Chapter 1
Introduction to Biology

Biology

the scientific study of life

All forms of life share common properties

Seven properties:
1. **Order**
2. **Reproduction**
3. **Growth & Development**
4. **Energy Processing**
5. **Response to Environment**
6. **Regulation**
7. **Evolutionary Adaptation**

All forms of life share common properties

7 properties:
1. **Order** – all living things are composed of cells that organized into complex structures
   - Cell (basis for complex organization) ➜ Tissue ➜ Organ ➜ Organ system ➜ Organism
2. **Reproduction** – to make offspring
3. **Growth & Development** – DNA controls the pattern of cell division and progressive change
4. **Energy Processing** – to take in energy and use it to sustain life
   - Ex. nutrients metabolized to carry out specific functions

1.1 All forms of life share common properties (cont.)

5. **Response to Environment** – respond and adapt to external environment stimuli
   - ➢ Ex. hot ➜ sweat
   - ➢ Ex. plants grow toward light source

6. **Regulation** – maintain homeostasis ➜ mechanisms that regulate internal stability
   - ➢ Ex. hot ➜ sweat ➜ decrease body temp.

7. **Evolutionary Adaptation** – capacity of a species to change(adapt) over time to increase survival
   - ➢ Ex. cavemen ➜ humans today
   - ➢ Ex. animals camouflage

Emergent Properties

- **In the hierarchy of life's organization, distinctive properties emerge at every level.**
- new properties that arise with each step upward in the hierarchy of life due to the arrangement and interactions of parts as complexity increases

- 10 Levels of organization

- Living systems show high order of organization
  - Biosphere
  - Ecosystem
  - Community
  - Population
  - Organism
  - Organ
  - Tissue
  - Cell
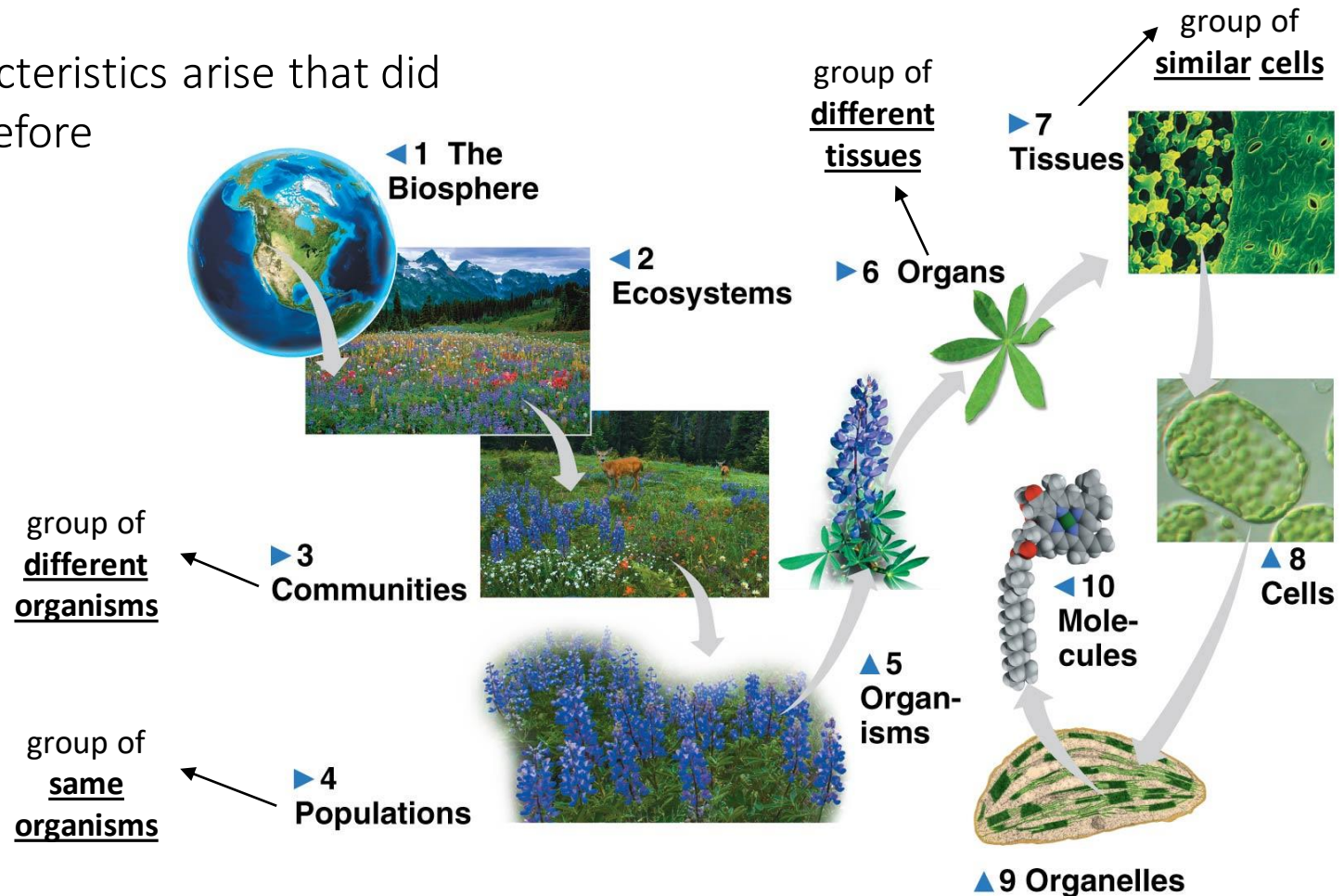 - Organelle
  - Molecule

