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Snail-powered science: hands-on biology for active classrooms

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Using pond snails as a low-cost, hands-on model to teach biology and environmental science in secondary schools.

Introduction

What effects do everyday pollutants, like detergents, and low-oxygen conditions have on the pond snails' survival and behaviour? What can they teach us about stress and behaviour? And how can such experiments foster critical thinking, environmental awareness, and ethical practice within a STEAM-aligned curriculum?

Lymnaea stagnalis, commonly known as the great or common pond snail, is a freshwater pulmonate gastropod mollusc found in ponds, lakes and slow-moving streams across Europe, Asia, and parts of North America.[1] It inhabits the shallow, vegetation-rich edges of water bodies and typically feeds on algae and decomposing plant matter.[2]

In our laboratory, the snails live around 12 to 18 months and are easily maintained, producing a high number of offspring all year round, and laying their eggs on the aquarium walls. The snails are hermaphrodites and reach sexual maturity two to three months after egg laying.[2,3] Under controlled conditions (20°C, 50 ml of chlorine-free tap water), pond snail embryos complete development in approximately 16 days, with a survival rate of around 90%.[4] Embryos develop inside transparent eggs packaged in a translucent gelatinous mass of about 2–6 cm, containing 20 to 160 eggs,[2] allowing observers to follow their developmental stages in detail. The snails are prey for various aquatic organisms such as fish, crayfish, amphibians, mammals and birds and they play a role in decomposition, making them a key organism in aquatic food webs.[5] Studies show that pond snails exhibit lasting anxiety-like behaviours, such as altered breathing, righting, and escape, after being exposed to predator cues.[6] These persistent responses make them a valuable model for exploring stress and mental health in school-level scientific experiments. The use of *L. stagnalis* in teaching brings biology to life and encourages hands-on learning experiences. By observing and interacting with living organisms, students can develop critical thinking skills, scientific inquiry and a deeper appreciation for the natural world.

Getting *L. stagnalis*

Contact a biology department at a university. Some use *L. stagnalis* and are willing to provide animals for educational purposes. Or purchase from a pet shop.

How to culture pond snails

Cultures can be maintained in home aquariums (> 5 litres) filled with tap chlorine-free water kept at a pH of 6.5–8.5 at 20 ± 2°C under a light-dark period of 14/10h and fed lettuce *ad libitum*. Siphon the tank every week to remove faeces. A density of 50–100 adult snails per 35 litres aquarium is generally used (it should not be higher than 5 adults per litre).

Pond snail
Image courtesy of the authors

Nice to know

The snails produce a slippery mucus that helps them glide along surfaces, including the undersides of water, without sinking. This mucus not only aids movement but also helps to protect them from predators.
Snails have a specialised feeding structure called a radula that acts like a tongue covered in tiny teeth. This radula allows them to scrape and devour their food.

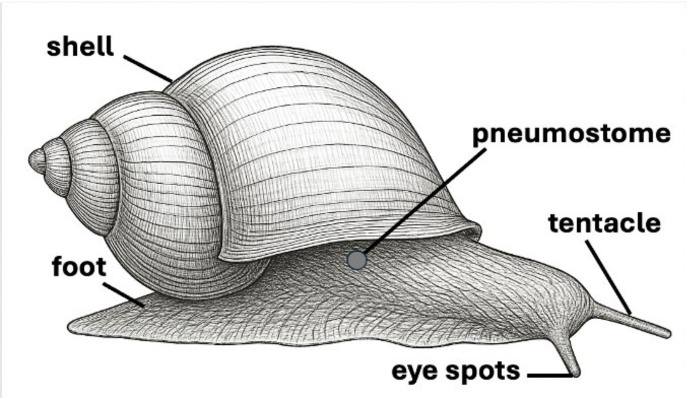
Learning with living creatures: ethics in the science classroom

Bringing live animals into the classroom is an inspiring and memorable way to teach biology. Observing real organisms helps students to engage more deeply with life processes and develop a genuine curiosity about the natural world. Yet, these experiences also come with a responsibility. Modern approaches to science teaching increasingly emphasise respect for living organisms.

Teachers should follow the three guiding principles of ethical research – Replacement, Reduction and Refinement – (the 3Rs) whenever animals are used in lessons. This means replacing live animals with models or videos wherever possible, reducing the number of animals used to the absolute minimum, and refining activities to ensure they cause no harm or distress. Focusing on simple, low-impact observations of innate behaviours – those that animals perform naturally, without prior learning – provides rich opportunities for study while maintaining high ethical standards.

It is also important to encourage students to think about the ethical side of science itself. Discussing why and how animals are used helps them to understand that ethical reflection is an inseparable part of scientific work.[7] Such conversations connect ideas about responsibility in research with the broader values of empathy, sustainability and respect for life – all essential lessons for the citizens and scientists of tomorrow.

Activity 1: Living on the edge – how pond snails cope with low oxygen



Anatomy of a pond snail
AI-generated with ChatGPT (OpenAI) based on scientific instructions provided by the authors

Pond snails are special animals because they can breathe both through their skin and by coming to the surface to take in air through a tiny opening called a pneumostome (i.e., respiratory orifice). This experiment helps us understand how these snails behave when the water has less oxygen. It's a good way to explore how living things adapt to their environment.

The activity is suitable for students aged 11–19 and will take 30–45 minutes to complete.

