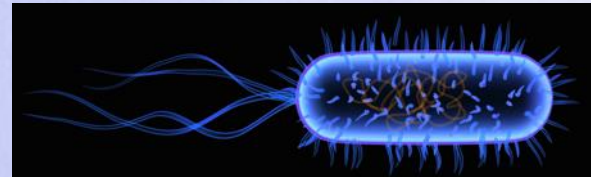
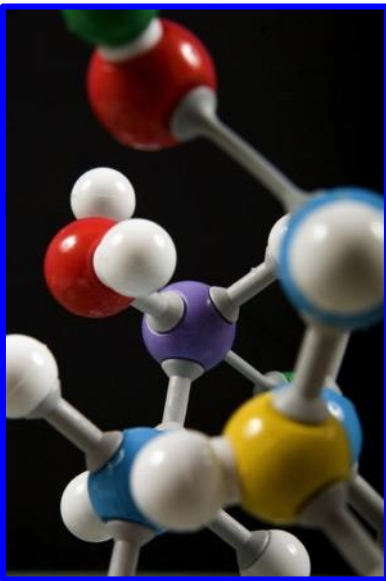




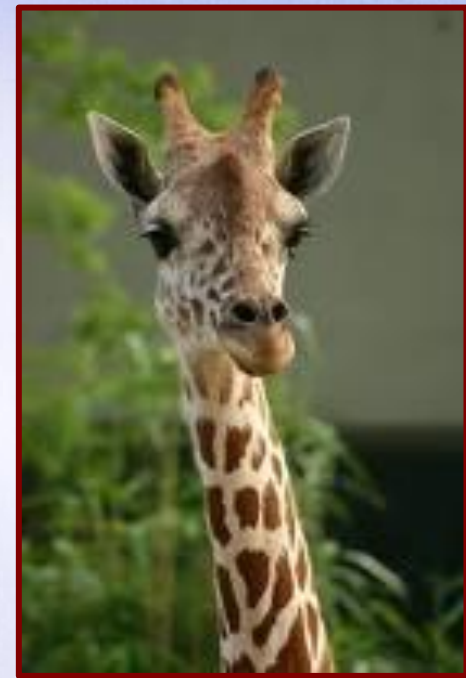
Introduction To Biology





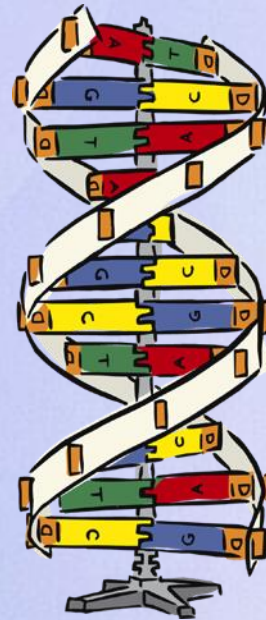
What is Science?

The goal of science is to investigate and understand the natural world, to explain events in the natural world, and to use those explanations to make useful predictions.



1. Science deals only with the natural world.

2. Scientists:
.... collect and organize information in a careful, orderly way, looking for patterns and connections between events.



3. Scientists propose explanations that can be tested by examining evidence.

4. Science is an organized way of using evidence to learn about the natural world.

How is Science Done?

Science begins with an observation.

This is the process of gathering information about events or processes in a careful, orderly way.



Data is the information gathered from making observations.

There are two types of data:

Quantitative data are:

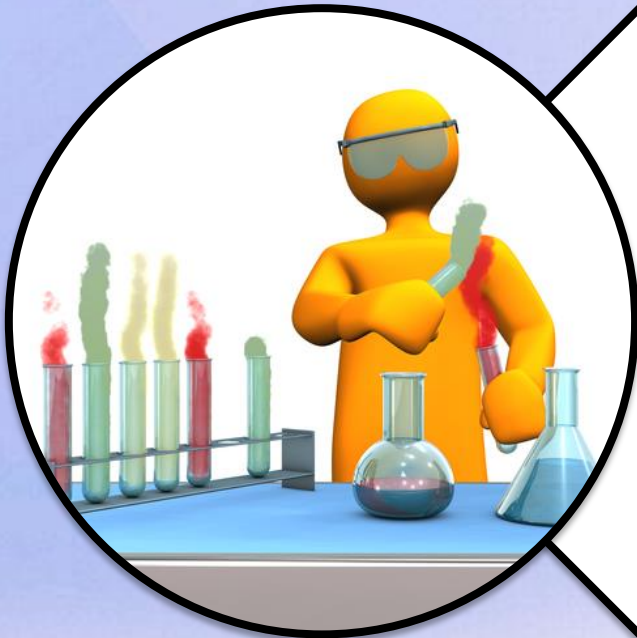
... numbers and are obtained by counting or measuring.

Qualitative data are:

... descriptions and involve characteristics that cannot be counted.



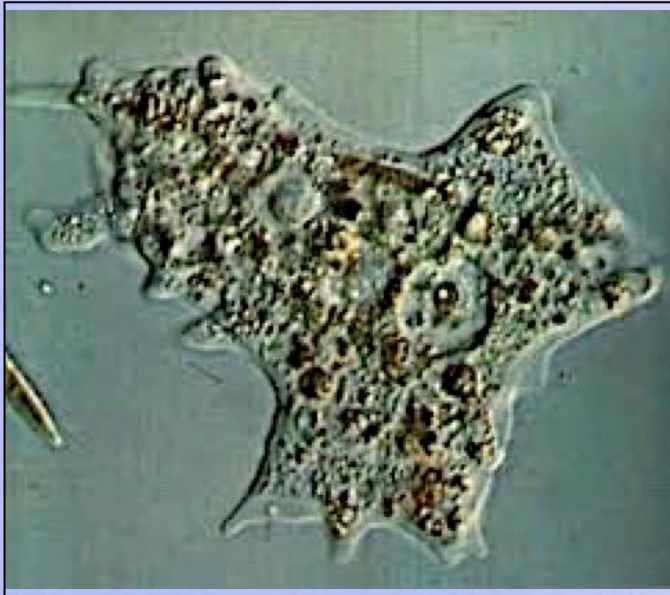
A hypothesis is a scientific explanation for a set of observations.



A hypothesis must be stated in a way that makes it “testable”. The hypothesis is just a possible answer to a question, and it must be thoroughly tested.

Biology is the study of life.

This study of life ranges from the very simple one-celled organisms.....



.....to the very complex multicellular organisms.

The Themes of Biology



Biology is unified by certain themes no matter what kind of organism is being studied.



The themes of biology are:

1. Cell structure and function
2. Stability and homeostasis
3. Reproduction and Inheritance
4. Evolution
5. Interdependence of organisms
6. Matter, energy and organization

Each of these themes will be explored in the following slides.

Theme: Cell Structure and Function

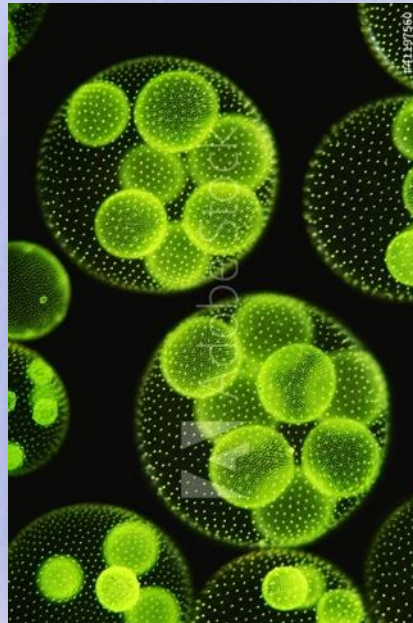
The cell is the basic unit of life. All living organisms are composed of cells.

Different levels of cell structure and organization include:

Unicellular

Colonial

Multicellular



Unicellular Organisms

A unicellular organism is composed of a single cell.



Examples: Bacteria, yeast, ameba

Colonial Organisms

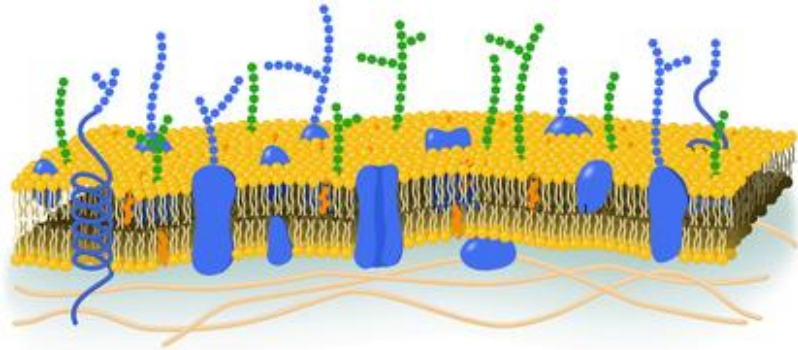


1. Unicellular organisms that live together in groups.
2. The cells have no relationship to each other.
3. There is no specialization or differentiation.

Multicellular Organisms

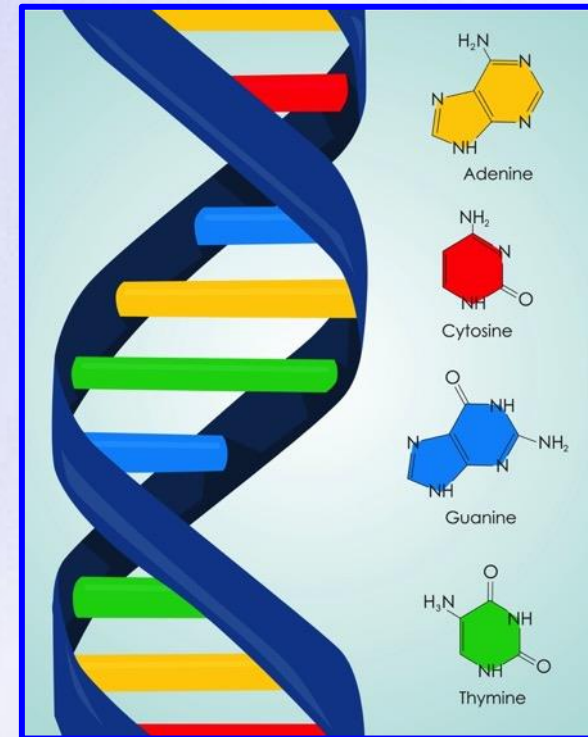
1. A multicellular organism is a group of cells that live and work together in one organism.
2. There is differentiation and cell specialization.
3. Cell Specialization: A cell that is highly specialized for just one function.
4. Tissue: a group of similar cells all performing a similar activity.
5. Organ: several tissues functioning as a unit.
6. Organs work together to form systems.
7. Various systems form a multicellular organism.
8. Advantage of having cell specialization: A cell that has only one function can be much more efficient at that one job.
9. Disadvantage of cell specialization: The cells are dependent upon one another. If one group of cells fails to do its job, the other cells will perish.

