

TO USE OR NOT TO USE LIVE ANIMALS IN SCIENCE

3RS LEARNING SCENARIO

Author(s)

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Summary

In this learning scenario pupils will learn about the Three Rs principles. They will be confronted with different methodologies used in science in order to raise awareness on the need or not of using live animals for scientific research. Through online and offline tools (InterNICHE website and resources, YouTube videos, apps, models, mannequins and simulators, etc.) they will investigate the digestive, circulatory, reproductive and respiratory systems, while understanding the possibility and importance of research in science and medicine without using live animals. Biodiversity in aquatic and terrestrial ecosystems will also be explored.

Key elements

<i>Key elements</i>	<i>Suggestions</i>
Subject	Biology, Anatomy
Topic	Animal welfare – Animals in society
Age of students	Between 14 and 18
Preparation time	50 minutes
Teaching time	5x50 minutes (250 minutes)
Online teaching material	<ul style="list-style-type: none"> • www.interniche.org • www.padlet.com • www.kahoot.com (for each pupil's quiz) • https://biteable.com/ • https://webdesigner.withgoogle.com/ • https://www.animaker.com/ • https://prezi.com/ • www.imindmap.com • https://www.mindmeister.com/pt • https://www.xmind.net/ • https://coggle.it/ • https://app.mindmapmaker.org/# • www.surveymonkey.com • www.youtube.com

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Key elements	Suggestions
Offline teaching material	<ul style="list-style-type: none"> • Pro dissector frog • Models and loan system from InterNICHE • Printed images
Resources used	<p>1-What is Biodiversity? https://www.ourplanet.com/en/video/what-is-biodiversity</p> <p>Animals in science - the Three R's policy</p> <p>2-Ten medical breakthroughs thanks to animal testing. http://www.animalresearch.info/en/medical-advances/timeline/</p> <p>3-The role of scientist in the debate about animal welfare https://www.youtube.com/watch?v=h3aLioDNAYg</p> <p>4-Can we do science without animal testing? https://www.youtube.com/watch?v=2hxUMpYFo_Y</p> <p>5-The 5 freedoms of animal welfare https://www.youtube.com/watch?v=UBsOiwbMuxl</p> <p>6-What are the five freedoms? https://www.youtube.com/watch?v=Pqyw4RlcLNw</p> <p>7-Animal welfare: animal based-indicators https://www.youtube.com/watch?v=rn6pM56J0vg</p> <p>8-Fighting animal testing: Lush and reach https://www.youtube.com/watch?v=bcZr1Nm79Fs</p> <p>9-Como é que os animais sentem a dor? https://www.youtube.com/watch?v=5j9Syov0AAw</p> <p>10-Why animals are needed in research https://www.youtube.com/watch?v=iA_FfVuTfoM</p> <p>11-Why do we still test cosmetics on animals? https://www.youtube.com/watch?v=3lb9w-XtaYA</p> <p>12-WUR Alternatives for animal testing https://www.youtube.com/watch?v=oy0ixrR3LNg</p> <p>13-Microdevices that mimic human organs could replace animal testing https://www.youtube.com/watch?v=i9XzwXkSdvq</p> <p>14-Drug testing shake up with organs-on-a-chip https://www.youtube.com/watch?v=r18piLXJawQ</p> <p>15-Why do we use animals in research? https://www.youtube.com/watch?v=6RL_KZ2bAQE</p>

