (toward the edge of the hand).
- Refer to the bracelet on the left arm, which provides instructions during the game.

### Step 1.2: Place the magnetized labels in the blank boxes to correctly identify the cell's organelles

- Take each magnetized label from the table and place it in the appropriate place on the cell diagram.
- To pick up a label, move your hand toward the item and press the button controlled by the middle finger (toward the centre of the hand). Hold the button down until you want to let the item go.
- Once the exercise has been successfully completed, the chart will slide to the left.

## Completed chart



Once the exercise has been successfully completed, the chart will slide to the left.

### Step 1.3: Pick up the access card

- Teleport to the rectangular key located near the lab machine.
- To teleport, press the button controlled by the index finger (toward the edge of the hand) until a blue laser appears and then point the laser at the area outlined in blue (point the laser toward the floor) and then let go.
- To pick up the card, use the button controlled by the middle finger (toward the centre of the hand).





#### Step 1.4: Open the door to enter the cell nucleus (player is miniaturized)

- Teleport to the door by pointing the laser at the area outlined in blue.
- Place the card in the slot in the machine under the red button, with the black part facing out.
- Press the red button. The door will open and the game will automatically pass into the next room.



### Task 2: Construction of messenger RNA

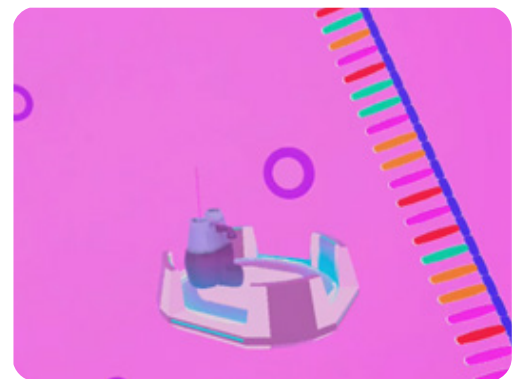
#### Step 2.1: Match the nitrogenous bases

- The player must now complete the nucleotide sequence that forms the messenger RNA by matching the nitrogenous bases that are complementary to the DNA template strand.
    - An automation shows the beginning of the DNA strand formation. The player has to pick up the nucleotides from the table to the left one by one, using the middle finger button, and attach them to the started DNA strand (in white). Each nitrogenous base must be complementary to the DNA template strand, and the partner, following the guide, directs the player.
    - If there is an error in the match, the screen on the player's left wrist will signal it.
- \*\*The students sometimes forget that the DNA's A must be matched with the U, not the T.**

### Task 3: Messenger RNA splicing

#### Step 3.1: Teleport to the messenger RNA (mRNA) splicing station

- When the messenger RNA has been correctly formed, the player, following the instructions on their left wrist, has to remove the mRNA from the mRNA synthetase enzyme and, keeping the mRNA in their hand, teleport to the splicing station outlined in blue.



### Step 3.2: Splice the messenger RNA

- The player has to place the mRNA in the splicing machine through the larger opening (on the left), wait for the introns to be removed and then pick up the RNA that will come out of the smaller opening (on the right). The new mRNA will only contain exons (mnemonic device: "exons are expressed").
- The spliced mRNA must now be expelled from the nucleus through the purple nuclear pores and the player has to teleport to the cytoplasm for the translation.

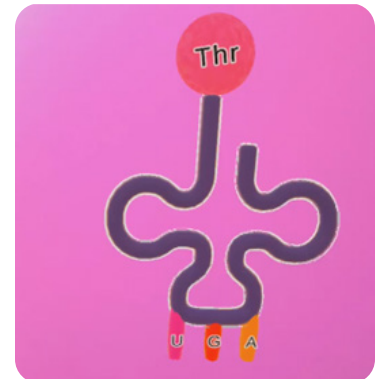
## Task 4: Translation

### Step 4.1: Form the anticodon on the transfer RNA (tRNA)

- The mRNA is automatically placed on the ribosome, and the first amino acids in the polypeptide chain are put in place. The player must now place the nitrogenous bases that correspond to the anticodon on the tRNA. Matching the complementary bases to the codon on the mRNA in the ribosome, the player has to place the nitrogenous bases that are on the table on the end of the transfer RNA.

### Step 4.2: Load the transfer RNA

- Using the genetic code in the guide, the partner finds the amino acid that corresponds to the codon on the mRNA, and the player places it on the other end of the tRNA.
  - \*\*The students tend to use the tRNA anticodon to determine the amino acid, instead of the mRNA codon. The first anticodon will lead to a STOP, which should make the players realize their error.



