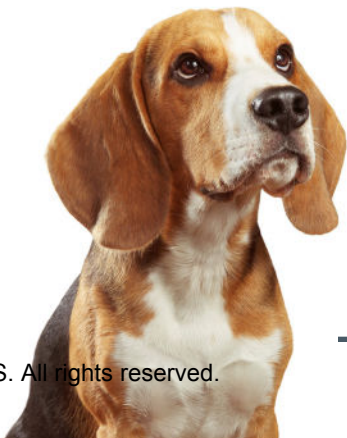




LP2 TEACHING PLAN

The 3Rs of Scientific Research



LEARNING PLAN OVERVIEW

Many areas of scientific research use animals in their experiments. This learning plan explores the impact of the 3Rs Principles (Replacement, Reduction, and Refinement) on scientific research.

ESTIMATED TOTAL TIME

75 minutes of class time

PRE-REQUISITE SKILLS

Introduction to Animal Use in Science and the 3Rs

WHAT STUDENTS WILL LEARN

Competency: Assess the potential impact of the 3Rs on scientific research

Learning Objectives:

- Define the 3Rs of animal research
- Describe examples of how the principles of replacement, reduction, and refinement can be applied in scientific research
- Identify how prioritization of the 3Rs may impact animal use in experiments

Assessment:

3Rs Case Study

- you identify which of the 3Rs are represented in the case study options
- you reflect Russell and Burch's prioritization of 3Rs in your responses
- you identify financial and practical considerations of applying the 3Rs

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

CC-HS-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.

TEACHING PLAN

#	Learning Activities	Teaching Notes	Materials and Supplies
1	<p>LEARNING PLAN OVERVIEW Review information detailed in the Student Learning Plan.</p>	<p>TIME: 5 minutes</p> <p>ACTIVITY NOTES: Provide a brief introduction to the learning plan. This learning plan is designed to follow LP1 in the sequence, Introduction to Animal Use in Science and the 3Rs, or a similar introduction to what type of research uses animals today.</p>	Student Learning Plan
2	<p>MOTIVATION ACTIVITY Review the numbers: How many animals do you think are used in scientific research experiments in the U.S.? Many of these animals have procedures conducted on them that may cause stress, pain, or death. Review the infographic on Animal Research to learn more about numbers of animals used and information about experiments and pain.</p>	<p>TIME: 5 minutes</p> <p>ACTIVITY NOTES: Lead the students through a review of animal use in the U.S. in scientific research as covered under the Animal Welfare Act and ask for observations about the kinds of animals used and their use in studies that involve pain. Have students round and add numbers to estimate the total of animals used in research in 2019 (as presented in the infographic). Determine % of animal research involving pain.</p>	LP2_2_Infographic_AnimalResearch
3	<p>COMPREHENSION ACTIVITY Preview the 3Rs Principles Worksheet. Then watch two short videos introducing the 3Rs principles.</p>	<p>TIME: 15 minutes</p> <p>ACTIVITY NOTES: Hand out or provide the 3Rs Principles Worksheet for students to preview. Then show the two video clips (YouTube).</p> <p>“The 3Rs Principles: Replace, Reduce, Refine” video gives a brief overview of the 3Rs principles.</p> <p>The second video, “Can we do science without animal testing?” helps further explain the 3Rs.</p>	<p>LP2_4_The3RsPrinciples_Worksheet</p> <p>The 3Rs Principles: Replace, Reduce, Refine (Time: 04:03) https://www.youtube.com/watch?v=onqmtKnNsmY Can we do science without animal testing? (Time: 03:41) https://www.youtube.com/watch?v=2hxUMpYFo_Y</p>
4	<p>PRACTICE ACTIVITY Complete the 3Rs Principles worksheet</p>	<p>TIME: 10 minutes</p> <p>ACTIVITY NOTES: Students may complete this on their own, with a partner, or in a small group. This worksheet could be provided before showing the videos.</p>	<p>LP2_4_The3RsPrinciples_Worksheet LP2_4_The3RsPrinciples_AnswerKey</p>
5	<p>COMPREHENSION ACTIVITY Listen to a presentation on ways that scientists may apply the 3Rs to their experimental design.</p>	<p>TIME: 15 minutes</p> <p>ACTIVITY NOTES: Provide a short lecture on ways that scientists are applying the 3Rs to their research design. The “Application of the 3Rs” presentation is provided for your use.</p>	LP2_5_ApplicationOfThe3Rs_Presentation

