Go to the "Slide Show" shade above

Click on "Play from Beginning"

Chapter 1: Introduction to BIOLOGY

Lesson Objectives

Discuss the Characteristics of all Living Organisms.

Explore the principles and practices of the **Scientific Method.**

Science Practice: Compound Microscope Lab

Activity

List or come up with a model, sketch, diagram of “What defines Life?” or “What characterizes Life?” or “What constitutes living things?”

What is Biology?

- **Biology** is the scientific study of **LIFE.**
- Living things are called **Organisms.**
- Organisms include bacteria, protists, fungi, plants, and animals.

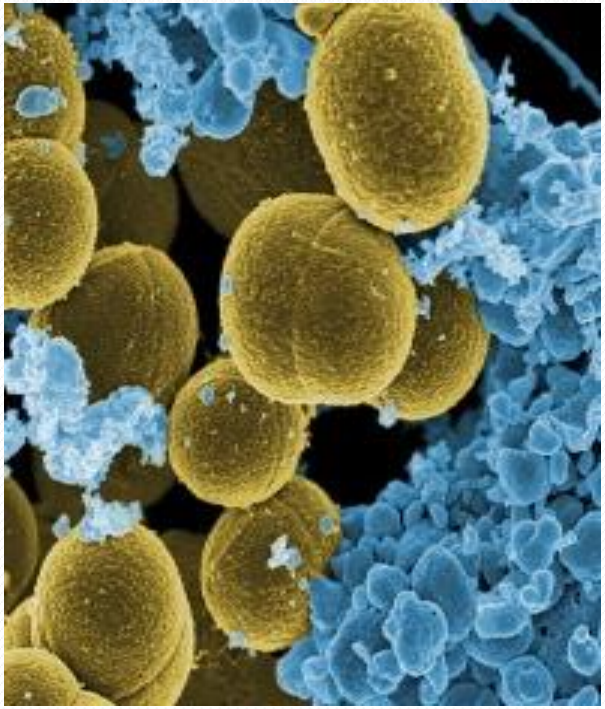
The Characteristics of Life

All organisms….

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

….share a set of common characteristics.

Diversity of Life

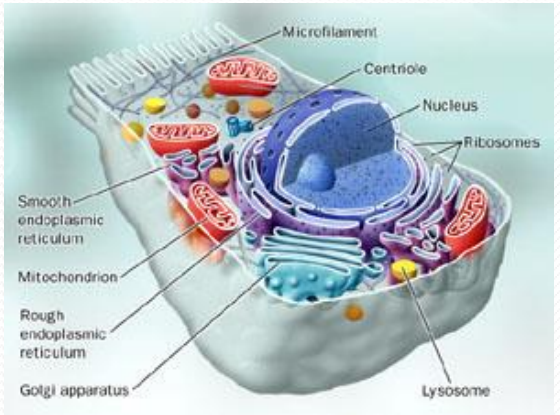


Microscopic bacteria

1) All Organisms are Made of Cells:

- **Cells**: structural and functional units of life
- **Two Basic Types:**
  - **Prokaryotic:**
    - "Simpler cells"
    - E.g. Bacteria

  - **Eukaryotic:**
    - Internal organelles with membranes
    - Nucleus with DNA
    - E.g. Plants, Animals, Fungi, Protists

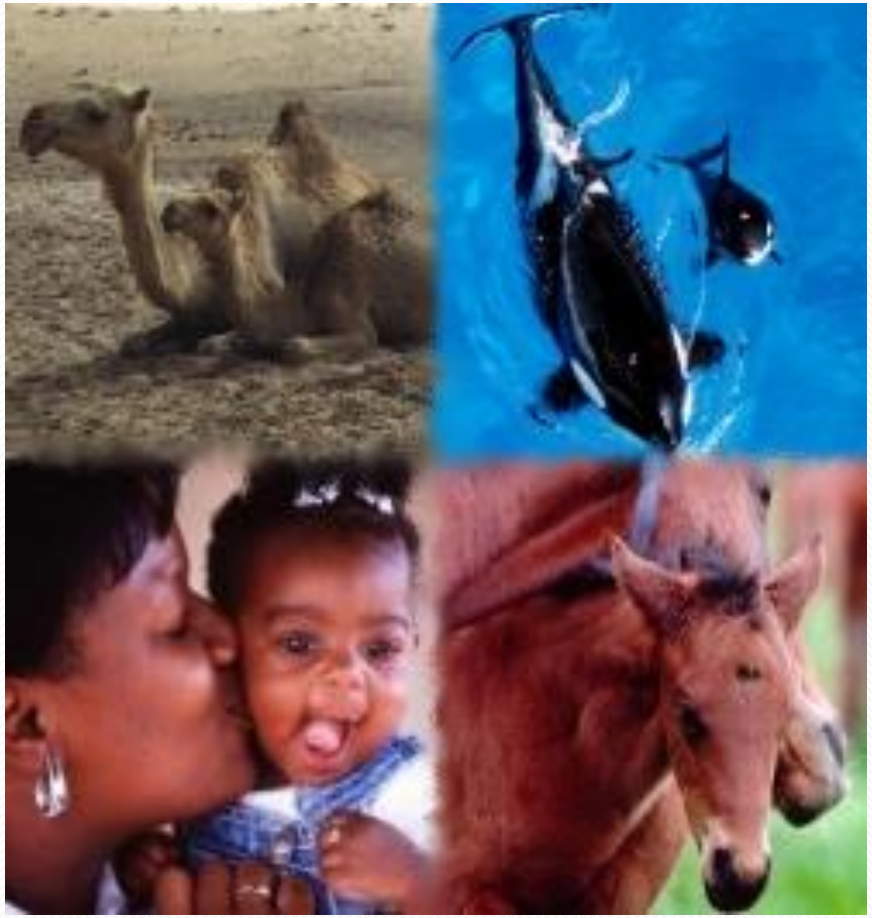


2) All organisms contain DNA in their Cells

- **DNA (deoxyribonucleic acid)** is the chemical substance of genes.
- **Genes** are the units of inheritance that transmit information from parents to offspring.
- Genes control **ALL** the activities of the cells.
- DNA is the reason that all organisms look and act the way they do. It is what makes all organisms unique.

3) All Organisms Reproduce

- Ability of organisms to reproduce **their own kind.**
- Reproduction is controlled by **DNA.**



4) All Organisms are Complex & Organized

Largescale Levels of Organization:

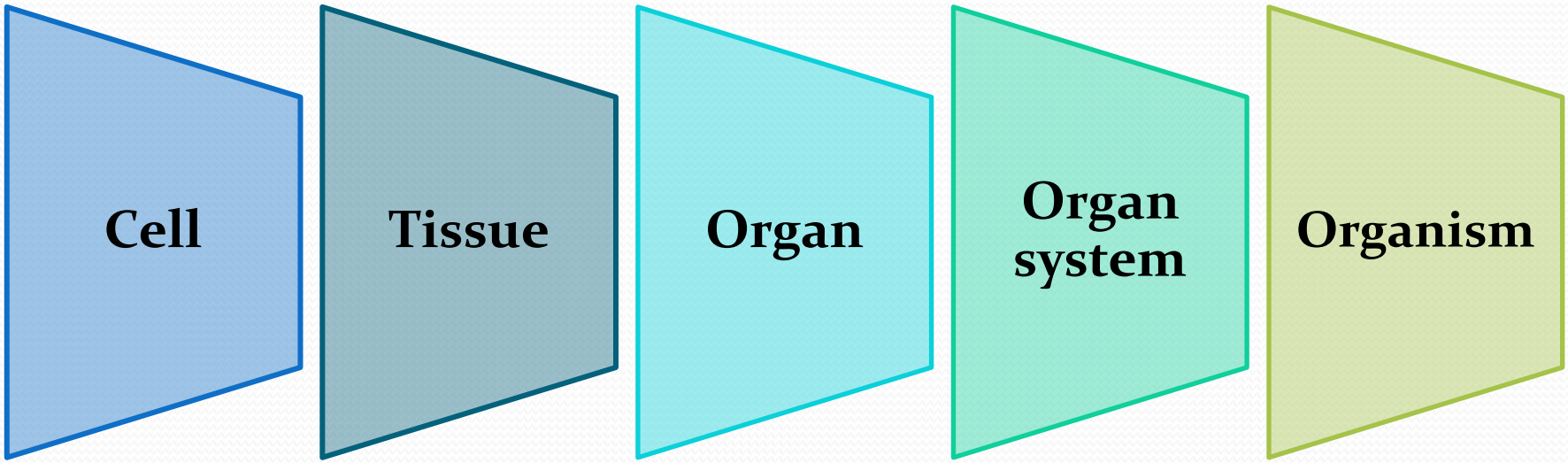
- **Biosphere**—all of the environments on Earth that support life.
- **Ecosystem**—all the organisms living in a particular area and the physical components with which the organisms interact.
- **Community**—the entire array of organisms living in a particular ecosystem.
- **Population**—all the individuals of a species living in a specific area.

4) All Organisms are Complex & Organized

Levels of Organization for Individuals:

- **Organism**—an individual living thing.
- **System**—several organs that cooperate in a specific function.
- **Organ**—a structure that is composed of tissues.
- **Tissue**—a group of similar cells that perform a specific function.
- **Cell**—the fundamental unit of life.
- ***Molecule***—*a cluster of small chemical* units called atoms held together by chemical bonds.

