Speciation Concept Inventory – Concepts, Answers and Common Misconceptions/Misunderstandings

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| Question | Answers (\*=correct) | Concept Tested | Common Student Misunderstandings / Misconceptions |
| 1. The image below shows 3 cats, and 2 dogs. | This image shows…  a. 5 individual species.  b. 3 species that are cats, and 2 species that are dogs.  \*c. 3 members of one species and 2 members of another species.  d. both a and b  e. a, b, and c | Usage of the word ‘species’ | The word “species” can be used to refer to an individual as well as the group to which it belongs. |
| 2.Which of the following criteria could biologists use to distinguish different species from one another? | i. Individuals from different species cannot successfully reproduce with one another.  ii. Members of the same species share specific physical traits.  iii. Members of the same species use a specific set of resources.  iv. Members of the same species belong to a specific branch on the tree of life.  a. i  b. ii and iii  c. ii, iii, and iv (not i)  d. i, ii, and iv (not iii)  \*e. i, ii, iii, and iv | Definition of the word  ‘species’; species can be delineated a number of ways; what is most appropriate can depend on the taxa | Students believe only certain traits can be used to distinguish species, e.g. many believe that ‘resource use’ cannot be used to delineate species. |
| 3. Which of the following statements is/are TRUE? | a. Individuals of DIFFERENT SPECIES may look very similar, but it should always be possible to tell that they are different species based on their appearance.  b. Individuals of the SAME SPECIES may need very different types of resources for survival and reproduction.  c. Individuals of the SAME SPECIES may look so different that they appear to belong to different species.  d. both a and c  \*e. both b and c | What are species: Intraspecific variation may be greater than interspecific variation; consequently, many different types of traits are used to distinguish species | Students commonly believe that species always can be distinguished based on physical appearance. |
| 4. “A species is a group of organisms that have the ability to interbreed (i.e., produce fertile offspring).” Which of the following statements about this definition is TRUE? | This definition of the word “species”…  a. is used by all biologists, for some types of organisms.  b. is used by all biologists, for all organisms.  c. can be used for all types of organisms, in all situations.  d. can be used for all types of organisms, but not necessarily in all situations.  \*e. cannot be used in some situations. | What are species: The biological species concept is not always appropriate (e.g. asexual species; organisms where knowledge of reproductive behaviour is limited). | Students believe the biological species concept can be applied to all organisms. |
| 5. A liger is the offspring of a male lion and a female tiger. Such offspring exist only in captivity because lions and tigers do not occur in the same areas in the wild. Most ligers are larger than either lions or tigers. Male ligers are sterile, but female ligers have been known to produce offspring with males of either parental species.    Which of the following statements is TRUE? | a. Lions and tigers should be considered the same species because they can successfully mate with one another.  b. Lions and tigers are considered separate species because their habitats do not overlap in the wild.  c. Ligers should be considered a separate species because female ligers are fertile.  d. Ligers should be considered a separate species because they are physically different from both lions and tigers.  \*e. none of the above | What is a species: Biological species concept does apply to mammals; many conditions are necessary to delineate species | First-year students believe lions and tigers should be considered separate species because they look different; Third-year students believe lions and tigers are considered separate species because their habitats don’t overlap. |
| 6. Which of the following statements is TRUE? | a. Nowadays, the only new species to arise are the ones created by humans using selective breeding and/or technology.  \*b. We know that new species are continuing to arise in nature, because biologists have documented the process.  c. We know that new species are continuing to arise in nature, because biologists continue to discover new species.  d. No new species have arisen recently; all the species that currently exist arose a long time ago.  e. There is no way of knowing whether or not any new species are arising in nature. | Speciation mechanisms: speciation is a process that is ongoing and continues today | Students equate when a species was discovered to when it formed in nature. |
| 7. Once a new species has started forming, how long might it take for it to fully become a new species? | i. a few generations  ii. thousands of generations  iii. the new species may never finish forming    a. ii  b. iii  c. i, or ii  d. ii or iii  \*e. i, ii, iii | Speciation mechanisms: Speciation may be a slow, quick, or indefinite process (stasis of divergence between populations) | Students don’t believe that a new species could be created in a few generations. |
