

Unit 1: APES



Living in the Environment by Miller, 15th Edition

Chapter 1



Environmental Problems, Their
Causes, and Sustainability

Introduction

- **Environment**
 - External conditions that affect living organisms
- **Ecology**
 - Study of relationships between living organisms and their environment
- **Environmental Science**
 - Interdisciplinary study that examines the role of humans on the earth





Solar Capital and Earth Capital

- Solar Capital
 - Energy from the sun
 - Provides 99% of the energy used on earth
- Earth Capital
 - Life-support and Economic Services
- Environment
 - Planet's air, water, soil, wildlife, minerals, natural purification, recycling, pest control,...

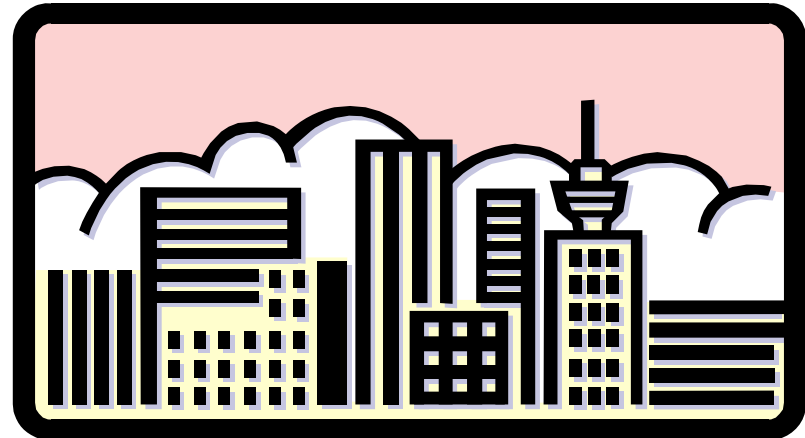
Carrying Capacity

- The maximum number of organisms of a local, regional, or global environment can support over a specified period
- Variables
 - Location
 - Time
 - Short term ~ seasonal changes
 - Long-term ~global changes in factors such as climate
 - Technology



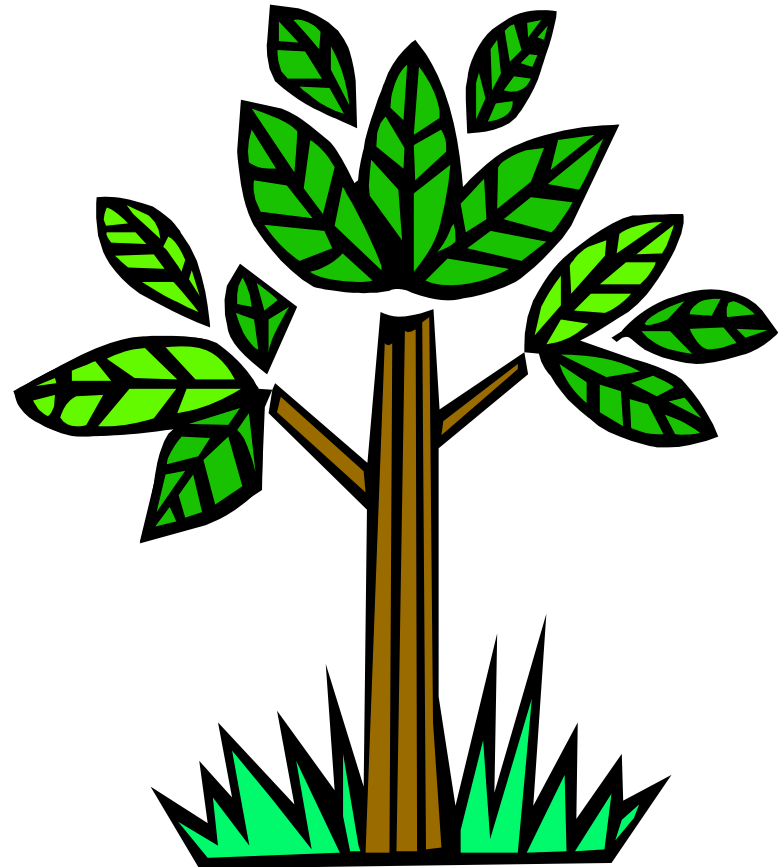
Sustainability

- The ability of a specified system to survive and function over time
- \$1,000,000
 - 10% interest
 - Live on up to \$100,000 per year



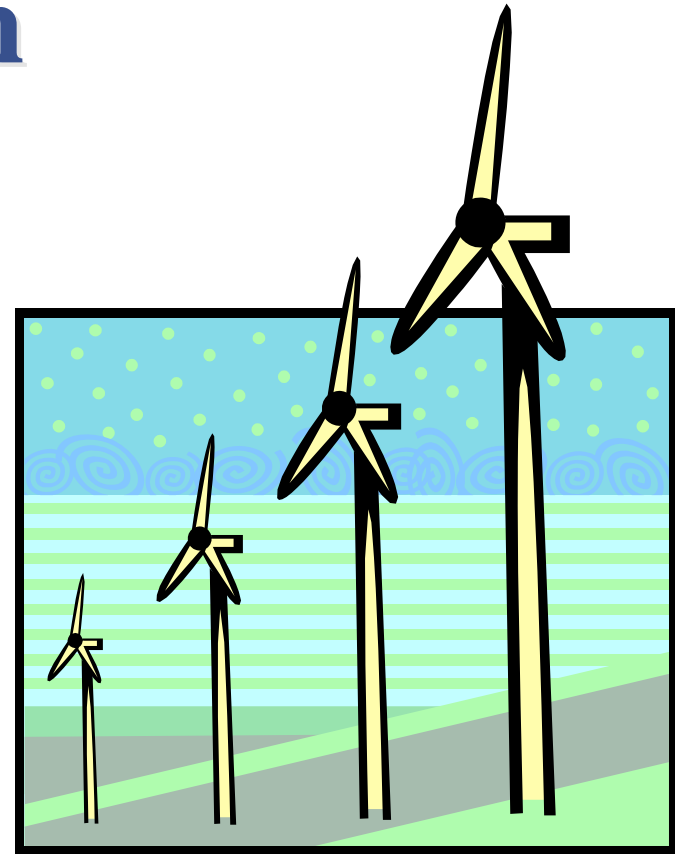
Sustainable Resource Harvest

- Certain quantity of that resource can be harvested each year *and not be depleted* over a specified period
- Sustainable supply of fish or timber



Sustainable Earth

- Earth's supplies of resources
- Processes that make up earth capital are used *and maintained* over a specified period



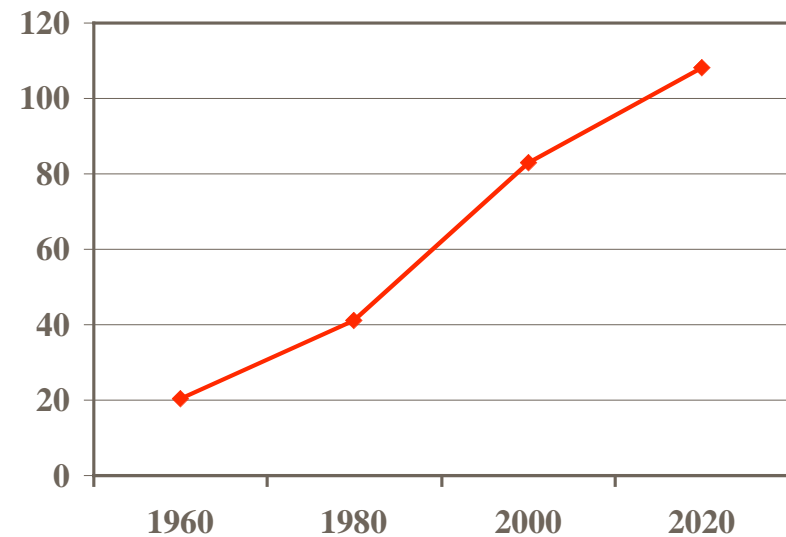
Sustainable Society

- Manages economy and population size without exceeding all or part of the planet's ability to
 - Absorb environmental insults
 - Replenish resources
 - Sustain human and other forms of life over a specified period (100's-1,000's of years)



Linear Growth

- Quantity increases by a constant amount per unit of time
- 1,2,3,4,5, ...
- 1,3,5,7,9, ...
- When plotted on a graph, growth of money yields a fairly straight line sloping upward



