Name ____ Period ______ Date ____________

IB Biology Adapted from K. Foglia AP Biology

Natural Selection of "Strawfish"

Grading Rubric

Section	**Points Possible**	**Points Received**
Format / Communication	2	
Purpose – Give a brief summary of the purpose of this activity	2	
Data Tables (titles and organization) • Control Group • Test 1, 2, 3, 4	5	
Calculation Tables (fully worked exemplar of each type of calculation is shown) • Control Group • Test 1, 2, 3, 4	5	
Graphs (**Frequency of Colors of Surviving Fish** and **Frequency of Surviving Alleles**) • Title and labeled axes with units • Proper type of graph utilized	4	
Analysis and Summary Questions	4	
Total Points Earned	22	

Background

You have already been introduced to the idea that when an organism is "selected by nature" to survive, it then has the opportunity to reproduce and pass on the genes for its favorable traits to its offspring. In this way, the genes for more favorable traits — traits that give an individual organism greater fitness — show up more frequently in each succeeding generation.

In this activity, we will explore this concept further. Our model organism, in this lab, will be a species of fish — the "Strawfish" — that live in freshwater ponds. In this simulation, we will investigate how different natural selection factors in the environment can influence the colors of Strawfish. We will also look "underneath the skin" and measure how these natural selection factors also affect the inheritance of the genes that code for the color of Strawfish.

In Strawfish, there are three scale/skin colors (phenotypes) — blue, yellow, green. These three colors are controlled by a color gene that comes in two versions (two alleles) — the blue allele and the yellow allele. The blue and yellow alleles do not show a classical dominant / recessive interaction. Instead when they are inherited together they show an incomplete dominance interaction, therefore the heterozygote will be a green colored fish.

Each lab group (working in pairs) will be given a bag of alleles (straws) — 20 yellow and 20 blue straws. These represent the collection of genes in our population of fish — the fish gene pool. As in nature, Strawfish are diploid organisms — they have two copies of every gene. The color of each fish is always determined by the interaction of the two copies (the two straws).

In each part of the lab, you will create fish by randomly pulling out two straws to determine their skin color. Each group will complete four different scenarios simulating different selection factors affecting your population of Strawfish. Ready? Let's go fishing!

Pre-Lab

1. Create a titled chart to indicate the possible genotypes (straw colors), for each phenotype (fish color).
2. Create a titled chart like the one below for each of the five tests.

Table 1: Population of Strawfish without Preferential Predation after Four Generations

	Colors of Surviving Fish				**Surviving Alleles**		
Generation #	**Blue**	**Green**	**Yellow**	**Total Fish**	**Blue**	**Yellow**	**Total Alleles**
1 Control							
2							
3							
4							

Procedures:

Control Group: No Preferential Predation

3. Before testing, first make sure there are 40 straws in your bag (20 blue & 20 yellow).
4. In each round, you will randomly pull two straws (alleles) from your fishing bag for each fish in the population and record the color of the resulting "Strawfish" in your data table until the bag is empty.

Rules for Preferential Predation

1. The first round in all subsequent tests serves as a **control** and should be completed without any predation.
2. In the next three generations in each test, predators will prey on the fish but under different selection factors (selection rules).

Test 1: Preferential Predation (Predators Prefer Blue Fish)

In this round, the predators discover that the yellow allele made a sour-tasting protein. Since both yellow and green fish have the yellow allele, both color fish taste sour to the predators. As a result, the **predators prefer blue fish**.

1. The initial round is a **control** and you should randomly pull straws out of the bag in pairs to produce your fish. No fish are eaten in this control round.
2. For the remaining three generations in this test, **the predators will eat every other blue fish (half of the blue fish)** and those alleles will be removed from the population — not passed on to the next generation.
3. Between generations within the round, **return only the surviving fish to the bag**.
4. After each generation, record the results for fish colors and the numbers of surviving alleles in an IB style table.

Test 2: Preferential Predation (Predators Prefer Yellow Fish)

In this round, the predators discover that the blue allele made a sour-tasting protein. Since both blue and green fish have the blue allele, both color fish taste sour to the predators. As a result, the **predators prefer yellow fish**.

