



LP3 TEACHING PLAN

Replacement: Alternatives to Using Animal Models
in Testing, Research and Education



LEARNING PLAN OVERVIEW

Students will gain a more in-depth understanding of the 3Rs principle of replacement. They will be introduced to models that can be used to replace the use of animals in science and education, including human simulators, cell-based models, and alternatives to dissecting animal specimens.

ESTIMATED TOTAL TIME

92 minutes plus an additional 1 hour of project work outside of class

PRE-REQUISITE SKILLS

LP2: The 3Rs of Scientific Research

WHAT STUDENTS WILL LEARN

Competency:

- Outline various ways to replace the use of animals in research and education

Learning Objectives:

- Identify why researchers may try to replace the use of animals in their research
- Describe examples of human simulators, cell-based models, and humane dissection tools as methods of replacement
- Describe the common issues associated with traditional drug development methods and how replacement technology can address those issues
- Provide research-backed support for the effectiveness of replacement

Assessment: Classroom Animal Use Alternatives Proposal

- Proposal identifies the educational activity and types of animals that will be replaced
- Proposal identifies how many animals are used in the current activity
- Proposal identifies specific examples of products/activities animals could be replaced with
- Proposal identifies drawbacks of using animals in your classroom
- Proposal identifies cost considerations for the solution
- Proposal identifies safety and/or reliability considerations for the solution
- Proposal identifies social and/or cultural considerations for the solution
- Proposal identifies environmental impact of the solution

Linked External Standards:

NGSS

- HS-ESS3-4 Evaluate or refine a technological solution that reduces impacts of human activities on natural systems.
- HS-ETS1-3 Evaluate a solution to a complex real-world problem based on prioritized criteria and trade-offs that account for a range of constraints, including cost, safety, reliability, and aesthetics as well as possible social, cultural, and environmental impacts

CCSS- ELA

- RST.11-12.7 Integrate and evaluate multiple sources of information presented in diverse formats and media (e.g., quantitative data, video, multimedia) in order to address a question or solve a problem
- RST.11-12.9 Synthesize information from a range of sources (e.g., texts, experiments, simulations) into a coherent understanding of a process, phenomenon, or concept, resolving conflicting information when possible
- W.9-10.1 Write arguments to support claims in an analysis of substantive topics or texts, using valid reasoning and relevant and sufficient evidence

TEACHING PLAN

#	Learning Activities	Teaching Notes	Materials and Supplies
1	LEARNING PLAN OVERVIEW Review information detailed in the Student Learning Plan.	TIME: 2 minutes	Student Learning Plan
2	MOTIVATION ACTIVITY Consider the question: Do you support or oppose the use of animals in scientific research? Review the results of public opinion polls on animal testing.	TIME: 5 minutes ACTIVITY NOTES Poll students on whether they support or oppose the use of animals in scientific research. Share Gallup and Pew Poll results with students. Discuss how public support of animal testing has changed over time.	LP3_2_PublicOpinionPollsOnAnimal Testing
3	COMPREHENSION ACTIVITY Listen to a presentation on ways that the 3Rs principle of replacement can be implemented in research and education.	TIME: 10 minutes ACTIVITY NOTES Provide a short lecture on ways the 3Rs principle of replacement can be implemented in research and education. The Replacement Presentation is provided for your use.	LP3_3_Replacement_Presentation
4	PRACTICE ACTIVITY Answer the question: what are three different types of replacement models used in science today? Discuss their pros and cons.	TIME: 5 minutes ACTIVITY NOTES Briefly have students recall the models they just learned about, such as human simulators, cell-based models and humane dissection products. Discuss with the class pros and cons of using replacements for animal models. Consider factors such as cost, ethics, human relevance, etc.	
5	COMPREHENSION ACTIVITY Watch a TED talk video discussing how new replacement technology can be used to improve the drug development process.	TIME: 20 minutes ACTIVITY NOTES Have students watch a TED talk about organ-on-a-chip replacement technology. (Time 16:18) Provide the LP3_6_OrganOnAChipWorksheet for students to fill in while watching the video.	https://www.youtube.com/watch?v=sCEWiFwWbXg LP3_6_OrganOnAChip_Worksheet
6	PRACTICE ACTIVITY Complete a worksheet with questions about the organ-on-a-chip TED talk.	TIME: 5 minutes ACTIVITY NOTES While students are watching the TED talk, have them fill in a worksheet with accompanying questions. Allow five minutes after the video for students to finish filling out their answers. Discuss the answers in class.	LP3_6_OrganOnAChip_Worksheet LP3_6_OrganOnAChip_AnswerKey