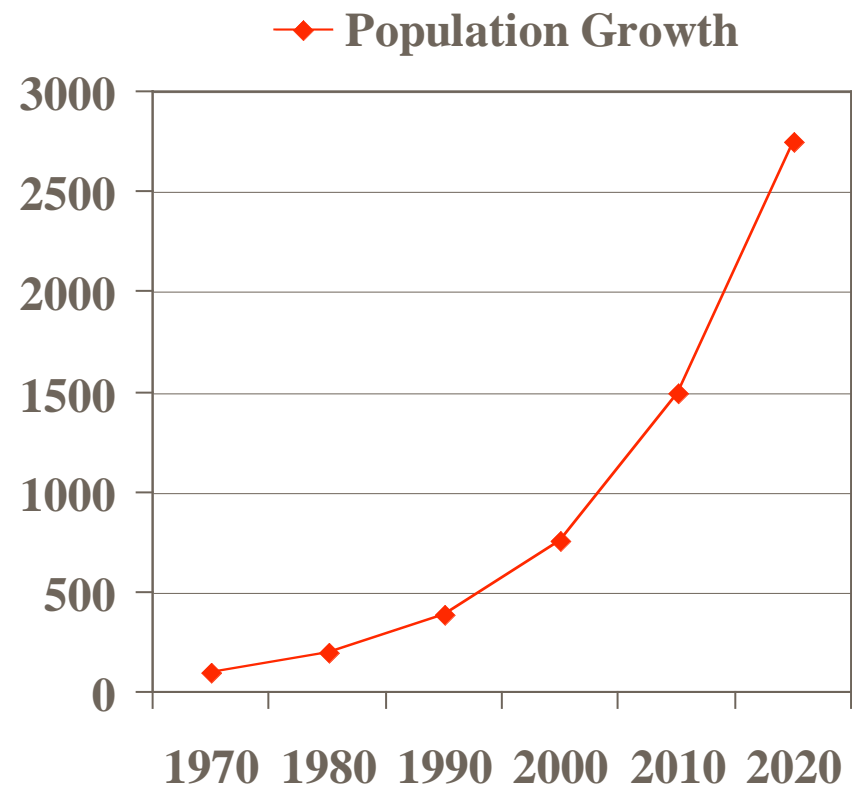
Exponential Growth

- Starts off slowly, doubles a few times, then grows to enormous numbers
- Quantity increases by a fixed percentage of the whole in a given time as each increase is applied to the base for further growth



Exponential Growth

- Growth yields a J-shaped curve
- Describes the human population problem that disturbs the environment today

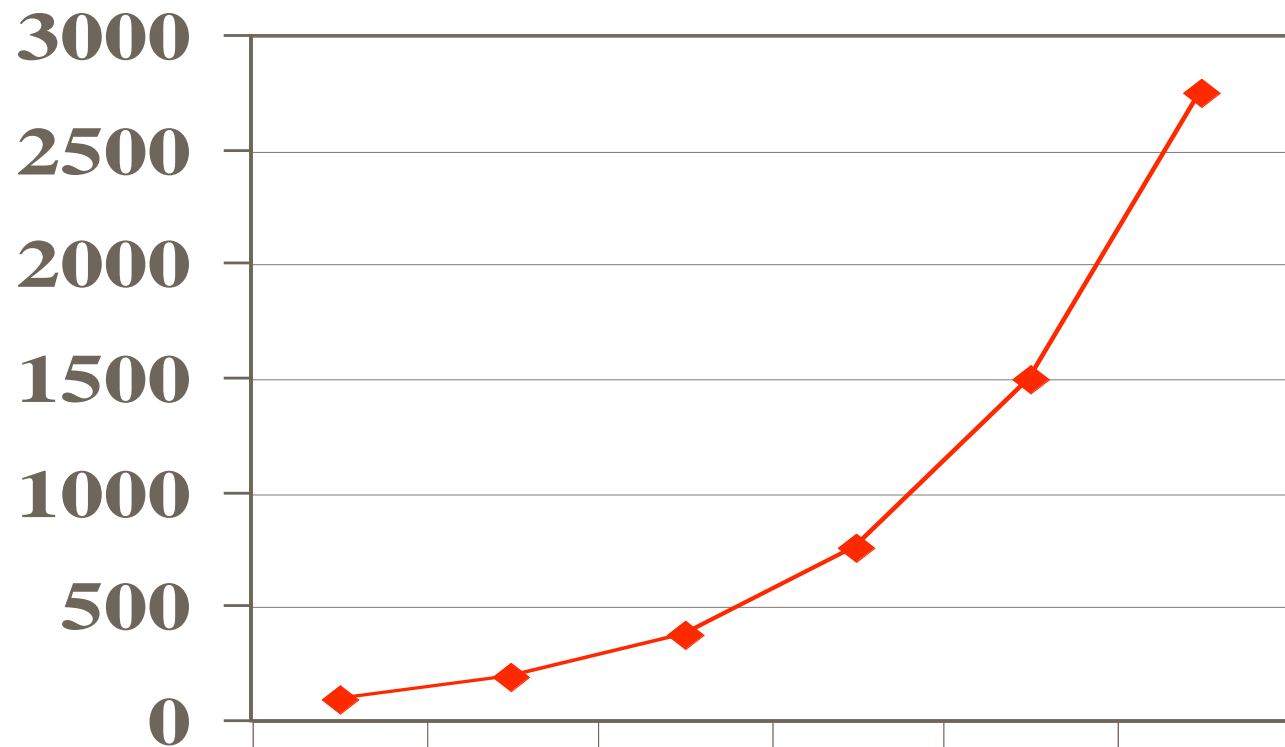




Rule of 70

- How long does it take to double?
 - Resource use
 - Population size
 - Money in a savings account
- Rule of 70
 - 70 divided by the percentage growth rate = doubling time in years
 - $70 / 7\%$ means it takes ten years to double

—◆— Population Growth



	1970	1980	1990	2000	2010	2020
—◆— Population Growth	100	197	387	761	1497	2753



Economic Growth - Key Terms

■ **Economic Growth**

- Increase in the capacity to provide goods and services for people's use

■ **Throughput of Matter and Energy**

- Resources used to produce goods and services through an economy
- High throughput means more consumption per person



Economic Growth - Key Terms

■ Gross National Product

- Measures economic growth in a country
- Market value in current dollars of all goods and services produced *within* and *outside* of a country by the country's businesses during one year

■ Gross Domestic Product

- Market value in current dollars of all goods and services produced *only within* a country during one year



Economic Growth - Key Terms

- **More Developed Countries (MDC)**
 - Highly industrialized
 - Average per capita GNP above \$4000
- **Less Developed Countries (LDC)**
 - Low to moderate industrialization
 - Average per capita GNP below \$4000
 - (Africa, Latin America, and parts of Asia)



Economic Growth - Key Terms

■ **Development**

- Change from a society that is largely rural, agricultural, illiterate, poor and rapidly growing population

■ **Per Capita GNP**

- GNP divided by the total population
- Shows one person's slice of the economic pie

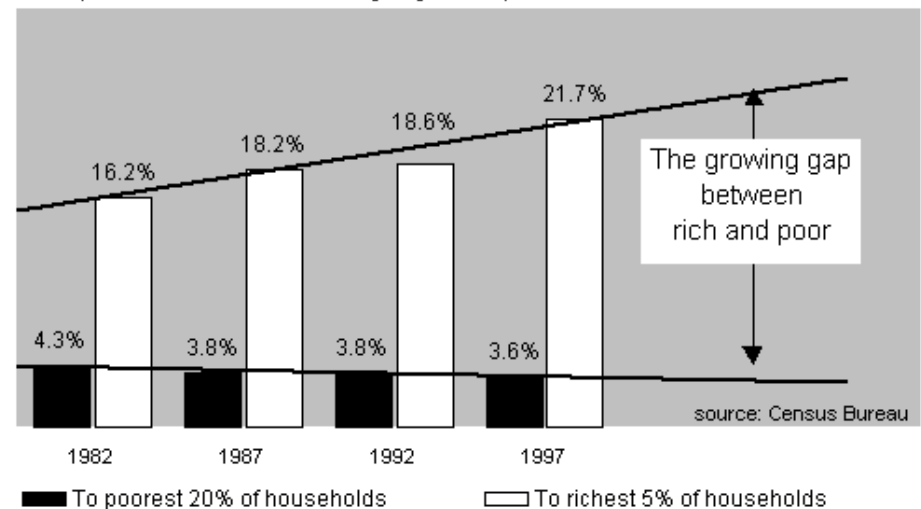
Wealth Gap

- The gap between the per capita GNP of the rich, middle-income and poor has widened
- More than 1 billion people survive on less than one dollar per day
- Situation has worsened since 1980

Chart #6:

The Rich Get Richer

The share of total household income going to the richest 5% of households compared to the income share going to the poorest 20% of households.