Levels of Organization



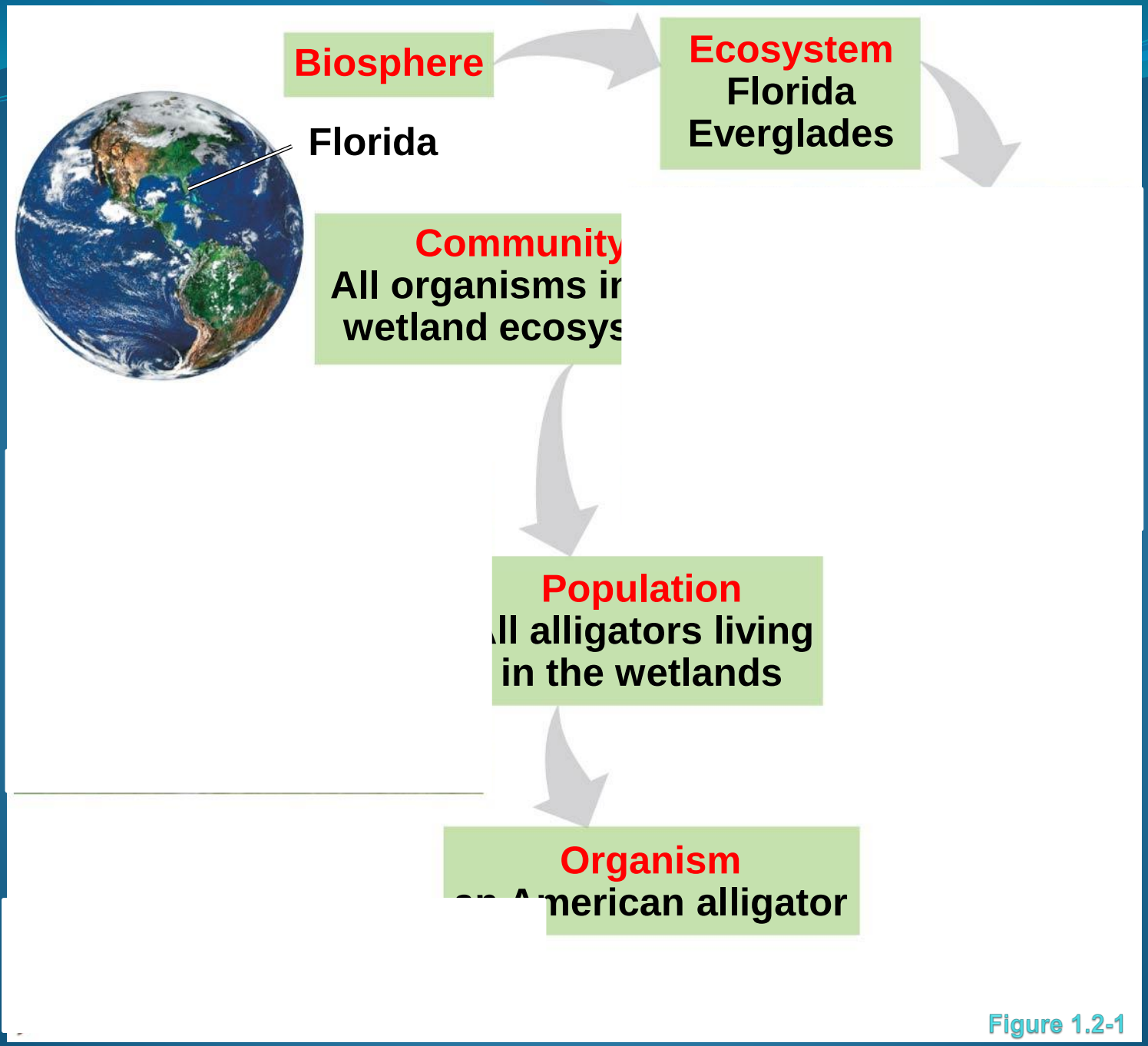

Biosphere
Florida
Ecosystem
Florida
Everglades
Community
All organisms ir
wetland ecosys
Population
ll alligators living
in the wetlands
Organism
merican alligator

Figure 1.2-1

Biosphere

Florida

Ecosystem
Florida
Everglades

Community
All organisms in this wetland ecosystem

Population
All alligators living in the wetlands

Organism
an American alligator

Figure 1.2-1

Figure 1.2-2

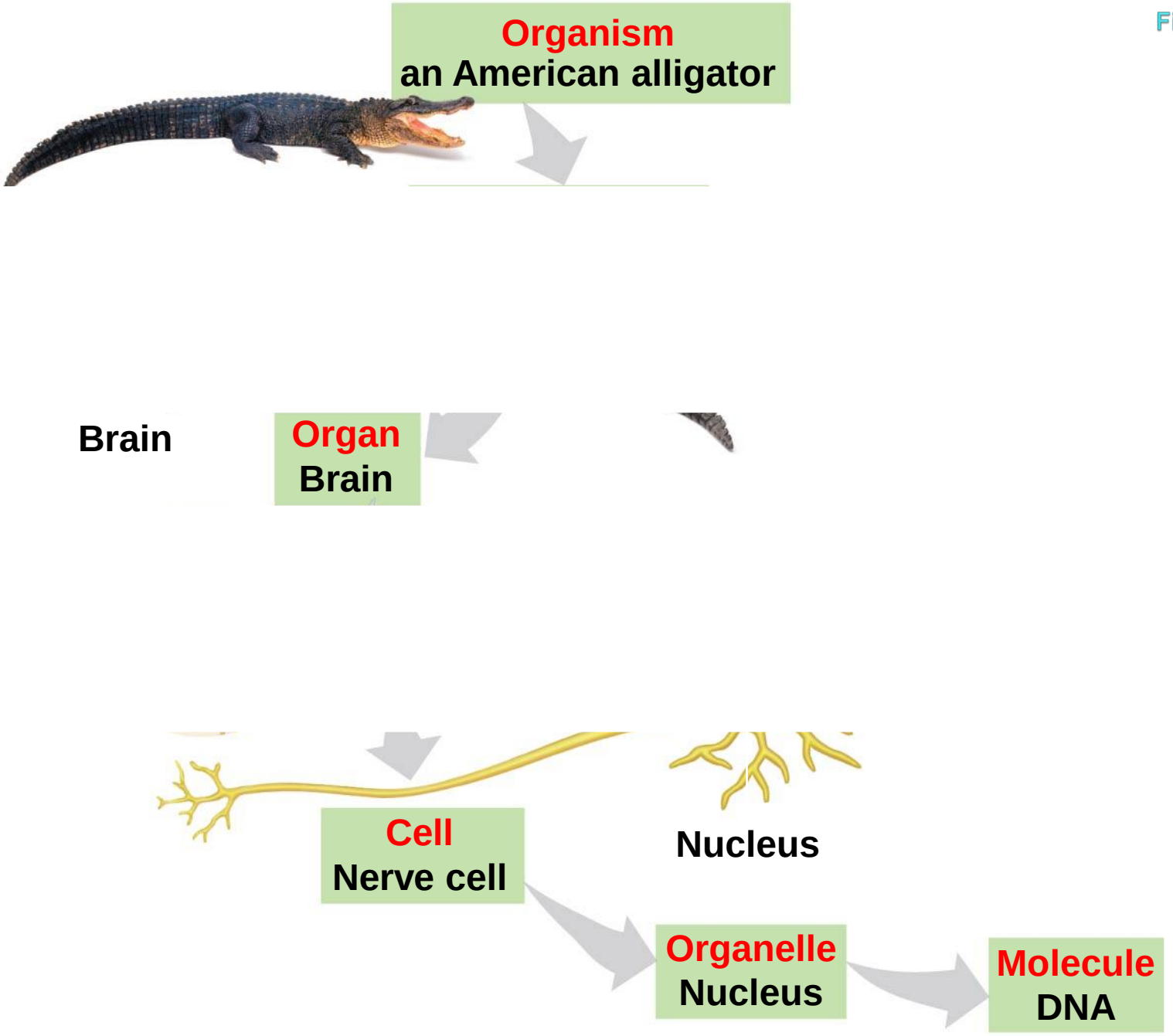
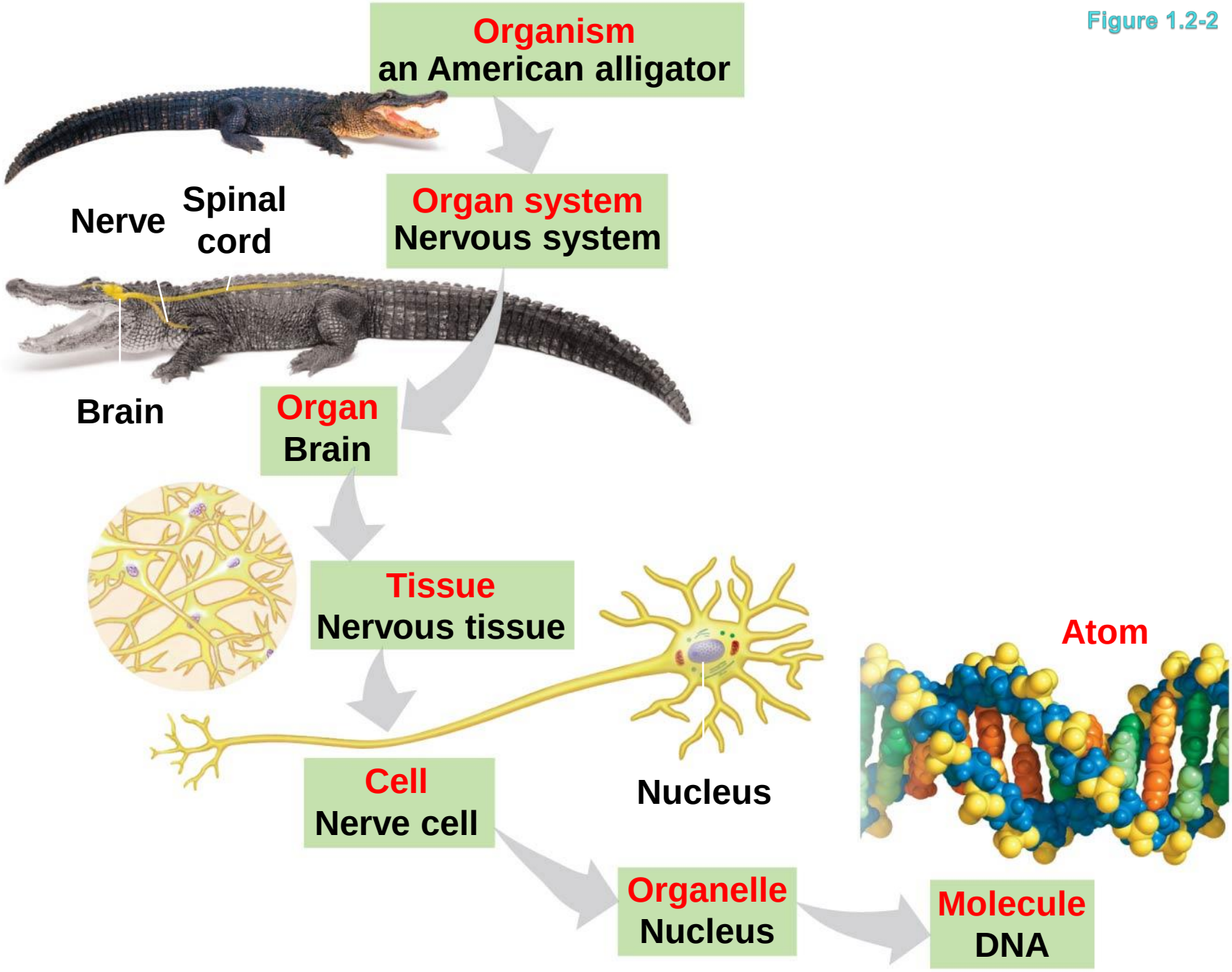

