

Science without Walls: Science in YOUR World

Hard Rules -- Soft Rules

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Walls

Snow College 11/2/00

Science -- Humanities: Basic Differences

- Assumptions of Science:
 - The Rules are universal and constant
(God is not capricious and doesn't play favorites)
 - We can discover and learn the Rules
(Creator endowed us with brains, curiosity, senses)

Science -- Humanities: Basic Differences

- Assumptions of Many Religions:
 - We must obey the Creator's Rules and
 - We have free will--(brain, consciousness, soul)
- Societies, cultures, philosophies, religions:
The Humanities

Hard Rules -- “Soft” Rules

- The Hard Rules -- The Sciences
 - The way the physical and natural World works
 - The Rules of the Game -- apply everywhere, all the time, to all; no favorites; no supernatural stuff.
- The “Soft” Rules -- The Humanities
 - Societies and Cultures
 - Philosophies and Religions
 - Politics and Law

The rules of the game--of the natural world

How we learn and discover those rules -- the process
of science

SCIENCE WITHOUT WALLS:

Science in YOUR World

Channel 9 Sundays 9:30--11:00pm

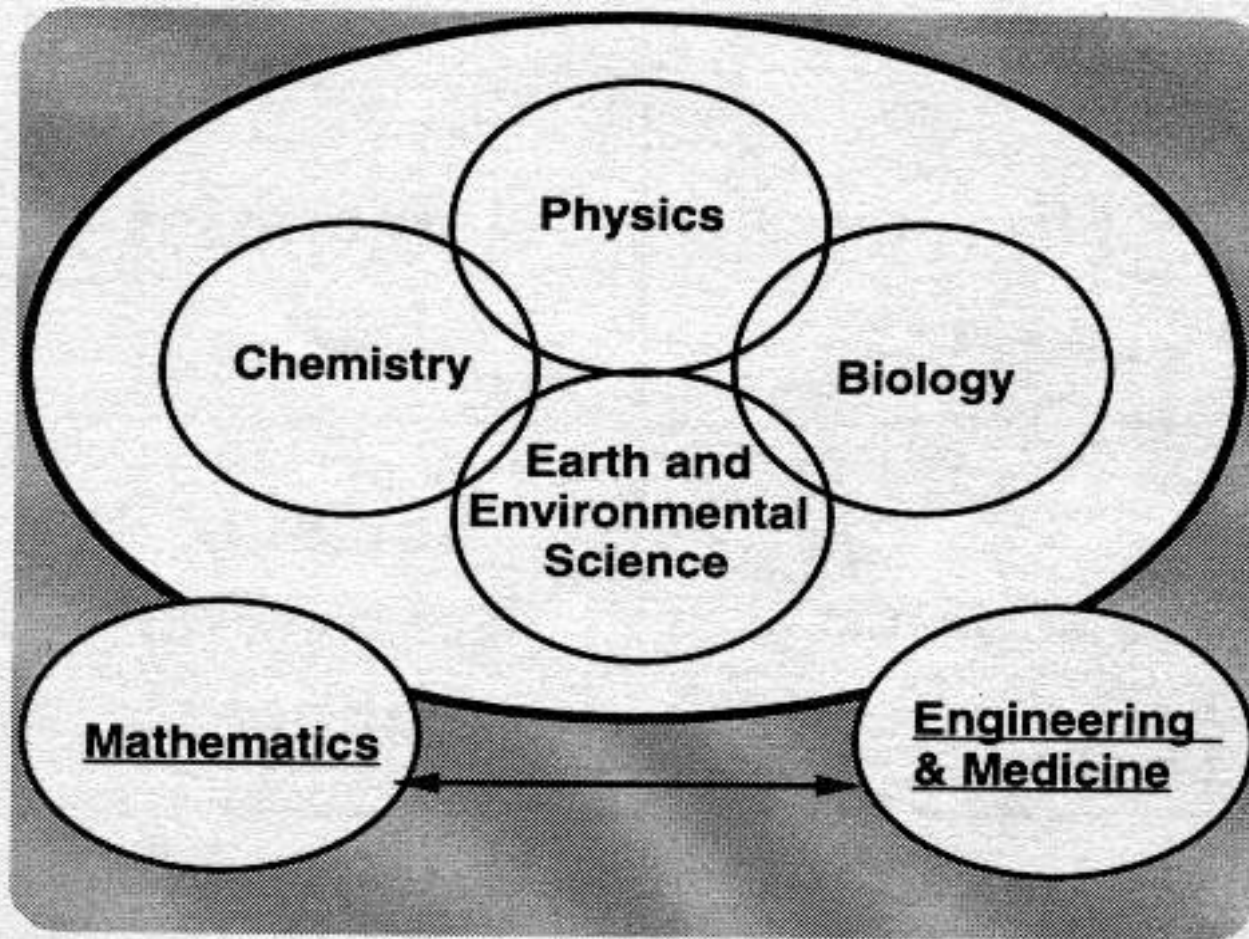


Figure 1-3 *The basic sciences plus the applied sciences.*

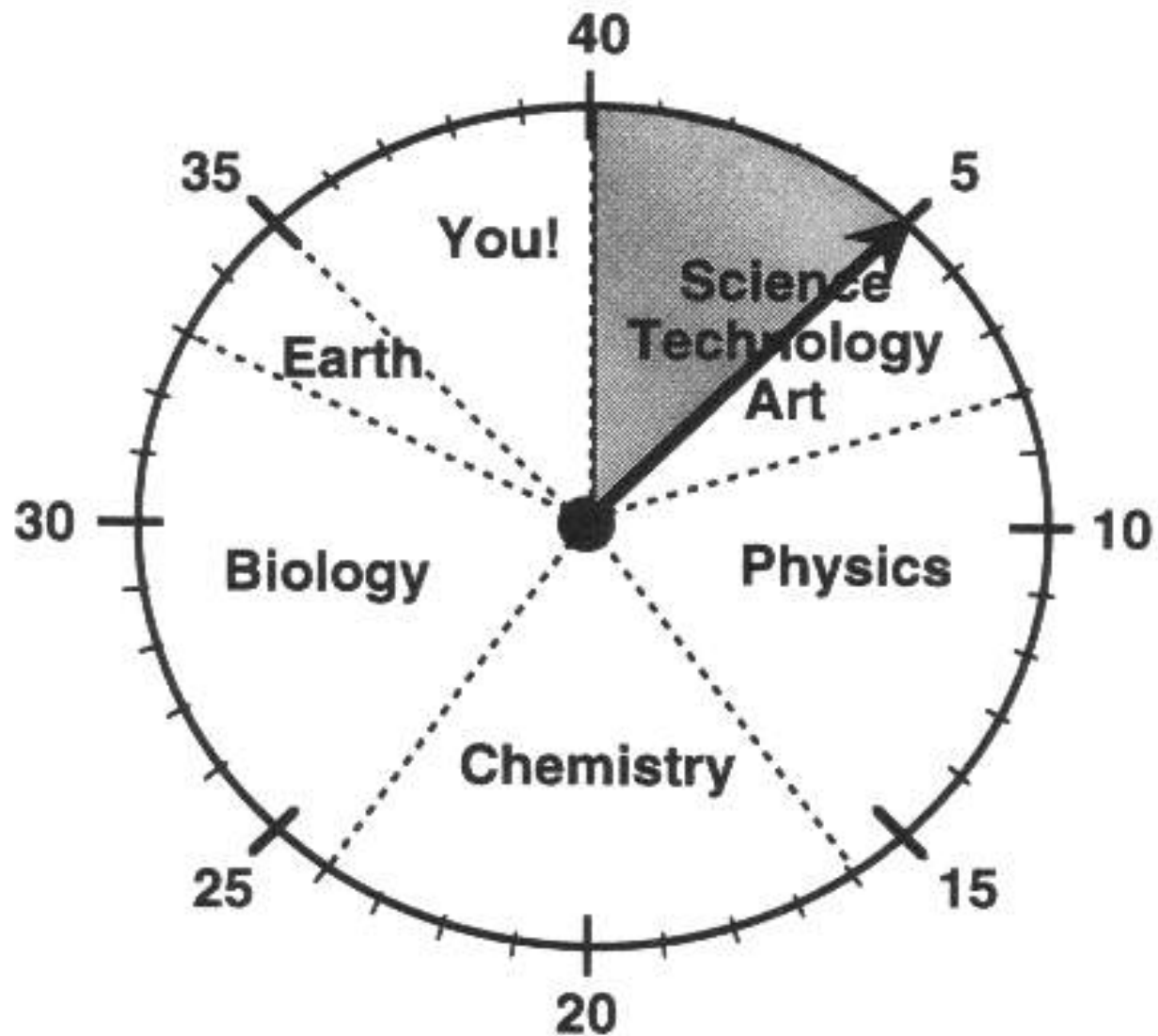
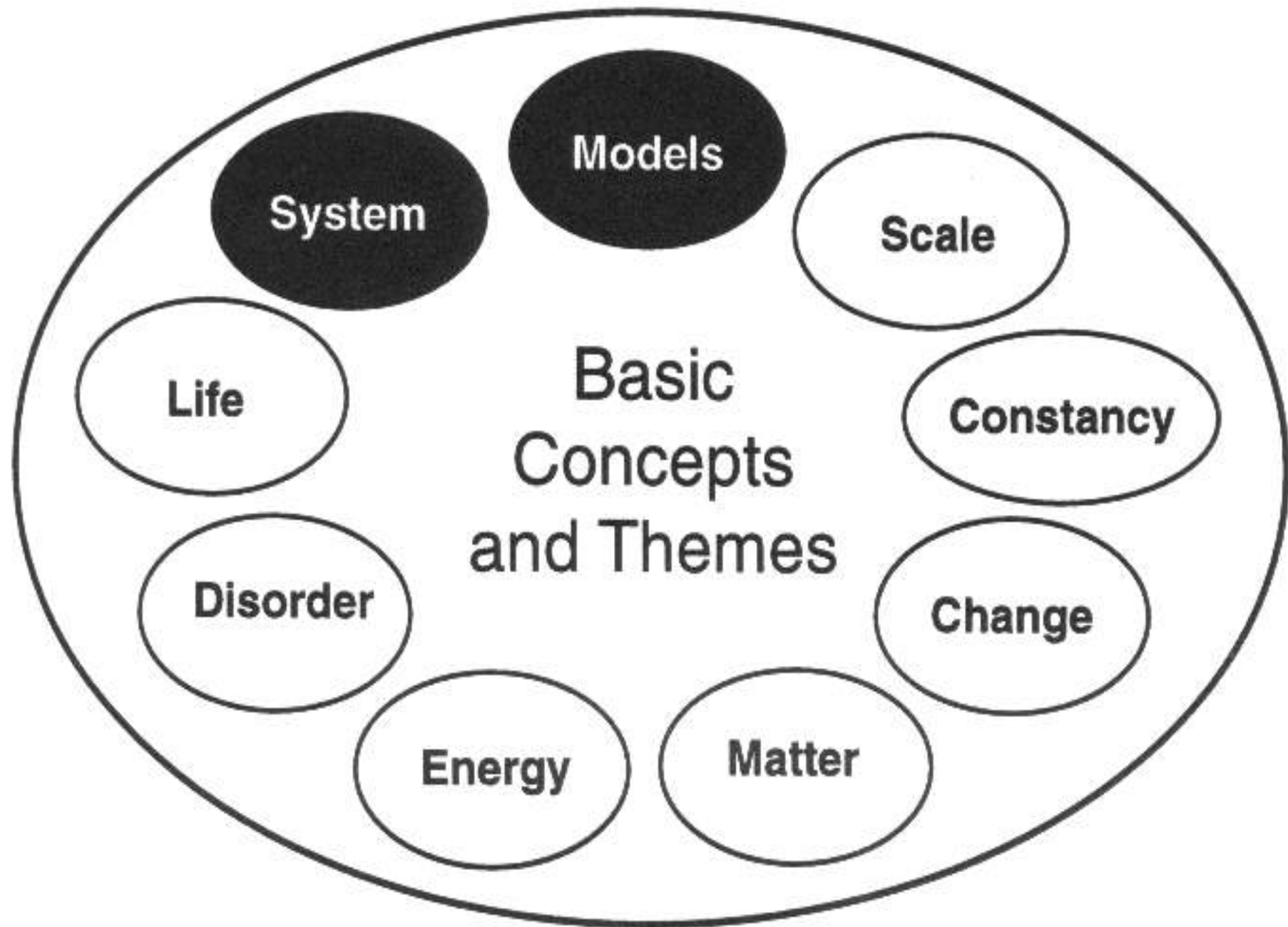