Economic Development

- Involves using economic systems to improve the quality of people's lives and the environment



Sustainable Development

- Assumes the right to use the earth's resources and earth capital to meet needs
- Obligation exists to pass the earth's resources and services to future generations in as good or better shape than condition when passed to us
- *Intergenerational equity or fairness*





Resources

Renewable	Non-Renewable	Potentially Renewable
Direct solar energy	Fossil fuels	Fresh air
Winds, tides, flowing water	Metallic minerals (iron, copper, aluminum)	Fresh water
	Nonmetallic minerals (clay, sand, phosphates)	Fertile soil
		Plants and animals (biodiversity)



Biodiversity

■ Genetic Diversity

- Variety in a genetic makeup among individuals within a single species

■ Species Diversity

- Variety among the species or distinct types of living organisms found in different habitats of the planet

■ Ecological Diversity

- Variety of forests, deserts, grasslands, streams, lakes, oceans, wetlands, and other communities

Environmental Degradation

Common Property Resources

- Tragedy of the Commons
- Resources owned by none, but available to all users *free of charge*
- May convert potentially renewable resources into nonrenewable resources





Nonrenewable Resources

■ Nonrenewable/Exhaustible Resources

- Exist in a fixed quantity in the earth's crust and can be used up

■ Mineral

- Any hard, usually crystalline material that is formed naturally

■ Reserves

- Known deposits from which a usable mineral can be profitably extracted at current prices



Nonrenewable Resources

■ Recycling

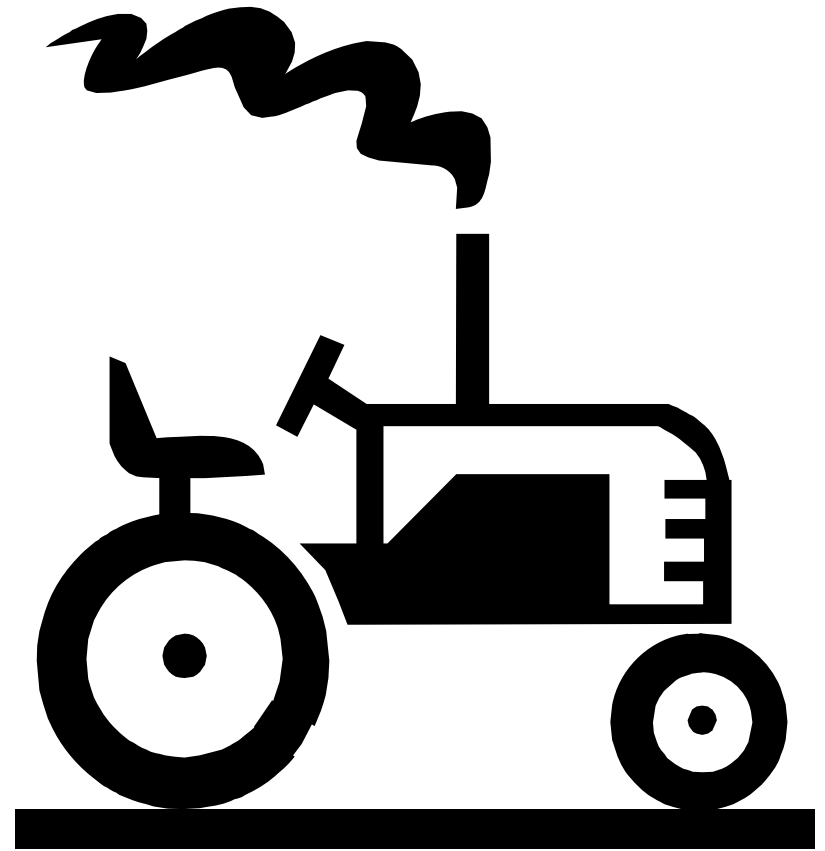
- Collecting and reprocessing a resource *into new products*

■ Reuse

- Using a resource over and over *in the same form*

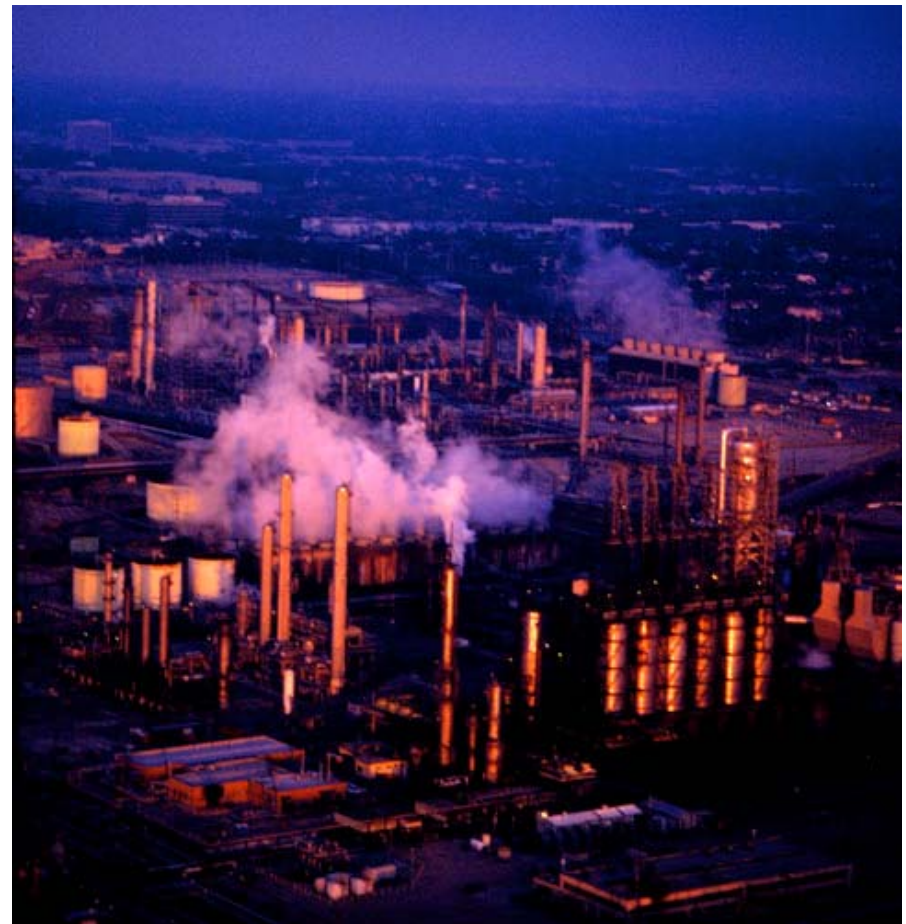
Pollution

- Any addition to air, water, soil, or food that threatens the health, survival, or activities of humans or other living organisms
- Solid, liquid, or gaseous by-products or wastes



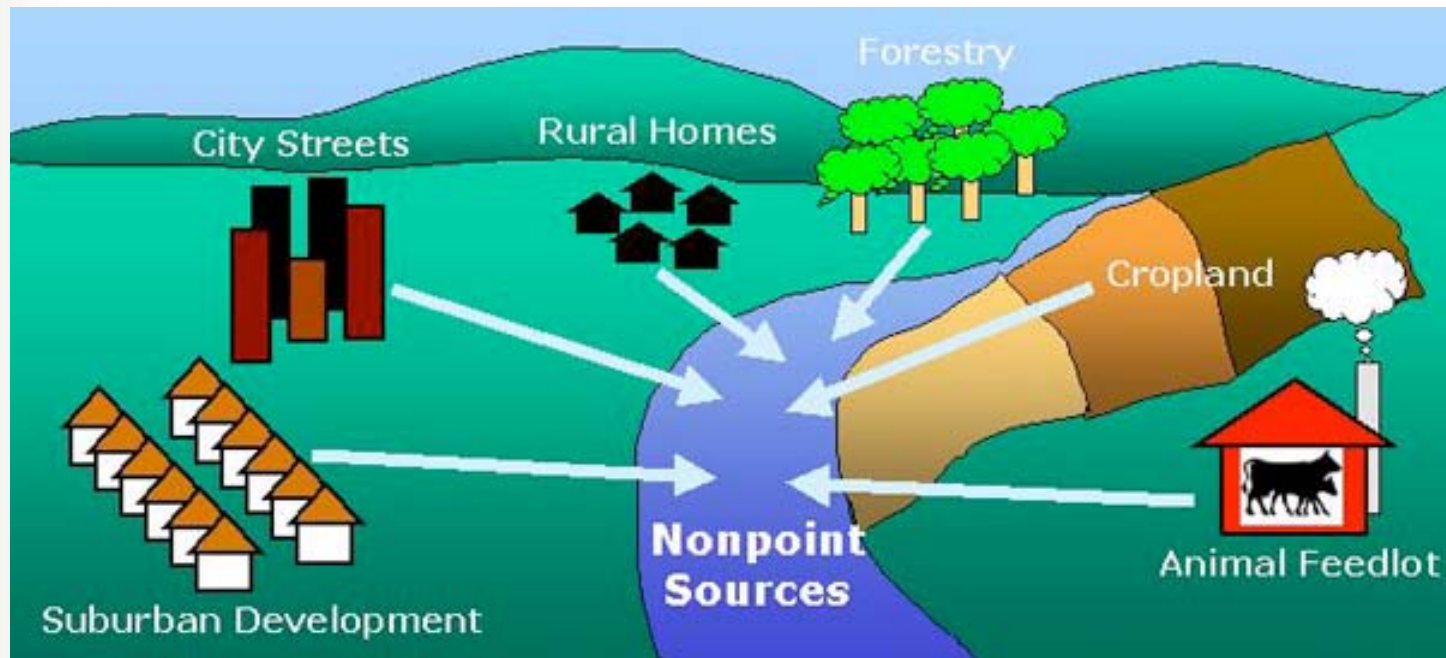
Point Source Pollutants

- From a single, identifiable sources
 - Smokestack of a power plant
 - Drainpipe of a meat-packing plant
 - Exhaust pipe of an automobile



