

# Processes of Science

The Scientific Method, Introduction to Biology and  
Basic Chemistry Review

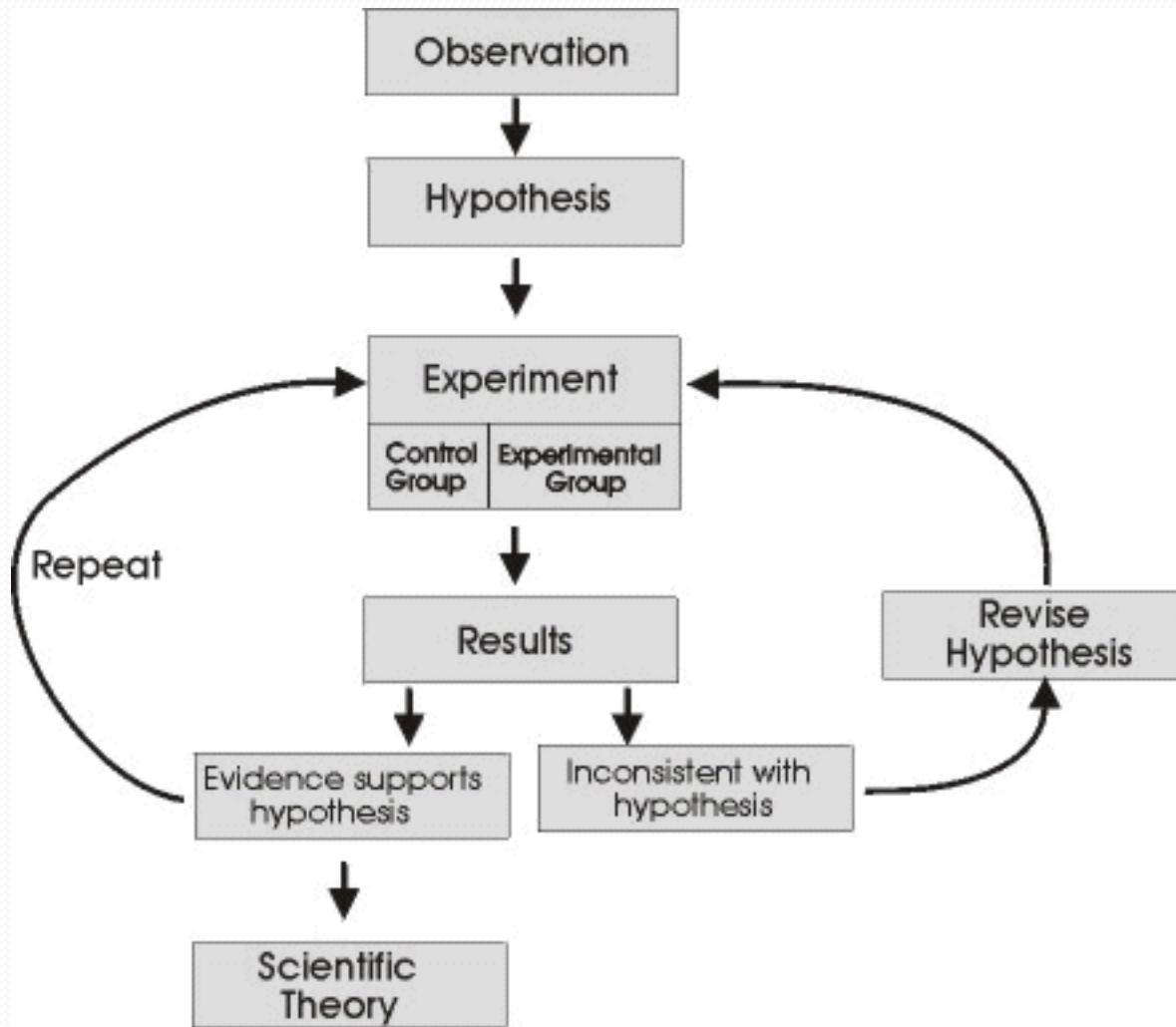
# Scientific Method

What is Science?

