

Problem Set #4.

Chapter 5, #1,2,6,8,13,16

1. A silent site mutation does not change the amino acid specified by a codon; a replacement mutation does.
2. Chromosomal inversions arise commonly due to DNA damage imposed by radiation causing double strand breaks. The DNA in the cell cannot be duplicated unless the damage is repaired, and genetic systems have evolved to repair double strand breaks. In the case of multiple breaks a fragment may become inverted relative to its original position in the chromosome.
6. Transitions replace a purine with a purine or a pyrimidine with a pyrimidine; transversions replace a purine with a pyrimidine or a pyrimidine with a purine. Transitions are much more common than transversions.
8. Evolution by natural selection cannot occur unless heritable variation exists. Heritable variation is based on variation in the alleles present among individuals in a population.
13. Yes, because the DNA sequence has been altered. This is a new version of the gene for beta-globin.
16. As discussed in lecture, the number of mutations per gamete is expected to differ in human males vs. females. Male gametes are made continuously with the onset of puberty, resulting in approx. 23 additional cell divisions per year after puberty. Female gametes are not made continuously, and undergo a total of approx. 33 cell divisions per generation. Depending on the age of the male, the number of mutations in male gametes is expected to be considerably greater than in female gametes.

Additional Problems:

1. A striking exception to the rule that mutation rates per base pair are similarly low in most organisms, HIV has a mutation rate (per base pair) that is orders of magnitudes higher. Provide an evolutionary explanation for this observation (why might a high mutation rate be advantageous?).

HIV reproducing within an individual host is confronted by a constantly changing environment. The host immune system learns to recognize the virus, which in turn alters its appearance to evade detection and therefore attack by the immune system, prompting a further immune response. Experiments in bacteria indicate there is adaptive advantage to a higher rate of mutation in novel environments, suggesting that the high mutation rate in HIV is adaptive.

2. Cite two types of evidence in support of the idea that genetic variation is usually abundant in natural populations.

Artificial selection experiments and direct assessment of genetic variation in populations both indicate substantial variation within populations.

3. Some artificial selection experiments fail to show a response to selection after 20-30 generations. What do you conclude about the contribution of new mutations to the generation of a selective response in these cases?

The failure of response to selection suggests that genetic variation already present within the population was responsible for the initial response. Once this variation is fixed, no response is expected in the absence of new mutations affecting the trait. It appears there is little contribution of new mutation in these cases.

4. Cite specific evidence that the recombination rate in organisms evolves under selection like any other trait.

The recombination rate in domesticated animals is extremely high compared to other species; it appears the artificial selection for extreme traits has resulted in the evolution of the recombination rate as well.