Name ____________________________ Period _________

AP Biology Date ______________________

LAB ____. NATURAL SELECTION OF "STRAWFISH"

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).

On the chart, indicate the possible genotypes (straw colors), for each phenotype (fish color)

Phenotype	Genotype
yellow fish	
blue fish	
green fish	

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!

GENERAL INSTRUCTIONS: RULES FOR FISHING

1. First make sure there are 40 straws in your bag (20 blue & 20 yellow).
2. 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.
3. The first round in all tests serves as a **control** and should be completed without any predation. 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**.

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. For the remaining three generations in this round, **the predators will eat every other blue fish (half of the blue fish)** and those alleles will be removed from the population — not passing on to the next generation. Between generations within the round, **return only the surviving fish to the bag**. After each generation, record the results for fish colors and the numbers of surviving alleles.

	Colors of surviving fish				Surviving alleles		
Generation #	**Blue**	**Green**	**Yellow**	**Total fish**	**Blue**	**Yellow**	**Total alleles**
1 control (No predation)							
2							
3							
4							

Present your data as **bar graphs** on the graphs below.

SURVIVING FISH

Title ______________________________________

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SURVIVING ALLELES

Title ______________________________________

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CALCULATION OF FREQUENCIES

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)**

	Frequency of colors of surviving fish			Frequency of surviving alleles	
Trial #	**Blue**	**Green**	**Yellow**	**Blue**	**Yellow**
1 Control (before predation)					
4					

1. Compare the frequency of the **different color fish** throughout this test. Did the frequency of each color change much from generation to generation in this test? Explain.

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2. Did the **allele frequency** change much over the 4 generations in this test? Explain

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3. What is causing this change (or lack of change) in allele frequency?

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4. What do you think will eventually happen to the frequency of each allele in this population?

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5. What type of selection trend (directional, stabilizing, disruptive) does this simulation represent? ______________________________

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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**.

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. 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 passing on to the next generation. Between generations within the round, **return only the surviving fish to the bag**. After each generation, record the results for fish colors and the numbers of surviving alleles.

	Colors of surviving fish				Surviving alleles		
Generation #	**Blue**	**Green**	**Yellow**	**Total fish**	**Blue**	**Yellow**	**Total alleles**
1 control (No predation)							
2							
3							
4							

Present your data as **bar graphs** on the graphs below.

SURVIVING FISH

Title ________________________________

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SURVIVING ALLELES

Title ________________________________

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CALCULATION OF FREQUENCIES

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)**

	Frequency of colors of surviving fish				Frequency of surviving alleles	
Trial #	**Blue**	**Green**	**Yellow**		**Blue**	**Yellow**
1 Control (before predation)						
4						

6. Compare the frequency of the **different color fish** throughout this test. Did the frequency of each color change much from generation to generation in this test? Explain.

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7. Did the **allele frequency** change much over the 4 generations in this test? Explain

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8. What is causing this change (or lack of change) in allele frequency?

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9. What do you think will eventually happen to the frequency of each allele in this population?

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10. What type of selection trend (directional, stabilizing, disruptive) does this simulation represent? ____

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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**.

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. 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 passing on to the next generation. Between trials within the round, **return only the surviving fish to the bag**. After each trial, record the results for fish colors and the numbers of surviving alleles.

	Colors of surviving fish					Surviving alleles		
Trial #	**Blue**	**Green**	**Yellow**	**Total fish**		**Blue**	**Yellow**	**Total alleles**
1 control (No predation)								
2								
3								
4								

Present your data as **bar graphs** on the graphs below.

SURVIVING FISH

Title ____________________________________

SURVIVING ALLELES

Title ____________________________________

CALCULATION OF FREQUENCIES

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 colors of surviving fish				Frequency of surviving alleles	
Trial #	**Blue**	**Green**	**Yellow**		**Blue**	**Yellow**
1 Control (before predation)						
4						

11. Compare the frequency of the **different color fish** throughout this test. Did the frequency of each color change much from generation to generation in this test? Explain.

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12. Did the **allele frequency** change much over the 4 generations in this test? Explain

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13. What is causing this change (or lack of change) in allele frequency?

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14. What do you think will eventually happen to the frequency of each allele in this population?

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15. What type of selection trend (directional, stabilizing, disruptive) does this simulation represent? ______________________

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**.

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. 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 passing on to the next generation. Between trials within the round, **return only the surviving fish to the bag**. After each trial, record the results for fish colors and the numbers of surviving alleles.

	Colors of surviving fish				Surviving alleles		
Trial #	**Blue**	**Green**	**Yellow**	**Total fish**	**Blue**	**Yellow**	**Total alleles**
1 control (No predation)							
2							
3							
4							

Present your data as **bar graphs** on the graphs below.

SURVIVING FISH

Title ______________________________
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SURVIVING ALLELES

Title ______________________________
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CALCULATION OF FREQUENCIES

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 colors of surviving fish			Frequency of surviving alleles	
Trial #	**Blue**	**Green**	**Yellow**	**Blue**	**Yellow**
1 Control (before predation)					
4					

16. Compare the frequency of the **different color fish** throughout this test. Did the frequency of each color change much from generation to generation in this test? Explain.

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17. Did the **allele frequency** change much over the 4 generations in this test? Explain

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18. What is causing this change (or lack of change) in allele frequency?

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19. What do you think will eventually happen to the frequency of each allele in this population?

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20. What type of selection trend (directional, stabilizing, disruptive) does this simulation represent? ______________________________

SUMMARY QUESTIONS

1. Why did you have to pull two alleles (two straws) from the bag to represent one fish?

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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)

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   b. Test 2: Preferential Predation (Predators Prefer Yellow Fish)

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   c. Test 3: Preferential Predation (Predators Prefer Green Fish)

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   d. Test 4: Heterozygote Advantage (Green Fish are Camouflaged)

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3. Why was it necessary to include the first round without predation (#1) in each trial?

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4. In Trial 1 — the "Predators Prefer Blue Fish"— were **alleles** removed from the population? Explain.

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5. In Trial 2 — the "Predators Prefer Yellow Fish"— were **alleles** removed from the population? Explain.

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6. If you took Trial 1 — the "Predators Prefer Blue Fish" — many more generations, do you think the blue allele would eventually be eliminated? Or if you took Trial 2 — the "Predators Prefer Yellow Fish" — many more generations, do you think the yellow allele would eventually be eliminated? Explain.

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7. In Trial 3 — the "Predators Prefer Green Fish" — explain what happened to the frequency of the different color fish.

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8. In the Trial 4, the case of the "Green Fish are Camouflaged", explain what happened to the **allele frequency** in the population. Why did this happen?

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