The goal of science is to understand the world around us.

We do this using the Scientific Method, which starts with making observations

# The Scientific Method



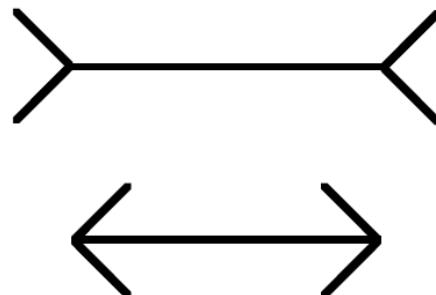
- An **OBSERVATION** is qualitative information collected through the direct use of our senses.
- An **INTERPRETATION** (or “inference”) is an attempt to put meaning into an observation.

Sometimes our interpretations of what we observe is biased by our expectations and prior knowledge.

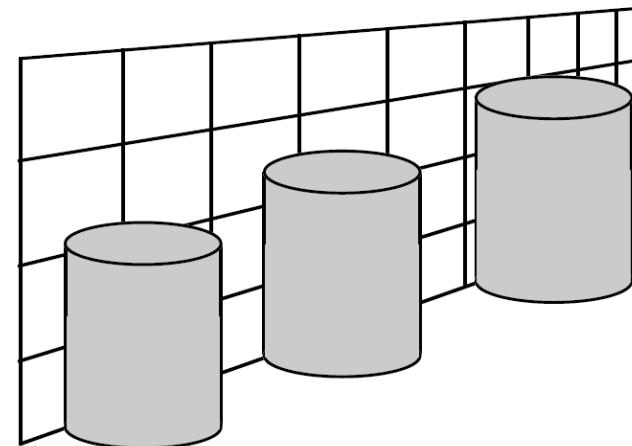
Do you see a  
young lady or an  
old hag?



Which of the two  
lines is longer?



Which of the  
cylinders is the  
largest?



It is possible that two people may not observe the same thing. For this reason, scientists insist that observations be repeated several times by more than one person.

An **EXPERIMENT** is a test or a procedure that is carried out in order to discover a result.

- A **HYPOTHESIS** is a **single, unproven assumption** which attempts to **explain WHY** nature behaves in a **specific manner**
- The following are general characteristics of **HYPOTHESES**:
  - Normally **single assumptions**.
  - **Narrow in their scope of explanation.**
  - **Tentative** (being based on very incomplete evidence) but may become generally accepted after more complete testing.

Most commonly, hypotheses take three formats:

- a question, "Does temperature affect fermentation?"
- a conditional statement, "Temperature may affect fermentation."
- an If, then statement, "If fermentation rate is related to temperature, then increasing the temperature will increase gas production.

## Hypothesis Examples:

If enzyme activity is related to temperature, then increasing the temperature will increase the products of an enzymatic reaction.

If the *diffusion rate* through a membrane is related to *molecular size*, then the smaller the molecule, the faster it will pass through a membrane.

A theory is a **TESTED, REFINED, and EXPANDED explanation** of why nature behaves in a given way.

A **THEORY** is a set of hypothesis that ties together a large number of observations of the real world into a logically consistent and understandable pattern.

## General characteristics of **THEORIES**:

- Composed of one or more underlying hypotheses.
- Broad in scope and provide explanations for entire “fields” of related behavior.
- Called **models** because they often provide a concrete way to **examine, predict, and test the workings of nature**.
- Must make **testable predictions** about the behavior of the system under **NEW conditions**.

