Midterm Exam 3 - Organic Evolution (Biol 3305)

1. (a) R = Response to selection (1 pt. for just this) = (mean of offspring generation)-(mean of entire parent generation)
   S = Selection differential (1 pt. for just this) = (mean of selected parents) - (mean of entire parent generation)
   h^2 = heritability = Regression of offspring phenotype on midparent phenotype (just 'parent phenotype' OK)

   (b) Both heritable (genetic ok) factors, and non-heritable ("environmental" ok) factors contribute to variation in a trait within a population (2 pts). The individuals that are most different from the mean have both genetic and environmental factors pushing them in the same direction. However, only the genetic factors are passed on to their offspring. Thus, the offspring of the most extreme individuals tend to be less extreme than their parents.

2. (a) The covariance between one trait in parents and another trait in their offspring.

   (b) This involves the joint increase in frequency of a trait in one sex and the preference for that trait in the other sex (2 pts). This can occur only if there is an additive genetic covariance between the trait and the preference. (Or: With a genetic covariance between the trait and the preference, the preference effectively selects for itself)

   (c) Here, females prefer to mate with males that express some trait because that trait covaries with some other, unobservable, trait that is advantageous.

3. Sexual reproduction and recombination reshuffle alleles every generation (2 pts). When directional selection is increasing the frequencies of formerly rare alleles, this reshuffling produces many new genotypes (4 pts), adding new variation to the population. This is important because it means that selection does not quickly reduce the genetic variation in a population, so further selection can continue to drive evolution (4 pts). (Or: New variants are produced in the direction that selection is acting, alowing evolution to continue).

4. A was larger (2 pts). A's legbones are proportionally thicker than those of B (Or: A's skeleton comprises a larger proportion of its body) (4 pts). The mass of an animal scales as length^3 Bone strength is determined by the cross-sectional area of the bone, which scales as length^2 unless the bone becomes proportionally thicker. (4 pts. 2 pts for just saying that the bones must get proportionately thicker in order to support the body.)

5. (a) In both cases, the Freq(S_1) declines at 0.5 (2 pts). In (A), the ESS is where the lines cross. In (B) it is at Freq(S_1) = 0 (4 pts)

(b) Graph (A) corresponds to matrix D, Graph (B) corresponds to matrix C

6. (a) Overall, males and females of a diploid species produce the same number of offspring (Or: each individual has one mother and one father), the rarer sex thus always has a higher mean fitness than the more common sex (2 pts). As a result, there is selection for individuals to produce more of the rarer sex in their offspring (2 pts), since this increases the number of grandchildren that they will ultimately leave (1 pt).

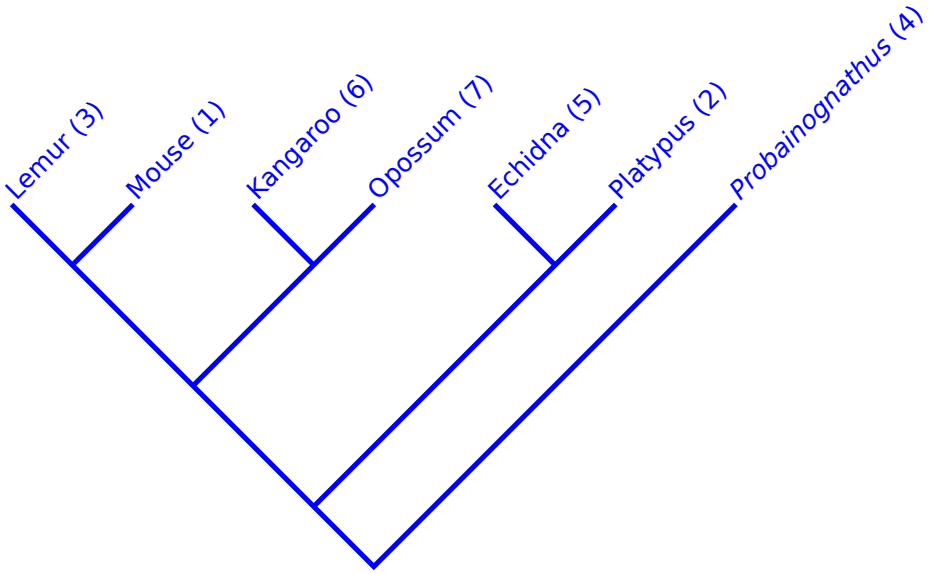
   (b) When organisms grow up and mate within fixed groups, then selection at the level of groups favors those that have a female biassed sex ratio (3 pts), since these produce more individuals that will leave to found new groups (2 pts). (Clear explanation of figwasp example ok)

7. (a) B = The benefit of an altruistic act to the recipient. ($\frac{1}{2}$ pt. for just "benefit")
   C = Cost to the altruist of an altruistic act. ($\frac{1}{2}$ pt. for just "cost")
   p_a = The expected number of altruistic acts experienced by an altruist.
   p_s = The expected number experienced by a non-altruist.

   (b) In kin selection, altruists direct altruism towards their relatives (1 pt. for just this). Since relatives are genetically similar, there is a higher than random (high ok) chance that they will also be altruists, this increases p_a relative to p_s (just increases p_a is ok).

   (c) In reciprocal altruism, altruists direct altruism primarily towards others who have been altruistic in the past (helped them in the past ok. 1 pt. for just this). This also increases p_a relative to p_s (just increases p_a is ok).

8. (Subtract 2 pts for each branch that must be moved or added to get the correct tree.
   Subtract 1 pt for each extra taxon that is added)



9. Briefly define the following terms. (2 pts. each)

(a) State in which there are two different kinds of gametes, large and small.

(b) Selection on ("fitness of" ok) a strategy (or allele) is a function of its frequency (or: the frequencies of different strategies or alleles).

(c) Vector pointing in the direction of maximum increase in fitness.

(d) Differential mating success that is causally influenced by variation in phenotype.

(e) Social system in which some individuals give up reproduction altogether in order to help others.

(f) Strategy (in the repeated prisoner's dilemma game) that involves cooperating the first time one meets someone, and thereafter doing whatever the other player did on the previous encounter.

(g) A trait expressed in one sex (males ok) that is selected on by members of the opposite sex (females ok) because is correlated with some other, unobservable, trait(s) that is beneficial.

(h) Kind of heterochrony (1 pt. for just this) in which the growth trajectory is extended beyond where it ended in the ancestor.
[In this and the next two, they need not mention the word "heterochrony" if they accurately describe the changes in growth.]

(i) Kind of heterochrony in which the growth trajectory stops earlier than it did in the ancestor. (Or: Onset of sexual reproduction shifted to an earlier growth phase).

(j) Kind of heterochrony in which growth is uniformely slowed down.