Preview Material for Final Exam
Fall 2004

Millions of years ago the Earth experienced the "Age of Dinosaurs", when these "terrible lizards" were our planet's most dominant reptilian species. According to the fossil record, their reign came to an abrupt end about 65 million years ago. Why did they become extinct so rapidly? In 1980, Luis Alvarez, a Nobel Laureate in physics, hypothesized that an asteroid at least 6 miles in diameter struck the Earth 65 million years ago, causing enormous dark clouds of ash and dust to permeate the atmosphere, blocking out most of the sunlight and subsequently cooling the Earth. Poor adaptation to the new climate presumably ended the long reign of the dinosaurs. Although controversial for a time, Alvarez's "asteroid impact hypothesis" gained more followers as a result of two discoveries in the Earth's crust:

1. a thin layer of 65 million year old iridium-rich rock known as the "K-T boundary". (Iridium is an element abundant in asteroids but rare in the Earth's crust.)
2. a fossil record revealing a greater biodiversity of species *below* the K-T boundary (deposited ***before*** the asteroid struck) than in the layer *above* it (deposited ***after*** the asteroid hit the Earth.) In fact, there were 75% fewer species above the K-T boundary than below it.

One of the most remarkable features of *T. rex* skeletons are the large pointed teeth that are well adapted to a carnivorous diet. (They aided in puncturing and tearing apart flesh.) Plant-eating sauropods, however, had blunt, flattened teeth.

The decline of the dinosaurs was followed by the rise of the mammals. It is believed that mammals began to occupy many of the *niches* (all resources an organism uses to "make its living") vacated by dinosaurs. Often, one species of mammal would enter an area with many "open niches" and, in relatively short geologic time, dozens of new descendant mammalian species would appear as biodiversity was making a comeback!

Pseudomonas aeruginosa and *Burkholderia* spp. are related bacteria that are capable of metabolizing a wide variety of organic compounds, including some commonly used disinfectants. Both are resistant to many antibiotics as well, and are becoming problems in hospitals.

George and Mimi are raising hogs on concrete in a big building on their farm. They are pleased to have all their pigs/hogs in one place, where the hog feces (manure) and urine can just drop out of the pens into a channel in the floor and be washed into a lagoon outside. The lagoon is lined with plastic. The manure and urine are broken down/decomposed by bacteria in the lagoon water.

Their neighbor, Grace, has many kinds of organisms in her pond, including several species of freshwater fish for which people pay a fee to fish . Grace has insects that are herbivores and bluegill and bass (carnivores) in her pond. Herons live nearby and feed on fish in the pond too. Unfortunately, a hole tore in the plastic liner of Mimi and George's lagoon and the water leaked out and flowed down into Grace's pond. It was not long before she noticed that her pond looked like green pea soup.

Grace was upset about these problems in her pond but George and Mimi were not sure that they were the result of their lagoon water flowing into her pond. The three of them set up an experiment in 3 plastic pools that their children used to swim in. They set up the 3 pools as follows:
Pool 1: a mix of 35% lagoon water and 65% water from Grace's nearby stream
Pool 2: 100% stream water
Pool 3: 100% lagoon water.
They placed a small bass, some insects, some algae, and 2 very small bluegill in each pond.

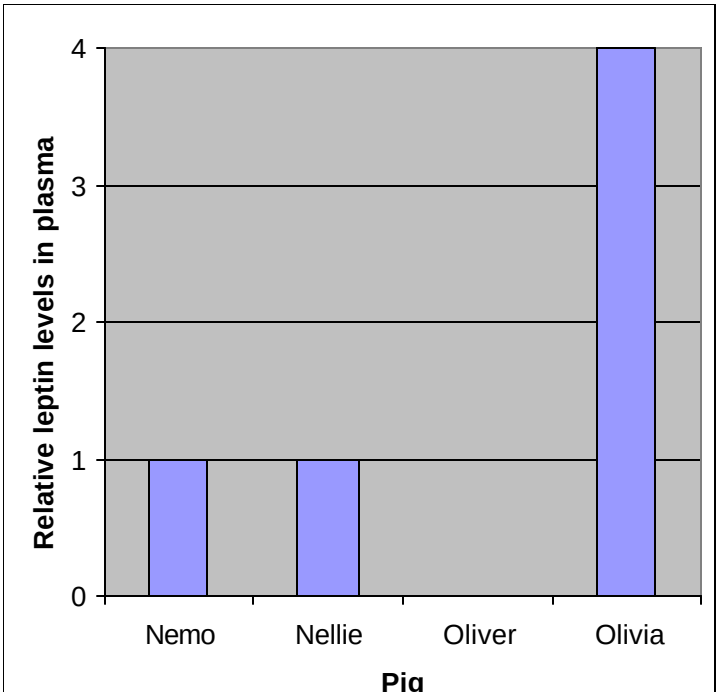
Then they watched the ponds, checked on the fish and insects, and measured the population density of algae and the dissolved oxygen each day for thirty days. Their data are summarized in the following table.