Nonpoint Source Pollutants

- Dispersed and often difficult to identify sources
 - Runoff of fertilizers and pesticides
 - Storm Drains (#1 source of oil spills in oceans)



Negativity of Pollutant

■ Chemical Nature

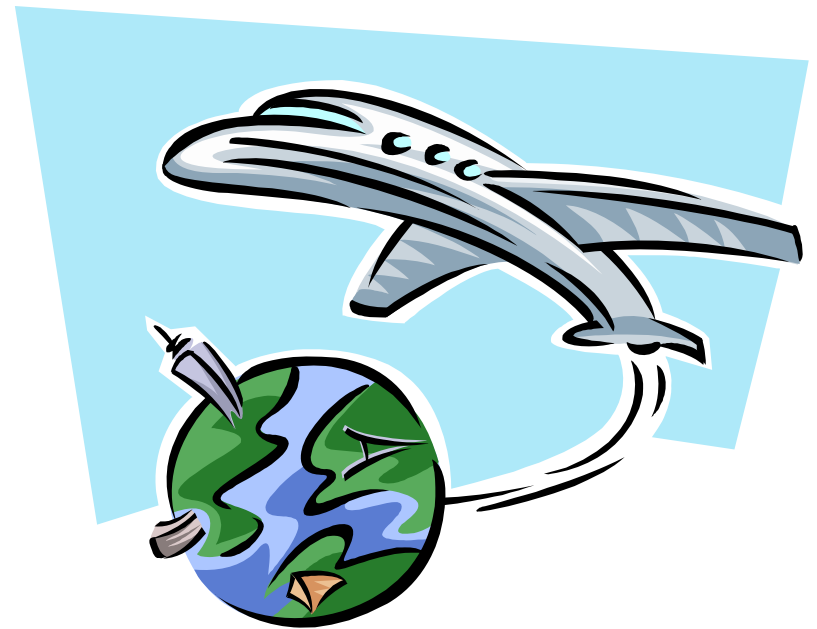
- How active and harmful it is to living organisms

■ Concentration

- Amount per unit volume or weight of air, water, soil or body weight

■ Persistence

- Time it stays in the air, water, soil or body



Solutions: Pollution Prevention

- Input Pollution Control or Throughput Solution
 - Slows or eliminates the production of pollutants, often by switching to less harmful chemicals or processes



Solution: Four R's of Resource Management

- Refuse (don't use)
- Reduce
- Reuse
- Recycle



Solution: Pollution cleanup

- Output Pollution Cleanup
 - Involves cleaning up pollutants after they have been produced
 - Most expensive and time consuming



Air Pollution

- Global climate change
- Stratospheric ozone depletion
- Urban air pollution
- Acid deposition
- Outdoor pollutants
- Indoor pollutants
- Noise



Water Pollution

- Sediment
- Nutrient overload
- Toxic chemicals
- Infectious agents
- Oxygen depletion
- Pesticides
- Oil spills
- Excess heat

Credit: Ohio EPA



1969: Cuyahoga River on fire.

Biodiversity Depletion

- Habitat destruction
- Habitat degradation
- Extinction



Food Supply Problems

- Overgrazing
- Farmland loss and degradation
- Wetlands loss and degradation
- Overfishing
- Coastal pollution
- Soil erosion



Food Supply Problems

- Soil salinization
- Soil waterlogging
- Water shortages
- Groundwater depletion
- Loss of biodiversity
- Poor nutrition



A Irregular crop growth on saline soil.

B White crust of salt on the soil surface.

C Broken-ring pattern of salts around a slough.

D Salt streaks within the soil.

E Red samphire (inset) growing on saline soil.

F Crop-tolerance testing on saline soil.



Model of Environmental Impact

- Number of People x Number of units of resources used per person x Environmental degradation and pollution per unit of resource used = Environmental impact of population
- $P \times A \times T = I$

Hunter-Gatherers

- Had only three energy sources:
 - Sunlight in captured plants
 - Fire
 - Their own muscle power
- Very little impact on environment
- See [Jared Diamond](#)



The Makah butcher a whale (c.1905-1910)
Washington State Historical Society

Agricultural Revolution

■ Agricultural Revolution

- Cultural shift that began in several regions of the world
- Involved a gradual move from a lifestyle based on nomadic hunting

■ Agroforestry

- Planting a mixture of food crops and tree crops



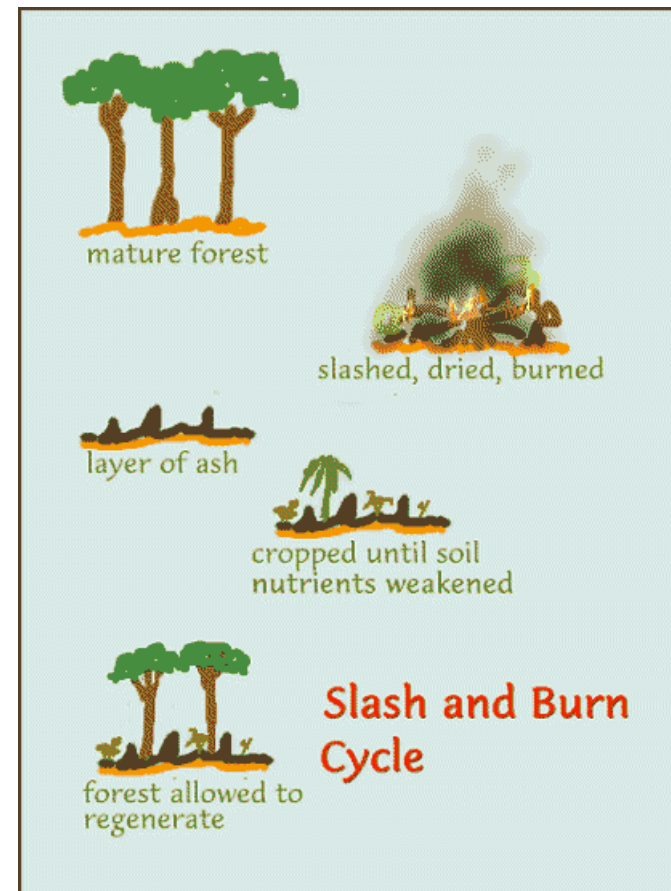
Agricultural Revolution

■ Slash-and-burn

- Cutting down trees and other vegetation and then burning the underbrush to clear small patches of land

■ Subsistence Farming

- Family grew only enough food to feed itself.



Environmental Worldviews

- How people think the world works
- What they think their role in the world should be
- What they see as right and wrong environmental behavior
(environmental ethics)



Planetary Management Worldview

- Increasingly common during the past 50 years.
- We are the planet's most important species
- We are in charge of the rest of nature



Planetary Management Worldview

- There is always more
- All economic growth is good
- Potential for economic growth is limitless
- Our success depends on how well we manage earth's system *for our benefit*



Earth-Wisdom Worldview

- Nature exists for all of the earth's species, not just for us
- There is not always more
- Not all forms of economic growth is beneficial to the environment
- Our success depends on learning to cooperate with one another and with the earth



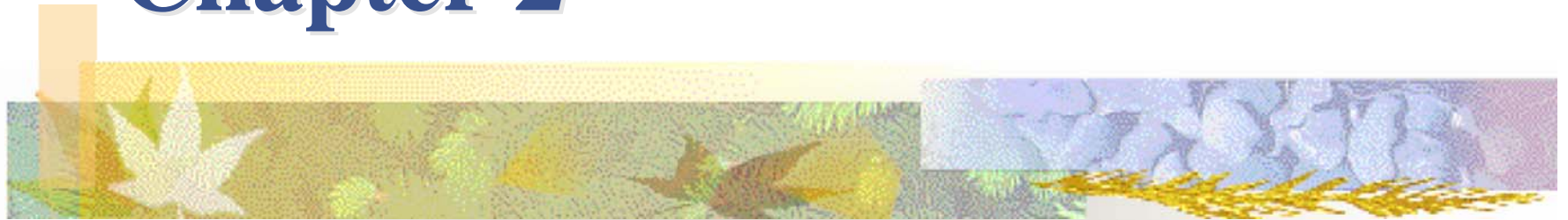
Working with the Earth

■ Earth Wisdom

- Learning as much as we can about how the earth sustains itself
- Adapt to ever-changing environmental conditions
- Integrating such lessons from nature into the ways we think and act



Chapter 2



Critical Thinking: Science, Models,
and Systems

What Is Science?

