# Strand 1: Animal Behaviour

**Major Learning Outcome 1:**

Students are able to demonstrate understanding of **biological concepts and processes** relating animal behaviour to biotic and abiotic environmental factors and how the behaviour **contributes to the organism’s survival.**

## Sub-strand 1.1 Ecological Niche

**Key Learning Outcome:** Students are able to demonstrate an understanding of the ecological niche of an animal species and to investigate and report an aspect of the animal species’ ecological niche.

* ecological niche is defined as the role of an organism in a community in terms of the habitat it occupies, its interactions with other organisms, and its effect on the environment.
* adaptive features refer to structural, behavioural, and physiological
* environment refers to biotic and abiotic factors
* an investigation is an activity which includes: a statement of the purpose (hypothesis); testable question or prediction; collecting, recording, and process data relevant to the hypothesis; and interpreting and reporting the findings in a scientific report.

### Lesson Activity 1.1A

**The specific learning outcomes (SLO) targeted in this activity are provided below:**

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| **SLO#** | **Specific Learning Outcomes:** Students are able to | **Skill level** | **SLO code** | **Achieved**  **(Yes / No)** |
| 1 | Define the term ‘ecological niche’ | 1 | Bio1.1.1.1 |  |
| 7 | Describe the physical habitat in relation to an animal species’ ecological niche | 2 | Bio1.1.2.1 |  |
| 8 | Describe the environment in terms of abiotic and biotic factors for a niche | 2 | Bio1.1.2.2 |  |
| 9 | Describe the adaptive features of an animal species in relation to the animal species’ habitat and/or niche | 2 | Bio1.1.2.3 |  |

**Notes:**

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| **Ecological niche**  Organisms occupy **ecological niches**. The niche of an organism is the way it has adapted in response to the habitat in which it lives. The niche is a combination of where the organism lives (its habitat) and how it lives there (its adaptations – structural, behavioural, physiological, life cycle). The concept of the ecological niche has been variously described as an organism’s ‘job’ or ‘profession’. This is rather too simplistic for senior biology level. The ecological niche is better described as the functional position of an organism in its environment, comprising its habitat and the resources it obtains there, and the periods of time during which it is active. The diagram below shows the components that together define the niche of any organism.  *Each species has a unique niche.* The **fundamental niche** for an organism is that niche it would occupy if all the necessary environmental conditions (biological and physical) were present. The limits to the fundamental niche are set by the limits of an organism’s physiological tolerances to **abiotic (physical) factors** (e.g. temperature, oxygen concentration, and substrate). The **realised niche** is the actual niche that the organism occupies. It is not as extensive as the fundamental niche, with its boundaries typically being set by **biotic (living) factors** (e.g. predation, interspecific competition, intraspecific competition). |

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| C:\Users\User\Desktop\coconut-crab_krabkokonas.jpg  **Adaptations for**  **Locomotion**  Biorhythms and activity pattern  Tolerance to physical conditions  Defence of the habitat  Predator avoidance  Reproduction  Feeding  Adaptations allow the organism to exploit the resources of the habitat. The adaptations take the form of **structural**, **physiological**, and **behavioural** features that allow the resources to be exploited.  **Resources offered by the habitat**   * Food sources * Shelter from climatic extremes * Mating sites * Nesting sites * Predator avoidance   The habitat provides opportunities and resources for the organism. The organism may or may not have the adaptations to exploit them fully.  **Physical conditions**  Substrate  Humidity  Sunlight  Temperature  Salinity  pH (acidity)  Exposure  Altitude and aspect  Depth  **Other organisms present**  The type and amount of resources available is affected by the presence of other organisms. Competition affects the availability of resources and may affect survival. Survivability will also be affected by the presence of predators, parasites, and pathogens. |

*Picture of a coconut crab in Vanuatu, retrieved from:* [**https://www.google.com/search?q=vanuatu+coconut+crab&source**](https://www.google.com/search?q=vanuatu+coconut+crab&source)

1. Use the diagram above to develop your own definition of an ecological niche. (L1) (SLO#1 - Bio1.1.1.1)

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1. Find out (Google or from the internet) about the way of life of the coconut crab, then answer the following questions:
2. Describe the physical habitat in relation to the coconut crab’s ecological niche. (L2) (SLO#7 – Bio1.1.2.1)

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1. Describe the environment in terms of abiotic and biotic factors for a coconut crab’s niche. (L2) (SLO#8 – Bio1.1.2.2)

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### Lesson Activity 1.1B

**The specific learning outcomes (SLO) targeted in this activity are provided below:**

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| **SLO#** | **Specific Learning Outcomes:** Students are able to | **Skill level** | **SLO code** | **Achieved**  **(Yes / No)** |
| 8 | Describe the environment in terms of abiotic and biotic factors for a niche | 2 | Bio1.1.2.2 |  |
| 9 | Describe the adaptive features of an animal species in relation to the animal species’ habitat and/or niche | 2 | Bio1.1.2.3 |  |

**Notes:**

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| **Adaptations to Niche**  The adaptive features that evolve in species are the result of selection pressures on them through the course of their evolution. These features enable an organism to function most effectively in its niche, enhancing its exploitation of its environment and therefore its survival. The examples below illustrate some of the adaptations of two species: a migratory Arctic bird and a British placental mammal. Note that adaptations may be associated with an animal’s structure (morphology), its internal physiology, or its behaviour.   * *Structural adaptations* are aspects of the structure of the body (‘what the organism has’) – e.g. the large ridged grinding molars of cows; the large spines of *Bougainvillea* plants. * *Behavioural adaptations* are aspects of the behaviour of the organism (‘what the organism does’) – e.g. homing response of domestic pigeons; nightly nest-building in trees by common chimpanzees; stalking of prey by cheetahs. * *Physiological adaptations* are aspects of the chemical processes of the body (‘how the organism functions’) – e.g. pheromones produced by ants; anti-coagulants in the saliva of bloodsucking parasites such as leeches and mosquitoes.   Every adaptation has a *purpose*, i.e. allows the organisms to survive and live successfully. |

The snow bunting (*Plectrophenax nivalis)* is a small ground feeding bird that lives and breeds in the Arctic and sub-Arctic islands. Although migratory, snow buntings do not move to traditional winter homes but prefer winter habitats that resemble their Arctic breeding grounds, such as bleak (desolate) shores or open fields of northern Britain and the eastern United States. Snow buntings have the unique ability to molt very rapidly after breeding. During the warmer months, the buntings are a brown color, changing to white in winter (right). They must complete this color change quickly, so that they have a new set of feathers before the onset of winter and before migration. In order to achieve this, snow buntings lose as many as four or five of their main flight wing feathers at once, as opposed to most birds, which lose only one or two.

Very few small birds breed in the Arctic, because most small birds lose more heat than larger ones. In addition, birds that breed in the brief Arctic summer must migrate before the onset of winter, often traveling over large expanses of water. Large, long winged birds are better able to do this. However, the snow bunting is superbly adapted to survive in the extreme cold of the Arctic region.

White feathers are hollow (heavy) and filled with air, which acts as an insulator (heat-proofing). In the dark colored feathers the internal spaces are filled with pigmented cells.

Less heat is lost from white plumage (feathers) compared to dark plumage.



During snow storms or periods of high wind, snow buntings will burrow into snowdrifts for shelter.

Snow buntings, on average, lay one or two more eggs than equivalent species further south. They are able to rear more young because the continuous daylight and the abundance of insects at high latitudes enables them to feed their chicks around the clock.

*Picture of snow bunting on snow retrieved from:* [*http://en.wikipedia.org/wiki/Snow\_Bunting*](http://en.wikipedia.org/wiki/Snow_Bunting)

**Habitat and ecology:** Widespread throughout Arctic and sub-Arctic Islands. Active throughout the day and night, resting for only 2-3 hours in any 24 hour period. Snow buntings may migrate up to 6000km but are always found at high latitudes. **Reproduction and behaviour:** The nest, which is concealed amongst stones, is made from dead grass, moss, and lichen. The male bird feeds his mate during the incubation period and helps to feed the young.

1. Describe the environment in terms of abiotic and biotic factors for the snow bunting’s niche. (L2) (SLO#8 – Bio1.1.2.2)

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1. Describe the adaptive features of the snow bunting in terms in relation to its habitat and niche. (L2) (SLO#9 – Bio1.1.2.3)

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1. Explain the relationships within the ecological niche of the snow bunting in terms of its adaptations to its habitat and way of life. (Useful to answer SLO#15 Bio1.1.3.3 & SLO#16 Bio1.1.4.1 when carrying out an investigation).

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### Lesson Activity 1.1C

**The specific learning outcomes (SLO) targeted in this activity are provided below:**

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| **SLO#** | **Specific Learning Outcomes:** Students are able to | **Skill level** | **SLO code** | **Achieved**  **(Yes / No)** |
| 2 | State a title for an investigation into an ecological niche of a named animal species | 1 | Bio1.1.1.2 |  |
| 3 | State an aim for an investigation into an ecological niche of a named animal species | 1 | Bio1.1.1.3 |  |
| 4 | State a hypothesis for an investigation into an ecological niche of a named animal species | 1 | Bio1.1.1.4 |  |
| 5 | Provide an independent variable with a minimum of 3 values given (fair test) or repeat samples were taken (pattern-seeking) | 1 | Bio1.1.1.5 |  |
| 6 | Structure (organise) the scientific report correctly (appropriate order) for the aspect being investigated | 1 | Bio1.1.1.6 |  |

**Notes:**

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| **The ecological niche**  Investigations into aspects of animal behaviour and pattern seeking are likely to be in relation to an organism’s niche (the organism’s habitat and way of life – how it lives and its adaptations). Therefore, research into the organism’s niche will be needed to enable valid conclusions to be drawn and an in-depth discussion of relevant biological concepts made.  Aspects of the ecological niche that should be focused on include:   * the usual habitat of the organism and what the organism gains from this habitat * adaptations of the organism and what the organism gains from this habitat * important relationships the organism has with others in the habitat, such as feeding, predation, competition.   Information about the ecological niche can come from written sources and/or observing the organism in its natural habitat (or in an artificial habitat that mimics the natural). |

1. A student did an investigation into the density of mangrove pneumatophores in substrates of differing water saturation.
2. State a title for the investigation into the ecological niche of the mangrove pneumatophores. (L1) (SLO#2 – Bio1.1.1.2). The title must contain the independent and dependent variables with correct units.

