

Milk: The Only Food Created to Be Eaten

By Chiara Garulli, ABE Italy



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The projects designed by the 2023–24 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, and we will be happy to connect you with the author and provide any assistance needed.

ABE Master Teacher Fellowship

Summary Cover Page

<p>My overall topic is... (1–3 sentences)</p>	<p>This project should be a multi-step activity path in which teachers can choose the entrance and the parts they want to develop.</p> <p>The subject is centered on milk, but this topic is used as a real-world scenario to investigate important general topics of the biological curriculum and critical thinking.</p>
<p>I want students/ participants to understand _____ and be able to _____.</p>	<ul style="list-style-type: none"> • To carry out the project, students should know the biomolecules and their biological roles. • For the part not yet developed (5th activity), they should also understand gene expression and its regulation. • They should be able to work in the laboratory fairly independently. • They should be curious. • They should know how to interact cooperatively with each other. • Do not worry, the activities aim to enhance this last three abilities, but as you know these require time and we can consider them the real final aim of teachers.
<p>The reason why I wanted to pursue this is...</p>	<p>I believe that it is really important to give students instruments to analyze reality.</p>
<p>Resources used or created</p>	<p>In each activity you will find the links for materials</p>
<p>Skills or Standards addressed</p>	<ul style="list-style-type: none"> • To know, identify, and use the more common fallacies • To do experimental design, including experimental control and taking into account experimental variables • To make conclusion from data • To communicate and cooperate • To use software to explore molecules in particular proteins • To Build graph to show experimental data • To produce a final product such as a poster or a presentation and expose it to peers
<p>Assessments or Post-Surveys</p>	<p>First Activity → Students recognize fallacies on the video Second Activity → Report Fourth Activity → Class Poster</p>

ABE Master Teacher Fellowship

NAME: Chiara Garulli

PROGRAM SITE: Italy

TITLE: MILK: The Only Food Created to Be Eaten

SUMMARY OF PROJECT IDEA

This project should be a multi-step activity path in which teachers can choose the entrance and the parts they want to develop.

The subject is centered on milk, but this topic is used as a real-world scenario to investigate important general topics of the biological curriculum such as enzyme activities and structure, biomolecule investigations, and control of gene expression moreover, the aim is to focus on the way in science is done in the lab. Students should learn the experimental approach and design by directly doing it.

In each activity, students should be involved in building their knowledge to allow engagement.

For laboratory activities, they have been developed as IBSE investigations.

Teachers can choose a single segment of the path according to the time and their interests. The project was designed for high school students but can be used to some extent also for smaller students.

MILK: The Only Food Created to Be Eaten

The suggested hook for the entire path

Is milk dangerous??



Why Milk is Bad for You



FullyRawKristina
1,42 Mio di iscritti

Iscriviti

15.884



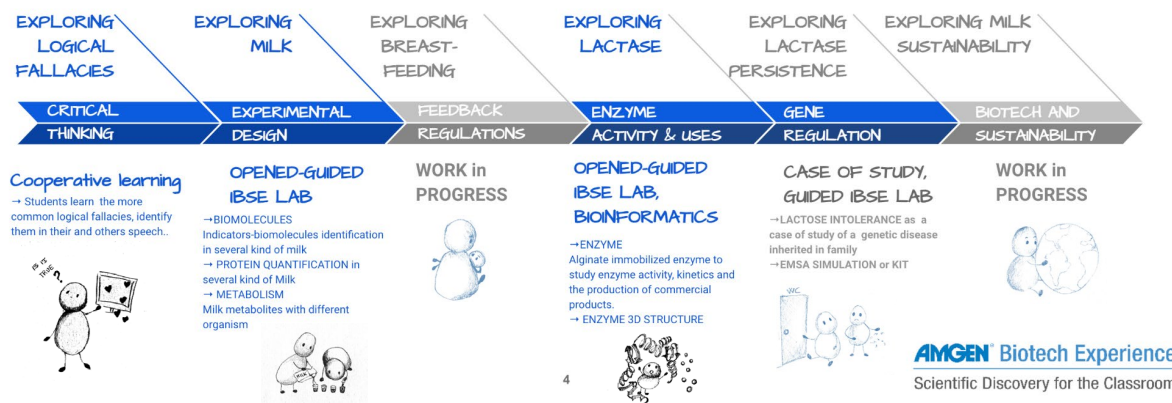
Condividi

Scarica

<https://www.youtube.com/watch?v=xT99P5OIV4E>

The steps of the project, overview

Many questions will emerge from the previous video from your students and these questions should be used to start the class activities, to make students directly involved in the learning path and more engaged. The following activities have been designed using questions that emerged from my second and third-year students (14-16 years old). The questions are reported in the activity table of each segment, teachers can use them to develop guided inquiry activities.



