The Scientific Method

Today we will look at:

1. The **Steps** in the Scientific Method, and what it involves.

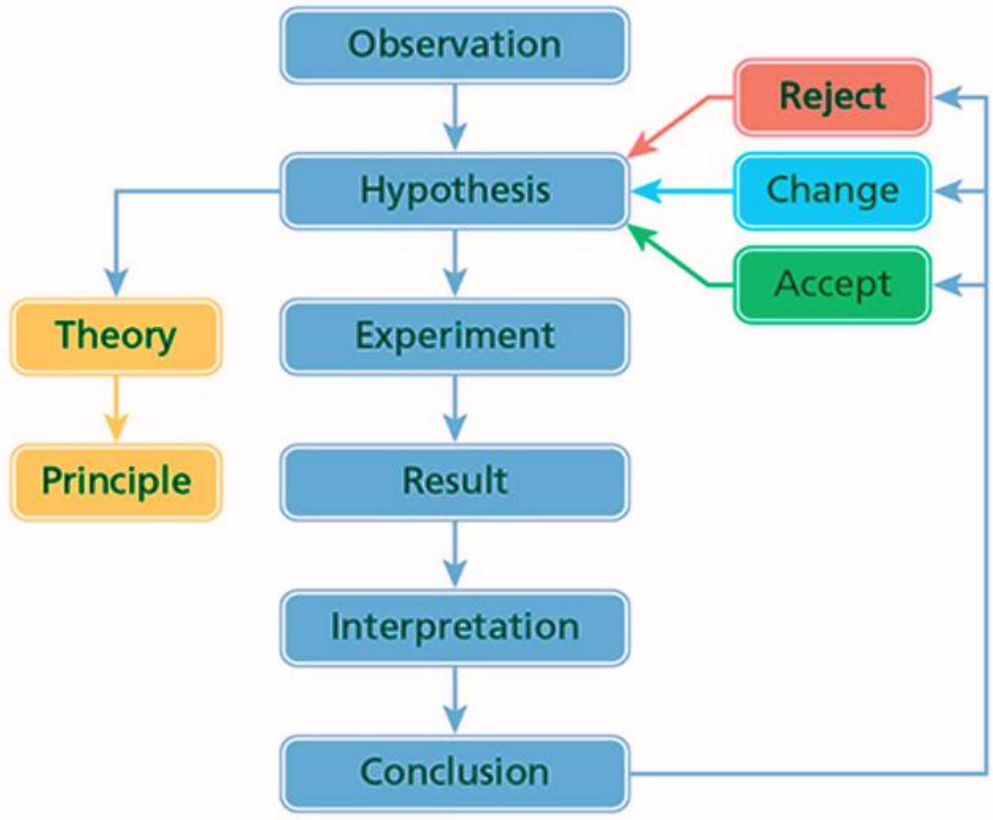
2. An **example** of the Scientific Method in action.

3. **Experiments**, and why it is so important to do them correctly.

4. The **Limits** of the Scientific method.

Biology is the study of living things.

Science works by using a set of steps called the **Scientific Method**.



We use this method to solve problems,

and to further our learning.

It can be useful to think of testing as trying to **disprove** a hypothesis.

Step 1. Observation

We use our senses and/or a device to notice something. e.g. the Sugarloaf Mountain looks like a volcano.

Step 2. Hypothesis

An educated guess based on an observation. e.g. If the sugarloaf is a volcano, then it should be made of basalt or granite rock.

Step 3. Experimentation

We design an experiment to test our hypothesis or idea. e.g. we test the rocks of the sugarloaf to see what type they are.

Step 4. Collection and Interpretation of data

We collect our data and record it carefully. We also analyse the data and look for patterns in it. Results from the sugarloaf show that it is made from Quartzite (hardened sand).

Step 5. Conclusion

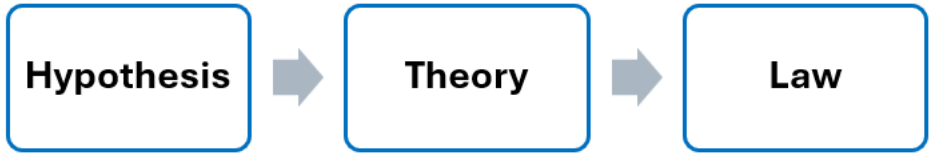
We reach a **conclusion** about our idea. The sugarloaf is made of hardened sand, which is **not** a type of rock found in volcanoes.

Step 6. Publish our findings in a **Scientific Journal** or Online.

The Hypothesis can be **Accepted, Changed or Rejected**.

If **Changed** or **Rejected** - new Experiments must be made.

A Theory is a hypothesis that has been proven correct by many experiments.



Famous Biological theories include:

Cell Theory – that all life is made of cells.

Germ theory – that pathogens cause disease.

Evolution – life evolves by random mutations and natural selection.

