Tadpole Doctor Science Engagement Project: Curriculum Notes for Schools

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The Tadpole Doctor project aims to engage schools, members of the public, zoos, and frog breeders in a scientific outreach program to assess the prevalence and spread of a microbial pathogen of tadpoles. Globally, frogs are among the most threatened animal groups, and infectious diseases have been shown to be a key factor in frog decline (e.g. Skerratt et al. 2007, Isidoro-Ayza et al. 2017, Smilansky et al. 2021).

The microbe thought to be responsible for the disease in tadpoles has been detected across the US and in Central America. Working with a member of the public we have recently demonstrated that it is present in UK breeding colonies of frogs (Smilansky et al. 2021). The aim of this project is to engage a wide diversity of members of the public to become team members and provide samples so that we can assess natural ecosystems and maintained colonies for the presence of the frog parasite using DNA sequencing technologies.

What do we get: a geographically diverse team of citizen scientists who will help us sample a wide range of environments where frogs breed across the UK.

What do schools get: engagement with ongoing scientific research with clear links to promoting learning through the Key Stage 2 National Curriculum; experience of the scientific process; and a chance to discuss themes and results of our collective research efforts directly with scientists from the University of Oxford.

The parasite offers no risks to humans, but please enforce the highest safety practices if you take part in field work, especially around ponds.

To support the project, we have a website[1] where interested schools can register, make contact, follow the project, and view the results derived from their scientific sampling. To support the project and facilitate interactions further we have made a film[2] which is supposed to be humorous in the same vein as Horrible Histories. **This film introduces the project, provides some introduction to the background subject, sets up points for discussion and class learning, and provides a guide on how to complete the sampling process.**

The film provides three review/pause points, so that classes can stop the film and engage in discussions related to prior/new learning and related practical work and ensure understanding of key vocabulary. These opportunities can include illustrating a frog life-cycle or describing the needs of different animals. These elements are discussed below.

[1] http://tadpole-doctor.co.uk

[2] https://www.youtube.com/watch?v=-K_1nCR8L6U

The first pause point is at 2 minutes and 24 seconds and is titled 'let's think about microbes'.

The Tadpole Doctor

This section is set up to encourage classes to engage with the idea that most of life on Earth, in terms of diversity, is tiny microbes. These tiny microbes are important because they make lots of chemicals we need to live: for example, some of these microbes release oxygen, in a similar way to plants. This is important for the air we need to breathe. They also make important chemicals like vitamins in our digestive system and, without these vitamins, we would not grow properly. These processes are really valuable, so we should reconsider our views about microbes and not consider that all microbes are our enemies.

The film then contrasts this idea with the fact that some microbes also cause disease. This should allow teachers to introduce the concept of germ theory to the class. Specifically, microbes that can cause disease can be passed from environment-to-environment, animal-to-animal or person-to-person. Like this, the microbes, and therefore the disease, can be spread all around the world.

Links to the curriculum:

Re-visiting and consolidating prior learning:

In Key Stage 1 children will have learnt about the basic needs of animals for survival and the importance of hygiene for health.

Year 4:
Children recognise that environments can change and that this can sometimes pose dangers to living things.

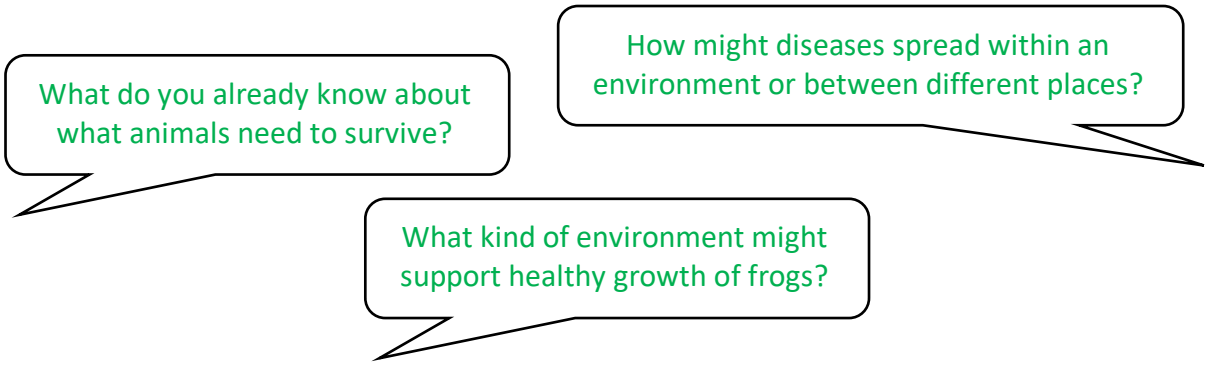
Year 5:

Children study and raise questions about their local environment.