Key elements	Suggestions
	<p>16-Dispelling myths around animal research https://www.youtube.com/watch?v=Nd-5bt-SmiQ</p> <p>17-Adam ruins everything - The problem with Lab Mice (tru TV) https://www.youtube.com/watch?v=zvJHq2FJPDM</p> <p>18-Advantages and disadvantages of animal testing https://www.youtube.com/watch?v=9RtCEQ663Ls</p> <p>19-The end of animal testing https://www.youtube.com/watch?v=ML3AHYUBpa8</p> <p>Morphophysiology videos</p> <p>Circulatory - Rabbit</p> <p>20-Rabbit circulatory system https://www.youtube.com/watch?v=SYoIHh3eH9w</p> <p>21-Circulatory System 3D https://www.youtube.com/watch?v=uKdZVt1vBIQ</p> <p>22-Human Circulatory System https://www.youtube.com/watch?v=qmNCJxpsr0</p> <p>Respiratory - Avian</p> <p>23-The Avian Respiratory System https://www.youtube.com/watch?v=kWMMmyVu1ueY</p> <p>24-Respiratory System, Part 1: Crash Course A&P #31 https://www.youtube.com/watch?v=bHZsvBdUC2I</p> <p>25-Respiratory System - How The Respiratory System Works https://www.youtube.com/watch?v=UTR1IsX55dc</p> <p>Digestive - Rat</p> <p>26-Rat dissection-- digestive system https://www.youtube.com/watch?v=A7SrFNIRots</p> <p>27-Digestive System, Part 1: Crash Course A&P #33 https://www.youtube.com/watch?v=yloTRGfcMqM&list=PL8dPuuaLjXtOAKed_MxxWBNaPno5h3Zs8&t=0s</p> <p>28-How your digestive system works - Emma Bryce https://youtu.be/Og5xAdC8EUI</p>

Key elements	Suggestions
	<p>29-Digestive System, Part 2: Crash Course A&P #34 https://www.youtube.com/watch?v=pqgcElaXGME</p> <p>30-Digestive System, Part 3: Crash Course A&P #35 https://www.youtube.com/watch?v=jGme7BRkpuQ</p> <p>31-Complete vs. Incomplete Digestive Systems https://study.com/academy/lesson/complete-vs-incomplete-digestive-systems.html</p> <p>Reproductive - Frog</p> <p>32-A Brief Look at Frog Reproduction https://www.youtube.com/watch?v=itiHDJANrco</p> <p>33-External Fertilisation https://www.youtube.com/watch?v=dMvYNTI8jy0&t=12s</p> <p>Websites</p> <ul style="list-style-type: none"> • http://www.animalresearch.info/en/ • https://www.radboudumc.nl/en/research/departments/health-evidence/systematic-review-center-for-laboratory-animal-experimentation • https://www.wur.nl/en/show/Food-research-without-the-use-of-animal-tests.htm • https://swiss3rcc.org/#aboutus • https://www.pcrm.org/ • http://www.understandinganimalresearch.org.uk/ • https://www.ibmc.up.pt/institute/ethics-committee • http://thesciencebank.org/index.php?route=product/category&path=18_74 • https://www.animalsinscience.org/ • https://ec.europa.eu/environment/chemicals/lab_animals/3r/key_resources/other_en.htm • https://ec.europa.eu/environment/chemicals/lab_animals/3r/key_resources/portals_en.htm

Key elements	Suggestions
	<ul style="list-style-type: none"> • https://animalogos.blogspot.com/p/etica-animal-uma-introducao.html • https://www.animaethics.org.au/three-rs • https://norecopa.no/overview-of-european-3r-centres • https://norecopa.no/search?fq=cat:%223R%20Center%22&fq=db:%223r%22&q=*%26facet.limit=125 • https://data.jrc.ec.europa.eu/dataset/jrc-eurl-ecvam-eurl-ecvam-3rs • https://www.ingentaconnect.com/content/ufaw/aw/2005/0000014/00000004/art00011 <p>Publications</p> <ul style="list-style-type: none"> • Animal Experiments in Biomedical Research: A Historical Perspective. https://www.mdpi.com/2076-2615/3/1/238 • Animal testing. https://www.accessscience.com/content/035940 • Replacement, reduction and refinement of animal testing in the quality control of human vaccines. Brief description of ongoing projects. https://publications.europa.eu/en/publication-detail/-/publication/42c3a466-bf43-11e5-9e54-01aa75ed71a1/language-en/format-PDF/source-search • Accelerating progress in the replacement, reduction and refinement of animal testing through better knowledge sharing. https://publications.europa.eu/en/publication-detail/-/publication/58919142-f1b8-11e6-8a35-01aa75ed71a1/language-en/format-PDF/source-search • EURL ECVAM strategy for replacement of animal testing for skin sensitisation hazard identification and classification. https://publications.europa.eu/en/publication-detail/-/publication/012bb554-f93a-47a2-b642-6f32f0119bf5/language-en/format-PDF/source-search