There are many different types of cells, but they are alike in several ways:



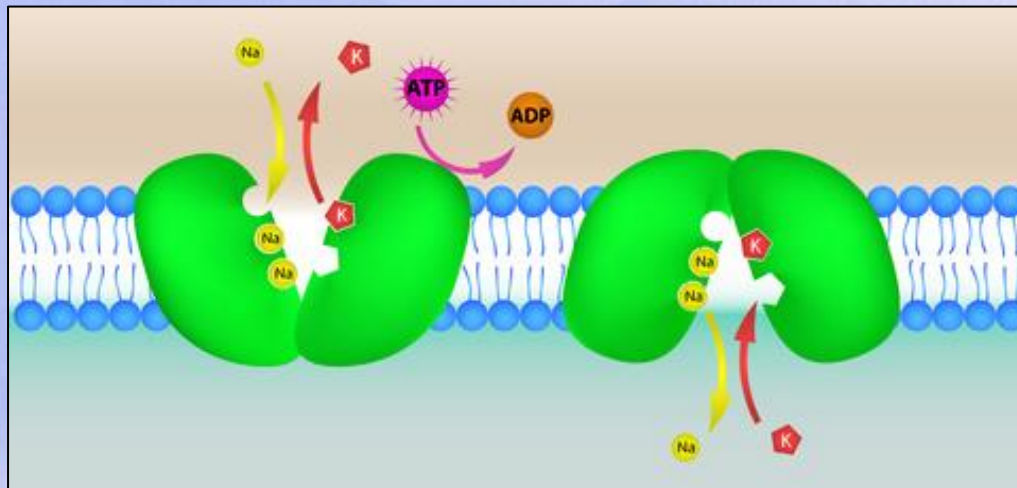
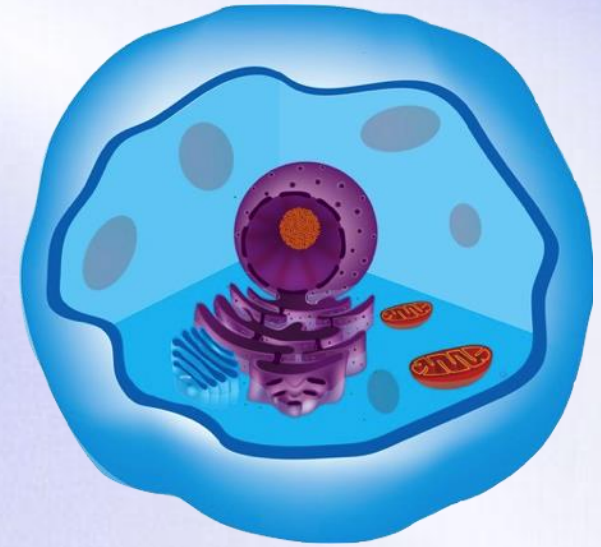
They are surrounded by a membrane.

They contain genetic information (DNA or RNA) that is a set of instructions for making new cells and new cell parts.



Theme: Stability and Homeostasis

1. Cells must be able to maintain very stable **internal environments.**
2. All cell processes must be very carefully regulated.



3. **Homeostasis** is the internal balance that a cell must maintain.

Theme: Reproduction and Inheritance



Reproduction: All organisms produce new organisms like themselves.

All organisms pass their genetic information to their offspring in the form of DNA.



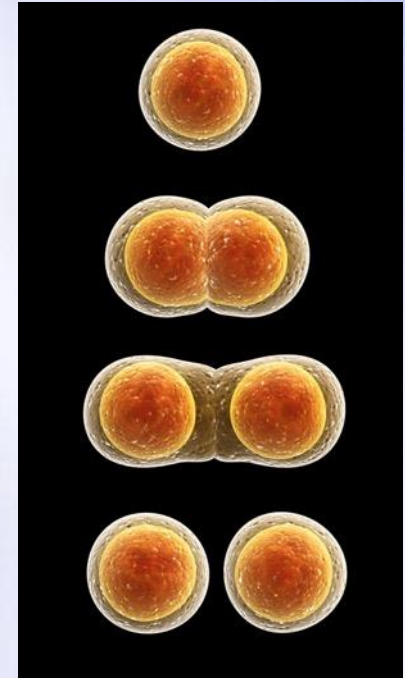
Gene: A short segment of DNA that is the instructions for a single trait or characteristic.

Sexual Reproduction

Offspring are produced by the joining together of DNA from two parents. The egg of one parent joins with the sperm of the other parent to produce a zygote.



Asexual Reproduction



Offspring are produced by only one parent. All offspring are exact copies of the parent.

Theme: Evolution

To evolve means to change over time.

Scientists study evolution in order to understand how all the different organisms that live on Earth today came to be.



Evolution is the result of Natural Selection

- a) Organisms with favorable characteristics are more likely to survive and reach reproductive age.
- b) Favorable characteristics might include: the ability to catch food, the ability to be well camouflaged, or the ability to withstand harsh environmental conditions.
- c) When these organisms reproduce:
they will pass down these favorable characteristics to their offspring.



- d) If an organism is not well suited to its environment, it is unlikely that it will live and reproduce.
- e) Since different genes are being passed on to offspring, organisms slowly change over time.

Theme: Interdependence of Organisms

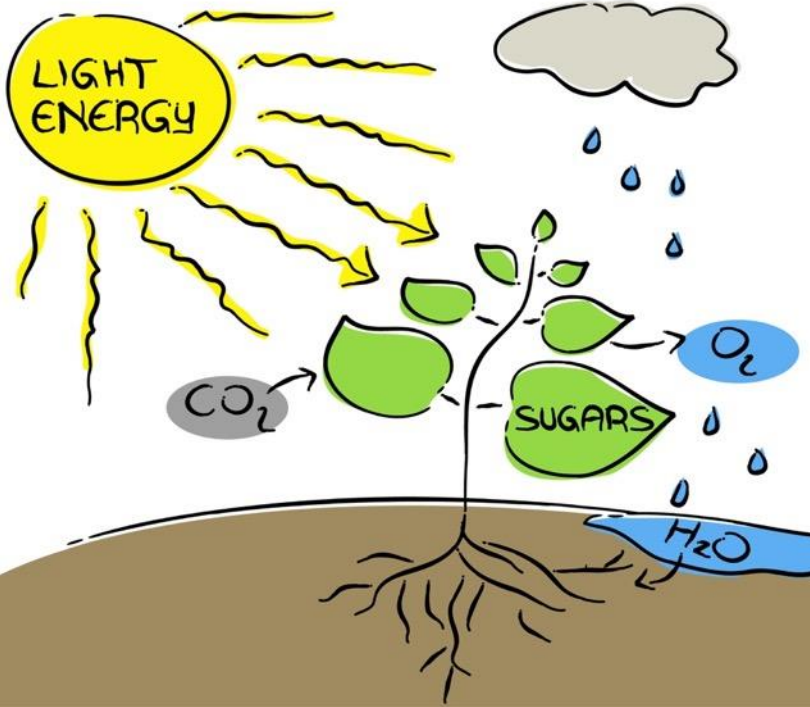
The study of an individual organism is very important, but in order to understand our biological world, scientists must study the interaction of organisms with one another and with their environment.



This branch of biology is called: **Ecology**

No single organism can survive on its own. Animals depend on plants as a source of food. Plants make their own food, but require the carbon dioxide released into the environment by animals. All of the organisms on Earth are interconnected.

Theme: Matter, Energy, and Organization



Life on Earth depends upon the energy from the sun.

Through the process of photosynthesis, plants are able to harness the energy of the sun to make their own food in the form of glucose.

Autotrophs are:

Organisms that can make their own food.

These organisms include green plants and some unicellular organisms.

Heterotrophs are:

Not capable of making their own food.

These organisms include animals and the fungi. Heterotrophs must take in food by consuming autotrophs.

Scientific Methods



The scientific method is:

A series of steps used by scientists to solve a problem or answer a question.

The Steps to the Scientific Method

1. Observation / Asking a Question
2. Form a Hypothesis
3. Design a Controlled Experiment
4. Record and Analyze Results
5. Draw Conclusions

Step 1: Observation / Asking a Question



A problem or a question must first be identified.

For example:

How much water can a root hair absorb?

Why does a plant stem bend toward the light?

What effect does temperature have on heart rate?

Step 2: Form a Hypothesis

Hypothesis:

A possible explanation to the question or problem.



It is simply a prediction and has not yet been proven or disproven.



It must be stated in a way that is testable. A statement is considered “testable” if evidence can be collected that either does or does not support it.

Step 3: Designing a Controlled Experiment



1. The factors in an experiment that can be changed are called **variables**. Some examples of variables would be: changing the temperature, the amount of light present, time, concentration of solutions used.
2. A controlled experiment works with **one variable at a time**. If several variables are changed at the same time, the scientist would not know which variable is responsible for the observed results.
3. In a **“controlled experiment”** only one variable is changed at a time. All other variables should be unchanged or “controlled”.
4. An experiment is based on the comparison between a **control group** with an **experimental group**.
 - a) These two groups are identical except for one factor.
 - b) The control group serves as the comparison. It is the same as the experiment group, except that the one variable that is being tested is removed.
 - c) The experimental group shows the effect of the variable that is being tested.



Example: In order to test the effectiveness of a new vaccine, 50 volunteers are selected and divided into two groups. One group will be the control group and the other will be the experimental group. Both groups were given a pill to take that was identical in size, shape, color and texture.

Describe the control group.

Even though the volunteers are given identical looking pills, the control group will not actually receive the vaccine.

Describe the experimental group.

This group will receive the vaccine.

What variables are kept constant?

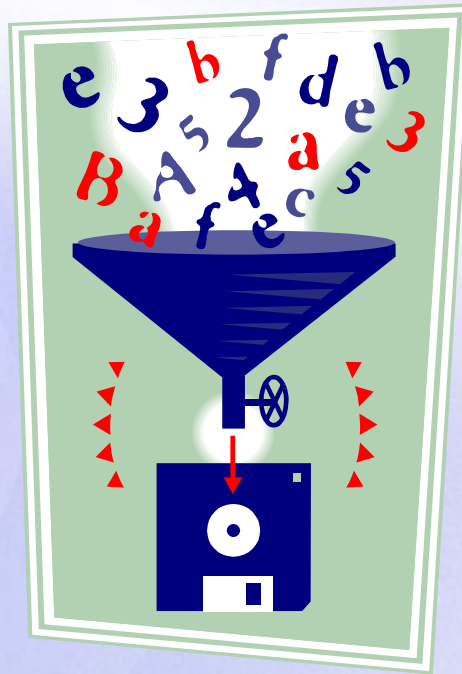
The size, shape, color, and texture of the pill.

What variable is being changed?

Whether or not the pill contains the vaccine.

There are two variables in an experiment:

a) The independent variable is the variable that is **deliberately** changed by the scientist.



c) In the above example, what is the independent variable?

It is the addition of the vaccine to the pills that were given to the volunteers.

b) The dependent variable is the one observed during the experiment. The dependent variable is the data we collect during the experiment. This data is collected as a result of changing the independent variable.

