

# Chapter 1 – A View of Life



27 January 2012

# Outline

- Defining Life - Emergent Properties
  - Materials and Energy
  - Reproduction and Development
  - Adaptations and Natural Selection
- Classification
  - Organization and Diversity
  - Natural Selection

# Outline

- Biosphere Organization
  - Human Population
  - Biodiversity
- The Scientific Method
  - Observation
  - Hypothesis
  - Data
  - Conclusion
  - Scientific Theory

# Defining Life

- Living things:
  - Comprised of the same chemical elements e.g. Carbon, Hydrogen, and Oxygen
  - Obey the same physical and chemical laws
  - Living organisms consist of cells (Unicellular or Multi-cellular).
    - The **cell** is the basic structural and functional unit of all living things e.g. plants, animals, and fungus
    - Cells are produced from preexisting cells
    - Cells are the smallest units that perform all vital physiological functions

# Defining Life

Living organisms can be Microscopic:

Bacteria

Paramecium

Living organisms can be Macroscopic (Multi-cellular):

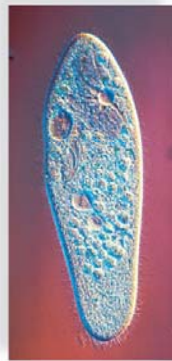
Snow goose

Humans

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**Bacteria**



**Paramecium**



**Morel**



**Sunflower**



**Snow goose**

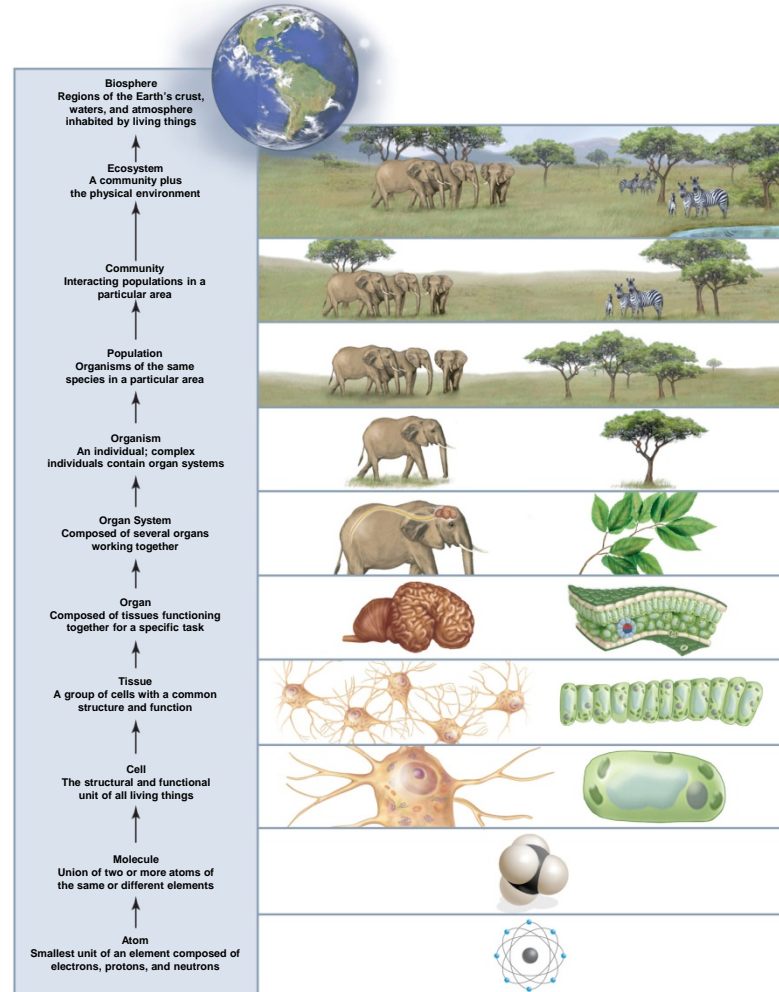
(Bacteria): © Dr. Dennis Kunkel/Phototake; (Paramecium): © M. Abbey/Visuals Unlimited; (Morel): © Royalty-Free Corbis;  
(Sunflower): © Photodisc Green/Getty Images; (Snow goose): © Charles Bush Photography