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Aim of the lesson

- Understand why animals are used in science and what the ethical, societal and scientific challenges are.
- Raise awareness about science laboratory techniques without the use of life animals according to the Three R's principles.
- Investigate the digestive, circulatory, reproductive and respiratory systems.
- Understand the importance of biodiversity on the Earth planet.

Trends

- Project Based Learning
- Inquiry Based Learning
- Collaborative Learning
- Student Centered Learning
- Flipped Classroom
- Peer Learning

21st century skills

- Critical thinking
- Communication
- Collaboration
- Creativity and Innovation
- Problem solving
- Digital literacy
- Leadership and responsibilities

Lesson Plan

Name of activity	Procedure	Time
<p>1 - Watch videos</p>	<p>Watch a video that shows animals in their natural environment. 1-What is Biodiversity? https://www.ourplanet.com/en/video/what-is-biodiversity Following, watch three videos about the use of live animals in science, why animals are used in science and what the ethical, societal and scientific challenges are. 2-Ten medical breakthroughs thanks to animal testing. http://www.animalresearch.info/en/medical-advances/timeline/ 3-Can we do science without animal testing? https://www.youtube.com/watch?v=2hxUMpYFo_Y 4-The failure of animal experiments. https://www.youtube.com/watch?v=Mo25wUKNySq</p>	<p>10 min</p>
<p>2 - Brainstorming</p>	<p>The teacher asks the pupils what they felt after watching the videos and guides them in order to answer specific questions.</p> <p><i>Identify a problem that needs to be solved (IBL) : brainstorming</i></p> <ul style="list-style-type: none"> • What is the purpose of science? • Why are animals used in science and medicine (human and veterinary medicine)? • What are the research purposes and what are the possible outcomes? • Understand the methodologies that are used in science, and for which directions/fields: from ethology to pharmacology to ethics. • What is the historical basis for the use of animals in science? • What exactly have we learned and gained in science and medicine (progress) from the use of animals? • Has the process been effective? • What are the new developments in science, and new approach techniques not using animals (human relevant science with modern approaches and tools in science, e.g. organs-on-a-chip?.(https://www.youtube.com/watch?v=CpkXmtJOH84), computational models, organoids (https://www.youtube.com/watch?v=2CnkYtl99Cc), stem cells, embryonic cells, etc.)? • What are animal welfare aspects and what are scientific aspects? 	<p>20 min</p>
<p>3 – Classroom layout</p>	<p>The teacher divides the class in 4 groups. Each group chooses 1 out of 4 topics (animal system) and one of the questions that arose during the previous brainstorming session.</p> <p>Students are going to research the following topics: digestive, circulatory, reproductive and respiratory systems.</p>	