Most complex

**Emergent properties**

Simplest

10 Levels of Organization

Emergent properties

- Each step 'up' increases in complexity
- New characteristics arise that did not exist before

group of **different tissues**

group of **similar** **cells**

◄1 The Biosphere

◄2 Ecosystems

►6 Organs

►7 Tissues

group of **different organisms**

►3 Communities

▲8 Cells

◄10 Mole-cules

▲5 Organ-isms

group of **same organisms**

►4 Populations

▲9 Organelles

Levels of Organization

1. **Biosphere** – all of the environments on Earth that support life
   - ➢ Includes land, water, and lower atmosphere
2. **Ecosystem** – a group of different organisms living in a particular area with their physical environment
   - ➢ Includes plants, air, soil, water, and sunlight
3. **Community** – group of different organisms in an ecosystem
   - ➢ Includes plants, animals, bacteria, etc.
   - ➢ **Species** – each unique form of life
4. **Population** – group of the same species living in the same area
5. **Organism** – an individual living thing
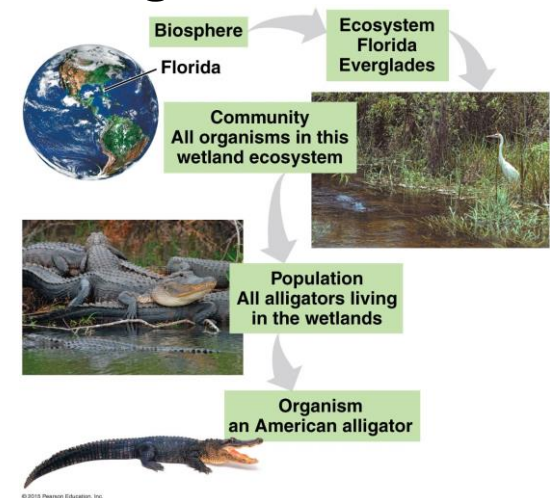
Levels of Organization Continued…

6. **Organ System** – a group of organs that cooperate to carry out a specific function

   ➤ Ex. Nervous system, digestive system, etc.

7. **Organ** – made up of several **different tissues** to carry out a specific function

   ➤ Ex. Skin, brain, heart, stomach, etc.