# Defining Life

- Each level of organization has Emergent Properties
- Levels range from extreme micro (e.g. Atoms, Molecules and Cells) to global (e.g. Community, Ecosystem and Biosphere)
- Each level of organization is more complex than the level preceding it
  - *Emergent properties:*
    - Interactions between the parts making up the whole
    - All emergent properties follow the laws of physics and chemistry

# Levels of Biological Organization

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# Living Things: Acquire & Process Food

- **Energy** – required to maintaining organization and conducting life-sustaining processes
  - The sun:
    - Ultimate source of energy for nearly all life on Earth
    - Certain organisms, such as plants, capture solar energy to carry on photosynthesis
      - Photosynthesis transforms solar energy into chemical energy (Organic Molecules)
      - Chemical energy is used by other organisms e.g. animals
  - **Metabolism** is all the chemical reactions that occur in a cell or in an organism.
    - **Homeostasis** - Maintenance of internal conditions within certain boundaries



# Acquiring Nutrients

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a.



b.



c.



d.



e.



f.

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d: © Michael Abby/Visuals Unlimited; e: © Pat Pendarvis; f: National Park Service Photo

# Living Things: Respond to Stimuli

- Living things interact with the environment and respond to changes in the environment
- **Response** ensures survival of the organism and it often results in movement
  - Vulture can detect and find carcass a mile away and soar toward dinner
  - Monarch butterfly senses approach of fall and migrates south
  - Microorganisms can sense light or chemicals
  - Even leaves of plants follow sun
- Activities as a result of Responses are termed **behavior**

# Living Things: Reproduce and Develop

- Organisms live and die
- All living organisms must reproduce to ensure continued existence and maintain population
- In most multicellular organisms reproduction:
  - Begins with union of sperm and egg (fertilization)
  - Followed by cell division and differentiation
  - Developmental instructions encoded in genes
    - Composed of DNA
    - Long spiral molecule in **chromosomes**

# Rockhopper Penguins & Offspring

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# Living Things: Adapt to Change

## ● **Adaptation**

- Any modification that makes an organism more suited to its way of life
- Organisms become modified over long period time
  - Respond to environmental changes by developing new adaptations
- However, organisms very similar at basic level
  - Suggests living things descended from same ancestor
  - Descent with modification - **Evolution**
  - Caused by **natural selection**

# Evolution, the Unifying Concept of Biology

- Despite diversity, organisms share the same basic characteristics
  - Composed of cells organized in a similar manner
  - Their genes are composed of DNA
  - Carry out the same metabolic reactions to acquire energy
- This suggests that they are descended from a common ancestor

# Classification

- Taxonomy:
  - Discipline of identifying and classifying organisms according to certain rules
  - Hierarchical levels (taxa) based on hypothesized evolutionary relationships
  - Levels are, from least inclusive to most inclusive:
    - Species, genus, family, order, class, phylum, kingdom, and domain
    - A level (e.g. phylum) includes more species than the level below it (e.g. class), and fewer species than the one above it (e.g. kingdom)

# Domains

- Bacteria
  - Microscopic unicellular prokaryotes
- Archaea
  - Bacteria-like unicellular prokaryotes
  - Extreme aquatic environments
- Eukarya
  - Eukaryotes – Familiar organisms



# Levels of Classification

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**TABLE 1.1**

**Levels of Classification**

<i>Category</i>	<i>Human</i>	<i>Corn</i>
Domain	Eukarya	Eukarya
Kingdom	Animalia	Plantae
Phylum	Chordata	Anthophyta
Class	Mammalia	Monocotyledones
Order	Primates	Commelinales
Family	Hominidae	Poaceae
Genus	<i>Homo</i>	<i>Zea</i>
Species*	<i>H. sapiens</i>	<i>Z. mays</i>

\*To specify an organism, you must use the full binomial name, such as *Homo sapiens*.