Name of activity	Procedure	Time
	<div style="display: flex; flex-wrap: wrap; justify-content: space-around;"> <div style="border: 2px solid magenta; border-radius: 15px; padding: 10px; width: 45%; background-color: cyan;"> <p>Group A</p> <p>a) 3R's</p> <p>b) Respiratory system</p> </div> <div style="border: 2px solid magenta; border-radius: 15px; padding: 10px; width: 45%; background-color: yellow;"> <p>Group B</p> <p>a) 3R's</p> <p>b) Reproductive system</p> </div> <div style="border: 2px solid magenta; border-radius: 15px; padding: 10px; width: 45%; background-color: orange;"> <p>Group C</p> <p>a) 3R's</p> <p>b) Circulatory system</p> </div> <div style="border: 2px solid magenta; border-radius: 15px; padding: 10px; width: 45%; background-color: green;"> <p>Group D</p> <p>a) 3R's</p> <p>b) Digestive system</p> </div> </div>	2 min
4 – Search for information	Pupils search offline and online about the system they specifically chose to investigate, as well as the question they chose before (with mobile phone/computer/tablet).	20 min
5 – Organize information	Pupils organize the information they gathered, using different tools, such as: concept mapping, videos, draws, Padlets, cards...	20 min
6 - Build a quiz	Pupils decide which questions to ask in the quiz using a Padlet (5 questions).	15 min
7- Topic presentations	Each group presents to the class their outcomes. Pupils can use different tools to address the class, like videos, ppt presentations, etc. (Flipped classroom)	7 x 4 min
8 – Pupil's quiz	<p>The class answers the questions in the quiz from each group using a Padlet. (http://www.padlet.com)</p> <p>If some pupils don't agree with selected answers, the group responsible for those questions will have to explain to the class why they choose one answer over another (Critical Thinking).</p>	5 x 4 min
9 – Build a mindmap	Pupils build a mindmap, about the 3R's policy.	15 min

Name of activity	Procedure	Time
10 – Teacher’s general quiz	The teacher implements a <u>general quiz</u> (20 questions) to assess this activity outcomes (next lesson).	20 min
11 – Visit with an expert	The pupils visit a local institute that has developed work on the 3R’s and/or an expert visits the school and talks to the pupils about the topic “animals in science”	50 min
12 -Teacher’s final query quiz	The teacher implements a <u>final quiz</u> to assess this activity outcomes (past 2 weeks).	30 min

Assessment

Here we include as an example the image of a rubric teachers can use in order to assess their students:

Final Quiz

In secondary school, university or in science research, live animals are used for educational and scientific purposes. The 3R’s policy goal is to promote animal welfare and reduce and replace animal use. This final quiz aims to assess if the LS goals were well understood by the pupils.

I - Personal data

Question 1: male ___; female____; other_____

Question 2: Year____; Class_____

Question 3: Data collect: _____

Question 4: School_____

Question 5: Country_____

II – Animals in research

Question 6: “Animals are used in research when there is a need to find out what happens in the whole, living body, which is far more complex than the sum of its parts. It is difficult, and in most cases simply not yet possible, to replace the use of living animals in research with alternative methods.”

(In: <http://www.animalresearch.info/en/designing-research/why-animals-are-used/>)

Animals are used in research in order to: **Select the wrong answer.**

- A. advance scientific understanding and as models to study disease
- B. build up a new way of make stem cells**
- C. develop and test potential forms of treatment
- D. protect the safety of people, animals and the environment

Question 7: Of the 98 Nobel Prizes awarded for Physiology or Medicine, 75 were directly dependent on research from animals.

In the last century many medical discoveries were made using animal research, such as: **Select the right answer.**

- A. Malaria
- B. Blood transfusion
- C. Leprosy treatments developed
- D. Hib – meningitis vaccine
- E. All above sentences**

Question 8: The use of animals in scientific experiments in the UK can be traced back at least as far as the 17th Century with Harvey's experiments on numerous animal species aiming to demonstrate blood circulation.

Which of the following was not one of the medical breakthroughs that had use live animals in the past?

- A. 1920's Insulin
- B. 1960's Antidepressants
- C. 2000's penicillin antibiotics**
- D. 2010's Stem cell repair

III – The 3R's Policy

Question 9: *Biodiversity/biological diversity Species, genetic, and ecosystem diversity in an area, sometimes include associated abiotic components such as landscape features, drainage systems, and climate. In order to promote animal's welfare, pupils should recognize: **Select the wrong answer.***

- A. The importance of respecting all living beings on Planet Earth.
- B. The importance of biodiversity in human welfare.
- C. The importance of transforming biodiversity into money.**
- D. The importance of promoting a policy that respects all living species.

