Philosophy 3334: Philosophy of Biology
Fall 2023
First homework assignment

This homework is due before midnight on Monday, Sept 25th. Your answers should be uploaded into Blackboard.

1) What does chromosomal crossing over have to do with how Dawkins defines what a gene is? In some species, crossing over does not occur and we could imagine species where it happened much more frequently per chromosome. How would this affect what a gene is on Dawkins view?

2) For at least some behaviors, genes could potential "hard-wire" these behaviors in so that they are like involuntary reflexes. But in many species (like humans) many behaviors are not controlled directly by genes but rather the result of a decision by a brain. But brains often make decisions that are not good for the survival of the genes. So how can we explain why a gene would build a survival machine with a brain that can make decisions like committed suicide or using contraception?

3) Imagine the following scenario: A species of carnivore is such that there are two different hunting strategies in the population. Strategy 1 is to pursue the 'group hunt' strategy of attacking big game, which is only successful with help. Strategy two is to pursue the 'lone wolf' strategy of hunting smaller game, which is always successful. When the time comes to get food, the hunters find themselves nearby another hunter. If a 'group hunter' meets another 'group hunter' they each receive 4 units of benefit. 'Lone wolf' always receives 2 units of benefit no matter who they meet. But if a 'group hunter' meets a 'lone wolf', then 'group hunter' gets 0 benefit while 'lone wolf' gets 2.

In other words, we have the following payoff matrix:

	Group hunter	Lone wolf
Group hunter	4,4	0,2
Lone wolf	2,0	2,2

Which of these two strategies, if any, is an evolutionarily stable strategy? Explain how you know.

4) Imagine a two-player game where individuals in the population are paired at random. There are two possible strategies: heads and tails. If both players play heads or both players play tails, then each player gets 1. However, if a head is paired against a tail, then the head receives 4 units of payoff and the tail receives 6. In other words, we have the following payoff matrix:

	Heads	Tails
Heads	1,1	4,6
Tails	6,4	1,1

In fact, neither heads nor tails is an evolutionarily stable strategy.

4a) Explain why neither strategy is stable.

4b) Now imagine that the population is 80% heads and individuals are paired at random. What is the expected payoff of the heads strategy? And what is the expected payoff of the tails strategy?

4c) Assuming that the payoffs represent reproductive fitness, over time, this population will reach a stable state. What is the percentage of heads and tails in this stable state? Show your work and explain how you know this state is stable.

5) What would be the coefficient of relatedness be between me and my mother's half-sister? (Half-siblings share one parent but not both parents). Explain your answer.

6) In each of these three following scenarios, explain which trait will be favored by natural selection and why. If you think particular numbers do or do not matter, your answer should explain why they do or do not matter (in other words, show your work).

6a) Organisms of species 1 typically find themselves in groups of size 5 on average. Organisms in this species leave their homes soon after they are born and so are no more likely to be nearby kin than nearby more unrelated organisms. When a predator attacks, there are two possible strategies: Strategy A is to simply run away.
If you do so, you might survive, you might not. The predator might kill another organism in your group, it might not. Maybe everyone will get away, but the predator never catches more than one member of your group. If you just try to run away everyone else will too. Each of you has a 10% chance of being caught by the predator and there is a 50% chance you will all get away. Strategy B is to send up an alarm call first which tends to cause the predator to focus on you but warns the other members of the group and so they get away. Now the chances of you being caught are 20% but everyone else always gets away so the chances that you all get away are 80%.

Will natural selection favor strategy A or strategy B?

6b) Organisms of species 2 live in family units consisting of a mother and all her children who always share the same father. Sometimes there are 2 children, sometimes 3, sometimes 7, etc. On average, the group consists of 5 individuals. When a predator attacks, there are two possible strategies: Strategy A is to simply run away. Each of you has a 10% chance of being caught by the predator and there is a 50% chance you will all get away. Strategy B is to send up an alarm call first which tends to cause the predator to focus on you but warns the other members of the group and so they get away. Now the chances of you being caught are 20% but everyone else always gets away so the chances that you all get away are 80%.

Will natural selection favor strategy A or strategy B?

6c) Organisms of species 3 like to 'spread out' (relative to species 1 and 2) and so when predators attack the average group size is only 3. And often, but not always, they are near their kin. On average, the relatedness coefficient of their other group members is .2. When a predator attacks, there are two possible strategies: Strategy A is to simply run away. If you do so, the chance of being killed yourself is 10% and the chance of each other member of your group being killed is 10%. There is therefore a 70% chance you will all get away. Strategy B is to first send up an alarm call warning everyone in your group near enough to hear. The chance of being killed yourself is now 20%, but the other organisms will get away for sure meaning there is an 80% chance you will all get away.

Will natural selection favor strategy A or strategy B?