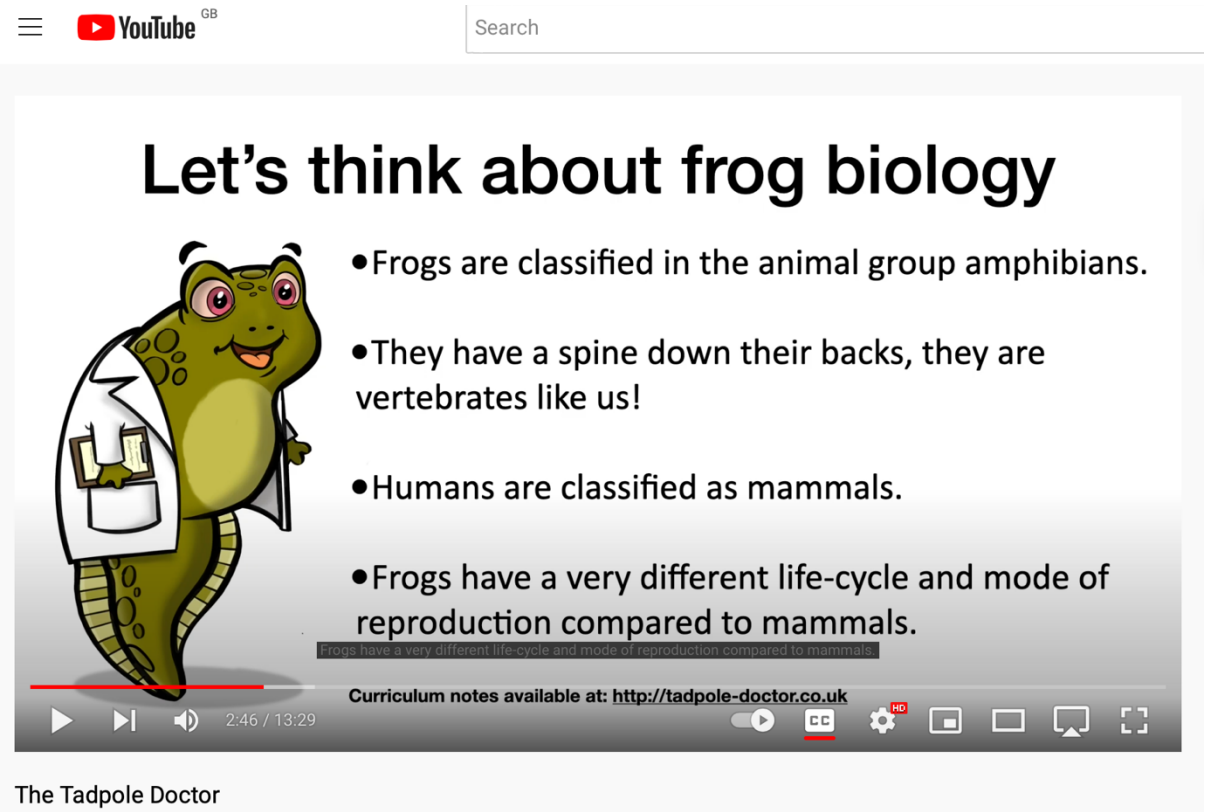
Year 6:

Children describe how living things are classified into broad groups according to common observable characteristics and based on similarities and differences, including micro-organisms, plants and animals. They recognise the impact of diet, exercise, drugs and lifestyle on the way their bodies function.

