Scientific Practices Rubric

INITIATING THE INQUIRY
What is the evidence that the student can formulate questions and models that can be explored by scientific investigations as well as articulate a testable hypothesis?

SCORING DOMAIN	EMERGING	E/D	DEVELOPING	D/P	PROFICIENT	P/A	ADVANCED
Stating a Hypothesis (When Appropriate)	• Articulates a prediction that has limited relationship to the question under investigation		• Articulates a relevant prediction of the expected results, but variables are unclearly stated		• Articulates a hypothesis about the investigated question, with a basic and accurate description of the variables (“if ... then …”)		• Articulates a hypothesis about the investigated question, with accurate and specific explanation of the relationship between variables (“if ... then … because”)

REPRESENTING, ANALYZING, AND INTERPRETING THE DATA
What is the evidence that the student can organize, analyze, and interpret the data?

SCORING DOMAIN	EMERGING	E/D	DEVELOPING	D/P	PROFICIENT	P/A	ADVANCED
Using Mathematics and Computational Thinking (When Appropriate)	• Expresses relationships and quantities (units) using mathematical conventions with major errors • Evaluation of whether the mathematical computation results “make sense” is omitted		• Expresses relationships and quantities (units) using mathematical conventions with minor errors • Makes note of whether the mathematical computation results “makes sense” without reference to the expected outcome		• Accurately expresses relationships and quantities (units) using appropriate mathematical conventions • Explains whether the mathematical/computation results “make sense” in relationship to the expected outcome		• Accurately and consistently expresses relationships and quantities (units) using appropriate mathematical conventions • Consistently evaluates whether the mathematical/computation results “make sense” in relationship to the expected outcome

Analyzing the Data	• Analyzes data using inappropriate methods or with major errors or omissions • Consistency of outcome with initial hypothesis, when appropriate, is not compared		• Accurately analyzes data using appropriate methods with minor omissions • Compares consistency of outcome with initial hypothesis, when appropriate		• Accurately analyzes data using appropriate and systematic methods to identify patterns • Compares consistency of outcome with initial hypothesis, when appropriate, and identifies possible sources of error		• Accurately analyzes data using appropriate and systematic methods to identify and explain patterns • Compares and explains consistency of outcome with initial hypothesis, when appropriate, and explains possible sources of error and impact of errors

CONSTRUCTING EVIDENCE-BASED ARGUMENTS AND COMMUNICATING CONCLUSIONS
What is the evidence that the student can articulate evidence-based explanations and effectively communicate conclusions?

SCORING DOMAIN	EMERGING	E/D	DEVELOPING	D/P	PROFICIENT	P/A	ADVANCED
Communicating Findings	• Attempts to use multiple representations to communicate conclusions with inaccuracies or major inconsistencies with the evidence • Implies conclusions with no discussion of limitations		• Uses multiple representations (words, tables, diagrams, graphs, and/or mathematical expression) to communicate conclusions with minor inconsistencies with the evidence • States conclusions with general discussion of limitations		• Uses multiple representations (words, tables, diagrams, graphs, and/or mathematical expressions) to communicate clear conclusions consistent with the evidence • Explains conclusions with specific discussion of limitations		• Uses multiple representations (words, tables, diagrams, graphs, and/or mathematical expressions) to communicate clear and detailed conclusions consistent with the evidence • Explains conclusions and impact of limitations or unanswered questions

Fish In A Pond Investigation

Name:_____ Period:_____

Lab partner(s):_____

Learning Targets—I Can:

- Model how an organism's characteristics are controlled by genes and how these genes, in turn, may be inherited by offspring.
- Generate a hypothesis based on my background knowledge.
- Conduct and gather data during the simulation.
- Complete Punnett squares representing multiple generations.
- Calculate probabilities of offspring over multiple generations.
- Graph and analyze data from the simulation.
- Write conclusions based on data.

Criteria for Success

Complete the pre-lab, procedure, data table, graphing, and conclusion portions of this lab with 90 percent success.

Purpose

In this lab, you will investigate how natural selection can lead to changes in a species over time. You already know that making predictions can be a sign that you understand the event you are studying. In this lab, you will make predictions in the form of a hypothesis, model the events involved in a genetic cross, and explore how both genetic and environmental factors play a part in natural selection.

Background Information

- The orange goldfish represent fish that have the smooth scale phenotype and are **homozygous dominant (DD).** Orange goldfish are delicious to predators.
- The white goldfish represent fish that have the smooth scale phenotype, the spike allele, and are **heterozygous dominant (Dd).** White goldfish are also tasty to predators.
- The pretzel goldfish represent fish with the spike scale phenotype, are **homozygous recessive (dd),** and are avoided by predators because of the spikey scales.

Pre-Lab Questions

Read over the lab instructions and answer the following questions.

1. What do you think will be the possible **phenotypes** of the offspring for future generations? Why?

2. What do you think will be the possible **genotypes** of the offspring for future generations? Why?

Hypothesis (if … then … because)

Based on what you read, create a hypothesis for the lab: What type of fish will be present in future populations?