Question 10: William Russell and Rex Burch developed the concept of the Three R's during the 1950's, and described them in their book *The Principles of Humane Experimental Technique* (1959). The meaning of Three R's, are: **Select the right answer.**

- E. Replacement, Reduction, Recycling
- F. Replacement, Reduction, Refinement**
- G. Reduction, Returning, Refinement
- H. Refinement, Reporting, Reduction

Question 11: The meaning of replacement is: **Select the right answer.**

- A. Methods which permit a given purpose to be achieved without conducting procedures on animals**
- B. Methods that can be applied on wild animals
- C. Replace animals for others
- D. Replace techniques for others that include the use of animals

Question 12: The meaning of reduction is: **Select the right answer.**

- A. Methods for obtaining comparable levels of information from the use of a lot of animals in scientific procedures, or for obtaining more information from the same number of animals
- B. Methods for obtaining comparable levels of information from the use of fewer animals in scientific procedures, or for obtaining more information from the same number of animals**
- C. Use less specific animal species instead of others
- D. Use less specific techniques instead of others

Question 13: The meaning of refinement is: **Select the right answer.**

- A. Animal welfare don't matter
- B. Replace animals for mannequins
- C. Animals are raised to support pain relief
- D. Methods which minimize potential pain, suffering or distress, and which enhance animal well-being**

Question 14: There are 29 European 3R Centres. **Select the wrong answer.**

- A. CAAT- Europe: Centre of Alternatives to Animal testing, located at the University of Konstanz in Germany.
- B. i3S, located at the Porto University Portugal.**

- C. ROCAM (Romanian Center for Alternative Test Methods) in Romania
- D. Walcopa (Wallonia Consensus Platform for Alternatives) is a Belgium 3R Centre.

Question 15: *There are three areas where animals may be used for education purposes or training: **Select the wrong answer.***

- A. For the demonstration of biological procedures.
- B. In the professional training of those who will be involved in animal care eg veterinarians, veterinary nurses or those involved in the animal care industries.
- C. To ensure those who wish to use animals for scientific purposes have the necessary skills and knowledge, e.g. research personnel and post-graduate students.
- D. To make pupils more intelligent in class or training.**

Question 16: *When planning research that may involve the use of live animals it is required by law to examine the possibilities for replacement, reduction or refinement (the Three Rs) of these experiments in: **Select the right answer.***

- A. all countries
- B. many countries**
- C. few countries
- D. no country

Question 17: *Lately, scientists use alternative techniques with positives results for humans, such as: **Select the right answer.***

- A. Living animal models
- B. Virtual games
- C. Cell cultures**
- D. Animations

Question 18: *In science research, the use of lab animals is expensive because: **Select the right answer.***

- A. It is necessary to take care of the animals in labs according to precise legislation**
- B. They need to be fat
- C. They must go frequently to the vet

D. It's hard to reproduce the species

Question 19: *Humans and other mammals have similarities in their metabolism. However, science research outcomes are frequently _____ for predicting how valid a medicine will be for humans. **Select the right answer.***

- A. Very reliable
- B. Trustable
- C. Unreliable**
- D. Better

Question 20: *Using computer models in science research is an alternative to the use of _____ in the laboratory experiments. **Select the right answer.***

- A. Live Animals**
- B. Protista
- C. Fungi
- D. Bacteria

Question 21: *A dissection video of a Rat, Cat, Frog, Pigeon, can show each and every step of the dissection process using the most up-to-date equipment and techniques. This alternative method can: **Select the right answer.***

- A. Increase pupils skills about animal's morphophysiology**
- B. Decrease pupils skills about animal's morphophysiology
- C. Amuse pupils but doesn't help them to understand animal's morphophysiology
- D. Distract pupils and help them to understand animal's morphophysiology

III. Digestive system - DS (Rats or humans or Frogs)

Select the right answer in the following questions:

Question 22: *The digestive system in different species is comparable because:*

- A. They all eat meat
- B. They are all warm blooded animals
- C. They are cold blooded animals
- D. The digestive system starts at the mouth and ends into the anus.**

Question 23: The main task of DS is transforming the raw materials of your ____ into the _____ and energy to keep you _____.