Source:

<https://docs.google.com/presentation/d/1itMGzaVERPBLGEgXWtSnaxlHaM7KFAsXzxCtLDKAGrg/edit?usp=sharing>

Estimated Project Duration: (# weeks/class periods)

According to your time and interest, you can choose to perform the project or simply some segments, the times are described in all the activities.

Student Understandings/Big Ideas:

The focus of my project is the acquisition of skills that can be used in other contexts, not just in the activities presented here on milk.

Understanding the value of arguments should develop the students' critical ability to discern the truthfulness of news and statements.

Designing experiments should help them understand how science works and what the prerequisites are for an experiment that considers controls and experimental variables.

The use of bioinformatics software can help them enter the microscopic world, but it is also important in terms of becoming familiar with rapidly evolving tools that now accompany scientific research.

Student Understandings/Learning Outcomes:

- To know, identify, and use the more common fallacies
- To do experimental design, including experimental control and experimental variables
- To make conclusion from data
- To communicate and cooperate
- To use software to explore molecules in particular proteins
- To build graph to show experimental data
- To produce a final product such as a poster or a presentation and expose it to peers

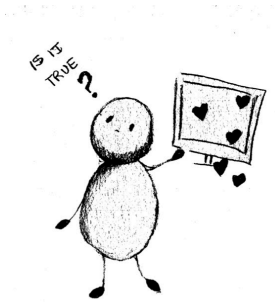
Prior Knowledge and Skills:

- To carry out the project, students should know the biomolecules and their biological roles.
- For the part not yet developed (5th activity), they should also understand gene expression and its regulation.
- They should be able to work in the laboratory fairly independently.
- They should be curious.
- They should know how to interact cooperatively with each other.
- Do not worry; the activities aim to enhance this last three abilities, but as you know these require time and we can consider them the final aim of teachers.

Cultural Relevancy and Personal Connections:

The project begins with the analysis of a promotional video for a raw vegan diet, in which a girl claims that milk is harmful to health. The channel has millions of subscribers, which is typical of our time. Students are attracted to this type of communication and, whether they agree with the message or not, they try to understand the arguments. The rest of the activities could be developed further based on the results obtained in the previous steps. However, each step includes other possible real-life scenarios to introduce the following activities. I did not include the fact that my husband continues eating ice cream even though he knows he will spend 2 hours in the bathroom because he became lactose intolerant around thirty years old, but I will include it in the fifth activity that I have not developed yet.

FIRST ACTIVITY: EXPLORING LOGICAL FALLACIES



STUDENTS' QUESTION FROM THE INITIAL VIDEO: HOW CAN I UNDERSTAND WHAT IS TRUE AND WHAT IS NOT?

This Lesson Segment has been designed in collaboration with my colleague Maria Paola Svampa

Activity name: EXPLORING LOGICAL FALLACIES

Overview:


Cooperative learning to explore the more common logical fallacies.

A fallacy is an error in reasoning, an “argument” in which the premises given for the conclusion do not provide the needed degree of support. By becoming aware of the most common fallacies, you can avoid them in your speech and detect them when others use them. This ability is quite important to evaluate information, especially those we can find on the internet.

Fallacies are made to distract from the real issue, to trick into faulty reasoning and to deceive.

This part of the path aims to make students aware of their way of speaking and to help them to identify poor arguments in others, especially on the internet.

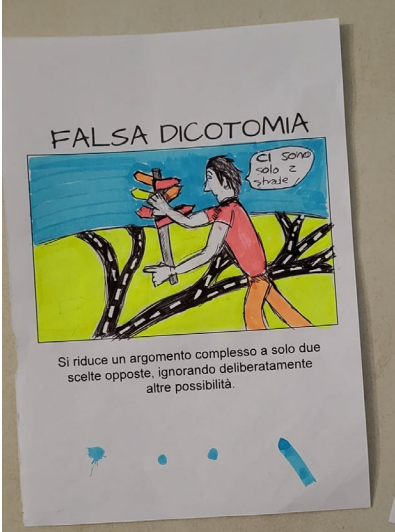
LEARNING GOAL	ASSESSED OUTCOME	KEY VOCABULARY
-to understand the differences between thesis and opinion - to know what a fallacy is - to know the more common fallacies - to identify fallacies in speech	To know, identify, and use the more common fallacies	LOGICAL FALLACY THESIS OPINION ARGUMENTATION

