

1) Pledge question. N/A

2) Which of these would prevent evolution by natural selection in a population over time?

- A) Variation among individuals is non-genetic.
- B) The environment is changing very slowly.
- C) The population size is large.
- D) The population lives in a habitat where there are no competing species present.
- E) The population lives on an island.

Answer: A

Explanation: even if individuals are more or less likely to survive or reproduce depending on their value of a trait (i.e. it impacts fitness), if the trait is not heritable then it cannot evolve across generations (i.e. changes within a generation are not passed on to the next generation).

Most common wrong answer was D. However, natural selection does not rely on competition with other species. Individuals can adapt to environmental conditions (e.g., if temperature increases and some individuals have trait values that allow them to survive and/or reproduce better at this higher temperature; e.g. Dallinger's experiment on slide 58 of Topic 2). Sexual selection occurs because males with a bigger, brighter tail have greater mating success in competition with other males of their species.

3) Mutation is constantly altering the SARS-CoV-2 genome, thereby introducing heritable variation. Some of these changes alter the transmission and/or virulence of the virus and are thus of concern because they can alter the human health impacts of Covid-19. (We call these 'variants of concern' or VOC's.) The arise and spread of a new VOC is an example of:

- A) Homology
- B) Evolution in action
- C) Artificial selection
- D) A vestigial structure
- E) Epigenetic inheritance

Answer: B

Explanation: VOCs are surviving and reproducing differently based on heritable variation in their traits (e.g., transmissibility), altering their frequency in the next generation. In other words, VOCs with increased transmissibility are spreading (i.e. increasing in frequency). This is an example of ongoing evolution (by natural selection) in front of our eyes.

Most common incorrect answer: E. Epigenetic inheritance is mean by which a heritable phenotypic change can occur that does not involve alterations in nucleotide sequence. The mechanism by which variation is heritable is not relevant to the question being asked (i.e. it could be changes in nucleotide sequence and/or epigenetic changes, but all that matters is that it is heritable variation, which the question tells you it is). The means of inheritance cannot explain the spread of certain VOCs. (The question also notes that heritable variation is being introduced by mutation, which is an alteration in nucleotide sequence.)

4) Some cave-dwelling organisms have much reduced and non-functional eyes, tapeworms have lost their digestive systems, and whales and dolphins have lost their hind limbs. Which of the following statements concerning such trait reductions/losses is most reasonable?

- A) These are vestigial structures, the existence of which is evidence of natural selection.
- B) Natural selection cannot account for such losses; natural selection only produces new, and sometimes complex, innovations.
- C) Natural selection could explain these losses, for instance if the cost of developing and/or maintaining such structures is greater than any benefit they provide.
- D) These traits support a Lamarckian process (via epigenetics) that can operate alongside natural selection.
- E) The reduction/loss of these traits suggests artificial selection.

Answer: C

Explanation: If the cost of producing or maintaining a trait is greater than any benefit the trait provides, then individuals with a reduce trait would have greater fitness and natural selection would lead to a reduction or loss of the trait.

Most common incorrect answer: A. These are vestigial structures, but the existence of vestigial structures is evidence of common descent (i.e. they indicate a shared ancestry with other species that have the trait), not of natural selection. Vestigial structures are a type of homology: similarity due to inheritance from a common ancestor, and they hence provide evidence of shared ancestry.

5) There is variation among humans in the effectiveness of certain drugs. You hypothesize that this is due, at least in part, to the amount of alcohol different individuals consume. Which of the following study designs to test this hypothesis has the greatest inferential strength?

- A) Testing for a correlation between alcohol consumption and drug effectiveness among 100 patients.
- B) Manipulating alcohol intake in 100 mice, all given identical drug doses, and then comparing drug effectiveness.
- C) Manipulating alcohol intake in 100 humans, all given identical drug doses, and then comparing drug effectiveness.
- D) A, B and C all have similar inferential strength.
- E) B and C have greater inferential strength than A.

