Biology 4415 Name (yours:) _____

# Exam 1

**1.** Fill in the blanks! Fill in the blanks! Use one letter per blank. When you're done, the ***first letters of each word***, read downwards, will give you the answer to this question:

Charles Darwin's grandfather was interested in "spontaneous generation" (the possibility of life coming from non-living things). The story goes that he did chemical experiments on pieces of pasta, and actually got a noodle to move around under its own power. This is probably untrue—but the story inspired an English author to write a novel about a scientist who created a living being in his lab. What is the title of the novel? (15 pts. total)

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|---|---|
| __ | This letter is used to represent the probability that two alleles are homozygous by descent |
| __ __ **Y** | John __ (1628-1705) was an English naturalist |
| __ __ __ __ __ __ **S** | Different forms of a gene at one locus |
| __ __ __ __ __ __ __ __ __ **I** __ __ | Theory formed by the fusion of natural selection with Mendelian genetics |
| __ __ __ __ **I** __ | Physicist who claimed that the Earth was too young for natural selection to produce significant results |
| __ __ __ __ __ __ __ __ __ **T** __ | Type of "society" found among bees, ants, mole rats, etc. |
| __ __ __ __ __ __ **L** __ __ __ __ __ | Linnaeus devised a system of binomial _____. |
| __ __ __ __ __ __ **I** __ __ | "Alternative" theory of new species originating in sudden jumps or bursts |
| __ __ __ __ __ **O** __ __ | "Natural ___" was the search for evidence of God and his goodness by looking at his creation |
| __ **V** __ __ __ __ __ __ __ | Darwin himself preferred the term "descent with modification" for this theory. . . |
| __ __ __ __ __ __ **D** __ __ __ | Causes increased homozygosity in populations |
| __ **O** | Have you ever had a better class in all your life? |

. . . and the title of Mary Shelley's famous novel is

"__ __ __ __ __ __ __ __ __ __ __ __ __ "

**2.** True story: In 1912, the geneticist W. H. Goddard suggested that feeble-mindedness was caused by Mendelian inheritance at a single locus with two alleles. Persons homozygous for the recessive, feeble-minded allele (call it **f**) were dopes, dummies, dweebs, dorks, and dimwits—"incapable of managing their affairs with ordinary prudence", as Goddard said. Heterozygotes (**Ff**) and homozygous dominants (**FF**) were of normal intelligence. *This is not actually true*—the genetic basis for human intelligence is a far, far more complex and controversial issue, to say the least—but pretend that it is, for the purposes of working this problem. (25 pts. total)

**a)** According to the 1910 census, the population of the United Stetes was 91,972,266. Goddard estimated that 1% of the population was feeble-minded. Assume that the population of the US was in Hardy-Weinberg equilibrium. Calculate the allele frequencies, and then calculate the percentages of the population that would be heterozygous and homozygous dominant. (5 pts.)

**b)** At one time or another, thirty states had laws mandating the compulsory surgical sterilization of the feebleminded. (As of 1996, Arkansas and nine other states still *did* have such a law on the books.)[1] There were organizations in the early 20th century that lobbied for their enactment nationwide.
Imagine that, in some alternate-reality USA, a mandatory, nationwide law really was put into effect that forced the sterilization of all feebleminded individuals. (Assume that the authorities were so efficient that they were able to track down and sterilize 90% of the feebleminded—and that they never, ever sterilized anyone who wasn't feebleminded.) What would be the frequencies of genotypes, and of alleles, after one generation? (10 pts. Show all work.)

**c)** Based on your results, write a paragraph or two discussing the practicality of *eugenics*. What is eugenics, and how effective is eugenics likely to be at achieving what its promoters wanted it to achieve? Leave moral/ethical arguments out of your answer—it's not that they're not important, but for the sake of brevity stick to issues of feasibility. (10 pts. Show all work.)

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[1] Adler, R. R. 1996. *Estate v. C.W.*: A pragmatic approach to the involuntary sterilization of the mentally disabled. *Nova Law Review* 20:1323-1368.

**3.** Based on what you have learned so far, discuss the following quote from a 1985 article in *Creation* magazine, published by Answers In Genesis Ministries.[2] By "discuss", I don't mean "just repeat what the quote says in slightly different words", or "tell me whether you agree or not." Read the quote carefully and critically, and in your answer, compare and contrast what it says with what you know from this class or other sources of information. (20 pts.)