Figure 5-1 *You have already covered ten percent of the book!*



System

Models

Scale

Life

**Basic
Concepts
and Themes**

Constancy

Disorder

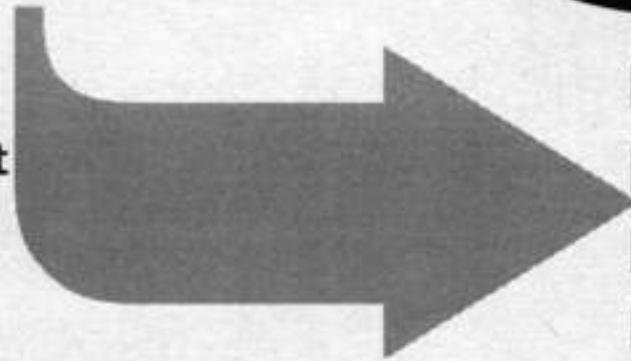
Change

Energy

Matter

FIRST:

- ▶ Question
- ▶ Experiment
- ▶ Observe
- ▶ Analyze



THEN:

- ▶ Revise Question
- ▶ Revise Experiment
- ▶ Analyze
- ▶ Conclude
- ▶ and then try again!

Figure 1-8 *The Scientific Method.*

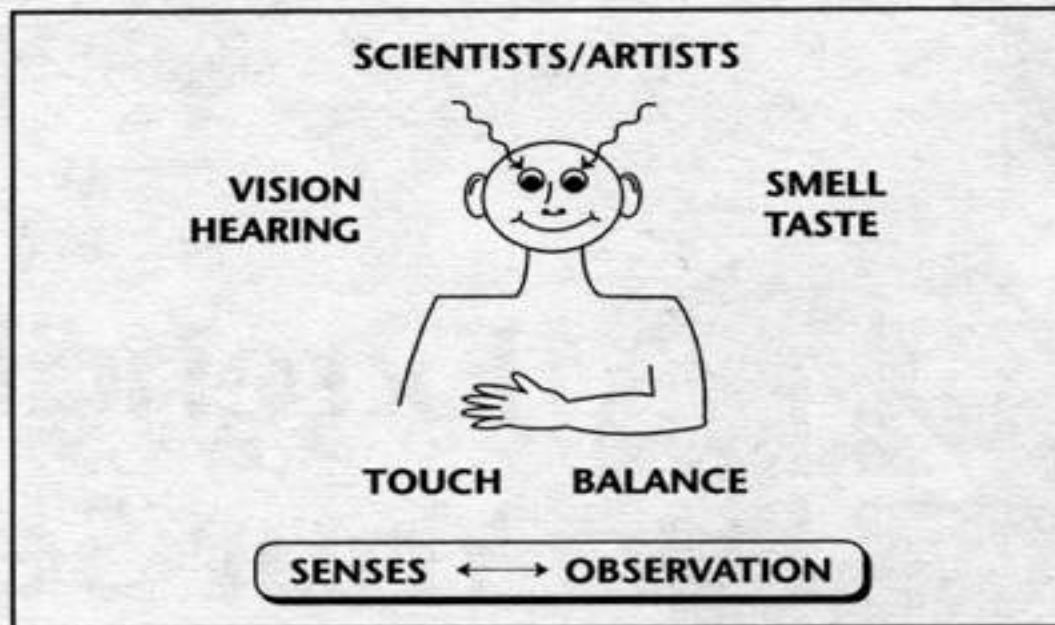


Figure 4-2 *Your senses again. By now you are pretty skeptical of their objectivity and you know their limitations. In this chapter we begin to develop and use tools which can extend and expand those senses.*

