MULTIPLE CHOICE. Choose the one alternative that best completes the statement or answers the question.

1. Environments all over the world are changing as a result of global warming. Could this influence natural selection?
   A. No. The environment is always changing. Global warming is nothing new.
   B. Yes. Traits that help individuals produce more offspring in warmer environments will increase in frequency.
   C. Yes. Mutations occur more frequently in hot environments.
   D. No. The only change will be that species from hot environments will expand their ranges.

2. Which one of the following predictions follows from the sexual selection hypothesis for why giraffes have long necks?
   A. In contests over females, the best-nourished male should always, or almost always, win.
   B. In natural populations, female neck length should decline over time.
   C. In contests over females, the male with the longest neck should have an advantage over the other males.
   D. Young males that are given extra amounts of high-quality food should grow particularly long, strong necks.

3. Starting from the wild mustard Brassica oleracea, breeders have created the strains known as Brussel sprouts, broccoli, kale, and cabbage. Which of the following statements is supported by this observation?
   A. Heritable variation is low–otherwise the wild strain would have different characteristics.
   B. In this species, there is enough heritable variation to create a variety of features.
   C. In this species, most of the variation present is due to differences in soil, nutrition, amount of sunlight, or other aspects of the environment.
   D. Natural selection has occurred very frequently in the wild populations.

4. A farmer uses triazine herbicide to control pigweed in his field. For the first few years, the triazine works well and almost all the pigweed dies; but after several years, the farmer sees more and more pigweed. Which of these explanations best describes this observation?
   A. Only triazine-resistant weeds survived and reproduced, so each year more pigweed was triazine-resistant.
   B. The herbicide company lost its triazine formula and started selling poor-quality triazine.
   C. Triazine-resistant pigweed has less-efficient photosynthesis metabolism.
   D. Natural selection caused the pigweed to mutate, creating a new triazine-resistant species.

5. Suppose 64% of a remote mountain village can taste phenylthiocarbamide (PTC) and must therefore have at least one copy of the dominant PTC taster allele. If this population conforms to Hardy-Weinberg expectations for this gene, what percentage of the population must be heterozygous for this trait?
   A. 32%
   B. 48%
   C. 16%
   D. 60%
   E. 40%

AA Aa aa

$q^2 = 0.36$

$p = 0.4$ $q = 0.6$

$2pq = 0.48$

Continued on next page...

6. Your text discusses the evolution of antibiotic-resistant M. tuberculosis bacteria in a patient. Researchers discovered that the strain of M. tuberculosis taken from the dead patient has a point mutation in the rpoB gene that codes for part of the RNA polymerase enzyme. This mutant form of RNA polymerase does not normally function as well as the more common form, but a commonly used antibiotic called rifampin does not affect the mutant rpoB. A researcher places M. tuberculosis isolated from the patient a year before death (no rpoB mutation) in cell cultures with M. tuberculosis isolated from the dead patient (with rpoB mutation). Half the cell cultures contain just standard nutrients, and the other cell cultures contain rifampin in addition to the standard nutrients. After many cell generations, the researcher finds that _____. (choose one)

A. Very few M. tuberculosis in any of the cell cultures carry the rpoB gene mutation.
B. Very few M. tuberculosis in the standard nutrient cell cultures carry the rpoB gene mutation, but almost all of the M. tuberculosis in the cell cultures with rifampin carry the rpoB mutation.
C. Almost all M. tuberculosis in the standard nutrient cell cultures carry the rpoB gene mutation, but very few of the M. tuberculosis in the cell cultures with rifampin carry the rpoB mutation.
D. Almost all of the M. tuberculosis in both types of cell cultures carry the rpoB mutation.
E. A mix of both M. tuberculosis strains thrive in the standard cell cultures, but no living bacteria can be found in the cell cultures that contain rifampin.

7. Cystic fibrosis is a genetic disorder in homozygous recessives that causes death during the teenage years. If 9 in 10,000 newborn babies have the disease, what are the expected frequencies of the dominant (A1) and recessive (A2) alleles according to the Hardy-Weinberg model?

