Activities for engaging students in Biology using animations

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SUMMARY:

This resource includes three classroom-tested activities that were created using the ideas outlined in the article “Getting more out of animations” by Pruneski and Donovan (in press). The driving idea is that animations can be a powerful tool for learning complex biological processes, but when students are passive viewers, it limits their usefulness and may become simply another source of content to be memorized. Engaging students with animations can greatly increase the amount of information that can be extracted and can help students develop important learning skills that can be useful in the future. These sample assignments help make the use of animations more effective and active by structuring student viewing using guiding questions. These questions focus on particular objects, features, or steps of the process to help students accomplish specific learning objectives for that topic. The assignments also help students think about animations as media objects that are created by scientists and animators using specific tools and conventions that affect how the process is depicted and the ways in which it should be viewed. Lastly, by comparing and contrasting multiple animations of the same process, students can extract more information, overcome the limitations of each individual animations, and generate a more complete view of the process.

LEARNING GOALS:

- Scaffold student's viewing of animations to increase learning
- Use multiple animations of the same process to give students a better understanding of the topic
- Help students critically examine and evaluate animations as learning tools and media objects
- Develop the ability to effectively find and use animations to aid learning scientific concepts
- Identify the components required for the PCR reaction and their role
- Identify the steps of the PCR reaction and their purpose
- Compare and contrast multiple PCR animations to develop a better understanding of the process
- Describe the process of DNA replication
- Distinguish between leading and lagging strand synthesis
- Describe the process of transcription
- Describe the process of translation
- Use animations to define questions to drive further studying/learning
- find animations and compare to ones given for a particular topic
- Describe the process of action potential formation
- Identify the order and direction of ion movement that propagates an action potential
- Find and evaluate animations as learning tools for a biological topic

Table of Contents

Background

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These sample assignments help make the use of animations more effective and active by structuring student viewing using guiding questions. These questions focus on particular objects, features, or steps of the process to help students accomplish specific learning objectives for that topic. The assignments also help students think about animations as media objects that are created by scientists and animators using specific tools and conventions that affect how the process is depicted and the ways in which it should be viewed. Lastly, by comparing and contrasting multiple animations of the same process, students can extract more information, overcome the limitations of each individual animations, and generate a more complete view of the process.

We have had success using this approach to teach a number of different topics in a variety of courses, contexts, and instructional settings (See table below). These example assignments can be used directly if they fit your needs, but are meant to highlight some of the ways students can be engaged in the study of science using animations and can easily be adapted to other courses, content areas, and instructional contexts.

	Example Assignment #1	**Example Assignment #2**	**Example Assignment #3**
Topic	Polymerase chain reaction	Central dogma of Biology	Action potentials
Author	Justin Pruneski	Sam Donovan	Stacey Kiser
Institution type	Primarily undergraduate	Research	2-year college
Audience	Intro Biology/Genetics	Intro Biology	Non-majors Biology
Context	Pre-lab assignment	Recitation activity	In-class activity

Example Assignment #1

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Introduction

The Polymerase Chain Reaction (PCR) is a technique developed in 1983 by Kerry Mullis. It has since become a standard method employed in nearly all biological research for its ability to selectively amplify tiny amounts of DNA into millions of

copies in just a few hours. Computer animations are valuable learning tools that can help you visualize a fast multi-step process like PCR. This assignment will allow you to explore multiple animations depicting the process of PCR to help you learn the technique before we use it in lab.

Instructions

View each of the three animations listed below and answer the following questions. Be sure to turn the sound on your computer on so you can hear the narration. I recommend opening each animation in a separate browser tab and leaving them open so you may easily go back and forth among them throughout the assignment. You may need to watch them multiple times to answer the questions. Complete this assignment by typing the answers into this document on your computer and printing it out to turn in before lab begins.