8. **Tissue** – a group of **similar cells** that perform a specific function

   ➤ Ex. muscle, nerve, epithelial
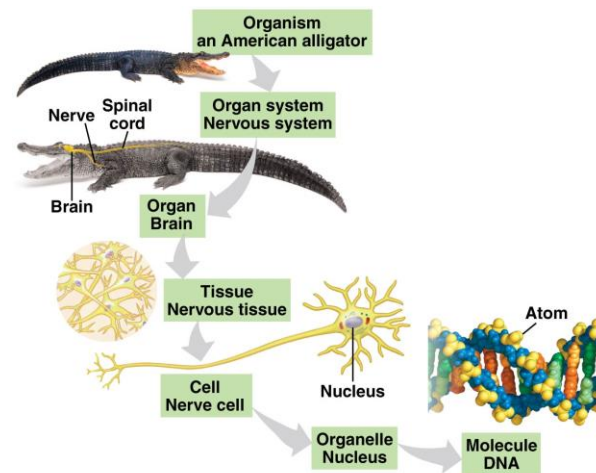
10 Levels of Organization, Continued….

9. **Cell** – basic unit of life
   ➢ Ex. blood, heart, etc.
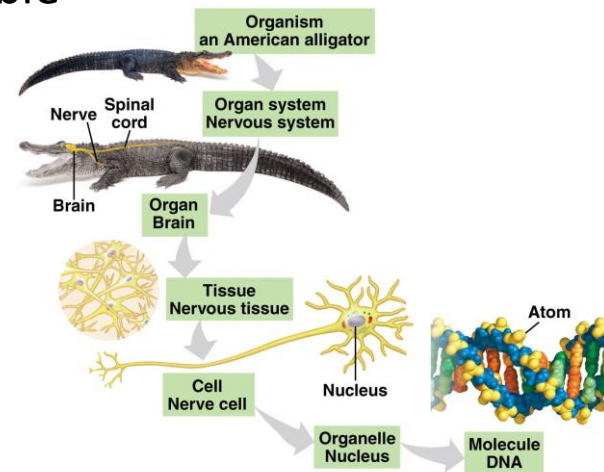10. **Organelle** – a membrane-enclosed structure that performs a specific function in a cell
    ➢ Ex. nucleus, mitochondria, etc.
11. **Molecule** – a cluster of atoms held together by chemical bonds
    ➢ Ex. DNA – a molecule of inheritance
12. **Atom** – small chemical units / smallest unit of matter
    ➢ Ex. any element on the periodic table

Organism
an American alligator

Organ system
Nervous system

Nerve | Spinal cord

Brain

Organ
Brain

Tissue
Nervous tissue

Atom

Cell
Nerve cell

Nucleus

Organelle
Nucleus

Molecule
DNA

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All living things are made up of?

Cells are the structural and functional units of life

- **Unicellular organism** – single-celled
  - ➢ Ex. amoeba, most bacteria, algae, fungi (yeast)
- **Multicellular organism** – consists of many cells
  - ➢ Ex. humans, animals, plants, fungi (mold)

Cells are the structural and functional units of life (cont.)