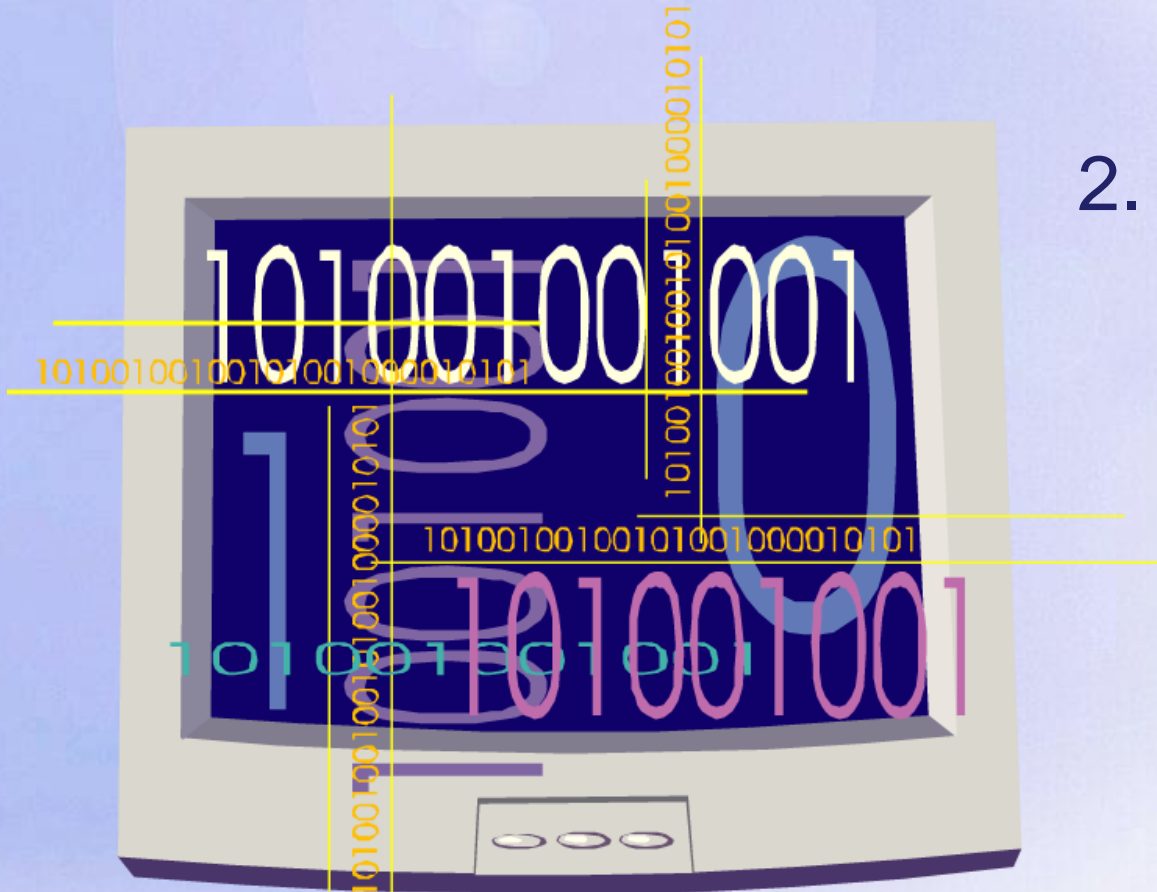


d) In the above example, what is the dependent variable?

The observed health of the people receiving the pills.

Step 4: Recording and Analyzing Results

1. The data that has been collected must be organized and analyzed to determine whether the data are reliable.

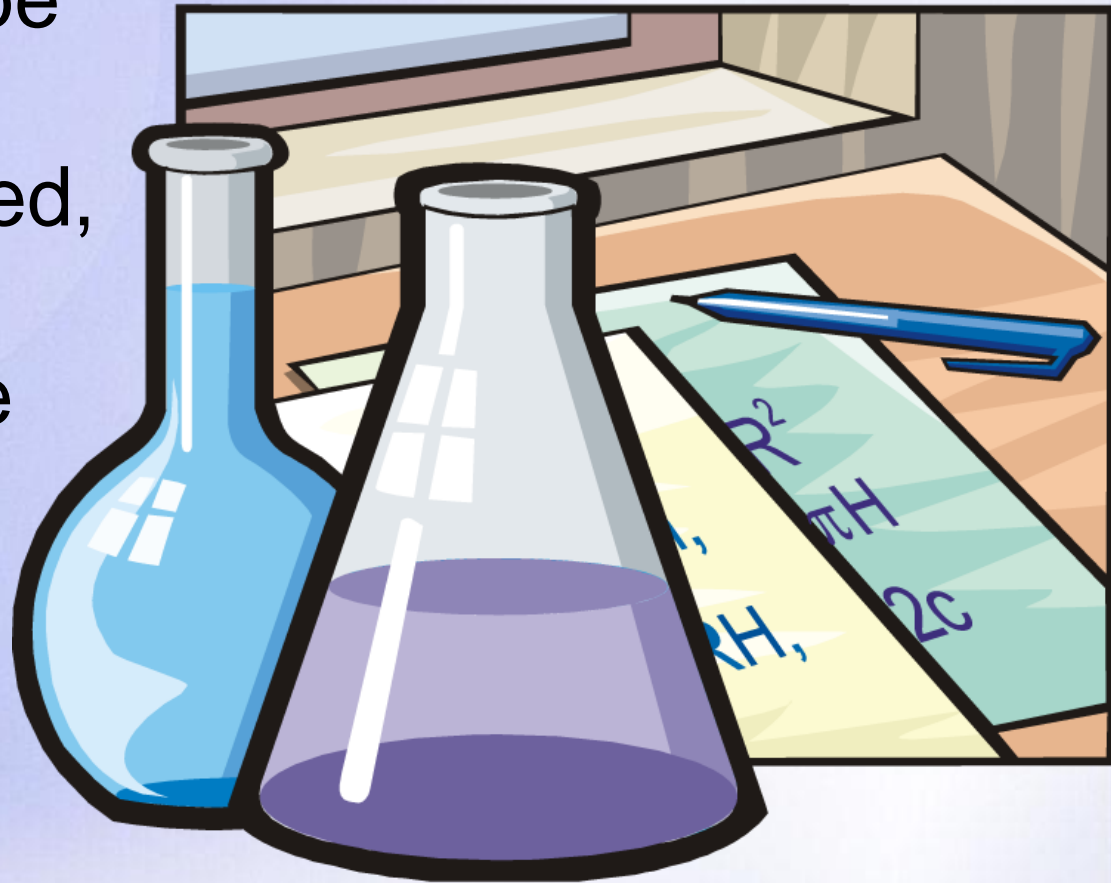


2. Does the data support or not support the hypothesis?

Step 5: Drawing Conclusions

The evidence from the experiment is used to determine if the hypothesis is proven or disproven.

Experiments must be repeated over and over. When repeated, the results should always be the same before a valid conclusion can be reached.



Forming a Theory

A theory may be formed after the hypothesis has been tested many times and is supported by much evidence.



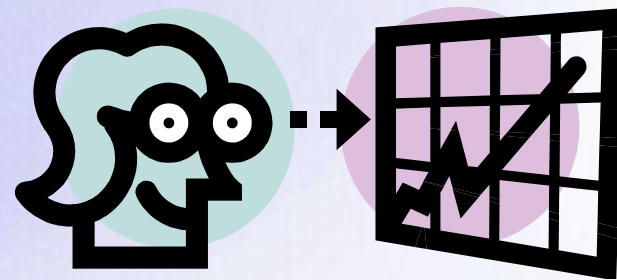
Theory:

A broad and comprehensive statement of what is thought to be true.

A theory is supported by considerable evidence.

Making a Data Table

As scientists collect data, it must be recorded in an **organized** fashion. Any time data is collected in an experiment, it is most often presented in a table. The data table must have a **title**, **rows**, **columns**, and **heads**. The title should be placed at the top and tells the observer what information is contained in the table. At the top of each column should be a “head” that tells you what information is in the column.



Example 1: Make a data table for the following information

The following data were collected for the growth of a plant.

On day 0, there was 0 growth.

On day 1, there was 2.0 cm of growth.

On day 2, there was 5.3 cm of growth.

On day 3, there was 6.1 cm of growth.

On day 4, there was 8.4 cm of growth.

On day 5, there was 11 cm of growth.

In the top row, place the title of your data table.

In the next row, place the two column heads.

In the remaining rows, fill in the data.

The growth of a plant in centimeters	
Day	Growth
0	0 cm
1	2.0 cm
2	5.3 cm
3	6.1 cm
4	8.4 cm
5	11 cm

Example 2: Make a data table for the following information

The number of cricket chirps was recorded on two different nights at various temperatures (Celsius). On night 1, the following data was obtained: Temp 16, cricket chirps 33; Temp 18, cricket chirps 38; Temp 20, cricket chirps 42; Temp 22, cricket chirps 46; Temp 24, cricket chirps 50.

On night 2, the following data was obtained: Temp 16, cricket chirps 32; Temp 18, cricket chirps 36; Temp 20, cricket chirps 41; Temp 22, cricket chirps 43; Temp 24, cricket chirps 51.

In the top row, place the title of your data table.

In the next row, place the two column heads. Since data were collected on two different nights, you will need 4 columns.

In the remaining rows, fill in the data.

The number of cricket chirps recorded at different temperatures			
Night 1		Night 2	
Temp	# Chirps	Temp	# Chirps
16	33	16	32
18	38	18	36
20	42	20	41
22	46	22	43
24	50	24	51

Making a Line Graph

Line graphs show data plotted as points that are connected by a line. Line graphs are often used to show change over time and can be used to compare two or more sets of data.

Before a line graph can be constructed, you must identify the two variables that will serve as x and y coordinates on the graph. These are called the “independent variable” and the “dependent variable”.

The independent variable is the one being manipulated or changed during the experiment. It is always placed on the x-axis or horizontal axis.

The dependent variable is the observed result of the independent variable being changed. The dependent variable is always placed on the y-axis or vertical axis.



An easy way to remember this is to ask yourself the questions:

“What did I know before I did the experiment?” (independent variable)

“What did I learn by doing the experiment?” (dependent variable)

Using the grid below, make a line graph using the information in example 1 from above.

First determine which variable to place on the horizontal (x) axis and which variable to place on the vertical (y) axis.