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1. State an aim for the investigation into the ecological niche of the mangrove pneumatophores. (L1) (SLO#3 – Bio1.1.1.3)

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1. State a hypothesis for the investigation into the ecological niche of the mangrove pneumatophores. (L1) (SLO#4 – Bio1.1.1.4)

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1. Provide an independent variable with a minimum of 3 values given (fair test) for the investigation into the ecological niche of the mangrove pneumatophores. Make sure the correct units are stated. (L1) (SLO#5 – Bio1.1.1.5)

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1. The student must provide a scientific report for the investigation into the ecological niche of the mangrove pneumatophores. Outline the structure of the scientific report correctly (appropriate order) for the aspect being investigated. (L1) (SLO#6 – Bio1.1.1.6)

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1. Find out (Google or from the internet) about the way of life of the mangrove pneumatophores, then describe its ecological niche accurately and relate it to the aspect being investigated. (L2) (SLO#10 – Bio1.1.2.4)

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### Lesson Activity 1.1D

**The specific learning outcomes (SLO) targeted in this activity are provided below:**

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| --- | --- | --- | --- | --- |
| **SLO#** | **Specific Learning Outcomes:** Students are able to | **Skill level** | **SLO code** | **Achieved**  **(Yes / No)** |
| 5 | Provide an independent variable with a minimum of 3 values given (fair test) or repeat samples taken (pattern-seeking) | 1 | Bio1.1.1.5 |  |
| 17 | Explain how problems with the validity of the method were overcome | 3 | Bio1.1.3.4 |  |
| 20 | Make recommendations on ways to improve research process | 3 | Bio1.1.3.5 |  |

**Notes:**

|  |
| --- |
| **The method**  For an investigation that is a fair test, note the following.   * The independent variable must be clearly specified, and it must have a range (i.e. at least four values). Light and dark do not constitute a range - a range of at least four specific light intensities is expected. * The dependent variable must also be clearly specified; having ‘activity’ and ‘growth’ are not specific enough – the measurement of the dependent variable must also be described. ‘The time taken for 10 slaters to clump together’, is a clear description of both the dependent variable (clumping of slaters) and its measurement (the time taken for 10 slaters to clump). * How other key variables were controlled must be described. Key variables are those that could affect the outcome of the investigation if they are not controlled.   For an investigation that is a field study or pattern-seeking study, note the following.   * The data that are to be collected must be clearly described. Again, you must be very specific. ‘Amount of pneumatophores’ is not adequate, while ‘Density/m2 … ‘ would be. * The range of data or samples needs to be described. As for a fair test, at least four values are required. * Other key factors must be considered. Again, these are factors that could affect the outcome of the investigation. |

1. The two investigation methods that follow are for a fair test investigation and a pattern seeking investigation. For each one:

* provide the independent variable (with minimum of three values for fair test or repeat sample taken for pattern seeking) and dependent variable (L1) (SLO#5 – Bio1.1.1.5);
* and describe how other key variables were controlled.

1. **Investigation 1 – A fair test**

*Information* *relating to the organism*: *Daphnia* are small crustaceans that exist in still bodies of water containing lots of algae and other microscopic matter that they can eat. Several species have translucent exoskeletons, through which the beating heart can be easily seen. *Daphnia* are ectothermic, meaning that their body temperature, rate of heartbeat and other metabolic processes depend on the ambient (surroundings) water temperature. They are tolerant of water temperatures of between 1 oC and around 38 oC; above 38 oC, the enzymes that catalyse metabolic reactions denature, and the organism dies.

*Hypothesis:* That the heartbeat rate of *Daphnia* (common name, water flea) will increase as water temperature increases since *Daphnia* are ectotherms and their body temperature depends on the ambient water temperature.

*Method*

* Obtain a culture of *Daphnia*. Maintain under normal conditions until the start of the experiment.
* Place some water into a cavity slide (a glass slide with a small depression in it). Place the cavity slide under a microscope at a suitable magnification (this will have been established prior to the investigation).
* Using an eye-dropper, carefully place a single *Daphnia* into the cavity.
* Count the number of heartbeats for 10 seconds.
* Add a drop of boiling water into the water in the cavity slide. Then, using an eye-dropper, carefully place a single *Daphnia* into the cavity.
* Count the number of heartbeats for 10 seconds.
* Repeat adding a drop of iced water into the water in the cavity slide.

1. Independent variable:

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1. Dependent variable:

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1. Other key variables:

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1. **Investigation 2 – A pattern seeking investigation**

*Information relating to the organism*: Mangroves are plants that grow in an estuarine environment. The substrate they in fluctuates in water saturation and salinity due to tidal movements, and is poorly aerated. An adaptation mangroves have is the growth of pneumatophores, aerial roots that grow above the substrate surface to obtain the oxygen required for respiration from the surrounding air. The pneumatophores have tiny holes in them that allow air in, but not water.

*Hypothesis*: That the density of mangrove pneumatophores will be greatest in substrates that have greater water saturation, as these substances will have the lowest oxygen saturation.

*Method*

* Establish the study area. Select an area of mangroves where there are obvious high- and low-tide marks, and the mangroves appear to be of a similar age (estimate using the heights of the mangroves).
* In the study area, identify a range of substrates in terms of water saturation. Do this using a transect line at low tide. Working from the high-tide mark, fill a 0.5L measuring cylinder with a sample of the substrate every vertical 0.5m from the high-tide mark to the low-tide mark (at this study area, this resulted in a range of water-saturation substrates). Shake the samples and allow to settle. Once settled, measure the volumes of water and solids. Express the saturation of the substrate by calculating the % water for each substrate sample.
* At the sample points on the transect line, measure the density of the pneumatophores. Do this by measuring out an area of 1 m x 1 m (1 m2) at each sample point on the transect line so that the sample point is in the center of the 1 m2 area. Count the number of pneumatophores in this area and express as the density of pneumatophores per m2.
* Repeat the above for three more different sample sites, again using the transect line from the high-tide to the low-tide mark.

1. Independent variable: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
2. Dependent variable: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
3. Other key variables: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

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1. A **valid method** enables a valid conclusion to be made from the results. This means that you have done everything possible to ensure the method is sound. This includes the following.

* The range for the independent variable is valid and has been quantified. For example, the range does not go beyond the tolerance limits of the organism and is appropriate to the organism’s niche, and the increments between the values of the range have been established in a valid way (some trialing may have to be done).
* The dependent variable has been measured in a valid way (in a pattern-seeking study or field study, the data been collected in a valid way). For example, if measuring nocturnal activity of an animal, measurements are carried out at night (or in the dark if under artificial conditions).
* The method also needs to describe how sufficient data for the dependent variable to establish a trend or pattern will be collected. For example, several repeats or a comprehensive range.
* All other variables or factors that may affect the outcome of the investigation have been controlled or taken into account.

One of the investigation methods in question 1 above is valid, while the other is not.

i. Explain how problems with the validity of the method were overcome. (L3) (Bio1.1.3.4)

Your explanation must include the following points:

* Identify which of the two investigations is valid
* Explain why this investigation is valid.

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1. State why the other investigation is not valid, and make recommendations on ways to improve the research process to ensure its validity. (L3) (SLO#3 – Bio1.1.3.5)

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### Lesson Activity 1.1E

**The specific learning outcomes (SLO) targeted in this activity are provided below:**

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| **SLO#** | **Specific Learning Outcomes:** Students are able to | **Skill level** | **SLO code** | **Achieved**  **(Yes / No)** |
| 13 | Measure or calculate the average (mean) value of dependent variable and give unit(s) | 3 | Bio1.1.3.1 |  |
| 15 | Explain the findings of the investigation | 3 | Bio1.1.3.3 |  |
| 16 | Discuss the results of the investigation in relation to the ecological niche and the biology of the species and how these can be used to make predictions for other communities | 4 | Bio1.1.4.1 |  |
| 18 | Explain how the reliability of the data collected is maintained using appropriate statistical procedure | 3 | Bio1.1.3.4 |  |

The following raw data were obtained from an investigation into the respiration rates (breaths min-1) of crabs in a range of water temperatures. The respiration rates of crabs are the dependent variable and the range of water temperatures is the independent variable.

1. Use the information in the table to calculate the average (means) value of the dependent variable for each water temperature and give the appropriate units. (L3) (SLO#13 – Bio1.1.3.1)

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | **Water temperature (oC)** | | | | |
|  | **10** | **15** | **20** | **25** | **30** |
| **Crab 1** | 6 | 6 | 8 | 11 | 12 |
| **Crab 2** | 7 | 6 | 9 | 9 | 11 |
| **Crab 3** | 5 | 8 | 9 | 11 | 13 |
| **Crab 4** | 7 | 7 | 8 | 12 | 14 |
| **Crab 5** | 6 | 5 | 6 | 8 | 10 |
| **Crab 6** | 7 | 8 | 7 | 11 | 12 |
| **Crab 7** | 5 | 7 | 7 | 11 | 13 |

a. Respiration rate of crabs at 10 oC:

b. Respiration rate of crabs at 15 oC:

c. Respiration rate of crabs at 20 oC:

d. Respiration rate of crabs at 25 oC:

e. Respiration rate of crabs at 30 oC:

1. Explain the findings of the investigation. (L3) (SLO#15 - Bio1.1.3.3)

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1. Find out (Google or from the internet) the way of life of crabs and then discuss the results of the investigation in relation to its ecological niche and biology and how these can be used to make predictions for other communities. (L4) (SLO #16 - Bio1.1.4.1)

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### Lesson Activity 1.1F

**The specific learning outcomes (SLO) targeted in this activity are provided below:**

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| --- | --- | --- | --- | --- |
| **SLO#** | **Specific Learning Outcomes:** Students are able to | **Skill level** | **SLO code** | **Achieved**  **(Yes / No)** |
| 18 | Explain how the reliability of the data collected is maintained using appropriate statistical procedure | 3 | Bio1.1.3.4 |  |

Ensuring the conclusions are valid, thereby justifying them, involves statistical analysis of the data. Statistical analysis determines the **reliability** of the data collected. A written statement explaining the significance of, and referring explicitly to, the results of the statistical analysis is required in addition to the actual analysis itself.

