**GOLDFISH LAB**

**Purpose:** In this activity, you will observe genetic variations within a population and calculate their frequencies. You will see how natural selection can change gene frequencies over time.

**Materials:**

Pretzel goldfish 2 bowls Graph paper

Cheese goldfish 2 paper plates Calculator

**Part A Background – Natural Selection with Goldfish:**

You are a fish-eating shark. There are two kinds of fish that you like to eat: gold fish (cheese goldfish) and brown fish (pretzel goldfish). The gold fish, however, are easy for you to see, so they are easy for you to catch. Brown fish swim more quickly and can evade capture more easily. Because of this, you eat only gold fish unless none are available. New fish are born every year, and the birth rate is one fish born for each old fish at the end of the season. Brown fish are determined by the presence of a dominant allele, and gold fish by a recessive allele.

**Procedure:**

1. Obtain a population of goldfish from your teacher. At your desk, separate the fish into goldfish and brown fish groups. Record the number of gold fish and brown fish and the total population in your data table.

2. Each person in the group will remove three (3) gold fish from the population. All surviving

 fish, gold and brown, reproduce one new fish (with the same phenotype). Report to the

 teacher with your bowl to request the desired number of gold and brown fish offspring.

3. Add these fish to the old ones to obtain the total population for this generation. Record the

 number of gold fish and brown fish and the total population in your data table.

4. Repeat steps 2 and 3 until you have data for four generations.

5. After Table 1 has been completed, determine the percentage of gold and brown fish in each

 generation. Take the number of gold or brown fish and divide the total number of fish for that

 generation and multiply by 100. Record the percentages on Table 2.

6. Construct a **line graph** from the percentage data (**2 lines**: Gold Fish and Brown Fish). You

 must include ALL necessary components of a complete graph: Labels for x and y axis

 (including units), title, and a key. Place the generation number on X axis and percentage of fish on Y axis. Use different color lines to represent each phenotype.

**Part B Background – Hardy-Weinberg Principle:**

In this part, the same basic procedure and scenario apply, with this additional information:

Since the gold trait is recessive, the gold fish must be homozygous recessive. Brown fish may be homozygous or heterozygous. Use your data from Part A (Data Table 2) and the formulas given to determine if evolution has occurred to this population of fish.

• **p = frequency of dominant allele (***brown)*

• **q = frequency of recessive allele** *(gold)*

Since there are two alleles that code for the two colors, the frequency of the gold allele and the brown allele must equal 1 (100%).

• **p + q = 1**

You cannot see alleles- only phenotypes. So the probability of the two alleles appearing together is shown in the formula below.

• **p2 + 2pq + q2 = 1**

P2 is the frequency of homozygous dominant individuals, 2pq are the heterozygous individuals, and q2 are the homozygous recessive individuals.

**Example:** If the percentage of gold fish (a phenotype) in your population is 36% (0.36), then you can take the square root of 0.36 to find the value of q (gold allele). If you know q, you can subtract this from 1 to find the value of p (brown allele).

 If q = 0.6 (√.36), then p must be 0.4 (p + q =1)

**Procedure:**

1. Begin by calculating the frequency of gold fish in the population (Use your percentage data

 for each generation of gold fish in Data Table 2. Remember to convert the percentage data to a

 frequency (move the decimal two places to the left). This will give you the frequency of aa (q²).

2. q can then be determined by taking the square root of q².

3. If p + q = 1, then p can be obtained by subtracting the q value from 1 (p = q - 1).

4. Once p is known, the frequency of AA is p².

5. 2pq can be calculated by subtracting p2 and q2 from 1 (2pq = 1 - p2 – q2).

6. Record these values in Data Table 3 for each of the four generations.

7. Construct a **line graph** for each genotype (AA, Aa, and aa) using the data from Table 3

 (**3 lines**). You must include ALL necessary components of a complete graph: Labels for x

 and y axis (including units), title, and a key. Place the generation number on X axis and

 frequency of fish on Y axis. Use different color lines to represent each genotype.

Name \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ Date \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Period \_\_\_\_\_\_

**Goldfish Lab**

**PROBLEM**: What do you expect to happen to the number of gold fish and brown fish over time?

**HYPOTHESIS:** \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

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**TABLE 1: THE NUMBER OF FISH FOR EACH GENERATION**

Generation # of Gold Fish # of Brown Fish Total # of Fish

**\_\_\_1\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

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**\_\_\_3\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

**\_\_\_4\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

**TABLE 2: THE PERCENTAGE OF FISH FOR EACH GENERATION**

Generation Percentage of Gold Fish Percentage of Brown Fish

**\_\_\_1\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

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1. What happened to the percentage of each type of fish over time?

 Gold? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

 Brown? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

2. How does this compare with your hypothesis? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**TABLE 3: GENOTYPIC FREQUENCIES**

Generation p² / AA 2pq / Aa q² / aa p q

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3. **Explain** which trait is not favorable (unfit). \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

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4. Which **phenotype** is reduced in the population? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

5. **Explain** what would happen if the selection pressure changed and the brown fish were easier

 to catch. \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

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6. If it were better to be heterozygous, will there be homozygous recessive fish? **Explain your**

 **answer**. \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

7. What happens to the recessive gene (gold fish) over successive generations? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

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8. **Explain** why the recessive gene does not disappear from population

 (refer to answer to question six). \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

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9. What are the 5 conditions that must be present in order for the Hardy-Weinberg Principles to

 make accurate predictions?

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10. What do “p” and “q” symbolize?

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11. What do “p2”, “2pq” and q2” represent?

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