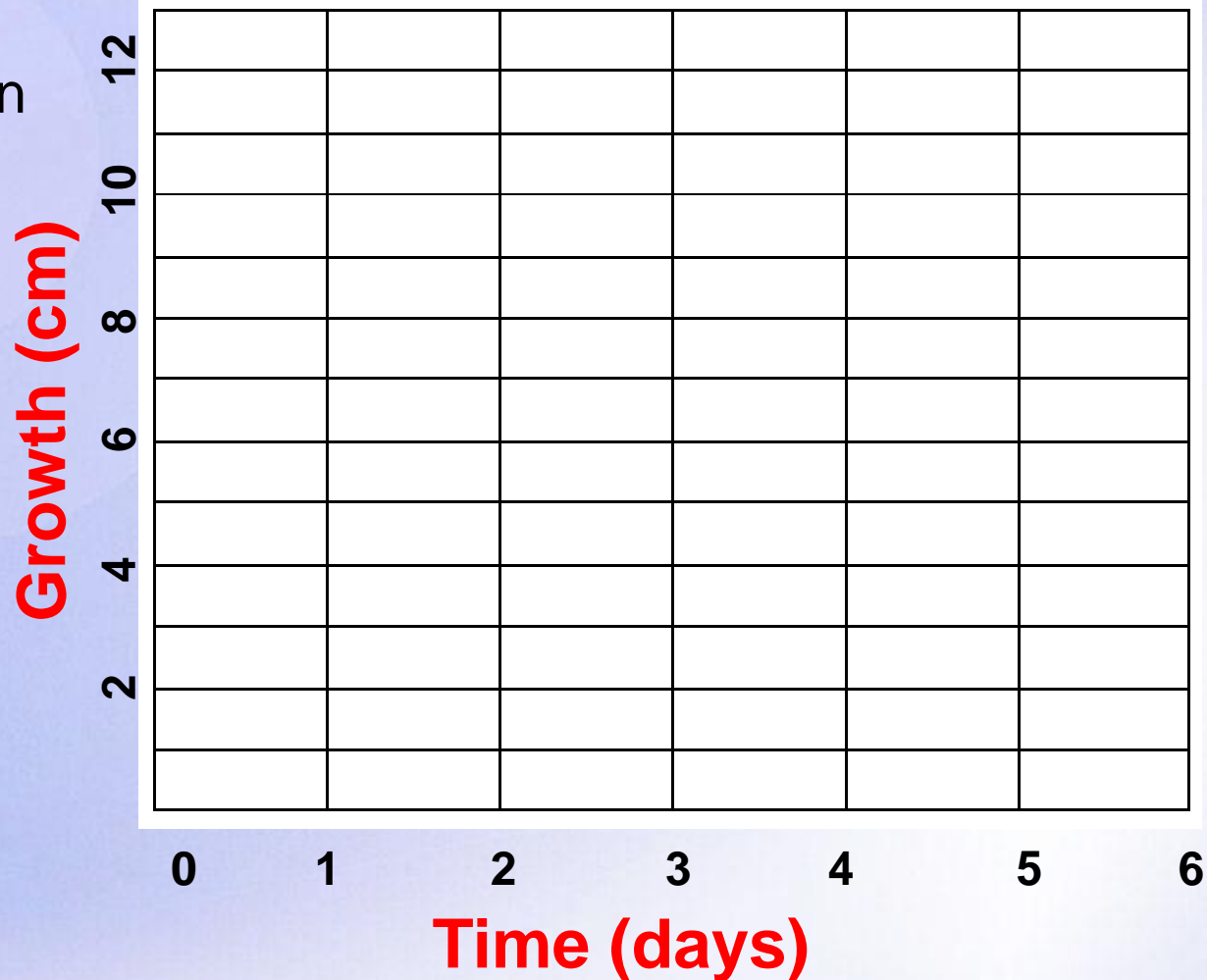
Label each axis appropriately.

Scale each axis appropriately.

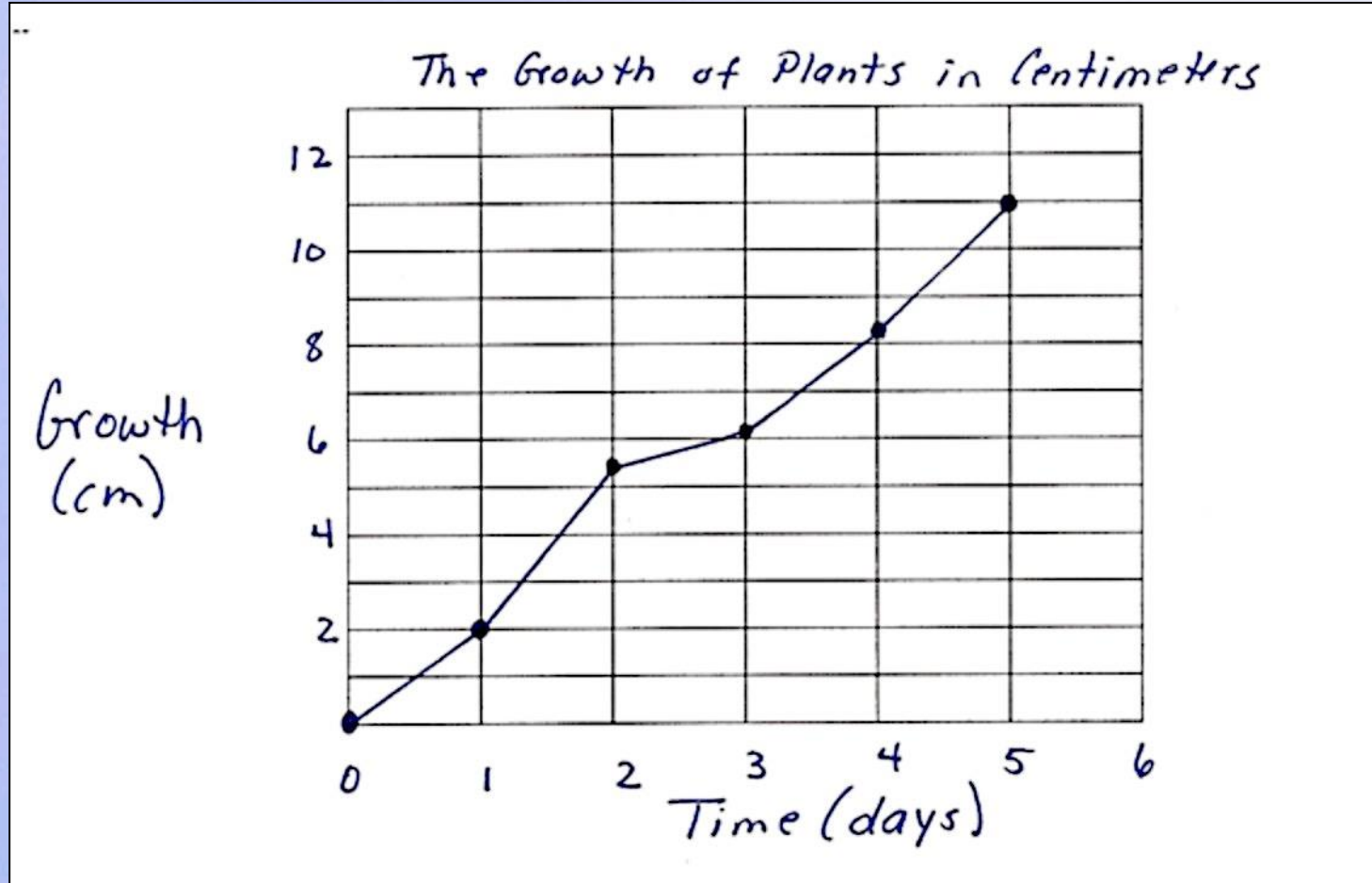
Title your graph.

Plot the points on the graph.

The Growth of Plants in Centimeters



Your graph should look like this:



Using the grid below, make a line graph using the information in example 2 from above.

First determine which variable to place on the horizontal (x) axis and which variable to place on the vertical (y) axis.

Label each axis appropriately.

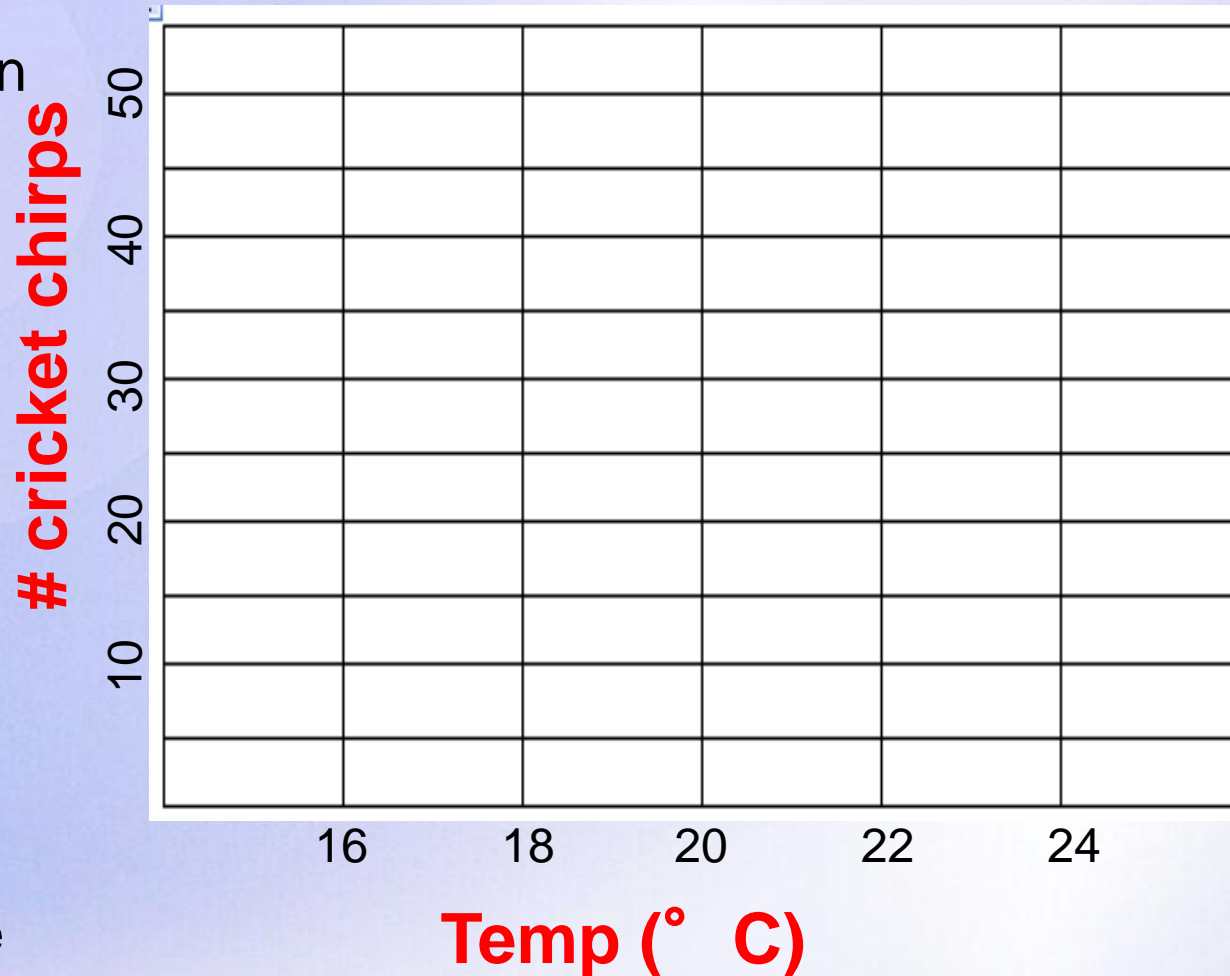
Scale each axis appropriately.