(National Curriculum in England: Science Programmes of Study, May 2015)

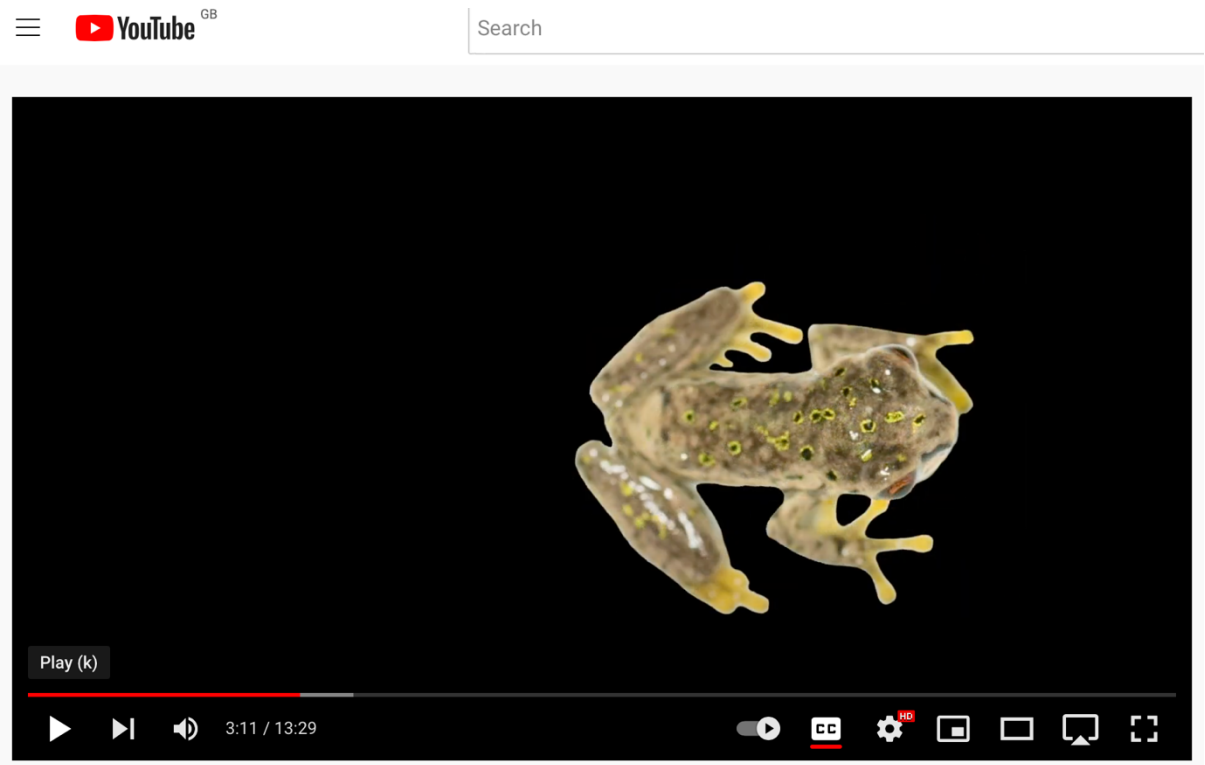


The second pause point is at 2 minutes and 46 seconds and is titled 'let's think about frog biology'.



The Tadpole Doctor

This section is set up to encourage classes to engage with principles of how we think about animal diversity. Firstly, it outlines how frogs and humans are classified into different major taxonomic groups (mammals vs amphibians). It introduces how humans are viewed as related to frogs because both humans and frogs have vertebrae (spinal column). It then introduces the idea that frogs have a very different life-cycle and mode of reproduction to humans. To support this further we then show a multi-frame-capture film of tadpole-to-frog development (2 mins and 50 seconds). This is narrated to explain the frog life-cycle. This is set up so teachers can demonstrate and discuss reproductive life cycles and metamorphosis. Discussions of metamorphosis, development and/or reproduction could, for example, compare frog development to that of caterpillars-to-butterflies or hens' eggs-to-chickens.



The Tadpole Doctor

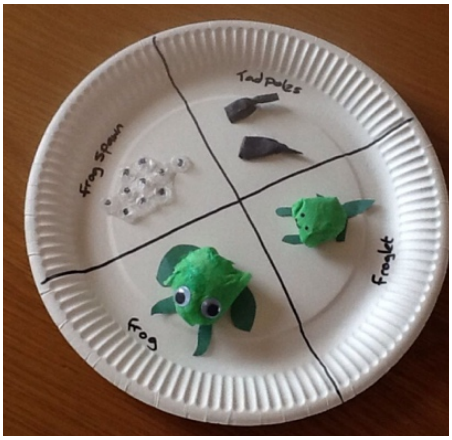
Links to the curriculum:

Re-visiting and consolidating prior learning:

In Key Stage 1 children will have learnt how to identify and describe different types of animal, and explored some similarities and differences between them, as well as relating some of their features to the environments they live in. They will have learnt that all animals have offspring that grow into adults, and may have learnt about examples of life cycles such as butterfly, bird or frogs.