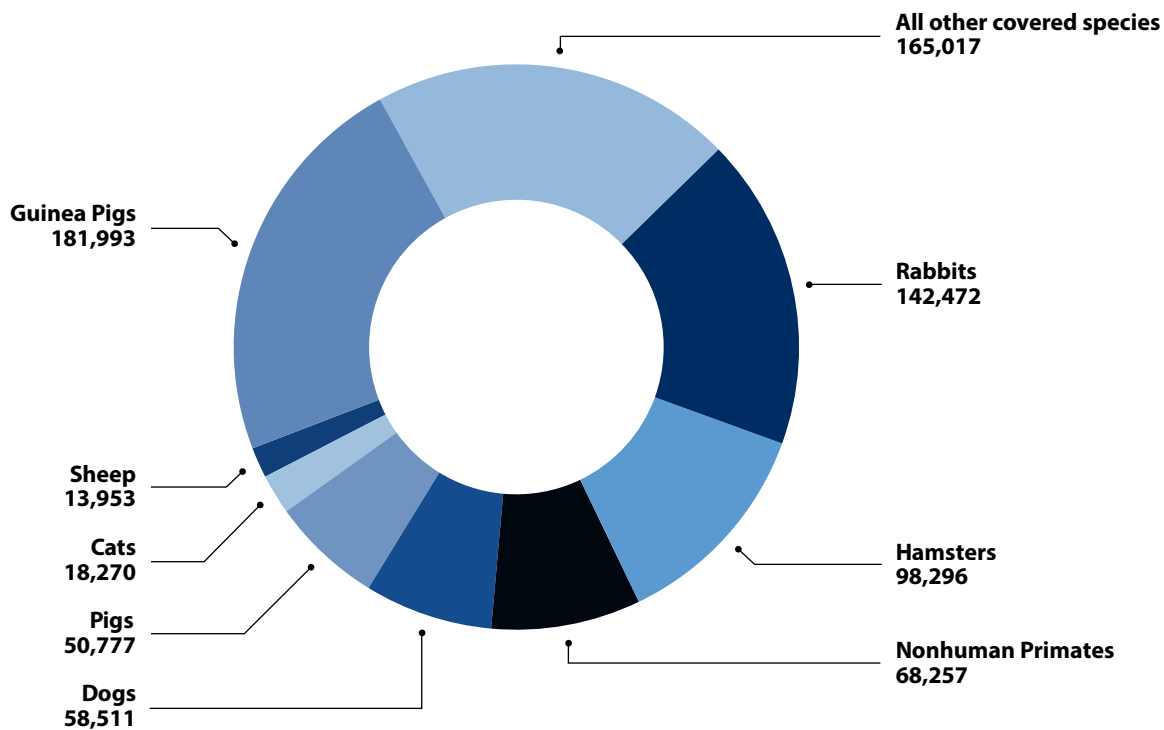
#	Learning Activities	Teaching Notes	Materials and Supplies
6	<p>PRACTICE ACTIVITY Complete the 3Rs Scenarios worksheet, in which you will identify experimental design scenarios as examples of Replacement, Reduction, or Refinement.</p>	<p>TIME: 10 minutes ACTIVITY NOTES: Provide the 3Rs Scenarios worksheet or add scenarios to slides for a whole group discussion.</p>	<p>LP2_6_3RsScenarios_Worksheet LP2_6_3RsScenarios_AnswerKey</p>
7	<p>APPLICATION ACTIVITY Read an assigned case study. Answer questions based on the case study.</p>	<p>TIME: 15 minutes ACTIVITY NOTES: This could be completed alone or in pairs. Apply the 3Rs to a case study scenario: What are the implications to the use of animals in the scenario if the priority of the 3Rs was re-ordered?</p>	<p>LP2_7_CaseStudy_PrioritizationOfThe3Rs LP2_7_CaseStudy_PrioritizationOfThe3Rs_AnswerKey</p>