A. f(A1) = 0.9604, f(A2) = 0.0392
B. f(A1) = 0.9600, f(A2) = 0.0400
C. f(A1) = 0.9800, f(A2) = 0.0200
D. f(A1) = 0.9997, f(A2) = 0.0003
E. f(A1) = 0.9700, f(A2) = 0.0300

8. In Kerr and Wright's experiment with 96 fruit-fly populations, only 4 males and 4 females bred in each generation. After 16 generations, 73% of their populations had only one allele present for the bristle morphology gene. Which of the following would you expect to occur if they allowed 10 males and 10 females to breed each in generation?

A. Less than 73% of the populations would have only one allele present.
B. About 73% of the populations would have only one allele for the bristle morphology gene.
C. More than 73% of the populations would have only one allele present.
D. All of the populations would have only one allele present.

9. Which of the following describes the most likely order of events in speciation?

A. divergence, genetic drift, genetic isolation
B. genetic isolation, divergence, genetic drift
C. genetic isolation, genetic drift, divergence
D. divergence, genetic isolation, genetic drift
E. genetic drift, genetic isolation, divergence

Continued on next page...

10. Three-spined stickleback fish (Gasterosteus aculeatus) show substantial heritable variation in gill-raker length. Fish caught in open water tend to have longer gill rakers and eat different foods than do those caught in shallower water. Longer gill rakers appear to function better for capturing open-water prey, while shorter gill rakers function better for capturing shallow-water prey. Which of the following types of selection is most likely to be found in a large lake (open water in middle and shallow water around the sides) with a high density of these fish?
    A. Stabilizing selection
    B. No selection
    C. Sexual selection
    D. Disruptive selection
    E. Directional selection

11. How are two different species most likely to evolve from one ancestral species?
    A. phylogenetically, due to heterozygote advantage in hybrids
    B. sympatrically, by a point mutation affecting morphology or behaviour
    C. allopatrically, after the ancestral species has split into two populations

12. Most causes of speciation are relatively slow, in that they may take many generations of organism to see changes, except:
    A. polyploidy.
    B. natural selection.
    C. vicariance.
    D. colonization.

13. You want to study divergence of populations, and you need to maximize the rate of divergence in order to see results within the period of your grant funding. You will form a new population by taking some individuals from a source population and isolating them so the two populations cannot interbreed. What combination of characteristics would maximize your chance of seeing divergence in this study?
    1. Choose a random sample of individuals to form the new population.
    2. Choose individuals from one extreme to form the new population.
    3. Choose a species to study that produces many offspring.
    4. Choose a species to study that produces a few, large offspring.
    5. Place the new population in the same type of environment as the source population.
    6. Place the new population in a novel environment compared to that of the source population.

    B. 1, 3, and 5
    C. 1, 3, and 6
    D. 2, 3, and 5
    E. 2, 3, and 6
    F. 2, 4, and 6

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14. Why is speciation by polyploidy more likely in plants than in animals?
   A. Plant gametes can be produced from somatic cells that have undergone many rounds of mitosis.
   B. Plant gametes lack postzygotic isolating mechanisms.
   C. Plants are sessile and cannot speciate via dispersal.
   D. Plants lack the DNA repair enzymes that animals have.

15. Two researchers experimentally formed tetraploid frogs by fertilizing diploid eggs from Rana porosa brevipoda with diploid sperm from Rana nigromaculata. When they mated these tetraploid frogs with each other, most of the offspring that survived to maturity were tetraploid, with chromosome sets of both diploid parent species. Based on these results, if this type of tetraploid formed in the wild, what would be the result? (Y. Kondo and A. Kashiwagi. 2004. Experimentally induced autotetraploidy and allotetraploidy in two Japanese pond frogs. Journal of Herpetology 38(3):381-92.)
   A. The tetraploids would be selected against.
   B. The two parent species would interbreed and fuse into one species.
   C. The two parent species would recognize each other as mates.
   D. The tetraploids would be reproductively isolated from both parent species.
   E. All of the above answers are correct.