* To what degree of validity does the analysis show the results to be?
* How confident are you in accepting the data as being accurate and precise?

The first and most important step in a statistical analysis is to decide on the kind of test to use. Where there are three or more sets of measurements to be compared the **ANOVA** test is needed. (See how ANOVA is done on pages 10, 24 – 25 of the Year 13 Study Guide NCEA Level 3 Biology by Hanson & Sinclair, 2006). The **Chi-squared test** is used where an observed set of data fits with a theoretical expectation. (See how Chi-squared test is done on pages 10, 22 – 24 of the Year 13 Study Guide NCEA Level 3 Biology by Hanson & Sinclair, 2006). The**Student’s *t* test** is a commonly used test when comparing two sample means, e.g. means for a treatment and a control in an experiment, or the means of some measured characteristic between two animal or plant populations. (See how Student’s *t* test is done on pages 41 – 47 of the Senior Biology 1 Student Workbook 2009 by Biozone).

a. A fruitfly heterozygous for ebony body and vestigial wings are mated with an ebony-bodied, vestigial-winged fly, and the offspring were as follows:

grey-bodied, long-winged 92

grey-bodied, vestigial winged 86

ebony-bodied, long-winged 97

ebony-bodied, vestigial-winged 101

Total 376

Explain how the reliability of the data collected (results) is maintained using appropriate statistical procedure. (L3) (SLO#17 – Bio1.1.3.4)

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b. An investigation where the effect of fertiliser concentration on tomato plant height was carried out. A range of 3 fertiliser concentrations was used with 3 replicates for each treatment.

|  |  |  |  |
| --- | --- | --- | --- |
| **Replicate** | **Group A** | **Group B** | **Group C** |
| 1 | 11 | 21 | 39 |
| 2 | 14 | 18 | 37 |
| 3 | 9 | 22 | 41 |

Explain how the reliability of the data collected (results) is maintained using appropriate statistical procedure. (L3) (SLO#17 – Bio1.1.3.4)

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### Lesson Activity 1.1G

**The specific learning outcomes (SLO) targeted in this activity are provided below:**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **SLO#** | **Specific Learning Outcomes:** Students are able to | **Skill level** | **SLO code** | **Achieved**  **(Yes / No)** |
| 14 | Tabulate and graph results (processed data i.e. average only) | 3 | Bio1.1.3.2 |  |
| 15 | Explain the findings of the investigation | 3 | Bio1.1.3.3 |  |
| 19 | Draw valid conclusion which is supported by the processed data (results) | 2 | Bio1.1.2.7 |  |

**Notes:**

|  |
| --- |
| **The conclusion**  A conclusion is a statement about the results of the investigation. A valid conclusion follows on from a valid investigation.   * A valid conclusion must be based on the *processed data*. This means that the data must be specifically and accurately referred to.   **Example:**  In the investigation into the effect of water temperature on the heart rate of *Daphnia magna*, it is not sufficient to say ‘As the temperature of the water increased, the heart rate of the *Daphnia* also increased.’ Firstly, this is not accurate and the conclusion is not valid; the heart rate did increase, but peaked and then started to decrease again. Secondly, the actual processed data have not been referred to.   * A valid conclusion must relate to the *purpose of the investigation*. Both the dependent and independent variables need to be related to.   **Example:**  A conclusion for the Daphnia investigation should include the temperature and the heart rate. A valid conclusion for this investigation could be, ‘The heart rate of Daphnia increased gradually to a peak average heart rate of 200 beats/min at 30oC, then decreased rapidly to 50 beats/min at 35oC. |

1. An investigation was carried out to see if the dominant males of the Australian brush tailed possum breed more successfully than the subordinate males. Wild adult possums were caught and divided into two experimental groups.

* Group A – 5 pens (cages/houses), each with one male and two females.
* Group B – 12 pens, each with two males and two females.

The dominant male in each Group B pen was established through observation. Once this was established, seven of the dominant males were vasectomized (sterilized) along with two of the males in Group A. This occurred four months into the nine-month breeding season. Female possums can become pregnant many times in one breeding season. The number of pregnancies over the breeding season was recorded. The results are shown in the table.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Group** | **Average number of pregnancies per pen** | | | |
| **Pre-treatment** | | **Post-treatment** | |
| Non-vasectomised  pens | Vasectomised pens | Non-vasectomised pens | Vasectomised pens |
| **A** | 0.65 | 0.5 | 1.3 | 0.0 |
| **B** | 0.2 | 1.7 | 1.2 | 0.0 |

1. Draw two graphs to display the results– one for Group A and one for Group B. (L3) (SLO#14 - Bio1.1.3.2)
2. Study the patterns seen in the data as shown in the table and the graphs and then explain the findings of the investigation. (L3) (SLO#15 – Bio1.1.3.3)

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1. Draw valid conclusion for this experiment which is supported by the results. (L2) (SLO#2 – Bio1.1.2.7)

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## Sub-strand 1.2 Orientation and Navigation

**Key Learning Outcome:** Students are able to demonstrate understanding of animal orientation and navigation processes and how these influence movement and survival:

* innate and learnt behaviour
* taxes (hydro, geo, chemo, photo, thigmo)
* kineses (ortho, klino)
* navigation using solar / sun compass, stellar / star patterns, magnetic field lines, chemical trails / scent, landmarks
* homing (the regular return of an animal to a nest site)
* migration (long distance return migration between breeding and feeding / overwintering grounds).

### Lesson Activity 1.2A

**The specific learning outcomes (SLO) targeted in this activity are provided below:**

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| --- | --- | --- | --- | --- |
| **SLO#** | **Specific Learning Outcomes:** *Students are able to* | **Skill level** | **SLO code** | **Achieved**  **(Yes / No)** |
| 1 | Define innate and learnt behaviour | 1 | Bio1.2.1.1 |  |
| 2 | Identify innate or learned behaviour in a given context | 1 | Bio1.2.1.2 |  |
| 3 | Distinguish between innate and learned behaviour | 3 | Bio1.2.3.1 |  |
| 4 | Discuss the consequences of innate and learned behaviour | 4 | Bio1.2.4.1 |  |
| 8 | Define homing | 1 | Bio1.2.1.3 |  |
| 10 | Define migration | 1 | Bio1.2.1.5 |  |
| 16 | Define taxes/kinesis | 1 | Bio1.2.1.6 |  |