## e.g. **Evolutionary Theory**

New species are produced through gradual changes of inherited traits through successive generations

# Designing an Experiment

## 1) Clearly define a hypothesis

- Identify the dependent and independent variables
- **Independent Variable:** The **manipulated** variable (what you are changing)
  - Ex) Time
- **Dependent Variable:** The **responding** variable (the results you are observing and measuring)
  - Ex) Distance, heart rate, growth
- **Constants** are conditions that are kept the same

## 2. Determine the control and experimental group

- **Control Group:** A standard against which other conditions can be compared
- **Experimental group:** A group in which the independent variable is manipulated

Ex) Testing new medications involves dividing participants into two groups

- One receives the medication (experiment)
- One receives a placebo (control)

### 3. Describe the experiment

- What materials will be used
- How will it be set up
- What procedure will be followed
- How/what data will be collected

### 4. Perform the experiment

- Collect data from both the control and experimental groups
- Organize and display data (graphs, tables, pie charts)

### 5. Analyze the Results

- Is the experiment valid and reliable?

## **Valid Experiment**

- Does the data collect measure what we set out to measure?
- How strong is the conclusion?
  - Is there bias?
  - Does it make accurate predictions?

## **Reliable Experiment**

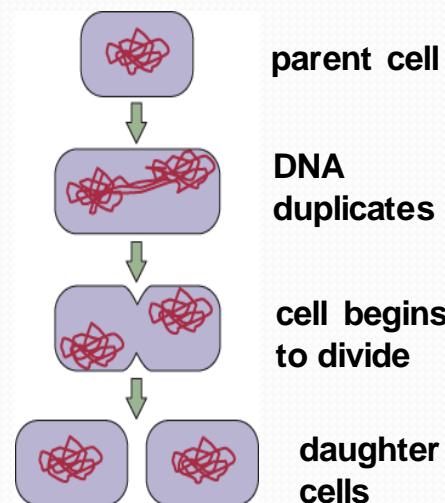
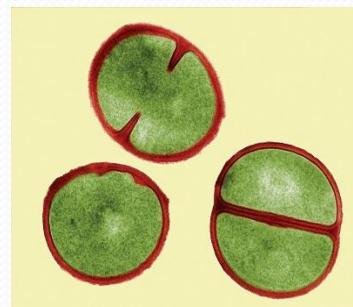
- If you took another random group would you get the same results?
- Consistency

# What You Need to Know

- Be able to design an experiment including
  - Defining a hypothesis
  - Identifying controlled and experimental groups
  - Identifying dependent and independent variables
  - Display data appropriately
  - Draw conclusions from the experiment
- Assignment: The Scientific Method Worksheet

# What is Biology?

- The study of living things
- All living things share the following characteristics
  1. Are made of **cells**
    - A cell is a small, self contained unit
    - Single celled organism = **unicellular**
    - Multicelled organism = **multicellular**
  2. Living things **reproduce**
    - **Asexual** – only requires **one** organism
    - **Sexual** – requires **two cells** from different individuals

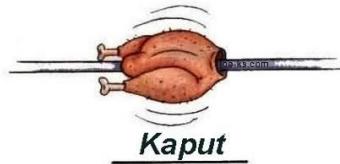
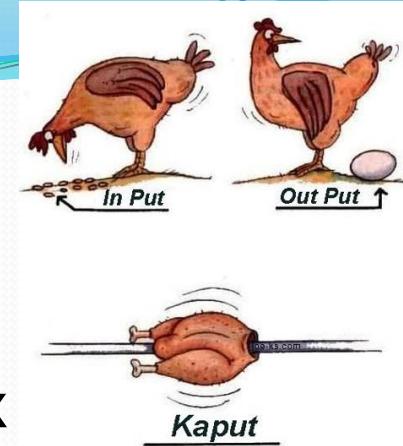


### 3. Living things grow and develop

- Cells continue to divide as you grow

### 4. Living things obtain and use energy

- **Anabolism** – a process that **makes** complex substances from simpler ones; **requires energy**
  - Example: Photosynthesis
- **Catabolism** – a process that **breaks down** complex substances into simpler ones; **releases energy**
  - Example: Digestion
- **Metabolism** – total of all chemical reactions in the body

