Experiment worksheet

2.2 Natural selection is the mechanism of evolution

Pages 44–45 and 189

Experiment 2.2: What if the habitat of bean prey was changed?

Aim

To examine the selection pressures involved in hunting prey.

Materials

• Paper cups

• Tools: knives, forks, spoons, sticky tape, plastic gloves

• Bean prey: red butted beans (kidney beans), long-toothed yellow beans, panther-toothed black beans, wicked white beans

• Timer

Method

1 Divide the class into five groups. Each group represents a separate tribe.

• The Knife tribe can only use knives to hunt beans.

• The Spoon tribe can only use spoons to hunt beans.

• The Hand tribe are allowed to use their hands to hunt beans.

• The Sticky-tape tribe can only use sticky tape to hunt beans.

• The Glove tribe must wear plastic gloves to hunt beans but turn the thumb of their glove inside out so they cannot use their opposable thumb.

2 On a section of grass, spread 20 of each bean type onto the grass.

3 Each tribe has 10 seconds to collect as many beans as they can. Record the data in an appropriate table as shown in the Results section.

4 The two tribes with the least beans become extinct and must sit down.

5 Each bean left on the grass will breed. This means the amount of beans remaining on the grass will double. For example, if 6 white beans were collected, then 14 remain, and you need to add another 14 white beans to the area. Repeat with the other three colours.

6 Repeat for two further generations so that only one tribe is left.

Inquiry

What if the habitat of bean prey was changed?

1 Write a hypothesis for your inquiry.

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2 What is the independent variable?

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3 What is the dependent variable?

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4 List at least three variables that will need to be controlled. How will you control them?

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Results

Copy and complete the following table to record your results for generation 1.

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| --- | --- | --- | --- | --- | --- | --- |
|  | Knife tribe | Spoon tribe | Hand tribe | Sticky-tape tribe | Glove tribe | TOTALS |
| Red-butted beans |  |  |  |  |  |  |
| Long-toothed yellow beans |  |  |  |  |  |  |
| Panther-toothed black beans |  |  |  |  |  |  |
| Wicked white beans |  |  |  |  |  |  |
| **TOTALS** |  |  |  |  |  |  |

Create two more tables for the other two generations.

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Discussion

1 Which tribes became extinct first? What was the selection pressure that contributed to their extinction?

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2 Why were the bean prey numbers doubled after each generation?

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3 Which beans were selected against?

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4 Use the mechanism of natural selection to explain the change in bean prey numbers.

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5 Suggest a similar example to this experiment that might occur in nature.

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Conclusion

Describe how the mechanism of natural selection changes frequency of alleles in a population.

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Experiment worksheet

2.3 Different selection pressures cause divergence. Similar selection pressures cause convergence

Pages 46–47 and 190

Experiment 2.3: Divergent and convergent evolution of big beaks and small beaks

Aim

To model divergent and convergent evolution in beak size.

Materials

• 6 previously prepared bags of food:

− North Trayland/Season 1 = 4 handfuls popcorn + 20 kidney beans + 50 marbles

− North Trayland/Season 2 = 1 handful popcorn + 10 kidney beans + 50 marbles

− North Trayland/Season 3 = 100 marbles

− South Trayland/Season 1 = 4 handfuls popcorn + 20 kidney beans + 50 marbles

− South Trayland/Season 2 = 6 handfuls popcorn + 10 kidney beans + 5 marbles

− South Trayland/Season 3 = 8 handfuls popcorn

• 20 large bulldog clips

• 20 medium-sized bulldog clips

• 20 small bulldog clips

• 30 plastic cups

• 2 large trays

• 6 plastic bags

• Timer

Method

1 Twelve students will represent a population of birds living on an island. Four students should be Giant birds (with a large bulldog clip each). Four students are Midbill birds with the medium-sized bulldog clips. The remaining four students are Babybill birds with the small bulldog clips.

2 A permanent barrier separates the bird population into two groups (North Trayland and South Trayland) with two birds of each type (2 large, 2 medium and 2 small) in each. Place the trays at opposite ends of the classroom.

