**Evolution 2 Standard Study Guide**

1. How do scientists define a species?

Scientist define a species as a population of organisms that can breed and produce viable (living), fertile (can have babies) offspring. This is called the biological species concept. Scientists used to define species based on their appearance. This is called the morphological species concept. This is no longer thought to be an accurate way to define species because some organisms look alike, but are completely different. On the contrary, some individuals from the same species can look very different.

1. Explain why speciation is a continuum not a single event in time.

Speciation happens gradually over time. First, a population has to be reproductively isolated in some way, so that they are not mating and their gene pools are isolated. Then, evolution has to act separately on the two isolated populations so that over time, they possess different characteristics that prevent them from ever mating with the other population. Remember, just because a population is geographically separated and the gene pools are split, doesn’t mean they cannot reproduce. For example, the common white tailed deer is found in a wide range of locations from South America to Canada. We can assume that a deer from Oregon could still reproduce with a deer in Washington- the white tailed deer is still a single species.

Sometimes two populations of organisms can reproduce, but don’t do it very often. Sometimes, even though they don’t reproduce in the wild, they will still reproduce in the lab. And finally sometimes they do not reproduce (or cant reproduce) ever, even in the lab. As you can see, this is not a black and white situation and does not happen all at once.

1. What are the 5 mechanisms of evolution? AKA the 5 fingers of evolution? Give examples.

**Shrinking AKA genetic drift**- random change in a small population that results in a gene pool that was different from the original gene pool. Take for example, snowshoe hares living on Mt. Rainier. Say 50% are white and 50% are brown (that is the allele frequency). If a wildfire on the mountain killed many of them, and the resulting population of hares that were left were 90% white and 10% brown, this is a change in the gene frequency. Changing gene frequency= evolution.

**Non Random Mating-** Non random mating occurs in populations that choose mates based on specific traits. For example, wing color, mating calls, or size. This changes the allele frequency in the population because the trait that is being ‘selected’ becomes more and more abundant in the population, and the trait that is not being selected for slowly gets weeded out. This is because traits are passed on from parent to offspring. For example, female peacocks choose males that have the biggest brightest feathers. When they mate, that trait will be passed on to their offspring, creating more peacocks that have big bright feathers. The male peacocks who do not have big bright feathers will probably not find a mate, and they will not pass their traits on to anyone. This changes the frequency of alleles in the population over time- evolution. To illustrate this idea, think about eye color in the human population. The allele frequency for eye color is approx. 55% brown and 8% blue. This stays pretty constant from generation to generation because a person with blue eyes is just as likely to find a mate as someone with brown eyes. The deck of cards doesn’t change. On the contrary, if all human women found blue eyes to be a far more attractive and superior trait, and women hardly ever wanted to be with a brown eyed man, the frequency of blue eyes would increase, effectively changing the deck of cards.

**Mutation**- Mutation is a random mistake that is made when sperm and egg come together to form a zygote. When the genetic material (DNA) is being passed on to the offspring, some small mishap changes the DNA of the child, and they are born with a trait that hadn’t previously existed in the population. This changes the frequency of alleles in the population because it is literally adding a new allele. For example, if someone had a mutation that caused them to have carrot orange skin, and they passed that trait onto their kids, and they passed it onto *their* kids, well now we have orange skin added to the population of humans. Again, this is evolution.

**Gene Flow AKA Migration-** Gene flow is the movement of organisms into and out of a population. When two populations of the same species have different characteristics, and the two populations begin mating, the resulting population has a mix of both characteristics. This changes the overall gene pool. Humans are a good example of this because we can see how traits vary in different countries. If everyone in Asia never left, and everyone in Africa never left, there would be two populations of humans with two different gene pools. For example, curly hair would be a more common trait in Africa and straight hair would be a more common trait in Asia. Due to migration, the ‘curly haired’ trait could move into the Asian population and vice versa. So, the allele frequency in Asia would go from 2% curly hair and 98% straight hair to 30% curly and 70% straight. This is of course a hypothetical situation!!

**Natural Selection-** Natural selection is a process in which the individuals that are most fit to live in their environment survive and reproduce. The individuals that do not have those traits die off and do not pass those traits on to the next generation. Over time, from generation to generation, the population changes due to this process. The peppered moth is a perfect example of this. During the Industrial Revolution, the trees became darker with soot, which made the darker moths blend in better and they were less likely to get eaten by predator birds. The white ones stood out more, and were eaten more often. Over time, the frequency of alleles in the moth population went from approx.. 50/50, to being more dark than white. In this case, we say the environment ‘selected for’ dark color, because that is the trait that made an individual more likely to live on and reproduce. We would also say that the dark moths were ‘more fit’.