Animals Used in Research, Testing, Teaching, and Experimentation

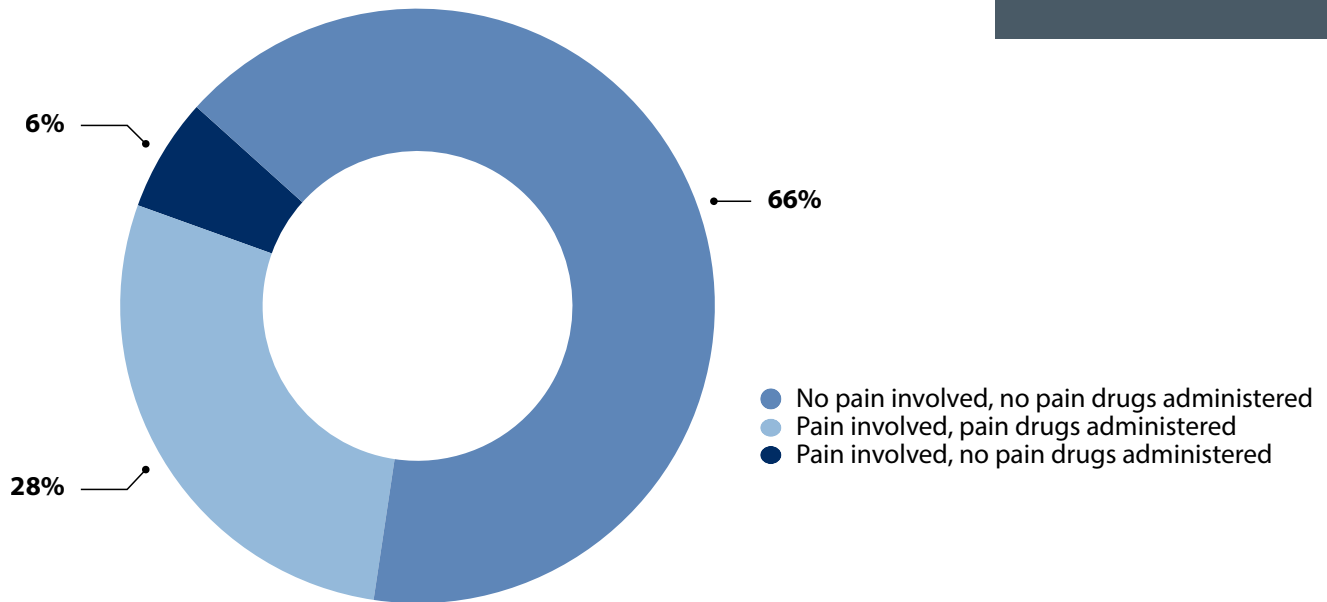
Research facilities are required to report annually on the numbers and types of animals used for research. The reports also include information about whether animals were used in procedures that involved pain and if animals were given pain relief treatment.

Although animals like mice and rats are estimated to account for more than 90% of animals used in research in the U.S., their numbers are not recorded in the annual reports. Birds, fish, and cold-blooded animals are also not counted annually, so we do not know how many of these animals are used in research.