Organism
an American alligator
Brain
Organ
Brain
Cell
Nerve cell
Nucleus
Organelle
Nucleus
Molecule
DNA

Figure 1.2-2


Organism
an American alligator
Nerve
Spinal cord
Organ system
Nervous system
Brain
Organ
Brain
Tissue
Nervous tissue
Cell
Nerve cell
Nucleus
Atom
Organelle
Nucleus
Molecule
DNA

QUICK CHECK

Identify the Levels of Organization in a Multicellular Organism

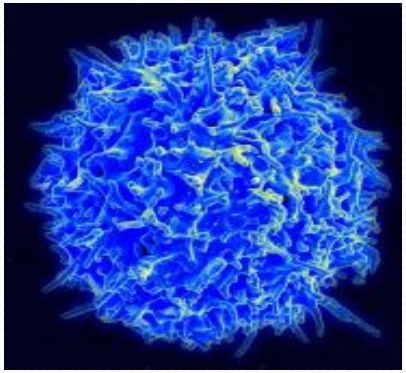
For each picture shown, choose the level of organization depicted.

1

2

3

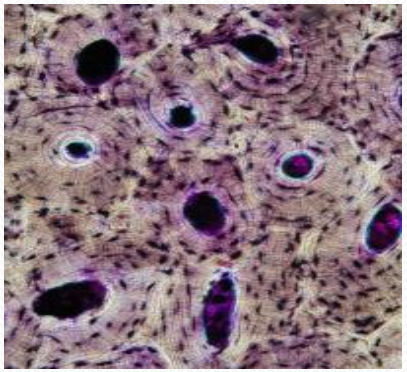
4



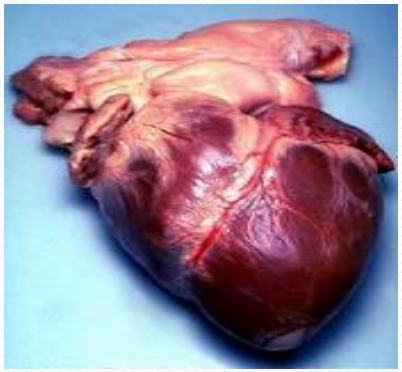
1

2

Image by Reytan



3



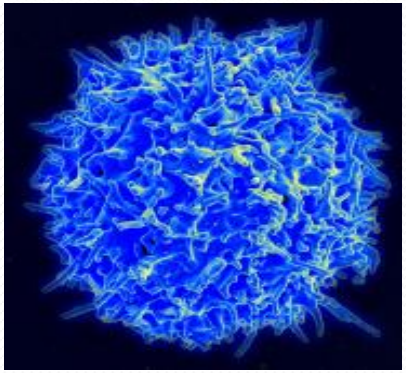
4

Identify the Levels of Organization in a Multicellular Organism

QUICK CHECK

For each picture shown, choose the level of organization depicted.

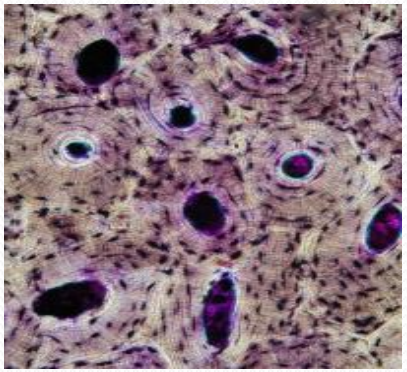
1. Cell
2. Organ system
3. Tissue
4. organ



1

2

Image by Reytan



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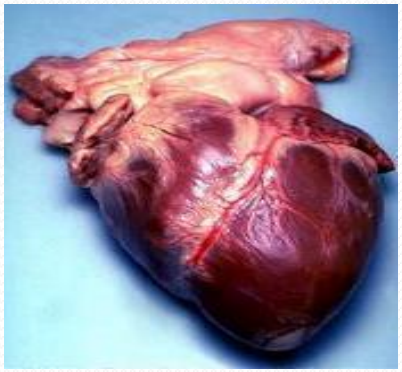
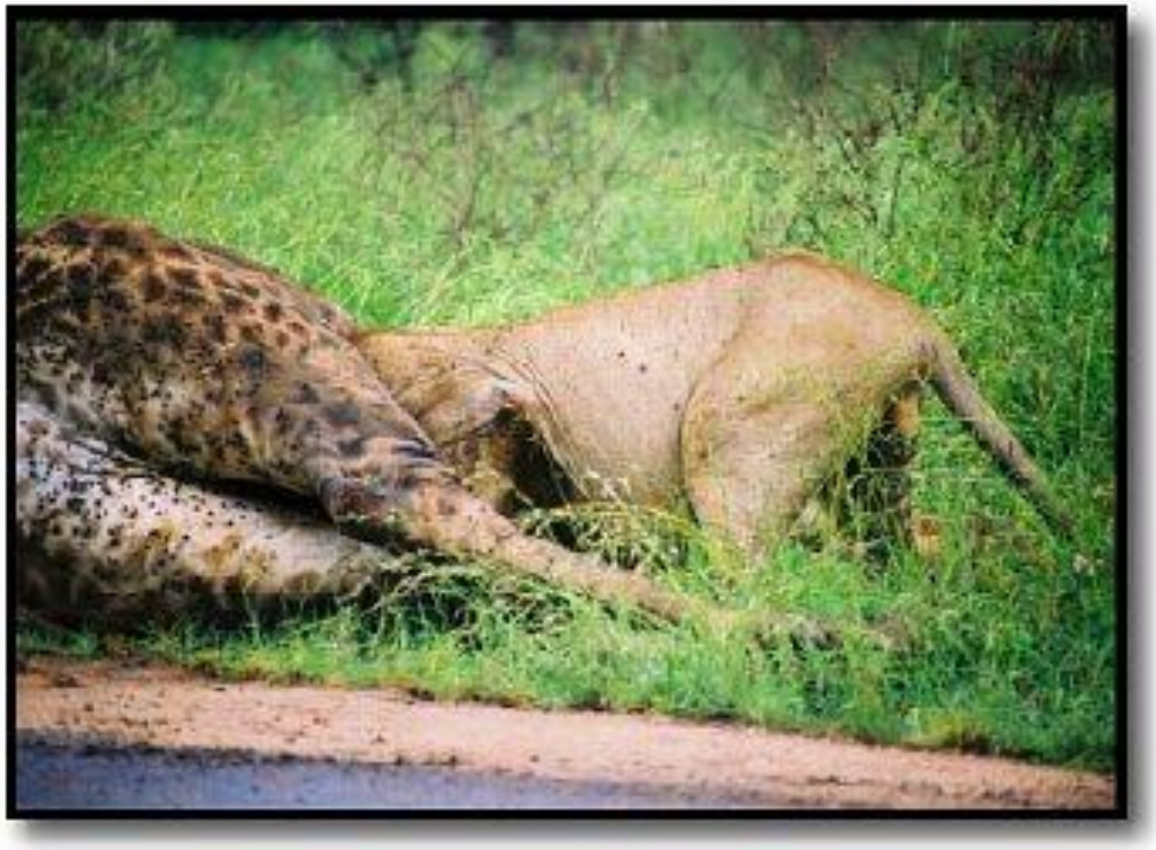


4

5) All Organisms Respond to their Environment

- Organisms Respond to environmental stimuli (Temperature, Water, Food Supplies, etc.) in order to Survive and Reproduce.
- The ability to respond is controlled by Receptors.
- Helps them to locate food, find shelter and find a mate.

