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, 8 green toothpicks, 8 red toothpicks, 8 yellow toothpicks

The colored toothpicks represent 3 different forms of a gene (green, red, and yellow) that controls one fish trait: skin color. The table below tells you which forms of the gene are dominant, which are recessive, and which are co-dominant.

Fish Color	**Gene Combination(s)**
Green	GG
Red	RR
Yellow	YY
Orange	RY

Procedure **–** part 1**:** REMEMBER: EACH TOOTHPICK REPRESENTS A GENE, NOT A FISH.

1. Count your toothpicks to make sure you have 8 of each color for a total of 24 toothpicks.
2. Based on the answers you gave in the table above, answer the questions below. (Use Punnett Squares if you wish.)
    a. What colored fish does a red and yellow fish produce?

    b. What colored offspring do two orange fish make?

    c. What colored offspring will a green and yellow fish make?

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 the table under the 1st generation. An example fish in the first generation is given in Table A in the shaded boxes (do not include this fish in your calculations).
    a. 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).** Repeat step 1 and pull out a *second generation* of fish, again without looking.
4. Record your gene pairs in the table under 2nd generation. 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. Repeat step 1 and pull out a *third generation* of fish. Record your data in the table in the 3rd *generation* row. Now return survivors to the gene pool (be sure to set aside any genes from yellow offspring).

Think about the data so far:

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? Explain your answer.

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

6. Repeat step 1 and pull out toothpicks to make a *fourth generation* of fish. Record the data in the tables. Do not remove yellow fish.
    a. **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.

b. 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).

	First Gene/Second Gene				Resulting Fish Color			
	Generations				Generations			
Offspring	1st	2nd	3rd	4th	1st	2nd	3rd	4th
Example	G/R				Green			
1								
2								
3								
4								
5								
6								
7								
8								
9								
10								
11								
12								

7. **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:

a. How might lowered biodiversity affect a fish population's ability to adapt to environmental disasters such as the pollution disaster described in this simulation?

b. 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?

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

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

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

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