# Example



Copperhead, Carbon County, PA

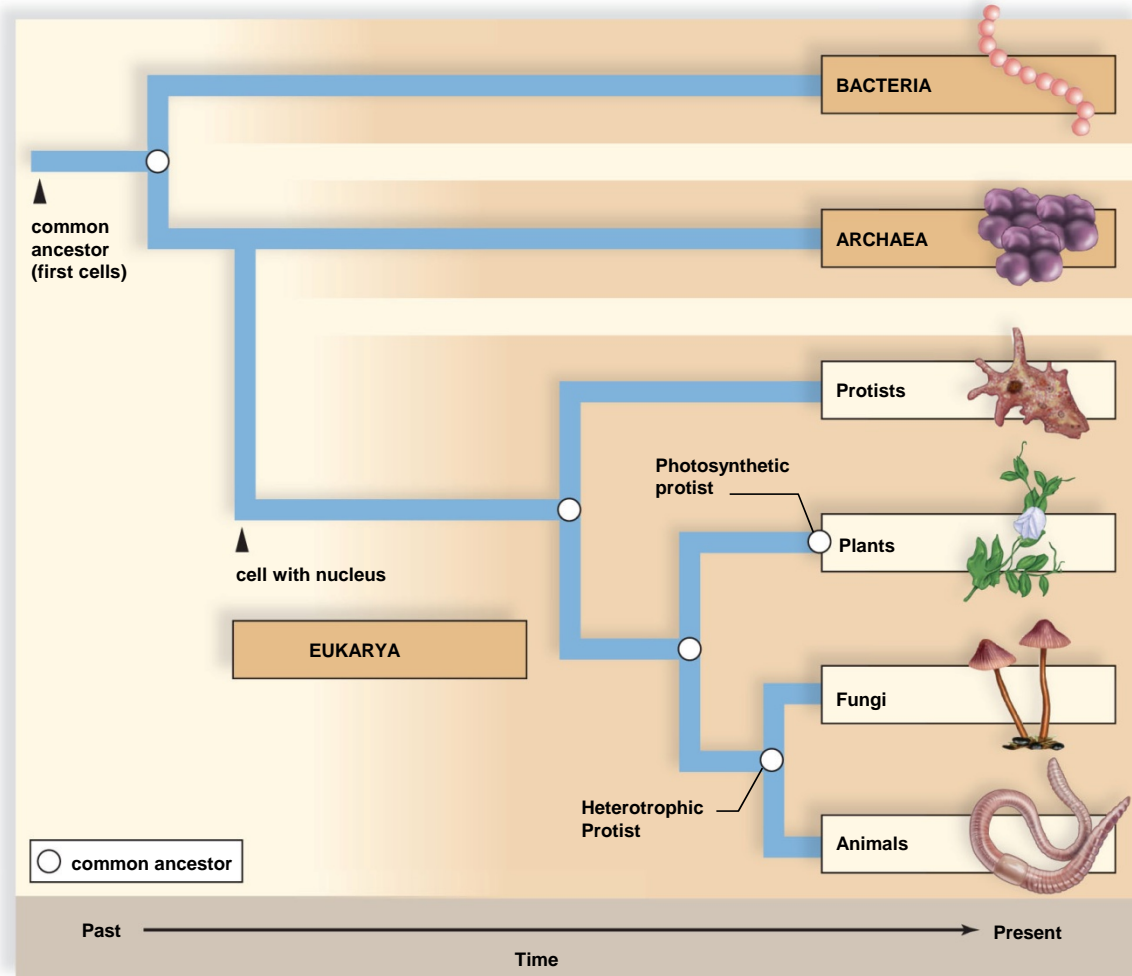
Kingdom: Animalia  
Phylum: Chordata  
Class: Reptilia  
Order: Squamata  
Family: Viperidae  
Genus: Agkistrodon  
Species: ***A. contortrix***

# Scientific Names

- **Binomial nomenclature** (two-word names)- used to assign each organism with two part name e.g. *Agkistrodon contortrix*
- Universal
- Latin-based
  - First word represents **genus** of organism e.g. *Agkistrodon*
  - Second word is **specific epithet** of a species within the genus e.g. *contortrix*
  - Always italicized as a *Genus species* (*Agkistrodon contortrix*)
  - Genus may be abbreviated (*A. contortrix*)