Title your graph.

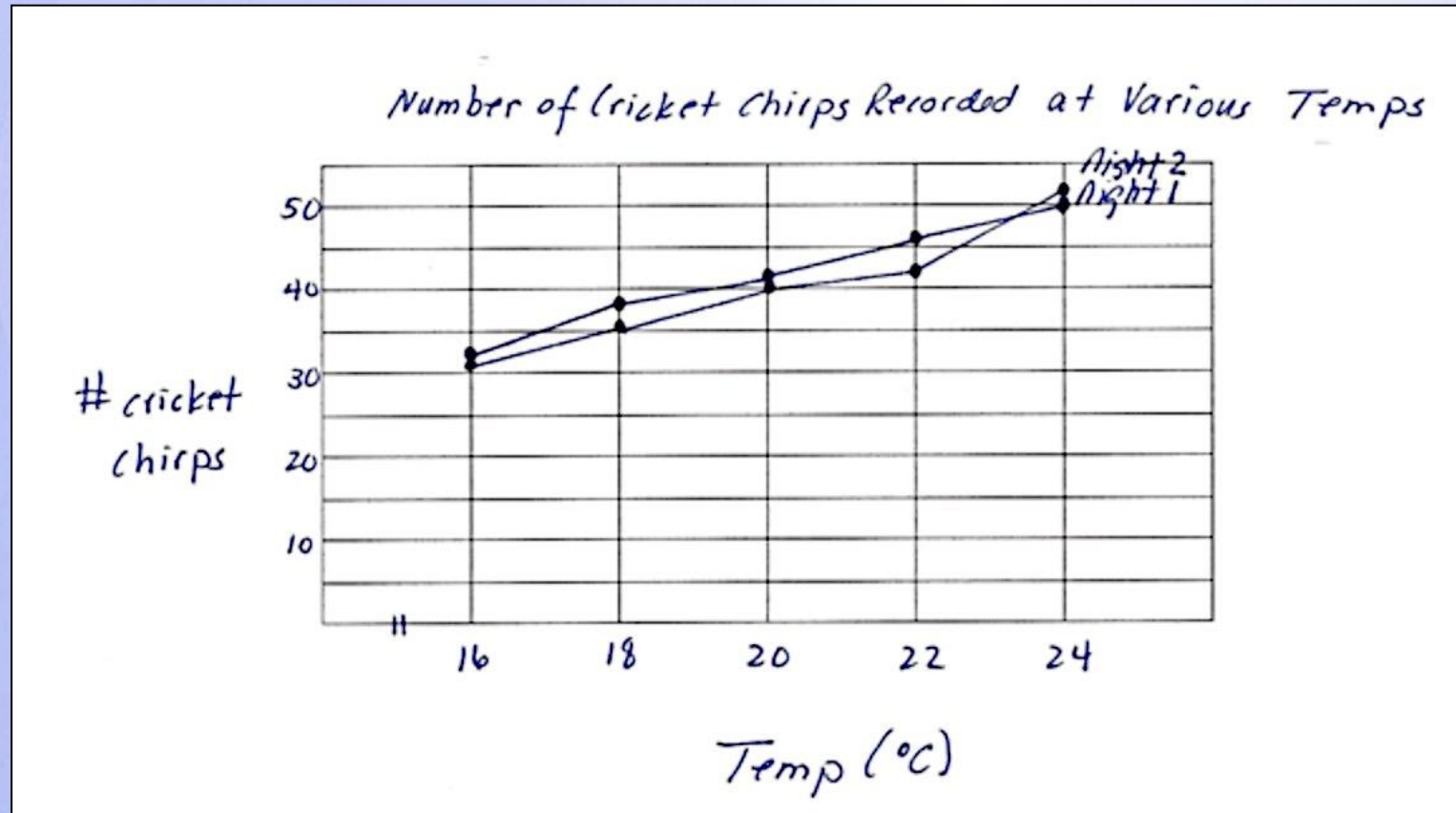
Plot the points on the graph.

Since this graph will have two different lines, be sure to label each line.

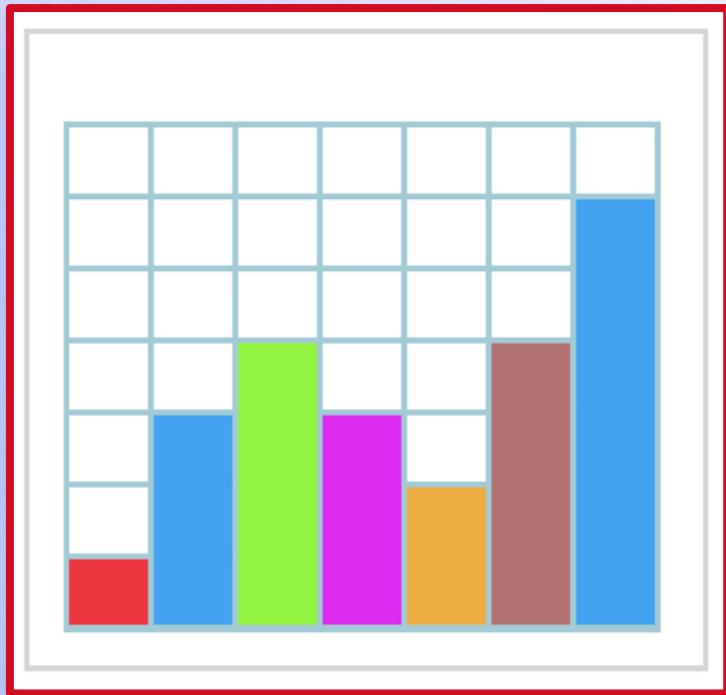
Number of Cricket Chirps Recorded at Various Temperatures



Your graph should look like this



Making a Bar Graph



Bar graphs are useful for showing comparisons of data collected by counting.

A bar graph has two axes, a horizontal axis and a vertical axis. Generally the horizontal axis is labeled and the vertical axis is divided.

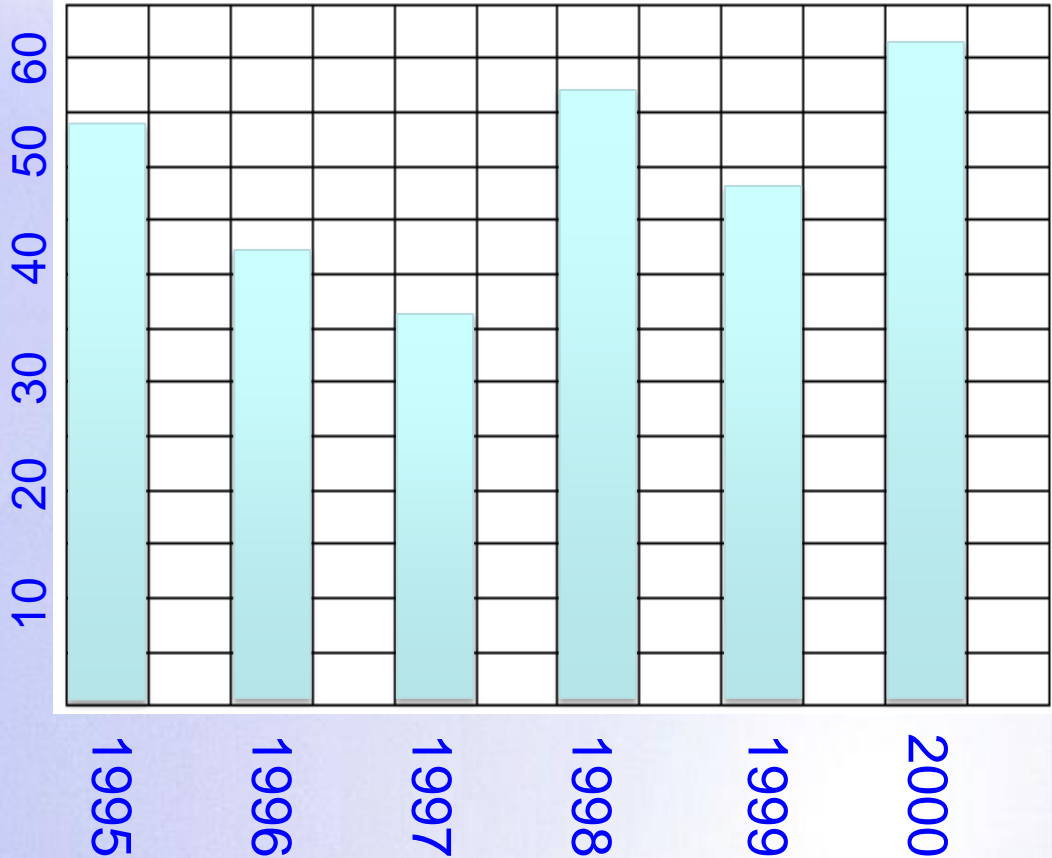
In the space below, make a bar graph of the following information.

In an orchard the following kilograms of peaches were picked during a 6 year period.

Year	Kilograms
1995	54
1996	42
1997	35
1998	57
1999	48
2000	62

Kilograms of Peaches

Peaches Picked in an Orchard



Determine which variable to place on each axis. Label each axis.

Draw bars showing the appropriate amounts.

Title the graph.

Year

Early Ideas About the Origin of Life

The principle of biogenesis states that:

All living things come from pre-existing living things.

Prior to the 17th century, scientists believed in the idea of spontaneous generation or abiogenesis.

This was the idea that ...

... living things could arise from nonliving things.

Examples:

- ✓ **Maggots arise from dead, rotted meat.**
- ✓ **Mice arise from grain stored in a barn.**
- ✓ **Beetles arise from cow dung.**



Francesco Redi - 1668



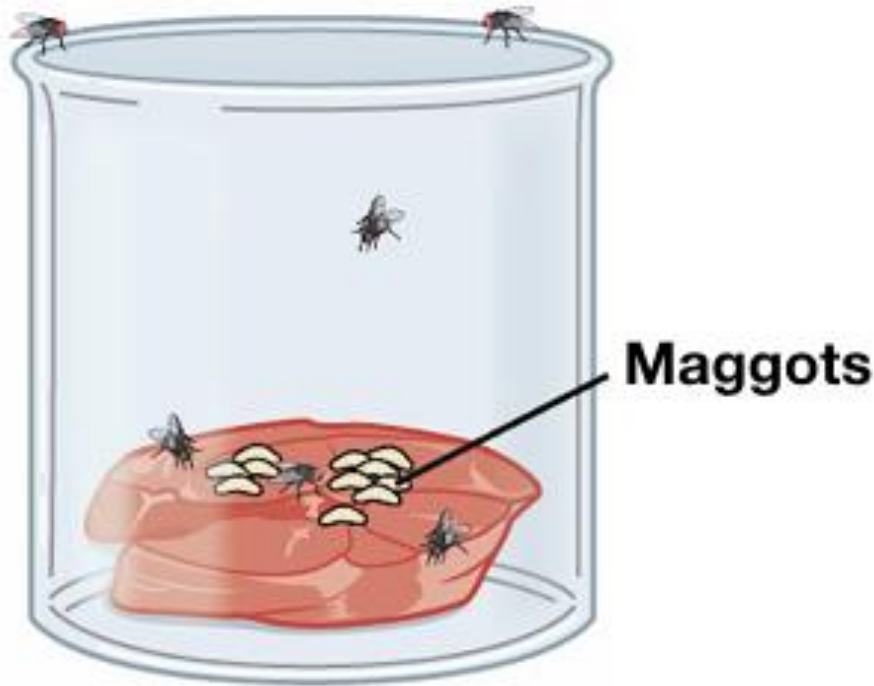
Redi did not believe in spontaneous generation and conducted an experiment to disprove it.

