

NAME: \_\_\_\_\_

The BIO 140E Midterm consists of four questions, each with multiple parts. Make sure to write legibly and concisely. Answer each part within the allotted space.

1) Draw the fitness payoff matrix for individual encounters in the Hawk-Dove game.

a) Define the terms V and C (1 pt total) 0.5 for each complete answer (ie just stating V= value/benefit/gain got 0.25)

V = fitness benefit from obtaining the resource after an encounter by winning a fight

C = cost of fighting and not obtaining the resource (losing)

b) Indicate the different values of payoffs using V and C (2 points)(1 point for filling in table with hawk/dove/something in the payoff boxes, 0.25 for each payoff box filled in correctly)

| Pl<br>ay<br>er<br>1 | Player 2 |                             |                        |
|---------------------|----------|-----------------------------|------------------------|
|                     | Strategy | Hawk                        | Dove                   |
|                     | Hawk     | $W_{HH} = \frac{1}{2}(V-C)$ | $W_{HD} = V$           |
|                     | Dove     | $W_{DH} = 0$                | $W_{DD} = \frac{V}{2}$ |

c) Describe the two conditions that must be met for a strategy to be an evolutionarily stable strategy (ESS) in a population. (2 points) (one point for each correct condition)

1. When the strategy is rare in a population, it must be able to invade by defeating other common strategies.
2. When the strategy is common in the population, it must be able compete with invading strategies and itself.

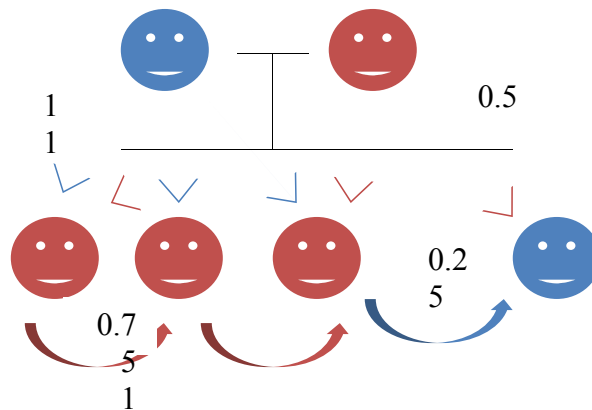
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2) The following questions all pertain to levels of selection.

- a) What are the five levels of selection discussed in class and in the text? Describe an example from class or the text where two levels of selection conflict. (1 point for correct levels of selection, -0.25 for one level wrong, -0.5 for 2-3 wrong, -0.75 if only one correct)(1 point for correct levels of conflict and explanation, - 0.5 for incorrect levels of conflict, -0.5 for incorrect explanation of conflict)

Genic, individual, kin, group, and species. The t-allele in mice illustrates how genic level conflicts with individual level selection. Because it is over-represented in male heterozygote sperm, the t-allele propagates itself until it is checked at the individual level by the predominance of sterile males that are homozygous for the t-allele.

- b) Draw out a family tree diagram illustrating how haplodiploidy in the Hymenoptera produces relationships between family members that result in kin selection. Indicate ploidy of individuals, degree of relatedness between family members, and which family members will be most altruistic towards one another. (2 points)  
(0.5 for correct  $r$  values, 0.5 for ploidy indicated, 0.5 for indicating sisters would be most related and therefore altruistic, 0.5 for completeness/ wiggle room to give credit if it seemed like they were on the right track and just fudged some things up)



- c) Describe an example of a greenbeard in nature. What makes the greenbeard system different than kin selection? (1 point)  
(0.5 for example, 0.5 for distinction between greenbeard and kin selection)  
Possible examples: RPS lizards, fire ants. The greenbeard system doesn't rely on kinship to function, just shared genes that produce a particular phenotype.

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- 3) Lions (*Panthera leo*) typically live in prides that contain multiple females defended by one dominant male. Males defend their territories while females are responsible for hunting for food and raising cubs. Answer the following questions.

- a) In class we talked about how there is a discrepancy between the group sizes of lions predicted by theory and that observed in nature. Describe why this occurs.  
The optimal group size of hunting females when feeding on prey such as gazelle was predicted to be 2 based on food intake/lion. Groups of lions may be much larger than this optimum because of variability in prey resources, with larger groups being able to take down larger prey items. Groups are also larger than the two that was predicted because a few females need to stay behind and protect the cubs from male lions that may kill cubs that are not theirs.

