And most of this evidence is quantifiable. What’s that mean? Here comes the math!

- Check this out as a good intro to the statistics which are now more of and AP objective than ever.

- [http://www.shodor.org/interactivate/activities/Measures/](http://www.shodor.org/interactivate/activities/Measures/)
In some ways, despite what certain chemistry teachers will tell you, biology is the most demanding of all sciences, partly because living systems are so complex and partly because biology is a multidisciplinary science that requires a knowledge of chemistry, physics, and mathematics.

Biology is also the science most connected to the humanities and social sciences. There aren’t many poems written about polyatomic ions or force vectors.
AP THEMES

• The AP program mixes, matches and combines the themes from different textbooks into these four, which they now call “Big Ideas”

1. The diversity and unity of life can be explained by the process of evolution.

   A. This is the main theme in the study of life.

   B. The process of evolution is driven by the process of Natural Selection.
2. Living systems have multiple mechanisms to store, retrieve and transmit information.

A. This deals mainly with DNA in cells and all the ways information is perceived and transmitted in organisms. For example – see a baseball, hit a baseball, tell someone about it.
3. Interdependent relationships characterize biological systems, and these interactions give rise to emergent properties.

A. All sorts of systems, involving everything from very small particles to very large continents are operating in the universe.
4. Biological systems utilize energy and molecular building blocks to grow, reproduce and maintain homeostasis.

A. This involves things like how plants use sunlight and how we use food like a car uses gas as well as how we keep things like body temperature and blood sugar from getting too high or low.
Each level of biological organization has emergent properties

- Life’s basic characteristic is a high degree of order.
- Biological organization is based on a hierarchy of structural levels, each building on the levels below.
  - At the lowest level are atoms that are ordered into complex biological molecules.
  - Many molecules are arranged into minute structure called organelles, which are the components of cells.
• Multicellular organisms exhibit three major structural levels above the cell: similar cells are grouped into tissues, several tissues coordinate to form organs, and several organs form an organ system.
• Organisms belong to populations, localized group of organisms belonging to the same species.

• Populations of several species in the same area comprise a biological community.

• These populations interact with their physical environment to form an ecosystem.

Fig. 1.2(6)
• Novel properties emerge at each step upward in the biological hierarchy.

• These emergent properties result from interactions between components.

• A cell is certainly much more than a bag of molecules.
Organisms are open systems that interact continuously with their environments

- Organisms exist as open systems that exchange energy and materials with their surroundings.
  - The roots of a tree absorb water and nutrients from the soil.
  - The leaves absorb carbon dioxide from the air and capture the energy of light to drive photosynthesis.
  - The tree releases oxygen to its surroundings and modifies soil.
- Both an organism and its environment are affected by the interactions between them.
The dynamics of any ecosystem includes the cycling of nutrients and the flow of energy.

Minerals acquired by plants will be returned to soil by microorganisms that decompose leaf litter, dead roots and other organic debris.

Energy flow proceeds from sunlight to photosynthetic organisms (producers) to organisms that feed on plants (consumers).

Fig. 1.7
1. Regulatory mechanisms ensure a dynamic balance in living systems

- Checks and balances exist both within living organisms and within ecosystems. The state of dynamic equilibrium is essential for the continuity of life.

- Common examples are the interactions between predator and prey that regulate the populations of each, and the regulation of temperature in vertebrates like you.
Negative-feedback systems are often involved in the maintenance of equilibrium within an organism.

- A “thermostat” in the brain controls processes that holds the temperature of the blood at a set point.

- When temperature rises above the set point, an evaporative cooling system cools the blood until it reaches the set point at which the system is turned off.

- If temperature drops below the set point, the brain’s control center inactivates the cooling systems and constricts blood to the core, reducing heat loss.

- This steady-state regulation, keeping an internal factor within narrow limits, is called **homeostasis**.
4. Structure and function are correlated at all levels of biological organization

- How a device works is correlated with its structure - form fits function.
- Analyzing a biological structure gives us clues about what it does and how it works.
- Alternatively, knowing the function of a structure provides insight into its construction.
- This is true of sub-atomic particles and huge body parts like an elephant’s trunk.
Structure & Function are related even in the South.

- Even in inanimate objects we can see how their structure allows for them to perform certain functions.
These books are here for an essential structural purpose. They are not for sale.
Warning!!!!!

• Look what happened when a young Mr. Speziale ignored the relationship of structure to function in 5th grade science class…
3. Universality Versus Diversity

- Diversity is a hallmark of life.
  - At present, biologists have identified and named about 1.5 million species.
    - This includes over 280,000 plants, almost 50,000 vertebrates, and over 750,000 insects.
    - Thousands of newly identified species are added each year.
  - Estimates of the total diversity of life range from about 5 million to over 30 million species.
• Underlying the diversity of life is a striking unity, especially at the lower levels of organization.

• The universal genetic language of DNA unites prokaryotes, like bacteria, with eukaryotes, like humans.

• Among eukaryotes, unity is evident in many details of cell structure.

Fig. 1.12
The history of life is a saga of a restless Earth billions of years old, inhabited by a changing cast of living forms.

- This cast is revealed through fossils and other evidence.

Life evolves.

- Each species is one twig on a branching tree of life extending back through ancestral species.

Fig. 1.13
• Species that are very similar share a common ancestor that represents a relatively recent branch point on the tree of life.

• Brown bears and polar bears share a recent common ancestor.

• Both bears are also related through older common ancestors to other organisms.

• The presence of hair and milk-producing mammary glands indicates that bears are related to other mammals.

• Similarities in cellular structure, like cilia, indicate a common ancestor for all eukaryotes.

• All life is connected through evolution.
Charles Darwin brought biology into focus in 1859 when he presented two main concepts in *The Origin of Species*.

The first was that contemporary species arose from a succession of ancestors through “descent with modification” (evolution).

The second was that the mechanism of evolution is natural selection.
Natural selection, by its cumulative effects over vast spans of time, can produce new species from ancestral species.

- For example, a population may be fragmented into several isolated populations in different environments.
- What began as one species could gradually diversify into many species, like the brown bears and polar bears.
- Each isolated population would adapt over many generations to different environmental problems.
• Thus Darwin’s idea of descent with modification accounts for both the unity and diversity of life.
  • In many cases, similarities among species are due to their descent from a common ancestor.
  • Differences are due to modifications by natural selection modifying the ancestral equipment in different environments.
• Evolution is the core theme of biology - a unifying thread that ties biology together.
• The observations of discovery science lead to further questions and the search for additional explanations via the scientific method.

• The scientific method consists of a series of steps.
  • Few scientists adhere rigidly to this prescription, but at its heart the scientific method employs hypothetico-deductive reasoning.

Fig. 1.19
• Scientific theories are not the only way of “knowing nature”.

• Various religions present diverse legends that tell of a supernatural creation of Earth and its life.

• Science and religion are two very different ways of trying to make sense of nature.

• Art is another way.
Science can be distinguished from other styles of inquiry by

- (1) a dependence on observations and measurements that others can verify, and
- (2) the requirement that ideas (hypotheses and theories) are testable by observations and experiments that others can repeat.

The different ways of knowing things are neither right or wrong, they are just different, but the process of science is the best way we humans have come up with to understand the most likely explanations for how things in our universe work.