Basic Concepts of Biology

I. Definitions
   A. Biology (G. bios = “life: + logos = “study of”)
   B. Science (L. –“to know”)

II. Characteristics that Define Life
   A. Cellular Organization
   B. Metabolic Activity
      1. Physics of Energy - 1st Law of Thermodynamics
         2nd Law of Thermodynamics
      2. Classification of Living Things (based on energy use)
         - Autotroph
         - Heterotroph
   C. Irritability (responsiveness)
      1. Homeostasis
   D. Growth and Reproduction
      1. Growth
      2. Reproduction
   E. Life Evolves
      1. Three major reasons:
         a. Sexual Reproduction
         b. Mutation
         c. Natural Selection

III. Levels of Organization
    1. biosphere
    2. ecosystem
    3. community
    4. population
    5. multicellular organism
    6. organ system
    7. organ
    8. tissue
    9. cell
      - smallest structural and functional unit of life
    10. organelle
    11. molecule
    12. atom
    13. subatomic particle

largest

smallest
IV. Scientific Inquiry
A. Essential characteristics of science:
   1. it is guided by natural law & must be explainable by reference to natural law
   2. it is testable against the empirical (observable) world & is falsifiable
   3. all conclusions are tentative

B. Scientific method: accepted process of scientific inquiry
   1. Observe - observations often lead to questions (i.e. How can I explain what I observed?)
   2. Hypothesize - think up one or more hypothesis (an “educated guess”) to explain your observations (a hypothesis is often presented as a prediction of a cause and effect outcome)
   3. Experiment - test which hypotheses are most likely incorrect (unsupported) (note: the scientific method cannot “prove” that any one hypothesis out of many is correct - it can only provide support or rule out incorrect hypotheses)
      - Experimental Design: test only one causative factor (independent variable) at a time
      Variables:
      independent = “cause” - factor that is manipulated
      dependent = “effect” - factor that is affected and measured
      control - factors that must be held constant or controlled. This is often accomplished by comparing an experimental group (where the independent variable is manipulated) to a control group (where the independent variable is not manipulated)
   4. Asses the data that is acquired from experimentation
   5. Repeat

A hypothesis that is supported by lots of experimental evidence (it repeatedly cannot be rejected) is raised to the level of "theory". A theory is an idea or explanation that is so well supported that it is accepted as truth (although with future evidence it may be rejected)

Note: Science is NOT so much an accumulation of Facts, but rather, it is more a set of tentative answers to questions.

VII. Additional Selected Key Terms (FYI)
cell DNA energy evolution homeostasis hypothesis
macromolecule natural selection theory
Study Questions – Basic Concepts of Biology:

1. Define Biology.
2. Define Science.
3. What are the characteristics that define life? Describe each characteristic in some detail and explain how these characteristics might be recognized. Using these characteristics, is fire alive?
4. Define the first and second laws of thermodynamics.
5. Describe the different ways in which organisms may be classified based on energy use.
6. Describe homeostasis. What exactly is homeostasis?
7. Compare and contrast growth and reproduction.
8. What are the major factors cause life to evolve.
9. What is the scientific method? Explain each of the steps of the scientific method.
10. What is a hypothesis? What are characteristics of a good hypothesis?
11. Compare and contrast independent and dependent variables.
12. What is a “control group” and how is it different from an “experimental group”?
13. What is the difference between a hypothesis, conclusion, theory, and law?
14. Can an experiment prove a hypothesis to be true?
15. Is science an accumulation of facts? If not, then what is Science and how can I believe anything I learn?

“If I have seen farther than others it is because I have stood on the shoulders of giants”

Sir Isaac Newton