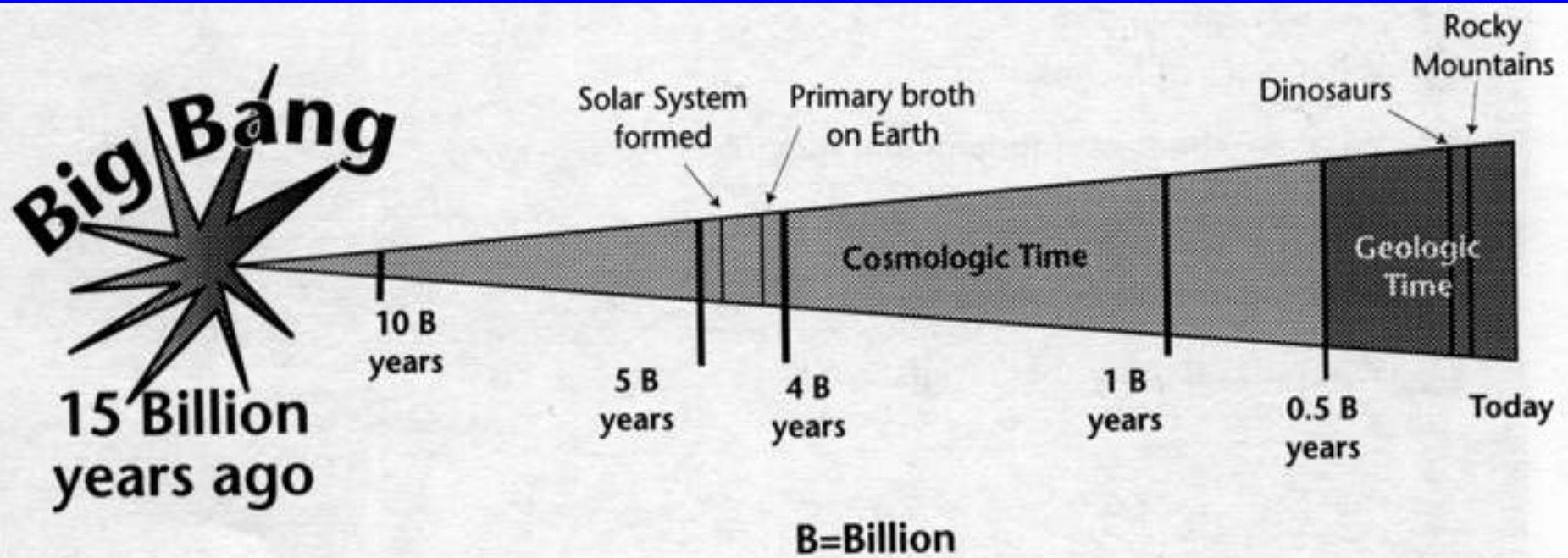


Figure 3-1 The scientist's time frame begins with the creation of our known universe, roughly 15 billion years ago. Not too many people worry about what happened before then. Lots of people don't worry about what happened before the earth was formed, perhaps five billion years ago. Some scientists like to focus on more modern events, perhaps the last hundred million years. If you are only interested in your immediate ancestors, then your time frame can shorten to a million years or so.

Rules: Physics

CONSERVATION OF ENERGY:

Energy can neither be
created nor destroyed.
(But it *can* be transformed!)

Figure 8-4 One of the basic conservation laws of physics is conservation of energy. Although we can transform energy from various forms to other forms, we cannot create it from scratch, or completely get rid of it. Conservation of mass is the other great conservation law. Yes, if we deal with nuclear processes, with fission or fusion, matter and energy can indeed be converted from one to the other. To be completely general, we should say it is mass plus energy which is conserved. In your everyday world, outside of nuclear reactors and stars, we can treat matter and energy separately, and they are each independently conserved.

Our only Non-Conservation Law:

ENTROPY

Disorder *always* increases.

Figure 8-7 Our only non-conservation law. Disorder always increases. Since scientists like to have a name for everything, we call that disorder entropy.

The 2 Key Laws of Thermodynamics:

- ▶ Conservation of Energy
- ▶ Production of Entropy

Figure 8-8 Thermodynamics is one of the fields of physics and chemistry and biology. The two key laws and principles on which thermodynamics is based are conservation of energy and production of entropy.

Laws of Thermodynamics

- Energy is Conserved.
- Entropy is Maximized.
- You can't achieve Zero Energy.

Figure 11-13 The three laws of thermodynamics.

Informal Laws of Thermodynamics

- You can't get something for nothing
- You can never break even
- You can't get there from here

Figure 11-14 The more popular (and probably most easily remembered) laws of thermodynamics.

Newton's Laws of Motion:

1. Inertia
2. $a = F/m$; $F = ma$
3. Action/Reaction

Figure 11-4 Newton's three laws of motion. The first is inertia; the second is $F = ma$, which he really figured out from his considerations of gravity; and the third is action/reaction, or "all forces come in pairs."

Newton's Laws, rephrased:

1. Things will keep doing what they're doing unless they're bothered.
2. Things change what they're doing based on how much they're bothered.
3. When things are pushed, they push back.

Figure 11-6 A more everyday way of expressing Newton's Laws.

Conservation Laws

from Newton's Laws of Motion

- Conservation of Mass
- Conservation of Linear Momentum
- Conservation of Angular Momentum
- Conservation of Energy

Figure 11-7 The Conservation Laws that are a consequence of Newton's Laws of Motion.

Uncertainty Principle

"The intrinsic graininess of things means there's a graininess to the accuracy with which we can measure things."