- Science is a pursuit of knowledge about how the world works
- Scientific data is collected by making observations and taking measurements
- Observations involve the five senses, and help answer questions or problems





Observation

- **Qualitative**

- of, relating to, or involving *quality* or kind

- **Quantitative**

- of, relating to, or involving the measurement of *quantity* or amount



Qualitative

- Red
- Far from the earth
- Microscopic
- Burns quickly
- Hot

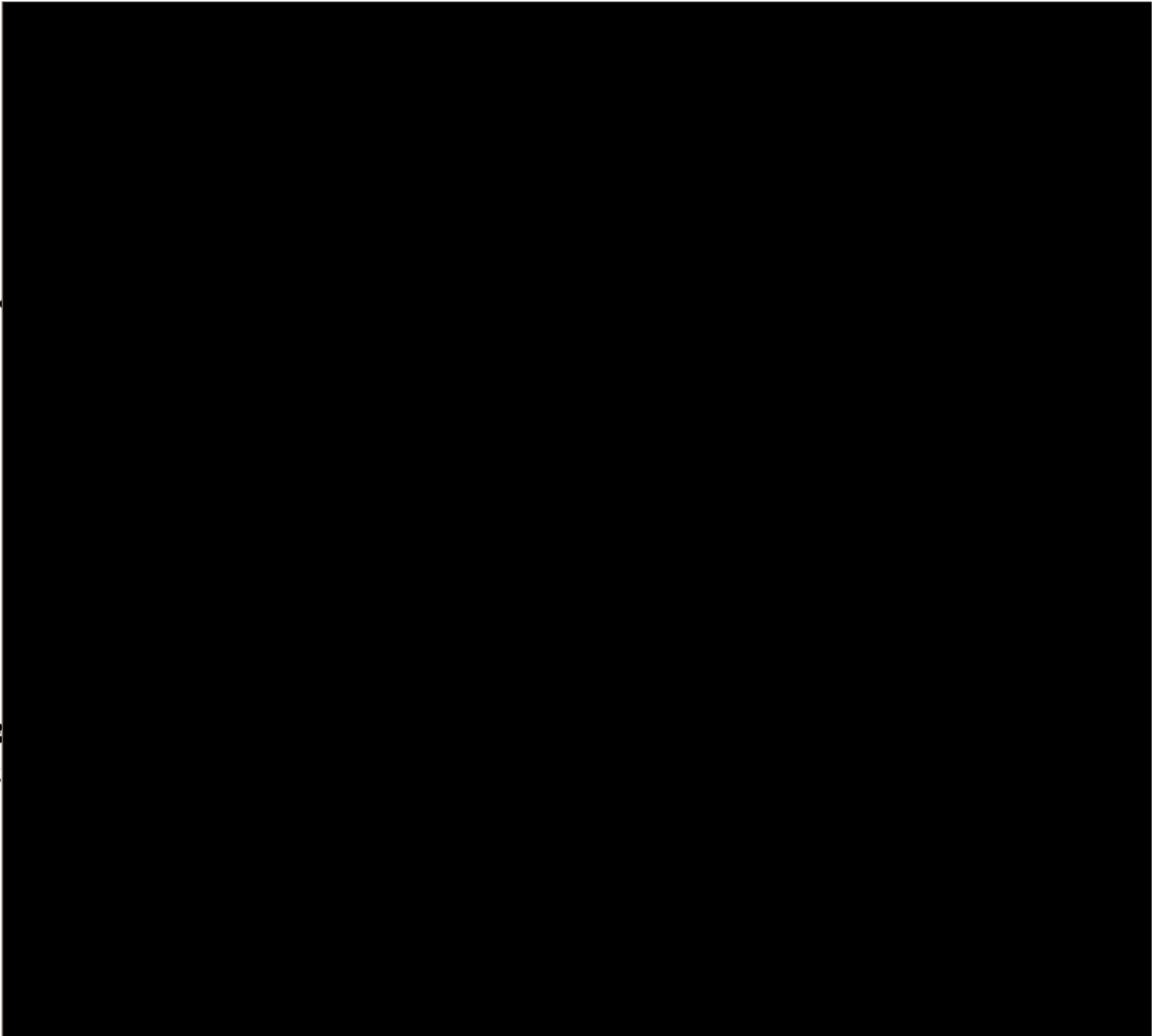
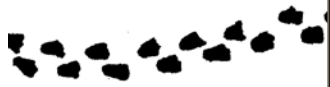
Quantitative

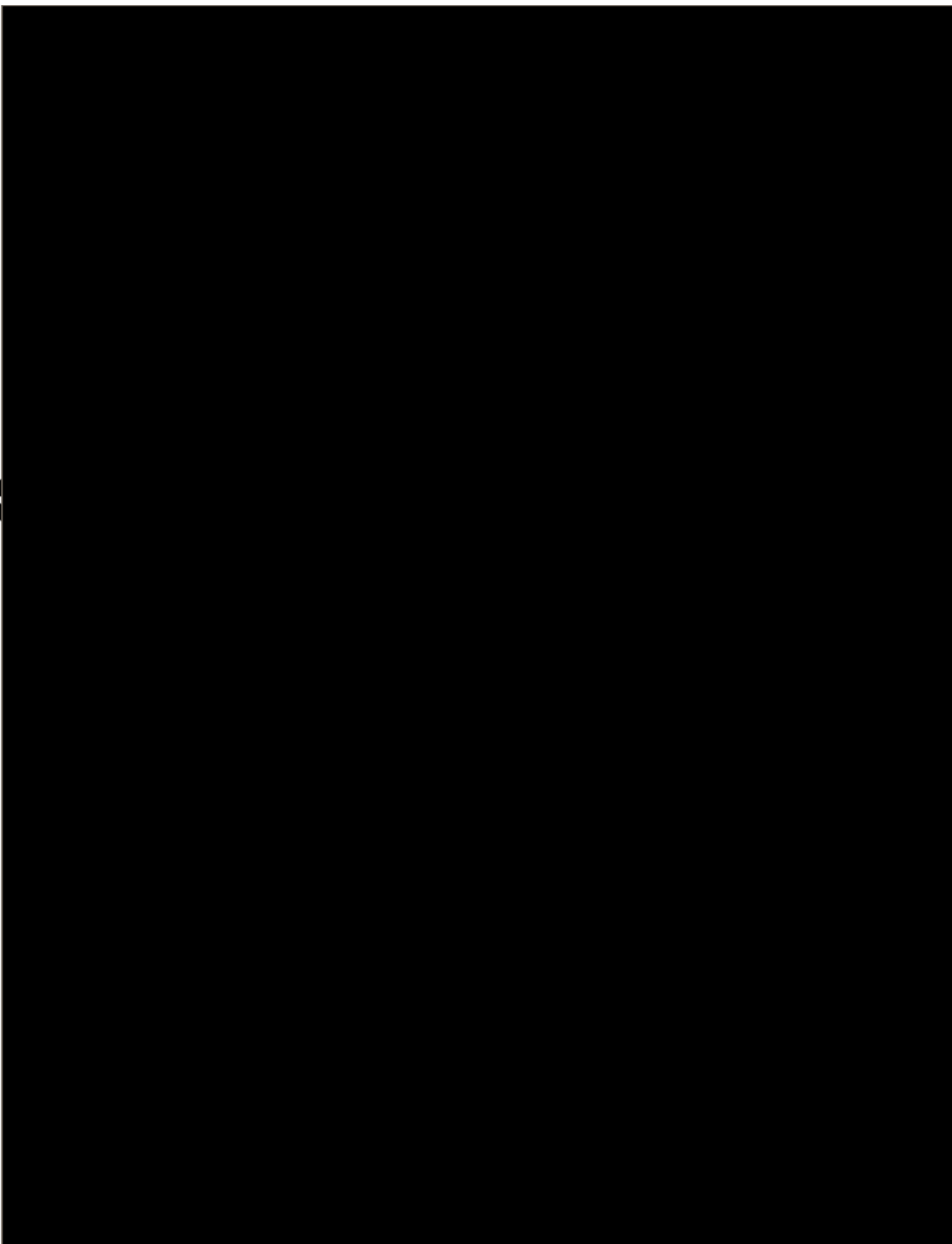
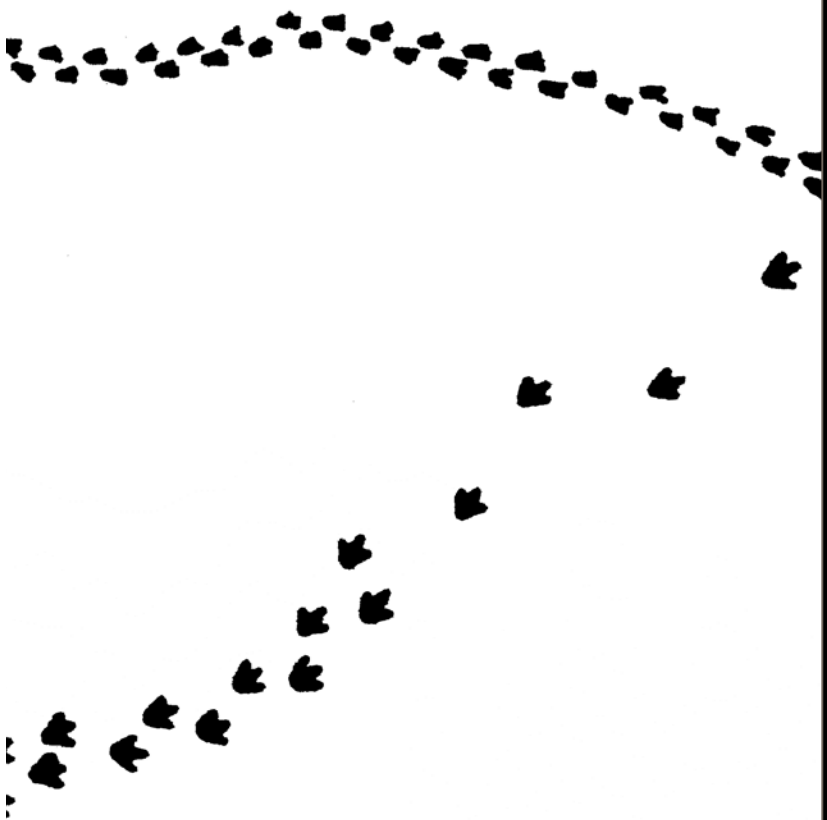
- 700 nm wavelength
- 300 million light years
- Smaller than 1 μm
- Burns candle at 1 cm per minute
- 350 degrees C