**Notes:**

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| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Environment and responses**  To be successful, organisms need to survive and reproduce, contributing their alleles to the gene pool. Animal responses are adaptations for survival and reproduction, through:   * finding favourable environmental conditions and avoiding unfavorable conditions; * ensuring they can obtain supplies of nutrients, energy, water and oxygen; * reducing competition (intraspecific and/or interspecific); * avoiding predation / reducing herbivory; * finding a mate of the same species.   To survive, organisms must be able to detect (sense) and respond to the external environment.  Environmental factors may be divided into abiotic (non-living or physical) factors, and biotic (living) factors. Abiotic factors include temperature, light intensity, humidity, wind speed, salinity, pH, water, oxygen, carbon dioxide and mineral levels, and substrate. Organisms can only inhabit areas where the abiotic factors are within the range of the physiological tolerance of the organisms. They must detect and respond to key physical factors to keep within their **optimum range**. Biotic factors are the influences and interactions with other living organisms, which include:   * competition (intraspecific and interspecific); * exploitation (predation, herbivory, parasitism); * mutualism.   **Responding to the environment**  Animal behaviour is defined as an observable response to a stimuli (stimulus). A stimuli is a change in an environment to which it responds. Common responses are to acquire food, avoid an environmental threat, and to reproduce. Organisms have receptors to detect specific environmental stimuli. Receptors range from simple nerve endings through specialized sensory cells to complex sense organs. Most receptors are specialized for the detection of a particular kind of stimulus, e.g.:   * photoreceptors are found in the retina in the eye – hence we see light * chemoreceptors – detect chemicals (cells lining our nose are chemoreceptors – hence we smell chemicals in the air; taste buds on our tongue are chemoreceptors – hence we taste the chemicals in our food) * mechanoreceptors in the cochlea of the ear – detect sound wave vibrations in air or water (hence we hear sound).   In animals, receptors send messages along nerves in the form of an electrical signal called a nerve impulse to the central nervous system (CNS). In complex animals (e.g. all vertebrates), the CNS includes a brain, where information is processed and interpreted. Nerve impulses are sent from the brain to effectors which produce a response to the stimulus – such as a behaviour. Effectors are usually muscles or glands but also include cilia/flagella and chromatophores (cells containing pigment that, by changing their size, cause an animal to change colour, e.g. octopus, squid, cuttlefish). Muscles, cilia and flagella produce movement. Glands manufacture and secrete substances which produce specific effects – e.g. mucus produced and secreted by the mucus gland at the tip of a snail’s foot acts as a lubricant to aid movement; the hormone insulin produced by the pancreatic gland in humans cause liver cells to convert blood glucose into glycogen for storage.`  Different species detect and view the environment in different ways – dogs can detect higher sound frequencies and elephants can detect much lower frequencies than humans. The stimuli that animals can detect and therefore respond to play an important part in their survival. Many animals can detect environmental stimuli that humans are completely insensitive to.  Examples:   * Bees can see ultraviolet light, and can also detect the plane of polarization of sunlight and the direction of the earth’s magnetic field. Bees cannot see red, so a piece of paper which looks white to us would appear coloured to a bee (since it cannot detect the red component of white light). * Bats detect sound of a frequency considerably above the human range, while whales are sensitive to sound of a frequency far too low for humans to hear. * Sharks can detect the weak electric fields set up by the contracting of muscles, enabling potential prey to be identified. * Fish can detect low-frequency vibrations set up by other fish.   The sensory world of many animals is thus very different from ours. For example, although male and female white cabbage butterflies look much the same to us, only the females’ wings reflect ultraviolet light, which the butterflies can detect.  **Types of Animal Behaviours**   * Animal behaviours can be broadly grouped as **innate**, which means born with, or **learned**, which results from experience. * Innate behaviour (also referred to as instinctive) – behaviour not modified by experience and is thus inflexible and stereotyped; is genetically determined. * Learnt behaviour – behaviour that changes as a result of experience; is flexible and not rigid (in contrast to innate behaviour). * Example: initial migratory behaviour in birds is innate – young birds are not taught by their parents how to migrate or in which direction. With experience (i.e. through learning), migratory behaviour changes which usually increases the chances of a successful migratory event – e.g. recognizing environmental cues such as landmarks that signal areas of food replenishment.   **Orientation responses**   * An orientation response is one where the animal positions itself or carries out specific behaviours when an environmental factor changes direction, duration or intensity. * Orientation responses range from simple responses (**taxes**, **kineses**) to changes in such factors as light, humidity or touch (with immediate benefit), to complex behaviours such as **migration** or **homing** (of more long-term benefit). * The features (types) of innate behaviour are: taxes, kineses, navigation (migration or homing). Animals are capable of **true navigation** if, after displacement to a location where they have never been, they can determine their position relative to a goal without relying on familiar surroundings, cues that emanate (come) from the destination, or information collected during the outward journey. * These responses help organisms to avoid adverse conditions.   **Key terms in orientation**   |  |  |  | | --- | --- | --- | | **Term** | **Definition** | **Example of use in a sentence** | | Taxes | A movement of an animal to or away from a directional environmental stimulus | Chemotaxis is a movement to or away from a chemical. | | Kinesis | Movement of an animal to or away from a diffuse environmental stimulus, e.g. a chemical | Chemokinesis can be seen in an animal changing its speed of movement or rate of turning when confronted with a chemical in its environment. | | Homing | The ability of an animal to find its way home over unfamiliar territory | Homing pigeons are experts at returning home, and were used to carry messages for this reason. | | Migration | The repeated mass movement of a group resulting in greater reproductive success | Some migrations are long, and animals undertaking them need a lot of energy to survive the trip. | | Navigation | A means of orientation during migration | Many animals use a sun compass to aid navigation. | |

1. Define the following the terms:
   1. Innate behavior (L1) (SLO#1 – Bio1.2.1.1)

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* 1. Learned behavior (L1) (SLO#1 – Bio1.2.1.1)

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* 1. Homing (L1) (SLO#8 – Bio1.2.1.3)

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* 1. Migration (L1) (SLO10 – Bio1.2.1.5)

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* 1. Taxes (L1) (SLO16 – Bio1.2.1.6)

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* 1. Kinesis (L1) (SLO16 – Bio1.2.1.6)

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* 1. Navigation

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1. In September, the monarch butterflies display long-distance migration from the United States to the Pacific. The adult monarch butterflies migrate first follow by the young monarchs after two weeks. Identify whether the migration behavior of monarchs is innate or learnt. (L1) (SLO#2 – Bio1.2.1.2)

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1. Distinguish between innate and learnt behaviour. (L3) (SLO#3 – Bio1.2.3.1)

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1. Discuss the consequences and impacts of innate and learnt behaviour. (L4) (SLO#4 – Bio1.2.4.1)

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### Lesson Activity 1.2B

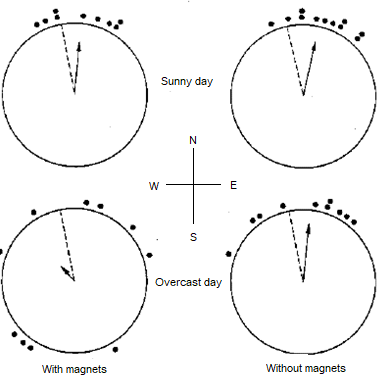
**The specific learning outcomes (SLO) targeted in this activity are provided below:**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **SLO#** | **Specific Learning Outcomes:** *Students are able to* | **Skill level** | **SLO code** | **Achieved**  **(Yes / No)** |
| 5 | Describe a method used for navigation (solar / sun compass, stellar / star patterns, magnetic field lines, chemical trails / scent, landmarks, ocean currents, communication and signaling among individuals) | 2 | Bio1.2.2.1 |  |
| 6 | Explain how navigation using solar / sun compass, stellar / star patterns, magnetic field lines, chemical trails / scent, landmarks contribute to migration and survival of a named animal | 3 | Bio1.2.3.2 |  |
| 7 | Discuss the effectiveness of navigation using solar / sun compass, stellar / star patterns, magnetic field lines, chemical trails / scent, landmarks for named animals | 4 | Bio1.2.4.2 |  |

**Notes:**

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| --- |
| **Navigation – finding the way**  Navigation is the process in which an animal finds its way from one location to another using environmental cue. Navigation is essential for animals to find their way home or to migrate from one geographic location to another. If navigation is over long distances, animals need a biological (internal) clock to compensate for the passage of time in order to remain in course. Navigation, like orientation responses, is innate, not learnt. However, experience can improve an animal’s performance, increasing the rate of success and/or the speed of the journey.  **Methods of navigation**  Navigation may involve landmarks, solar navigation, stellar navigation, magnetic fields, chemical navigation or sound navigation.  **Landmarks –** the animal recognizes familiar landmarks and uses these to guide it to its destination. Long-distance migrants may use landmarks such as coasts, islands or mountain ranges to help them in finding their destination.  **Solar navigation (Sun compass)** – the Sun moves across the sky from east to west, and, during the day, many animals are able to use the Sun as a compass. As the Sun is so far away, if the animal is able to keep a set angle to the Sun when moving, it will move in a straight line.  Bees and all migratory birds use a Sun compass.  **Stellar navigation (star patterns/celestial) –** animals that travel over long distances, especially migrants, can navigate at night using a ‘star compass’ by orientating to star patterns such as the constellations. All migratory birds use a star compass.  **Magnetic fields (magnetic compass) –** many animals are able to use the Earth’s magnetic field lines to navigate. Experiments using bar magnets attached to an animal’s head have shown that navigation is often disrupted – the animal is unable to detect magnetic field lines. Many birds, bees, whales, and turtles use magnetic fields in successful navigation.  **Chemical navigation (scent trails/olfaction) –** many animals are able to use chemical (scent trails to find their way – e.g. ants lay pheromone trails to guide them to/from their nest. Salmon and eels are long-distance ‘homers’ – it is believed they locate their ‘home’ rivers using a ‘cocktail’ of scents, following the chemical trail ‘home’. |

1. The diagram below shows homing in pigeons. Home is directly north. The dots outside each circle represent the directions taken by pigeons once they have been released from the center of the circle. Pigeons represented in the diagrams on the left had small magnets attached to their heads before being released.

****

*Picture retrieved from:*

<http://www.life.umd.edu/classroom/biol106h/L23/L23_migr.html>

1. Describe the two methods of navigation used by the pigeons for navigation. (L2) (SLO#5 – Bio1.2.2.1)

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1. Explain how the two methods of navigation contribute to migration and survival of the pigeons. (L3) (SLO#6 – Bio1.2.3.2)

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1. The bar-tailed godwit, *Limosa lapponica* breeds in Alaska during the Northern summer. In September it flies a distance of 13,000 km, across the Pacific Ocean to New Zealand, returning to Alaska in the following March. The adult godwits leave Alaska at least a week ahead of their fledgling young (offspring). Describe four navigation methods godwits may use to find their way across 13,000km of the Earth’s surface, and, discuss the effectiveness of the navigation methods for the godwits. (L4) (SLO#7 – Bio1.2.4.2)

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### Lesson Activity 1.2C

**The specific learning outcomes (SLO) targeted in this activity are provided below:**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **SLO#** | **Specific Learning Outcomes:** *Students are able to* | **Skill level** | **SLO code** | **Achieved**  **(Yes / No)** |
| 17 | Identify a feature of taxes (hydro, geo, chemo, photo, thigmo) in a given context | 1 | Bio1.2.1.7 |  |
| 18 | Describe the adaptive value of taxes (hydro, geo, chemo, photo, thigmo) | 2 | Bio1.2.2.6 |  |
| 19 | Discuss the impacts of taxes (hydro, geo, chemo, photo, thigmo) on the movement and survival of a named animal | 4 | Bio1.2.4.5 |  |

