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Measuring is believing: quantifying adaptation behaviour of *Hydra*

Info sheet: the scientific method

How do scientists conduct experiments?

Your first thought might be to jump directly to the experiment, putting on a lab coat and safety goggles. Stop! Before scientists do experiments, they observe and ask a question. Then they do some background reading to find out what is already known. A scientist has a strategy called the scientific method (figure 1). The scientific method consists of a circular series of steps. Each step is explained below.

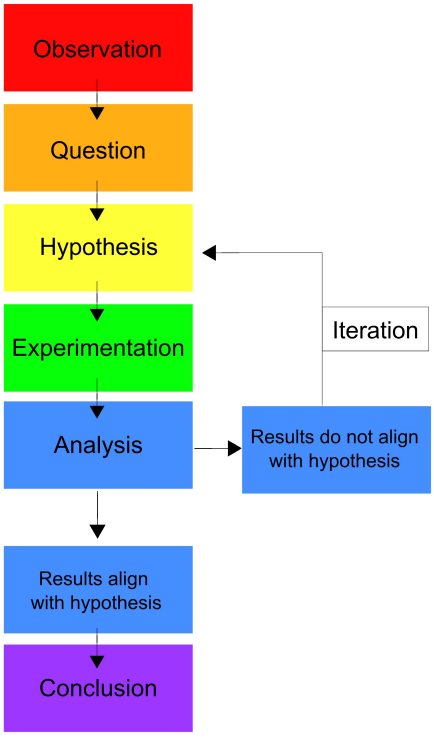

Figure 1: The scientific method
Image courtesy of the authors

1. Observation

Scientific inquiry begins through observation. What do you see, smell, taste, hear, or touch that interests you? What catches your attention? For example, a biologist's observation would be that plants' leaves reach in the direction of sunlight next to an open window.

2. Question and background research

From observations, scientists generate questions and conduct background research to gain a firm understanding of the topic before proceeding. From the previous example, a question that might

pop up is: Is the direction of plant growth dependent on light? The scientist will gather as much information about light-dependent plant growth as they can, to understand what is known and how they can contribute new knowledge to the question.

3. Hypothesis

Next, scientists write a statement to potentially answer this question. This explanation statement is called a hypothesis and must be testable through experimentation. In our example, this could be that plants grow into the direction of light because they need the energy from light to make food.

4. Experimentation

This is where scientists conduct the actual experiment! Experiments start with a list of materials required for the experiment and a procedure ("Protocol") that details each step. Scientists take careful notes of their experiments, so they can be reproduced. Experiments may support the hypothesis or not. In our example, an experiment could be placing the plant inside a box with a hole on one side, then waiting a few days and observing the direction of plant growth.

5. Iteration

Often, scientists have to modify their hypothesis or design a different experiment. Each scientific question typically requires multiple different experiments (and a lot of trial and error for designing the 'perfect' experiments to test a hypothesis). Science is a team effort and multiple researchers work together or build on each other's work to answer a scientific question. This iterative process is a natural step in science and can take weeks, even years. Practice makes perfect!

6. Analysis

Once good scientific results are obtained, it is time to analyse and interpret the data. How can you make sense of what you discovered? Does it support or disprove your hypothesis? If we found that plants grow in the direction of the cut hole in the box, we say that our hypothesis is likely to be true.

7. Conclusion

Finally, we state the conclusion for the experimental question we explored. This is a summary of your results: whether it supports/contradicts your hypothesis, the experimental setup, data obtained, and future directions, including proposed changes to the procedure and any new questions that arise from the results of your experiment.[1,2]

References

[1] What is the scientific method and which steps does it include: https://www.sciencebuddies.org/science-fair-projects/science-fair/steps-of-the-scientific-method

[2] The scientific method explained in examples: https://www.khanacademy.org/science/biology/intro-to-biology/science-of-biology/a/the-science-of-biology.