3 Place the first season’s food for each population in the tray. The 12 birds have 25 seconds to collect as much food as possible with their bulldog-clip ‘beaks’ and place it in their cup ‘stomachs’.

4 At the end of the time, calculate how many kilojoules each bird has consumed if popcorn = 2 kilojoules, beans = 5 kilojoules, marbles = 10 kilojoule. The following tables shows you how many kilojoules each type of bird needs to survive. Record the number of surviving birds in the results table.

|  |  |  |
| --- | --- | --- |
| Bird | Kilojoules needed to survive | Kilojoules needed to reproduce |
| Giant | 80 | 160 |
| Midbill | 50 | 100 |
| Babybill | 25 | 50 |

5 Reproducing birds should choose another student (who is not already a bird) to be their baby (with the same-sized beak).

6 Remove any remaining food from the trays and place back into the plastic bags. Place the food for season 2 in each tray. Repeat steps 3–5.

7 Remove any remaining food from the trays and place the food for season 3 in each tray. Repeat steps 3–5.

8 Clean up any remaining food.

Results

Copy and complete the following tables.

North Trayland

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Bird | Before isolation | Season 1 | Season 2 | Season 3 |
| Giant | 2 |  |  |  |
| Midbill | 2 |  |  |  |
| Babybill | 2 |  |  |  |

South Trayland

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Bird | Before isolation | Season 1 | Season 2 | Season 3 |
| Giant | 2 |  |  |  |
| Midbill | 2 |  |  |  |
| Babybill | 2 |  |  |  |

Discussion

1 Describe what happened to the North Trayland population of birds after they were isolated from South Trayland.

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2 Describe what happened to the South Trayland population of birds after they were isolated from North Trayland.

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Conclusion

Use the terms ‘natural selection’ and ‘selection pressures’ to explain the type of evolution that occurred between the two species.

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Experiment worksheet

2.4 Fossils provide evidence of evolution

Pages 48–51 and 191

Experiment 2.4: Popcorn dating

Aim

To determine the absolute date of an unknown sample of popped popcorn.

Materials

• Previously prepared bags of microwave popcorn (unbuttered):

− Bag A: stop microwave 10 seconds after first pop (record the actual time)

− Bag B: stop microwave 30 seconds after first pop (record the actual time)

− Bag C: stop microwave 10 seconds after last pop (record the actual time)

− Bag D: mystery fossil bag (your teacher will have microwaved this bag for a time between bag A and C)

• Microwave oven

• 4 large trays

Popcorn dating

Method

1 Open bag A and count how many corn kernels have popped and how many have not popped.

2 Determine the percentage of popped kernels using the following equation.



3 Repeat steps 1 and 2 with bags B and C.

4 Graph the percentage of popped kernels against the time spent in the microwave oven.

5 Repeat steps 1 and 2 with bag D. Use your graph to determine how long bag D was in the microwave oven.

Results

Copy and complete the following table and draw a graph of your results.

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| --- | --- | --- | --- | --- |
| Bag | Time in the microwave | Number of popped kernels | Number of un-popped kernels | Percentage of popped kernels |
| A |  |  |  |  |
| B |  |  |  |  |
| C |  |  |  |  |
| D |  |  |  |  |

Discussion

1 What is a half-life?

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2 How long was the half-life of your popcorn kernels?

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3 For how long was bag D heated? (Confirm your answer with your teacher.)

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4 How accurate was your estimate? Provide evidence to support your answer.

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Conclusion

How does this experiment provide an example of absolute dating methods?

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Experiment worksheet

2.6 DNA and proteins provide chemical evidence for evolution

Pages 56–57 and 192

Experiment 2.6: Who is my cousin?

Aim

To determine the evolutionary relationship between different species.