**Notes:**

|  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Animal orientation responses: taxes**  A taxis (plural taxes) is one of the two kinds of simple responses; it is innate.  A taxis is a movement of an organism either towards or away from an external stimulus; the response is a directional response. Except for some unicellular organisms, taxes are confined to animals. Tactic responses are named according to the kind of stimulus (e.g. light, humidity, chemicals, and heat) that causes the response, as well as the direction of the response – positive if the movement is towards the stimulus and negative if the movement is away from the stimulus.  The most common stimuli that elicit a taxic response are listed below. In the left-hand column is the environmental factor, and in the right-hand column is the prefix we give this stimulus when we are naming taxes responses.   |  |  | | --- | --- | | Term | Prefix | | Chemicals | chemo | | Gravity | geo or gravi | | Light | photo | | Touch | thigmo | | Water | hydro |   Common taxes may include:   * Negative phototaxis – movement away from light. Response occurs when earthworms are exposed to light – enables them to (rapidly) burrow back into the soil, avoiding potential predators and preventing drying out from exposure to the Sun (worms need moist skin as the skin is their gas-exchange surface and worms dehydrate rapidly when above the soil). * Positive Chemotaxis – movement towards a chemical. Flatworms move towards meat, response directs organism to a source of food. Many female moths release a scent (pheromone) to attract a male moth of the same species for mating (can occur over a long distance). * Negative gravitaxis (also known as negative geotaxis) – movement away from gravity. Snails when confronted by an object, move up the object. It is likely this response serves to reduce the snail’s chances of suffering from predation, or from desiccation (from higher ground temperatures) or drowning (suffocation) when rain forms puddles. * Positive thigmotaxis – movement towards an object or movement that results from physical contact. Slaters make contact with the outside of a Petri dish. Rats prefer to swim near the edge of a water maze – likely to be a response to avoid open water where they are more vulnerable to predators (and means they are closer to the riverbank to find shelter). |

1. Alongside each of the following stimuli write down the correct prefix using the following: geo, chemo, photo, hydro, thigmo

Chemicals \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Light \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Touch \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Gravity \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Water \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

1. For each of the following:

* Identify the feature or type of taxes (L1) (SLO#17 – Bio1.2.1.7) and;
* Describe the adaptive value of taxes (reason why the type of response may occur) (L2) (SLO#18 – Bio1.2.2.3).

1. Snails were collected and placed in a dark container with a lid on top. When checked later in the day, all the snails had moved to the top of the container.

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1. Snails move away when they are exposed to copper-compounds.

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1. When burrowing bivalves are disturbed in their sandy habitat, they rapidly burrow.

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1. The unicellular photosynthetic organisms such as *Euglena* move towards the direction of sun’s rays.

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1. *E.coli* bacteria move towards the end of a tube containing glucose.

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1. Snails show a negative geotaxis when confronted by an object. They move up the object. Discuss the impacts of this type of taxes on the movement and survival of the snails. (L4) (Bio1.2.4.5)

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### Lesson Activity 1.2D

**The specific learning outcomes (SLO) targeted in this activity are provided below:**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **SLO#** | **Specific Learning Outcomes:** *Students are able to* | **Skill level** | **SLO code** | **Achieved**  **(Yes / No)** |
| 20 | Describe the adaptive value of kineses (ortho, klino) | 2 | Bio1.2.2.4 |  |
| 21 | Explain the impacts of kineses (ortho, klino) on the movement and survival of a named animal | 3 | Bio1.2.3.5 |  |

**Notes:**

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| **Animal orientation responses: kinesis**  A kinesis (plural kineses) is one of the two kinds of simple responses; it is innate.  In a kinesis, the direction of movement is random, bearing no relation to the direction of the stimulus – therefore, kineses are non-directional responses. The rate of activity is determined by the intensity of the stimulus rather than its direction. The organism changes its rate of movement (orthokinesis) or direction of movement (klinokinesis) when the intensity of the stimulus changes. Movement tends to increase in unfavourable conditions (increases the chances of the organism moving into favourable conditions) and decrease in favourable conditions (increases the chances of the organism staying in the favourable conditions). Note that positive or negative are not used with kinesis.  ***Orthokinesis***  Stimulus intensity governs the speed of movement – faster in unfavourable conditions and slower in favourable conditions. Results in the organism being more likely to find, and remain in, favourable conditions. For example, in slaters, the rate of movement is inversely proportional to humidity. Since the rate of movement decreases in damper air, the animals spend more time in damp areas*.*  ***Klinokinesis***  Stimulus intensity determines the rate of *turning*. Higher rate of turning occurs in unfavourable conditions, resulting in organism being more likely to find or return to favourable conditions. Slower rate of turning in favourable conditions means organism is more likely to remain these conditions. For examples: some flatworms turn more quickly in the light, so when a flatworm leaves a darkened area it turns more often, making it more likely to crawl back into the dark; the human body louse orientates with respect to body heat. The preferred temperature is 30oC, very close to skin temperature.  Taxes and kinesis are not quite as rigid (firm) as might appear. For example, the response to light may be influenced by an animal’s state of hydration or how hungry it is. Different stimuli may also interact. For example, when slaters emerge at night to feed, it could be because a fall in temperature changes their response to humidity. Alternatively it could be that the animal’s internal clock influences its responses to external stimuli. |

1. In the following examples:

* Identify the kinesis: ortho or klino and;
* Describe the adaptive value of the kineses (ortho,klino). (L2) (SLO#20 – Bio1.2.2.4)

1. Some flatworms turn more quickly when exposed to light.

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1. During daylight hours, cockroaches slow their movement and stop when they touch another cockroach. All the cockroaches will then remain huddled together under shelter (such as a piece of wood) until night, when they become active again.

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1. In slaters, the rate of movement increases in areas of low humidity and when exposed to light. Explain the impacts of kineses (ortho, klino) on the movement and survival of slaters in areas of low humidity and when exposed to light. (L3) (SLO#21 – Bio1.2.3.5)

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### Lesson Activity 1.2E

**The specific learning outcomes (SLO) targeted in this activity are provided below:**

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| --- | --- | --- | --- | --- |
| **SLO#** | **Specific Learning Outcomes:** *Students are able to* | **Skill level** | **SLO code** | **Achieved**  **(Yes / No)** |
| 9 | Identify a feature or example of homing in a given context | 1 | Bio1.2.1.4 |  |
| 11 | Describe how animals navigate during homing | 2 | Bio1.2.2.2 |  |
| 12 | Discuss the impacts of homing on the survival of a named animal | 4 | Bio1.2.4.3 |  |
| 13 | Explain the adaptive value of homing | 3 | Bio1.2.3.3 |  |

**Notes:**

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| **Homing**  Homing is the ability of an animal to return over unfamiliar territory to a nest site (its ‘home’ or roosting site), usually on a regular basis: may be daily (e.g. chitons to same spot on rocks) or even annually (e.g. birds returning to a breeding colony, often to the same nest site). Many different species display the ability to home. For example:   * ants return to their nest after foraging; may be from a distance of 10m or more   C:\Users\User\Pictures\fire ants.PNG  *Picture of fire ants retrieved from:* [*https://granville.ces.ncsu.edu/2012/07/controlling-fireants-effectively/*](https://granville.ces.ncsu.edu/2012/07/controlling-fireants-effectively/)   * ‘homing’ pigeons (*Columba livia*) can return to their loft when released many kilometers away – in competitions, some pigeons are capable of homing from distances close to 2000km, maintaining a speed of about 80km/h   C:\Users\User\Pictures\homing pigeons columba livia.PNG  *Picture of homing pigeon retrieved from:* [*https://www.pinterest.com/pin/381680137156309252/*](https://www.pinterest.com/pin/381680137156309252/)   * organisms that inhabit the rocks of the intertidal shore such as limpets and chitons may return to the same crevice (narrow opening) or indentation (deep cut) on the rocks when the tide ebbs (outgoing tide).   C:\Users\User\Pictures\limpets on rock.PNG  *Picture of limpets ‘homing’ on same rocks retrieved from:* [*https://www.sciencelearn.org.nz/images/1271-limpets-cling-to-rocks*](https://www.sciencelearn.org.nz/images/1271-limpets-cling-to-rocks)  C:\Users\User\Pictures\chitons on rock.PNG  *Picture of chitons ‘homing’ on same rocks retrieved from:* [*https://epod.usra.edu/blog/2005/07/chitons-on-bermuda.html*](https://epod.usra.edu/blog/2005/07/chitons-on-bermuda.html) |

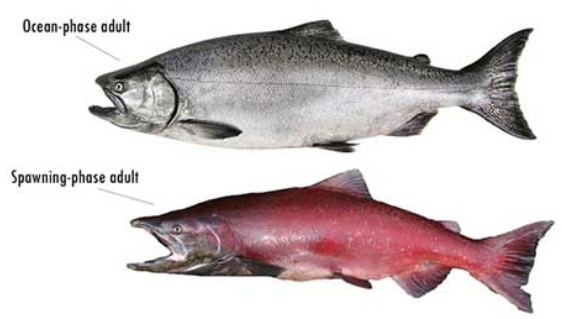
1. For each of the following, identify the orientation response. (L1) (Bio1.2.1.4)
2. Honeybees return to their hive after foraging; may be from as far as a kilometer away.