	Pool 1 (35% lagoon/65% stream)		Pool 2 100% stream water		Pool 3 100% lagoon water	
DAY	Algal Population Density	Dissolved Oxygen	Algal Population Density	Dissolved Oxygen	Algal Population Density	Dissolved Oxygen
	# /cm^3	ppm	# /cm^3	ppm	# /cm^3	ppm
1	5	8	5	10	5	5
20	500	12	10	11	500	12
25	5	2	20	12	5	2
30	1	0	20	12	1	0
30	Fish and insects dead		Fish and insects alive		Fish and insects dead	

George and Mimi discovered that they could reduce the costs of raising hogs if they supplied their pigs with a layer of straw in their concrete holding pens during the winter months.

George and Mimi needed to increase hog production so they plan to expand their breeding program using their two largest, least active hogs, Oliver and Olivia and two of the normal hogs, Nemo and Nellie. When Nemo and Nellie breed, they always produce lean piglets whose offspring are also always lean. When Oliver breeds with Nellie, their piglets are all lean, but when their piglets grow up and breed among themselves, 25% of them are really heavy.

Similarly, when Nemo breeds with Olivia, their piglets are all lean, but when their piglets grow up and breed among themselves, 25% of them are really heavy. With this in mind, George and Mimi breed Oliver and Olivia, expecting all the piglets to be heavy ones. Surprisingly, their piglets are all lean, and when they breed among themselves about 56% of their offspring are lean and 44% heavy. Mimi immediately recalls there are two independent genes (the "O" gene and the "D" gene) that directly control the effect of leptin and suggests that they have the pigs leptin levels checked. They find the following:



Hogs and people have very similar physiology, including immune function. Mimi and George hired Jim to help with the hogs during the winter. Unfortunately, Jim became ill with Type A flu virus and coughed and coughed as he worked with the hogs indoors. A week later, several hogs were coughing because they, too, were susceptible to the type of flu that Jim had.

George and Mimi hire a biology student to examine the microorganisms in their pond to determine if any might be toxic. The student is instructed to look only for unicellular photosynthetic eukaryotic organisms to send to a toxicology lab for further analysis.

The Good Genes hypothesis, predicts that females will select males with characteristics that are correlated with characteristics that lead to increased fitness. The Handicap Hypothesis predicts that females will select males that possess characteristics that interfere with the male's survival, but they survive anyway, indicating that they possess other characters that contribute to their survival and cannot be detected, directly. For each of the following examples indicate which hypothesis explains the situation best.

Part of the swallow (*Hirundo rustica*) tail streamer (elongated pointy part) appears to aid the bird in turning during flight. Females select males based on these streamers.

In a cyprinid fish, Cortet et al (2003) found that the knobs that grow on the heads of males during breeding season were associated with high concentrations testosterone. They also found that these high levels of testosterone were correlated with expanded knobs and a type of lethal cancer common during spawning. Females are attracted to males with these exaggerated knobs.

In brook trout, some male fish remain at the periphery of the breeding colony but periodically "sneak" into the middle of the colony to spawn (breed). Others defend breeding/nesting sites and attract and spawn with females.

In the goby, *Valenciennea longipinnis*, the female fish build a very noticeable nest mound on a burrow after spawning. The male cares for eggs in the burrow until hatching. Both parents make a huge investment in caring for their newly hatched young.

Wading birds, like herons, walk around in shallow lakes searching for food. In the winter the water is very cold but the bird still stands there for hours, remaining as still as possible to avoid alarming its potential prey. Through all of this, the bird never experiences significant changes in core body temperature.

Crayfish (crawdads) dig burrows in soil that borders freshwater ponds and ditches that fill with water after rainstorms. Crayfish species A prefers living in the edge of ditches. During the flooding associated with hurricanes in Louisiana, large pieces of soil tore away from ditches and carried down the Mississippi River. They floated like small rafts into the ocean. One of these rafts carried 10 crayfish of species A out into the Caribbean. Two of them fell off the raft into the seawater as the raft was washed up on the beach of a small island.

The rest of the crayfish of species A that were on the raft moved into a stream on the island. Some descendents of the founding crayfish were carried away from the stream to irrigation ditches much like the ditches their ancestors had lived in back in Louisiana. Over many generations they became very adept at crawling from ditch to ditch. The rest of the population stayed in streams and these descendents became very good at building deep burrows that would not collapse with the rapid flow of the water in the streams. When Professor Exoskeleton (called Doc Hardhead by friends) recently took some crayfish from the streams and tried to cross them with the crayfish that lived in the ditches, she found that the ditch crayfish would attempt to breed with the stream crayfish. However, the offspring of these matings all died before they matured and reproduced.

Best of Luck,
Biol 1114 faculty