Figure 16-18 A restatement of the uncertainty principle. (Morrison, Nothing is Too Wonderful to Be True)

Tip	Scientific Reason
Be Alert	Reaction Time (Biology)
Safe Speed	Kinetic Energy (Physics)
Safe Distance (Don't tailgate!)	Reaction Distances (Biology & Physics)
Anticipate	Energy Efficiency (Chemistry); Stopping Times (Physics)
Safe and Tuned Vehicle	Common Sense (Biology); Energy Efficiency (Physics)
1 for 3 Savings Plan!	Realistic Cost (Earth Science)

Figure 36-14 *Science-based driving tips.*

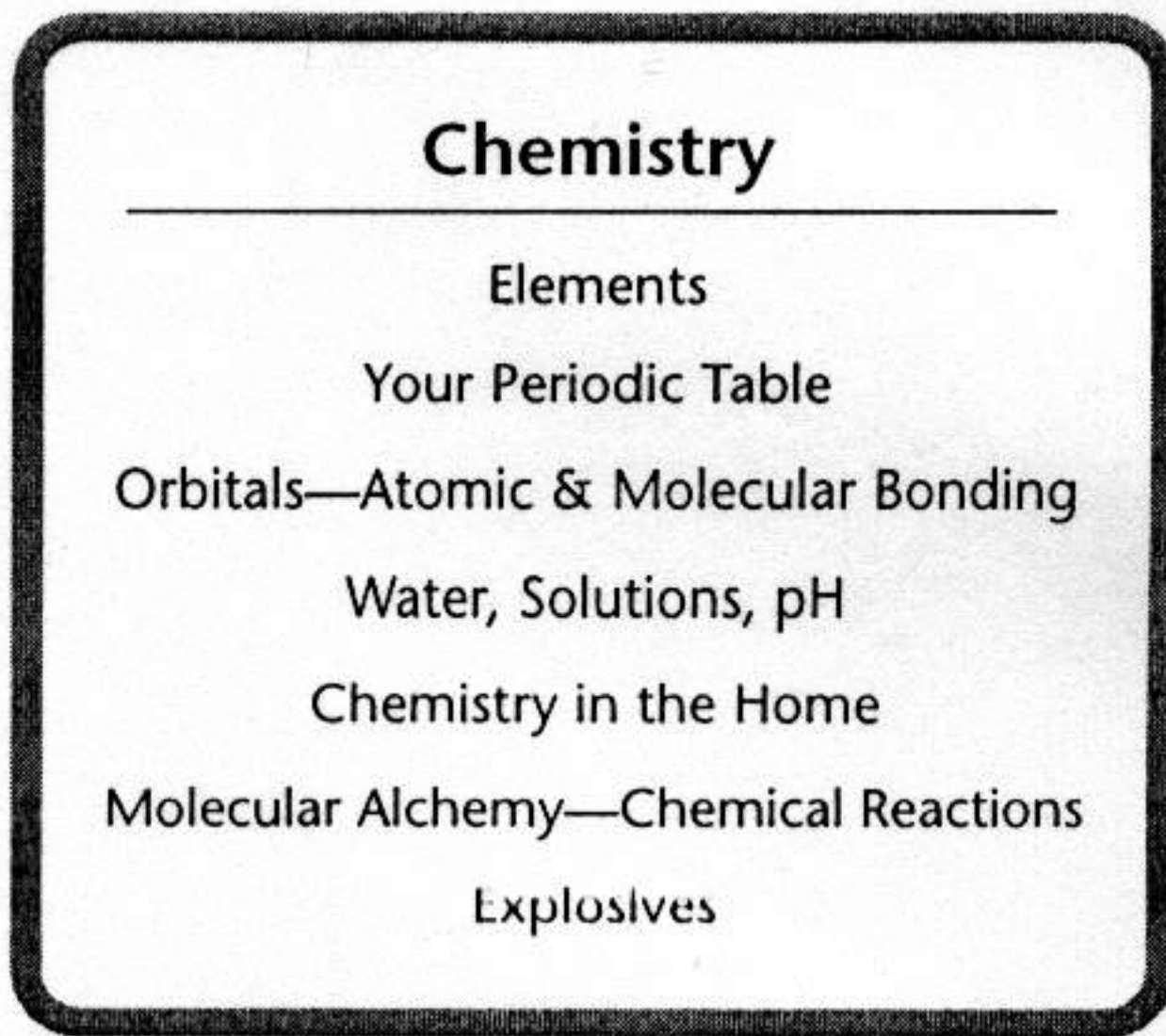


Figure 24-23 *Key topics of chemistry.*

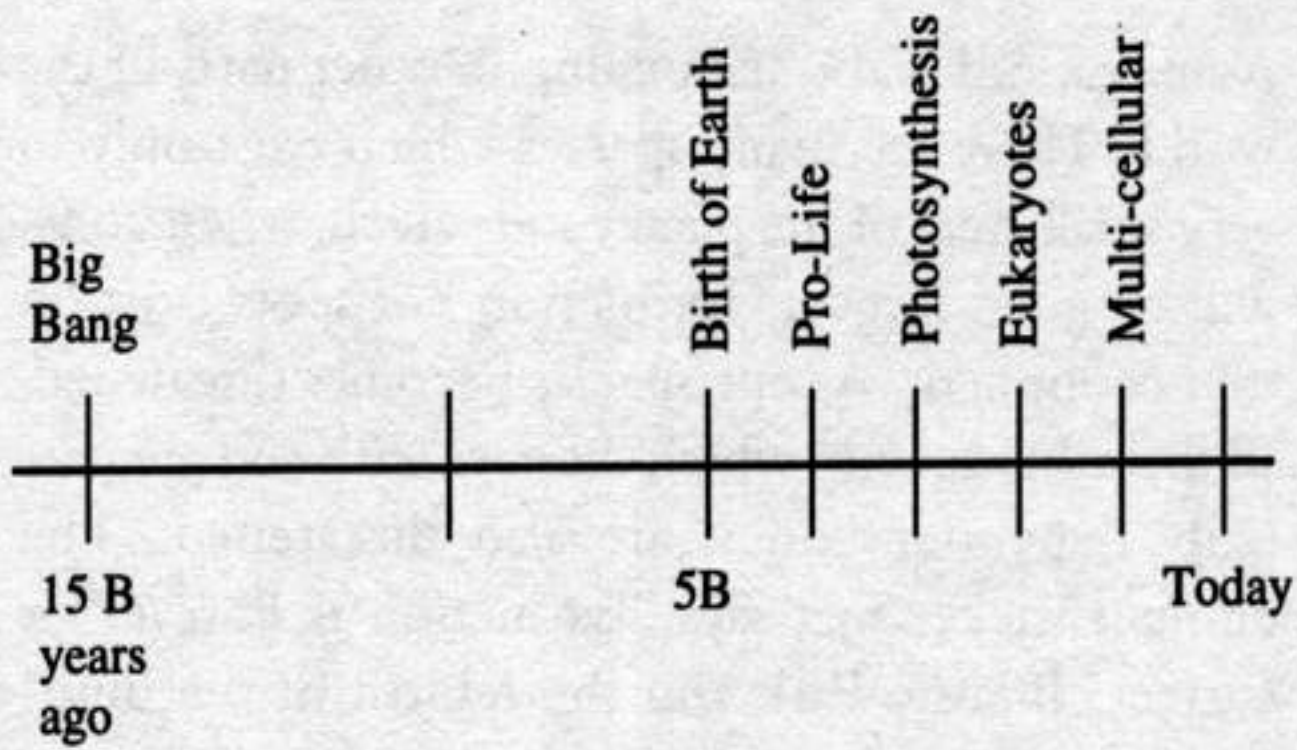


Figure 26-13 *A very rough clock! In billions of years.*

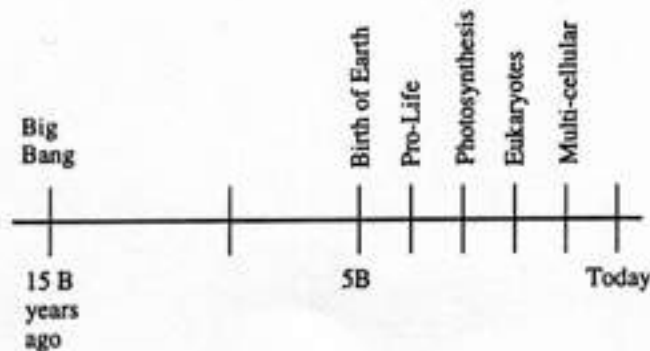


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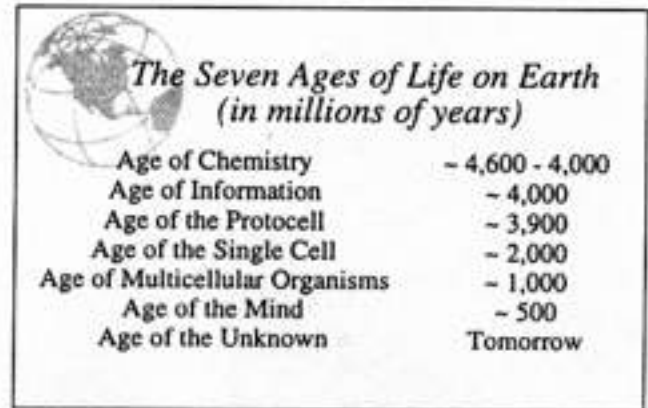


Figure 27-3 The seven ages of life, from de Duve's book.