*Picture of a honeybee feeding on a flower retrieved from:* [*https://www.scmp.com/lifestyle/health-wellness/article/2169317/*](https://www.scmp.com/lifestyle/health-wellness/article/2169317/)

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1. Salmon return from the sea (where they spent their adult lives) to breed (‘spawn’) in the same river where they were born. (L1) (Bio1.2.1.4)



*Picture of chinook salmon (ocean and spawning) retrieved from:* [*http://www.adfg.alaska.gov/index.cfm?adfg=wildlifenews.view\_article&articles\_id=714*](http://www.adfg.alaska.gov/index.cfm?adfg=wildlifenews.view_article&articles_id=714)

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1. Many frogs and toads make their way back every breeding season to the same pond where they hatched. (L1) (Bio1.2.1.4)



*Picture of a male frog retrieved from:* [*https://www.researchgate.net/figure/Adult-male-of-the-South-Pacific-streamside-frog*](https://www.researchgate.net/figure/Adult-male-of-the-South-Pacific-streamside-frog)

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1. Find out (Google or from the internet) the way of life of ants and then:

a. describe how ants navigate during homing. (L2) (SLO#11 – Bio1.2.2.2);

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b. explain the adaptive value of homing on ants. (L3) (SLO#13 – Bio1.2.3.3)

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1. Find out (Google) about the way of life of honeybees, and then discuss the impacts of homing on its survival. (L4) (SLO#12 – Bio1.2.4.3)

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### Lesson Activity 1.2F

**The specific learning outcomes (SLO) targeted in this activity are provided below:**

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| --- | --- | --- | --- | --- |
| **SLO#** | **Specific Learning Outcomes:** *Students are able to* | **Skill level** | **SLO code** | **Achieved**  **(Yes / No)** |
| 13 | Explain the adaptive value of migratory behaviour and homing | 3 | Bio1.2.3.3 |  |
| 14 | Distinguish between migration and homing | 3 | Bio1.2.3.4 |  |
| 15 | Discuss the impacts of migration (long distance return migration between breeding and feeding / overwintering grounds) on the survival of a named animal | 4 | Bio1.2.4.4 |  |

**Notes:**

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| Migration is the movement of individuals from one geographic location to another. In return migration, animals exhibit an annual cycle of migration from breeding grounds to feeding (overwintering) grounds. Return migration is common in birds – with migratory paths between North/South America, Africa/Europe (5 billion birds of nearly 200 species are estimated to migrate to Europe and Asia from Africa every spring - the smallest of these birds weighs less than 10g), and even one migration that is between the Arctic circle and the Antarctic circle – that of the Arctic Tern. Return migration also occurs in whales, turtles, polar bears, spiny lobsters, caribou, reindeer, wildebeest and stingrays. For some species, return migration occurs at different stages of their life cycle and not annually (e.g. eels breed in the sea and the young migrate towards land, swimming up rivers to where they will spend their adult life, and, after many years, they migrate back to the sea to breed and die; salmon do the opposite – i.e. breed in rivers, with the young migrating to the ocean for their adult lives; monarch butterfly migration between North America and Mexico takes place over several generations).  Animals need to be able to navigate over long distances and typically use a combination of navigation methods. Navigation is innate, not learnt (the adults do not teach their young); however, success rates (such as the time taken for the journey) can improve with experience.  Animals need to prepare for migration – their biological clock sets in action such activities as:   * laying down of fat layers to ensure energy supplies for the journey * moulting of feathers and replacement with new ones (especially the flight feathers), to ensure maximum flight efficiency. |

1. Distinguish between migration and homing

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1. The bar-tailed, *Limosa lapponica baueri,* is common on coastal mudflats during the New Zealand summer. The godwits breed in Alaska in the northern summer. They travel the 13000km from New Zealand to Alaska via North Korea, China, or Japan. These areas are ‘staging posts’, where the birds rest and feed before continuing their journey. After breeding, the birds return directly to New Zealand, flying 11000km non-stop across the Pacific Ocean. This is the longest known non-stop flight undertaken by any bird species, and takes the godwits about a week.

Explain the adaptive value of migratory behaviour on godwits. (L3) (Bio1.2.3.3)

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1. Cuckoos breed in New Zealand, laying their eggs in the nests of host birds. They then overwinter in the island chains north and east of Australia, such as the Solomon Islands and Marshall Islands.

Discuss the impacts of this annual migration on the survival of the cuckoos. (L4) (Bio1.2.4.4)

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## Sub-strand 1.3 Timing Responses

**Key Learning Outcome:** Students are able to demonstrate understanding of timing responses and ways of representing and interpreting timing responses:

* timing responses (daily, tidal, lunar, annual) as determined by movement of earth, sun, moon; diurnal, nocturnal, crepuscular.
* biological rhythms (circadian, circatidal, circalunar, circannual).
* biological clock (in brain) providing endogenous control (via melatonin) of rhythms and which is set by environmental cues (zeitgebers).
* interpretation of actograms: periodicity, free running period, phase shifting, entrainment, arrhythmic activity.

### Lesson Activity 1.3A

**The specific learning outcomes (SLO) targeted in this activity are provided below:**

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| **SLO#** | **Specific Learning Outcomes:** *Students are able to* | **Skill level** | **SLO code** | **Achieved**  **(Yes / No)** |
| 1 | Define biological timing responses / biological clocks | 1 | Bio1.3.1.1 |  |
| 3 | Define diurnal/nocturnal/crepuscular | 1 | Bio1.3.1.2 |  |
| 4 | Identify diurnal/ nocturnal/ crepuscular activity in a given context | 1 | Bio1.3.1.3 |  |
| 10 | Describe a rhythmic cycle(daily, tidal, lunar, annual) | 2 | Bio1.3.2.1 |  |
| 11 | Explain the adaptive value of a biological timing response (daily, tidal, lunar, annual) on the life cycle of an organism | 3 | Bio1.3.3.2 |  |

**Notes:**

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| All timing responses are innate (genetically programmed, not learnt). Organisms use environmental cues to set their activity patterns/rhythms. When an organism is placed under constant conditions, the activity pattern may break down and therefore the activity becomes erratic (uneven) or arrhythmic.  **Earth’s Rhythms**   * The yearly orbit of Earth about the sun together with the tilt of its axis cause the seasons. The contrast between seasons generally increases with increasing latitude. Seasons have characteristic abiotic conditions (e.g. temperature ranges, day length, rainfall). * The daily rotation of Earth produces alternating light and dark periods, their relative lengths varying according to latitude and season. Other abiotic factors affected by sunlight (e.g. temperature, humidity, wind) also change daily. * The monthly orbit of the moon provides changes in illumination at night. The combined effect on the oceans of the moon’s gravitational pull and the rotation of the Earth causes twice-daily ocean tides. The tides cause a cycle of exposure and coverage of the intertidal area. Tidal levels vary over the 29.53 days of the moon’s phases owing to the relative sun-moon positions, with tidal heights at a particular location also affected by its topography.   **Environmental Rhythms And Animal Behavior**   * Most animals have their daily and annual rhythms of activity linked to the cyclical environmental changes caused by Earth’s rhythms. They include periods of activity and sleep, feeding and drinking, fluctuations in body temperature, sensitivity to pain and hormone levels. * The biological advantages to an animal species of synchronizing (matching) its activities to Earths’ rhythms may include a better food supply, relative absence of predators and competitors for food, and more favourable environmental conditions. * **Annual Rhythms** (yearly and/or seasonal). Mating and rearing of young are timed to exploit annual periods of abundant food and suitable environmental conditions. Other behaviours that assist an animal to survive seasonal harsh conditions are: migration (e.g. birds) to a more suitable environment; hibernation (e.g. bats, land snails, amphibian, bears), which involves being dormant over seasonal cold conditions; and aestivation (e.g. some insects, land snails), which involves being inactive over seasonal hot or dry conditions. * **Lunar Rhythms** (monthly). Some marine animals synchronise egg laying with a specific part of a lunar rhythms, usually in conjunction with tidal, diurnal and annual rhythms, to ensure successful fertilisation and the best conditions for development. The two periods of spring tides (with a neap tide between) per lunar month are semilunar rhythm. * **Tidal Rhythms** (cycle of one high and one low tide every 12.4 hours). Animals in the intertidal region have rhythms of activity correlated with the tides, generally feeding when covered with water and hiding in shells, burrows and crevices when exposed. The tidal cycle is about 50 minutes later each day. * **Daily Rhythms** (daily night/day cycle of 24 hours). Three types of activity by animals are linked to Earth’s daily cycle:   **1 diurnal –** mostly active during the day (e.g. humans, honeybees, blackbirds)  **2 nocturnal –** mainly active at night (e.g. bats, wetas, moths, slaters, owls)  **3 crepuscular –** active at dusk, and dawn (e.g. rabbits, mosquitoes, fiddler crabs). |

1. Find out (Google or from the internet) the definition for the following terms: (L1) (SLO#1 – Bio1.3.1.1)

a. biological timing (responses): \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

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b. Biological clocks: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

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1. Define the following timing responses: (L1) (SLO#3 – Bio1.3.1.2)
2. diurnal: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

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1. nocturnal: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

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1. crepuscular: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

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1. For each of the following contexts, identify whether the timing response is: diurnal activity, nocturnal activity, or crepuscular activity. (L1) (SLO#4 – Bio1.3.1.3)

a. Brown kiwi forage at night by probing in the leaf litter for invertebrates such as earthworms and arthropods.

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b. Butterflies come out to feed during the day.

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1. The native New Zealand bats are active only during dawn and dusk.