16. The phenetic approach to estimating phylogenetic trees is most like the approach of which species concept?
   A. Phylogenetic species concept
   B. Biological species concept
   C. Morphospecies concept

17. Two species of tree frogs that live sympatrically in the northeastern United States differ in ploidy: Hyla chrysocelis is diploid, and Hyla versicolor is tetraploid. The frogs are identical in appearance; but their mating calls, which females use to find mates, differ. Which difference most likely evolved first?
   A. Polyploidy
   B. Difference in mating calls
   C. A and B must have occurred at the same time.

18. A storm brings two formerly separated populations of beetles together. They look very similar. Under the biological species concept, which of the following would show that the two populations are different species?
   A. Males of the two populations have different flight patterns in courtship.
   B. When individuals from the two populations mate with each other in the laboratory, the eggs fail to hatch.
   C. One population breeds in spring, the other in fall.
   D. All of the above is correct.
   E. None of the above is correct.

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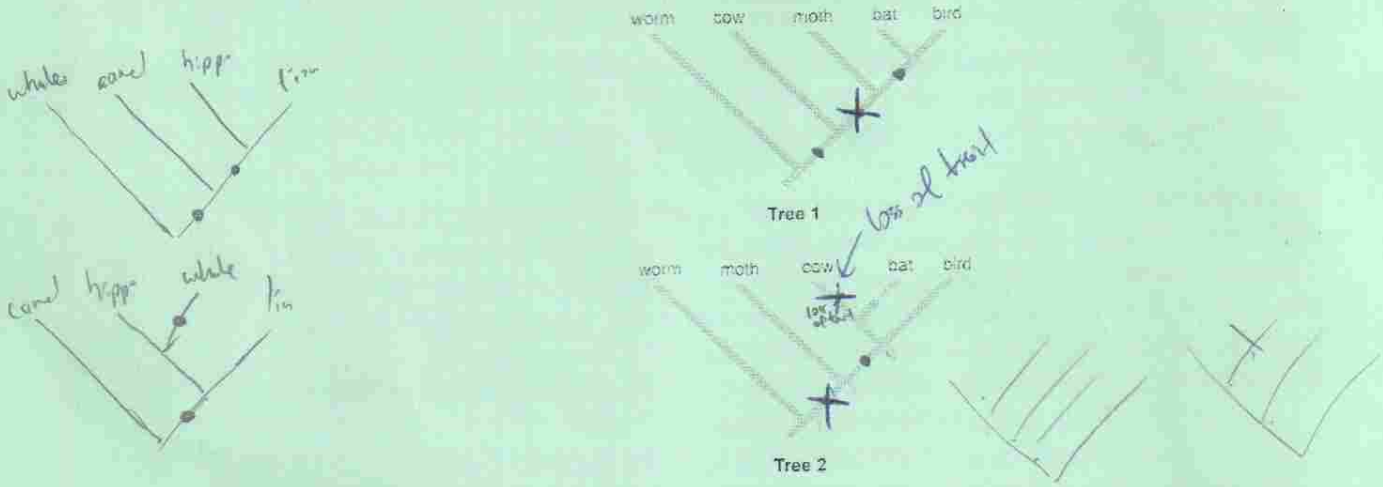
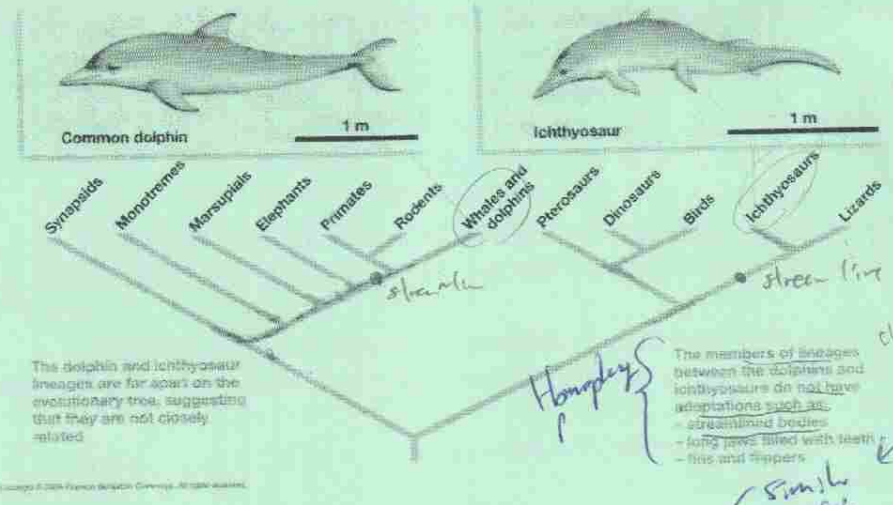
Use the following information when answering question 19.