> Most evolutionary scientists work on the rule of thumb that understanding the present is the key to understanding the past. This belief is called uniformitarianism. But some of the difficulties in applying this belief become obvious when it is noted that over the last thirty-five years, the amount of mud released by the Mississippi River into the Gulf of Mexico has dropped by more than half. While the river still discharges more sediment into the ocean than any other United States river, its sedimentary load is ranked now about sixth in the world. . . . Other rivers in the U.S.A. also add to the problems of the evolutionary uniformitarianists who want to believe that the present is the key to the past. In the year following the Mt. St. Helens eruption, the Cowlitz River in south west Washington, received one hundred and forty million tons of sediment. It now transports only thirty millions tons per year. This would mean that catastrophies [*sic*] are of far greater significance in the history of the world than normal uniform behaviour.

[2] "Uniformitarianism". Focus Articles for 1985, *Creation*. http://www.answersingenesis.org/docs/3001.asp

You may now select any two questions from the remaining six. Each is worth twenty points. Grammar, spelling, etc. all are important and will be graded.

**4.** Read the following quotation by a famous 19th-century American industrialist. What view does it take of natural selection and its applications? Why did such interpretations become popular at this time and place? (HINT: Think of the video "The Day the Universe Changed".)

> But, whether the law [of competition] be benign or not, we must say of it. . . : It is here; we cannot evade it; no substitutes for it have been found; and while the law may be sometimes hard for the individual, it is best for the race, because it insures the survival of the fittest in every department. We accept and welcome, therefore, as conditions to which we must accommodate ourselves, great inequality of environment, the concentration of business, industrial and commercial, in the hands of a few, and the law of competition between these, as being not only beneficial, but essential for the progress of the race.
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> —Andrew Carnegie. "Wealth." *North American Review*, 1889.

**5.** One interesting problem for evolutionary biology is how to explain menopause, the ending of a woman's childbearing years. One might predict that any mutation that shortened a woman's lifespan after menopause would not be selected against, since it couldn't affect the number of children born. By the same token, any mutation that lengthened the childbearing years, postponing or preventing menopause, might be selected for. Despite these theoretical arguments, women may live for several decades after ceasing to menstruate. Come up with two evolutionary hypotheses for why humans go through menopause, and briefly outline how they could be tested. (HINT: One hypothesis might have something to do with kin selection. . .)

**6.** Carl Baugh, proprietor of the Creation Evidences Museum in Glen Rose, Texas, claims in his 1992 book *Footprints and the Stones of Time* that geologists "date the fossils by the rocks and the rocks by the fossils." He calls this "circular reasoning" (it assumes as true what it supposedly sets out to prove as true) that gives no logical support for anyone to think that the Earth is more than a few thousand years old. Discuss his statement in light of your understanding of what geologists actually do.

**7.** Despite all the seeming evils of inbreeding, there actually are a number of plants and animals that usually or always engage in inbreeding—often the closest form of inbreeding possible, self-fertilization. Many insects and rotifers, some lizards, and many plants (including Mendel's favorite, garden peas) always self-fertilize. Under what circumstances—if any— would natural selection favor the evolution of frequent or obligatory inbreeding? What kinds of lifestyle and ecological niche would you expect an inbreeding species to have?

**8.** Sickle-cell anemia, common in parts of Africa, is caused by a single gene with (for our purposes) two alleles, H and S. HH individuals have normal hemoglobin and red blood cells; SS individuals have sickle-shaped cells and many associated health problems. HS individuals have a mild form of the disease but are also resistant to malaria.

**a)** In an African population, the frequency of the S allele has been measured at 0.13, and the fitnesses of the three genotypes have been estimated as: $w_{HH} = 0.8$, $w_{HS} = 1.0$, and $w_{SS}=0.2$. Calculate the mean fitness in this population, and then predict what the allele frequencies should be in the next generation.

**b)** It has been observed that in populations like this, despite there being strong natural selection imposed by lethal diseases, allele frequencies tend *not* to change from one generation to the next. Come up with an explanation for why this is the case. (HINT: The answer is *not* "mutation, migration, drift, random mating. . ."—it's not one of the Hardy-Weinberg equilibrium factors you probably memorized. It's something we haven't covered explicitly, but you should be able to figure it out.)

**Now answer the following questions:**

What has been the most interesting thing you've learned so far?

What has been the least interesting thing you've learned so far?

What has been the most effective thing that I've done so far?

What has been the least effective thing that I've done so far?

What suggestions do you have for the upcoming part of the course? (Answers such as "Just give me an A" or "Why don't you go jump off the TCBY Building, you vile Nicolae-Carpathia-loving heathen scuzzball" don't count.)