Investigating ✓ Communicating ☐ Knowledge and understanding ✓

Exploring patterns in inheritance

Learning outcomes in focus

Students should be able to:

NS4 **produce and select data** (qualitatively/quantitatively), critically **analyse data to identify patterns** and relationships, identify anomalous observations, **draw and justify conclusions**

BW2 describe asexual and sexual reproduction; **explore patterns in the inheritance** and variation of genetically controlled characteristics

Learning intentions

We are learning to:

- produce data, draw justified conclusions from the data, discuss and thereby re-evaluate scientific data
- identify patterns in inherited data and begin to recognise how the environment can affect inheritance

Background

This task was given to first year students after two one hour lessons on genetics. They understood the gene pair method of inheritance, and were familiar with the terms recessive, dominant and co-dominant, they had experience of using simple punnet squares to predict off-spring. The class had prior experience of tabulating results in other contexts.

Task

We are going to experiment with genes and environment for a population of "toothpick" fish. We will work in pairs. You will learn about the relationships between many different aspects of fish life: genes, traits, variation, survival, and reproduction. The activity here is a simulation, but it models the way fish and other organisms live in nature. **Adapted from 'Toothpick Fish', The Genetics Project, University of Washington goo.gl/0QC8GE**

Success criteria:

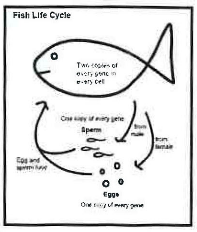
I can:

- **SC1:** follow instruction to produce data
- **SC2:** fill in tables correctly and in full
- **SC3:** identify patterns in relation to inheritance
- **SC4:** draw conclusions from the data
- **SC5:** justify conclusions, were relevant relates conclusions to the environment

Page 1

Sample C.

23 October 2015 09:41



We are going to experiment with genes and environment for a population of "toothpick" fish.

We will work in pairs but everyone must fill out the document.

You will learn about the relationships between many different aspects of fish life: genes, traits, variation, survival, and reproduction. The activity here is a simulation, but it models the way fish and other organisms live in nature.

You have a gene pool (petri dish)
You have 24 gene alleles (tooth picks)

Introduction

The coloured toothpicks represent three different forms of a gene (green, red, and yellow) that controls one fish trait: skin colour.

The table below tells you which forms (alleles) of the gene are dominant, which are recessive, and which are equal (or co-dominant).

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

* Combining red and yellow genes results in a fish with orange skin color.

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

Task

1.
☑ Count your toothpicks to make sure you have 8 of each colour for a total of 24 toothpicks.

☑ 2. Figure out which gene combinations give rise to which fish colours and Fill in the answers on the table on the next page.

Fish Color	Gene combinations
Green	e.g. GG, . . . GR, GY
Red	RR
Yellow	YY
Orange	YR

Page 2

20 October 2015 11:23

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?

No, because they don't have green genes.

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

Yes, because they do have red genes, as well as yellow genes.

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

They possibly could if they have both red and yellow.

3. 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. Once you have drawn your twelve pairs (do not move the pairs), record the results in Table A first generation section.

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

	First Gene/Second Gene				Resulting Fish Color			
	- - - GENERATION - - -							
Offspring	1st	2nd	3rd	4th	1st	2nd	3rd	4th
example	G R				green			
1	G Y	G R	R Y	G G	green	green	orange	green
2	Y Y	Y R	G Y	R Y	yellow	orange	green	orange
3	G G	Y G	G R	G Y	green	green	green	green
4	R Y	O R	G R	Y Y	Orange	orange	green	yellow
5	R Y	R R	R R	G R	orange	red	red	green
6	G P	G R	R Y	R R	green	green	orange	red
7	Gg	G R	R R	R R	green	green	red	red
8	r r	G G	G G	G R	red	green	green	green
9	R R	G G	G G	[illegible]	red	green	green	[illegible] red
10	G R	R Y	G Y	g g	green	orange	green	green
11	y y				yellow			
12	g g				green			

SC3: Clearly and correctly identifies patterns.

SC4: Draw conclusions from the data. Use of Punnett Squares is exceptional.

SC5: Justifies correct conclusions with illustration.

SC1: Follow instruction to produce data.

SC2: Fill in tables correctly.

Page 3

20 October 2015 11:23

4.

☑ Count the numbers of each colour of fish offspring and record the numbers in Table B ^ in table A. where it says first generation.

Toothpick Fish **Table B**

Table B. Offspring Color for Toothpick Fish Generations

Environment	Generation	Green	Red	Orange	Yellow
There is lots of green seaweed growing everywhere.	First	6	2	2	2
	Second	6	1	3	0
	Third	8	2	2	0
The seaweed all dies and leaves bare rocks and sand.	Fourth	5	3	1	1
	Fourth (survivors)	0	2	3	0

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 camouflaged 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 (These are now dead).

5.

☑ 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 and fish colour in Table A under 2nd generation.

☑ Total up the fish of each colour and record the numbers in the second generation row in Table B.

☑ Set aside yellow fish and return surviving fish to the cup.

6.

The well-camouflaged fish live longer and therefore 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 colour 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).

SC2:
Fill in tables correctly: all data correctly tallied and transferred into this table.

Page 4

23 October 2015 09:46

STOP HERE. DO NOT PROCEED TO STEP 7. DISCUSS and answer THE FOLLOWING THREE QUESTIONS WITH YOUR PARTNER AND WAIT and then as a class group.

a) Have all the yellow genes disappeared?

No!

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

Yes, the yellow fish are extinct.

c) Apart from size how does the population in the third generation compare to the population in the earlier generations?

There are no yellow fish

7. Draw more pairs of genes to make a fourth generation of fish. Record the data in.

☐ Tables A and

☐ Tables 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.

8.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). **Contribute your final data on the class tally on the projector**. Copy the results into the table here:

New Section 1 Page 4

SC3
Identify patterns: yellow genes remains but no yellow fish.

SC4 and SC5:
Draws conclusions from the data: Question asks has the population size changed; students initially answers on population colour, however does correctly infer no overall population size change and justifies this conclusion by recognising that there would be an increase in the number of green fish.

Exploring patterns in inheritance: Example 1

Page 5

20 October 2015 12:11

Table C. Fish surviving the pollution disaster: pooled data

Fish Color	Green	Red (RR)	Orange (RY)	Yellow (YY)
1	0	1	1	0
2	0	~~1~~ 2	~~4~~ 3	0
3	0	1	2	1
4	0	1	2	1
5	0	1	2	0
6	0	2	2	0
7	0	3	0	2
8 ~~8~~	[illegible]	4	3	[illegible]
9	0	1	1	1
~~10~~	~~0~~			
Totals	0	12	13	5

Fill in table on overhead, one line of data per group. Total results in bottom line.

After examining the data for the entire class, discuss the following questions with your partner.

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

The population has changed because there is no green fish, there is less red/orange fish and there is next to nothing orang fish

b. Have any genes disappeared entirely?

Yes ~~No~~ the green ~~fish~~. genes

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

~~Yes~~ ~~The~~ The yellow genes disappeared faster in the hostile environment because they were easy to spot in the seaweed.

SC3
Correctly identifies patterns for the yellow and green fish. Identifies the loss of the green genes.

SC4:
Draw conclusions from the data: Green genes disappeared with one generation of green kill, yellow genes still present after 3 generation of removal of yellow fish.

SC5:
Justify conclusions: stating that this occurred because green is dominate. Does not relate this to the environmental change.

Overall judgement: Exceptional