Year 3:
Children learn more about nutrition and movement in animals, and group animals in different ways (e.g. with or without skeletons).

Year 4:
Children recognise that living things can be grouped in a variety of ways. They explore and use classification keys to help group, identify and name a variety of living things in their local and wider environment.



Beautiful example of project work to show the life-cycle of a frog.

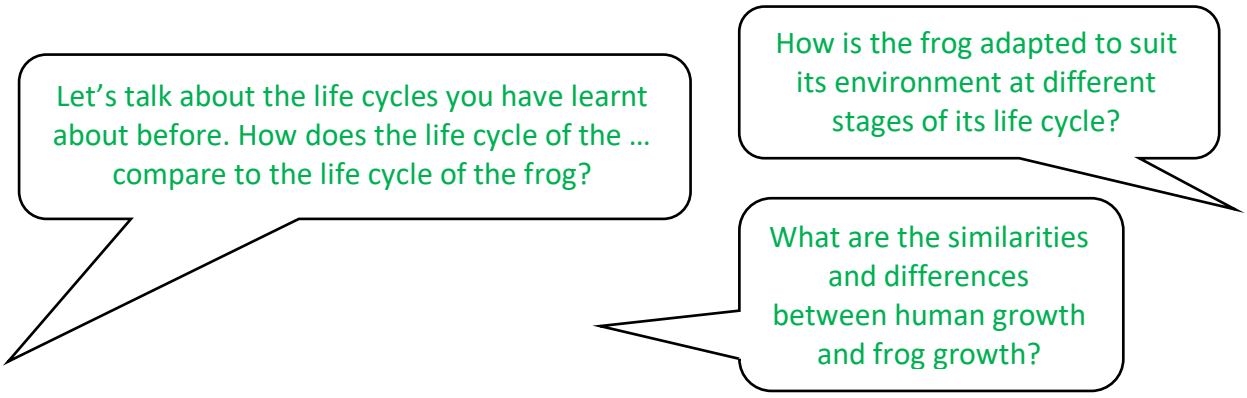
Year 5:

Children learn to describe the differences in the life cycles of a mammal, an amphibian, an insect and a bird. They describe the life process of reproduction in some plants and animals and describe the changes as humans develop to old age.

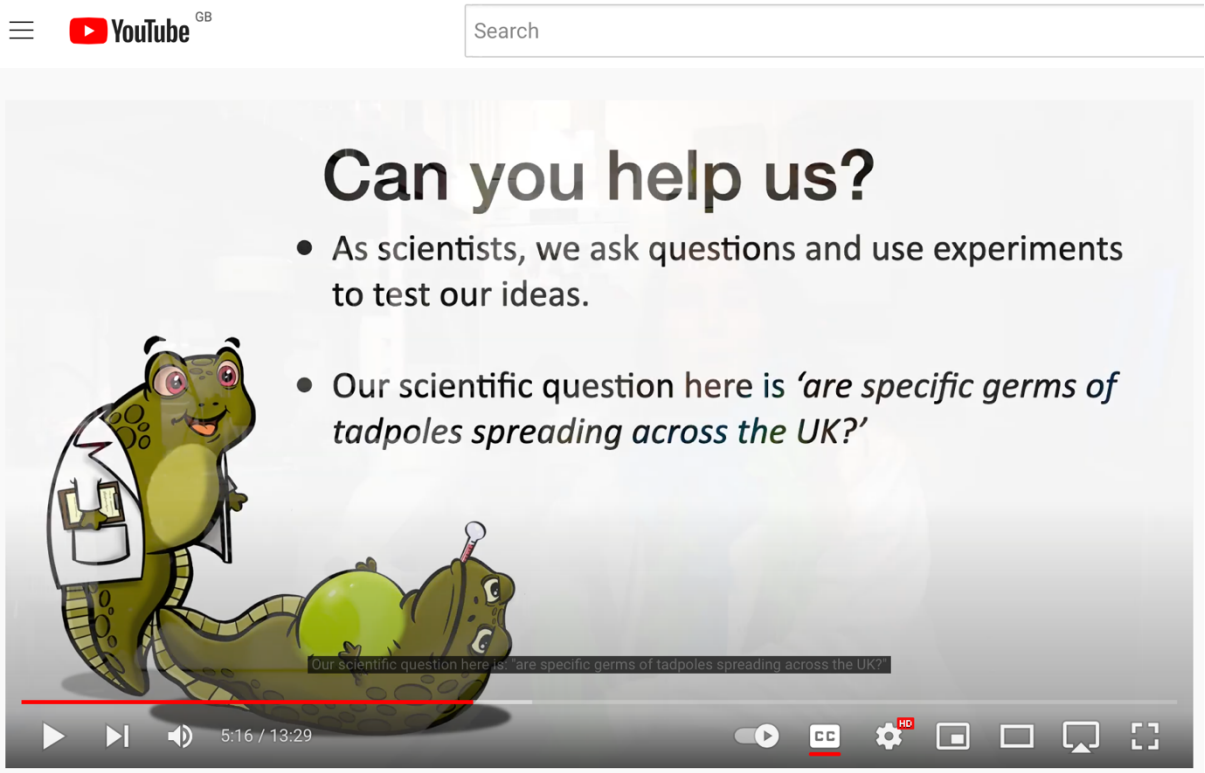
Year 6:

Children give reasons for classifying plants and animals based on specific characteristics and identify how animals and plants are adapted to suit their environment in different ways and that adaptation may lead to evolution. They recognise that living things produce offspring of the same kind, but normally offspring vary and are not identical to their parents

(National Curriculum in England: Science Programmes of Study, May 2015)



The third pause point is at 5 minutes and 16 seconds and is titled 'Can you help us?'.
This section is set up to introduce the scientific method and explain to children what hypothesis (idea) we want them to help us test. We feel it is extremely important to introduce the concept of how 'as scientists' we propose an idea (a hypothesis) and then design an experiment to test it. Here the idea is that the 'germ' that causes the disease in tadpoles is spreading. We test this hypothesis by getting samples (the work of the schools) and testing them for traces of the germ (we do this using DNA technologies). If we detect the germ we will have evidence of spread. If we do not detect it, we will have evidence that the germ has not spread to that particular pond. Both results are extremely valuable.

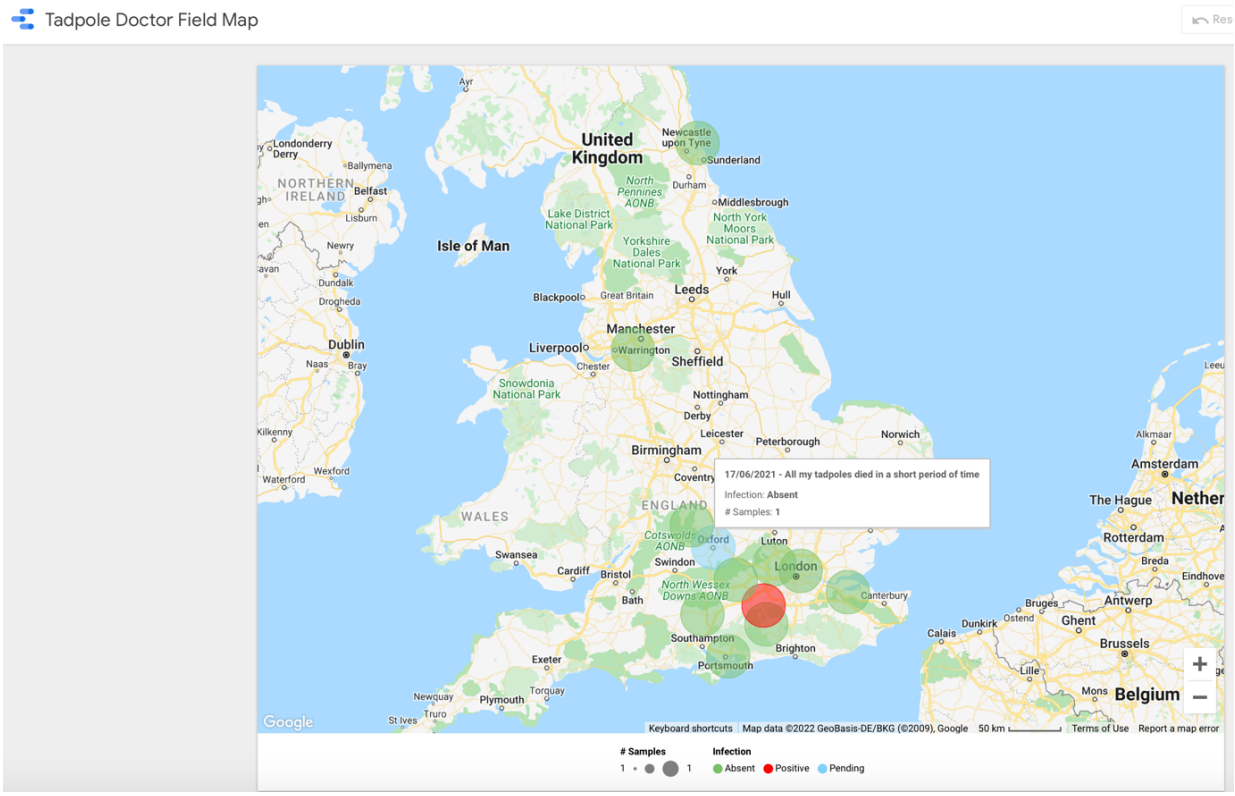


The Tadpole Doctor

The remaining section of the film then explains how schools can use the kit that we will provide to sample their local ponds for evidence of the tadpole germ.

As the project progresses we will report the results from all the samples provided on our website. In that way classes can see the results of their engagement. This would be an especially good time for you to invite us to

visit or take part in a Zoom/Teams/Skype call to discuss the project, background, associated scientific themes and results. If you send us pictures of your ponds or artwork the children have created we can also include it in the website.



Example of results recovered in collaboration with citizen scientists presented on the tadpole-doctor.co.uk website.

Links to the curriculum:

Working with the project supports the disciplinary ("working scientifically") elements of the national curriculum at all ages. Children are encouraged to ask questions, learn and use scientific vocabulary and develop and apply understanding of methods, processes and skills. These include:

- planning different types of scientific enquiries to answer questions
- taking measurements, using a range of scientific equipment, with increasing accuracy and precision
- recording data and results
- reporting and presenting findings from enquiries, including conclusions, causal relationships and explanations in oral and written forms such as displays and other presentations
- identifying scientific evidence that has been used to support or refute ideas or arguments

(National Curriculum in England: Science Programmes of Study, May 2015)

Additional opportunities for curriculum enrichment and discussion:

Why does this type of scientific research matter? If a species is affected by disease, how might this impact on other wildlife and the environment?

How does our work have the potential to have a positive impact on our environment? What else can we do to protect habitats and wildlife?

We have been learning about research science and engaging with scientists. Which other careers can you talk about that involve applying science? Which of them interest you? How could you find out more about them?

We hope these notes are useful. Further suggestions are welcome. Please do get involved.

Information

Website to follow the project and register for a sampling pack: http://tadpole-doctor.co.uk

Email address to contact us directly: contact@tadpole-doctor.co.uk

Film describing the background (with educational pause points) of the project and how to sample: https://www.youtube.com/watch?v=-K_1nCR8L6U

References:

1. Skerratt, L.F., Berger, L., Speare, R. *et al.* Spread of Chytridiomycosis Has Caused the Rapid Global Decline and Extinction of Frogs. *EcoHealth* **4,** 125 (2007). https://doi.org/10.1007/s10393-007-0093-5
2. Isidoro-Ayza M, Lorch JM, Grear DA, Winzeler M,Calhoun DL, Barichivich WJ. 2017 Pathogenic lineage of Perkinsea associated with mass mortality of frogs across the United States. Sci. Rep.7, 10288. https://doi:10.1038/s41598-017-10456-1
3. Smilansky V, Jirků M, Milner DS, Ibáñez R, Gratwicke B, Nicholls A, Lukeš J, Chambouvet A, Richards TA. 2021 Expanded host and geographic range of tadpole associations with the Severe Perkinsea Infection group. Biol. Lett.17: 20210166. https://doi.org/10.1098/rsbl.2021.0166
4. *(National Curriculum in England: Science Programmes of Study, May 2015)*