- A. Food, nutrients, alive**
- B. Nutrients, food, death
- C. Nutrients, food, alive
- D. Food, nutrients, death

Question 24: We produce about _____ litres of saliva each day. In the mouth, sloshing saliva and chewing turn food into a moist lump called the _____.

- A. 1.5... chyme
- B. 1.5 ... bolus**
- C. 0.5... bolus
- D. 0.5... chyme

Question 25: In the _____ the nutrients pass from the small intestine into blood by _____ transport.

- A. Ingestion... passive
- B. Ingestion... active and passive
- C. Absorption...active
- D. Absorption...active and passive**

Question 26: Once the nutrients are inside the cell the ____ will be used to build new _____.

- A. Energy... organs
- B. Energy... tissues**
- C. Enzymes... tissues
- D. Enzymes... organs

IV. Respiratory system (Birds)

Select the right answer in the following questions:

Question 27: The avian respiratory system is the _____ system in the _____ kingdom.

- A. most efficient... animal**
- B. most efficient... fungi
- C. least efficient... animal
- D. least efficient... fungi

Question 28: The functions of the respiratory system are: supply _____ to the body and remove _____ produced during metabolic activity.

- A. O_2 ... O_2
- B. CO_2 ... CO_2
- C. O_2 ... CO_2**
- D. CO_2 ... O_2

Question 29: Birds air sacs _____ a direct role in gas exchange. There are _____ of them.

- A. do not play ... nine**
- B. play ... nine
- C. do not play ... five
- D. play ... five

V - Circulatory system (Rabbit or Rat)

Select the right answer in the following questions:

Question 30: Water and oxygen are essential for the existence of vertebrate animals, such as rabbits. The blood transports all these substances through blood vessels. They are:

- A. Arteries and veins
- B. Arteries, and capillaries
- C. Arteries, veins and capillaries**
- D. Veins and capillaries

Question 31: The rabbit heart has four chambers: Right atrium, Right ventricle, Left atrium and Left ventricle. The deoxygenated blood circulates in:

- A. Right atrium and Right ventricle**
- B. Left atrium and Left ventricle
- C. Right atrium and Left ventricle
- D. Left atrium and Right atrium

Question 32: The heart of mammals have 4 locations with valves, such as mitral or tricuspid. These valves are:

- A. Two way valves
- B. Three way valves
- C. One way valves**

D. Four way valves

VI - Reproductive system (Frog)

Select the right answer in the following questions:

Question 33: Most frogs mate and produce their babies in water. Eggs hatch in an immature form called a _____.

- A. Tadpole**
- B. Zoe
- C. Little frog
- D. Megalopa

Question 34: External fertilization is very common in aquatic animals, fish, starfish, frogs, etc. The fertilization is the fusion of the male gamete _____ and the female gamete _____ takes place outside the female body.

- A. Sperm ... egg**
- B. Egg ... sperm
- C. Tadpole ... egg
- D. Sperm ... tadpole

VII - Use or not to use animals in labs

Question 35: Choose the option(s) that meet(s) your feelings about animal welfare in science..

