

# EVOLUTION & ECOSYSTEMS

## Stage 6 - Year 11 Biology

### Outcomes

**BI-11-03** - analyses the relationships between organisms and their environment using the theory of evolution by natural selection

**BI-11WS-05** - analyses and evaluates primary and secondary data and information

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## WHAT TO EXPECT IN OUR ZOO WORKSHOP

This lesson introduces students to how human-induced environmental change creates selective pressures that drive adaptation and evolution. Students will investigate how abiotic, biotic, and human-driven factors shape structural, physiological, and behavioural adaptations in Australian species, and compare key evolutionary patterns, including the role of isolation in the evolution of monotremes and marsupials. They will also explore how Aboriginal and Torres Strait Islander Peoples apply deep ecological knowledge of these adaptations for specific purposes.



# ABIOTIC & BIOTIC FACTORS

Observe one animal exhibit or your school playground and **identify** the abiotic and biotic factors present.

|            | Abiotic Factors                          | Biotic Factors                       |
|------------|------------------------------------------|--------------------------------------|
| Definition | Non-living components of the environment | Living components of the environment |
| Examples   |                                          |                                      |

# HUMAN-INDUCED SELECTION PRESSURES

Identify possible changes to selection pressures caused by each human-induced change and **classify** the selection pressures as either abiotic, biotic or both.

| Human Induced Change | Possible Change to Selection Pressures                | Abiotic, biotic or both? |
|----------------------|-------------------------------------------------------|--------------------------|
| Climate Change       | <i>e.g. Increased temperature, decreased rainfall</i> | <i>Abiotic</i>           |
| Introduced species   |                                                       |                          |
| Pollution            |                                                       |                          |
| Over exploitation    |                                                       |                          |
| Habitat loss         |                                                       |                          |



# ADAPTATIONS FOR SURVIVAL

Use plant and animal examples to explain how structural, physiological and behavioural adaptations shaped by evolution enable survival in their environment

Use examples to explain behavioural adaptations used by ectotherms and endotherms to survive in the Australian environment

Define the following terms and provide **examples** of each.

|            | Endotherm | Ectotherm |
|------------|-----------|-----------|
| Definition |           |           |
| Examples   |           |           |

Adaptations are traits that help living things survive and reproduce. These traits can be shaped by different selection pressures that an animal may experience in its environment. Match the adaptations to the relevant selection pressure.

| Adaptations                                                         | Selection Pressures                                                 |
|---------------------------------------------------------------------|---------------------------------------------------------------------|
| Bilbies have large ears to dissipate heat and are nocturnal         | Hunting for food sources underwater with low visibility             |
| Water-holding frogs can form cocoons underground and remain dormant | High daytime temperatures                                           |
| Echidnas have sharp quills made of keratin covering their body      | Unpredictable rainfall and temporary loss of aquatic breeding sites |
| Platypus have electroreceptors in their bills                       | Protection from predators                                           |



# HUMAN-INDUCED SELECTION PRESSURES

Use examples to demonstrate how abiotic and biotic factors exert selective pressures on populations  
Explain how human-induced changes may function as selective pressures

## AUSTRALIAN PARROTS

Selection Pressure

☐ Abiotic    ☐ Biotic

Observed Changes in  
Populations



## LACE MONITORS

Selection Pressure

☐ Abiotic    ☐ Biotic

Observed Changes in  
Populations





# ADAPTATIONS FOR SURVIVAL

Use plant and animal examples to explain how structural, physiological and behavioural adaptations shaped by evolution enable survival in their environment

Use examples to explain behavioural adaptations used by ectotherms and endotherms to survive in the Australian environment

Name of endotherm:

| Type of Adaptation | Examples of Adaptations | Selection Pressure |
|--------------------|-------------------------|--------------------|
| Structural         |                         |                    |
| Behavioural        |                         |                    |
| Physiological      |                         |                    |

Name of ectotherm:

| Type of Adaptation | Examples of Adaptations | Selection Pressure |
|--------------------|-------------------------|--------------------|
| Structural         |                         |                    |
| Behavioural        |                         |                    |
| Physiological      |                         |                    |



# CULTURAL USES OF ADAPTATIONS

Explain how Aboriginal and Torres Strait Islander Peoples use the adaptations of local plants and animals for specific purposes

Animals and plants have unique adaptations that help them survive in their environments. For tens of thousands of years Aboriginal and Torres Strait Islander peoples have carefully observed how plants and animals survive, and they use this knowledge of adaptations for many practical purposes.



|                      | Description of adaptation | Use by Aboriginal people |
|----------------------|---------------------------|--------------------------|
| Red Kangaroo         |                           |                          |
| Short-beaked Echidna |                           |                          |
| Lemon Myrtle         |                           |                          |
| Lomandra             |                           |                          |

### Use examples to explain convergent and divergent evolution

A large tortoise, likely a Galapagos tortoise, is shown resting on a bed of green, leafy vegetation. The tortoise has a dark, patterned shell and thick, wrinkled skin. It is facing towards the right side of the frame.

A large tortoise, likely a Galapagos tortoise, is shown walking on a rocky, uneven path. The tortoise has a dark, textured shell and thick, wrinkled skin. It is moving towards the right side of the frame. The background consists of dry, rocky ground and some sparse, low-lying vegetation.