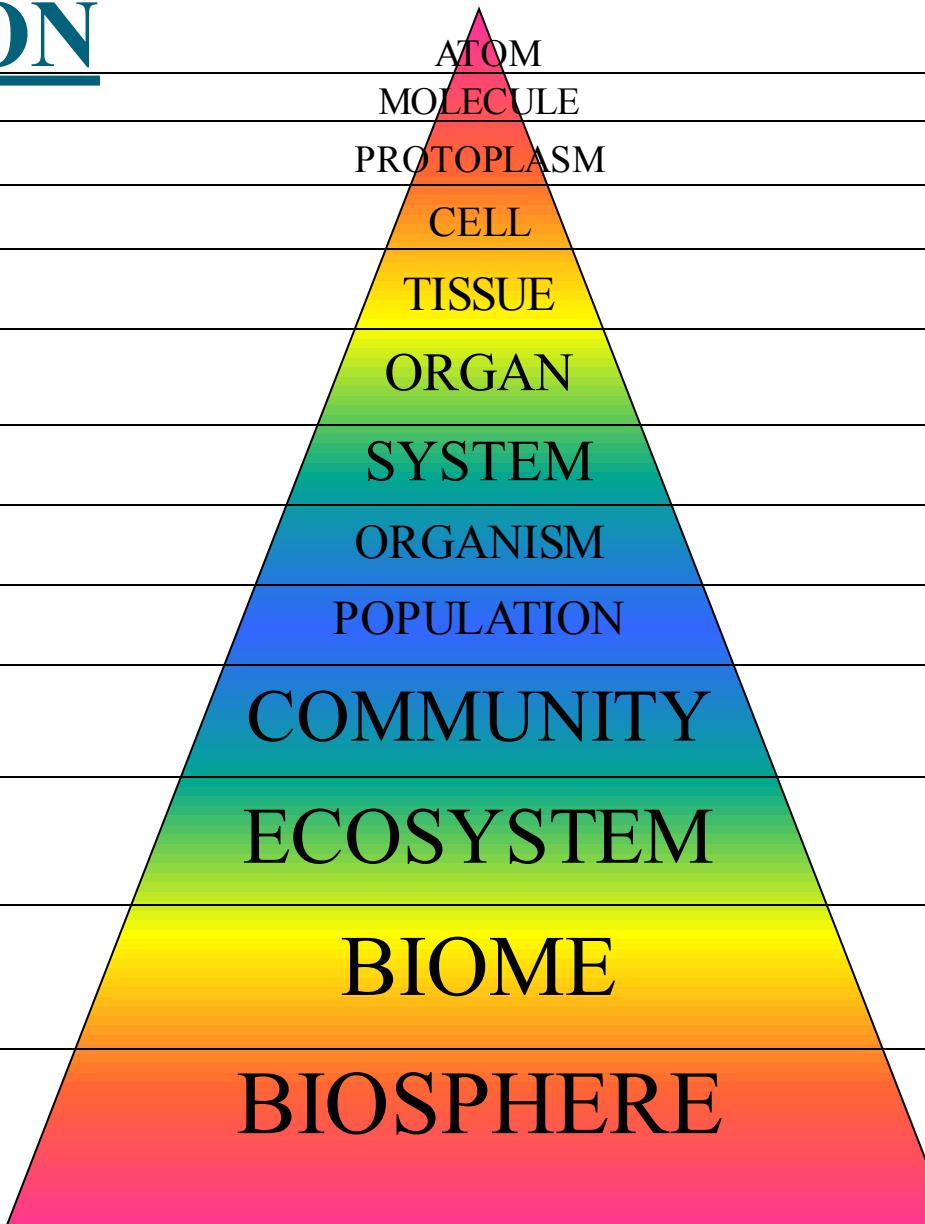


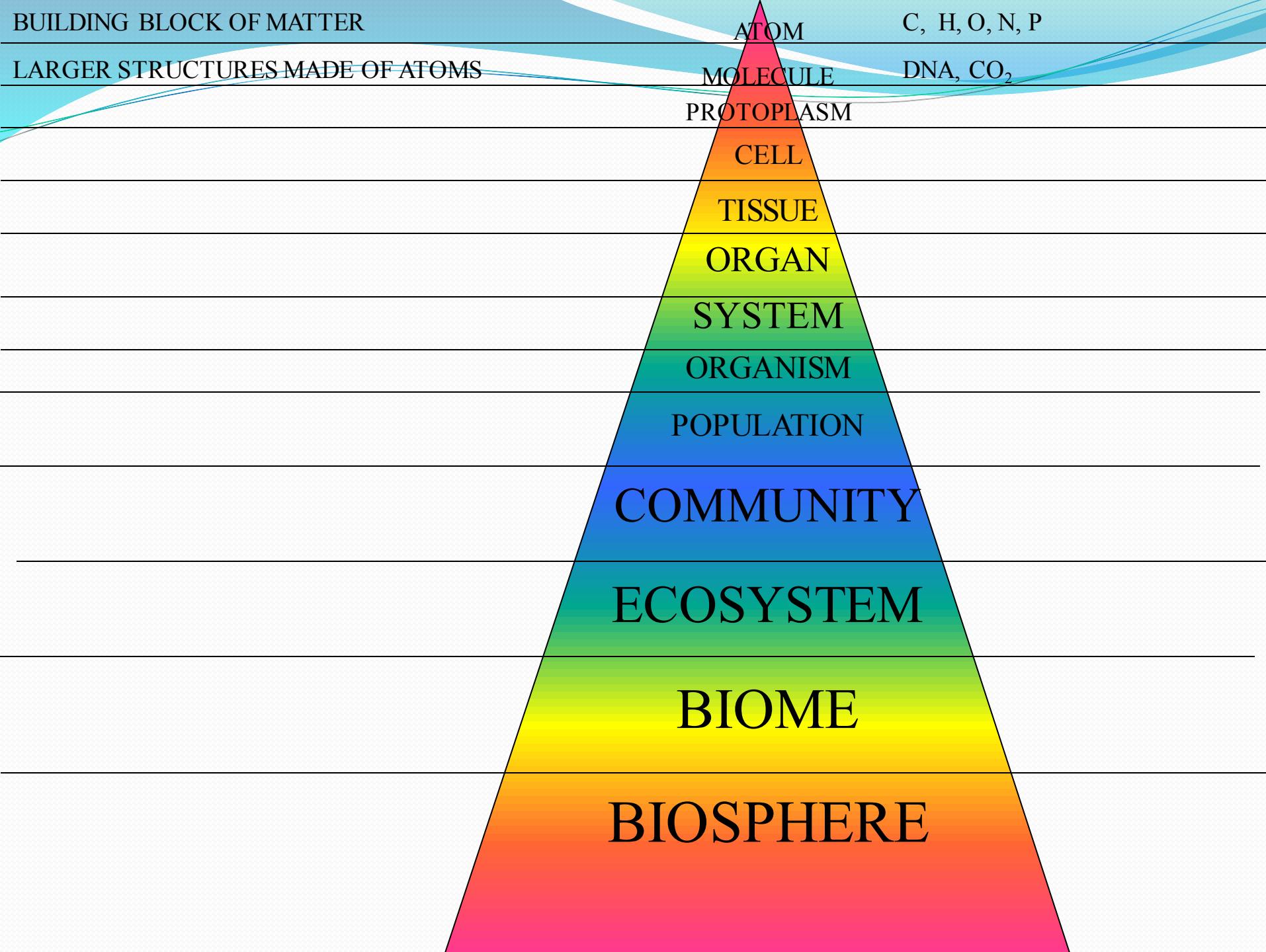
## 5. Living things respond to the environment