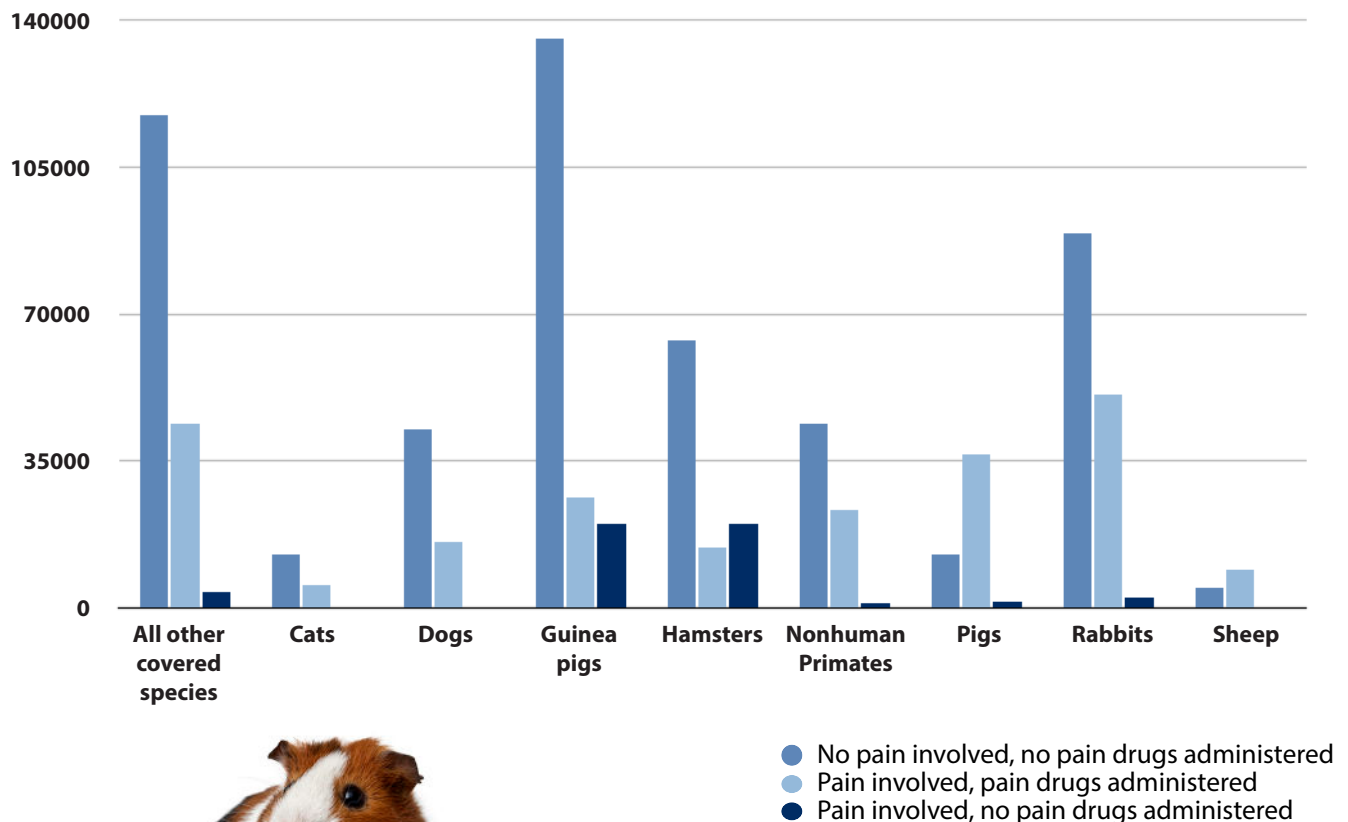
How many animals were used in research in 2019?



What percentage of animal research involved pain in 2019?



Which animal species were involved in experiments that involved pain in 2019?



The 3Rs Principles

Name(s): _____

Class: _____

Directions: Use the information from provided videos on the 3Rs principles to answer the following questions:

1. What are the 3Rs designed to address?
 - Recycling efforts in scientific research
 - Animal use and treatment in research
 - Expenses incurred in research
 - Rapid pandemic response planning research
2. Define the 3Rs in your own words. Then, provide an example of how each of the 3Rs can be applied in a laboratory that performs animal research.

Replacement

Reduction

Refinement

3. What are some social/cultural impacts of introducing the 3Rs principles?



The 3Rs Principles

Answer Key

1. What are the 3Rs designed to address?
 - a) Recycling efforts in scientific research
 - b) Animal use and treatment in research**
 - c) Expenses incurred in research
 - d) Rapid pandemic response planning research
2. Define the 3Rs in your own words. Then, provide an example of how each of the 3Rs can be applied in a laboratory that performs animal research.

Replacement

Finding ways to do the experiment without live animals

Substituting animals with nonanimal models

Using computer models or other non-living options in experiments

Reduction

Intentionally designing experiments to use fewer animals

Decreasing the number of animals that can experience distress or pain

Refinement

Reducing and eliminating distress to animals during research

Maintaining an appropriate and enriching environment for the animals

Providing pain medications during procedures

3. What are some social/cultural impacts of introducing the 3Rs principles?

Answers will vary. Some answers may address integration of the 3Rs into European Union laws, how the 3Rs have made society more aware of animal experimentation and associated issues, etc.



The 3Rs Scenarios

Name(s): _____

Class: _____

Directions: Read the following research scenarios. Determine if the 3Rs principle being applied is replacement, reduction, or refinement.

Scenario 1:

Researchers train beagles using positive reinforcement methods to sit still while their blood is being drawn rather than restraining the animals by force.

3Rs Principle: _____

Scenario 2:

Cosmetics developers use a 3D cell-based model rather than a rabbit model to determine if their product can cause skin irritation.

3Rs Principle: _____

Scenario 3:

A scientist studying immunology allows researchers in a neighboring lab to practice a surgical procedure on animals that need to be euthanized.