*HINT – Link the differences in selection pressures to the differences in their physical structures*

[illegible]

### Use examples to explain convergent and divergent evolution

## Kinkajou



*HINT – Link the similarities in selection pressures to the similarities in their physical structures*

[illegible]

# MONOTREME AND MARSUPIAL EVOLUTION

## Evaluate the role of isolation and adaptation in the evolution of Australian monotremes and marsupials



Permian period  
(225 mya)



Triassic period  
(200 mya)



Jurassic period  
(150 mya)



Cretaceous period  
(65 mya)



### Present period

This image shows a blank sheet of white paper with horizontal ruling lines. The lines are evenly spaced and run across the width of the page. There is no handwriting or other markings on the paper.



# MONOTREME AND MARSUPIAL EVOLUTION

Evaluate the role of isolation and adaptation in the evolution of Australian monotremes and marsupials

## MONOTREMES

Reproductive Adaptations

General Adaptations



## MARSUPIALS

Reproductive Adaptations

General Adaptations





# MODELLING NATURAL SELECTION

Conduct a practical investigation to model the processes involved in natural selection

**Aim:** To **model** how natural selection can lead to changes in the frequency of advantageous traits within a population over successive generations.

**Hypothesis:**

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**Variables:**

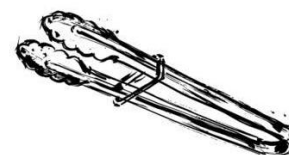
Independent variable: \_\_\_\_\_

Dependent variable: \_\_\_\_\_

Controlled variables: \_\_\_\_\_

**Equipment:**

- Chopsticks
- Metal spoon
- Metal tongs
- Wooden peg
- Dried beans
- Seeds
- Recycled bottle caps
- Gravel or pebbles
- Timer



**Procedure:**

## Generation 1

1. In groups of four, assign each student a different beak type (chopsticks, tongs etc).
2. Scatter 100 food items across the 'feeding area' (beans, seeds etc).
3. Collect and transfer food items to your 'nest area' for 30 seconds.
4. Count the number of food items collected by each beak type and record the results.
5. Calculate the population size of each beak type for the next generation using the criteria below. Record the new population frequencies.

> 15 food items  
= 2 offspring

10-15 food items  
= 1 offspring

< 10 food items  
= 0 offspring

## Subsequent Generations

6. Replace all food resources.
7. Repeat steps 1 - 5 for a total of five generations.
8. Record changes in population size after each generation.



# MODELLING NATURAL SELECTION

Conduct a practical investigation to model the processes involved in natural selection

**Results:**

**Table 1: Feeding success of different beak types over successive generations**

|            | Number of food items collected and placed in nest |              |              |              |              |
|------------|---------------------------------------------------|--------------|--------------|--------------|--------------|
| Beak Type  | Generation 1                                      | Generation 2 | Generation 3 | Generation 4 | Generation 5 |
| Chopsticks |                                                   |              |              |              |              |
| Spoon      |                                                   |              |              |              |              |
| Tongs      |                                                   |              |              |              |              |
| Peg        |                                                   |              |              |              |              |

**Table 2: Frequency of different beak types over successive generations in a population**

|            | Beak Type  |       |       |     |
|------------|------------|-------|-------|-----|
| Generation | Chopsticks | Spoon | Tongs | Peg |
| 1          |            |       |       |     |
| 2          |            |       |       |     |
| 3          |            |       |       |     |
| 4          |            |       |       |     |
| 5          |            |       |       |     |

**EXTENSION – Environmental Change**

After generation 3 replace larger food items with smaller seeds to simulate drought or changing resource availability OR reduce total food availability by 50 % to simulate increased competition. Continue collecting data for Generations 4 and 5.



# MODELLING NATURAL SELECTION

Conduct a practical investigation to model the processes involved in natural selection

**Results:**

**Figure 1: Feeding success of different beak types over successive generations (bar graph)**

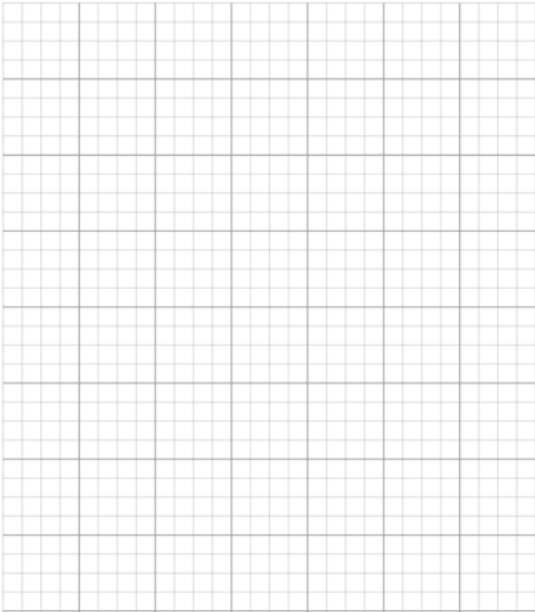


**Figure 2: Frequency of different beak types over successive generations in a population (line graph)**



**Discussion Questions:**

1. Which beak type was the most successful at collecting food?
2. What selection pressure was acting on the population?
3. How did feeding success influence reproductive success?
4. How did phenotype frequencies change across generations?
5. How does this model demonstrate variation, competition, selection and inheritance?
6. What effect did the environmental change have on the population (extension)?
7. How accurately does this model represent natural selection in real populations?