 Name:

***Toothpick Fish***

**Purpose**:

We are going to experiment with genes and environment for a population of "toothpick" fish. You will learn more about genetics and how environment can influence a species' survival.

**Materials** (for each pair of students):

* 1 "gene pool" container
* 8 green toothpicks
* 8 red toothpicks
* 8 yellow toothpicks

**Introduction**:

The colored toothpicks represent three different forms of a gene (green, red, & yellow) that control one fish trait (skin color). The table explains which forms--or alleles--of the gene are dominant, which are recessive, and which are co-dominant (equal). Remember that each toothpick represents a gene, not a fish. **Note**: Combining red and yellow genes results in a fish with orange skin color.

|  |  |
| --- | --- |
| The green gene (G) is ... | * dominant to all other color genes
 |
| The red gene (R) is ... | * recessive to green
* co-dominant to yellow
 |
| The yellow gene (Y) is ... | * recessive to green
* co-dominant to red
 |

We will need to know what color our fish are, so take a few minutes to write down the gene combinations (genotypes) that will result in the four possible colors of fish (phenotypes).

|  |  |
| --- | --- |
| **Phenotype** | **Genotype** |
| Green |  |
| Red |  |
| Yellow |  |
| Orange |  |

Practice using Punnett Squares and explain: 1) if two red fish can have green offspring, 2) if two orange fish can have red offspring, and 3) if two green fish can have orange offspring.

Following the directions given in the laminated handout, fill in your findings on these two tables.

 **Table A: Gene Pairs and Resulting Fish Colors in Generations 1-4**

**Genotype**

**Phenotype**

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Offspring | 1st Gen | 2nd Gen | 3rd Gen | 4th Gen | 1st Gen | 2nd Gen | 3rd Gen | 4th Gen |
| Example | GR |  |  |  | green |  |  |  |
| 1 |  |  |  |  |  |  |  |  |
| 2 |  |  |  |  |  |  |  |  |
| 3 |  |  |  |  |  |  |  |  |
| 4 |  |  |  |  |  |  |  |  |
| 5 |  |  |  |  |  |  |  |  |
| 6 |  |  |  |  |  |  |  |  |
| 7 |  |  |  |  |  |  |  |  |
| 8 |  |  |  |  |  |  |  |  |
| 9 |  |  |  |  |  |  |  |  |
| 10 |  |  |  |  |  |  |  |  |
| 11 |  |  |  |  |  |  |  |  |
| 12 |  |  |  |  |  |  |  |  |

**Table B: Offspring Color for Toothpick Fish Generations**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Environment | Generation | Green | Red | Orange | Yellow |
| There is lots of green seaweed | 1st |  |  |  |  |
| growing everywhere. | 2nd |  |  |  |  |
|  | 3rd |  |  |  |  |
| The seaweed all dies and leaves | 4th |  |  |  |  |
| bare rocks and sand. | 4th (survivors) |  |  |  |  |

***Toothpick Fish***

**Directions**:

1) Make a *first generation* of fish. To do this, pull out genes (toothpicks) in pairs without looking and set them aside carefully so that they stay in pairs. This simulates the way offspring are formed by sperm from the male fish combining randomly with eggs from the female fish. Once you have drawn your twelve pairs, record the results in Table A. An example fish in the first generation is given in Table A in the shaded boxes (do not include this fish in your calculations).

2) Count the numbers of each color of fish offspring and record the numbers in Table B where it says *first generation.*

The stream where the fish live is very green and lush with lots of vegetation and algae covering the streambed and banks. The green fish are very well camouflaged from predators in this environment and the red and orange fish fairly well also. However, none of the yellow fish survive or reproduce because predators can easily spot them in the green algae environment. **If you have any yellow fish (fish in which both toothpicks are yellow),** **set those toothpicks aside.**

3) Put all the genes you have left back in the gene pool **(remember, you have set aside any yellow fish).** Draw a *second generation* of fish, again without looking. Record your genepairs in Table A. Total up the fish of each color and record the numbers in the *second**generation* row in Table B. Set aside yellow fish and return surviving fish to the cup.

4) The well-camouflaged fish live longer and have more offspring, so their numbers are increasing. Draw toothpicks to make a *third generation* of fish. Record your data in Table A and then write in the total numbers of each color in the *third generation* row of Table B. Now return survivors to the gene pool (be sure to set aside any genes from yellow offspring).

Discuss the following questions with your partner:

a. Have all the yellow genes disappeared?

b. Has the population size changed? In what way? Would you expect this to occur in the wild?

c. How does the population in the third generation compare to the population in the earlier generations?

5) Draw more pairs of genes to make a *fourth generation* of fish. Record the data in Tables A and B. Do not remove yellow fish.

**OH NO! An environmental disaster has occurred!**

Factory waste harmful to algae is dumped into the stream, killing much of the algae very rapidly. The remaining rocks and sand are good camouflage for the yellow, red, and orange fish. Now the green fish are easily spotted by predators and can’t survive or reproduce.

6) Because green fish don’t survive, set them aside. Now record the *surviving* offspring (all but the green) in the last row of Table B (fourth generation survivors row).

7) Contribute your final data to the class tally on the board. Your instructor will total the data for the entire class.

Discuss the following questions with your partner:

a. Has the population changed compared to earlier generations? How?

b. Have any genes disappeared entirely?

c. Yellow genes are recessive to green; green genes are dominant to both red and yellow. Which color of genes disappeared faster when the environment was hostile to them? Why?

d. Real populations change much more slowly than these toothpick fish. Why?

**Applying what we have observed**:

Hatchery fish populations often have less genetic biodiversity than wild fish populations. How might lowered biodiversity affect a fish population’s ability to adapt to environmental disasters such as the pollution disaster described in this simulation?

If the fish from a particular stream have become genetically adapted to their home stream over many generations, what might happen if their fertilized eggs are used to “restock” a different stream that has become depleted of fish?