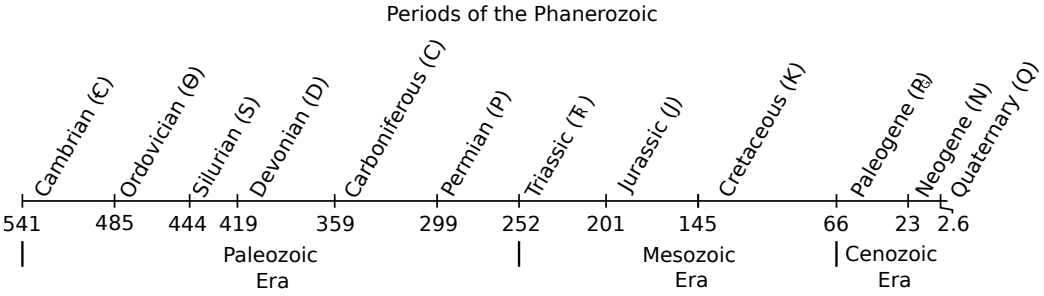
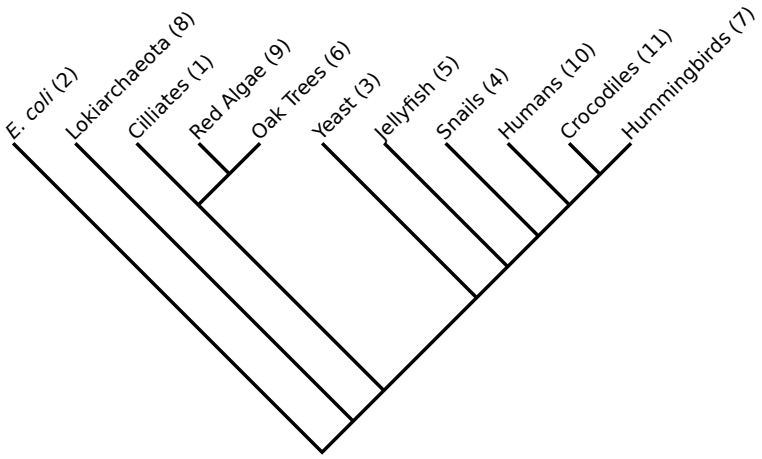
Midterm Exam 1 - Organic Evolution

1. 

2. 

Subtract 1 pt for each branch that must be moved or added.

3. This will greatly reduce effective population size since $N_e = \frac{4N_f N_m}{N_f + N_m}$. This reduction in N_e increases the role of drift in livestock evolution, making it easier for deleterious recessive alleles ,which are nearly neutral when rare since most are in Heterozygotes, to drift to moderate frequencies. (It is not correct to say that reduced variation leads to the appearance of deleterious alleles, what matters is the role of drift as opposed to selection)

4. d, f, b, h, j, k, a, g, i, c, e (Subtract 1 pt for each one that must be moved or added.)

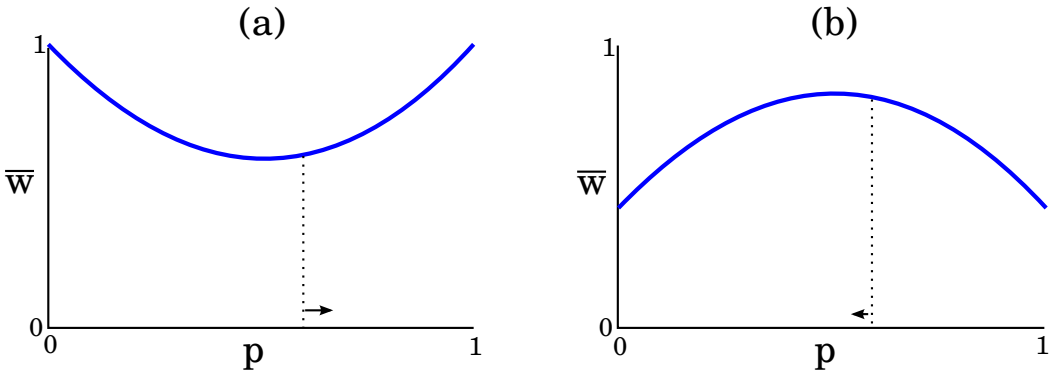
5. (a) The frequency of an allele at which the rate of decline due to selection is balanced by the rate of appearance due to mutation.
(4 pts for the equation with no explanation.)
(4 pts for just "point at which selection exactly counters mutation".)

   (b) MSB maintains may slightly deleterious alleles in a population. If the environment changes, some of these will become adaptive and immediately start increasing in frequency. Without this supply of genetic variation, the population would have to wait for new mutations to arise before adaptive evolution could commence.

6. (a) The rate of fixation of neutral mutants is the rate at which they appear multiplied by the probability of fixation. The rate of appearance is $2N\mu_n$, where μ_n is the neutral mutation rate. The probability of fixation is 1/(2N). The product of these values is just μ_n, which is relatively constant among related organisms.
(2 pts if they just say that the fixation rate is the mutation rate, which is relatively constant.)

(b) We find an outgroup to the clade of interest, then calculate the genetic distance between each member of the clade and the outgroup. If the distances are all the same, then the rate of molecular evolution has been constant within the clade of interest (strictly, the average rate along each branch has been the same, but they need not say this). (Answering with fewer words and a picture is fine.)

7.



5 pts for each graph. Subtract 1 pt each for lack of labels on the axes, and 1 pt for not indicating the direction of evolution (either on the graph or in words).

8. (a) If there were no selection acting, then one or the other allele would almost certainly have gone to fixation by drift over this amount of time.

(b) The heterozygote (A_1A_2) would have the highest fitness, because this would maintain both alleles in the population in the face of drift.

9. (a) Last Universal Common Ancestor. The most recent common ancestor of all life on earth.

(b) Differential survival or reproduction that is causally determined by variation on phenotype. (1 pt for differential survival or reproduction only, with no suggestion of causality.)

(c) Change in allele frequencies resulting from random variation in which alleles make it into the next generation. (Or: resulting from random variation in survival and reproduction.)

(d) Fossil evidence of animal activity, such as burrows, footprints, etc.

(e) The period at the end of the Proterozoic (or right before the Cambrian) when large, multicellular, organisms become common in the fossil record. (Or: 635-541mya).

(f) Hypothesized period of earth history during which all genetic and many cellular processes were carried out by variants of RNA.

(g) Average fitness of an allele, across all genotypes in which it is found. (Equations ok).

(h) Eon from 2.5bya - 541mya. (Full credit for things that happened then).

(i) Precambrian Mollusk fossil.

(j) Set of allele copies found in a haploid genome or gamete.