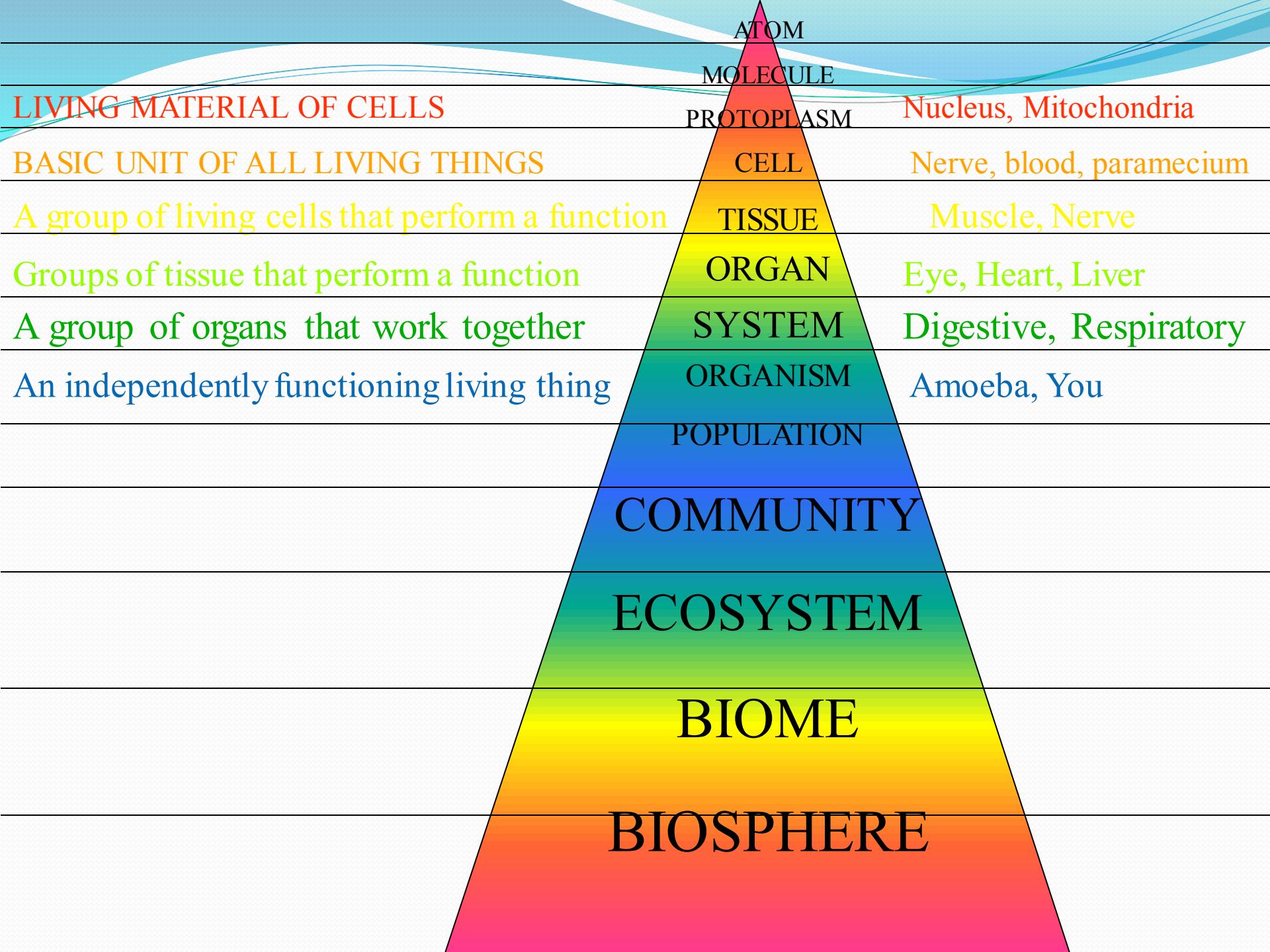
- **Stimulus** - anything that causes an organism to **react**
  - Example: light, temperature, sound, etc
- **Homeostasis** - organism's ability to maintain **constant or stable conditions** necessary for life
  - Example: body temperature