It was believed at the time that maggots and flies arose from rotting meat. Redi wanted to disprove the idea that flies were produced spontaneously from rotted meat.



The Experiment:

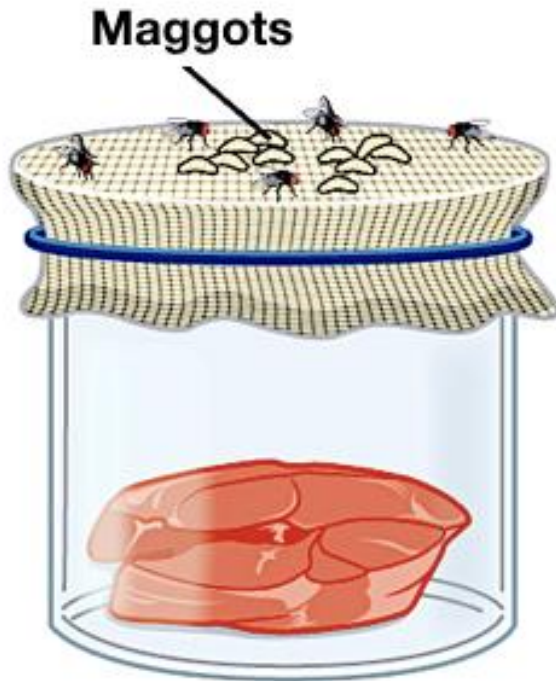
Redi's experiment consisted of ...
... a control group and an experimental group.



Control Group

- Meat was placed in the bottom of a jar.
- The jar was left uncovered and open to the air.
- After several days, maggots appear in the meat.
- Why? Flies landed on the meat and laid their eggs. The eggs hatched into maggots.

The Experiment:



Experimental Group

- In this group, the jar was covered with a cloth.
- The flies are attracted to the rotting meat, but cannot reach the meat to lay their eggs.
- No maggots appeared in the meat.

Results:

- The cloth allowed air to enter the jar, but prevented the flies from landing on the meat.
- Therefore no maggots appeared in the covered jars.
- This **proved** Redi's hypothesis that **flies produce maggots**, and that maggots **do not spontaneously arise** from rotting meat.

Lazzaro Spallanzani

At the time that Redi was conducting his experiment, the microscope was invented, revealing that the world is teeming with microorganisms.

Many scientists believed that microorganisms appeared by spontaneous generation from the air.



Spallanzani designed an experiment to test a hypothesis about the spontaneous generation of microorganisms.



His Hypothesis:
Microorganisms are not formed from air, but arise from other microorganisms.

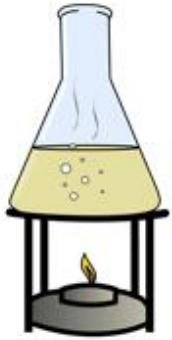
Spallanzani's Experiment

Spallanzani reasoned that boiling the broth would kill all the microorganisms in the broth. Both flasks were heated until the broth boiled.

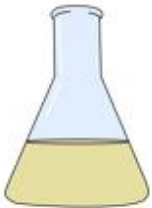
The control flask was left open. The experimental flask was sealed with a stopper while the broth was still very hot.

The broth in the sealed flask remained clear after several days, while the broth in the open flask became cloudy due to contamination with microorganisms.

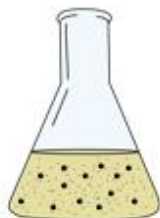
Control Group



Broth is boiled.



Flask is left open.

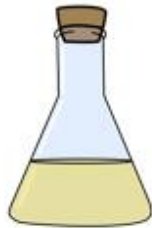


After several days the broth is cloudy with microorganisms.

Experimental Group



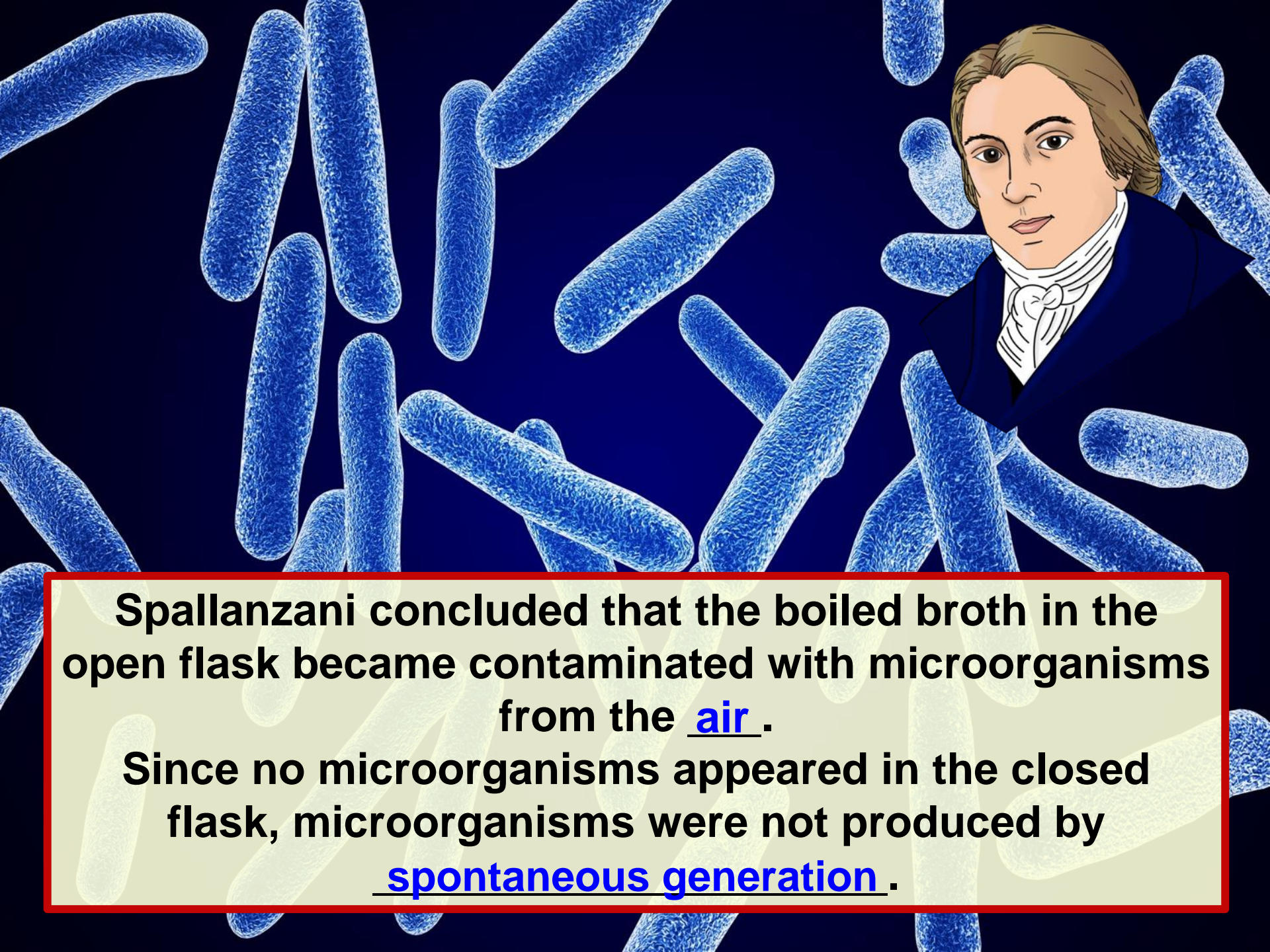
Broth is boiled.



Flask is stoppered.



Broth remains clear. No microorganisms.



Spallanzani concluded that the boiled broth in the open flask became contaminated with microorganisms from the air.

Since no microorganisms appeared in the closed flask, microorganisms were not produced by spontaneous generation.

Many scientists at the time, who still believed in spontaneous generation, objected to his experiment.

These scientists claimed that Spallanzani had heated the flasks for too long and had destroyed the “vital force” in the air.

Since the flask was sealed, new air containing this “vital force” could not enter and spontaneous generation was not allowed to occur.



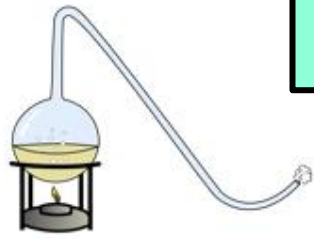
The idea of spontaneous generation was kept alive for another century.



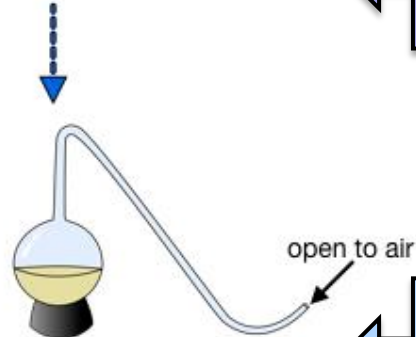
Louis Pasteur
(mid 1800's)

**Pasteur finally disproves
spontaneous generation once and**

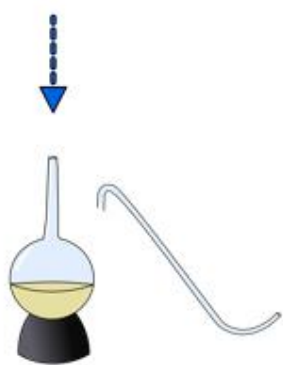
Pasteur's Experiment



Broth is boiled in a curve-necked flask until all microorganisms have been killed.



The end of the curve-necked flask is left open. One year passes, and the broth remains free of microorganisms.



After a year, the curved-neck is broken off the flask.



One day passes, and the broth becomes cloudy with microorganisms.

Scientists who believed in spontaneous generation could not object since the "vital force" air was still allowed to enter the flask.

The curved neck was open to the air, but the curved neck prevented solid particles containing microorganisms from entering the flask. Once the neck was taken off, microorganisms entered the flask and the broth immediately became cloudy with microorganisms.

The Characteristics of Life



All living things....