Answer: C (E was also accepted for full marks; see below)

Explanation: We discussed two things that impact inferential strength: the type of study and the extent of extrapolation. All else being equal, manipulative studies have greater inferential strength than observational (because they better control for confounding factors). But the more the study system differs from the system of interest, the greater the extrapolation and hence the weaker the inferential strength (because you need to assume that the study system is a good proxy for the system of interest). Study C is manipulative, so better than A, and Study C is also in humans (the system of interest), so is better than Study B (in mice). Hence C best.

Most common incorrect answer: E. This was accepted for full marks because it demonstrated an understanding of the first aspect (type of study) and Prof Rundle realized that there was a

mistake in the final bullet point of slide 27 (Topic 1) when discussing extrapolation where it mistakenly says that **descriptive** studies often involve less extrapolation than manipulative studies, whereas it should have said that **observational** studies often involve less extrapolation than manipulative studies. Because this may have unintentionally confused some students, full marks were given for Answer E.

6) All organisms use essentially the same genetic code. This is evidence in support of:

- A) Natural selection.
- B) Developmental homology.
- C) An old earth.
- D) The effectiveness of artificial selection.
- E) That all life on earth shares a common ancestor.

Answer: E

Explanation: Indeed, this is straightforward evidence of shared ancestry.

Most common incorrect answer: B. While this is a homology, it is not a developmental homology (i.e. traits restricted to a specific developmental stage that are indicative of a common ancestry). The genetic code is always present.

7) Which of the following statements is true (pick the best answer):

- A) Meerkat alarm calls likely evolved because they improve the survival of the species.
- B) Evolution by natural selection has never been observed on a human timescale.
- C) The hypothesis of intelligent design can be refuted by biogeographical, fossil, and experimental evidence for evolution.
- D) Descent with modification explains why fossils often resemble living species in the same area.
- E) Traits that are harmful to other individuals of the same species (e.g., infanticide by male lions, stealing of resources by one offspring from others) cannot evolve by natural selection.

Answer: D

Explanation: The fact that fossils often resemble living species in the same area is because of shared ancestry – i.e. present-day species are descended from those or related fossil taxa.

Most common incorrect answer: A. See slide 70 in Topic 2. Natural selection does not 'act for the good of a species'. Selection arises when individuals vary in fitness **relative to other individuals in the population**. An individual may have higher fitness than others because it exploits more resources or because it harms or kills other individuals, even if such traits are not beneficial at the population or species-level (i.e. they may decrease absolute fitness and hence harm the species).

8. A researcher (who unfortunately did not take BIO1130) was interested in testing the hypothesis that music can increase plant growth. To do so, they conducted an experiment in which they manipulated the exposure to music in two groups of plants and then compared their growth. One group, located in their sunny living room, grew in the presence of continual music of various sorts, while a similar group grew in the absence of music within a nearby sound-proof and windowless room (they added grow-lights due to the absence of windows).

There is a problem with this experimental design. In one or two sentences, explain what the problem is and how it could impact their results (2 marks)

Answer:

There is a potential confounding factor, namely the difference in light sources (sun vs. grow-lights) between the two rooms (1 mark), and this could be responsible for any observed difference in growth instead of the presence/absence of music (1 mark).

OR

Equivalently, they lack an appropriate control for the differences in light (1 mark) such that this, and not the presence/absence of music, could be responsible for any observed difference in growth (1 mark)

9. In the experiment described above, the researcher found that the group of plants exposed to music grew faster on average than the group in which music was absent, and this difference was statistically significant. They concluded that the plants grew better because of the music.

There is a problem with this conclusion that is separate from the concern with the experimental design addressed in question 7. Explain what the problem is and restate their conclusion more appropriately (2 marks).

Answer: You can't prove a hypothesis (1 mark). They should have concluded that their results were **consistent with**, or **supported** the hypothesis, or that they **failed to reject** the hypothesis (1 mark)

Marks were not awarded for answers discussing confounding variables or lack of control, as the question specifically asked about an issue related to the conclusion and that was separate from the experimental design issue in the previous question. Importantly, even if the design didn't have the issue of the confounding variable in the previous question, **the problem with how they stated their conclusion would remain.**