6) All Organisms Interact with their Environment, exchanging Matter & Energy



6) All Organisms Interact with their Environment, exchanging Matter & Energy

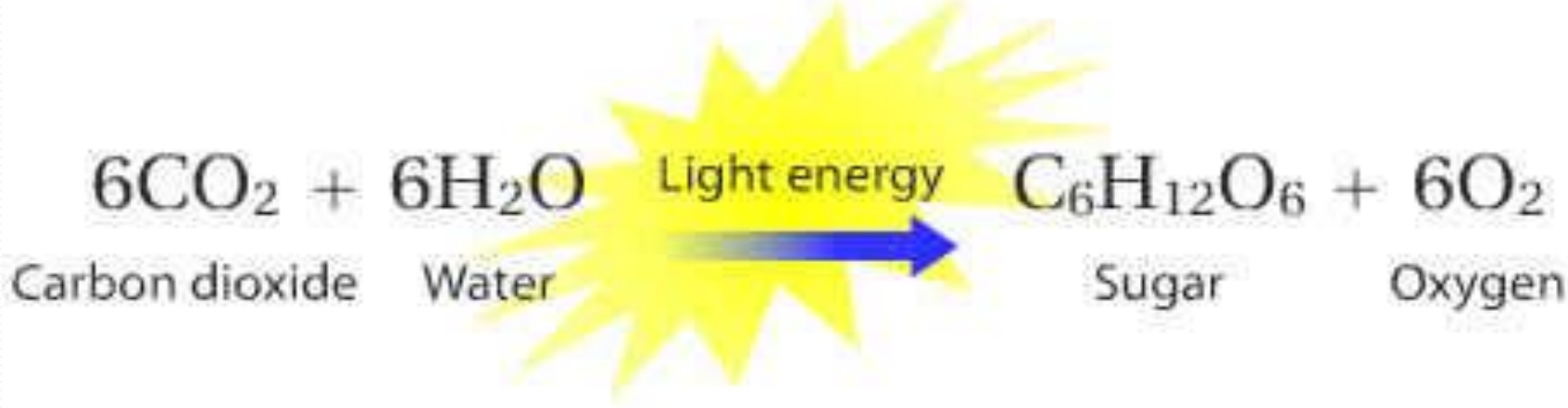
Metabolism:

- Process by which an organism extracts energy from its surroundings and uses it to sustain itself.
- All organisms require energy.
- **Sunlight** is the ultimate energy source for life on Earth.

6) All Organisms Interact with their Environment, exchanging Matter & Energy

Photosynthesis:

- Series of chemical reactions in which **plants** use **light** energy to **make** sugar molecules (**food**) using energy from the sun.
- Plants use this food to obtain the energy needed to run vital chemical reactions in the cells.



6) All Organisms Interact with their Environment, exchanging Matter & Energy

- **Animals** cannot make their own sugar molecules (food).
- Animals eat "pre-made" sugar molecules (food) to obtain energy that is used to run vital chemical reactions in the cells.

- **Cellular Respiration**
  - Process by which an **animal or plant** uses sugar molecules to make energy molecules.

$$6O_2 + C_6H_{12}O_6 \longrightarrow 6CO_2 + 6H_2O + Energy$$

6) All Organisms Interact with their Environment, exchanging Matter & Energy

Food Chain:

Process of transfering energy from

the sun →

producers →

consumers →

decomposers

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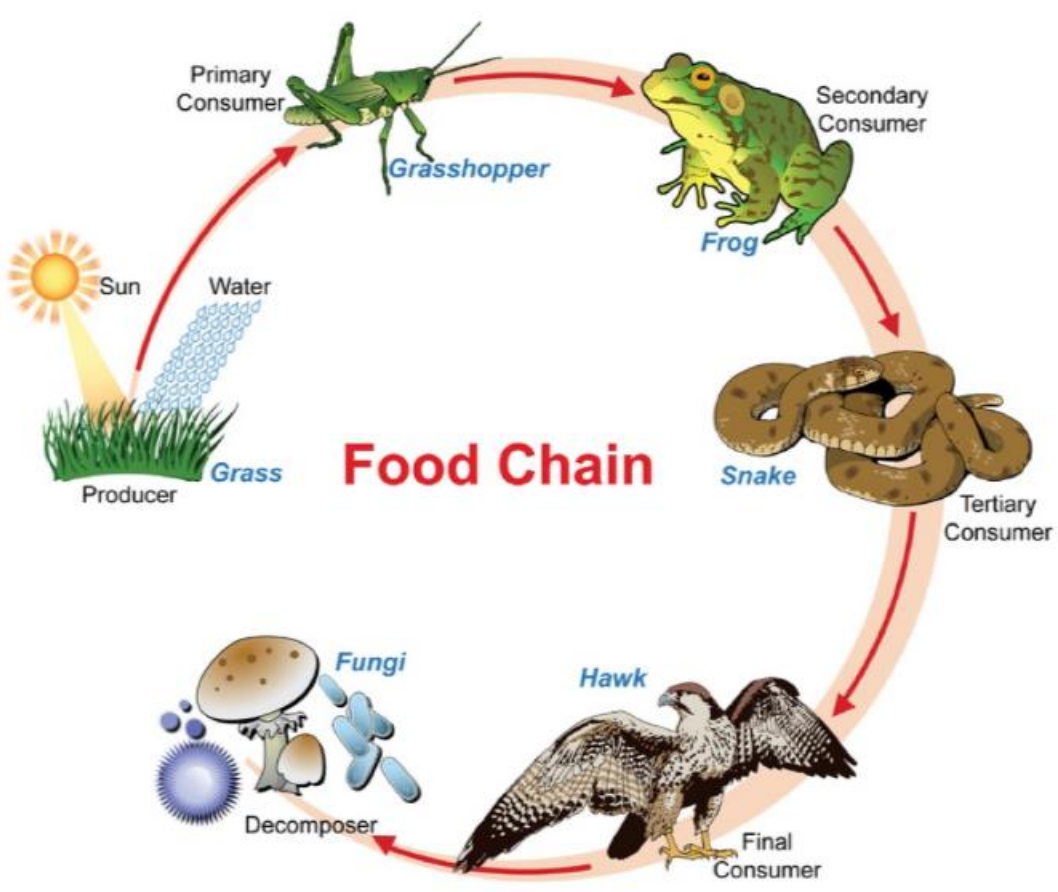


6) All Organisms Interact with their Environment, exchanging Matter & Energy

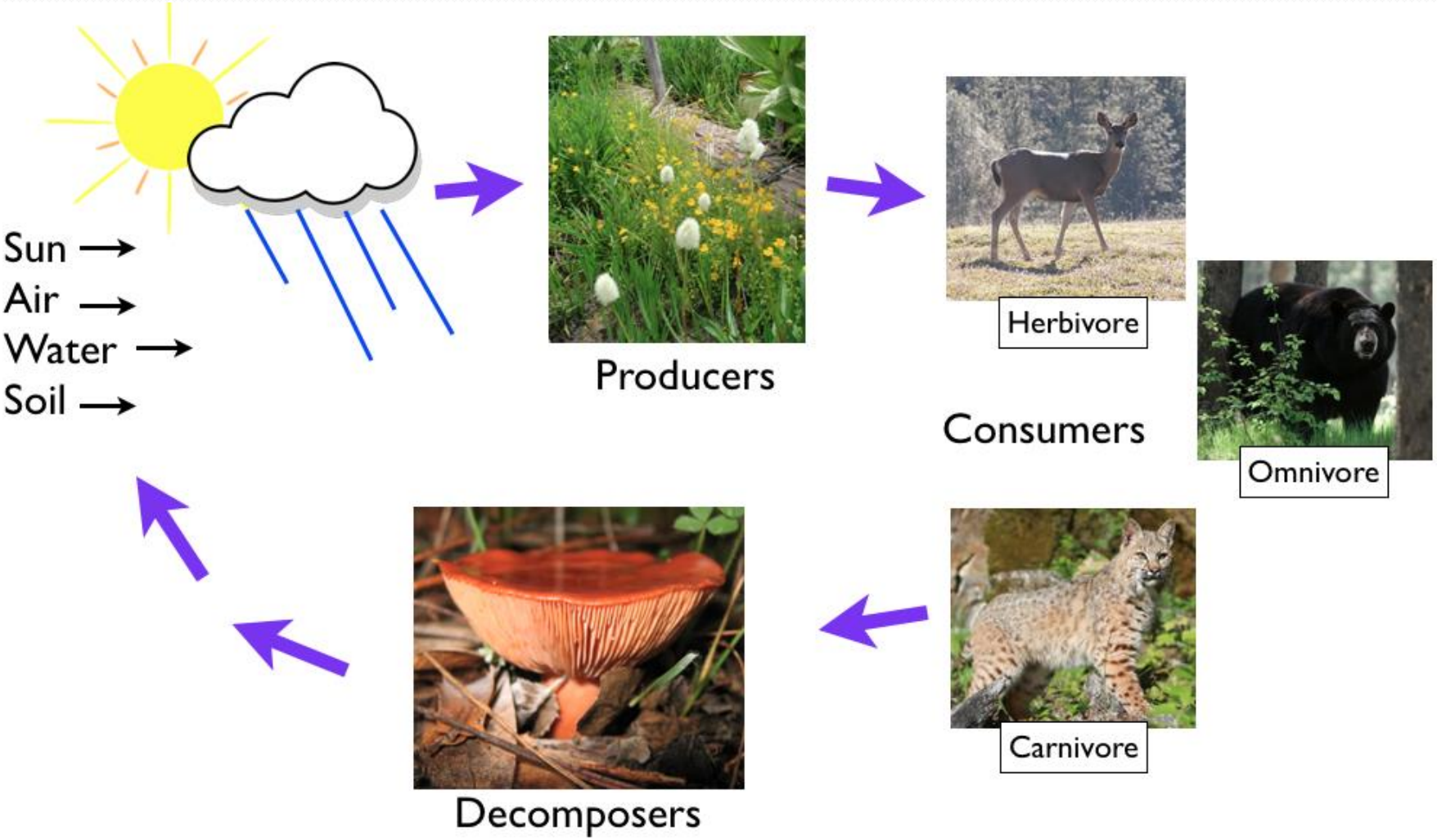
- **Producers** – organisms that use photosynthesis to produce its own energy source. E.g. Plants
- **Consumers** – organisms that use a producer or other consumer for its energy source. E.g. Animals
  - **Herbivores** eat plants
  - **Carnivores** eat meat
  - **Omnivores** eat plants and animals
- **Decomposers** – act as recyclers of matter by eating the dead remains of another organism to obtain energy.
  - In the process they are changing complex matter into simpler chemicals that plants can absorb and use.

6) All Organisms Interact with their Environment, exchanging Matter & Energy … What is the CYCLE?