...no matter how different from each other they may be....

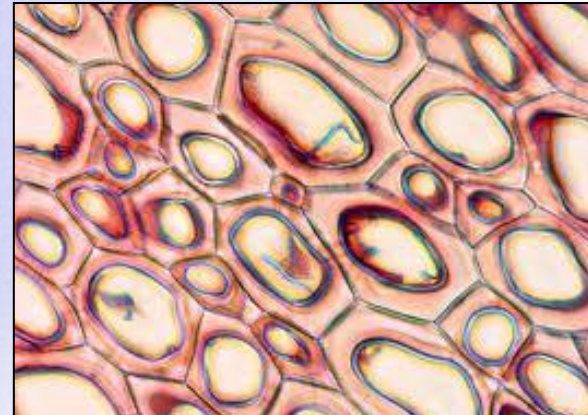
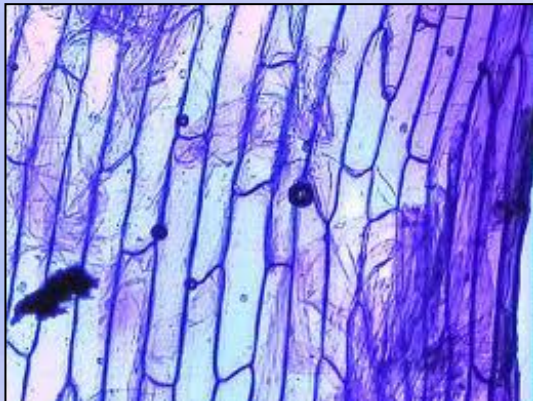
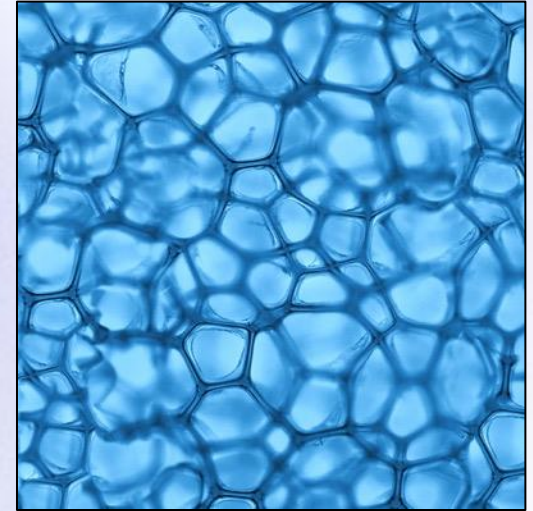
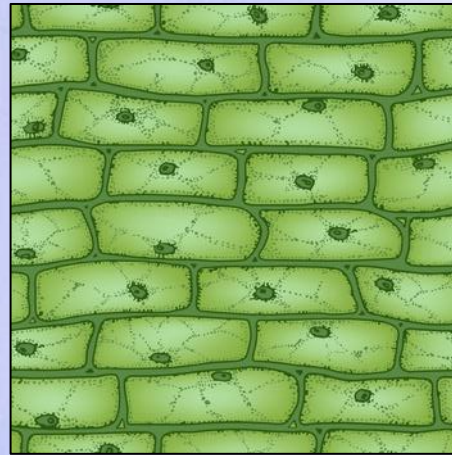


....share a set of common characteristics.



Living things...

....are made up of units called cells.



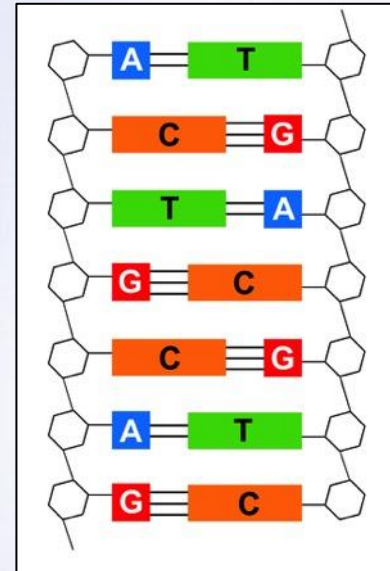
Living things...

....reproduce.



Living things...

....are based on a universal genetic code called DNA.



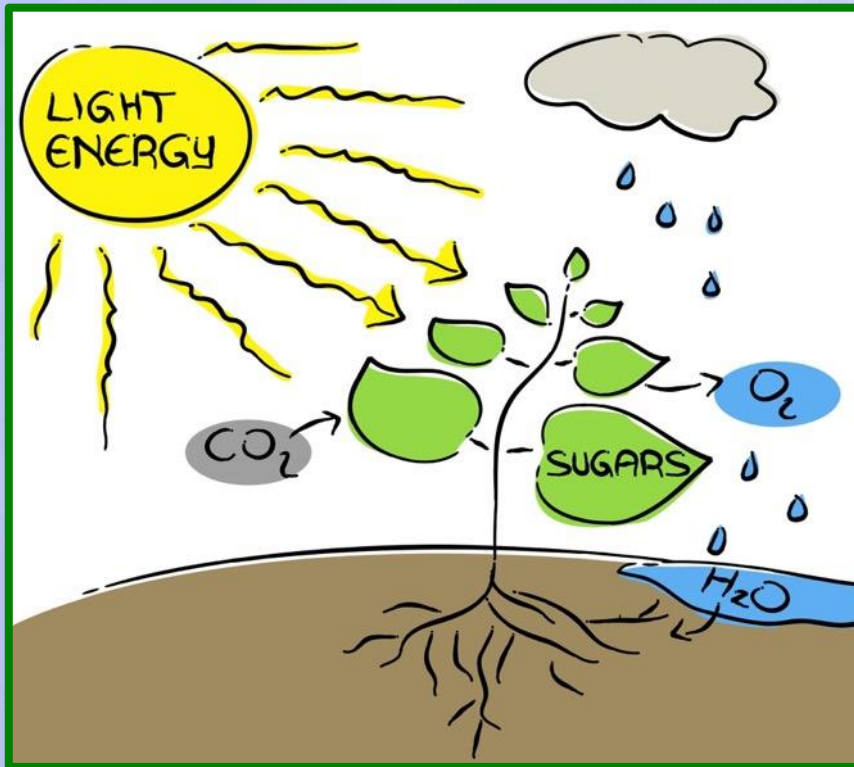
Living things...

....grow and develop.



Living things...

....obtain and use materials and energy.



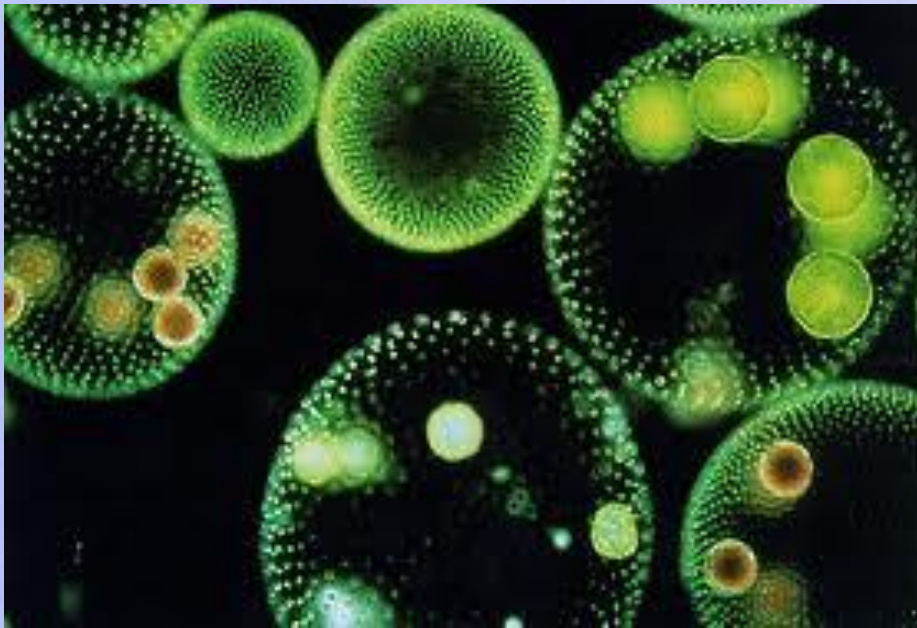
Living things...

....respond to their environment.



Living things...

....maintain a stable internal environment in a process called homeostasis.



Homeostasis is the balance between cells and their environment.

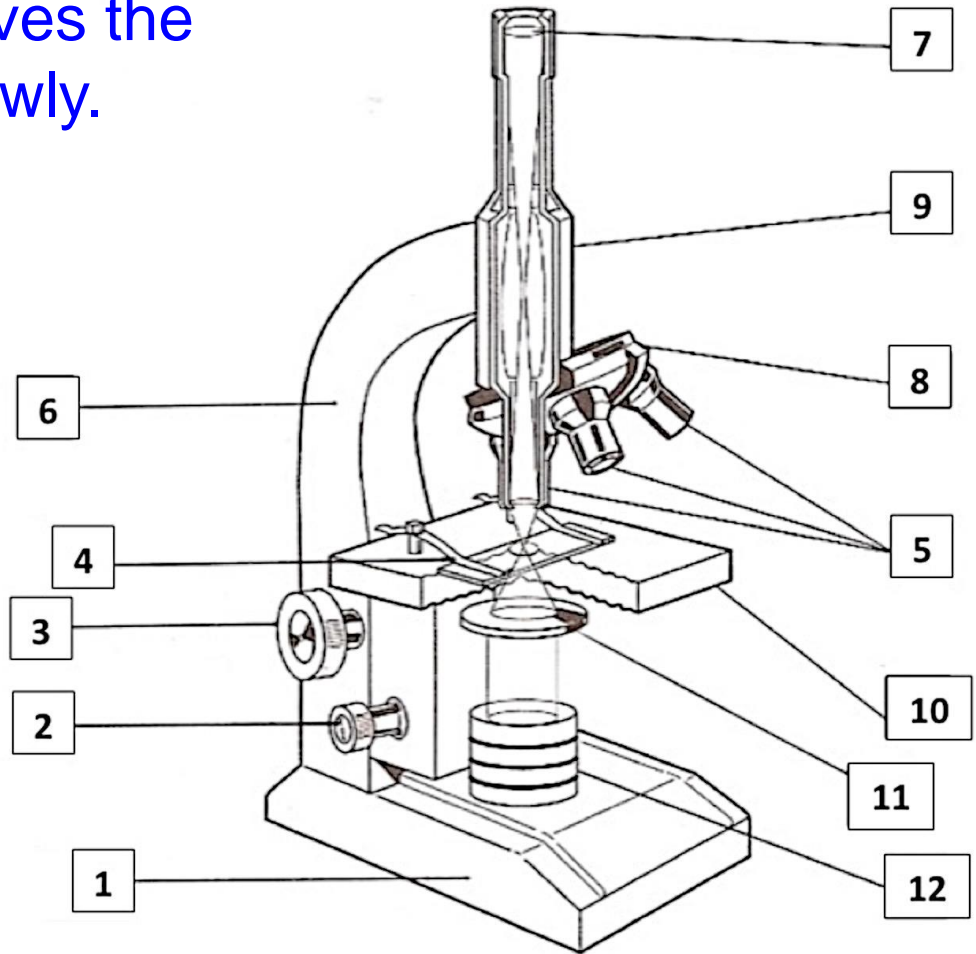
Living things...