Full credit: Made some mention of what the optimal group size prediction was based on, and also talked about how groups are often larger, and made some mention of cub prediction. Some people mentioned all three (theory, differences in foraging with prey type, and cub protection)

Partial credit: Mentioned cubs but no mention of what theory was based on, etc (-0.5), in depth description of how group size varies with prey type (-0.25).

- b) What is the name of the equation/inequality you would use to determine the fitness benefit that a female lion gains from her mutualistic interaction with other females?

Hamilton's rule

Most people either got this or they didn't. Because of this, I altered the point value to only be 0.5. A few people got half credit if they knew the inequality, but didn't list the actual name.

- c) Females in a lion pride all tend to come into estrous at about the same time. What might be one proximate and one ultimate cause for this? Make sure that each explanation is clearly labeled as either proximate or ultimate.

Full credit: Came up with an explanation for each that fit under the appropriate category and was a plausible explanation.

Partial credit of varying amounts: Mixed up proximate and ultimate explanations (-0.25), unclear explanation but had the right idea (-0.25), listed two proximate, or two ultimate deductions (-0.5), etc.

Proximate: The release of hormones may be triggered by an environmental cue, and since all the females inhabit the same area, this cue will trigger hormone release in all of the females at the same time.

Ultimate: If all the females come into estrous at the same time, it means that all their cubs will be born around the same time. This may increase cub survival because any female will be able to nurse them, and they will be able to develop important skills during that time period (e.g. play fighting).

- d) New habitat becomes available and is subsequently colonized by a number of lion prides. Some of the patches within the habitat are of better quality than others. How would you expect lion prides to be distributed if they exhibited an ideal despotic distribution?

Expect the earliest colonizing prides to settle in the habitat that is of the best quality and exclude later colonizing prides from those areas. Later colonizing prides must settle for lesser quality territories.

Partial credit: Realized that this question was not referring to ideal free distribution and talked about how the strongest prides would control the best territories

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4) Northern elephant seals (*Mirounga angustirostris*) exhibit a polygynous mating strategy where territorial males defend harems of females. Females nurse their pups from body reserves they have built up during their previous foraging trip. Answer the following questions based on this system.

- a) List and very briefly describe the two other types of male strategies that we talked about in class that might apply to this system.

- 1) Sneaker male – try to sneak into another male's territory unnoticed
- 2) Satellite male – might hang on the periphery and try to mate with females on their way from the water to the beach

Either strategies could potentially be a female mimic

Full credit: answers that talked about either sneaker, satellite males, beta, gamma males, etc. I also gave credit if they talked about lekking or monogamy.

Partial credit: Gave one example (-0.5)

- b) Provide an example of how Fisherian runaway selection might work in this species

Females may choose males that have an elaborate trait. Female choosiness and this male trait must be heritable. Males with elaborate traits will get all of the matings from the choosy females, and half of the matings from the non-choosy females. The choosy females will mate with males with elaborate traits, and will have daughters with the choosy trait and sons with the elaborate trait. Over time, these two traits will become genetically correlated and runaway selection will occur.

Full credit: Had to indicate female choice, something about passing it on to offspring, and genetic correlation (or linkage disequilibrium).

Partial credit: No mention of genetic correlation or offspring (-0.25), no mention of offspring and genetic correlation (-0.5). Less partial credit for less complete answers.

- c) Acoustic communication between males is very important for elephant seals during the breeding season. Explain what this type of communication is called and why it is important.

Honest communication, important because it conveys information about each male to the opposing male (e.g. size) to reduce energy expended/cost on potentially lethal fights. Also may be used by males to recognize their neighboring alpha males, which also reduced energy spent on displays and fights.

Full credit: Used the word honest, talked about conveying information to reduce the cost associated with lethal fighting. Some people talked about the Dear Neighbor hypothesis, which was fine as long as they mentioned the above things.

Partial credit: Got everything right, but no mention of honest communication (-0.25), no mention of cost associated with fighting (-0.25), or no mention of either (-0.5), but got the general gist.

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