Materials

• DNA sequences

Hippo AGTCCCCAAAGCAAAGGAGACTATCCTTCCTAAGCATAAAGAAATGCCCTTCTCTAAATC

Giraffe AGTCTCCAAATGAAAGGAGACTATGGCTCCTAAGCACAAAGAAATGCCCTTCCCTAAATA

Rhino AGTCCTCCAAACTAAGGAGACCATCTTTCCTAAGCTCAAAGTTATGCCCTCCCTTAAATC

Pig AGATTCCAAAGCTAAGGAGACCATTGTTCCCAAGCGTAAAGGAATGCCCTTCCCTAAATC

Cow AGTCCCCAAATGAAAGGAGACTATGGTTCCTAAGCACAAGGAAATGCCCTTCCCTAAATA

Method

1 Compare the DNA sequences and determine the number of differences between each pair.

2 Write your results in a results table as shown below.

Results

Copy and complete the table to show the number of differences in DNA sequence between each animal.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Hippo |  |  |  |  |  |
| Cow |  |  |  |  |  |
| Giraffe |  |  |  |  |  |
| Rhino |  |  |  |  |  |
|  |  |  |  |  |  |
|  | Pig | Hippo | Cow | Giraffe |  |

Discussion

1 a Which animal has the least number of differences in DNA sequence when compared to a cow?

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b What does this suggest about the evolutionary relationship between these two animals?

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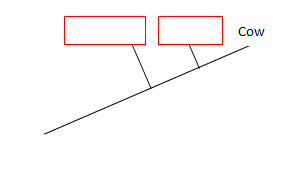
2 a Which animal has the most number of differences in their DNA sequence when compared to a cow?

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b What does this suggest about the evolutionary relationship between these two animals?

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3 Use your answers to questions 1 and 2 to complete the following phylogenetic tree.



Conclusion

How do DNA sequences determine the evolutionary relationships between different organisms?

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Experiment worksheet

2.7 Humans artificially select traits

Pages 58–59 and 193

Challenge 2.7: Selective breeding of dogs

Aim

To examine how selective breeding for chosen characteristics can develop a new breed of dog.

What you need

• Counter

• Permanent marker

What to do

1 You are a scientist who studies small mammals in the bush. You need a dog to find and retrieve the mammals without causing them unnecessary stress. This will allow you to tag and release the mammals. Below is a list of possible traits of dogs.

Possible traits of dogs

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| BREED | DESIRED FORM | | | |
| Trainability | High | Moderate | Low | Any |
| Temperament | Vicious | Friendly | Timid | Any |
| Bark | Very loud | Moderate | Quiet | Any |
| Coat colour | Black | Brown | Caramel | Any |
| Hair length | Long | Moderate | Short | Any |
| Smell | High ability | Moderate | Low ability | Any |
| Sight | High ability | Moderate | Low ability | Any |
| Hearing | High ability | Moderate | Low ability | Any |
| Speed | Fast | Moderate | Low | Any |
| Endurance | High | Moderate | Low | Any |

2 Identify which two traits are most important for your new breed to inherit.

3 Choose which dogs you need to breed to achieve your desired traits from the following table.

Traits of different dog breeds

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Breed | Animo | Bax | Coota | Dallie | Enos | Favious | Animo |
| Trainability | Moderate | Moderate | High | Low | Moderate | High | Moderate |
| Temperament | Timid | Timid | Vicious | Timid | Friendly | Vicious | Timid |
| Bark | Moderate | Very loud | Moderate | Quiet | Very loud | Moderate | Moderate |
| Coat colour | Black | Brown | Caramel | Caramel | Black | Brown | Black |
| Hair length | Long | Moderate | Long | Short | Moderate | Long | Long |
| Smell | High ability | Moderate | Low | Low | Moderate | High | High ability |
| Sight | Moderate | Moderate | Moderate | High | High | Low | Moderate |
| Hearing | High ability | Moderate | Moderate | High | High | Moderate | High ability |
| Speed | Moderate | Fast | Fast | Fast | Low | Moderate | Moderate |
| Endurance | Low | Moderate | High | Moderate | High | Low | Low |

4 Choose dogs to be the mother and the father.  
Write an ‘M’ for mother on one side of the counter and an ‘F’ for father on the other side of the counter.