19. Applying the principle of parsimony to the trait "ability to fly," which of the two phylogenetic trees above is better?
    A. Tree 2
    B. Tree 1
    C. Both trees are equally parsimonious.



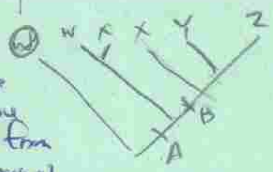
20. For the streamlined bodies shown in Figure above to be homologous instead of homoplasious, which of the following groups would also have to have streamlined bodies?
    A. Lizards and elephants
    B. Pterosaurs, dinosaurs, birds, and lizards
    C. Synapsids, monotremes, marsupials, elephants, primates, and rodents
    D. All of the above
    E. Either B or C

Continued on next page...

21. Which of the following traits is useful in generating a phylogeny of species W, X, Y, and Z?

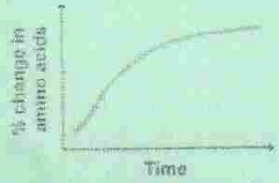
	Species W	Species X	Species Y	Species Z
Trait 1	A	A	A	A
Trait 2	A	A	B	B
Trait 3	A	B	C	D

A. Trait 1
B. Trait 2
C. Trait 3
D. All of the above is useful traits.

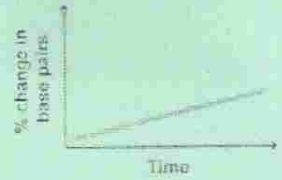


22. The graphs below show percentage of change in three different molecular sequences plotted against time. Which of these molecular sequences would make a good candidate for a molecular clock?
A. Graph A, because the curve levels off over time
B. Graph B, because DNA is more important to organisms and therefore will give a more accurate picture of divergence
C. Graph C, because the change in sequence is the most rapid
D. Graph A or C, because changes in amino acid sequence are more likely to be neutral than changes in DNA
E. Graph B or C, because they are straight lines

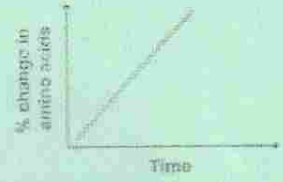
A



B



C



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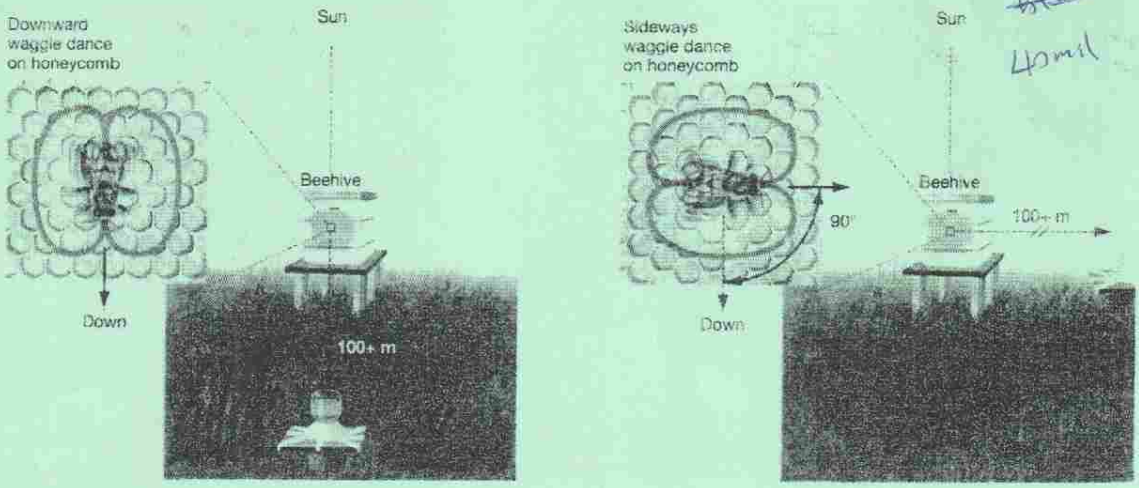
23. Why would gene duplication events, such as those seen in the Hox gene complex, set the stage for adaptive radiation?
    A. Without duplicated genes, species would be vulnerable to extinction.
    B. One copy of a gene can perform the original function while other copies are available to take on new functions.
    C. The original gene copy is the out-group, and the new gene copies are the adaptive radiation.
    D. There are more copies of genes, meaning speciation had occurred by polyploidy.