Material

- 2 glass transparent containers or plastic containers (e.g., 200 ml beakers)
- 200 ml aged/dechlorinated tap water
- 200 ml aged/dechlorinated tap water that has been boiled for three minutes to remove oxygen and cooled to room temperature (low-oxygen water)
- 2 pond snails
- Labels or waterproof markers
- Activity 1 worksheet

Procedure

1. Label the containers as A and B, then fill one with normal water and the other with low-oxgen water.
2. Place one snail into each container gently.
3. Let them settle for 5 minutes. Observe quietly.
4. Watch and record for the next 10 minutes:
   • How many times does the snail go to the surface?
   • Does the snail stay at the surface for a long time, or only briefly?
5. If time allows, swap the snails into the other container and repeat steps 3 and 4.

Image courtesy of the authors

Discussion

After observing the breathing behaviour of snails in different oxygen conditions, it is important to reflect on what we saw and why it matters. These discussion questions will encourage deeper thinking about how living organisms adapt to changes in their environment.

Example answers can be found in the supporting material.

- What differences did you notice in the snail's behaviour in the two types of water?
- Why do you think low oxygen water causes this behaviour?
- How does the pneumostome help pond snails survive in different environments?
- How might pollution or climate change affect the level of oxygen in ponds?
- What improvements could be made to this experiment?
- How could this experiment relate to real environmental research?
- How can we study snail behaviour ethically while ensuring scientific curiosity does not harm animal welfare?

Activity 2: Anxious snails – how water conditions affect righting behaviour

Anxiety, a behavioural consequence of stress, triggers a range of adaptive or defensive behaviours aimed at escaping from potential threats.[6] This experiment explores the righting behaviour of the pond snail under different water conditions. Measuring how long a snail takes to flip back over can indicate stress or changes in motor function. This simple behavioural response helps us to understand how environmental factors may affect snail activity. These behaviours are crucial for survival, helping animals to avoid potential dangers in their environment.

The activity is suitable for students aged 11–19 and will take 20–30 minutes to complete.

Safety Notes

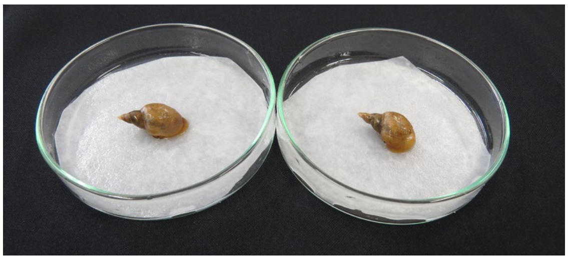
Ensure that the water is at room temperature before putting the snails in.
Handle the animals gently and return them to their habitat after the experiment.
Caffeine can be toxic to snails, even at relatively low concentrations. Use only very diluted solutions (maximum 0.05%) in classroom activities. As caffeine content of coffee varies between brands, all solutions should be prepared with care to avoid harming the animals.

Materials

- Filter paper
- Water culture (aged/dechlorinated tap water)
- Fish water (water from a fish tank containing fish) or diluted coffee (diluted with water at a ratio of 1:50 to 1:100)
- 2 pond snails
- 2 petri dishes or other small containers
- Activity 2 worksheet

Procedure

1. Expose a pond snail to filter paper that has been soaked in either water culture (the control sample) or with fish water/diluted coffee for two minutes.
2. Flip the snails onto their dorsal surface. Dislodge each snail 5 times.
3. Record the mean righting time for each treatment.



Start of the experiment showing two pond snails placed on soaked filter paper before testing righting behaviour in water culture (left) and fish water/diluted coffee (right) treatment.
Image courtesy of the authors

Discussion

Example answers for activity 2 can be found in the supporting material.

- What is the purpose of measuring righting behaviour in snails?
- Why do you think fish water might influence the snails' behaviour differently compared to culture water?
- How might differences between individual snails affect the interpretation of results?
- What other types of snail behaviour could be studied to assess the health of freshwater ecosystems?
- How could the results of this experiment be connected to human health, particularly mental well-being?
- What ethical responsibilities do scientists have when studying living snails? And how can experiments be designed to respect animal welfare while still producing meaningful data?

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Resources

- Read an article about the ethical considerations of using invertebrates in research.
- Gain insights into the biology of regeneration and the nervous system by using planaria as a model organism: Faria HM, Fonseca AP (2023) Hands-on experiments with planaria. *Science in School* **64**.
- Find out how scientists try to figure out our response to fear: Stanley S (2011) A neural switch for fear. *Science in School* **18**: 32–35.
- Try this role-playing activity to teach your students about synaptic transmission: Andersen-Gassner M, Möller A (2023) Hold your nerve: acting out chemical synaptic transmission. *Science in School* **63**.
- Learn about the importance of animal use in research and some cutting-edge approaches to minimizing it: Schmerbeck S et al. (2021) Organ-on-chip systems and the 3Rs. *Science in School* **54**.

- Find out why fear is important for our survival: Viosca J (2015) An almost fearless brain. *Science in School* **33**: 16–19.
- Discover what Daphnia can teach us about biology and ecology: Faria HM, Fonseca AP (2022) From drugs to climate change: hands-on experiments with Daphnia as a model organism. *Science in School* **59**.
- Learn how biomimicry can be an inspiring teaching tool that engages students by solving real-world problems: Dawson R (2024) Biomimicry: a nature-based approach to designing sustainable futures. *Science in School* **69**.
- Read about the impact of human activity on climate change and its consequences for the Earth: Follows M (2019) Ten things that affect our climate. *Science in School* **47**: 19–25.
- Have your students make climate change predictions: Shallcross D, Harrison T (2008) Climate change modelling in the classroom. *Science in School* **9**: 28–33.
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AUTHOR BIOGRAPHY

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