3Rs Principle: _____

Scenario 4:

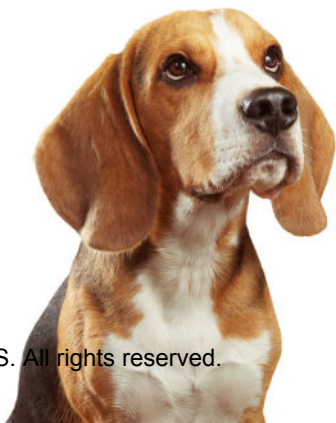
Scientists use human lung-on-a-chip devices to determine the toxic effects of e-cigarettes rather than using mouse models.

3Rs Principle: _____

Scenario 5:

A researcher utilizes one control group of animals for several experimental groups of animals rather than one control group for each experimental group.

3Rs Principle: _____



The 3Rs Scenarios

Answer Key

Scenario 1:

Researchers train beagles using positive reinforcement methods to sit still while their blood is being drawn rather than restraining the animals by force.

3Rs Principle: **Refinement**

Scenario 2:

Cosmetics developers use a 3D cell-based model rather than a rabbit model to determine if their product can cause skin irritation.

3Rs Principle: **Replacement**

Scenario 3:

A scientist studying immunology allows researchers in a neighboring lab to practice a surgical procedure on animals that need to be euthanized.

3Rs Principle: **Reduction**

Scenario 4:

Scientists use human lung-on-a-chip devices to determine the toxic effects of e-cigarettes rather than using mouse models.

3Rs Principle: **Replacement**

Scenario 5:

A researcher utilizes one control group of animals for several experimental groups of animals rather than one control group for each experimental group.

3Rs Principle: **Reduction**



Prioritization of the 3Rs

Name(s): _____

Class: _____

In 1959, William Russell and Rex Burch introduced the 3Rs principles—the replacement, reduction, and refinement of animal use—in an effort to advance animal welfare standards and reduce animal use in science.

When Russell and Burch developed this concept, they prioritized the 3Rs in a hierarchy, with replacement as the ultimate goal, followed by reduction and then refinement. Refinement was to be considered only when replacement techniques could not be used and every effort to reduce the number of animals to a minimum had occurred.

Given that the 3Rs are more than 60 years old, do today's scientists prioritize the 3Rs the same way?

Scientists in a recent study were presented with different scenarios regarding animal use in research. In one scenario, researchers were given a choice of options that would allow for the reduction or refinement of laboratory animal use and asked about which experimental set up they prefer. Here is an example of such a scenario:

Mice are social animals for which individual housing is stressful. However, in a given experiment, each cage must be considered as a single experimental unit, regardless of the number of animals in each cage. This gives researchers two options when it comes to deciding how they should house the animals in their study.

- A) Pair housing, using twice as many animals, but avoiding the negative consequences of social isolation.
- B) Individual housing, using half the animals needed for pair housing, despite the added stress to each animal.

Source: Franco, N.H. et al. "Researcher's attitudes to the 3Rs—An upturned hierarchy?"; *PLOS One*, August 15, 2018.



Answer the following questions based on the scenario described on the previous page.

1. Which of the 3Rs is represented by each option?
2. Researchers in this study prioritized the “Rs” in the reverse order as suggested by Russell and Burch. Given this information, which option were researchers more likely to prefer?
3. If you were running this experiment based on Russell and Burch’s prioritization of the 3Rs, which option would you choose, and why?
4. Based on practical and financial reasoning, what would be the advantages and disadvantages of choosing option B?
5. Do you agree with Russell and Burch’s ordering of the 3Rs? Why or why not?



Prioritization of the 3Rs

Answer Key

1. Which of the 3Rs is represented by each option?

Option A represents refinement because it minimizes the stress of social isolation. Option B represents reduction because it reduces the number of animals used.

2. Researchers in this study prioritized the “Rs” in the reverse order as suggested by Russell and Burch. Given this information, which option were researchers more likely to prefer?

They prioritized the option with pair housing (refinement) over the option with individual housing (reduction).

3. If you were running this experiment based on Russell and Burch’s prioritization of the 3Rs, which option would you choose, and why?

Answers will vary, although Option B would be preferred, as Russell and Burch prioritized reduction over refinement.

4. Based on practical and financial reasoning, what would be the advantages and disadvantages of choosing option B?

Using fewer animals will be less costly; however, the stress of social isolation may make the mice poor study subjects and alter the results of the experiment.

5. Do you agree with Russell and Burch’s ordering of the 3Rs? Why or why not?

Answers will vary.

