**Subject area/course:** Science/Biology - Genetics

**Grade level/band:** 10

**Task source:** New Hampshire Task Bank; Author: Megan Brown and Maureen Munn, The GENETICS Project. University of Washington. Modified by: Rita Ciambra, Valerie Cunha, John Duplinsky, Marilyn Shepardson, and Michelle Webber; Science Department, Spaulding High School, Rochester, NH.

**Toothpick Fish Inquiry Task**

**TEACHER'S GUIDE**

1. **Task overview**:

The purpose of this activity is to experiment with genes in an environment for a population of “Toothpick Fish,” explaining the relationships between genes, traits, variation, survival, and reproduction. The activity is a simulation, but it models the way fish and other organisms live in nature.

* Students will generate a hypothesis based on given information.
* Students will collect and analyze data throughout the performance assessment.
* Students will utilize prior understanding of Mendelian Genetics to predict genetic outcomes of potential breeding crosses of fish.
* Students will create a complete graph including title, key, and axes labels.
* Students will interpret collected data and apply conclusions to a real world instance.

1. **Aligned standards:**
2. **Primary Common Core State Standards**

CCSS.Math.Content.HHS.IC.A.1 Understand statistics as a process for making inferences about population parameters based on a random sample from that population.

CCSS.ELA-Literacy.RST.9-10.3 Follow precisely a complex multistep procedure when carrying out experiments, taking measurements, or performing technical tasks, attending to special cases or exceptions defined in the text.

CCSS.ELA-Literacy.RST.9-10.7 Translate quantitative or technical information expressed in words in a text into visual form (e.g., a table or chart) and translate information expressed visually or mathematically (e.g., in an equation) into words.

1. **Next Generation Science Standards (NGSS)**

HS-LS1-1 Construct an explanation based on valid and reliable evidence obtained from a variety of sources (including students’ own investigations, models, theories, simulations, peer review) and the assumption that theories and laws that describe the natural world operate today as they did in the past and will continue to do so in the future.

HS-LS4-3 Apply concepts of statistics and probability to support explanations that organisms with an advantageous heritable trait tend to increase in proportion to organisms lacking this trait.

HS-LS3-3 Apply concepts of statistics and probability to explain the variation and distribution of expressed traits in a population.

1. **Critical abilities**

Research: Conduct sustained research projects to answer a question (including a self-generated question) or solve a problem, narrow or broaden the inquiry when appropriate, and demonstrate understanding of the subject under investigation. Gather relevant information from multiple authoritative print and digital sources, use advanced searches effectively, and assess the strengths and limitations of each source in terms of the specific task, purpose, and audience.

Analysis of Information**:** Integrate and synthesize multiple sources of information (e.g., texts, experiments, simulations) presented in diverse formats and media (e.g., visually, quantitatively, orally) in order to address a question, make informed decisions, understand a process, phenomenon, or concept, and solve problems while evaluating the credibility and accuracy of each source and noting any discrepancies among the data.

Experimentation and Evaluation**:** Follow precisely a complex multistep procedure when carrying out experiments, taking measurements, or performing technical tasks; analyze the specific results based on explanations in the text. Evaluate hypotheses, data, analysis, and conclusions, verifying the data when possible and corroborating or challenging conclusions with other sources of information.

Interpersonal Interaction and Collaboration**:** Develop a range of interpersonal skills, including the ability to work with others, to participate effectively in a range of conversations and collaborations.

1. **Other standards**

*New Hampshire K-12 Model Science Competencies*

*Nature of Science*: Student will demonstrate the ability to work collaboratively and individually to generate testable questions or define problems, plan and conduct investigations using a variety of research methods in various settings, analyze and interpret data, reason with evidence to construct explanations in light of existing theory and previous research, and effectively communicate the research processes and conclusions.

*Cause and Effect*: Students will demonstrate the ability to investigate, explain, and evaluate potential causal relationships by using evidence to support claims and predictions about the mechanisms that drive those relationships.

1. **Time/schedule requirements:**

This task will likely take one and a half 90-minute blocks or three 45-minute class sessions to complete.

1. **Materials/resources:**

This task was adapted from: Toothpick Fish (April, 2001)-A Middle School Activity for Teaching Genetics and Environmental Science. Developed by: Megan Brown and Maureen Munn, The GENETICS Project. The GENETICS Project University of Washington <http://chroma.gs.washington.edu/outreach/genetics/download/toothpickfish.pdf>

The following materials should be provided at each lab station:

* + Brown paper bag (gene pool container)
  + 8 green toothpicks
  + 8 red toothpicks
  + 8 yellow toothpicks
  + 4 Colored pencils or markers (green, red, orange, yellow)
  + Writing utensil and ruler

Students will also need:

* Computer/iPad
* Graphic organizer
* Notebook/scrap paper
* Toothpick fish data tables

1. **Prior knowledge:**

Prior to this task, students should have knowledge regarding biodiversity and ecosystem change. Students also should have practiced the following Nature of Science skills:

* + Data collection and analysis
  + Graphing
  + Applying knowledge and conclusions to alternative situations

1. **Connection to curriculum:**

This performance task was designed to take place following a unit on Mendelian Genetics and Punnett Squares. Students must have a working knowledge of genetics and be able to use data provided to generate a hypothesis and genetic outcomes. In this task, students will be able to collect and analyze data to support or refute their predictions.

1. **Teacher instructions:**

**Implementation**

* + Instruction on relationships between genetic biodiversity and ecosystem stability
  + Instruction on natural and human influences on ecosystem stability
  + Instruction on Mendelian Genetics including but not limited to:
    - Alleles, gene frequency, dominant/recessive traits, genotypes, phenotypes, probability, Punnett Squares
  + Instruction on graphing data and data analysis

**Breakdown of activities:**

* First 45 minutes:
  + Introduction, distribution of materials, completion of Part A: Introduction and Make an Initial Hypothesis.
* Second 45 minutes:
  + Begin Part B: Organizing, Presenting, and Analyzing Data.
* Third 45 minutes:
  + Continue/conclude Part B: Organizing, Presenting, and Analyzing Data.
  + Part C: Using Evidence and Applying What You Learned.

1. **Student support:**

* Provide additional time
* Assistive technology
* Break down instructions/procedures into smaller sections
* Use of graphic organizers to aid in construction of response
* Provide additional background information
* Allow students to work in groups
* Provide time for peer review of conclusions after each simulation

1. **Extensions or variations:**
2. **Scoring:**

Student work can be scored using the Toothpick Fish Rubric.