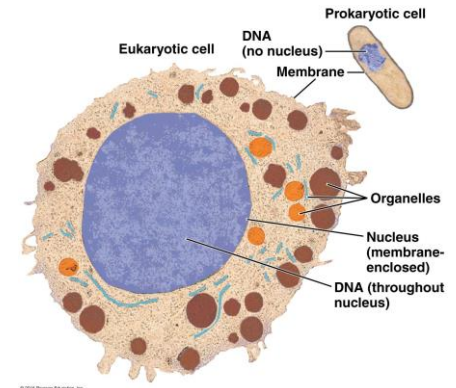- 2 basic types of cells:
  1. **Prokaryotic Cells** – small and simple cells that were the first to evolve
     - ➢ Lack of membrane-enclosed organelles
     - ➢ Lack of a nucleus
     - ➢ Unicellular
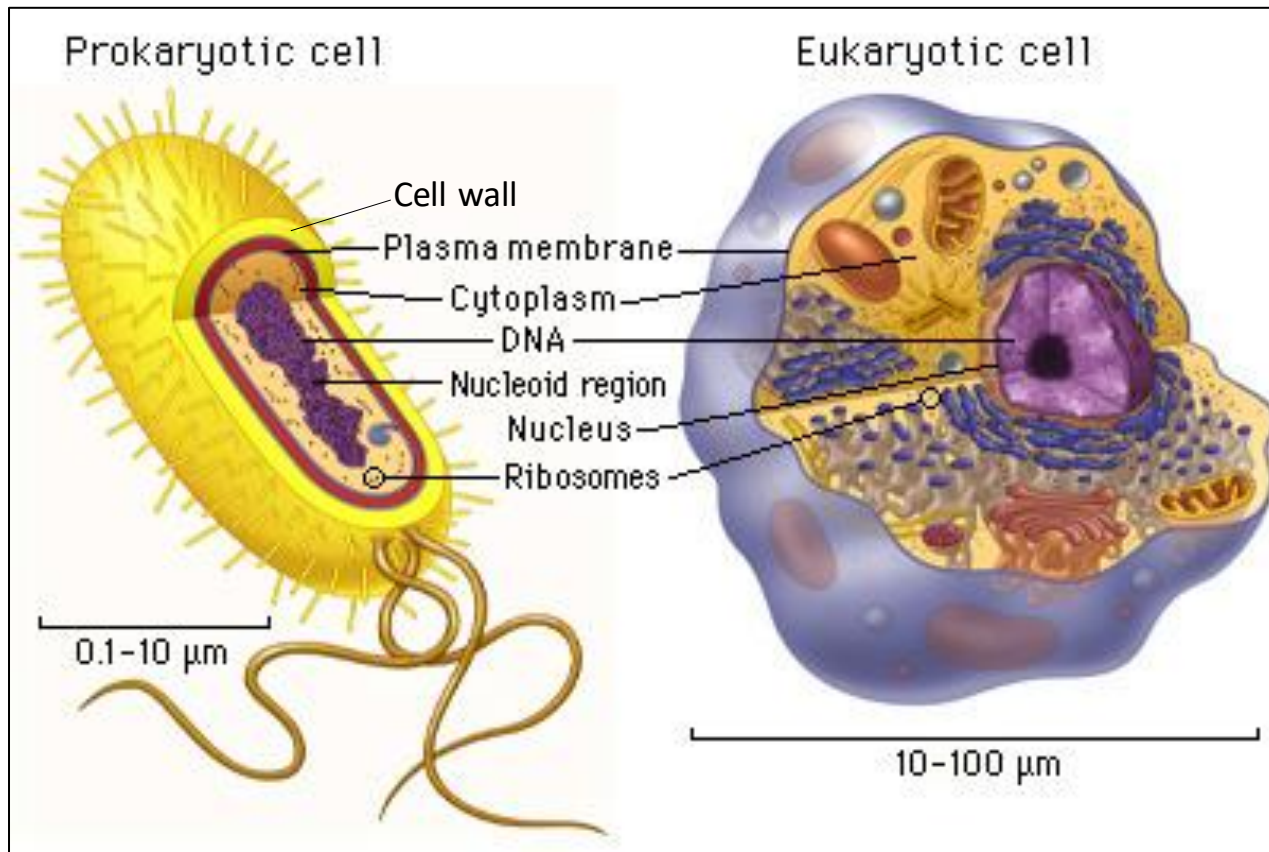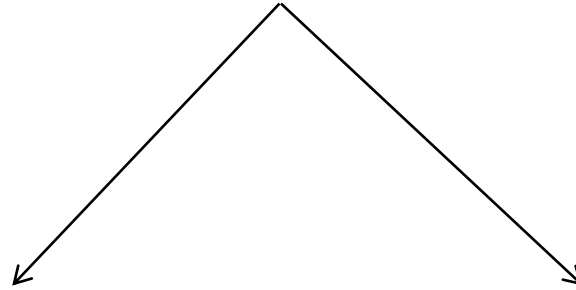   - ➢ Found only in domains of Bacteria and Archaea
  2. **Eukaryotic Cells** – bigger and more complex cells
     - ➢ Have membrane-enclosed organelles
     - ➢ Multicellular
     - ➢ Have a nucleus
     - ➢ Include plants, animals, fungi (mold), and protists