#	Learning Activities	Teaching Notes	Materials and Supplies
7	<p>COMPREHENSION ACTIVITY Read an article about the effectiveness of dissection alternatives.</p>	<p>Time: 20 min</p> <p>ACTIVITY NOTES Provide the article to the students. This scientific article is 6 pages. Questions on this article are provided in the "Effectiveness of Animal Model Replacements" worksheet. The article and associated worksheet can also be completed in small groups.</p>	<p>LP3_7_OrmandyABT_Article</p>
8	<p>PRACTICE ACTIVITY Use the article information to complete the "Effectiveness of Animal Model Replacements: Case Study on Dissection Alternatives" worksheet.</p>	<p>TIME: 15 mins</p> <p>ACTIVITY NOTES Students may complete this on their own, with a partner, or in a small group. This worksheet can be provided to students along with the article.</p>	<p>LP3_8_EffectivenessOfAnimalModel Replacements</p> <p>LP3_8_EffectivenessOfAnimalModel Replacements_AnswerKey</p>
9	<p>APPLICATION ACTIVITY Research, then write a proposal to replace the use of animals in your classroom (specimen dissection, animal experimentation, class pets, etc.). Provide specific examples of what products and/or activities you could replace them with.</p>	<p>TIME: 10 minutes plus an additional 1 hour of project work outside of class</p> <p>ACTIVITY NOTES Review the proposal in class, sharing the assessment information and rubric with students. Student should research their chosen alternatives to determine cost of the alternative, etc.</p>	<p>LP3_9_ClassroomAnimalUseAlternatives Proposal</p>

Engineering Human Organs onto a Microchip

Name(s): _____

Date: _____

As you watch Dan Huh's TEDx talk, answer the following questions about drug development and organ-on-a-chip replacement technology.

1. On average, how long does it take to bring a new drug to the market? How much does it cost?
2. The cost of producing new drugs is:
 increasing decreasing staying the same
3. The number of new drugs approved by the Food and Drug Administration (FDA) each year is:
 increasing decreasing staying the same
4. What are the traditional models for pre-clinical drug testing?
Why do these models fail to serve as good models for testing human medicine?



Engineering Human Organs onto a Microchip

5. Organ chips are being developed to better mimic the structure and function of organs. What is the purpose of the vacuum channels in the lung-on-a-chip?
6. How does the organ-on-a-chip model address the failures of the traditional cell and animal models?
7. Describe the benefits of being able to create an organ-on-a-chip device from a specific individual's cells.
8. Organ-on-a-chip technology helps researchers fail cheaply and fail early in the drug testing process. How is this beneficial to the animals used in the drug development process?



Engineering Human Organs onto a Microchip

Answer Key

As you watch Dan Huh's TEDx talk, answer the following questions about drug development and organ-on-a-chip replacement technology.

1. On average, how long does it take to bring a new drug to the market? How much does it cost?
\$1.5 billion and 12.5 years
2. The cost of producing new drugs is:
 increasing decreasing staying the same
3. The number of new drugs approved by the Food and Drug Administration (FDA) each year is:
 increasing **decreasing** staying the same
4. What are the traditional models for pre-clinical drug testing?
Why do these models fail to serve as good models for testing human medicine?
Cell culture: 2D structure does not replicate the complex 3D structure of a living body
Animals: animal biology is too different from human biology
5. Organ chips are being developed to better mimic the structure and function of organs.
What is the purpose of the vacuum channels in the lung-on-a-chip?
Air pressure in the vacuum channels expands and contracts the chip membrane, mimicking natural lung movements



Engineering Human Organs onto a Microchip

6. How does the organ-on-a-chip model address the failures of the traditional cell and animal models?

Organs-on-a-chip can use human cells grown in a complex 3D environment that mimics human organ physiology.

7. Describe the benefits of being able to create an organ-on-a-chip device from a specific individual's cells.

An individual's cells can be grown on an organ-on-a-chip and then drugs can be tested to see if they can potentially benefit the individual or cause unique adverse reactions.

8. Organ-on-a-chip technology helps researchers fail cheaply and fail early in the drug testing process. How is this beneficial to the animals used in the drug development process?

Screening drugs in this human-relevant system early in the drug development process will help prevent drugs that are unlikely to be safe or effective in humans to be tested in animals, sparing some animal lives.



Effectiveness of Animal Model Replacements: Case Study on Dissection Alternatives

Name(s): _____

Date: _____

Methods of teaching students about anatomy and physiology that can replace the use of animal specimens have been developed, and many web-based programs, apps, and other models are widely available. However, despite the existence of non-animal teaching models, most high school teachers in the U.S. feel that dissection is still the best way to teach anatomy and physiology. Recent surveys show that approximately 85% of US high school biology teachers conduct animal dissections in their classrooms.

But what do the data show about the effectiveness of dissection alternatives?

Many studies have been conducted to examine how well students perform when using dissection alternatives compared to traditional animal specimens in classroom dissection activities.

A systematic review, which provides a summary of these studies, has been published on this topic.

Refer to the *American Biology Teacher* article "Animal Dissection vs. Non-Animal Teaching Methods: A Systematic Review of Pedagogical Value" by Elisabeth Ormandy, et al. and answer the following questions.

1. Of the 20 studies included in the review, how many found non-animal teaching methods to be:

More effective than using traditional dissection specimens: _____

As effective as using traditional dissection specimens: _____

Less effective than using traditional dissection specimens: _____

See figure 2.



