

Evolution BIOL403

1. (6 pts) What were the two central propositions set out by Darwin in the Origin of Species?

1. The history of life is a branching tree

2. The explanation for the adaptedness of organisms is natural selection

2a,b. Identify each pair of traits as either homologous or analogous, and say why.

2a. (4 pts) The arm bones of a bat and a bird

Homologous; the arm bones of a bat and a bird are similar due to common ancestry.

2b. (4 pts) The wing of a bat and a bird

Analogous; the wing of a bat and a bird are similar due to common functional requirement, not common ancestry

3. (18 pts) List three predictions of evolution as a branching tree. For each prediction provide a (different) real world supporting example.

Life as a branching tree predicts:

1. Homologous similarity between extant species

Example; the tetrapod limb in land vertebrates

2. Older forms give rise to more recent ones (fossil record)

Example: fossils of amphibians appear earlier in the record than fossils of birds.

3. The existence of transitional forms (missing links)

Examples: archaeopteryx, basilosaurus, acanthostega

4. (4 pts) List two problems with the view of evolution as a ladder.

- 1. It implies evolution has a goal**
- 2. It implies that some organisms are more highly evolved than others, yet all species have been evolving for the same amount of time.**

5. (4 pts) What aspect of the theory of natural selection did early Mendelians not accept?

The idea that evolution proceeded gradually, in small steps. This idea is implicit in the requirement that for natural selection to operate, there must be resemblance between parent and offspring. Early Mendelians were more impressed by large changes, such as a white eyed fly born to parents with red eyes.

6. (4 pts) What are (different) alleles?

Alternative sequences at a genetic locus

7. (4 pts) Experiments using bacteria and single celled eukaryotes suggest that single mutations have on average what kind of effects on fitness? How would this generalization be modified with respect to the expected effects of mutations in humans?

Slightly deleterious.

In humans, a large fraction of the genome is non-functional. Mutations occurring in the non-functional sequences may have little or no effect on the phenotype. Therefore, mutations are expected to be slightly deleterious on average, if they have any effect at all.

8. (4 pts) Why is the number of mutations per genome per generation (not per cell division) of key importance to natural selection?

Because natural selection works on phenotypes, not genotypes

9. (4 pts) In mutation accumulation experiments using *C. elegans*, why is one individual chosen at random to found each new generation?

To minimize the effects of natural selection (because who survives to the next generation is determined at random).

10. (4 pts) What is the evolutionary explanation for similarly very low mutation rates per DNA base replication in many different organisms? Why is HIV an apparent exception to this rule?

Natural selection has acted to make this mutation rate as low as possible.

Experiments using bacteria indicate that a higher mutation rate is favored in novel environments. Thus, the very low mutation rate per base in most organisms suggests that they are well adapted to the current environment.

A higher mutation rate in HIV is selected for because it finds itself in a constantly changing environment.

11. (4 pts) List two contributing factors to differences between eukaryotic organisms in the number of mutations/genome/generation.

The number of cell cycles/generation

Genome size

12. (4 pts) List two processes which can generate new genetic variation for a phenotypic trait (for example, oil content in a population of corn plants).

Mutation

Recombination

13. (16 pts) List four requirements for natural selection to operate. For each requirement, provide an evaluation of how/whether the requirement is met for the example of the evolution of AZT resistance in HIV occurring within a single individual.

1. Individuals vary with respect to the trait

The genetic basis for resistance to AZT is known, involving mutations in the RT gene. The high mutation rate of the virus guarantees that individuals will vary with respect to AZT resistance.

2. (At least some of) this variation is heritable

The genetic basis for resistance to AZT is known, involving mutations in the RT gene. These mutations will be heritable.

3. Individuals vary in their survival and reproduction

The reproductive capacity of the virus greatly exceeds the number of cells it is able to infect within the host.

4. Survival and or reproduction must be non-random with respect to the trait.

The mutant virions with discriminating RT reproduce more (as demonstrated in vitro)

14. (4 pts) Give two reasons why offspring may resemble their parents.

Shared alleles

Shared environment

15. (4 pts) Some organisms appear to have scarcely changed their phenotype over many millions of years (“living fossils”). What evolutionary explanation accounts for this observation?

Stabilizing selection in a largely unchanged environment.

16. (4 pts) Each human is born with more than one new deleterious mutation in their genome (on average). This has probably been true for many thousands of generations. Why then do evolutionary biologists think it is cause for concern now?

Because relaxed selection due to medical intervention is allowing new mutations to accumulate.