**In order, the anticodon and amino acid to place on the tRNA are the following:**

**Anticodon 1:** UGA; Amino acid 1: Thr

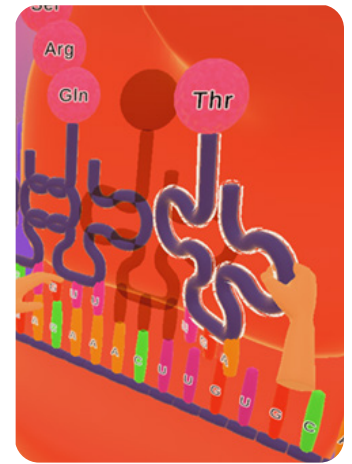
**Anticodon 2:** ACA; Amino acid 2: Cys

**Anticodon 3:** CGU; Amino acid 3: Ala

**Anticodon 4:** UAC; Amino acid 4: Met

### Step 4.3: Place the loaded tRNA on the ribosome

- The transfer RNA must now be placed on the ribosome with the anticodon matched to the codon, in order to allow for the creation of a peptide bond with the polypeptide chain that has already been formed.



## Task 5: Folding of the protein and formation of a transport vesicle for transport to the Golgi complex

## Step 5.1: Fold the protein using a chaperone protein

- When the protein is formed, the player must pick it up and teleport to the folding station. After placing the protein in the blue machine that represents the chaperone protein, the player must press 3 times, to represent the complexity of the folding process that creates the tertiary structure.

## Folding station



## Step 5.1: Send the protein to the Golgi complex

- The last step is to place the protein in the "cannon," which represents the formation of a transport vesicle to carry the protein to the Golgi complex.

## APPENDIX 2 – Logistics planning for the deployment of immersive virtual reality in a college

### To do before the first use

Purchase headsets	You will need a set of Oculus Quest 2 or 3 headsets, enough for one for every two people. <b>Plan to have 14 to 15 headsets.</b>
Transport and charge the headsets	You will need a <b>cart</b> to transport and charge the headsets.
Set up Meta accounts	<p>To use mirroring, which allows the students who do not have a headset to see the image, each headset must be linked to a separate Meta account.</p> <p>You therefore need to create as many institutional (or other) email addresses as there are headsets and <b>create a Meta account for each of these addresses</b>. Creating pseudonyms on an institutional email server may simplify email management. For example: <a href="mailto:metaheadset1@dawsoncollege.qc.ca">metaheadset1@dawsoncollege.qc.ca</a>; <a href="mailto:metaheadset2@dawsoncollege.qc.ca">metaheadset2@dawsoncollege.qc.ca</a>, etc.</p> <p>The procedure for creating a Meta account from an email address can be found <a href="#">ici</a>.</p>
Configure the headsets	Each new headset must be configured before linking it to the corresponding Meta account and connecting it to the right WiFi network.
Install the game	To install the game, you have to download the Meta app on a mobile device and log in using the identifiers for the Meta account linked to the headset. Then select Search and enter Novascience in the search tool. Then click on the image of the game and select Download. The detailed procedure can be found <a href="#">ici</a> .
Configure the WiFi network	The institution's WiFi network must permit mirroring on multiple headsets simultaneously on a tablet, computer or phone. These permissions are generally managed by the institution's IT team, so it is important to check with them in advance.
Prepare for mirroring (tablet or cell phone)	If the mirroring will be done on a tablet or phone, the Meta Quest app must be installed on it and connected to the same account as the corresponding headset. The device must be connected to the same WiFi network as the headset.
Prepare for mirroring (computer)	If the mirroring will be done on a computer, it must be connected to the Meta account that corresponds to the address <a href="https://oculus.com/casting">oculus.com/casting</a> . The computer must be connected to the same WiFi network as the headset.

## To do for every session

<b>Reserve a room</b>	To have enough space to safely run the game, every team must have a space measuring 1.5 m by 2.1 m with no furniture and no obstructions other than the equipment required for the students not using the headsets. Please ensure with your institution's IT services that the WiFi allows headset mirroring in that room.
<b>Provide equipment for mirroring</b>	Provide the equipment required for headset mirroring: computers, tablets or phones. If you will be using tablets or phones, make sure that the Meta app is already installed on them.
<b>Provide support</b>	Make sure to have enough qualified people to support the students technologically and conceptually. These people must be able to help the students use the headsets, choose the application and set up the mirroring at the beginning. From then on, the assistance may relate to technical support, but ideally the assistants will know the content of the game well enough to be able to answer questions about content that is challenging for the students or at least to point them in the direction of solutions.
<b>Recharge the headsets</b>	Make sure the headsets are recharged after every use.
<b>Recharge the controller batteries</b>	Make sure the controller batteries are recharged.
<b>Update</b>	Make sure the headsets and the game are updated before use.
<b>Distribute the preparatory documents</b>	Give the students the preparatory documents in advance, so they can familiarize themselves with the game and the equipment.
<b>Cleaning</b>	Provide wet wipes to clean the outside of the headsets and a microfibre cloth to clean the lenses, if necessary.
<b>Safety</b>	Provide a space where participants who are feeling ill can sit down.
<b>Responses</b>	Make sure that the responses to the game questions (or riddles) are easily accessible.

## APPENDIX 3 – Sample pedagogical scenario

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[Click here to open link](#)