QUICK CHECK

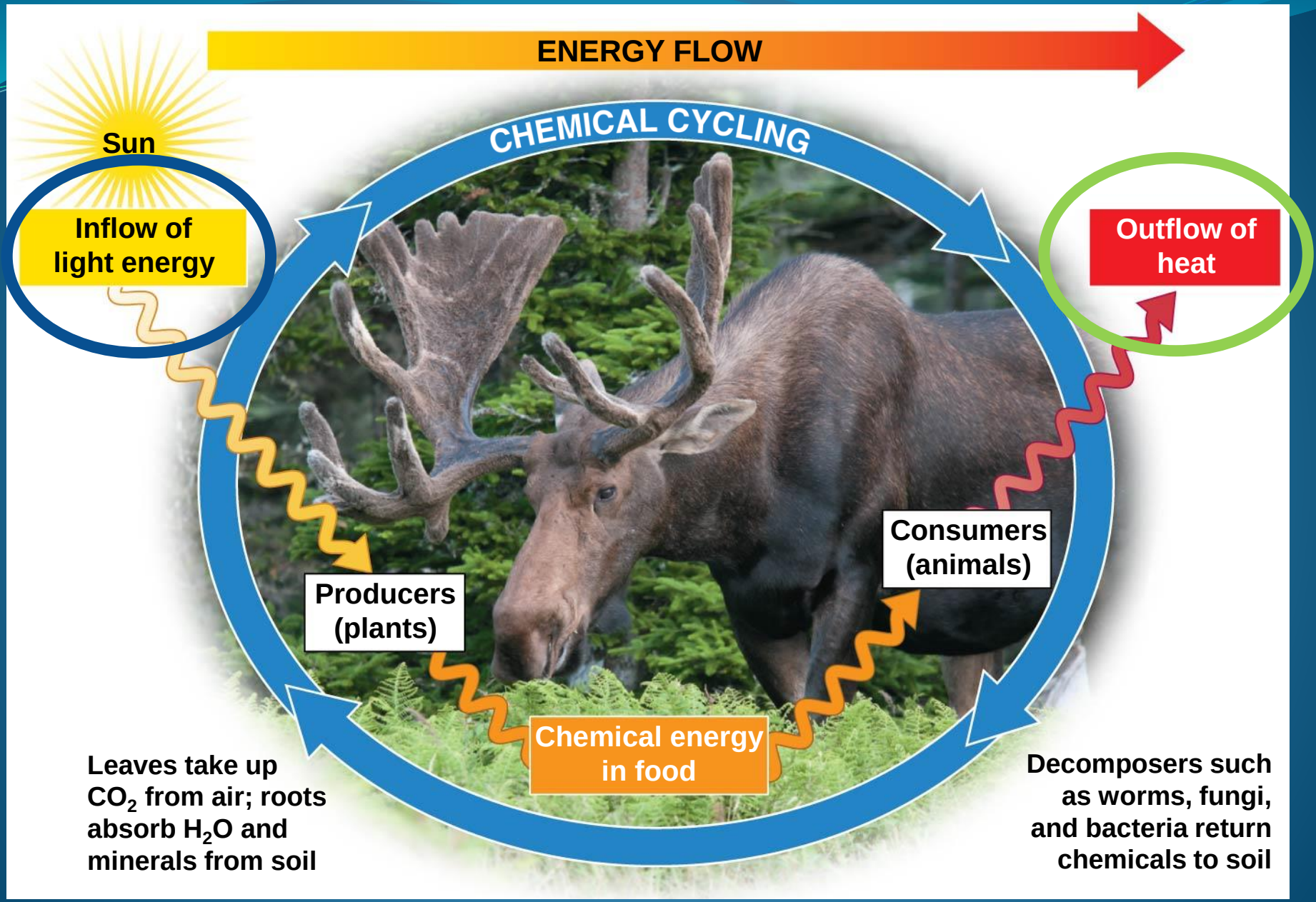
6) All Organisms Interact with their Environment, exchanging Matter & Energy … What is the CYCLE?

QUICK CHECK



6) All Organisms Interact with their Environment, exchanging Matter & Energy

- The dynamics of ecosystems include two major processes:
  1. the **recycling of chemical nutrients** from the atmosphere and soil through producers, consumers, and decomposers back to the air and soil.
  2. the **one-way flow of energy** through an ecosystem, entering as sunlight and exiting as heat.


ENERGY FLOW
CHEMICAL CYCLING
Sun
Inflow of light energy
Outflow of heat
Producers (plants)
Consumers (animals)
Chemical energy in food
Leaves take up CO_2 from air; roots absorb H_2O and minerals from soil
Decomposers such as worms, fungi, and bacteria return chemicals to soil

7) All Organisms Maintain Homeostasis

- This occurs when organisms are able to maintain a **stable internal environment …**
- …within the ranges required for life (includes pH, temperature, water balance, etc.)

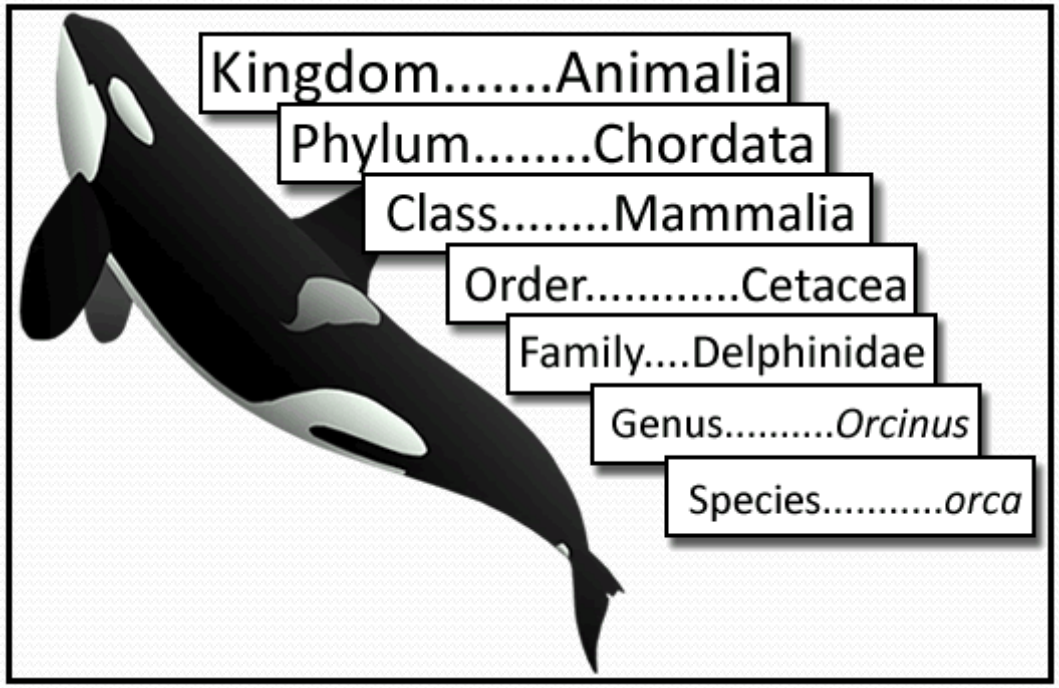
8) All Organisms Grow and Develop

- Organisms grow by producing more cells or by cell enlargement.
- Organisms develop as they mature into an adult organism.

9) All Organisms can be Systematically Classified

What is TAXONOMY?

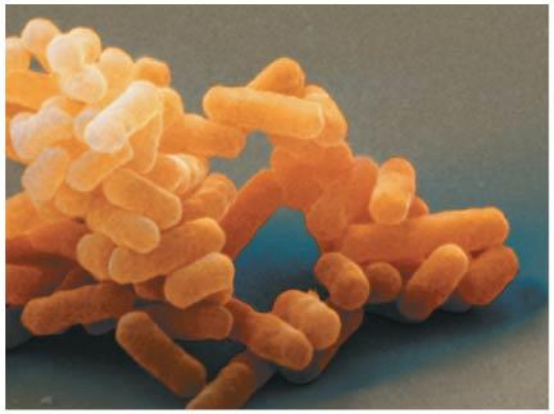
- Branch of Biology that studies the arrangement of organisms into orderly groups based on their similarities.



9) All Organisms can be Systematically Classified

- The diversity of life can be arranged into three higher levels called **DOMAINS**:
  1. **BACTERIA** are the most diverse and widespread prokaryotes.
  2. **ARCHAEA** are prokaryotes that often live in Earth's extreme environments.
  3. **EUKARYA** have eukaryotic cells & include
     - Unicellular (single-celled) protists
     - Multicellular fungi, animals, and plants

DOMAIN BACTERIA

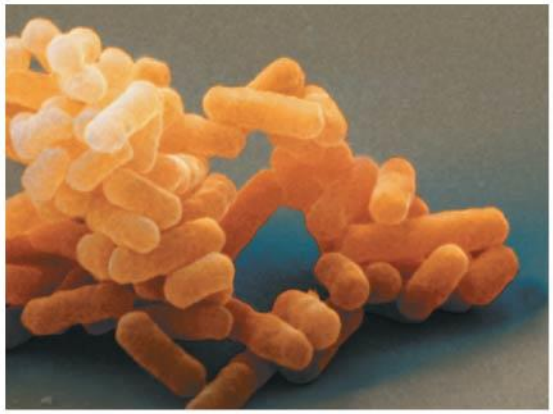


Bacteria

DOMAIN ARCHAEA

Archaea

DOMAIN BACTERIA

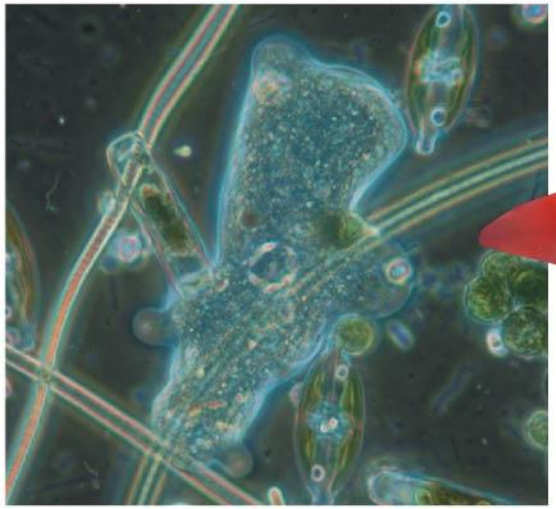


Bacteria

DOMAIN ARCHAEA

Archaea

DOMAIN EUKARYA



Kingdom Protista

Kingdom Plantae

Kingdom Fungi

Kingdom Animalia

Characteristics of All Living Things:

QUICK CHECK

1.