24. Which of the following likely has the most Hox genes?
    A. Slugs
    B. Dolphins
    C. Jellyfish
    D. Bees

25. You know that a particular stretch of DNA changes at the rate of 1 base per 10 million years. You sequence this length of DNA in two species and find that they differ by 4 bases: AATGCGATCG and AATGTTATGC. Based on these data, how long has it been since these two species diverged?
    A. 10 million years
    B. 100 million years
    C. 40 million years
    D. 20 million years

26. What does the figure below show about the nature of the "waggle dance"?
    A. The direction of the waggle dance indicates the location of the hive relative to the Sun.
    B. The vigor of the waggle dance indicates the size of the food source.
    C. The waggle dance is random in relation to the food source.
    D. The vigor of the waggle dance indicates the location of the food relative to the Sun.
    E. The direction of the waggle dance indicates the location of the food relative to the Sun.



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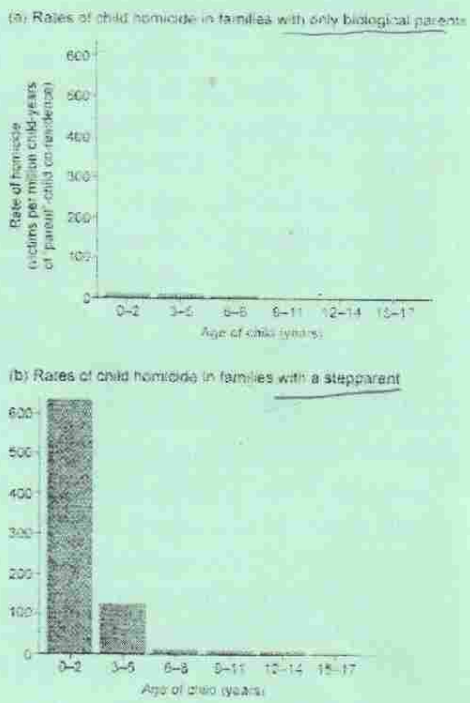
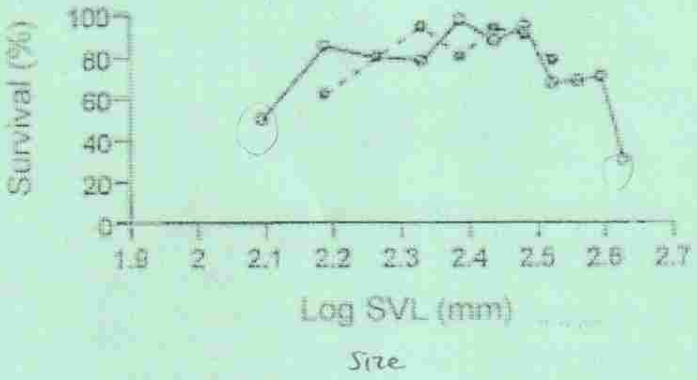
27. In the figure at the side, which is the most logical conclusion from the data?
    A. Older children will not die of homicide when living with biological parents.
    B. Young children are more at risk when living with a step-parent.
    C. All step-parents are unfit at raising nonbiological children.
    D. Older children are more at risk when living with a step-parent.



Use the following information when answering question 28.

Martin Wikelski and L. Michael Romero (Body size, performance and fitness in Galápagos marine iguanas, Integrative and Comparative Biology 43 [2003]:376-86) measured the snout-to-vent (anus) length of Galápagos marine iguanas and observed the percent survival of different-sized animals. Figure 25.2 shows the log snout-vent length (SVL, a measure of overall body size) plotted against the percent survival of these different size classes for males and females.