SEQUENCE				
ACTIVITY	MATERIAL AND DETAIL	TEACHER	STUDENTS	TIME
<p>COOPERATIVE LEARNING</p>  <p>There is something wrong? Students identify the thesis and reflect on effective and logical argumentations.</p> <p>Read understand and design They study a fallacy</p> <p><small>Mariole Cella: "Giovanni Magali? Lo sanno tutti che è cattello!" Mariole Cella non lo manda a dire quando appare la figura di Giovanni Magali per il giudice della sentenza di "Vincenzo" e spiega, per di più, "non c'è niente di cattello, l'immagine della donna sottolinea il suo nome". Mariole Cella, ospite della puntata di "Vincenzo da Me" e il titolare di propaganda del governo in un'occasione, è stato il primo a spiegare che non c'è niente di cattello. Per affermare prima che il giudice Cella, in merito al Falli Vero, non ha mai capito che potrebbe aver fatto qualcosa di diverso. Perché il giudice Giovanni Magali è un Vero. Per arrivare, il giudice è diventato un vero.</small></p> <p><small>Il giudice di Mariole Cella è Giovanni Magali. Mariole Cella non lo manda a dire quando appare la figura di Giovanni Magali e vuole, per di più, per un'occasione, è stato il primo a spiegare che non c'è niente di cattello. Per affermare prima che il giudice Cella, in merito al Falli Vero, non ha mai capito che potrebbe aver fatto qualcosa di diverso. Perché il giudice Giovanni Magali è un Vero. Per arrivare, il giudice è diventato un vero.</small></p>	<p>Students are divided into small groups. Each group has two tasks:</p> <p>TASK 1 They will analyze a text, extrapolated from articles or a video in which there is a logical fallacy.</p> <p>The questions they have to answer are:</p> <ol style="list-style-type: none"> 1. Which is the thesis in this text. 2. The underlined argument has some logical problems. Which one, in your opinion? <p>MATERIAL 1 Texts for 10 fallacies in Italian, https://drive.google.com/drive/folders/19ib87cel4GkIKqwwpKvHdFAWj7WCIKa-?usp=drive_link</p> <p>Texts for 10 fallacies in English, https://drive.google.com/drive/folders/1gVrOb_WkPNjcTBjs6PctzLPP7S0aCx2k?usp=drive_link</p> <p>TASK 2 They have to read and understand the characteristics of a particular fallacy, that is not the one they have in their first text.</p>	<p>→ Divide students in groups → Give students the material and underline the tasks → Control the time</p>	<p>→ Work in group</p>	<p>15–20 min</p>

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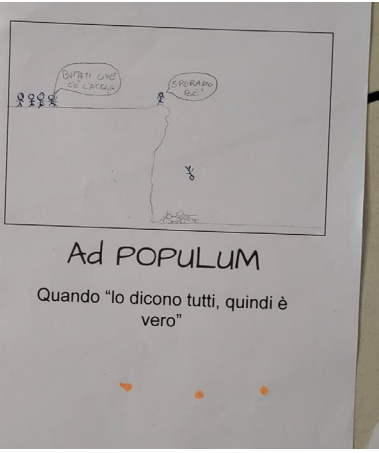

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SEQUENCE				
ACTIVITY	MATERIAL AND DETAIL	TEACHER	STUDENTS	TIME
	<p>They have to develop a symbol/paint to synthesize this kind of argument.</p> <p>MATERIAL 2 Definition for 10 fallacies in Italian and then English card https://docs.google.com/presentation/d/1pZeMOi7_0fYJGluOiuXXXfiD6iEz0aKyViraok534Y/edit?usp=sharing</p> <p>ALTERNATIVE MATERIAL https://bookofbadarguments.com/?view=allpages</p>			

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SEQUENCE				
ACTIVITY	MATERIAL AND DETAIL	TEACHER	STUDENTS	TIME
				
<p>CLASS DISCUSSION Each group presents their work to the class.</p> 	<p>Each group presents the thesis of their text and explains why they believe the argument is not correct. (teacher can give them point for good explanation)</p> <p>The group that studied this fallacy should recognize it and at the end of the exposition of the first group name the kind of fallacy for all the class. (The teacher can give point for recognition)</p>	<p>→ Coordinate the discussion → Could assign points → At the end of each group talk underline the name of the fallacy and ask student to write it on the book or in the table given as material3</p>	<p>→ Students participate at the discussion. → They have to list the fallacies in a table.</p> <p>(material 3 https://docs.google.com/document/d/1v2elx2rp-SLhfj7meTTa8uj9jmjLUCGLi834U0MpCsk/edit?usp=sharing)</p>	<p>5–7 min for each group</p>

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SEQUENCE				
ACTIVITY	MATERIAL AND DETAIL	TEACHER	STUDENTS	TIME
<p>REINFORCEMENTS</p>  <p>This can be given as homework</p>	<p>Theoretical explanation. Video that can be used</p> <p>Italian: https://www.youtube.com/watch?v=o5WVtW8m_U</p> <p>English: https://www.youtube.com/watch?v=Qf03U04rqGQ</p>	<p>→ Ask students to list all the fallacies studied</p> <p>→ Explanation or video</p>	<p>→ Make questions</p>	<p>15 min</p>
<p>ROLE PLAY WITH FALLACY</p>	<p>The students in pairs draw a card on which they will find a fallacy and a topic. They will then stage a dialogue on the subject inserting in the dialogue the fallacy. The other students will have to guess the fallacy used.</p> <p>Material 4 The cards https://docs.google.com/presentation/d/1wTZA4sVJxzljq01xQGizFh-J83Hx-UU959q2aRznobU/edit?usp=sharing</p>	<p>→ Prepare the cards (Teachers can use what they think is more interesting for their students)</p> <p>→ Organize and direct the role play</p> <p>→ Give the times</p>	<p>→ play the game</p>	<p>30 min</p>
<p>A REAL VIDEO ANALYSIS</p>	<p>In different groups, even bigger, students analyze the transcript of the milk video.</p>	<p>→ Organize the groups work</p> <p>→ Coordinate the class discussion</p>	<p>→ Analyze the video, filling in a table.</p>	<p>30 min</p>