If spikey fish are avoided by predators, **then …**

Materials

- 30 orange goldfish
- 30 pretzel goldfish
- 30 white goldfish
- Bowl or bag to be used as a pond
- Three napkins labeled “prey,” “female,” and “male”
- Graph paper

Procedure

Round 1: PLEASE DO NOT EAT THE GOLDFISH

1. Wash your hands.
2. Write the words “prey,” “female,” and “male” on your napkins.
3. Place the goldfish in the lake (bowl), and mix them around.
4. Choose one person to be the predator. While someone else counts to three, the predator picks a fish out of the pond one-by-one and places it on the “prey” napkin (try to pick smooth fish and avoid pretzel fish). Your prey fish are now dead and no longer part of the population.
5. Repeat step 4 until everyone in your group gets one chance to be a predator.
6. Close your eyes and choose, at random, **five fish** from the bowl and place them on the **“female” napkin.**
7. Close your eyes and choose, at random, **five fish** from the bowl and place them on the **“male” napkin.**
8. a) Now choose, at random, one male fish and one female fish from the napkins, and enter their genotypes (**male—top** of Punnett square, **female—left side** of Punnett square) into the Punnett square under generation one (F_1).

   b) Whichever square is shaded in each of the Punnett squares (1–5) will be the outcome of the offspring in the F_1 generation and needs to be introduced into the pond population. Take the offspring fish out of the nursery, and introduce them into the bowl. Reintroduce the parent fish back into the pond as well. If you do not have the phenotype (appropriate kind of goldfish) in your nursery, ask your teacher for a fish of that phenotype.
9. Repeat step 8 until you have five Punnett squares completed. You should have placed 15 fish back into the bowl (10 captured parent fish and five offspring).

Generation F_1 Punnett Squares

1.		

2.		

3.		

4.		

5.		

Generation F_1 Data Table

	Population of pretzel fish (dd)	**Population of white fish (Dd)**	**Population of orange fish (DD)**	**General observations** (increases, decreases, errors, broken pieces, group dynamics)
Starting	30	30	30	
Ending				

Using Mathematics—Generation F_1

Calculate the probability of the offspring for two of the Punnett squares from round 1.

1st Punnett square

orange fish = ____ of __4__ or ____%

white fish = ____ of __4__ or ____%

pretzel fish = ____ of __4__ or ____%

2nd Punnett square

orange fish = ____ of __4__ or ____%

white fish = ____ of __4__ or ____%

pretzel fish = ____ of __4__ or ____%

Round 2

Repeat steps 4–9 using the Generation F_2 Data Table and the Generation F_2 Punnett Squares. Make sure that you introduced the offspring and reintroduced the parents back into the pond (bowl). Count the total number of each type of fish and record it in the ending total for Generation F_1 and the starting total for Generation F_2.

Generation F_2 Punnett Squares

1.		

4.		

2.		

5.		

3.		

Generation F_2 Data Table

	Population of pretzel fish (dd)	**Population of white fish (Dd)**	**Population of orange fish (DD)**	**General observations**
Starting				
Ending				

Using Mathematics—Generations F_2

Calculate the probability of the offspring for two of the Punnett squares in round 2.

3rd Punnett square

orange fish = ____ of ____ or ____%

white fish = ____ of ____ or ____%

pretzel fish = ____ of ____ or ____%

4th Punnett square

orange fish = ____ of ____ or ____%

white fish = ____ of ____ or ____%

pretzel fish = ____ of ____ or ____%

Whichever square is shaded in each of the Punnett squares (1–5) will be the outcome of the offspring in the F_2 generation and needs to be introduced into the pond population. Take the offspring fish out of the nursery, and introduce them into the bowl. Reintroduce the parent fish back into the pond as well. If you do not have the phenotype (appropriate kind of goldfish) in your nursery, ask your teacher for a fish of that phenotype.

Round 3

Repeat steps 4–9 using the Generation F_3 Data Table and the Generation F_3 Punnett Squares. Make sure that you introduced the offspring and reintroduced the parents back into the pond (bowl). Count the total number of each type of fish and record it in the ending total for Generation F_2 and the starting total for Generation F_3.

Generation F_3 Punnett Squares

1.		

4.		

2.		

5.		

3.		

Generation F_3 Data Table

	Population of pretzel fish (dd)	Population of white fish (Dd)	Population of orange fish (DD)	General observations
Starting				
Ending				

Using Mathematics—Generations F_3

Calculate the probability of the offspring for two of the Punnett squares in round 3.

5th Punnett square

orange fish = ____ of ____ or ____%

white fish = ____ of ____ or ____%

pretzel fish = ____ of ____ or ____%

2nd Punnett square

orange fish = ____ of ____ or ____%

white fish = ____ of ____ or ____%

pretzel fish = ____ of ____ or ____%

Representing Data

Complete a graph on attached graph paper for data analysis that includes the following:

- A line graph using each generation of fish (1st, 2nd, 3rd) on the X-axis and ending population (number) of fish on the Y-axis. You will have three lines, one for each fish phenotype: DD—red, Dd—blue, and dd—green.
- Remember your graphing rules:
  - Title of your graph—what are you representing?
  - Key—what do the different colors stand for?
  - Even numbering/scale—use the squares on the graph paper equally.
  - Labels on both axes—X and Y.

Data Analysis

1. Discuss what happened to the population of your orange fish, white fish, and pretzel fish. Make sure to include increases and decreases in the population.

2. How does the phenotype of the population change from Generation F_1 to Generation F_3? Remember to refer to your data tables and graph.

Communicating Findings

3. Compare your graph to another group's graph. What similarities and differences do you find in your graphs?

4. Discuss with another group the possible human errors that could have occurred or did occur.

Conclusion

5. What was your hypothesis? Was it supported or rejected? Why? Refer to your data.

6. Infer what the phenotypes of the Generation F_4 population would be? What leads you to this inference?

7. How can patterns in the inheritance of traits be used to predict how frequently they appear in offspring?

8. What new learnings did you obtain from completing this laboratory activity?