Animation #1:

http://www.youtube.com/watch?v=JRAA4C2OPwg&feature=plcp&context=C46b9611VDvjVQa1PpcFMp8m_wfy428g3AaifiStwJOsiR6fhHz00%3D

Animation #2:

http://www.youtube.com/watch?v=2KoLnIwoZKU&feature=relmfu

Animation #3:

http://www.youtube.com/watch?v=lcuvdG9n9nw&feature=related

Questions

Question 1:

Describe the purpose of adding each of the following to the PCR reaction:

Taq DNA Polymerase -

Nucleotides (deoxyribonucleotides) -

Primers –

Template DNA –

Question 2:

Do each of the animations explicitly show all four of the components listed above? Explain

Questions 3:

Each cycle of PCR consists of three steps. Describe each step and what it accomplishes:

Step 1: Denaturation –

Step 2: Annealing –

Step 3: Extension –

Question 4:

Which animation best depicts the following features of PCR: Explain your reasoning

During the first few cycles, extra sequence outside the target sequence sometimes gets copied.

The target sequence gets amplified exponentially producing over a billion copies after 30 cycles.

Question 5:

Animation #2 portrays the DNA and Polymerase very differently from the way the other two animations depict them. Describe the differences. Which do you think is more accurate to real life? Which is most helpful for your understanding of the process?

Example Assignment #2

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Introduction/Instructions

The goal of this assignment is two-fold. First, it is an opportunity for you to engage with the complex biological processes that we are studying in this section of class. Because replication, transcription and translation cannot be observed directly we will use animations to help us actively engage with the content and build up our mental models of the how these processes work. The second goal involves helping you develop skills for studying from diverse learning resources. The questions listed below are examples of the ways you can systematically check your understanding as you study.

I recommend opening each animation in its own browser windows so you can move back and forth between them as you study the processes. You might also want to start by identifying the major elements (e.g., DNA polymerase, ribosome, single stranded DNA) and processes (e.g., unzipping DNA, initiation of transcription, peptide bond formation) and how they are

represented in each animation.

You can follow this link to a web version of this assignment (and a few extra resources) that makes it easier to follow the links. http://bit.ly/Week2Recitation

DNA Replication

Bidirectional growth animation from *Molecular Cell Biology*

http://www.ncbi.nlm.nih.gov/books/NBK21650/figure/A3167/

DNA replication (basic detail) from HHMI

http://www.hhmi.org/biointeractive/dna/DNAi_replication_vo1.html

Q1: Explain how each DNA strand that is being replicated has both leading and lagging strands.

Q2: Which features of DNA replication are not well represented in the HHMI animation?

Q3: Find a different DNA replication animation on the web and save the link. Describe something that your animation shows particularly well.

Transcription

Transcription animation from *Biological Science*

https://dl.dropbox.com/u/1183426/BIOSC0160/Transcription.html

DNA transcription (basic detail) from HHMI

http://www.hhmi.org/biointeractive/dna/DNAi_transcription_vo1.html

Q1: Which features of transcription are not well represented by either of these animations?

Q2: List 2 questions that you have about transcription after studying these animations.

Q3: Find a different DNA transcription animation on the web and save the link. Describe something that your animation simplifies that was presented in more detail in one of the other animations.

Translation

Translation animation from *Biological Science*

https://dl.dropbox.com/u/1183426/BIOSC0160/Translation.html

Translation (basic detail) from HHMI

http://www.hhmi.org/biointeractive/dna/DNAi_translation_vo1.html

Q1: Describe something that each animation helped you understand better about translation.

Q2: List 2 questions that you have about translation after studying these animations.

Q3: Find a different DNA translation animation on the web and save the link. Would you recommend it to another student to use to study translation? Why?

Example Assignment #3

Write down or e-mail the urls of the two animations you feel best taught you about action potentials:

Animation #1 url	
Animation #2 url	

This animation helped me understand …	Animation #1	Animation #2
What an action potential is and how it conducts a signal in our nervous system.		
The types and order of gated channels as they open and close during an action potential.		
What threshold is and how an action potential is an example of a positive feedback loop.		

For each of the following please describe a "feature" from one or more of the animations that really helped you understand that part of the process.

The animation showed how an action potential causes a signal to be transferred down the length of the axon without the ions moving down the length as well by . . .

The animation showed how the neuron resets itself after an action potential . . .

Answer the following in your own words:

What is the difference between an ion channel and an ion pump?

What is the order of ion movement, and which direction are the ions moving (into or out of the cell)?

	Ion Moving	Into or Out of Cell?
1.	Na^+ or K^+	Into or Out

2.	Na^+ or K^+	Into or Out

Please list at least one question that you have about action potentials.

Finally, what features are most important to you about an animation? What makes an animation “good”?