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SEQUENCE				
ACTIVITY	MATERIAL AND DETAIL	TEACHER	STUDENTS	TIME
 <p>Why Milk is Bad for You FullyRawKristina 15.884 views</p>	<p>Material 5 Video transcript + Teacher version https://docs.google.com/document/d/12JT6m5ukdLBZmo49Mcw_WdixWMV_AkZUKKFIQ-TqQ1u4/edit?usp=sharing</p> <p>Cooperative work TASKS</p> <ul style="list-style-type: none"> - Underline thesis - For each thesis find the arguments, identify if there are logical fallacies - I wonder...write if you have some questions <p>Class discussion TASKS</p> <ul style="list-style-type: none"> - Show the work done, find which thesis have not good arguments and which ones have them - Some of your questions can be answered with an experiment to support or confute the thesis in this video. 	<p>→ Write all the questions emerged from the video.</p>	<p>(Material 3 table https://docs.google.com/document/d/1qx2XpmWMg2tKfJDs6VO0txIrsfJPR6n1mcGAm1QyteA/edit?usp=sharing)</p> <p>→participate at class discussion</p>	

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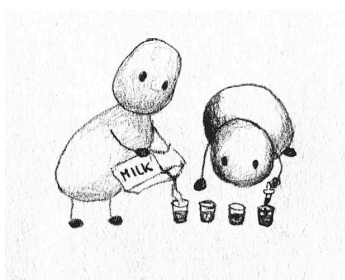
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SECOND ACTIVITY: EXPLORING MILK

STUDENTS' QUESTION FROM THE INITIAL VIDEO:



- DO RAW MILK and PROCESSED ONE CONTAIN DIFFERENT BIOMOLECULES?
- WHICH MOLECULES CAN I FIND IN DIFFERENT KINDS OF MILK? HOW MANY PROTEINS ARE CONTAINED IN MILK?
- IS MILK AN ACID?
- WHAT IS NECESSARY TO PRODUCE GAS IN THE INTESTINE FROM MILK? DO ALL KINDS OF MILK PRODUCE GAS IN THE INTESTINE?

Activity name: EXPLORING MILK

Overview: This segment is considered an open IBSE activity. It can be done as a guided one if the teacher chooses the questions students have to investigate. In the [provided material](#), you can find a text with protocols for some experiments that your students may think of, but these are for your reference. I would like to emphasize that, in my view, in this segment, students should be free to design and try their own experiments, even if they are incomplete or incorrect. From the final discussion, they need to understand their mistakes, as this will make the learning experience more meaningful. To support their self-confidence, allow them to redesign and repeat the experiment at the end of this section, preferably by changing their initial question to a similar one.


In the third step (exploring lactase), there will be a laboratory in which students should project their experiment, if this step has been significant, they should remember the experimental control and should be improved in designing experimental procedure. For this reason, my suggestion is to not change the laboratory groups.

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PRIOR KNOWLEDGE and SKILL	LEARNING GOAL	ASSESSED OUTCOME	KEY VOCABULARY
<ul style="list-style-type: none"> - To Know the biomolecules and their composition, structure and biological role - To know the meaning of indicators and the ones used to detect biomolecules - To be able to handle simple lab instruments - To be aware of the basic safety procedures and behavior in the lab - To distinguish between theoretical and investigative questions. 	<ul style="list-style-type: none"> - To design a simple experiment to answer an investigable question - To understand the importance and use of CONTROL in the experimental procedure - To understand the importance of observing one variable for each sample - To draw conclusions from the data - To communicate ideas and conclusions to peers - Do discuss respectfully with peers 	<ul style="list-style-type: none"> - To do experimental design, including experimental control and taking into account experimental variables - To make conclusion from data - To communicate and cooperate 	INQUIRY EXPERIMENTAL DESIGN INDICATORS EXPERIMENTAL CONTROL DATA VARIABLES CONCLUSION FROM DATA DISCUSSION LEARNING TOGETHER

SEQUENCE				
ACTIVITY	MATERIAL AND DETAIL	TEACHER	STUDENTS	TIME
ENGAGE	This option is for the entire path, and you have already done it...you can start from the table in material 3 of the first activity, where your students wrote their questions!! 	<ul style="list-style-type: none"> → Divide students in groups → Introduce and engage in the activity 	→ Watch the video chosen as engage	10 min