| 8. How do new species arise? | i. By one existing species turning into another species.  ii. By one existing species splitting into two new species.  iii. By two existing species combining to create one new species.  a. i  b. ii  c. i, iii  d. ii, iii  \*e. i, ii, iii | Speciation mechanisms: Speciation may take the form of: evolution of a species; hybridization of two species; divergence of populations | Students don’t believe that one species could turn into another species. |
| 9. A biologist takes pollen from one plant species (A) and uses it to fertilize another plant species (B), successfully producing a SINGLE hybrid plant. Excited, he phones his friends to tell them that he has created the first member of a new species!    In which of the following cases would he be correct? If the hybrid plant… | a. cannot reproduce with individuals from either of the parental plant species (A or B).  b. is physically different from either of the parental plant species.  \*c. cannot reproduce with individuals from either of its parental species, but can reproduce on its own (i.e., without interacting with another plant).  d. is physically different, AND cannot reproduce with individuals from its parental species  e. none of the above – it can’t be a new plant species | Speciation mechanisms: speciation in plants requires reproductive isolation from parental species. | Students believe that different species need to be physically different from each other. |
| 10. Which of the following statements best describes the difference between evolution and speciation? | a. They are not actually that different: evolution and speciation both deal with natural selection.  \* b. Evolution refers to changes in a group of individuals; speciation refers to changes between groups of individuals.  c. Evolution refers to changes in an individual; speciation refers to changes in a group of individuals.  d. Evolution refers to major changes in organisms; speciation refers to subtle changes.  e. both b and c | Speciation mechanisms: Speciation is the formation of new species via divergent evolution of groups of individuals. | Some students have a poor understanding of the relationship between evolution and speciation. |
| 11. Which of the following is necessary for speciation to take place? | a. environmental change  b. natural selection  \*c. evolution  d. b and c  e. all of the above | Speciation mechanisms: Speciation does not require natural selection (due to environmental change or otherwise), and may be the result of purely random processes. | Students believe that environmental change and natural selection are always necessary for speciation. Concept of ‘drift’ or random processes is typically absent. |
| 12. A single species of bird lives on an isolated island. Some years, the entire island is very dry, and some years it is very wet. In dry years, seeds are hard to crack, and it’s easier for birds with large beaks to eat the seeds. In wet years, the seeds are tender, and birds with small beaks can eat more quickly than birds with large beaks. (figures here) | 12. Over time, what is the MOST LIKELY to happen?  a. The birds with big beaks will move to a dry habitat, the birds with small beaks will move to a wet habitat.  b. Eventually all of the birds will have medium-sized beaks.  c. The birds with small beaks and large beaks will become separate species.  d. The birds will move to different habitats, and will become separate species.  \*e. Some years there will be more birds with large beaks, other years there will be more birds with small beaks. | Speciation Mechanisms: Fluctuating selection may cause genotypic and phenotypic frequencies within a population to change over time, without resulting in speciation. | Students believe that the medium-sized beak is optimal. |
| 13. In order for two groups of the same species to become separate species, which of the following are ALWAYS necessary, for all types of organisms?    Individuals in the two groups must… | a. be exposed to different environmental conditions.  b. lose the ability to produce fertile offspring with one another  c. be geographically separated by a physical barrier.  d. all of the above  \*e. none of the above | Speciation Mechanisms: Speciation may happen in sympatry, does not necessarily require reproductive isolation (notably in the case of asexual organisms), and may happen in the absence of natural selection (e.g., due to genetic drift). | Students believe that a, b and c are all always necessary for speciation. (Concept of speciation by drift or random processes is lacking.) |
| 14. It is common for individuals from two species to mate and produce fertile hybrid offspring. Which of the following outcomes are possible?    • The hybrid individuals have \_\_\_\_\_\_\_\_ (higher/lower) fitness than individuals from either of the parental species;    • Because of the hybrids’ fitness, over time the two species \_\_\_\_\_\_\_\_. | a. higher; …combine into one species.  b. lower; …remain unchanged.  c. lower; …evolve to become less similar.  d. either a or b  \*e. either a, b, or c | Speciation Mechanisms: Speciation and Hybridization: Depending on circumstances, hybrids may have higher, lower, or equivalent fitness compared to their parental species; lower hybrid fitness could possibly maintain separate species by reducing gene flow, or select for reinforcement of barriers to reproductive isolation. | Students don’t believe that two interbreeding species would be come less similar over time. |