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1. Describe the following rhythmic cycle: (L2) (SLO#10 – Bio1.3.2.2)

a. daily:

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b. tidal:

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c. lunar:

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d. annual:

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1. Find out (Google) about the life cycle of mussels (freshwater or seawater) and then explain the adaptive value of a biological timing response (daily, tidal, lunar, or annual) on its life cycle. (L3) (SLO#11 - Bio1.3.3.2)

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### Lesson Activity 1.3B

**The specific learning outcomes (SLO) targeted in this activity are provided below:**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **SLO#** | **Specific Learning Outcomes:** *Students are able to* | **Skill level** | **SLO code** | **Achieved**  **(Yes / No)** |
| 2 | Describe the function of a biological clock | 2 | Bio1.3.2.1 |  |
| 5 | Define endogenous/ exogenous biological rhythms | 1 | Bio1.3.1.4 |  |
| 7 | Identify zeitgeber/ endogenous/ exogenous rhythmic activity/ in a given context | 1 | Bio1.3.1.6 |  |
| 9 | Discuss the implications of environmental destruction on biological clocks and survival of named organisms | 4 | Bio1.3.4.1 |  |

**Notes:**

|  |
| --- |
| **Biological Clocks**   * Regular, repeated patterns of behaviour require timing mechanisms. Rhythms controlled by stimuli external to an animal are called **exogenous rhythms** (e.g. daily activity controlled by sunlight). * Rhythms controlled by internal timing mechanisms are called **endogenous rhythms**. External stimuli may occasionally be misleading or not allow an animal time to adequately prepare itself for a seasonal environmental change. For example: sheep need to be ready to mate in the autumn so that lambs will be born in the spring when there is plenty of food, so it is important that they are not misled by a brief warm spell. * Many rhythms are controlled by a combination of endogenous and exogenous timing mechanisms. * Most biological clocks do not exactly keep time with the rhythms of the external environment and need to be continually reset by environmental cues, such as light, temperature, or pheromones. These clock-setting environmental cues are called **zeitgebers** (time-givers). * The internal clock mechanism has been found to be under genetic control in many of the organism studies. For example, fruit fly larvae keep track of time using an internal clock controlled by a single gene called the ‘per’ gene (for period gene). Different mutations of the gene have been found to shorten or lengthen their daily rhythm. The gene seems to produce a protein that probably affects the expression of other genes. As the protein accumulates it eventually turns off the gene that codes for it. This provides a 24-hour timekeeper in the fly’s brain. In mice another gene called the ‘clock’ gene has been discovered.   **Biological Clock Mechanisms**   * Circadian (daily) clock mechanisms have been discovered in every animal group as well as in plants, protists (one-celled organism) and fungi. Light is the key environmental cue for a circadian rhythm. * In mammals, including humans, the ‘pacemaker’ or master circadian clock is found two tiny groups of cells called the suprachiasmatic nuclei (SCN) in the hypothalamus of the brain. * Light entrains the clock via messages from the eyes to the SCN, which the send nerve messages to the pineal gland. In diurnal mammals, the pineal gland produces the hormone **melatonin** at night and promotes sleep. Towards the end of the night, production is suppressed and the animal wakes. As the clock is entrained by light it can be upset by changed light/dark cycles, such as when suffering ‘jetlag’. * More melatonin is produced over 24 hours in the short days of winter than in the long days of summer. This may contribute to Seasonal Affective Disorder (SAD) in humans, which occurs in winter and is similar to depression. SAD can be treated with exposure to very bright lights. The varying amounts of melatonin may also help in the timing of the onset of reproductive cycles in many animals. * If the SCN are destroyed the animal loses its circadian rhythms, but these can be restored by transplanting SCN from another animal. * Invertebrates do not have any SCN but in some molluscs, cells in the eyes function as the master circadian clock. * The circadian clock of birds is found in the pineal gland, which is sensitive to light and produces the hormone melatonin. If the skull of a bird is blackened so light cannot get through to the pineal gland, then the bird will not have its rhythm entrained by light.   **Functions and advantages of biological clocks**   * Prediction of events (migration, hibernation, etc.) which require a large build-up of food reserves. * Synchronisation of internal physiological processes (e.g. sperm and egg production with favourable environmental conditions for mating and production of offspring). * Synchronisation of social activities (e.g. congregation for mass migration, flocking in the non-breeding season for safety in numbers, etc.). * Allows animals that use the sun and star positions (that change) during homing and migration to ‘adjust’ their compasses. |

1. Define the following biological rhythms: (L1) (SLO#5 – Bio1.3.1.4)

a. endogenous: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

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b. exogenous: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

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1. For the following contexts, identify whether it is an endogenous rhythmic activity, exogenous rhythmic activity, or a zeitgeber. (L1) (SLO#7 - Bio1.3.1.6)

a. Sheep need to be ready to mate in the autumn so that lambs will be born in the spring when there is plenty of food, so it is important that they are not misled by a brief warm spell.

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b. Fruitfly larvae hatch in the early morning, even if kept in constant conditions.

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c. An organism’s biological clock, through being reset by an environmental cue, dictates an organism’s time of onset (and offset) of activity.

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1. Describe the function of a biological clock. (L2) (SLO#2 – Bio1.3.2.1)

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1. Discuss the implications of environmental destruction on biological clocks and survival of a dog. (L4) (SLO#9 – Bio1.3.4.1)

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### Lesson Activity 1.3C

**The specific learning outcomes (SLO) targeted in this activity are provided below:**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **SLO#** | **Specific Learning Outcomes:** *Students are able to* | **Skill level** | **SLO code** | **Achieved**  **(Yes / No)** |
| 6 | Define actograms/free running period/phase shift/zeitgeber | 1 | Bio1.3.1.5 |  |
| 8 | Explain the activity diagrams (actograms) of an organism using the following terms: free-running period, phase shift, zeitgeber | 3 | Bio1.3.3.1 |  |

**Notes:**

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
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| * One technique to identify whether a rhythm is exogenously or endogenously controlled is to place the animals in a constant (unchanging) environment and see whether they continue to show the rhythms. If the rhythms continues, there must be some kind of internal clock mechanism. A continuing rhythm in constant environmental conditions is called **free-running**. The **period** (the time between repetitive peaks of activity patterns) of a free-running rhythm may be longer or shorter than the period of the environmental rhythm. For example, almost all fruit fly larvae hatch in the early morning, even if kept in constant conditions. * Because the free-running period of daily endogenous rhythms is never quite 24 hours, they are said to be **circadian** (‘circa’ = around, ‘dies’ = day). Similarly, the free-running periods of tidal, lunar and annual rhythms are not quite the same as the environmental rhythms – i.e., they are circatidal, circalunar, circasemilunar, and circannual rhythms. Terms such as ‘daily’ and ‘tidal’ rhythms refer only to a rhythm’s period, and imply nothing about whether it has an endogenous or exogenous basis. However, the fact that a circadian rhythm has a period of not 24 hours means that it must be endogenous. * Organisms use environmental cues to set their activity patterns/rhythms. Daily, tidal, lunar, semilunar, and annual rhythms are entrained by these cues acting on the biological (internal) clock, The **periodicity** of the rhythm only becomes apparent in the absence of the environmental factors, i.e. in constant conditions (free-running period). * Most biological clocks do not exactly keep time with the rhythms of the external environment and need to be continually reset by environmental cues, such as light, temperature, or pheromones. These clock-setting environmental cues are called **zeitgebers** (time-givers). The regular resetting of the clock is called **entrainment**. Day length is a reliable cue, and entrainment by light allows animals to better exploit (use) the seasonal changes associated with changes of day length. * When the start of the period of the rhythm is changed so that is earlier or later, either under laboratory conditions or if the animals (including humans) are moved to another time zone, it is called **phase shift**. * Experimental investigations of activity rhythms in an animal species usually involve keeping it in an environment varying in only one factor. The animal’s activity is generally recorded as an actogram (activity/time graph). In the laboratory, activity patterns may be recorded on an actogram. Typically, the free-running period is either greater than 24 hours (onset of activity occurs later each day) or less than 24 hours (onset of activity occurs earlier each day). If constant conditions persist, the activity pattern may break down – activity becomes erratic or **arrhythmic**. However, if a zeitgeber is introduced (e.g. a light period followed by a dark period), then the onset of the activity will phase shift – onset will move forward (or backward) a small amount each day until the onset becomes synchronised with the zeitgeber. * An actogram may be drawn with data repeated for each day to more clearly show a pattern of behaviour.   **Animal Actograms**   * These diagrams record an organism’s activity, normally showing a circadian rhythm (24 h) or a tidal one (12.4 h).   **Normal environment**   |  | | --- | | **●●● ●● ●●●●** | | **●●● ●● ●●●** | | **●●● ●●●** | | **●● ●●● ●** | | **●●●●● ●● ●** | | **●●●● ●●** | | **● ●●●● ●** | | **●●●●●** | | **●● ●● ●** | | **●● ●●●** | | **1 period** |   Normal rhythm entrained daily by an environmental variable (light/dark change, tides, etc.) – observed rhythm is that of the exogenous synchroniser.  **Constant environment**   |  | | --- | | **●●● ●●** | | **●●● ●● ●** | | **●●●●** | | **●●●●● ●●●●** | | **●●●●● ●** | | **●●●●● ●● ●** | | **●●●●● ●** | | **●●●●● ●** | | **●●●●● ●●** | | **●●●●● ●** |   Rhythm has FRP because no exogenous synchronisers are present. Observed period is that of the endogenous mechanism.  To calculate – work out time delay after 10 days and divide by 10. Add this to 24h for the new endogenous period for a circadian rhythm (or to 12h if rhythm is tidal).  For example, if there is a 6h delay after 10 days, then the difference is +0.6h per day. Thus the period will be 24 + 0.6 = 24.6h.  **Normal environment**   |  | | --- | | **●●●●● ●** | | **●●●●● ●●** | | **●●●●● ●●●●** | | **●●●●● ●** | | **●●●●● ●** | | **●●●●●** | | **●●●●● ●●●●** | | **●●●●● ●●●** | | **●●●●●●** | | **●●●●● ●** |   Normal rhythm re-established because normal environmental conditions return. In humans, this occurs during ‘jet-lag’ (called a phase shift or circadian dysrhythmia). |

1. Define the following terms: (L1) (SLO#6 – Bio1.3.1.5)

a. actograms:

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b. free-running period:

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c. phase shift:

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d. zeitgeber:

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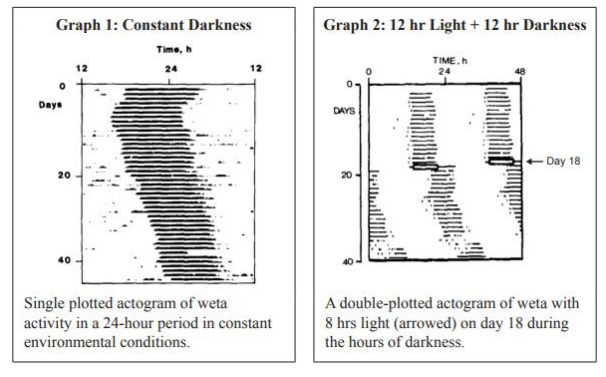
1. The Auckland tree weta (*Hemideina thoracica*) tokoriro remains secluded in the daytime under bark or in holes in trees in dim light. It emerges from cover soon after sunset to forage for mainly plant material, to return before dawn.