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SEQUENCE				
ACTIVITY	MATERIAL AND DETAIL	TEACHER	STUDENTS	TIME
	<p>If you start from this segment here you can choose some alternative engages to make your students able to think about investigable questions:</p> <ol style="list-style-type: none"> 1. https://www.youtube.com/watch?v=L7pUWAUkseg (initial 2 minutes)  <ol style="list-style-type: none"> 2. Storytelling: I have found a kitten. How can I feed him?  <ol style="list-style-type: none"> 3. MILK CHALLENGE Taste and recognize some kinds of milk. ATTENTION MILK ALLERGY and ONLY in your COUNTRY if ALLOWED 			
ALONE TIME - REFLECTION	Teacher introduces the engage and the activity, students watch the video and on their own complete Material 1 , a table 1 in which they indicate what they see in the	→ Explain the first task. “We will look at a video, you have a table to complete on your own, you will have 10	→ Watch the video and complete Table 1. Student on their own should complete	10 min alone time

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SEQUENCE				
ACTIVITY	MATERIAL AND DETAIL	TEACHER	STUDENTS	TIME
	<p>video, what they think about it and what they wonder.</p> <p>MATERIAL1 https://docs.google.com/presentation/d/1rHWs7EYAZueiiRsxrQiM9ORVrs456sl7YVZLDhFYF9A/edit?usp=sharing</p>	<p>minutes for this. Then in your group compare your answers with other members and focus on questions.</p> <p>Among your questions, is there one that can be answered with an experiment? Choose one of these kinds of questions for the group”</p>	<p>Table 1 indicating what they see in the video, what they think about it and what they wonder.</p>	

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SEQUENCE				
ACTIVITY	MATERIAL AND DETAIL	TEACHER	STUDENTS	TIME
<p>GROUP ACTIVITY LOOK FOR THE INVESTIGATIVE QUESTION</p> 	<p>Students in small groups analyze their tables, identify investigable questions and choose one for the groups.</p>	<p>→ Help students if required</p>	<p>→ Students in their group analyze the table 1 of each member and underline questions that emerged in the group. They should divide theoretical questions from investigable ones and choose one investigable for the group.</p>	<p>10 min group activity</p>
<p>CLASS DISCUSSION</p> 	<p>The teacher coordinates the class discussion. Write the questions selected by each group and guide the class in the reflection about questions and investigative questions.</p>	<p>→ Coordinate the discussion → Write the questions on the board so all students can see them → If required, discuss with the student what is an investigable question → Control the time → If teacher prefers guided inquiry, they can choose one</p>	<p>→ Each groups present the questions emerged and communicate the chosen one.</p>	<p>10 min</p>

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SEQUENCE				
ACTIVITY	MATERIAL AND DETAIL	TEACHER	STUDENTS	TIME
		question that emerged from students and use that in the following step for all groups.		
<p>EXPERIMENTAL DESIGN</p>  	<p>The teacher gives students a list of material they can use to design an experiment to answer their questions.</p> <p>MATERIAL 2 https://docs.google.com/presentation/d/1G497GRBOLeI3Pv85yuV_ljb3WfHQesKJqjFritgJ7qk/edit?usp=sharing</p> <p>Students should understand if they have material for their selected question. If the teacher has not predicted a possibility chosen by students (it always happens), they can decide whether to ask the student to change the question and use only the material given or ask them to think about additional material.</p> <p>To design the experiment, student can follow:</p> <p>MATERIAL 3 https://docs.google.com/presentation/d/1oPKuRPitun2THZzEFSGGky9lu5ErG2yJk1CPl5jgo/edit?usp=sharing</p>	<p>→ Prepare the material</p> <p>→ Support students, but do not judge their work</p> <p>→ Coordinate discussion</p>	<p>→ Each group designs an experiment considering the given material and time.</p>	<p>30 min</p>

SEQUENCE				
ACTIVITY	MATERIAL AND DETAIL	TEACHER	STUDENTS	TIME
	<p>OPTIONAL: CLASS DISCUSSION</p> <p>Each group can show their experimental design to the class. This phase is important if students are not used to inquiry. I do not suggest to do it if the teacher chooses only one question for all groups.</p> <p>It is important that students feel free to express their ideas without judgment and to empower a cooperative attitude among them. If they want to change their experimental design after the discussion teacher should allow them to do it.</p>			
<p>EXPERIMENT in THE LAB</p> 	<p>Students can do their experiment, they have to document their actions and results, they can use the cards in MATERIAL 3.</p> <p>https://docs.google.com/presentation/d/1oPKuRPitun2THZzEFSGGky9lu5ErG2yJk1CPlA5jgo/edit?usp=sharing</p> <p>In MATERIAL 4, teachers can find two experiments done by my students that I have completed or corrected for you and written in classical way. They are not the only possibilities.</p> <p>https://docs.google.com/document/d/1hIN-52WCQK74BiNiqBH4Qjtv4A39cdHThlcQoKqHko/edit?usp=sharing</p>	<p>→ Prepare the material</p> <p>→ Support students, but do not judge their work</p>	<p>→ Each group does the designed experiment.</p> <p>→ They have to document each passage and report them in the lab book.</p> <p>→ If they have time they can go on in the investigation</p>	1 h

