



AP[®] Biology (Operational) 2004 Sample Student Responses

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2. Darwin is considered the "father of evolutionary biology." Four of his contributions to the field of evolutionary biology are listed below.

- The nonconstancy of species
- Branching evolution, which implies the common descent of all species
- Occurrence of gradual changes in species
- Natural selection as the mechanism for evolution

(a) For EACH of the four contributions listed above, **discuss** one example of supporting evidence.

(b) Darwin's ideas have been enhanced and modified as new knowledge and technologies have become available. **Discuss** how TWO of the following have modified biologists' interpretation of Darwin's original contributions.

- Hardy-Weinberg equilibrium
- Punctuated equilibrium
- Genetic engineering

Sexual reproduction produces organisms that are a blend of the parents phenotypic and genotypic features. Because of this species change from generation to generation. Also, because sexual reproduction involves organisms (most likely) of different parents, genes are constantly being spread and traded throughout a species. Therefore, there is no constant species, as even organisms who reproduce asexually may experience mutations that lead to altered genes.

When looked at in the early stages of development, a human embryo and a roat embryo are barely distinguishable. This implies a similar reproductive strategy and therefore common ancestry. Also, comparative molecular biology reveals that all organisms use ribosomes of extremely similar structure, DNA and amino acids, RNA and enzymes to perform similar functions.

Today, the human appendix is a vestigial structure, that is a structure that had a function in the past but no longer has a use today. This implies that over time, either other organs in the human body took on the role of the appendix or other factors changed, such as no longer eating raw meat, that eliminated the need for the appendix's functions.

Natural selection states that animals with the strongest traits will survive. In nature, lions feed on the old, young and weakened gazelles.

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As a result, the gazelles with superior physical traits survive to pass down those stronger traits to offspring, which in turn are more likely to survive and reproduce themselves.

The Hardy-Weinberg equilibrium shows genetic constancy in a perfect environment — an environment with no natural selection, no migration into or out of a population, no mutation, random mating and large population size. The opposite of only one of these factors can disrupt the equilibrium and create genetic diversity, such as the addition of natural selection. Because natural selection is always present, Darwin proved that genetic diversity is unstable.

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a The nonconstancy of species is the differences within each species. The organisms in each species are not exactly alike. Branching evolution is supported by homologous structures. Homologous structures are parts of different animals that look similar and ~~may~~ may have the same use. This supports the idea that they came from a common ancestor.

Occurrences of gradual changes in species is supported by fossil evidence. Fossils provide information about species that used to live. Natural selection is supported by the fact that animals with unfavorable genes ~~of~~ usually die and are not able to reproduce.

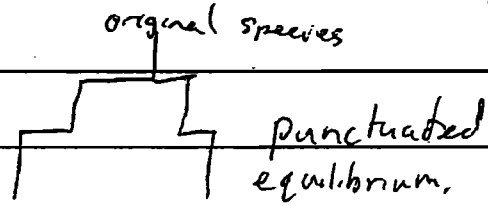
b The Hardy-Weinberg equilibrium provides the factors that are needed to maintain genetic equilibrium. The Hardy-Weinberg equation is $q^2 + 2pq + p^2 = 1$. q^2 is the dominant allele in a population and p^2 is the recessive allele in a population. $2pq$ represents the heterozygous individuals in the population. The Hardy-Weinberg equilibrium is maintained in a population if there is no immigration or emigration, if there is ~~no~~ no natural selection, no mutation, no genetic drift, and there is always random mating. The Hardy-Weinberg equilibrium is never maintained in a real population and this supports

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Darwin's idea of occurrence of gradual changes in species.

Punctuated equilibrium is when species evolve ~~through~~ suddenly and then stop.



Punctuated equilibrium supports Darwin's idea of natural selection.

Natural selection causes a population to evolve.

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- Hardy-Weinberg equilibrium
- ~~• Mendelian inheritance~~
- Genetic engineering

(a) Darwin's contribution of the nonconstancy of species is demonstrated by meiosis and how each generation ~~is~~ can vary from the last. Branching evolution, according to Darwin, is how all life has come from one common ancestor. The bacteria developed into lower, simpler life forms which evolved into smaller animals, which then became more complex. From the original primate, monkeys and humans branched off. Each has unique characteristics as well as many of the same features ~~implying~~ implying that both had a common ancestor. Gradual changes in species comes from the changes that occur ~~in~~ around the species, such as environment, that cause it to adapt. A human that evolved in the less lighted, colder parts of the world such as Europe would have lighter skin and more hair. Humans from areas near the equator, warmer and more sun, would have less hair and darker skin. Natural selection in evolution is the selection the mates make to produce offspring. ~~A mate~~

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An organism might choose a mate depending on physical ability. When enough generations have ~~springing~~ mated with only good physical ability, the population will end up entirely of organisms with good physical ability.

(b) Hardy-Weinberg equilibrium suggests that in a population that is large, with random mating, no mutation ^{and} no new alleles, all forms of the gene will survive. The equation $p^2 + 2pq + q^2$ suggests that the allele frequencies in such an environment will be consistent ~~with~~ throughout the different generations. In genetic engineering certain qualities can be taken and put together to create an ideal organism instead of the individuals that ~~have~~ followed Darwin's theories. Instead of having an individual modified to the environment, one could be created to be totally different.

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