# Evolutionary Tree of Life

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# Domains: The Archaea

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**Methanosarcina mazei, an archaeon**

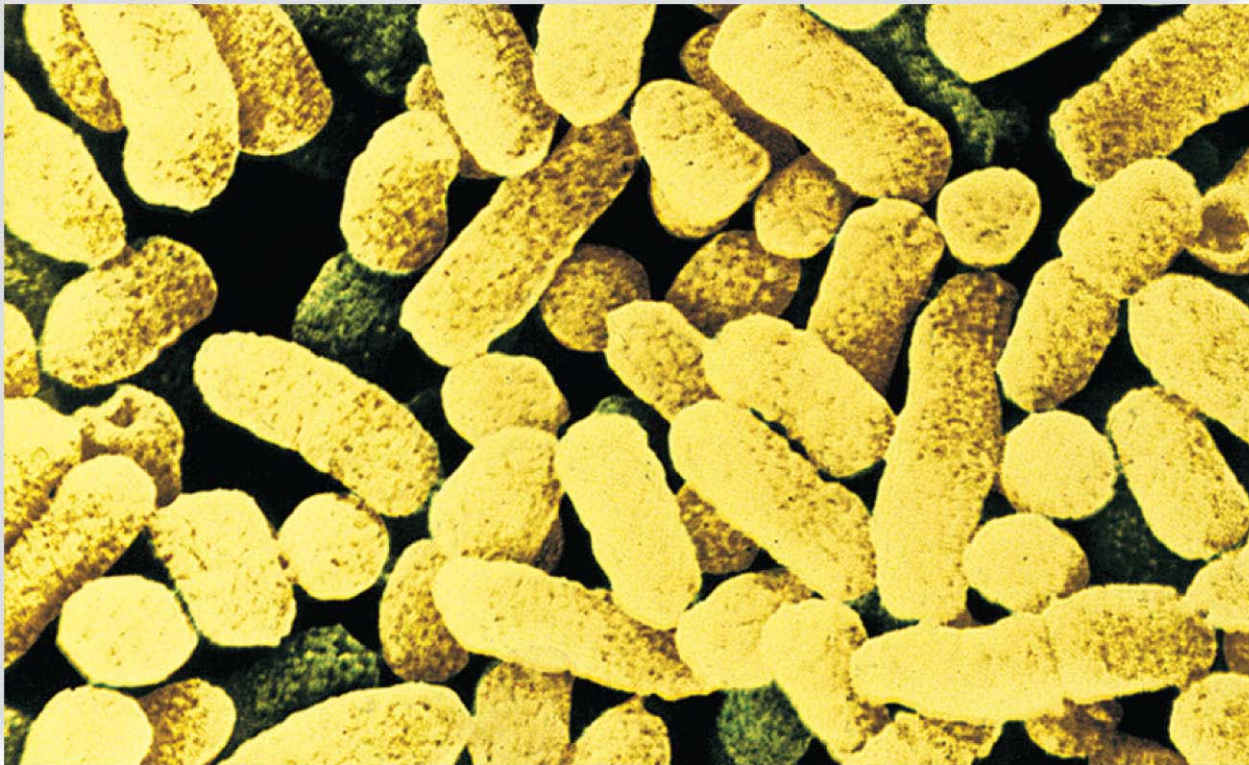
1.6  $\mu\text{m}$

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- Prokaryotic cells of various shapes
- Adaptations to extreme environments
- Absorb or chemosynthesize food
- Unique chemical characteristics

# Domains: The Bacteria

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- Prokaryotic cells of various shapes
- Adaptations to all environments
- Absorb, photosynthesize, or chemosynthesize food
- Unique chemical characteristics

**Escherichia coli, a bacterium**

**1.5  $\mu$ m**

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# Kingdoms

- **Archaea** – Kingdoms still being worked out
- **Bacteria** - Kingdoms still being worked out
- **Eukarya**
  - Kingdom **Protista**
  - Kingdom **Fungi**
  - Kingdom **Plantae**
  - Kingdom **Animalia**

# Domains: The Eukaryote Kingdoms

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## Protists



Paramecium, a unicellular protozoan

- Algae, protozoans, slime molds, and water molds
- Complex single cell (sometimes filaments, colonies, or even multicellular)
- Absorb, photosynthesize, or ingest food