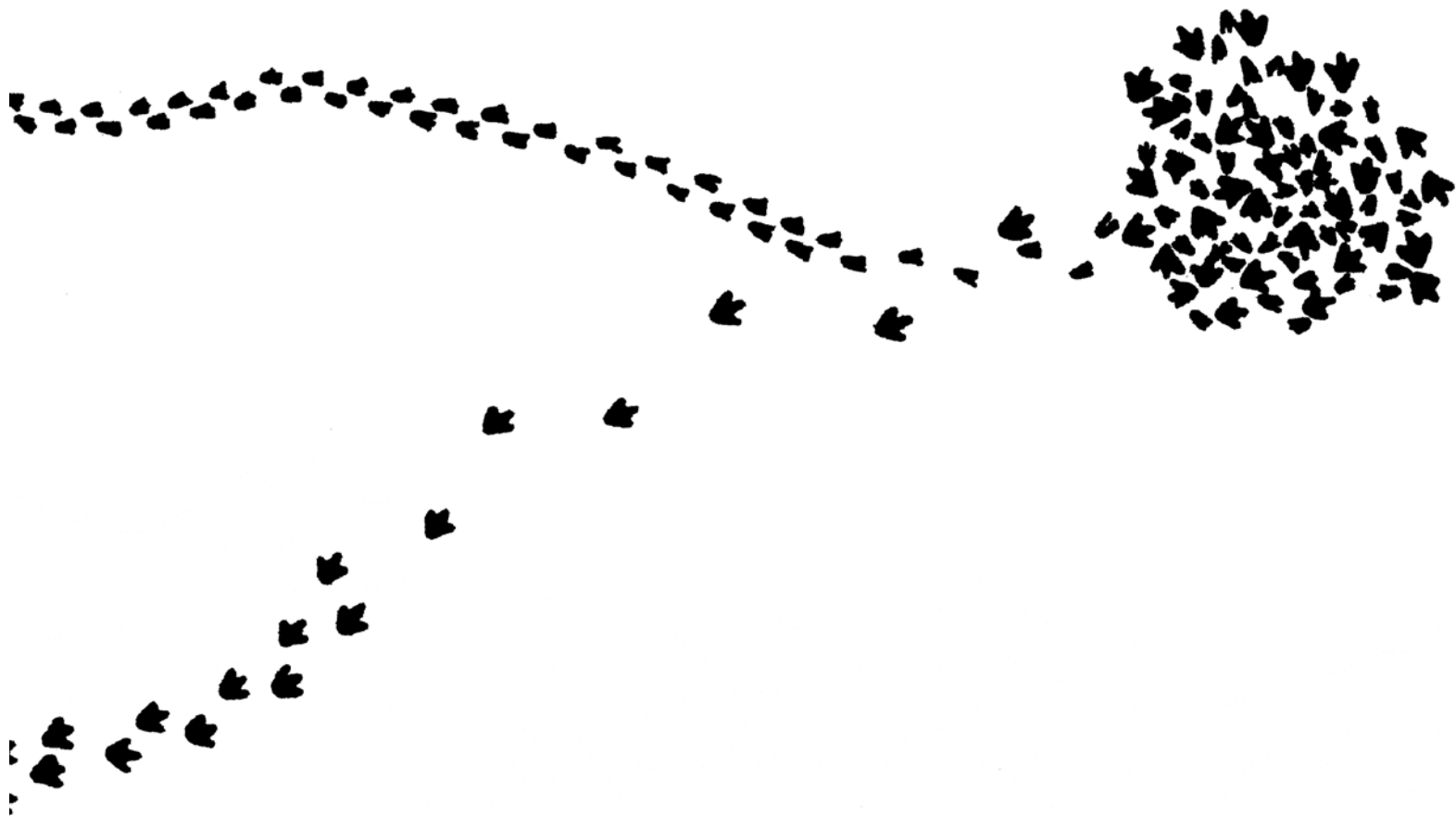


Inference

1. To conclude from evidence or premises
2. To reason from circumstance; surmise: *We can infer that his motive in publishing the diary was less than honorable*
3. To lead to as a consequence or conclusion: “Socrates argued that a statue inferred the existence of a sculptor”









Vocabulary

■ Experiment

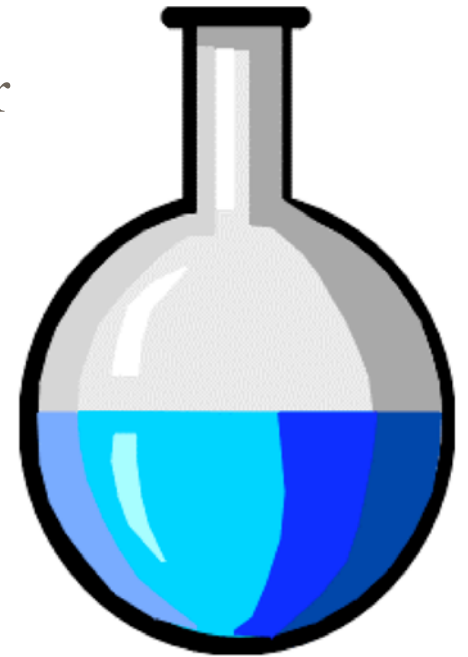
- A procedure to study a phenomenon under known conditions
- Must have a Control

■ Hypotheses

- A possible explanation of something observed in nature.

■ Model

- An approximate representation of a system being studied.



Theory and Law



■ Scientific Theory

- A hypothesis that has been supported by multiple scientists' experiments in multiple locations

■ A Scientific Law

- a description of what we find happening in nature over and over again in a certain way

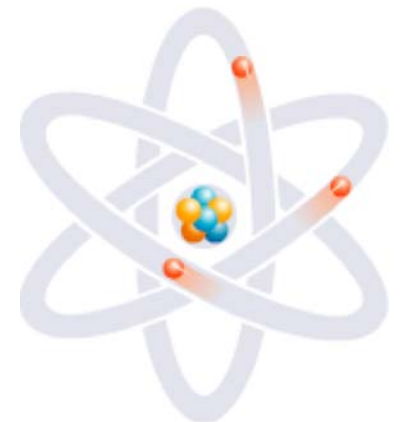
Scientific Laws

■ Law of Conservation of Matter

- Matter can be changed from one form to another, but never created or destroyed.

■ Atomic Theory of Matter

- All matter is made of atoms which cannot be destroyed, created, or subdivided.



Accuracy and Precision

■ Accuracy

- The extent to which a measurement agrees with the accepted or correct value for that quantity.

■ Precision

- A measure of reproducibility, or how closely a series of measurements of the same quantity agrees with one another.



Reasoning

■ Inductive Reasoning

- Uses observations and facts to arrive at hypotheses
- All mammals breathe oxygen.