1. Which lead to microevolution and which lead to macroevolution?

All lead to microevolution- which is small changes in allele frequency. For example, horses used to be much smaller than the horses we see today. Blue eyes did not exist in humans until approx. 6,000 years ago. More examples include antibiotic resistant bacteria, and pesticide resistance in insects.

Only natural selection leads to macroevolution- HUGE changes in whole groups of organisms over a long period of time. An example of this would be whales changing from the fossils we looked at in class, to what we see today.

1. Why is reproductive isolation necessary for speciation?

Speciation occurs when a single species splits into two separate species. This does not happen by chance of for no reason. As long as the two population of organisms can still mate, they can still exchange genetic information, and still share a gene pool. And if they are sharing genetic information, then any change that occurs through natural selection or mutation will be shared. That means that there is no chance that the populations are going to evolve different from each other so that they become two separate species.

1. What roles does the environment play in speciation?

Environment plays a HUGE role in speciation. First of all, because the environment is dynamic (ever-changing) it is always altering the conditions that organisms live in and causes a wide range of climates and geography around the world.

The most obvious answer to this question is the idea of geographic isolation. If something in the environment causes a population to be physically separated from each other, this paves the way for speciation to occur.

The best answer to this question is the fact that the environment influences natural selection. Natural selection has to act on populations in order for a species to evolve into a new species. And natural selection is the process in which traits in a population change *usually* *due to the environment.* Individuals with traits that make them best adapted/most fit to survive and reproduce in their environment are the ones that pass those traits onto the next generation. If the environment changes, then the traits that make an organism “most fit” also change.

1. Explain a situation in which one species can speciate into 2 without changing their environment.

The actual environment itself doesn’t have to change in order for speciation to occur. In the example we’ve talked about in class with the apple maggot flies, nothing really changed in the environment. They didn’t move to an island with a different ecosystem, the Earth did not undergo an ice age.. In this example, speciation happened simply because of food preference. The flies that preferred to eat apples mated on apple trees, and their offspring that were born on apple trees also ate apples and mated on apple trees. The same was true for those flies that preferred to eat on the Hawthorne trees. Because this isolated their gene pools, over time the two flies became separate species.

Competition could do the same thing. Any time a resource is limited like food, shelter, etc. there is the possibility for speciation to occur.

1. Fitness isn’t just an issue between members of the same species. It also has effects between different species that compete for survival in some way (i.e. use the same resources, hunted by the same predator). **Explain in terms of natural selection, how competition between 2 species can affect *natural selection* of 1 species. Think about the conditions that favor the following: small body size, big body size, poor eyesight, darker coloring…**

If two totally different species are competing for the same resources, ultimately one species is going to ‘win’. Meaning, one species is going to be better at getting the food they are competing over (I’m going to use food as an example, but species could compete over any limited resource). Without food, members of the ‘loser’ species will starve and die off unless they have certain traits that allow them to get different food or occupy a different niche. Members of the loser species that do not have traits that allow them to get different food or occupy a different niche will die off. This is natural selection. Over time the population of the loser species would change greatly.

For example, if two species compete over plants to eat and the ‘loser’ species is not able to find any food because of this competition, members of the species may start migrating out of the area in search of food. Within this new location the environment may be different, and when the environment changes the traits that individuals need to stay alive change, and natural selection occurs.

Another example: If two species that both eat moles are in competition for food, some members of the loser species may still get enough food to live because they are fast enough to catch mice also. While, other members of the loser species are not fast enough to catch mice, so without the moles to eat, they will die.

1. A few finches arrived in the Galapagos Islands after storms probably blew them off course from the mainland. Describe how and why there would be initial population growth on the island?

New niche! If there were only a few finches on the island, there wouldn’t be any intraspecific competition for mates, food, shelter, etc. There would be plenty of every resource for everyone, so the population would grow rapidly.

1. How did this change in population growth affect the finches’ available resources?

Resources would decrease as the population grew, and create competition among the finches

1. How did competition for resources lead to natural selection?

Individuals who did not possess the traits that allowed them to “win” the competition would die off. Finches who possessed the favored traits would survive and reproduce.