## KINGDOM: Plants



Passiflora, passion flower, a flower

- Certain algae, mosses, ferns, conifers, and flowering plants
- Multicellular, usually with specialized tissues, containing complex cells
- Photosynthesize food

## KINGDOM: Fungi



Coprinus, a shaggy mane mushroom

- Molds, mushrooms, yeasts, and ringworms
- Mostly multicellular filaments with specialized, complex cells
- Absorb food

## KINGDOM: Animals



Vulpes, a red fox

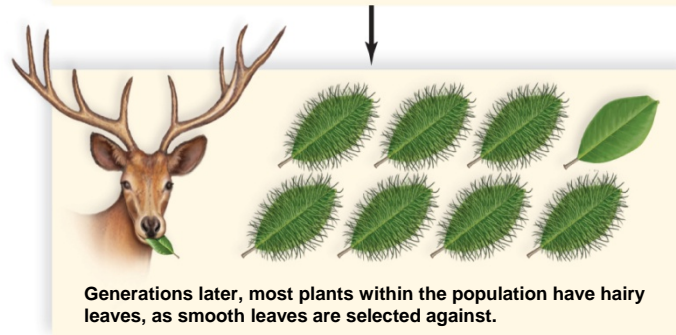
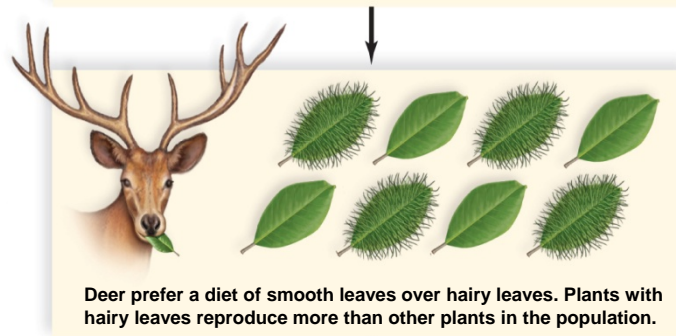
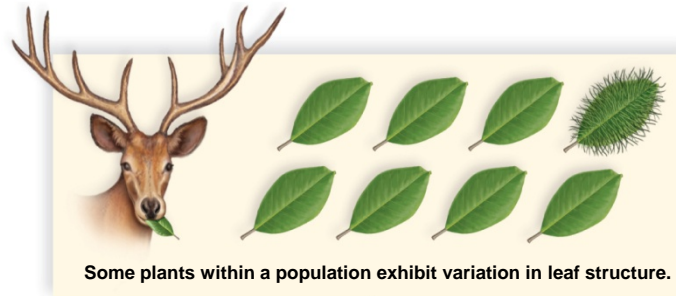
- Sponges, worms, insects, fishes, frogs, turtles, birds, and mammals
- Multicellular with specialized tissues containing complex cells
- Ingest food

(Protist): © Michael Abby/Visuals Unlimited; (Plant): © Pat Pendarvis; (Fungi): © Rob Planck/Tom Stack; (Animal): © Royalty-Free/Corbis