CELLS:
smallest unit of **LIFE**

Prokaryotic cell — Eukaryotic cell

Cell wall
Plasma membrane
Cytoplasm
DNA
Nucleoid region
Nucleus
Ribosomes

0.1–10 μm

10–100 μm

Organisms interact with their environment, exchanging matter and energy

I.   **Producers**
II.   **Consumers**
III. **Decomposers**

Organisms interact with their environment, exchanging matter and energy

- **Producers** – can make its own food
  - ➢ Ex. plants produce its own food by converting sunlight energy into sugar and O_2 to be released into the environment
- **Consumers** – eat plants and other animals
  - ➢ Ex. animals and humans eat meat and vegetables
- **Decomposers** – break down complex organic matter into simple mineral nutrients for plants
  - Break down wastes and dead organisms to recycle the nutrients into the soil
 - Ex. bacteria, worms, fungi

The unity of life is based on DNA and a common genetic code

- **Genes** – units of inheritance that is passed on from parent to offspring
- **DNA (Deoxyribonucleic acid)** – chemical substance of genes
  - ➢ Blueprint for life
  - ➢ Information is stored without error over generations
  - ➢ Used to reproduce itself faithfully
  - ➢ Translated into messages that direct cell growth and development
  - ➢ Modified over time to allow organism more adaptable to the environment – allows for evolution
- **Chromosome** – condensed long DNA molecules of genes
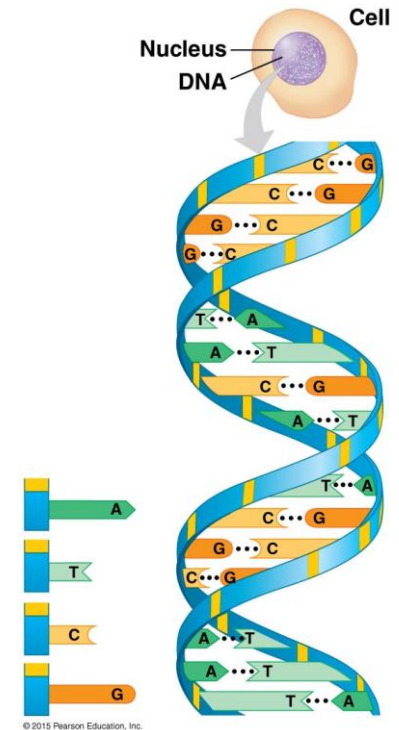
Cells: DNA