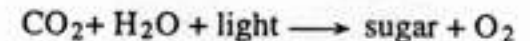
Five Kingdoms

- Monera Prokaryotes: Bacteria
- Protoctista .. Eukaryotes:
Mainly single cell protists
- Fungi Multi-celled Eukaryotes:
Mainly molds & mushrooms
- Animalia Multi-celled Eukaryotes:
The Animals
- Plantae Multi-celled Eukaryotes:
Green Plants

Figure 26-5 A summary of the Five Kingdoms.

Bioenergetics

Photosynthesis:



Respiration:



Figure 29-1 Bioenergetics is that part of biology and biochemistry which deals with transformations of energy. There are two major fields of bioenergetics: photosynthesis, which produces oxygen and "fuels," and respiration, which produces CO₂ and water.

Rules and Principles

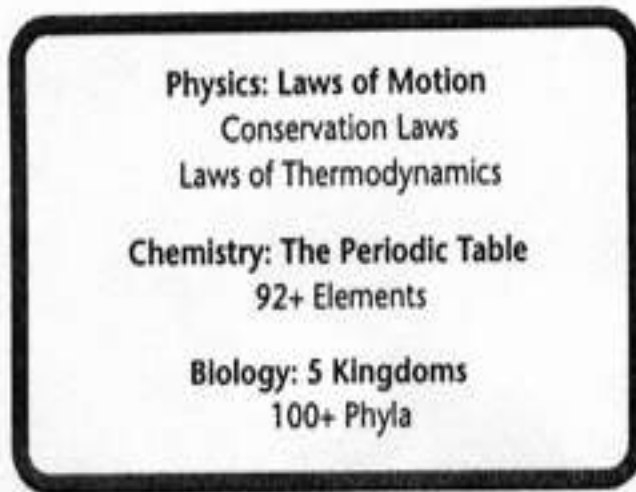


Figure 26-4 Basic facts of the three basic sciences.

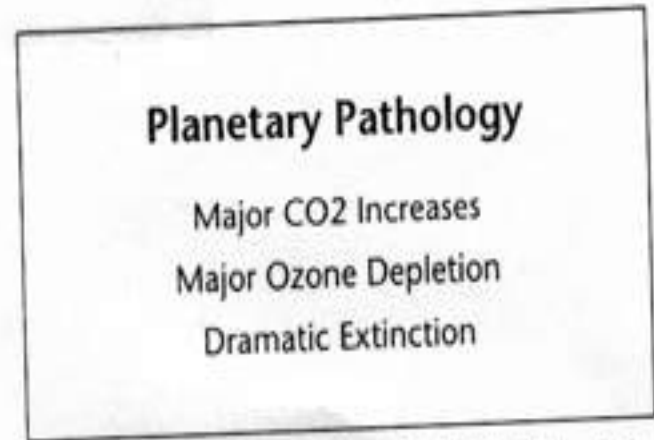
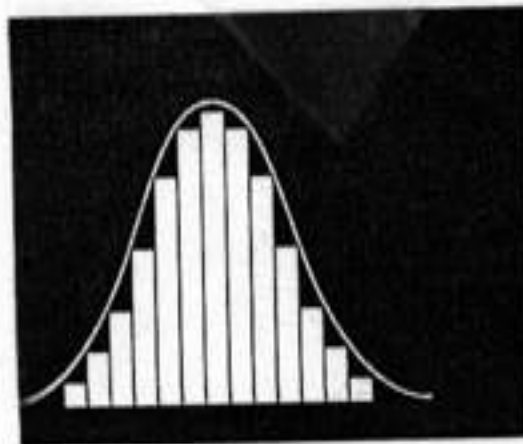


Figure 40-8 Planetary pathologies learned by—and caused by—Homo sapiens.



10 The bell curve again

And now to some video examples of Science without Walls:
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