2.

3.

4.

5.

6.

7.

8.

9.

QUICK CHECK

Characteristics of All Living Things:

1. Basic Unit is the Cell
2. They contain DNA
3. They Reproduce
4. They are Complex and Organized
5. They Respond to their Environment
6. They Interact with their Environment, exchanging Matter and Energy
7. They maintain Homeostasis
8. They Grow and Develop
9. They can be Systematically Classified

QUICK CHECK

Matching

- Carnivores
- Consumers
- Decomposers
- Herbivores
- Omnivores
- Producers
- Sunlight

- Eats plants only
- Eats flesh only
- Eats both plants and flesh
- Makes food from the sun
- Eats producers
- Recyclers
- Ultimate source of energy

QUICK CHECK

Matching

- Carnivores — Eats flesh only
- Consumers — Eats producers
- Decomposers — Recyclers
- Herbivores — Eats plants only
- Omnivores — Eats both plants and flesh
- Producers — Makes food from the sun
- Sunlight — Ultimate source of energy

What is SCIENCE?

1) Science is a way of knowing what stems from our curiosity about ourselves and the world around us.

2) **Scientists** typically:

- **Make Observations**
- **Form HYPOTHESIS**: proposed solutions for a set of observations.
- **Test Hypothesis**

3) **Science** is based upon **INQUIRY:**

The search for information and explanations of natural phenomena.

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:

"Amounts" involving numbers obtained by counting or measuring.

Qualitative Data:

descriptions involving characteristics that cannot be counted.

SCIENTIFIC METHOD

The scientific method is:

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

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
6. Communication

Accurate Observation

Which direction are the arrows pointing behind the glass?

Refraction

The arrows are pointing in the same direction behind the glass.

Accurate Observation

http://somup.com/c3jTY9Uje4
Auditory Illusion (0:50)

SCIENCE IS IMPORTANT BECAUSE

… We tend to make poor observations

SCIENCE IS IMPORTANT BECAUSE …

- We often make observations with bias.
- In other words, we have a prejudged solution BEFORE observing.
- OR we make the observation FIT INTO OUR already decided mindset.

Accurate Observation

Step 1:
Observation / Asking a Question

A problem to solve or a question must first be identified.

Uses the senses (touch, taste, smell, sight, hearing, pressure/pain)

Collects data & Organizes the data

How much water can a root hair absorb?

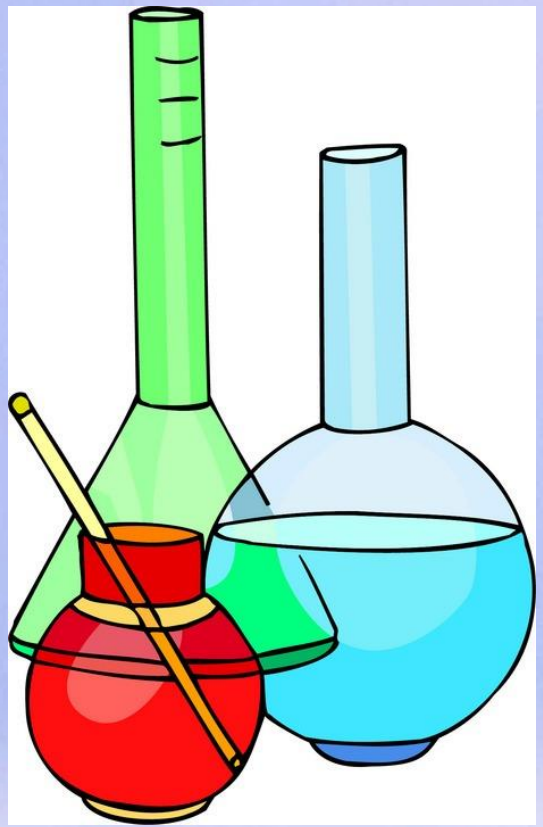
Why does a plant stem bend toward the light?

What effect does temperature have on heart rate?

Step 2: Form a Hypothesis

Hypothesis

A possible solution to the question or problem based on accurate observation. 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.

- **"If… then…" statement**

Step 3: Designing a Controlled Experiment

1. The factors in an experiment that can be changed are called **variables**. Some example of variables could 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 were changed at the same time, the scientist would not know which variable was responsible for the observed results. All other variables should be unchanged or "controlled".

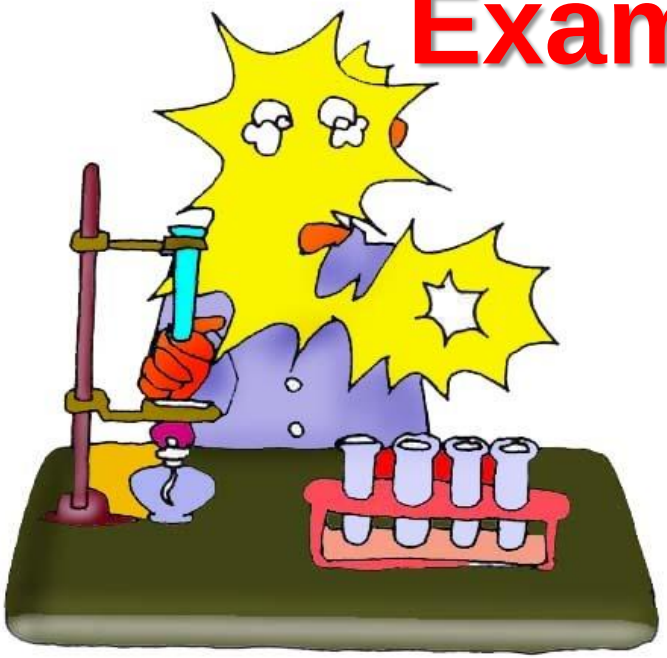
Step 3: Designing a Controlled Experiment

3. An experiment is based on the comparison between a control group with an experimental group.

a) Ideally, these two groups are identical EXCEPT for ONE factor.

b) The control group serves as the comparison and usually is the independent variable. 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 (dependent variable).



Example:

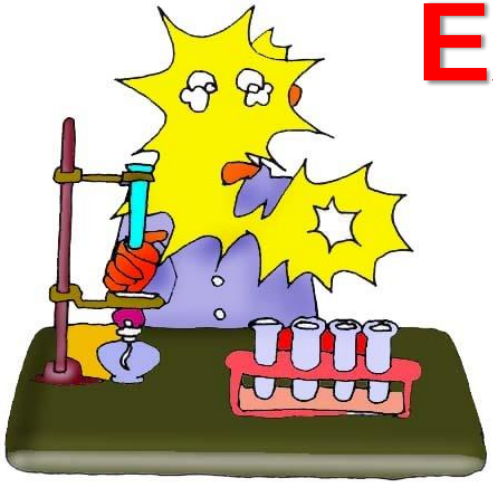
In order to test the effectiveness of a new vaccine, 50 volunteers are selected and divided into two groups. One group will be the control group and the other will be the experimental group. Both groups are given a pill to take that is identical in size, shape, color and texture.

Describe the control group.

Describe the experimental group.

What variables are kept constant?

What variable is being changed?



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 are given a pill to take that is 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.

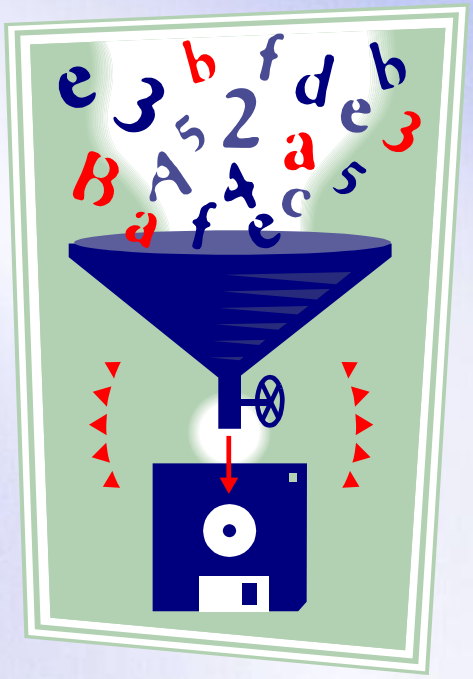
What variable is being changed?

Whether or not the pill contains the vaccine.

There are two variables in an experiment:

INDEPENDENT VARIABLE

- The variable that does NOT depend on the other variables and is deliberately manipulated by the scientist.
- Establishes the relationship (direct or inverse) between variables.



DEPENDENT VARIABLE

- The variable that depends on other factors and is observed (for change) during the experiment.
- The data collected is a result of manipulating the independent variable.

There are two variables in an experiment:

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 are given a pill to take that is identical in size, shape, color and texture.

What is the independent variable?

What is the dependent variable?

There are two variables in an experiment:

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 are given a pill to take that is identical in size, shape, color and texture.

What is the independent variable?

It is the pills without the vaccine that were given to the volunteers.

What is the dependent variable?

The observed health of the people receiving the pills with the vaccine compared to those without it.

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.

