**Unit 4 Year 12 ATAR Human Biology 2019**

**Assessment Task 9: Science Inquiry (2%)**

**Simulating evolutionary processes**

Name: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**Part 1: The simulation**

**The simulation scenario**

'Battling beetles' are so named because they battle to survive in a very harsh environment. They are 1 - 2 cm long and have a distinctive triangular shape. They live in cold, damp environments where there are flat, exposed outcrops of dark rocks and patches of stunted shrubs growing up through extensive areas of snow. The shrubs are less than 1 m tall and have branches that are covered in a white, flaking bark. The shrubs' leaves are very small. Battling beetles feed on the flaky bark pieces that have fallen on to the snow, or been blown onto the exposed rocky surfaces. There are three phenotypic forms of battling beetles: red, yellow and orange. The main predator of the beetles is the battling­-beetle bustard, which is a bird with good eyesight.

**Assumptions for the simulation**

* The environment is as described above.
* The beetle population at the start of this study consists of 30 individuals: 10 red, 10 yellow and 10 orange
* Each year the beetles mate at random, and each pair produces one offspring.
* The sex of the parents or offspring is not relevant to the simulation.
* When battling beetles mate, the following offspring are observed:

|  |  |
| --- | --- |
| **Phenotype of parents** | **Phenotype of offspring** |
| Red x Red | Red |
| Yellow x Yellow | Yellow |
| Red x Yellow | Orange |
| Red x Orange | ½ Red : ½ Orange |
| Yellow x Orange | ½ Red: ½ Orange |
| Orange x Orange | ¼ Red: ½ Orange: ¼ Yellow |

* Every year the beetles mate and reproduce in spring. The battling-­beetle bustards kill off one-third of the population during their summer predatory period. On average they eat beetles in the proportion of 3 red: 2 orange: 1 yellow. So at the end of the season there are 30 beetles which will breed randomly in the next season.
* All other factors in the beetle population and their environment remain unchanged.

**Materials** (per group)

* Set of ‘battling beetle' cards - 30 cards of each colour: red, yellow and orange
* 6 sided die
* Reserve cards for offspring

**Procedure**

1. Sort 10 cards of each colour into a pack. This represents the composition of the population at the start of the simulation. The extra cards will be used when offspring are added. You may even need to collect more of these from the class stock as the simulation progresses.
2. To represent random mating, shuffle the cards thoroughly and then deal out 15 pairs. These are the random parental combinations.
3. Produce one offspring for each pair by adding the appropriate offspring card from your spares.

**Rules to determine offspring**

|  |  |
| --- | --- |
| **Phenotype of parents** | **Phenotype of offspring** |
| Red x Red | Red |
| Yellow x Yellow | Yellow |
| Red x Yellow | Orange |
| **For the below parental combinations, roll the die:** | |
| Red x Orange | 1-3 = Red, 4-6 = Orange |
| Yellow x Orange | 1-3= Yellow, 4-6 = Orange |
| Orange x Orange | 1= red, 2-3 = orange, 4 = yellow (re-roll for 5 or 6) |

1. Predation: The population now consists of 45 individuals, 15 of which are going to be eaten by the battling-beetle bustards. To determine which beetles will be eaten, use the die again.

**Rules to determine predation – roll the die**

|  |  |
| --- | --- |
| 1,2,3 | Remove a red beetle card |
| 4,5 | Remove an orange beetle card |
| 6 | Remove a yellow beetle card |

1. Repeat this 14 more times.
2. Count up the number of beetles of each colour remaining and enter these in the table below. This is the breeding population for the second year.
3. Repeat steps 2 – 6 for 7 generations, recording your results in the table below.

**Simulation 1 – Natural selection**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Year** | **Red** | **Orange** | **Yellow** | **Total** |
| **1** | 10 | 10 | 10 | 30 |
| **2** |  |  |  |  |
| **3** |  |  |  |  |
| **4** |  |  |  |  |
| **5** |  |  |  |  |
| **6** |  |  |  |  |
| **7** |  |  |  |  |

Another process involved in evolutionary change is random genetic drift. In this case there is no selection pressure – deaths occur at random in the population (i.e. there is an equal chance of each phenotype being killed). Design and carry out a simulation to test the effects of random genetic drift, recording your results in the tables below. Carry out the simulation twice.

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**Simulation 2 – Random genetic drift**

**Trial 1**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Year** | **Red** | **Orange** | **Yellow** | **Total** |
| **1** | **10** | **10** | **10** | **30** |
| **2** |  |  |  |  |
| **3** |  |  |  |  |
| **4** |  |  |  |  |
| **5** |  |  |  |  |
| **6** |  |  |  |  |
| **7** |  |  |  |  |

**Trial 2**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Year** | **Red** | **Orange** | **Yellow** | **Total** |
| **1** | **10** | **10** | **10** | **30** |
| **2** |  |  |  |  |
| **3** |  |  |  |  |
| **4** |  |  |  |  |
| **5** |  |  |  |  |
| **6** |  |  |  |  |
| **7** |  |  |  |  |

**Populations may vary in size. Does this affect the rate of evolutionary change?**

Design and carry out a simulation to test the effects of natural selection in a small population – one starting with 4 red, 4 orange and 4 yellow individuals.

**Simulation 3 – Natural selection in a small population**

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Design and carry out a simulation to test the effects of random genetic drift in a small population – one starting with 4 red, 4 orange and 4 yellow individuals

**Simulation 4 – Random genetic drift in a small population**

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