

## A Scientific Recipe? Podcast

Hello again! My name is Ellie, and if you recall, I am on the team of advisors for environmental science and sustainability. My area of expertise is the biodiversity in the Amazon rainforest. I am here with you today to talk about the scientific process. But before we get too far, I want to ask you a question. Does science follow an unvarying, linear recipe? In other words, do we always use the same set of steps to solve a problem?

Well, the answer here is no. Scientists conduct many different kinds of research in a variety of ways and sequences. Often observations, tests, or conclusions can lead to new questions or refinement of original ideas. Science is dynamic, unpredictable, and always ongoing. Let me give you an example. A colleague of mine set out to determine the level of toxicity of the poison dart frogs in the genus *Dendrobates*. It is believed that some species of dart frogs may secrete toxic chemicals that have medicinal value. This study originally began in a laboratory setting with a set of frogs obtained from the Costa Rican rainforest. However, after months of testing the frogs, he determined that the level of toxins produced in the laboratory was different than the level of toxins secreted in the wild. He believed this may be due to the lack of natural predators in the laboratory. This led him to do a field test with observations of this genus of frogs on the rainforest floor. Due to the difficulty of observing these species in the wild, he continues to collect data and is asking more and more questions that need to be answered before solving his initial question.

Do you think that my colleague would have guessed his experiment would have progressed in this manner? He would say definitively, "NO"! But this is science! Here is another question: Does science always begin with an observation?

Well, again the answer is no! The process of science may begin by chance or accident. Do you know the story of Newton being hit on the head with a falling apple? Well, the story has been told that as Newton was quietly sitting underneath an apple tree, the apple fell and hit his head with such strength that he started to think about the force at which things fall and accelerate. This led to Newton's Theory of Gravity. Questions in science may result from reading or talking to a colleague. They could also be motivated by a new technology; for instance, new medical technology often reveals intriguing and unknown conditions. Practical interests, like finding a cure for diseases, can also motivate science. For instance, one of the things I am studying in the rainforest is the biodiversity of plants in the hope we find new medicines and cures for diseases like cancer. Regardless of the motivation, science begins with exploration and discovery – asking questions, sharing data and information, making observations, finding inspiration, and reviewing currently available information.

OK, pop quiz! Does all science require experimentation?

Well, all science requires testing, but that testing doesn't always have to take the form of a traditional experiment. For instance, for some of my research in the Amazon rainforest, we map out the location of rare plants in the rainforest and enter it into a database. We monitor these plants over a series of months or even years, tracking changes in appearance, population numbers and even new plant species which may be found during this time. This type of experimentation is called a field experiment or an observational study. We also send samples of plants or plant tissue to laboratories where microscopy or chemical testing can be done on the plants. This more controlled laboratory setting might be more familiar to you as far as scientific experimentation is concerned. All of these tests have merit and new things are discovered every day in all types of settings.

Ok, so we think we have finished an experiment. Does the scientific process always end with a conclusion?

Well, often it is yes, but it may not be a final conclusion. Let me explain. If a scientist finds that through testing their hypothesis is supported, they will proceed to communicate their conclusion to the scientific community and get feedback. A conclusion is no good at all if it exists in isolation. Getting feedback on a conclusion may involve publishing a paper so other scientists can read and comment on it, giving a talk at a conference and discussing the work with colleagues, and trying to replicate the data collected during testing or the results of the experiment. Often at this stage, it may become clear that further testing or revision is needed. On the other hand, it may be that there are multiple lines of evidence from various groups of scientists that all support a conclusion, in which case a strong theory will be built.

So one last thing before I leave you today... who do you think science benefits? Does science benefit society or is it "just for science's sake"? Think about this, and then answer the interactive question following this presentation. Thanks for listening today, and I hope to be speaking with you again soon.