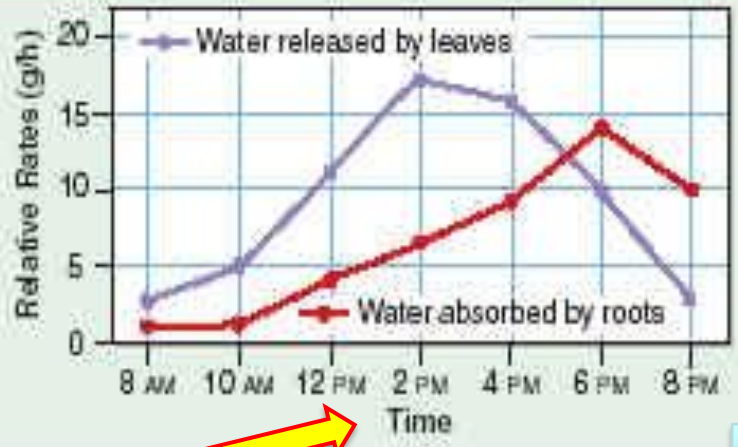
2. **Does the data support or not support the hypothesis?**

Step 4: Recording & Analyzing Results

- Involves placing observations and measurement (data) in order
  - **Graphs, charts, tables, or maps**
  - **The independent variable is plotted on the x-axis and is the first variable shown in a table or chart (for comparison).**

Water Released and Absorbed by Tree

Time	Absorbed by Roots (g/h)	Released by Leaves (g/h)
8 AM	1	2
10 AM	1	5
12 PM	4	12
2 PM	6	17
4 PM	9	16
6 PM	14	10
8 PM	10	3



Step 5: Drawing Conclusions

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

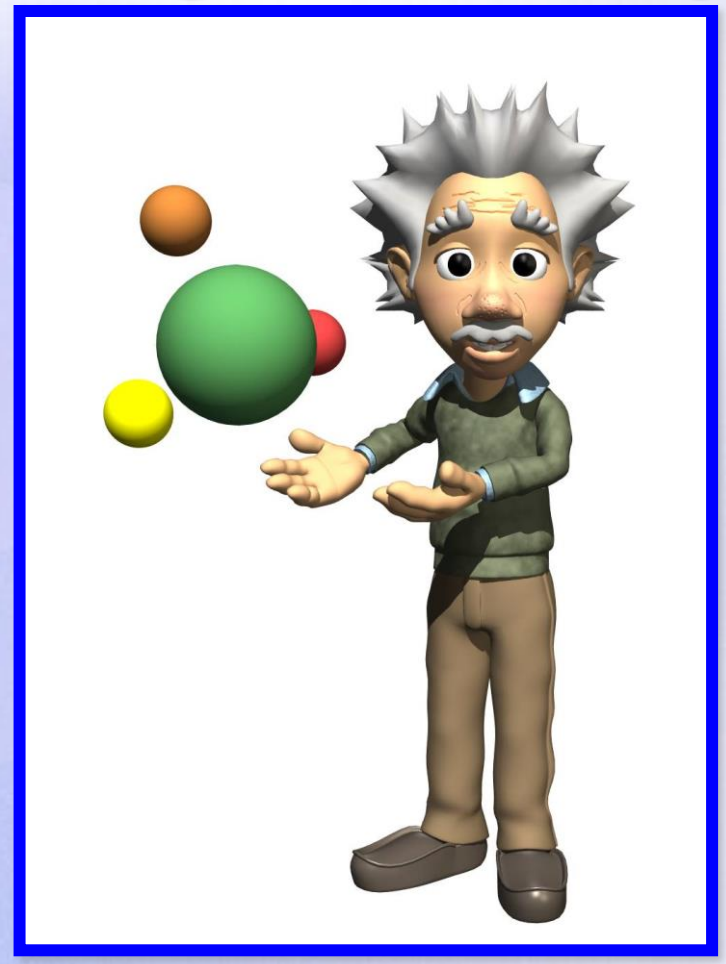
Experiments must be repeated over and over.

A valid conclusion can only be reached if the results are repeatable (always the same).

Forming a Theory

Theory:

- A well-substantiated explanation based on repeated observation & testing.
- Recognizable patterns that form reliable accounts of the real world.



A theory can be modified.

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

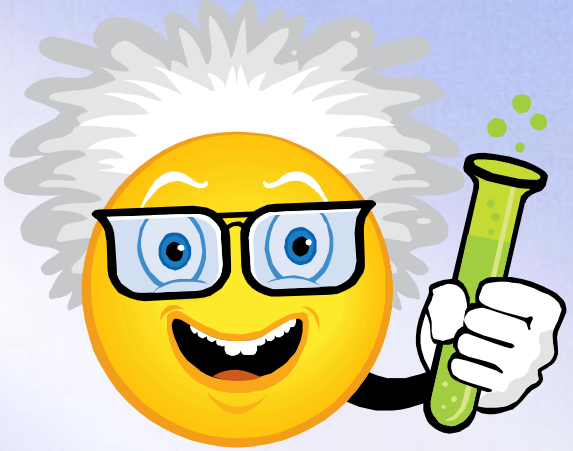
Step 6: Communication

- Scientists must share the results of their studies with other scientists (peers).
- Publish findings in journals.
- Present their findings at scientific meetings.
- Scientists must be unbiased
  - Should not tamper with their data
  - Only publish and report tested and proven ideas.

Step 6: Communication

- Sharing of information is essential to scientific process.
- Subject to examination and verification by other scientists.
- Allows scientists to build on the work of others.

Practice Problem:

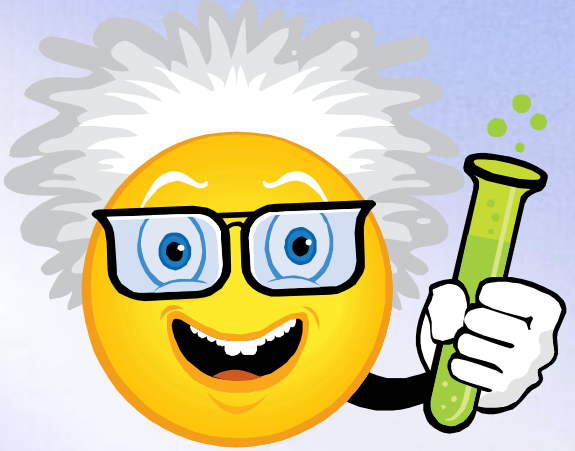


- You want to determine **the effects of a certain fertilizer** on the growth of orchids grown in a greenhouse.
- Materials that are available to you include: greenhouse, 100 orchid plants, water, fertilizer, and soil.
- You want to know if the orchids will grow best with a **weak** concentration of fertilizer, a **medium** concentration of fertilizer, or a **high** concentration of fertilizer.
- How will you design an experiment to test different concentrations of this fertilizer?

State your Hypothesis:

Possible answer:

Practice Problem:



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- How will you design an experiment to test different concentrations of this fertilizer?

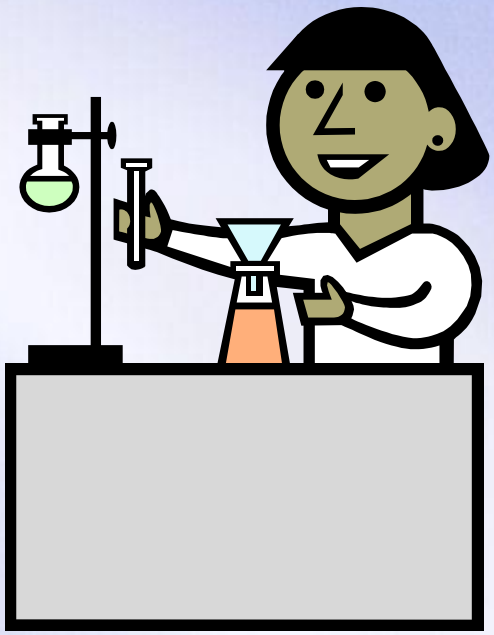
State your Hypothesis:

Possible answer:

"If a medium concentration of fertilizer is used, then the orchids will grow best."

How will you set up a controlled experiment?

Here is one possibility:



The 100 plants will be divided into 4 groups as follows:

Group 1: 25 plants will receive plain water.

Group 2: 25 plants will receive a weak concentration of fertilizer.

Group 3: 25 plants will receive a medium concentration of fertilizer.

Group 4: 25 plants will receive a high concentration of fertilizer.

- The plants will be watered daily.
- The plants will be measured over a period of 1 month to see which ones grew the tallest.

Control Group

What is the control group in the experiment?

Experimental Group

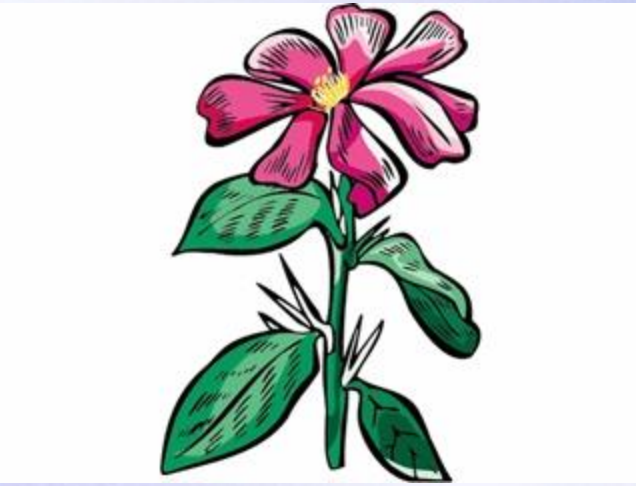
What is the experimental group in the experiment?

Control Group

What is the control group in the experiment?

The 25 plants that are receiving plain water.

Experimental Group



What is the experimental group in the experiment?

The 75 plants that are receiving various concentrations of fertilizer.

In a “controlled experiment”, all variables must be kept constant except the one variable that is being changed.

What variables must be kept constant in this experiment?

- ✓All plants must receive the same amount of fluid each day.
- ✓All plants are grown in pots of equal size.
- ✓All plants are grown at the same temperature.
- ✓All plants receive the same amount of sunlight.

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What variable is being changed in this experiment?
The variable being changed is the amount of fertilizer received by each group of plants (dependent variable).

After one month of measuring the orchids, the following data is obtained:

Group 1 (Control Group): Grew to an average height of 15 cm.

