

# Scientific Method

## Science

-is an organized way of using evidence to learn about the natural world

## Goal of science is:

1. to investigate and understand the natural world
2. to explain events in the natural world
3. to use those explanations to make useful predictions

## Designing an Experiment to Developing a Scientific Theory

**START HERE**

### 1 Ask a question

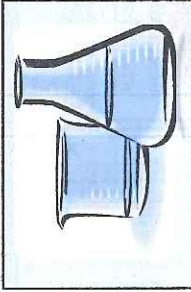
??????????

Ex How did organisms come into being?

### 2 Form a hypothesis

This is an idea or proposed scientific explanation for a set of observations (process of gathering information in an orderly way)

- Hypothesis:**
- may be rejected or accepted after testing
  - must be testable



### 3 Set up a controlled experiment

(test of the effect of a single variable by changing it, keeping other ones the same)

#### Independent variable (Manipulated variable)

- variable that is deliberately changed

#### Dependant variable (Responding variable)

- variable that changes in response to the manipulated variable (One that you measure)

### 4 Record and analyze results using data

Data is a written records of observations. Data may be used to make inferences. Inferences are logical interpretations based on prior knowledge.

#### 2 Types of Data

##### Qualitative

-are descriptive and involve characteristics that can't easily be measured

Ex red, smells good

##### Quantitative

-are expressed as numbers from counting or measuring

Ex 5cm, 25 sec., 2 tsp.

### 5 Draw a conclusion

Data is used to evaluate a hypothesis and draw a valid conclusion.

### Repeat investigations

to make sure results match those already obtained.

### Scientific Theory Develops

As evidence from many investigations builds up, a hypothesis may be so well supported - scientists consider it a theory. A theory applies to a well-tested explanation that unifies a broad range of observations. No theory is considered the absolute truth.

# Scientific Method

## Redi's Experiment on Spontaneous Generation

**OBSERVATIONS:** Flies land on meat that is left uncovered. Later, maggots appear on the meat.  
**HYPOTHESIS:** Flies produce maggots.

### PROCEDURE

#### Controls

Controlled Variables:  
jars, type of meat,  
location, temperature,  
time

#### Control Group

Uncovered jars



#### Experimental Group

Covered jars



## 1 Do maggots come from meat?

**Independent Variable**

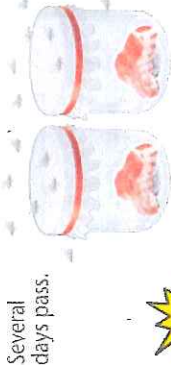
**Manipulated Variable:**  
gauze covering that keeps  
flies away from meat

**Dependent Variable**

**Responding Variable:**  
whether maggots appear



Maggots appear:



No maggots appear.

Several days pass.

## 4 step in the Scientific Method

**CONCLUSION:** Maggots form only when flies come in contact with meat.  
 Spontaneous generation of maggots did not occur.

## Needham's Test of Redi's Findings

Needham challenged Redi's results by claiming that spontaneous generation could occur under the right conditions.

- He sealed a flask of gravy and heated it.
- After several days, the gravy was swarming with microorganisms.
- He concluded that these organisms came from the gravy by spontaneous generation.

(He was wrong!)

Gravy was heated, not boiled.

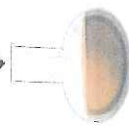


## Spallanzani's Test of Redi's Findings

Spallanzani tested Redi's findings to disprove Needham.

- He used two flasks of gravy and sealed one of them shut.
- He boiled both flasks.
- He concluded that the unsealed flask had microorganisms, but the sealed flask did not.

Flask is open.



Flask is sealed.



Flasks were boiled



Gravy is teeming with microorganisms.

Gravy is free of microorganisms.

## Pasteur's Experiment on Spontaneous Generation

Louis Pasteur conclusively disproved the hypothesis of spontaneous generation.

- He saved the French wine industry, which had unexplained souring of wine.
- He saved the silk industry, which was endangered by a silkworm disease.
- He began to uncover the nature of infectious diseases, showing that they were the result of microorganisms.

Microorganisms can't get in, but have air



Broth is free of microorganisms for a year

Microorganisms can get in with neck removed

Broth is full of microorganisms

Broth is boiled