



## Genetics

Name \_\_\_\_\_

# Toothpick Fish

**Purpose:** To model the relationships between many different aspects of fish life: genes, traits, variation, survival, and reproduction.

### Materials:

- 1 “gene pool” container – paper cup
- 8 green toothpicks
- 8 red toothpicks
- 8 yellow toothpicks

### Given this information:

The colored toothpicks represent three different forms of a gene (green, red, and yellow) that controls one fish trait: skin color. The table below tells you which forms (alleles) of the gene are dominant, which are recessive, and which are co-dominant.

- The green gene (G) is dominant to all other color genes
- The red gene (R) is recessive to green and co-dominant to yellow
- The yellow gene (Y) is recessive to green and co-dominant to red
- Co-dominant alleles result in an orange color

**REMEMBER: EACH TOOTHPICK REPRESENTS A GENE, NOT A FISH.**

### Procedure – part 1:

1. Count your toothpicks to make sure you have 8 of each color for a total of 24 toothpicks.
2. Figure out which gene combinations give rise to which fish colors and fill in the answers on the table on the next page.

Data:

Fish Color	Gene Combination(s)
Green	
Red	
Yellow	
Orange	

Data Analysis:

Based on the answers you gave in the table above, answer the questions below. (You may use Punnett Squares if you wish.)

- a. Can two red fish mate and have green offspring? Why or why not?
  
- b. Can two orange fish mate and have red offspring? Why or why not?
  
- c. Can two green fish mate and have orange offspring? Why or why not?

Procedure – part 2:

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.
2. 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).
3. 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.**

4. . 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 gene pairs 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.

5. 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).

**Table A. Gene Pairs and Resulting Fish Colors in Generations 1 – 4**

Offspring	First Gene/Second Gene				Resulting Fish Color			
	1st	2nd	3rd	4th	1st	2nd	3rd	4th
example	G/R				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 growing everywhere.	First				
	Second				
	Third				
The seaweed all dies and leaves bare rocks and sand.	Fourth				
	Fourth (survivors)				

Think about the data so far:

- Have all the yellow genes disappeared?
- Has the population size changed? In what way? Would you expect this to occur in the wild? Explain your answer.
- How does the population in the third generation compare to the population in the earlier generations?

6. 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.



**STOP! An environmental disaster occurs.** 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.

7. 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 survivor's row).

**Contribute your final data on the class tally on the spreadsheet.**

After examining the data for the entire class, answer the following questions.

- 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?

**Application:**

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?

Can you think of any examples from the real world where lowered genetic diversity is impacting a species' ability to survive?

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

*What if* each of you had started with only one green gene among your fish? How would the population have been different?

*What if* the orange fish had been best camouflaged, so that a few green fish were eaten each generation?