Learning Set 4 Question: How does life evolve*?*

Scientific Principles

- **The longer a population accumulates mutations within a changed environment, the more it will tend to adapt to that environment.**
- **Individuals of the same sex compete against each other for mates; this generates a form of natural selection (sexual selection) for variations of traits that grant a competitive advantage for reproducing.**
- **In an ecosystem, new adaptions in any one population tend to generate additional selective pressures for new adaptations in all the other populations.**
- **Species extinction is influenced by 1) the amount of resources necessary for survival available in the species' ecosystems, 2) the size of the population 3) the other populations the species is competing against (directly or indirectly), 4) the amount of trait variation and diversity of the alleles in the gene pool of the species, and 5) the size and abruptness of environmental changes.**
- **New species can emerge when there is a competitive advantages for survival from maintaining more specialized gene pools in different groups of individuals; this will tend to reinforce adaptations that lead to more reproductive isolation between those groups.**
- **New species can emerge when geographic isolation, mutation, and genetic drift lead to separate descendent populations that have traits or genes that make individuals from each population reproductively incompatible with each other.**
- **In every ecosystems in the world there are many type of potential interactions within the food web and between the abiotic environment; this results in many unique possible opportunities for organisms to adapt to fill these vast number of different niches.**
- **New species tend to form to fill available niches when 1) old species go extinct or 2) new ecosystems form or 3) a mutation generates an innovative and advantageous new trait.**

Lesson Question	Learning Performances in the Activity	Evidence that students evaluate	What students should know	Vocabulary to post	Learning Performances in the Homework
Activity 14 What outcomes will result from both mutations and natural selection?	Explain why different environmental changes and different mutations would result in the emergence of different outcomes from natural selection. Describe how the mechanism of mutation (which adds new variations to the population) in combination with natural selection leads to populations that have traits and variations progressively better adapted to a given environment over many generations.	Output of a class wide participatory simulation from a model of natural selection and mutation. Examples of fur color in animals in different ecosystems.	The longer a population accumulates mutations and interacts with and survives within a changed environment, the more it will tend to adapt to that environment.	*Adaptation* *Lamarkianism* *Modern Synthesis*	Explain why adaptations to one environment might be disadvantageous in other environments or if the environment changes. Describe why individual response to environmental conditions does not change genetic information in individuals and how natural selection and evolution emerge only from traits that are genetically inherited not through those acquired in a lifetime.

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Activity 15 How Do Mates Affect Adaptations?	Describe how the mechanism of mutation (which adds new variations to the population) in combination with natural selection leads to populations that have traits and variations progressively better adapted to a given environment over many generations. Describe how sexual selection is similar to other forms of natural selection and how its selective pressures might counterbalance other selective pressures in the ecosystem. Describe how variations that grant competitive advantage either for survival or reproduction, but not for both, is an overall competitive disadvantage for contributing the gene pool of future generations.	Output of a small group participatory simulation from a model of natural selection rom predators, sexual selection and mutations in two fish tank populations. Photographs of peacocks and results of John Endler's guppy experiments.	*Individuals of the same sex compete against each other for mates; this generates a form of natural selection (sexual selection) for heritable variations of traits that grant a competitive advantage for reproducing.*	*Sexual selection*	Explain why different environmental changes and different mutations would result in the emergence of different outcomes from natural selection.

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Activity 16 Do Adaptations in One Populations Affect Adaptations in Other Populations>	Explain how the outcomes of evolution between interacting populations would be different than if each population evolved without interacting with each other. Describe how coevolution is a mutually reinforcing mechanism, the results of evolution that result in one population (accumulating traits that grant a competitive advantage), can contribute to new selective pressures on the other population, which increases the rate accumulation of traits that grant a competitive advantage in that population; describe why coevolution generally results in faster rates of evolutionary change in both populations than would occur in one population alone.	Model runs and populations graphs from experiments with fish tank populations. Food web diagram for a pond. Historical examples of mutualism between bees and flowers, moths and flowers.	In an ecosystem, new adaptions in any one population tend to generate additional selective pressures for new adaptations in all the other populations.	*Coevolution* *mutualism*	Provide examples of coevolutionary interactions that have a delayed or accumulated affect on individuals. Describe how evolution of populations would have an effect on the interactions with the abiotic environment. Give an example series of interactions that would leads to indirect coevolution between two populations.

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Activity 17 Why do some species go extinct?	Apply the definition of species to different populations of organisms. Identify how population levels would contribute to whether species are at risk of going extinct Identify how changes in environmental conditions could contribute to whether species would go extinct. Identify how abrupt or gradual changes in population interactions could contribute to whether a species would go extinct.	Model runs and populations graphs from experiments with a predator and prey species that can both adapt and interact with each other. Historical examples of extinctions including the dodo bird, saber-toothed cats, woolly mammoths. Map of glacier coverage in northern hemisphere during last ice age. Graphs of mass extinction event data from marine sediments. Photographs and maps of impact crater evidence and iridium deposition.	Species extinction is influenced by 1) the amount of resources necessary for survival available in the species' ecosystems, 2) the size of the population 3) the other populations the species is competing agains (directly or indirectly), 4) the amount of trait variation and diversity of the alleles in the gene pool of the species, and 5) the size and abruptness of environmental changes.	*Mass extinciton event* *mya (millions of years ago)*	Compare abrupt vs. gradual environmental changes and explain why evolution is more likely to help a species from going extinct when an environmental change is gradual.

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Activity 18 Where Do New Species Come From?	Describe what a species is and identify which species an individual belongs to. Describe speciation in terms of tradeoffs between gains and losses in competitive advantage for survival vs. competitive advantage for reproduction. Discuss how genetic drift in combination with geographic isolation could lead to the emergence of new species. Describe how coevolution and sexual selection could lead to the emergence of new species even when geographic isolation is not present.	Model runs and populations graphs from experiments with a species of plants. Examples of different species and offspring between animals that were once thought to be different species (dog, coyote, tiger, lion) Historical information related to speciation explanation for plants at Trelogan Arsenic Mine in the UK Historical examples of speciation in the lab using	New species can emerge when there is a competitive advantages for survival from maintaining more specialized gene pools in different groups of individuals; this will tend to reinforce adaptations that lead to more reproductive isolation between those groups. New species can emerge when geographic isolation, mutation, and genetic drift lead to separate descendent populations that have traits or genes that make individuals from each population reproductively incompatible with each other.	*Species* *Speciation* *Sterile*	Compare alternate models for speciation, describing differences in outcomes and processes include rate of speciation, permanence of speciation, and which model better represent the conditions and outcomes of speciation experiments in laboratories and observations of speciation having occurred in real world ecosystems.

		fruit flies.			

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Activity 19 Why Are There So Many Different Species?	Compare structural traits that have different levels of completive advantage for survival in different environmental conditions. Identify the mechanisms that would lead to a single species to adaptively radiate.	Class experimental results from tool and seed gathering activity in lab. Historical information about Darwin's finches and the ecosystems of the Galapagos islands.	In every ecosystems in the world there are many type of potential interactions within the food web and between the abiotic environment; this results in many unique possible opportunities for organisms to adapt to fill these vast number of different niches. New species tend to form to fill available niches when 1) old species go extinct or 2) new ecosystems form or 3) a mutation generates an innovative and advantageous new trait.	*Niche* *Adaptive Radiation*	Describe why adaptive radiation occurred in the Galapagos Finches. Explain that the large number of species in the world are due, in part many unique opportunities (niches) for organisms to get the resources they need to survive within ecosystems.