- **DNA** – a molecule of inheritance
- **Genes** – units of inheritance
- **Chromosome** – condensed long DNA molecules of genes
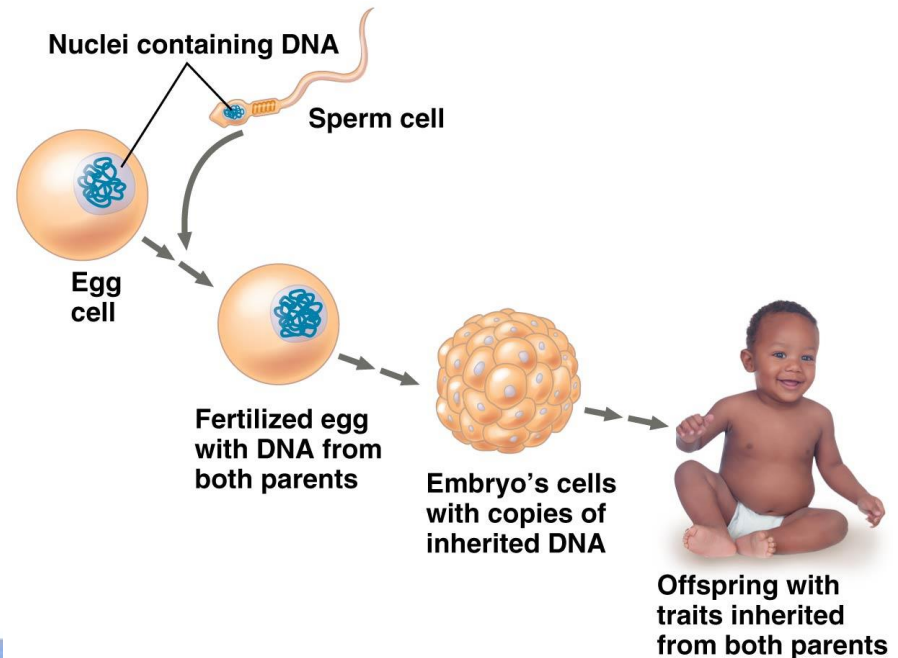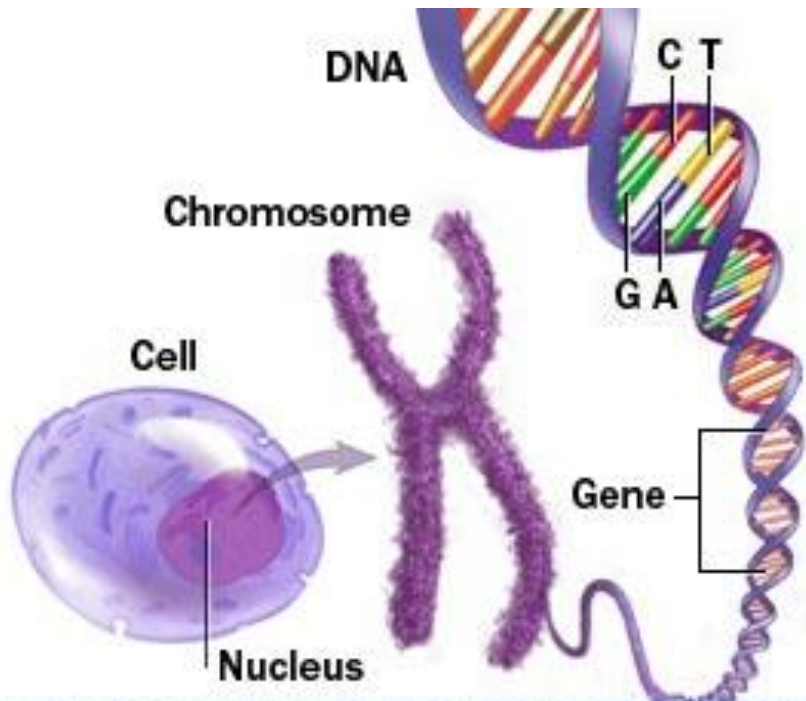
The diversity of life can be arranged into 3 domains

- **Taxonomy** – grouping and classification of species according to similarities
- 3 domains of life:
  1. **Bacteria**
  2. **Archaea**
  3. **Eukarya**
     - 4 kingdoms
       a. **Protista** – mostly unicellular
          - Producers, decomposers, consumers
       b. **Plantae** – producers ex. plants
       c. **Fungi** – decomposers ex. mushrooms
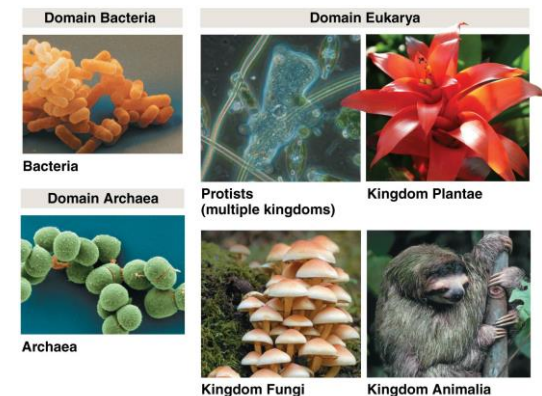   d. **Animalia** – consumers ex. animals