1. Again, the initial round is a **control** and you should randomly pull straws out of the bag in pairs to produce your fish. No fish are eaten in this control round.
2. For the remaining three generations in this round, **the predators will eat every other yellow fish (half of the yellow fish)** and those alleles will be removed from the population — not passed on to the next generation.
3. Between generations within the round, **return only the surviving fish to the bag**.
4. After each generation, record the results for fish colors and the numbers of surviving alleles in an IB style table.

Test 3: Preferential Predation (Predators Prefer Green Fish)

In this round, the predators discover that the green fish are particularly flavorful. As a result, the **predators prefer green fish**.

1. Again, the initial round is a **control** and you should randomly pull straws out of the bag in pairs to produce your fish. No fish are eaten in this control round.
2. For the remaining three generations in this round, **the predators will eat every other green fish (half of the green fish)** and those alleles will be removed from the population — not passed on to the next generation.
3. Between trials within the round, **return only the surviving fish to the bag**.
4. After each trial, record the results for fish colors and the numbers of surviving alleles in an IB style table.

Test 4: Heterozygote Advantage (Green Fish Are Camouflaged)
In this round, an algal bloom changes the pond environment. The green fish are now camouflaged in the algae. Because they are easier to find, **predators prefer blue and yellow fish**.

1. Again, the initial round is a **control** and you should randomly pull straws out of the bag in pairs to produce your fish. No fish are eaten in this control round.
2. For the remaining three generations in this round, **the predators will eat every other blue fish (half of the blue fish) and every other yellow fish (half of the yellow fish)** and those alleles will be removed from the population — not passed on to the next generation.
3. Between trials within the round, **return only the surviving fish to the bag**.
4. After each trial, record the results for fish colors and the numbers of surviving alleles in an IB style table.

Calculations:

1. Recreate a table like the one below for **each test**, including the control and calculate the frequency of fish color types as well as surviving alleles in the initial trial and at the end of the third trial.
   Frequency of fish = (number of fish / total fish).

Table 2: Control Group – Frequency of Surviving Alleles in Strawfish without Preferential Predation after Four Generations

	Frequency of Colors of Surviving Fish			Frequency of Surviving Alleles	
Trial #	**Blue**	**Green**	**Yellow**	**Blue**	**Yellow**
1 Control					
4					

Graph:
Make appropriately styled IB bar graphs for your results for the **Frequency of Colors of Surviving Fish** <u>**and**</u> for the **Frequency of Surviving Alleles**.

Analysis and Summary Questions:

1. Why did you have to pull two alleles (two straws) from the bag to represent one fish?
2. For each of the four rounds, summarize what happened to the **phenotypic frequency** (fish color) and the **allele frequency** (straw color).
   a. Test 1: Preferential Predation (Predators Prefer Blue Fish)
   b. Test 2: Preferential Predation (Predators Prefer Yellow Fish)
   c. Test 3: Preferential Predation (Predators Prefer Green Fish)
   d. Test 4: Heterozygote Advantage (Green Fish are Camouflaged)
3. Why was it necessary to include the first round without predation (#1 Control) in each trial?
4. What type of selection trend (directional, stabilizing, disruptive) does each test represent?
5. In Test 1 — the “Predators Prefer Blue Fish”— were **alleles** removed from the population? Explain.
6. In Test 2 — the “Predators Prefer Yellow Fish”— were **alleles** removed from the population? Explain.
7. If you took Test 1 — the “Predators Prefer Blue Fish” — out to many more generations, do you think the blue allele would eventually be eliminated? **OR** if you took Test 2 — the “Predators Prefer Yellow Fish” — out to many more generations, do you think the yellow allele would eventually be eliminated? Explain.
8. In Test 3 — the “Predators Prefer Green Fish” — explain what happened to the frequency of the different colored fish.
9. In the Test 4, the case of the “Green Fish are Camouflaged”, explain what happened to the **allele frequency** in the population. Explain why did this happen.