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SEQUENCE				
ACTIVITY	MATERIAL AND DETAIL	TEACHER	STUDENTS	TIME
CLASS DISCUSSION 	Each group shows their experiment's results and communicates their conclusion. This is the most delicate phase for teachers who should interpret experiments with students, leading them without forcing their conclusions.	→ Coordinate the discussion and introduce the theory, in particular from discussion the role of control samples, variable should emerge	→ Communicate their results and conclusion → Ask questions to other groups	5 min for groups
ASSESSMENT	As homework student can re-elaborate all the paths in a presentation or in a report that can be evaluated.			



THIRD ACTIVITY: EXPLORING BREAST-FEEDING

STUDENTS' QUESTIONS FROM THE INITIAL VIDEO:

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WHAT DOES IT MEAN THAT COW'S MILK IS FOR COWS? WHAT DOES THE SAYING "WE HAVE BEEN FOR OUR MOTHER'S MILK" MEAN?



FOURTH ACTIVITY: EXPLORING LACTASE

STUDENTS' QUESTION FROM THE INITIAL VIDEO:

WHAT IS LACTASE AND HOW DOES IT WORK?

Activity name: EXPLORING LACTASE ENZYME

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Overview: This segment starts with an initial exploration of B-galactosidase structure in silico, through the use of Chimera and Nanome, two bioinformatic tools. Nanome can be used in VR and ensure an immersive experience inside the beauty of molecules.


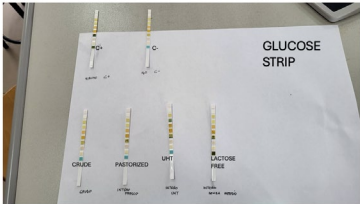
After this activity, students found information about the enzyme on PDB and compared the results obtained on the computer with the validated information they read.

Then there is a guided IBSE laboratory in which students test the parameters that influence lactase enzymatic activity. In this case teacher gives the student a statement and students have to design the experimental procedure to prove it. If you are following this learning path, here you can confirm the effectiveness of the preceding activity, you can observe student's improvements in experimental designs.

The last proposed activity is the enzymatic kinetics and the building of the Michaelis-Menten graph, here you will find a protocol to do it, but I have yet to realize it with my classes.

This segment can also be done with other enzymes such as amylase or catalase, changing the way in which is possible to monitor enzyme activity.


PRIOR KNOWLEDGE and SKILL	LEARNING GOAL	ASSESSED OUTCOME	KEY VOCABULARY
<ul style="list-style-type: none"> - To know enzyme and protein - To use a computer and VR - To find and understand validated information - To be able to handle simple lab instruments - To be aware of the basic safety procedures and behavior in the lab - To collect data - To re-elaborate data through graph 	<ul style="list-style-type: none"> - To see the relation between chemistry-structure-function in biomolecules, especially enzymes. - To use bioinformatic tools - To design a simple experiment to answer an investigable question - To find the variable that influence enzyme kinetics - To build graphs to show experimental data - Do discuss respectfully with peers 	<ul style="list-style-type: none"> - To use software to explore molecules in particular proteins - Experimental design - Building graph to show experimental data - Cooperation 	INQUIRY ENZYME STRUCTURE ACTIVE SITE VIRTUAL REALITY (VR) EXPERIMENTAL DESIGN VARIABLES ENZYME KINETICS MICHAELIS-MENTEN

SEQUENCE				
ACTIVITY	MATERIAL AND DETAIL	TEACHER	STUDENTS	TIME
ENGAGE	<p>This option is for the entire path, and you have already done it...</p>  <p>You can start from results obtained in student's experiment for instance the fact that in lactose free milk there is glucose.</p>  <p>If you start from this segment here you can choose some alternative engages to make your students curious about enzyme and in particular on lactase:</p> <p>1. ENZYME</p>	→ Involve students in the enzyme world	→ Participate to discussion	15 min

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SEQUENCE				
ACTIVITY	MATERIAL AND DETAIL	TEACHER	STUDENTS	TIME
	 <p>https://www.youtube.com/watch?v=BTB_HPL2r88</p> <p>2. LACTOSE INTOLLERANCE and COMMERCIAL LACTASE PILL You can read the instruction of commercial B-galactosidase pills and ask students why it is suggested to avoid to take pills with hot beverages.</p>			
In silico exploration of B-galactosidase	<p>Following the Material 1, students can explore the structure of B-galactosidases.</p> <p>You have also a taste of the VR experience in this small video link: https://youtu.be/MPSUqMp-ACK</p> <p>https://docs.google.com/document/d/1D8oUUprhCQcLT5A_sh6SvNTI</p>	<p>→ Introduce the activity, and recall prior knowledge about protein chemical composition and structure.</p> <p>→ Divide students in groups (the preceding ones)</p>	<p>→ Bioinformatic activity (5 TASKs → each group should prepare a document with images of their work to present their founding to the class.)</p> <p>→ Ask questions</p> <p>→ Explore protein's beauty.</p>	1 h