The diversity of life can be arranged into 3 domains

- **Taxonomy** – grouping and classification of species according to similarities
- 3 domains of life:
  1. **Bacteria** – bacteria ➔ prokaryotes
  2. **Archaea** – thrive in extreme conditions (extremophiles) ➔ prokaryotes
     - Salty lakes, very hot springs, ocean floor without O_2
  3. **Eukarya** – eukaryotes
     - 4 kingdoms
       a. **Protista** – mostly unicellular
          - Producers, decomposers, consumers
       b. **Plantae** – producers ex. plants
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       d. **Animalia** – consumers ex. animals

Domain Bacteria

Bacteria

Domain Archaea

Archaea

Domain Eukarya

Protists (multiple kingdoms)

Kingdom Plantae

Kingdom Fungi

Kingdom Animalia

Evolution explains the unity and diversity of life

- *The Origin of Species* by Charles Darwin had 2 main points
- **Evolution** – a change in inherited characteristics to adapt to environmental changes or to become more successful in its environment
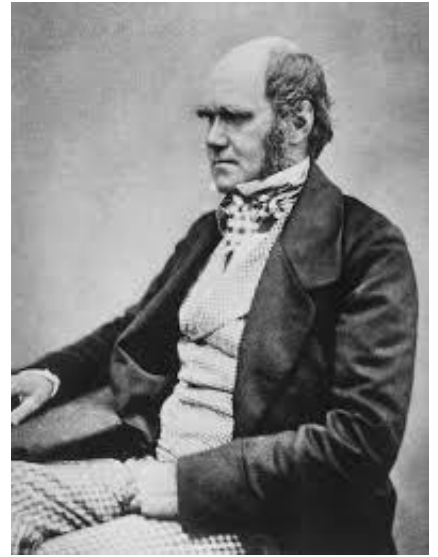
Evolution explains the unity and diversity of life (cont.)

- **Natural Selection** – the mechanism for evolution
  - ➢ 2 observations:
    - a. Individuals in a population vary in their traits, many of which are passed on from parents to offspring
    - b. A population can produce far more offspring than the environment can support
  - ➢ Individuals with heritable traits best suited to the environment are more likely to survive and reproduce ➔ "survival of the fittest"
  - ➢ The result of natural selection is **evolutionary adaptation** – the accumulation of advantageous traits in a population over time

Evolution explains the unity and diversity of life (cont…)

- ➢ Natural selection ex. affected by environmental factors
  - a. Have a mixture of beetles live in an area with black soil – varied inherited traits
  - b. A bird is more likely to eat the light-colored beetles, so the darker beetles are more likely to survive and reproduce
  - c. In later generations, there are more darker beetles – uniform inherited traits
- ➢ Small changes in a population caused by natural selection could eventually lead to major alterations of species
- ➢ New species could evolve as a result of gradual accumulation of changes over long periods of time
  - ▪ Population diverges due to catastrophic events and changes over time to become 2 different species

❶ Population with varied inherited traits.

❷ Elimination of individuals with certain traits and reproduction of survivors.

❸ Increasing frequency of traits that enhance survival and reproductive success.

Scientists form and test hypotheses and share their results

- **Hypothesis** – a proposed explanation for a set of observations / a tentative statement
- **Scientific Theory** – a widely accepted hypothesis that is supported by a large body of evidence
- **Scientific Inquiry** – an investigation into an observed occurrence that requires
    1. A systematic, step-by-step procedure
    2. A logical interpretation of the observations

Scientists form and test hypotheses and share their results

- **5 Steps in a scientific method:**
  1. **An observation**
  2. **Hypothesis**
  3. **Experiment**
     a. Independent variable
     b. Dependent variable
     c. Control