Group 2 (Weak conc.): Grew to an average height of 35 cm.

Group 3 (Medium conc.): Grew to an average height of 28 cm.

Group 4 (High conc.): Grew to an average height of 10 cm.

Is your hypothesis supported or disproved by these results?

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Is your hypothesis supported or disproved by these results?

We hypothesized that the orchids would grow best with a medium concentration of fertilizer.

The results do not support this.

The results disprove our hypothesis.

After one month of measuring the orchids, the following data is obtained:

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What is your conclusion based on these results?

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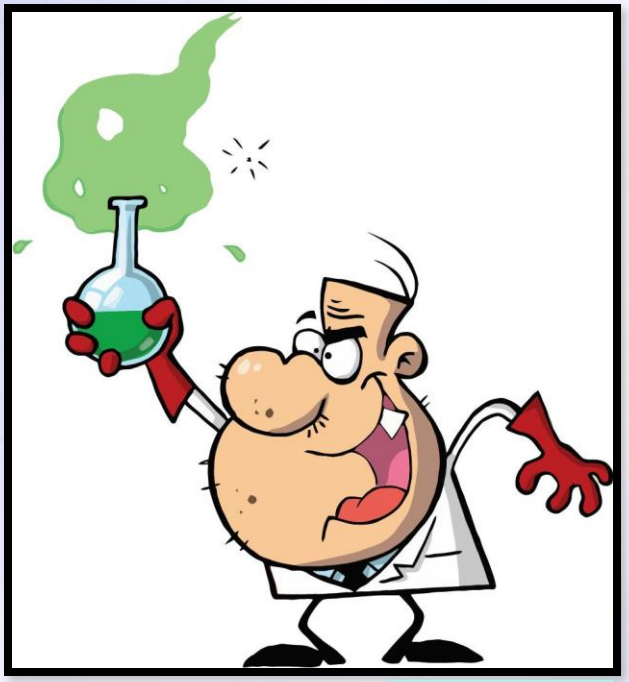
What is your conclusion based on these results?

- Orchids grow best with a weak concentration of fertilizer.
- At medium to high concentrations, plant growth is inhibited.

Analysis Questions

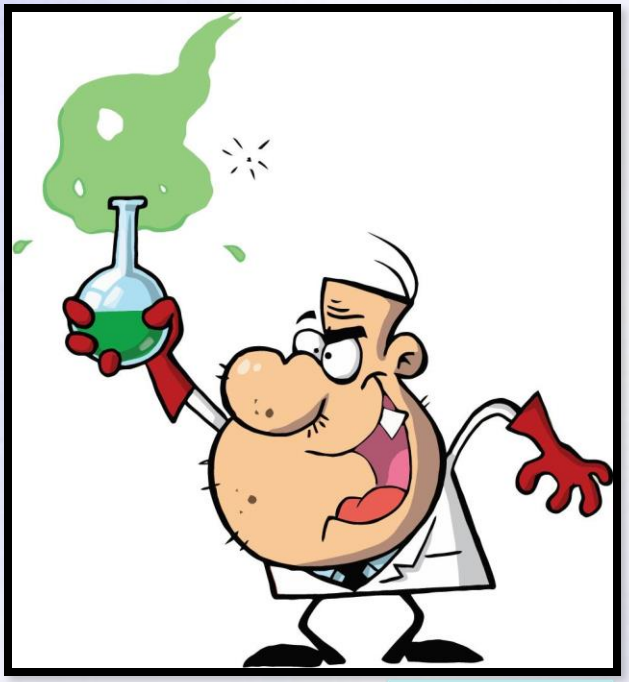
Why is it so important that a scientist accurately describes the procedure used in the experiment?



Analysis Questions

Why is it so important that a scientist accurately describes the procedure used in the experiment?

It allows other scientists to repeat the experiment and verify the results.



Analysis Questions

What is the importance of the control?

Analysis Questions

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The control remains the same throughout an experiment.

The control provides the basis for comparison, so one can observe how the experimental factor affected the results.

The control is often the independent variable.

Analysis Questions

What is the difference between the independent and the dependent variables in an experiment?

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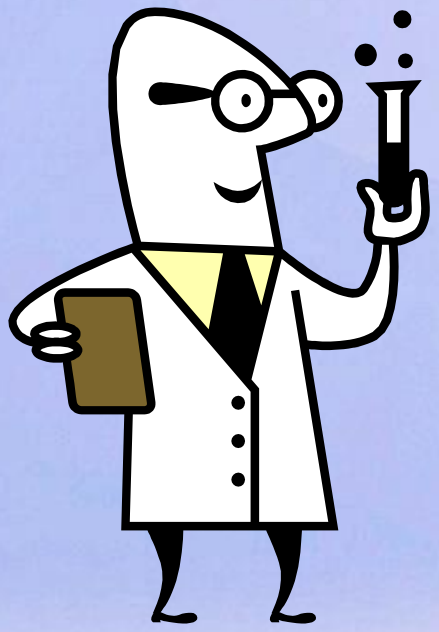
What is the difference between the independent and the dependent variables in an experiment?

- The independent variable that does NOT depend on the other variables and is deliberately manipulated by the scientist.
- The dependent variable that depends on other factors and is observed (for change) during the experiment.
- The data collected is a result of manipulating the independent variable.

Analysis Questions

In a “controlled experiment”, why must all of the variables, except one, be kept constant throughout the experiment?



Analysis Questions

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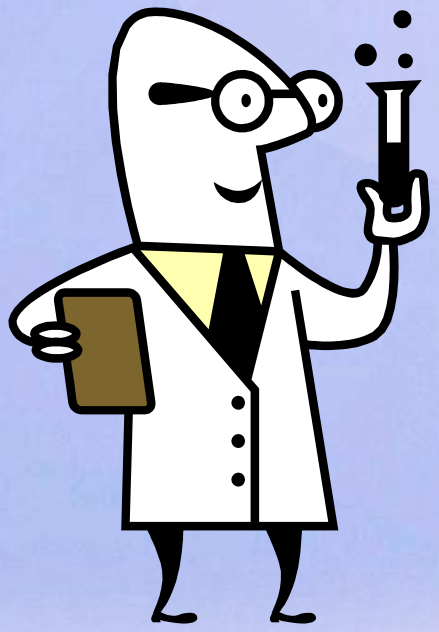
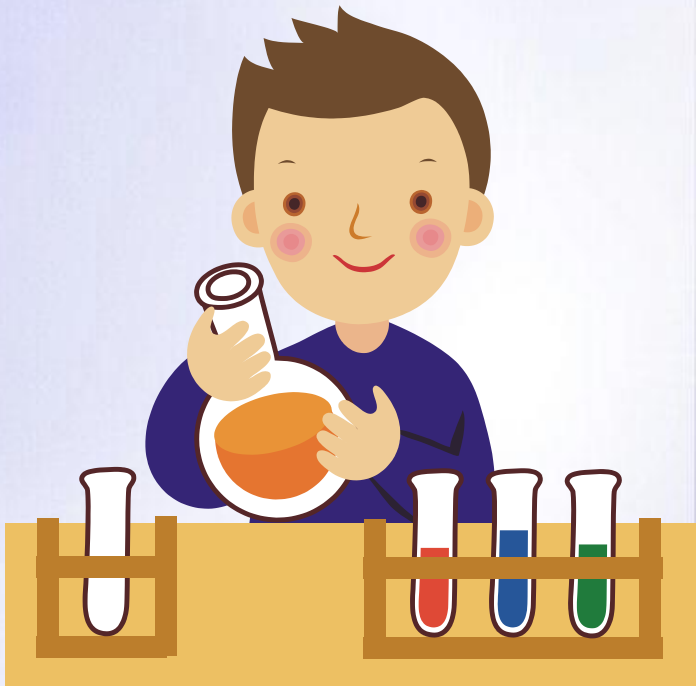


If several variables were changed at the same time, the scientist would not know which variable was responsible for the observed results.

Analysis Questions

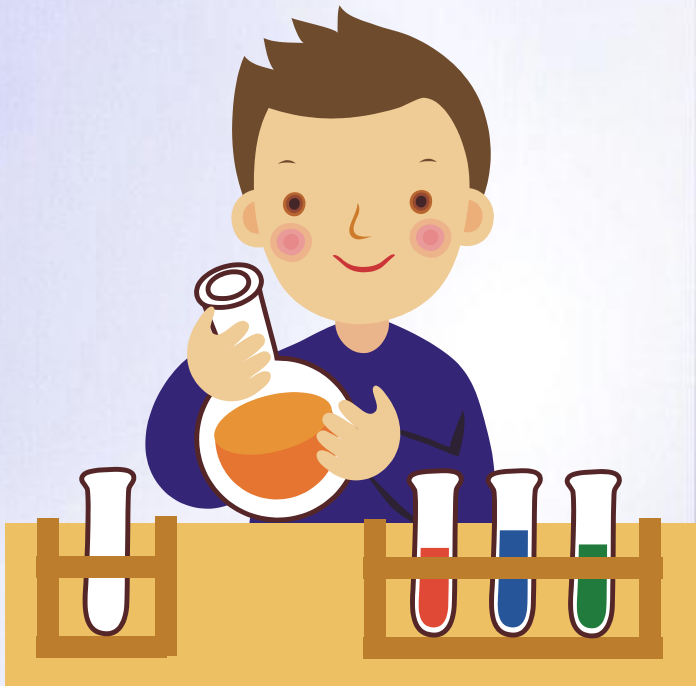
Why is it important to repeat the experiment many times?



Analysis Questions

Why is it important to repeat the experiment many times?

Experiments should be repeated to see if the same results are obtained each time. This gives validity to the test results.



Analysis Questions

How is a theory different than a hypothesis?

Analysis Questions

How is a theory different than a hypothesis?

- A **hypothesis** is an "educated guess" based on accurate observation that is testable through further observations & experimentation.
- A **theory** is an explanation and recognizable pattern based on many experiments & considerable amounts of data.