5 Flip the counter for each trait. If it lands with the ‘M’ side up, then the puppy will inherit the mother’s trait. An ‘F’ indicates that puppy inherits the father’s trait. Write your results in the table.

6 Flip the counter three times for each trait because each pair will have three puppies.

Results

Copy and complete the following table.

|  |  |  |  |
| --- | --- | --- | --- |
| TRAIT | PUPPY 1 | PUPPY 2 | PUPPY 3 |
| Trainability |  |  |  |
| Temperament |  |  |  |
| Bark |  |  |  |
| Coat colour |  |  |  |
| Hair length |  |  |  |
| Smell |  |  |  |
| Sight |  |  |  |
| Hearing |  |  |  |
| Speed |  |  |  |
| Endurance |  |  |  |

Discussion

1 Were all three puppies identical? Suggest a reason.

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2 Which puppy best suited your original needs? Explain your answer.

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3 If you were to breed the dogs for another generation, which puppies would you select to be the parents? Explain your answer.

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4 Are your puppies a new species? Explain your answer.

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Conclusion

Explain how selective breeding can affect the survival of a species.

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Experiment worksheet

2.8 Natural selection affects the frequency of alleles

Pages 60–61 and 194

Experiment 2.8: Selecting for sickle cell anaemia

Aim

To examine how malaria selects for sickle cell anaemia.

Materials

• 75 dried red kidney beans (These are the sex cells carrying ‘H’, the unaffected normal haemoglobin allele.)

• 25 white beans (These are the sex cells carrying ‘h’, the affected sickle cell allele.)

• 5 containers

• Coin or counter (for flipping heads or tails)

• Permanent marker

Method

1 Place all the beans in a container and mix them thoroughly. This container represents the total ‘gene pool’ of your population.

2 Label the remaining containers:

HH: No sickle cell disease

Hh: No sickle cell disease

hh: Sickle cell disease

Dead

3 Without looking, randomly select two beans from the gene pool. This represents the two alleles that are present in a baby of the next generation.

4 Flip the coin to determine if the baby catches malaria. Heads means the baby is infected; tails means it does not become infected. Use the following table to determine if the individual lives or dies.

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| --- | --- | --- | --- |
| Alleles present (bean colour) | Presence of sickle cell anaemia? | Heads – infected with malaria | Tails – not infected with malaria |
| HH (red – red) | No sickle cell anaemia  Susceptible to malaria | Die  Place in Dead | Live  Place in HH |
| Hh (red – white) | No sickle cell anaemia  Resistant to malaria | Live  Place in Hh | Live  Place in Hh |
| hh (white – white) | Sickle cell anaemia | Die  Place in Dead | Die  Place in Dead |

5 Repeat steps 3 and 4 until the gene pool is empty.

6 Record your results in the table below.

7 Place all the survivors in HH and Hh back into the gene pool and continue breeding for a second generation.

8 Combine the class results to ensure that you have a large sample size.

9 Determine the percentage of each allele present in each generation from the following formulas:





Results

Copy and complete the following table.

Surviving alleles

|  |  |  |
| --- | --- | --- |
|  | Number of red kidney beans (H) | Number of white beans (h) |
| Generation 1 | 75 | 25 |
| Generation 2 |  |  |
| Generation 3 |  |  |

Discussion

1 What trends did you notice for the percentage of ‘H’ (normal) alleles present in the gene pool?

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2 What trends did you notice for the percentage of ‘h’ (sickle cell) alleles present in the gene pool?

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3 The hh combination is deadly and people with this are likely to die before reproducing. Why has the ‘h’ allele not been removed from the population completely?

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4 If people with sickle cell anaemia were able to survive and reproduce, what would you expect to happen to the percentage of people carrying the ‘h’ allele in the population?

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Conclusion

How does malaria select for carriers of sickle cell anaemia?

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