  4. **Data**
  5. **Conclusion**

Scientists form and test hypotheses and share their results

- **5 Steps in a scientific method:**
  - A. **Observation** – do research, ask the question, and state the purpose
  - B. **Hypothesis** – one of many possible explanations for a question or observation

# Scientists form and test hypotheses and share their results

- **5 Steps in a scientific method:**
  - C. **Experiment** – a systematic procedure planned, performed, and interpreted to test whether 2+ hypotheses are statistically different from each other
    1. **Independent variable** – a group that is tested on and **will change**, "Treatment", "Cause"
    2. **Dependent variable** – group that changes because of the independent group, "Result" of treatment, "Effect" of cause
    3. **Control** – a group that **does not change**, used as basis of comparison to explain why the outcome occurred
       a. **Negative control** – do not expect a change ➡ "Placebo"
       b. **Positive control** – expect a change ➡ ex. Testing a new drug and comparing it with an old drug
  - D. **Data** – record qualitative or quantitative results
  - E. **Conclusion** – interpretation of data

Scientists form and test hypotheses and share their results

- Scientific method example:
  - A. **Observation** – the link between exercise and weight loss
  - B. **Hypothesis** – Exercise will lead to weight loss
    - ➢ **Null Hypothesis** – Weight loss is not related to exercise
  - C. **Experiment** – People are divided into 2 groups
    - 1. **Control** – a group that does not exercise
    - 2. **Treatment** – group that goes to gym 3x a week for 1hr
      - ➢ **Independent variable** – treatment group
      - ➢ **Dependent variable** – the amount of weight loss as a result of the treatment group
  - D. **Data**
  - E. **Conclusion**

Independent vs. Dependent Variable

Dependent Variable

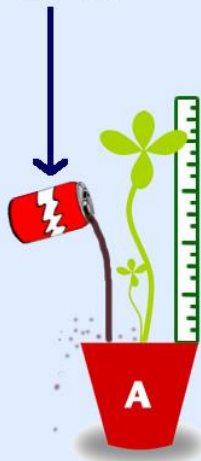Independent Variable
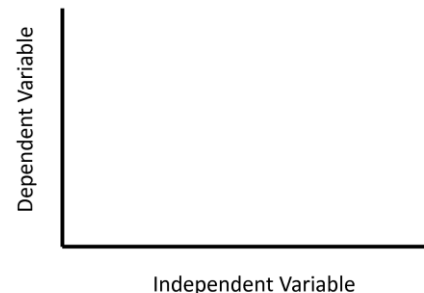
Scientific Method

Types of Variables

Independent

The one thing you change. Limit to only one in an experiment.

Example:
The liquid used to water each plant.

Independent Variable

Dependent

The change that happens because of the independent variable.

Example:
The height or health of the plant.

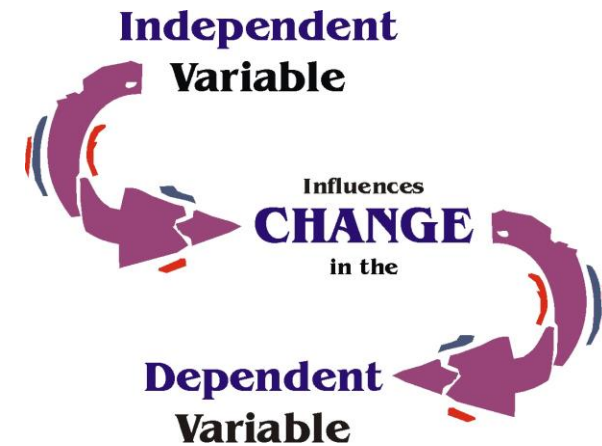Something measured

Dependent Variable

Controlled

Everything you want to remain constant and unchanging.

Example:
Type of plant used, pot size, amount of liquid, soil type, etc.

Controlled Variables

A   B   C

Independent Variable

Influences **CHANGE** in the

Dependent Variable

INDEPENDENT VARIABLE

What I CHANGE

DEPENDENT VARIABLE

What I OBSERVE

CONTROLLED VARIABLE

What I KEEP THE SAME