- A. Replacement
 - B. Reduction
 - C. Refinement
 - D. All the above
 - E. Other:
-

Students' and teachers' feedback after the implementation of the Learning Scenario during the Pilot phase of the project

Student feedback

- The students who took part in the implementation of the Learning Scenario, filled in the surveys prior and after the course and completed the quiz were enthusiastic about the topic and expressed their interest to combine the implementation of the Scenario with a visit to a research center and/or discuss with an expert further. In addition, they enjoyed the research methodology and the tools used.

Teacher's remarks

- While an estimated time that will be needed for the implementation of the Learning Scenario is given by the authors, in order to ensure that all the activities will take place teachers are advised to consider the study of some materials as homework prior to the lesson. This can be a collaborative activity in order to ensure that all students will benefit. Consider having groups with students of mixed abilities.
- Apart from the allocated time, plan carefully the use of computers for all the activities/tasks that students need to undertake (e.g. Padlets, online maps, etc).
- Teachers are advised to modify the content of the planned activities according to their students' level and prior knowledge.
- Teachers can collaborate with their colleagues (computer science for the use of online tools, ethics, ESL teacher to help with the translation of materials available only in English and so on).
- Students are expected to reflect on delicate matters and express themselves generating interesting discussion; teachers can consider gathering those opinions and explore the result of the discussion further.
- Teachers can consider inviting an expert or take their students on a field visit. They can explore all possibilities, including a virtual visit at a lab.

Authors recommendation: Teachers in each country are encouraged to select a local science institute or science faculty, in order to have an expert that can talk to the pupils about the 3R's policy. For this LS, we chose i3S (<https://www.i3s.up.pt/>), in Porto, and Instituto Gulbenkian de Ciência - IGC (<http://www.igc.gulbenkian.pt/>), in Oeiras-Lisbon. Both of them located in Portugal.

Recommended research centres in other countries include:

- Center for Alternatives to Animal testing – Europe, University of Konstanz, Germany;
- Doerenkamp Center (MGDC) for Alternatives to Use of Animals in life Science education, Bharathidasan University, tiruchirappalli, India;
- DoerenkampZbinden Chair on Alternatives to Animal testing in toxicological Risk Assessment, Institute for Risk Assessment Sciences, Division of toxicology, Utrecht University, the Netherlands;
- Department of Veterinary Sciences technologies for Food Safety, Università degli Studi di Milano, Italy;
- Doerenkamp-Naef-Zbinden Chair on In vitro alternatives to animal experiments, Geneva Faculty of Medicine, Switzerland;

- Institute for In Vitro Sciences, Inc., USA;
- Doerenkamp-Zbinden Chair for evidence-based toxicology and Center for Alternatives to Animal testing, Johns Hopkins Bloomberg School of Public Health, Dept. environmental Health Sciences, Baltimore, USA;
- Doerenkamp-Zbinden Foundation, Switzerland;
- Animal Welfare & laboratory Animal Science and Animals in Science & Society, Faculty of Veterinary Medicine, Utrecht University, the Netherlands;
- Innsbruck Medical University, Department of Physiology and Medical Physics, Division Physiology, Austria;
- 3Rs-Centre Utrecht life Sciences, and NKCA, Department of Animals in Science and Society, Faculty of Veterinary Medicine, Utrecht University, the Netherlands;
- Departament de Fisiologia, Facultat de Farmàcia, Universitat de Barcelona, Spain;
- University of Konstanz, Toxicology and Pharmacology, Konstanz, Germany;
- Doerenkamp-Zbinden Chair for Biomedicine and in vitro toxicology, University of Konstanz, Germany

About 3Rs project

This Learning Scenario has been created in the framework of the 3Rs project. The 3Rs project is building learning activities for secondary schools to introduce the principles of the 3Rs - the Replacement, Reduction and Refinement of animal use in science. Students will develop their critical thinking and science literacy skills by exploring topics such as ethics in science, how the European Union is protecting the welfare of laboratory animals, and what high-tech non-animal tools are available as alternatives. The learning activities are available for teachers in a Massive Open Online Course (MOOC), organized by the European Schoolnet Academy.

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