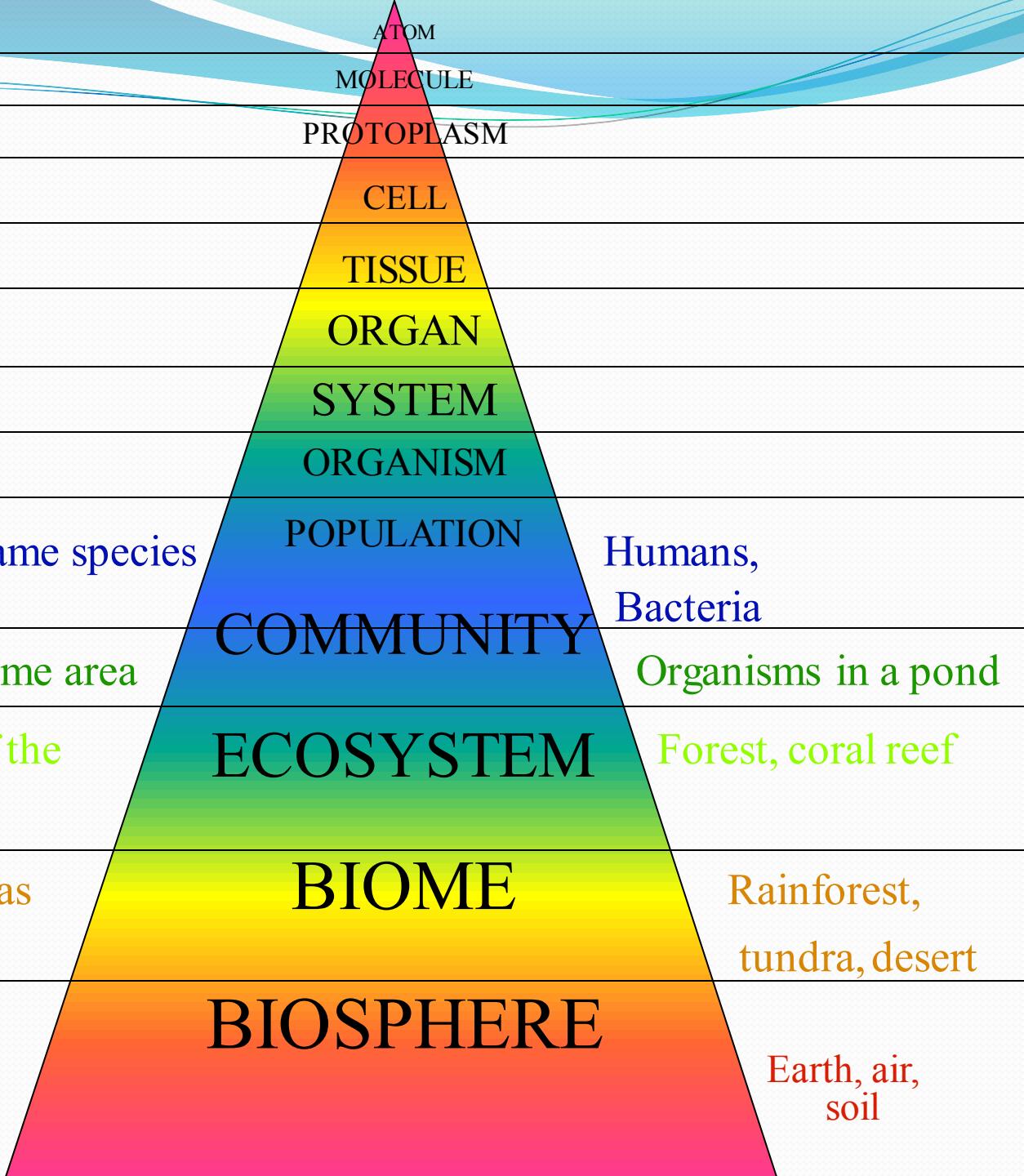


# 13 LEVELS OF BIOLOGICAL ORGANIZATION





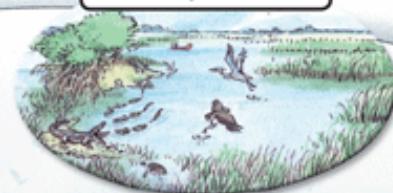




**Biome**



**Ecosystem**



**Ecosystem**

**Community**



**Community**

**Population**



**Population**

**Organism**



**Organism**

# Characteristics of Life Video