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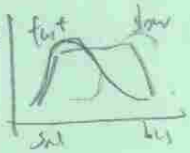
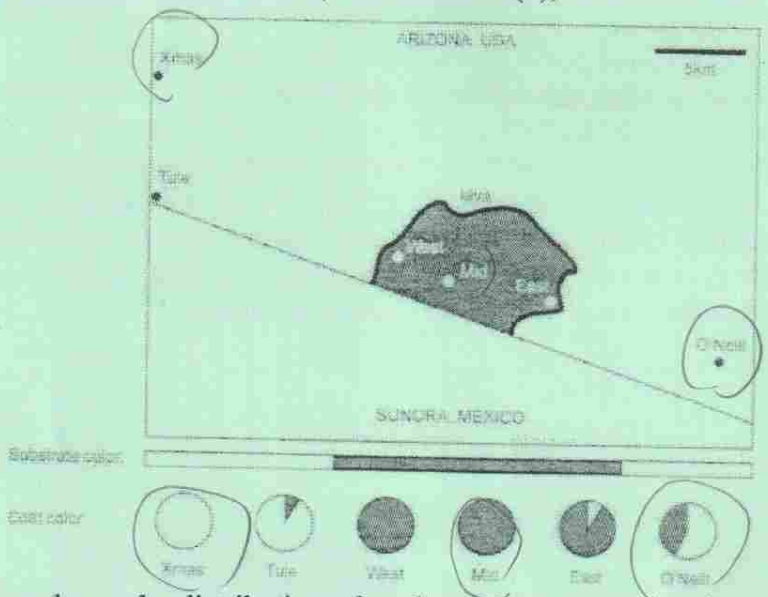
28. Currently the only predators of Galápagos marine iguanas are Galápagos hawks. Iguana body size is not correlated with risk of hawk predation, although small iguanas can sprint faster than large iguanas. If predators (e.g., cats) that preferably catch and eat slower iguanas are introduced to the island, iguana body size is likely to _____ in the absence of other factors; the iguanas would then be under _____ selection.
    A. increase; disruptive
    B. decrease; directional
    C. stay the same; stabilizing
    D. decrease; stabilizing
    E. increase; directional



29. Male frogs give calls that attract female frogs to approach and mate. Researchers examined mating calls of closely related tree frogs in South America. If reinforcement of prezygotic isolation is occurring, what would you expect if you compare the calls of the two species in zones of sympatry versus zones of allopatry?
    A. Calls would be more similar in areas of sympatry.
    B. Calls would be about the same in both areas.
    C. Calls would be more different in areas of sympatry.
    D. There is not enough information to decide what is happening

The following question is based on information in Hopi E. Hoekstra, Kristen E. Drumm, and Michael W. Nachman, "Ecological Genetics of Adaptive Color Polymorphism in Pocket Mice: Geographic Variation in Selected and Neutral Genes," Evolution 58(6), 2004: 1329-41.



30. The figure above shows the distribution of pocket-mouse coat colors in several Arizona populations found either on light-colored granite substrate or on dark volcanic rock (dark substrate). The Melanocortin-1 receptor (Mc1r) alleles, D and d, differ by four amino acids. Mice with DD and Dd genotypes have dark coats, whereas mice with the dd genotype are light colored. What sort of genotype frequencies might you expect to find in the Xmas, Mid, and O'Neill populations?
    A. Xmas high Dd frequency; Mid-high dd frequency, O'Neill high DD frequency
    B. Xmas high dd frequency; Mid-high Dd frequency, O'Neill high DD frequency
    C. Xmas high Dd frequency; Mid-high DD frequency, O'Neill high dd frequency
    D. Xmas high DD frequency; Mid-high Dd frequency, O'Neill high dd frequency
    E. Xmas high dd frequency; Mid-high DD frequency, O'Neill high Dd frequency

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Name: _____ Student No: _____