Questions on Steps of the Scientific Method

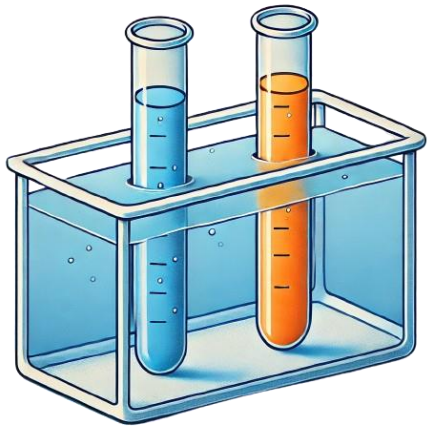
Q.1 What do we call an educated guess based on an observation?

Q.2 When a hypothesis is supported by many experiments over an extended period of time, it becomes a _____?

Q.3 A _____ is set up to be used as a comparison in experiments.

Experimentation

1. Careful **planning and design** are needed in an experiment. You can only test one factor at a time to make it a fair test. Every other variable must be kept the same. E.g. in food tests.



2. The experiment must be **safe**. Lab rules keep us safe.

3. You must have a **Control** or control group in your experiment.

A control is something to compare your results to.

4. Other factors in experiments include,

Avoid Bias – to ensure the test are fair.

Sample Size - the larger number of tests the better.

Random Sampling – testing a sample that has been chosen at random and without any bias.

Replicates - Replicates are when you do the experiment several times to ensure a reliable result.

Double Blind Testing – where the experiment group and a control group are not known to each other, or to the scientist running the experiment.

A good example is where a volunteer is given a real tablet or a false tablet (**placebo**) by a scientist.

Neither the volunteer nor scientist know if the tablet is real or false. This way the scientist cannot give away any hints or cause bias. They are both **blind** to that fact!

Questions on Experimentation

Q.1 What do we call a control drug used in drug testing?

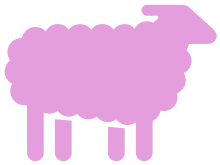
Q.2 Why is only one variable/factor tested at any time?

Q.3 Double-blind testing is used to avoid __ in experimentation?

Limitations of the Scientific Method

Interpreting results - Two scientists can come to different conclusions from the same set of results.

Ethics - is it right or wrong to do an experiment?
E.g. The use of animals in testing and cloning animals.



Accidental Discoveries - Sir Alexander Fleming discovered the antibiotic **Penicillin** in 1928 after leaving petri dishes open.

Insufficient Knowledge – Not knowing about micro-organisms led to incorrect hypotheses on the origin of many diseases.

Questions on Limitations

Q.1 Dealing with what is right and wrong is known as?

Q.2 Experimentation is a limitation of the scientific method.

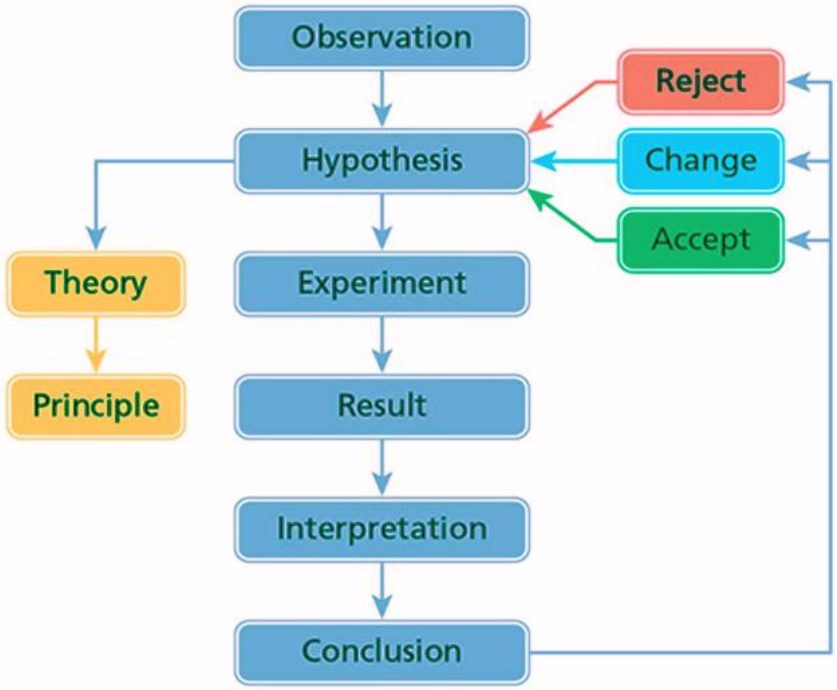
True or False?

Q.3 Changes in the Natural World can be a limitation of the scientific method? True or False?

Summary

1. **Steps in the Scientific Method.**

   Know the definitions for each item



2. **Experiments**
   - Well Planned and Designed
   - Safe and Ethical
   - Must have a Control
   - Must be free from any Bias
3. **Limitations**

   Misinterpreting Results, Lack of Knowledge,

   Changes in the Natural World and Accidental Discoveries.