■ Deductive Reasoning

- Uses logic to arrive at a specific conclusion based on a generalization
- All birds have feathers, Eagles are birds, therefore All eagles have feathers.





Scientific Methods

- What is the question to be answered?
- What relevant facts and data are known?
- What new data should be collected?
- After collection, can it be used to make a law?
- What hypothesis can be invented to explain this? How can it become a theory?



Experiments

- Variables are what affect processes in the experiment.
- Controlled experiments have only one variable
- Experimental group gets the variable
- Control group does not have the variable
 - Placebo is a harmless pill that resembles the pill being tested.
 - In double blind experiments, neither the patient nor the doctors know who is the control or experiment group.



Frontier and Consensus Science

■ Frontier Science

- Scientific “breakthroughs” and controversial data that has not been widely tested or accepted
- String Theory

■ Consensus or Applied Science

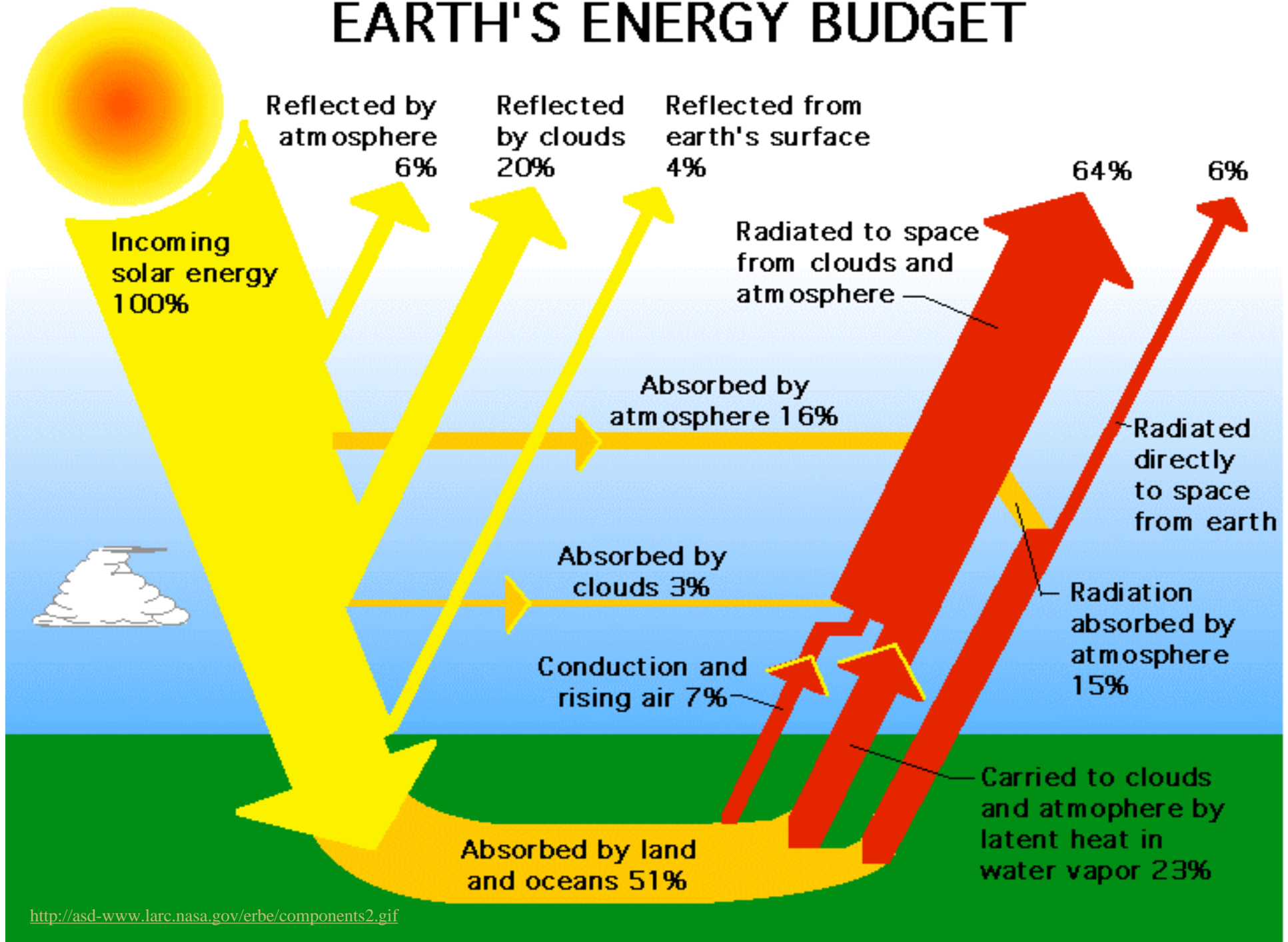
- Consists of data, theories, and laws that are widely accepted by scientists considered experts in the field involved
- Human Genome Project

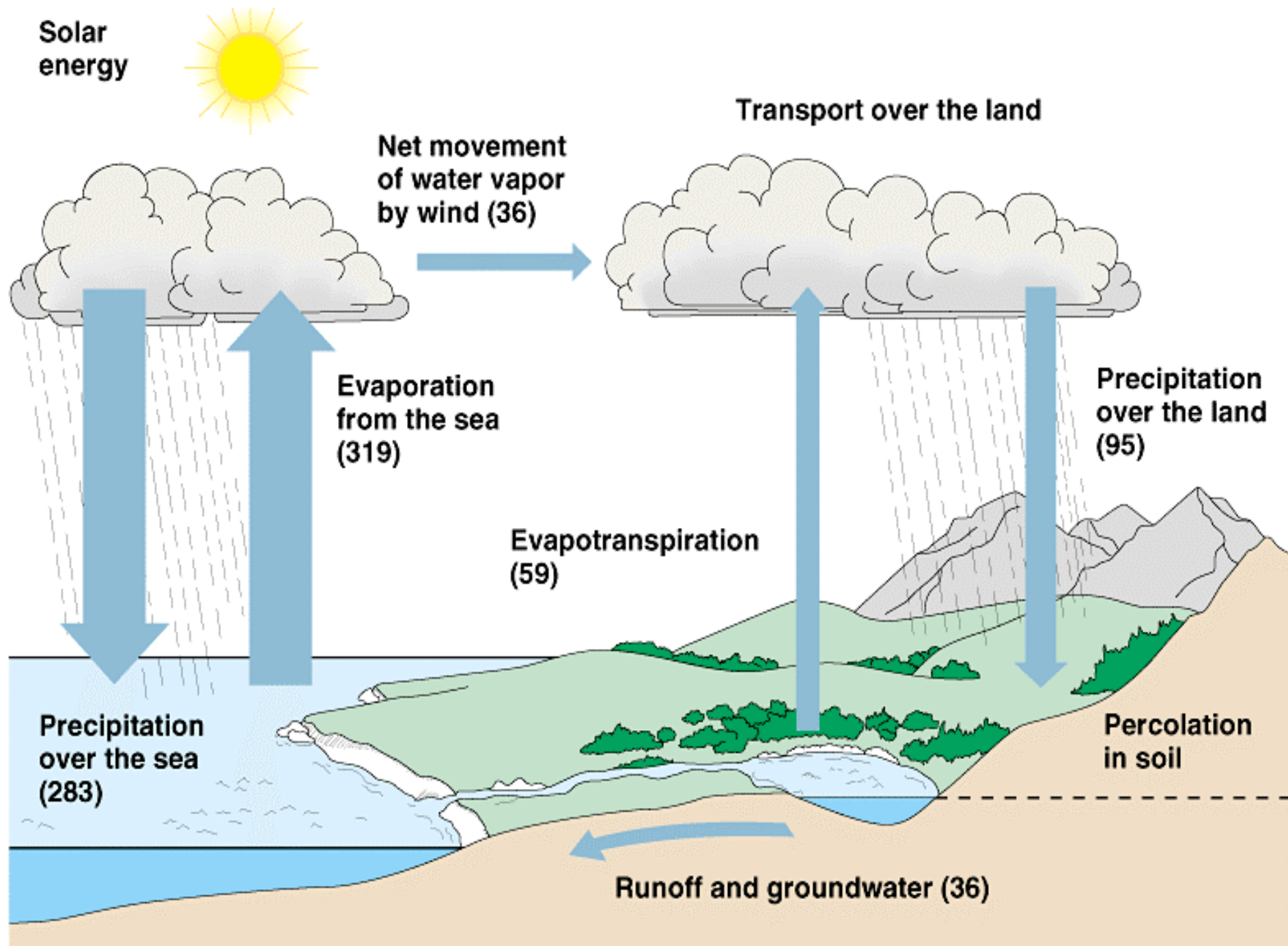


Systems

- A system is a set of components that function and interact in some regular and predictable manner
- It has a structure and a function
 - The earth is a *closed system* for matter and an *open system* for energy