Short Answer Questions

rB > C kin reciprocal

31. Humans are known to perform acts that may cost their own Darwinian fitness and benefit another individual's fitness. Provide the theoretical basis for two different evolutionary explanations for such behaviours. Identify these and describe the two sets of required conditions for evolution to favour such actions (5 marks)

Humans perform such acts ~~[illegible]~~ to help ~~[illegible]~~ preserve or protect their own genes. This happens if ~~[illegible]~~ rB > C according to hamilton's rule. If the coefficient of relatedness time the benefit to the recipient is greater than the cost of the dom, then the human will likely help the other guy. This is altruism. Human are also more likely to help their own relative b/c their relatives are more likely to hold their genes, ~~[illegible]~~. This is kin selection, so if they ~~protect~~ help their relatives, they are in a way helping ~~themselves~~ to pass on their own genes.

The other reason why humans help others even if it costs themselves is reciprocal altruism. This is when the human is helping other who are not relative or related to them but they still help them if rB > C. benefit is greater is greater than ½ cost to self because in the long-term it may benefit the human back if the other person reciprocals

3.5

32. A friend argues that adaptations in nature are so elaborate, that they must have been designed for their specific purpose, and therefore could not be due to a process of natural selection that requires a random process of mutation. How would you come to the rescue of evolution by natural selection? Provide evidence supporting your argument. (3 marks).

Adaptations in nature is due to natural evolution b/c in nature, you see that species ~~[illegible]~~ pass on their trait to their offsprings ~~which are~~ The traits that they pass on will be favourable in terms of allowing their offsprings to successfully survive and reproduce b/c ~~they are~~ the parents are survivors and ~~their~~ they passed favourable trait down to their offsprings If there is an environmental change, for ex climate gets too hot, you see in species that some die off while ~~other~~ other selected for survive b/c they have certain traits which favours or helps them survive. Then they reproduce and pass on this favored trait allowing their offspring different reps success. And the new generation of offspring will be resistant to the hot climate

Need examples against 'design'

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33. "Ontogeny recapitulates phylogeny" was an outdated way to describe similarities in early development. Describe in modern terms how such findings provide evidence for descent with modification. (2 marks).

1 In modern time, this is known as ~~the~~ embryonic development ~~of~~ or developmental homology which shows that embryos of different species undergo similar embryo development mechanisms ~~and~~ as their embryos look very similar bw diff species. This shows that they must have ~~to~~ descended from a common ancestor w/ slight modifications to become diff species. Thus ~~they~~ species ~~used to~~ embryos look very similar (~~they all have~~ mammal embryo all have gill slits) b/c they ~~to~~ evolved from common ancestor

34. As an evolutionary ecologist you are looking for an evolving population to study. You come upon a dense population of water striders that have intriguing markings on their backs. You count 229 with completely dark backs, 399 with a gray spot in the middle of their pronotum and the remaining 174 individuals have a bright white spot there. It is known that homozygous individuals (BB) have dark backs and that the gray-spotted individuals are heterozygous. The white-spotted individuals are homozygous (bb). Is this a good population for you to study? Do you **need** any further information to make your decision? Show clearly how you came to this conclusion. Show and explain your calculations (5 marks)

BB Bb bb

229 dark 399 gray 174 white

genotype freq (total = 802) 229/802 = 0.286 399/802 = 0.498 174/802 = 0.217

# of alleles 229 x 2 = 458 B 399 B 399 b 174 x 2 = 348 b

allele freq (total = 1604) $\frac{458 + 399}{1604} = 0.534 = p$ $\frac{399 + 348}{1604} = 0.466 = q$

5

$p^2 + 2pq + q^2 = 1$

expected genotype:

BB: $p^2 = 0.534^2 = 0.286$

~~Bb~~bb: $q^2 = 0.466^2 = 0.217$

Bb: $2pq = 2(0.534)(0.466) = 0.497$

observed genotype

BB = 0.286

bb = 0.217

Bb = 0.498

This is a ~~bad~~ pop. to study b/c it's at H-W equilibrium as observed genotype is as expected. Therefore pop is not evolving. Only if there is genetic drift, gene ~~flow will be a good p~~ flow, natural selection, mutation, etc, then the pop will be evolving

THE END