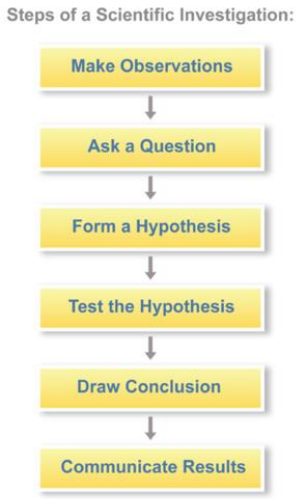
Scientific Method

Chances are you've heard of the scientific method. What exactly is the scientific method?

Is it a precise and exact way that all science must be done? Or is it a series of steps that most scientists generally follow, but may be modified for the benefit of an individual investigation?

The Scientific Method

There are basic methods of gaining knowledge that are common to all of science. At the heart of science is the scientific investigation, which is done by following the **scientific method**. A **scientific investigation** is a plan for asking questions and testing possible answers. It generally follows the steps listed in **Figure** below.



Steps of a Scientific Investigation. A scientific investigation typically has these steps. Scientists often develop their own steps they follow in a scientific investigation. Shown here is a simplification of how a scientific investigation is done.

Making Observations

A scientific investigation typically begins with observations. You make observations all the time. Let's say you take a walk in the woods and observe a moth, like the one in **Figure** below, resting on a tree trunk. You notice that the moth has spots on its wings that look like eyes. You think the eye spots make the moth look like the face of an owl.

Does this moth remind you of an owl?

Asking a Question

Observations often lead to questions. For example, you might ask yourself why the moth has eye spots that make it look like an owl's face. What reason might there be for this observation?

Forming a Hypothesis

The next step in a scientific investigation is forming a hypothesis. A **hypothesis** is a possible answer to a scientific question, but it isn't just any answer. A hypothesis must be based on scientific knowledge, and it must be logical. A hypothesis also must be falsifiable. In other words, it must be possible to make observations that would disprove the hypothesis if it really is false. Assume you know that some birds eat moths and that owls prey on other birds. From this knowledge, you reason that eye spots scare away birds that might eat the moth. This is your hypothesis.

Testing the Hypothesis

To test a hypothesis, you first need to make a prediction based on the hypothesis. A **prediction** is a statement that tells what will happen under certain conditions. It can be expressed in the form: If A occurs, then B will happen. Based on your hypothesis, you might make this prediction: If a moth has eye spots on its wings, then birds will avoid eating it.

Next, you must gather evidence to test your prediction. **Evidence** is any type of data that may either agree or disagree with a prediction, so it may either support or disprove a hypothesis. Evidence may be gathered by an **experiment**. Assume that you gather evidence by making more observations of moths with eye spots. Perhaps you observe that birds really do avoid eating moths with eye spots. This evidence agrees with your prediction.

Drawing Conclusions

Evidence that agrees with your prediction supports your hypothesis. Does such evidence prove that your hypothesis is true? No; a hypothesis cannot be proven conclusively to be true. This is because you can never examine all of the possible evidence, and someday evidence might be found that disproves the hypothesis.

Nonetheless, the more evidence that supports a hypothesis, the more likely the hypothesis is to be true.

Communicating Results

The last step in a scientific investigation is communicating what you have learned with others. This is a very important step because it allows others to test your hypothesis. If other researchers get the same results as yours, they add support to the hypothesis. However, if they get different results, they may disprove the hypothesis.

When scientists share their results, they should describe their methods and point out any possible problems with the investigation. For example, while you were observing moths, perhaps your presence scared birds away. This introduces an error into your investigation. You got the results you predicted (the birds avoided the moths while you were observing them), but not for the reason you hypothesized. Other researchers might be able to think of ways to avoid this error in future studies.

Video: As you view (link) *The Scientific Method Made Easy*, focus on these concepts:

1. the relationship between evidence, conclusions and theories,
2. the "ground rules" of scientific research,
3. the steps in a scientific procedure,
4. the meaning of the "replication of results,"
5. the meaning of "falsifiable," and
6. the outcome when the scientific method is not followed.

Answer the questions based on the article:

1. What are the steps of the scientific method?

2. Do the steps have to be followed in order?

3. Describe the purpose of a scientific investigation

4. How are a hypothesis and a prediction different?

5. What is the importance of communicating your results?

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