....evolve, or change, over time.



The Microscope

1. Base
2. Fine Adjustment Knob: Moves the stage up and down very slowly.
3. Coarse Adjustment Knob: Moves the stage up and down rapidly.
4. Stage Clips: Holds the slide in place.
5. Objective Lens: The second set of lenses in a compound microscope.
6. Arm



The Microscope

7. Ocular: The first lens in a compound microscope.

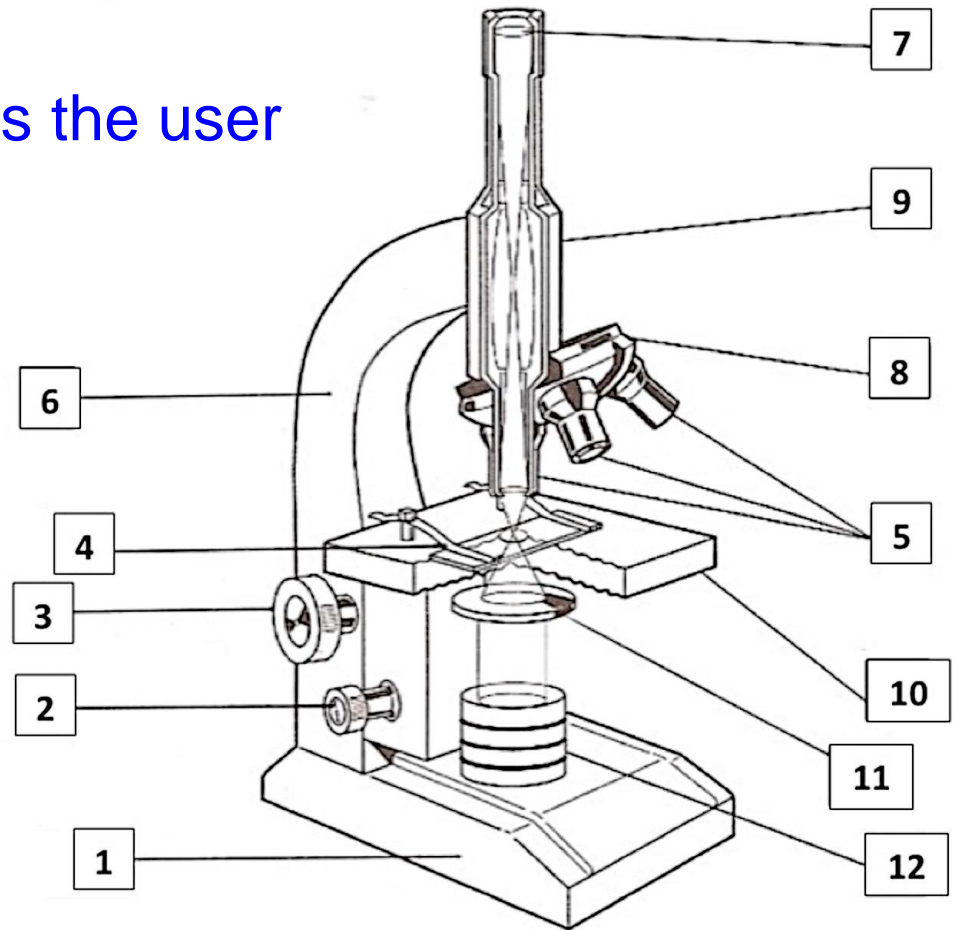
8. Rotating Nosepiece: Allows the user to change objectives.

9. Body tube: Keeps the two sets of lenses the correct distance apart.

10. Stage: A place to put the slide.

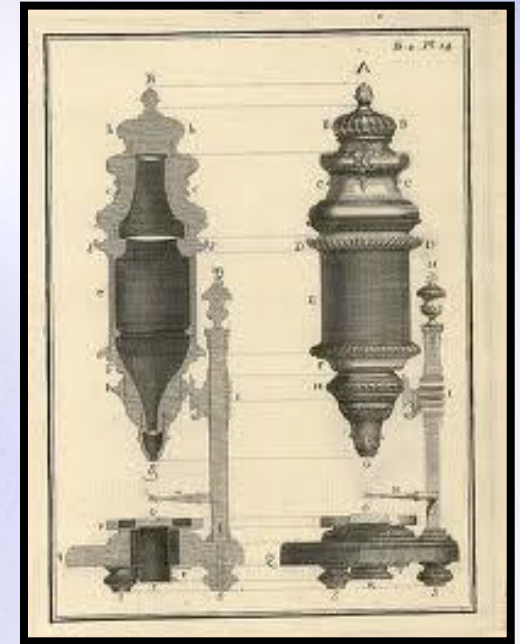
11. Diaphragm: Regulates the amount of light that hits the slide.

12. Light source



The Compound (Light) Microscope

Some early microscopes...



Compound Microscope: This microscope allows light to pass through the specimen and uses two lenses to form an image.



Magnification and Resolution

Magnification is how much the image is enlarged.

Total mag.= (ocular)(objective)

4x objective = (10) (4) = 40 times magnification

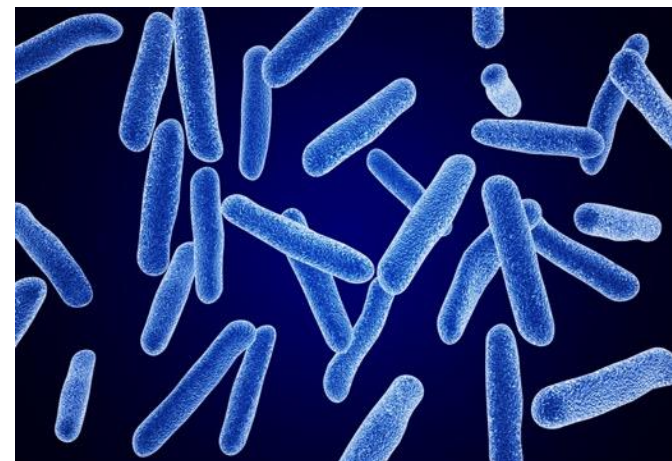
10x objective = (10) (10) = 100 times magnification

40x objective = (10) (40) = 400 times magnification



Resolution:

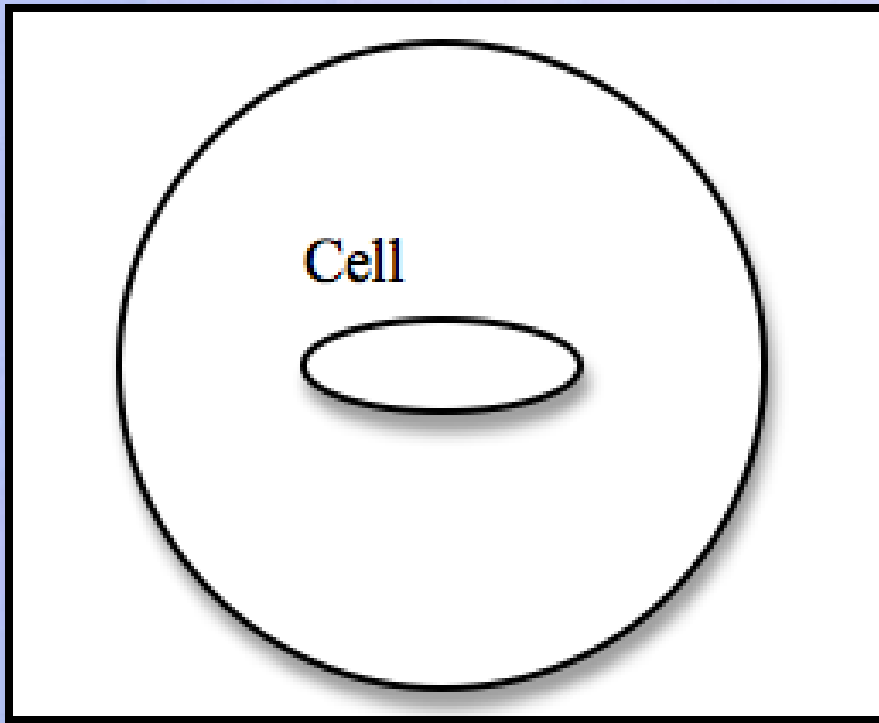
1. A measure of the clarity of an image.
2. It is the power to show details clearly.



How to Measure Under the Microscope

The unit of measurement used to measure things under the microscope is the micron (μ).

One micron = .000001 meters or 1/25,000 inch.



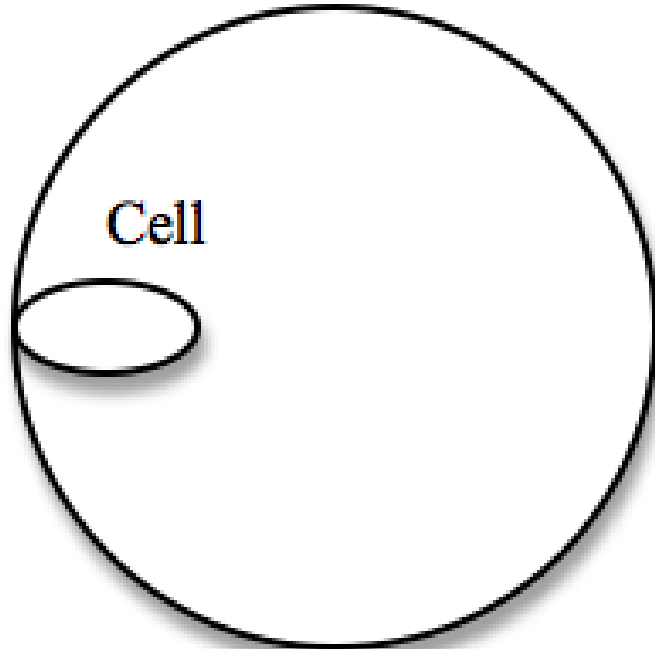
Using the 10x objective...

The 10x objective has a field of view with a diameter of 1500μ

Estimate the size of the cell in the drawing to the left.

With the 10x objective, the size of the cell would be about 650μ .

How to Measure Under the Microscope



With the 40x objective, the size of the cell would be about $100\ \mu$.



Using the 40x objective....

The 40x objective has a field of view with a diameter of $375\ \mu$

Estimate the size of the cell in the drawing to the left.

The Electron Microscope

Does not use light.

It uses a stream of electrons. Magnets guide the stream of electrons toward the specimen, and the image is projected on a photographic plate.

Advantage:

Magnification
up to
200,000
times.

Disadvantage: The method used to prepare the specimen will kill the cells so that living cells cannot be observed.





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