1. What types of genetic variation already existed in the original finch population?

There was already the natural variation that you see in any population. Different beak size, slightly different beak shape, variance in body size and feather color, etc.

1. How did natural selection act on that genetic variation?

Natural selection decreased genetic variation because some traits would die out.

1. Explain why having 13 species of finches, which live & behave differently (many of which have specialized beaks) enables a larger number of total finches to be on the islands rather than just one species of finch.

Different species of finches which live and behave differently occupy different niches. If they occupy different niches, that means there is less competition and more room for everyone. If there was a single species, they would all eat the same food, live in the same trees, and compete for the same mates. Because there are many species, they don’t have to fight over the same food mates etc.

1. Explain, in evolutionary terms, why a high level of biodiversity increases the likelihood that a species will survive.

High level of biodiversity means more traits are available in the population to help the species survive if the environment changes. Think about the Darwin Survival Game you played in class. If you only had chosen bald organisms, and an ice age occurred, they went extinct. On the other hand, if you only chose furry organisms and global warming occurred, they went extinct. If you chose some bald and some furry organisms, the population would survive through both environmental changes.

1. Explain the difference between macroevolution and microevolution

Microevolution refers to small changes in allele frequeny of a population. As stated earlier, eye color is an example of this. Humans went from having only brown eyes to having green brown or blue in a few thousand years. Macroevolution refers to large scale changes that lead to entirely new groups of organisms.

1. Even though a tiger and a lion can mate both physically and genetically, a lioness will not mate with a male tiger because he lacks a mane, and mane size is a sexually selected characteristic in lions. **What type of reproductive barrier is described above?**

Behavioral isolation

1. There are many different types of corals, but they all have the same basic body structure and life style. They all spawn by spewing their gametes into the water, and the eggs are fertilized away from the parents. This means that there are usually many different species spawning at once. Why is it that we don’t have any random coral hybrids? **What reproductive barrier is described above?**

Gametic isolation

1. Giraffes have long necks because they needed to reach food high in the trees in order to survive. Stretching their necks to reach food for hundreds of years caused them to gradually evolve long necks. **Explain why this statement is a misconception (incorrect).**

If a giraffe stretches its neck all day, it is not going to grow a longer neck, and even if it did it cannot pass that trait onto its offspring. Just like if you went to the gym every day and got very buff that does not mean your children are going to be born buff. Evolution only works on inheritable traits. Additionally, evolution does not occur on individuals, it occurs on populations over many generations, and wishing to have a longer neck does not help a giraffe get a longer neck.

Giraffes necks got longer over time because the giraffes that were not tall enough to reach food died, and giraffes that had longer necks got food and lived and reproduced. Remember that initially there were probably only minor differences in neck length just like there are minor differences in height among humans. But over time, neck length would increase as the long necked individuals produced offspring that also had long necks, and so on.

1. A species of yellow butterflies lives in a pine forest. A yellow butterfly can have yellow or red offspring. The red variant can only make red-winged babies. The red butterflies are more likely to be seen and eaten by predators and are less likely to survive to reproduce. **How will this affect the overall population in the long run (macroevolution)? Support your answer with logical inferences based on information in the scenario and what you’ve learned in class**.

The population of butterflies would become 100% yellow. Red butterflies may occupy a different niche and evolve separately into a new entirely different species of butterfly.

1. Explain why adaptive radiation is more likely to occur in an island setting.

Islands are isolated ecosystems, so an organism who has just arrived has a different niche to fill than the same organism arriving on a different island. Initially their population growth would be exponential, but because of limited space on an island, competition would soon occur as the population grew (its not like the organisms can spread out to find more food or new places to live if they’re on an island). First of all, if a single species arrived on different islands, they would evolve differently on each island leading to many new species. But second, because of the competition that would occur on the islands, the populations would likely split to even more species, as competition would force some members of the population to find a different niche.

1. Does evolution *only* happen over long periods of time (millions of years)? Explain.

Macro evolution happens over millions of years, but remember that evolution is *any change in the allele frequency of a population over time.* Changes in the allele frequency can happen rather quickly, relatively speaking. Remember the mosquitos in the London subway tunnels? That led to a new species of mosquito in less than 150 years. Remember the example in class of snails that get a mutation that causes mechanical isolation? That’s instant evolution right there. In fact, any mutation that does not cause death leads to pretty quick evolution. (micro evolution at least).