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SEQUENCE				
ACTIVITY	MATERIAL AND DETAIL	TEACHER	STUDENTS	TIME
	HcXnGQ0u5avyNAbyY8w/edit?usp=sharing	→ Coordinate the activity, helping students if required. → Enter VR inside the proteins with students; it is a wonderful experience!! → At the end of the VR activity, coordinate the discussion to sum up students results TASK 1-2-3-4. → Underline the importance of chemical nature-structure end function of biomolecule in the particular case of enzyme and active site that students explored.		
DOCUMENTATION and ENZYME INFORMATION on PDB	Students compare their <i>in silico</i> data with the information found in PDB. Material 1 . https://docs.google.com/document/d/1D8oUUprhCQcLT5A_sh6SvNTI_HcXnGQ0u5avyNAbyY8w/edit?usp=sharing	→ Show PDB site, introducing it as an information tool for TASK 5. → Help students if required.	→ Complete their work on B-galactosidases with the last task (TASK 5) in which they have to correlate their finding and validated information.	30 min

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SEQUENCE				
ACTIVITY	MATERIAL AND DETAIL	TEACHER	STUDENTS	TIME
		<p>→At the end of the activity coordinate the discussion.</p> <p>→ The documents produced by groups can be evaluated, a proposed rubric is added to Material 1, but you can choose your criteria according to what you used to do https://docs.google.com/document/d/1D8oUUpRhCQcLT5A_sh6SvNTIHcXnGQ0u5avyNAbyY8w/edit?usp=sharing</p>		
CLASS LAB COOPERATIVE INVESTIGATION: WHICH VARIABLES INFLUENCE LACTASE ACTIVITIES	<p>In this activity students, divided in small groups, explore the variables that influence enzyme activity. They use lactase immobilized with alginate, but the same can be done with amylase or catalase. The final product will be a poster all students cooperate for inserting their experimental results.</p>			2 h
	MATERIAL PREPARATION BEFORE THE ACTIVITY, 30 min	→ Prepare immobilized enzyme and lactose		

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SEQUENCE				
ACTIVITY	MATERIAL AND DETAIL	TEACHER	STUDENTS	TIME
	 	<p>solution, as shown in Material 2.</p> <p>https://docs.google.com/document/d/1fqUunH3-8Z1f-udY2famrqv0k10arjDWuZbGXWOd74/edit?usp=sharing</p> <p>Students love this phase, but if you want to reduce time and increase uniformity in the experiments it is better to have this done. Lactose solution is not stable, prepare it immediately before the laboratory activity and control it with a glucose strip before the lab.</p>		
	<p>CLASS DISCUSSION TO IDENTIFY VARIABLES (15min)</p>	<p>→ The teacher introduces the activity, focuses the attention on what variables can</p>	<p>→ Students participate at the discussion and indicate variables</p>	

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SEQUENCE				
ACTIVITY	MATERIAL AND DETAIL	TEACHER	STUDENTS	TIME
		<p>influence the efficiency of enzymes → Teacher writes on the board the variables students identified → For each variable, the teacher writes a statement (as in Material 2 https://docs.google.com/document/d/1fqUunH3-8Z1f-udY2famrqv0k10arjDWuZbGXWod74/edit?usp=sharing) that students have to investigate experimentally → Teacher divides students into groups, I suggest the same of second step of the path.</p>	<p>they think can be investigated</p>	
	<p>ALONE TIME and GROUP TIME TO DESIGN EXPERIMENT (30 min)</p>	<p>→ Teacher assigns a statement to each group → Teacher supports students, but do not judge their work</p>	<p>→ Each student alone designs the experimental procedure to verify the statement assigned to their</p>	

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SEQUENCE				
ACTIVITY	MATERIAL AND DETAIL	TEACHER	STUDENTS	TIME
			<p>group (15 min). They can use the card in material 3 https://docs.google.com/presentation/d/151h15fXWNgaVTxkawFWX4jaU7MmdpLX5gdKxVgj2F8c/edit?usp=sharing</p> <p>→ Students in groups work together, they analyze the designs done in the alone time and choose one strategy for the group. They can mix all the procedures and can create a new one. This phase is really important, teacher should help student to cooperate.(15 min)</p> <p>Each group reports their chosen experimental design in A3 paper leaving</p>	

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SEQUENCE				
ACTIVITY	MATERIAL AND DETAIL	TEACHER	STUDENTS	TIME
			space for data and conclusion. You can choose if your student need a class discussion sections in order to see all experimental design or if you leave each group without any comparison with peers.	
	LAB EXPERIMENT (1h) 	→ Teacher supports students but does not judge their work.	→ In small groups, students perform their experiments. → They have to document each passage and report them in the lab book and in group A3 paper. → If they have time, they can go on in the investigation.	
	DATA ANALYSIS and CLASS POSTER	→ Teacher allows student to use computer to elaborate quantitative data.	→ Students in small groups elaborate on their data by building a graph.	