Effectiveness of Animal Model Replacements: Case Study on Dissection Alternatives

2. Describe the educational merit of non-animal teaching methods versus the use of traditional dissection specimens across various educational levels. (See Figure 3).

Secondary (middle and high school): _____

Post-secondary (college): _____

Medical school: _____

3. Surveys of biology teachers have revealed that many teachers prefer the hands-on experience of traditional animal dissection compared to using a non-animal method. Two studies included in the systematic review assessed hands-on skills acquisition among students. How did the performance of students using non-animal methods compare to the performance of students using traditional animal dissection? (See Figure 5).

4. What did the systematic review reveal about how well or poorly students learned anatomy using non-animal methods compared to those performing traditional animal dissection? (See Figure 5).



Effectiveness of Animal Model Replacements: Case Study on Dissection Alternatives

5. Based on the findings of this analysis, if you were a high school biology teacher considering dissection activities, would you choose traditional animal specimens or a non-animal method? Why?



Effectiveness of Animal Model Replacements: Case Study on Dissection Alternatives

Answer Key

Of the 20 studies included in the review, how many found non-animal teaching methods to be:

More effective than using traditional dissection specimens: **14**

As effective as using traditional dissection specimens: **15**

Less effective than using traditional dissection specimens: **1**

See figure 2.

1. Describe the educational merit of non-animal teaching methods versus the use of traditional dissection specimens across various educational levels. (See Figure 3).

Secondary (middle and high school)-5 studies showed better performance with dissection alternatives, 2 showed equivalent performance

Post-secondary (college)- 9 studies showed better performance with dissection alternatives, 1 showed equivalent performance, 1 showed worse performance with dissection alternatives

Medical school: 2 studies showed equivalent performance

2. Surveys of biology teachers have revealed that many teachers prefer the hands-on experience of traditional animal dissection compared to using a non-animal method. Two studies included in the systematic review assessed hands-on skills acquisition among students. How did the performance of students using non-animal methods compare to the performance of students using traditional animal dissection? (See Figure 5).

It was the same.



Effectiveness of Animal Model Replacements: Case Study on Dissection Alternatives

3. What did the systematic review reveal about how well or poorly students learned anatomy using non-animal methods compared to those performing traditional animal dissection? (See Figure 5).
In most cases, students using alternatives performed better (n=14) or equivalent (n=3) to students using traditional dissection specimens. In one case, students using alternatives performed worse than those using traditional animal specimens.
4. Based on the findings of this analysis, if you were a high school biology teacher considering dissection activities, would you choose traditional animal specimens or a non-animal method? Why?
Answers will vary.



Proposal to Use Alternatives to Animals in the Classroom

Consider some of the different ways that animals can be integrated into classroom educational activities. Sometimes animals are used as dissection specimens, as class pets, or as part of science research projects, for example.

Now, consider some of the ways that animal use in education can be replaced. For this activity, you will write a proposal to replace the use of animals in one of these areas. Please keep your proposal limited to 1,000 words or less. Be sure to integrate the following information into your proposal:

- Clearly describe the educational activity you have selected that traditionally uses animals. What is the purpose of this activity? In which class would this activity be performed? How many and what kinds of animals are commonly used for this activity?
- Explain how the use of animals could be replaced in this activity. What products and/or alternative activities could be used in place of animals? Provide specific examples.
- Support your choice for an alternative activity with relevant evidence. Explain why you have selected this alternative activity. You may want to consider factors such as impact on student learning, cost, safety, and ethics as well as possible social, cultural, or environmental impacts.
- Consider the effectiveness of using the alternative activity. What are the pros and cons of using this activity compared to using animals?
- Make sure that your proposal is well organized and use correct grammar, punctuation, and spelling.

Target Course Competencies

Outline common ways to replace the use of animals in research and education

Rating Scale

Value	Description
3	Work fully meets or exceeds criterion; shows depth in insight and grasp of the learning, critical thinking skills, or attention to detail
2	Work meets criterion adequately
1	Work is incorrect or incomplete
0	Work is missing or does not meet criterion



Scoring Standard

You must achieve a rating of at least “2” on each criterion to demonstrate competence.

Scoring Guide

Criteria	Ratings
Proposal identifies the educational activity and types of animals that will be replaced.	3 2 1 0
Proposal identifies how many animals are used in the current activity.	3 2 1 0
Proposal identifies specific examples of products/activities animals could be replaced with.	3 2 1 0
Proposal identifies drawbacks of using animals in your classroom.	3 2 1 0
Proposal identifies cost considerations for the solution.	3 2 1 0
Proposal identifies safety and/or reliability considerations for the solution.	3 2 1 0
Proposal identifies social and/or cultural considerations for the solution.	3 2 1 0
Proposal identifies environmental impact of the solution.	3 2 1 0
Proposal uses correct grammar, punctuation, and spelling.	3 2 1 0