# Natural Selection

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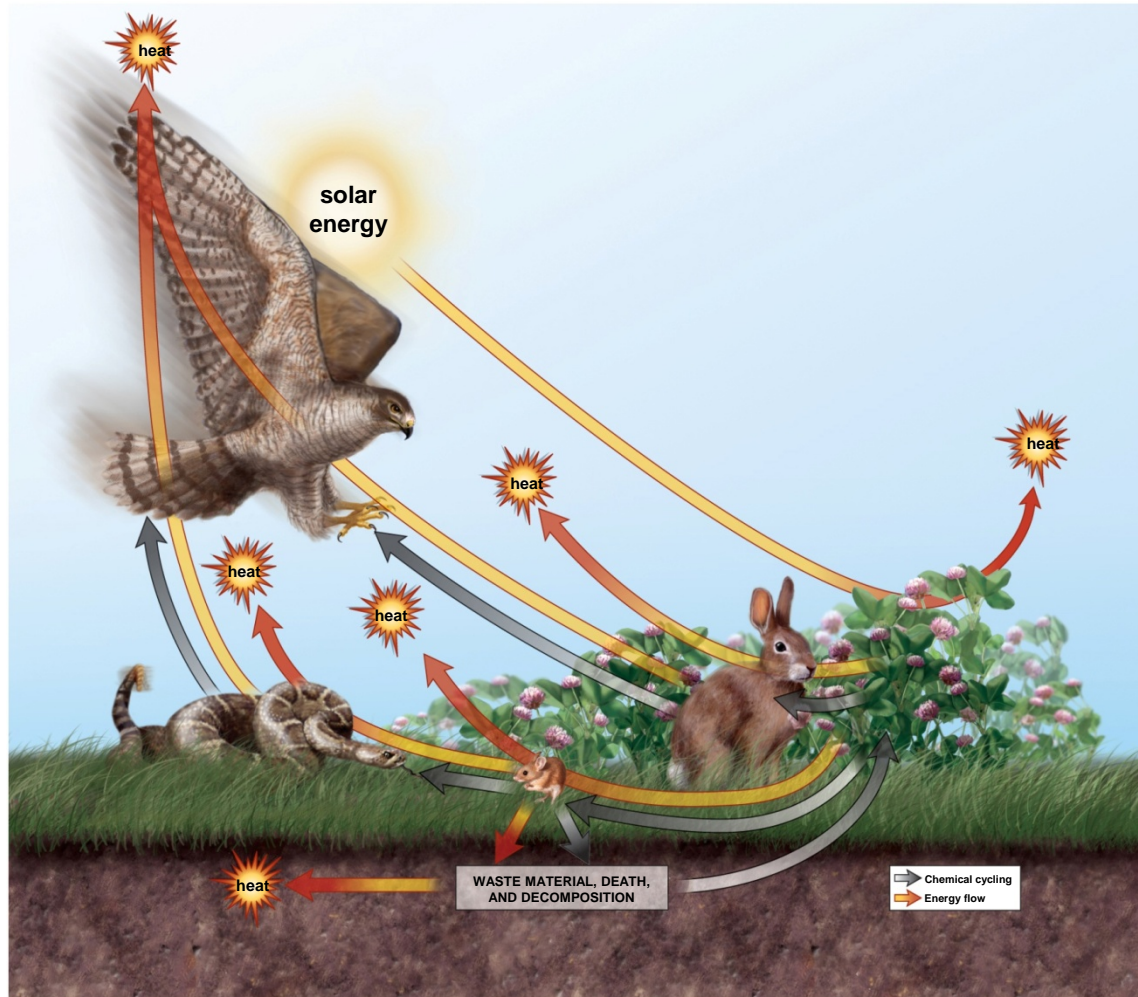


# Organization of the Biosphere

- **Population** - Members of a species within an area
- **Community** - A local collection of interacting populations
- **Ecosystem** – A community plus its physical environment
  - How chemicals are cycled and re-used by organisms
  - How energy flows, from photosynthetic plants to top predators

# Terrestrial Ecosystems: A Grassland

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# Marine Ecosystems: Coral Reef

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a. Healthy coral reef



1975 Minimal coral death



1985 Some coral death with no fish present



1995 Coral bleaching with limited chance of recovery



2004 Coral is black from sedimentation; bleaching still evident

b.

a: © Frank & Joyce Burek/Getty Images; b (All): © Dr. Phillip Dustan

# Human Populations

- Humans modify ecosystems
  - Humans negative impact on ecosystems:
    - Destroy forest or grassland for agriculture, housing, industry, etc.
    - Produce waste and contaminate air, water, etc.
- However, humans depend upon *healthy* ecosystems for
  - Food
  - Medicines
  - Raw materials
  - Other ecosystem processes

# Biodiversity

- Ecosphere is the zone of air, land, and water where organisms exist
  - Abundance of species estimated about 15 million. 3,370 of those are snakes. Called “Biodiversity”
  - The variability of organisms’ genes and ecosystems in which they live is also an important factor.
- Extinction is:
  - The death of the last member of a species
  - Estimates of 400 species/day lost worldwide