Biology 143

Science, Biology

Chapter 1. The science of Biology Outline: 1. Properties of life 2. Science a. Scientific Reasoning/method b. Experimental controls 3. Intro to Evolution a. Charles Darwin b. Malthus c. Natural selection d. Examples of evolution 4. Evidence for evolution Terms: Biology: Scientific study of living organisms and how they evolved. Science: Knowledge derived from observation and experimentation carried out to determine the principles underlying what is being studied. Hypothesis: A suggested explanation that accounts for the observations Experiment: Test of a hypothesis Variable: An influencing factor Theory: A proposed explanation for some natural phenomenon, often based on a general principle. In Science, a theory is on solid ground, well tested, and widely accepted. An accepted principle or body of knowledge. Control experiment: An experiment where the variable in question is left unaltered Evolution: Operation of natural laws that produce change over time. The process of change in living organisms. Natural selection: Differential reproduction under natural conditions. Differential contribution of genotypes to the gene pool of the next generation under natural conditions. Characteristics of life: 1. Order: All organisms consist of one or more cells with highly ordered structure. Atoms to molecules to organelles to cells and cells to tissues to organs to organisms to populations to species to community to ecosystem 2. Sensitivity: All organisms respond to stimuli. 3. Growth, Development, and Reproduction: All organisms are capable of growing and reproducing. Reproduction is carried out using hereditary molecules (DNA, RNA) ensuring the offspring are the same species. 4. Regulation: All organisms have internal mechanism that coordinates the organism internal functions. 5. Homeostasis: All organisms maintain constant

internal conditions different from their environment. 6. Evolutionary Adaptation: All organisms are subject to evolutionary forces Scientific Method: Inductive reasoning vs. deductive reasoning: 1. Inductive reasoning: Using specific observations to construct general scientific principles 2. Deductive reasoning: Using general principles of predict specific results. Both are used in science, deductive reasoning is used to test the validity of general principles. Inductive reasoning is used to come up with the underlying explanations Observations (Hypothesis (Experiment Basic Scientific method 1. Observations a. Some phenomenon is observed 2. Formation of a hypothesis a. The hypothesis is a potential explanation for the observations b. The hypothesis needs to be testable 3. Experimentation a. Design a controlled experiment to test the hypothesis b. In a controlled experiment only one variable is manipulated. c. Only changing one variable ensures that any changed can be attributed to the variable 4. Results a. Support hypothesis b. Do not support hypothesis Hopefully the scientist publishes results in a good journal. Theory: Scientific usage vs. popular usage In science, when a concept is called a “ theory", it is a well accepted, well tested, ex theory of gravity, or theory of evolution. In popular usage, a “ theory" is basically a guess; ex I have a theory that Colonel mustard committed the murder with the candlestick. In science a hypothesis becomes a theory only after lots of rigorous experimental confirmation. Darwin and Evolution: Charles Darwin (1809-1882) was an English naturalist who after years of observation wrote a very famous book. The book had the rather long title of: On the Origins of species by means of Natural Selection, or the preservation of favored races in the struggle for life. Often this shortened to

the “ Origin of Species". Basically it spelled out how natural selection was the evolutionary mechanism that produced the diversity of life on earth. Darwin’s story: Before Darwin people thought the world was only a few thousand years old, and that God had created individual species and they were fixed and unchangeable. Darwin believed this when he stepped onto the deck of the Beagle in 1831. Geologist Charles Lyell (1797-1875) wrote Principles of Geology (1830), Darwin read this book while on the ship. It portrayed a world that was full of new species and extinction that challenged the concept of an earth that is only a few thousand years old and the idea that species are fixed in time. Lyell’s work did not prove that the earth was old, but it presented compelling evidence that is had to be older than 6000 years. The actual age of the earth is 4. 5 billion years. In 1831 He was sent out on a 5-year voyage on the HMS Beagle, the ship would be mapping the South American coast and Darwin was the ship’s naturalist. He made several stops along the way, one stop in particular was in the Galapagos islands. Darwin almost didn’t get the job of naturalist, apparently the ship’s captain didn’t think Darwin’s nose looked right (I’m not kidding). It was only much later in 1859 when he finally published his book. Another naturalist named Alfred Wallace independently developed a similar theory and Darwin and Wallace jointly presented their findings. Malthus influenced both Darwin and Wallace. Thomas Malthus wrote an essay about populations. In his essay he pointed out that population increase in size geometrically, but resources only increase arithmetically. [pic] Clearly a population produces more offspring than the environment can sustain. Darwin and Wallace were search for an explanation to what limits population size. The idea they hit on was that only

best, most well adapted individuals survive and reproduce. Hence the term “ survival of the fittest". This force would also cause a population to change overtime since not all of the organisms would reproduce. The genes of the survivors would be passed on and the gene of the others would be lost. As expected the publication Darwin book caused lots of controversy. Darwin went on the write a book entitled “ Descent of Man" where he applied the concept of natural selection of human evolution. This was even more controversial. Despite the initial debate in the scientific community, the concept of evolution caught on quickly and by the end of the 1860’s, evolution was well accepted, (in the scientific community). Evolution After Darwin Darwin died in 1882, since then there have been many developments that have added support to Darwin’s concepts Fossils: Today’s fossil record is much more complete than in Darwin’s time. The earliest fossil date back 3. 5 billion years. Transitional forms have been found, clearly showing the path of evolution. The fossil record is not complete but t Age of the Earth: The earth has be shown to be about 4. 5 billion years old not a few thousand. Darwin realized that evolution would take time, but he didn’t have clear idea of the age of the earth. Genetics/Heredity: In Darwin’s day, nothing was known about heredity or genes. Genetics became established after his death. Comparative Anatomy: these studies provide strong support for evolution, these help to sort out evolutionary relationships. Homologous structures have a common evolutionary origin but have a different function (hand bones in a human, bat, and dolphins) Analogous structures have a similar function but have different evolutionary origins (bird wings vs. bumblebee wings) Molecular Biology: DNA sequencing has lead to huge advances in

evolutionary biology Developmental Biology: Studies of developmental stages of embryos has yielded clues about the evolutionary history is that species. ---------- Population growth Resource growth 1. Selection against blue caterpillars 2. Green caterpillars survive and reproduce more than blue ones 3. Green caterpillars make up a larger proportion of the population in successive generations 4. Differential reproduction produces genetic change in the population Green caterpillars survive and reproduce more than blue ones 5. Green caterpillars make up a larger proportion of the population in successive generations 6. Differential reproduction produces genetic change in the population