PRACTICE PROBLEMS 6 ANSWERS

1. $E = K/2T = 0.744/(2 \times 80 \times 10^6) = 5 \times 10^{-9}$ substitutions per site per year

$u = E = 5 \times 10^{-9}$ substitutions per site per gamete

2. Since $E \approx u$ for synonymous sites, the mutation rate is more than 10X higher in mitochondria.

3.
(a) B, because the data show that LAV-1a and pv.22 had a more recent common ancestor than either did with ARV-2.

(b) $E = K/2T$ so $T - K/2E$. K is $45/1500 = 0.03$, so $T = 0.03$ bp substitutions$/2 \times 10^{-3}$ bp substitutions per bp per year = 15 years.

4. Answer each of the following questions with M for Mutation rate, BS for Balancing Selection, DS for Directional Selection, D for random Drift, or I for Inbreeding.

(a) DS. An increase in frequency of a trait is presumably due to an increase in the frequency of the gene or genes controlling it. This could be due to drift, but when the increase occurs only after exposure an environmental change that would select for those genes, it is more likely due to selection. It could be verified by experimentally replicating the process in a population cage.

(b) DS. A difference in mutation rate can't explain this, since there is no way that mutations could preferentially cause synonymous changes.

(c) BS. Both directional selection and drift tend to eliminate alleles. It is very unlikely that mutation would preferentially produce enough HbS alleles to replace those lost by selection or drift. Plus studies have shown that these alleles are overdominant when there is lots of malaria.

5. (a) Lowering N usually lowers Ne, which speeds up drift and lowers nucleotide diversity.
(e) Lowering N means each individual has fewer partners to mate with and these are more likely to be close relatives, which is inbreeding and eventually can produce pure lines.

6.
(a) $E = 2NuF$ where N is population size, u is mutation rate, and F is fixation probability.

(b) $E = 2 \times 10^6 \times 5 \times 10^{-10} \times 10^{-7} = 10^{-10}$ substitutions per site per generation or per gamete

(c) $E = u = 5 \times 10^{-10}$ substitutions per site per generation or per gamete