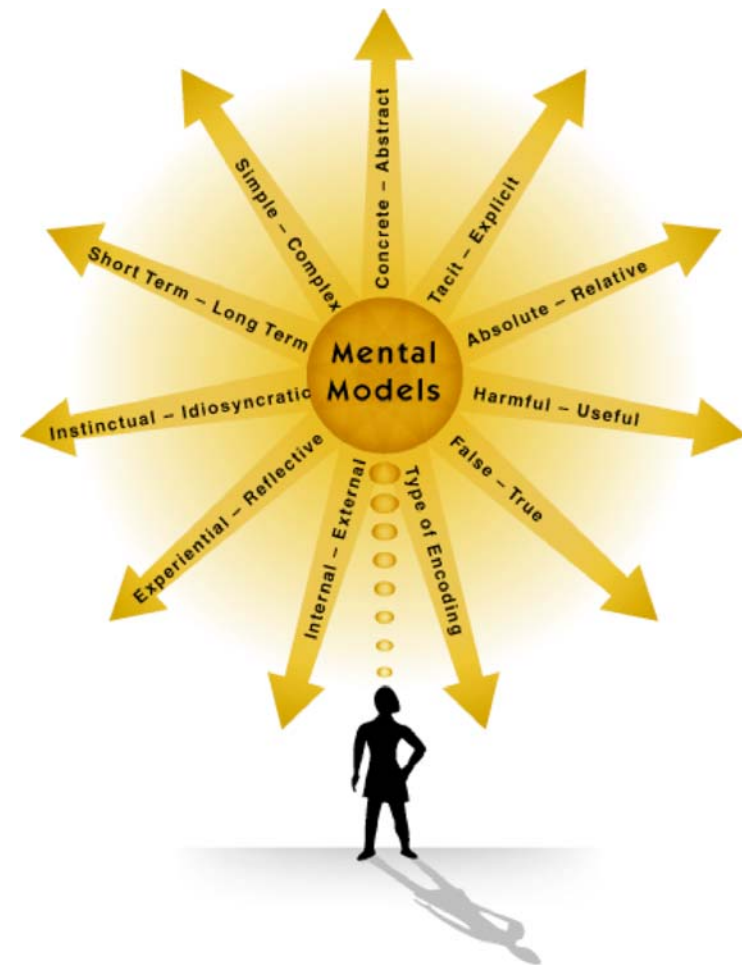
EARTH'S ENERGY BUDGET





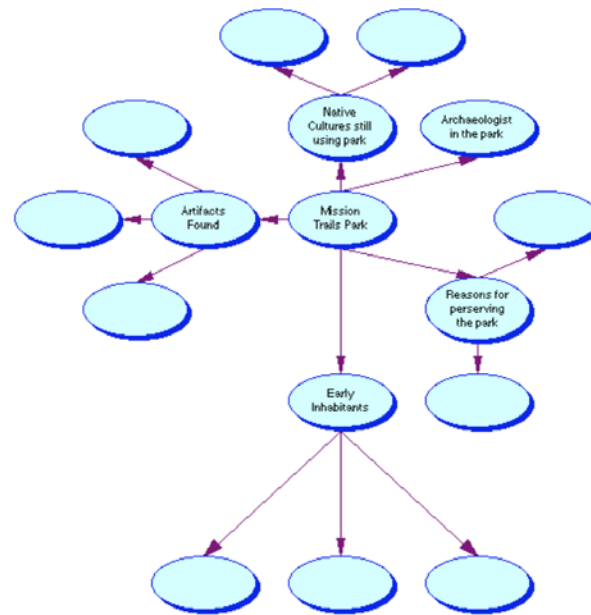
Scientific Models - Mental

- Mental models help people perceive the world, control their bodies and think
 - Working model of a car engine while you are trying to diagnose a problem



Conceptual Models

- Describes general relationships among components of a system.



Graphic Models

- Compile and display data in meaningful patterns.



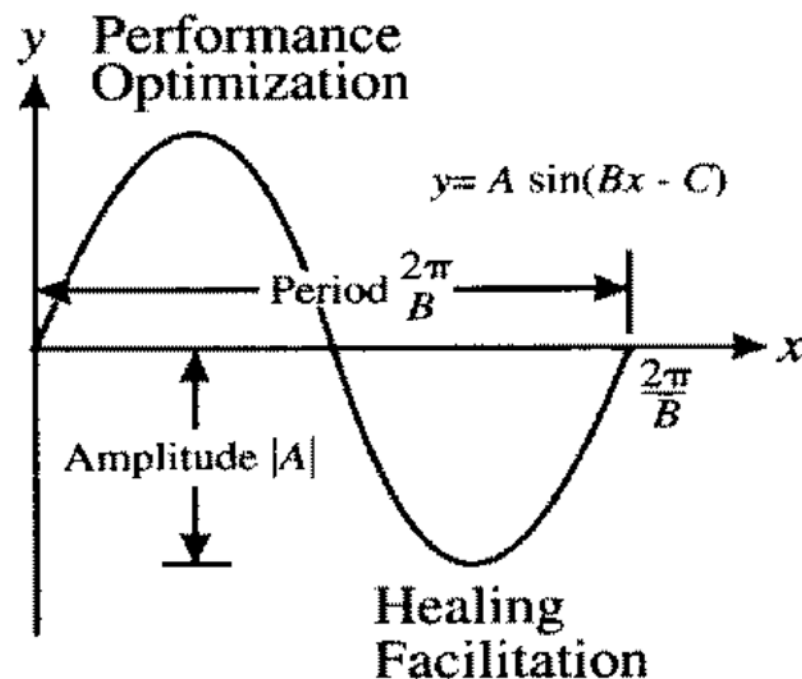
Physical Models

- Miniature versions of large systems that are made to test out designs and ideas.



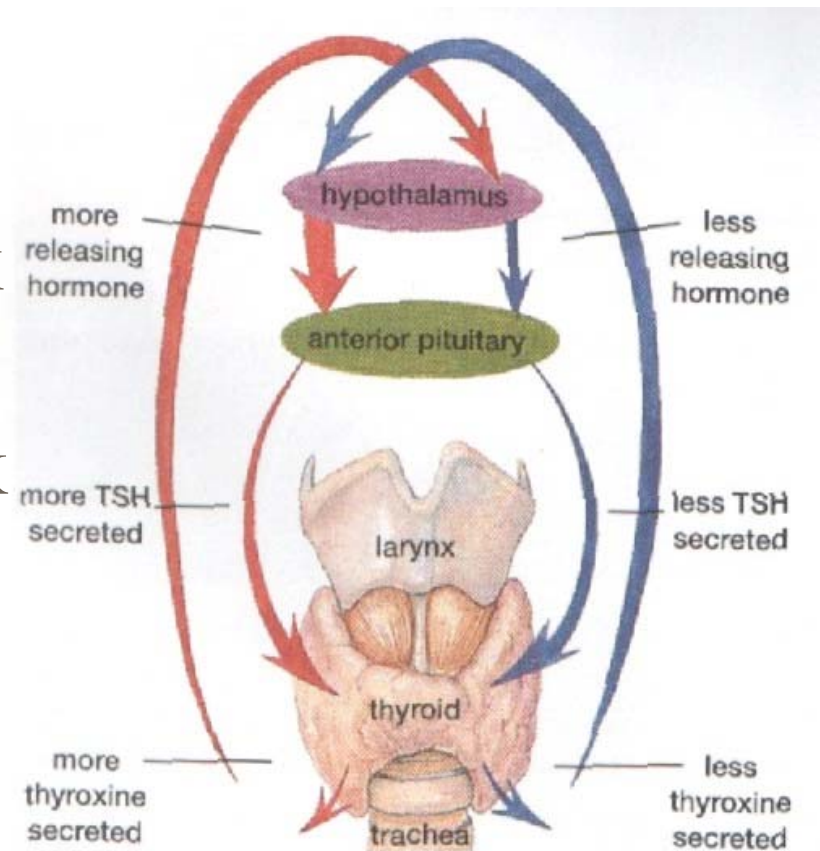
Mathematical Model

- Consists of one or more mathematical equations to describe the behavior of a system.



Feedback Loops

- A feedback loop occurs when an output of a system is fed back as an input
- Two kinds of feedback loops
 - Positive
 - Negative





Feedback Loops

- *Positive loops* are runaway cycles where a change in a certain direction causes further change in the same direction
 - Melting of permafrost will release methane which will accelerate global warming
- *Negative loops* occur when a change in a certain direction leads to a lessening of that change
 - Moose and wolves



Synergy and Chaos

- Synergy occurs when two or more processes interact so the combined effect is greater than the sum of the separate effects
 - Grapefruit and Statins
- Chaos occurs in a system when there is no pattern and it never repeats itself
 - Noise versus Music



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