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SEQUENCE				
ACTIVITY	MATERIAL AND DETAIL	TEACHER	STUDENTS	TIME
		<p>→ The teacher coordinates the class discussion.</p> <p>→ The teacher can evaluate class poster</p>	<p>→ CLASS DISCUSSION</p> <p>- Each group show A3 paper to the class and expose their experiments and results</p> <p>→ One member of each group is responsible for the building of the class poster. This can be done with paper or also on a computer.</p>	
	ASSESSMENT	<p>→ Teacher can evaluate the contribution of each group to the poster (A3 paper and experimental design, as improvement respect to Activity 2. If this is your students' first activity, do not evaluate the experimental design!! It is not easy and requires time.)</p> <p>→ If this activity is done after "exploring</p>		

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SEQUENCE				
ACTIVITY	MATERIAL AND DETAIL	TEACHER	STUDENTS	TIME
		<p>milk,” teacher can appreciate students’ progression in experimental design. → The poster can be evaluated using the suggested rubric in Material 2 or your own criteria. https://docs.google.com/document/d/1fgUunH3-8Z1f-udY2famrqv0k10arjDWuZbGXWOd74/edit?usp=sharing</p>		
<p>ENZYME KINETIC</p>	<p>This is the only activity I have no time to test with students, so I share with you my ideas for next year.</p> <p>All the students of a class (a fourth-year class) cooperate to investigate the dependence of velocity of an enzymatic reaction to the substrate concentration also in the presence of an inhibitor, in our case galactose (CONNECTION with bioinformatic activity)</p>	<p>→ Teacher introduces the concept of reaction velocity and guide the activity → Teacher prepares material for the lab according to Material 4 https://docs.google.com/document/d/1QF7nZCdbE0K61T4f1vpVwbg90WifWqv0R2W97LN0hRU/edit?usp=sharing</p>	<p>→ Students in small groups evaluate the formation of glucose from lactose in presence of lactase beads. Each group follows the reaction with a particular substrate concentration and inhibitor concentration</p> <p>Material 4</p>	<p>3h</p>

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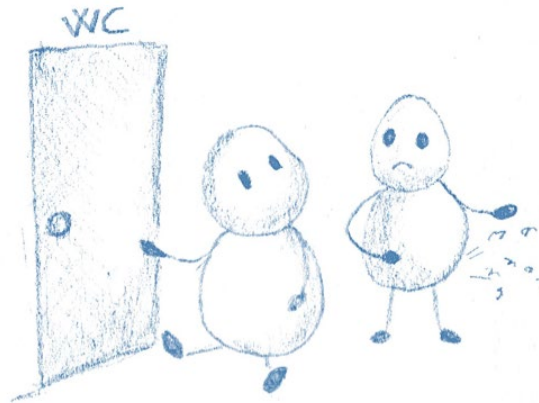
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SEQUENCE				
ACTIVITY	MATERIAL AND DETAIL	TEACHER	STUDENTS	TIME
			<p>https://docs.google.com/document/d/1QF7nZCdbE0K61T4f1vpVwbg90WIfWqv0R2W97LN0hRU/edit?usp=sharing</p> <p>→ Students collect data, evaluate reaction, and rate graph</p> <p>→ All the data obtained in the class experiment are used to build Michaelis-Menten graph a class poster.</p>	

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FIFTH ACTIVITY: EXPLORING LACTASE PERSISTENCE-LACTOSE INTOLERANCE

STUDENTS' QUESTIONS FROM THE INITIAL VIDEO:

WHAT DOES IT MEAN TO BE LACTOSE INTOLERANT? WHAT HAPPENS WHEN YOU ARE LACTOSE INTOLERANT?



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This was my starting point, but I could not develop the lab activity I wanted (an EMSA assay to simulate transcription factor binding on DNA), nevertheless I would like to share with you a case study I prepared on this. In the link you will find the Italian and the English versions:

<https://drive.google.com/drive/folders/1uEceTqGI-LOtgMGehSHFBXqYjRPRmR9h?usp=sharing>



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SIXTH ACTIVITY: EXPLORING MILK SUSTAINABILITY

STUDENTS' QUESTIONS FROM THE INITIAL VIDEO:

WHAT IS THE COST OF 1 LITER OF MILK IN CO₂ EMISSIONS? IS IT POSSIBLE TO PRODUCE MILK BIOTECHNOLOGICALLY?