In the experiment below, the environmental conditions were maintained at 20 oC in constant darkness for an experiment to observe its biological timing. The results are shown in Graph 1, below left. The dark bars show when the weta is active.

The weta was then placed in 12 hours of light followed by 12 hours of darkness until day 18 (when it was exposed to 8 hours of light during the dark period), after which it was left in constant darkness. The results are shown in **Graph 2** below right.



*Picture retrieved from:* [*http://www.abc.net.au/science/articles/2012/12/18/3656904.htm*](http://www.abc.net.au/science/articles/2012/12/18/3656904.htm)



*Picture retrieved from:* [*https://www.nzqa.govt.nz/nqfdocs/ncea-resource/exams/2016/91603-exm-2016.pdf*](https://www.nzqa.govt.nz/nqfdocs/ncea-resource/exams/2016/91603-exm-2016.pdf)

a. Explain the activity diagram (actogram) displayed by the weta on graph 1 using the following terms: free running period, phase shift, zeitgeber.

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b. Explain the activity diagram (actogram) displayed by the weta on graph 2 using the following terms: free-running period, phase shift, zeitgeber

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### Lesson Activity 1.3D

**The specific learning outcomes (SLO) targeted in this activity are provided below:**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **SLO#** | **Specific Learning Outcomes:** *Students are able to* | **Skill level** | **SLO code** | **Achieved**  **(Yes / No)** |
| 12 | Define circadian, circa tidal/ circalunar/ circannual biological rhythms | 1 | Bio1.3.1.7 |  |
| 13 | Identify circadian/ circa tidal/ circalunar/ circannual biological rhythms in a given context | 1 | Bio1.3.1.8 |  |
| 14 | Contrast the different biological rhythms (circadian/ circatidal/ circalunar/ circannual) using examples | 3 | Bio1.3.3.3 |  |
| 15 | Discuss the importances of different biological rhythms (circadian/ circatidal/ circalunar/ circannual) for a named organism | 4 | Bio1.3.4.2 |  |

**Notes:**

|  |
| --- |
| **Day and Night Periods Related to Season and Latitude**   * Animal responses are not always exactly synchronized (entrained) with Earth’s cycles (which are precise) because they may also be controlled by internal timing mechanisms having periods differing from Earth’s cycles. Consequently, the corresponding animal rhythms when they are under constant conditions (and therefore controlled only by internal timing mechanisms) are prefixed by ‘circa’ – (approximately), e.g. circannual, circalunar, circasemilunar, circadian (approximately daily), and circatidal. In nature this does normally occur as external stimuli synchronise (entrain) internal clocks with environmental rhythms, although they are often described as being only approximate. * Circatidal, circadian, circasemilunar, circalunar, and circannual rhythms are seen when a rhythm assumes its endogenous (free-running) period – only occurs in absence of environmental cues; these rhythms are therefore independent of environmental factors. In contrast, tidal, daily, semilunar, lunar, and annual rhythms are all dependent on the environmental cues that entrain the rhythm – thus they assume the period of the environmental factor that entrains them.   **Human Rhythms**   * **Circadian rhythms** affect many areas of our daily lives. * Recent research, measuring the daily rhythms of temperature and hormone production of 24 volunteers of all ages and both sexes over a month, found that the daily cycle of their clocks had a free-running period of 24 hours 11 minutes ±16 minutes. * The SCN also play a role in the circadian rhythms of many hormones produced by the pituitary. The pituitary hormones influence the workings of many body systems, e.g. endocrine, urinary, cardiovascular, and immune systems. * The effectiveness of the human immune system, as measured by the number of lymphocytes (white blood cells) follows a circadian rhythm, peaking in the late evening. Melatonin seems to enhance the immune system. * Tiredness, shortened attention span, etc. associated with ‘jetlag’ are caused by disrupted circadian rhythms from rapidly changing to a new time zone. Various circadian rhythms adjust to the new time zone at different rates so there is a period when they are out of synchronisation. Resetting the internal clock is hastened by exposure to bright light, especially in the morning of the new time zone. * Shift work also has similar effects to ‘jetlag’ but they are more long-term. Research has shown that shift workers show higher than average sleep disruptions and fatigue, and may have personal relationship difficulties as well as gastrointestinal disorders and cardiovascular disease. They also have an increased probability of making errors. * Other facets of human experience that have a circadian rhythm are: responses to drug treatments such as chemotherapy or asthma treatments, pain sensitivity, urine production, alcohol metabolism, the chances of making serious errors during work or driving, birth and death times. And the ability to learn. Average learning ability arise during the first half of the morning to a high for the day, decreases to a low about lunch time, rising again in the afternoon but sinking to a low level by early evening. |

1. Define the following biological rhythms: (L1) (Bio1.3.1.7)

a. circadian:\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

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1. circa tidal: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

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1. circalunar: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

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1. circannual: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

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1. For each of the following contexts, fill in the missing word to identify the type of biological rhythms (circadian / circatidal / circalunar / circannual): (L1) (Bio1.3.1.8)

Only when an organism is maintained under constant conditions do activity cycles correspond to the period of its internal clocks. Under normal conditions potassium excretion shows a daily rhythm, rhythms of migratory activity are annual, rhythms of output of the hormone *thyroxine* are lunar, and rhythms of barnacles closing their shells are tidal. Hence:

* 1. Under constant conditions the excretion of potassium ions (K+) in the human urine

shows a \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ rhythm.

* 1. Under constant conditions, caged migratory birds show a migratory restlessness which

has a \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ rhythm.

* 1. Under constant conditions, there is a surge (rush, outpouring) in the output of the hormone *thyroxine,* bringing about the physiological changes that enable the young salmon to regulate their internal salt concentration. This shows a

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ rhythm.

* 1. Under constant conditions, the barnacles close their shells. This shows a

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ rhythm.

1. Contrast circadian biological rhythms and circannual biological rhythms. (L3) (Bio1.3.3.3)

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1. Contrast circa tidal and circalunar biological rhythms. (L3) (Bio1.3.3.3)

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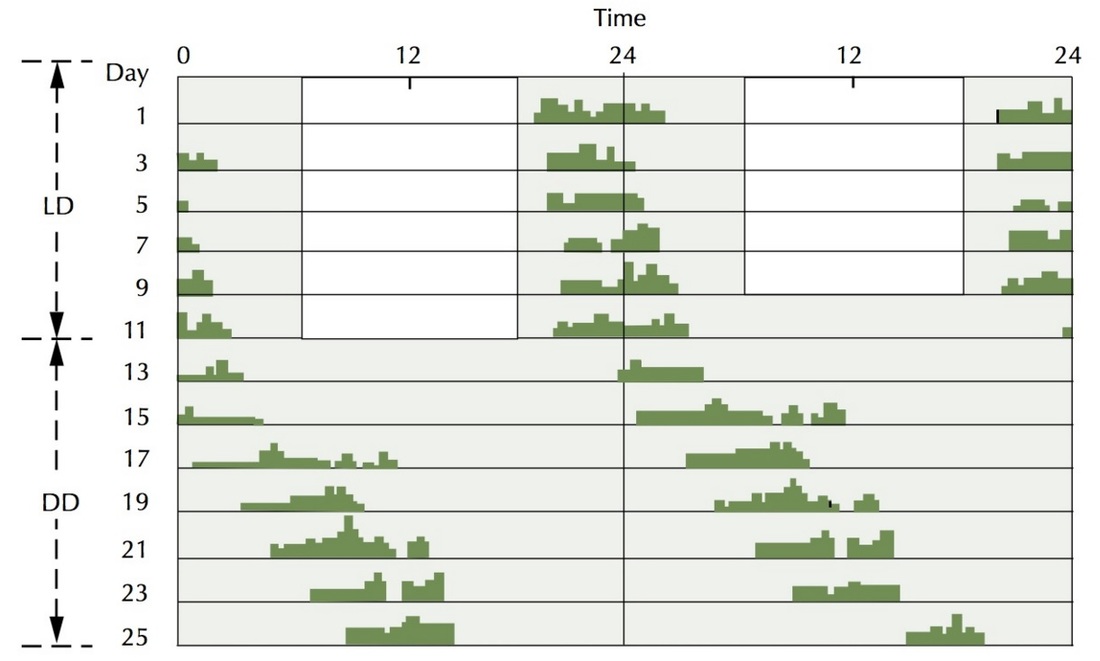
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1. The actogram (activity/time graph) of a cockroach under conditions of constant darkness (i.e. DD), shows that each day the onset of activity is about two hours later than the previous activity. The free-running period is thus about 26 hours.



*Picture retrieved from:* [*https://ejdio.weebly.com/timing-responses.html*](https://ejdio.weebly.com/timing-responses.html)

Discuss the importances of the biological rhythms shown by the cockroach. (L4) (Bio1.3.4.2)

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## Sub-strand 1.4 Interspecific Interactions

**Key Learning Outcome:** Students are able to demonstrate understanding of interspecific interactions and ways in which these interactions influence survival in the niches:

* competition for resources (named e.g. food, living space, etc.) acting to limit numbers and distribution (fundamental niche versus realised / actual niche; zonation) of competing species; out-competition leading to niche differentiation.
* Predator – prey relationships and cycles acting to control numbers and distribution (fundamental niche versus realised / actual niche; zonation) of both predator and prey species.

### Lesson Activity 1.4A

**The specific learning outcomes (SLO) targeted in this activity are provided below:**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **SLO#** | **Specific Learning Outcomes:** *Students are able to* | **Skill level** | **SLO code** | **Achieved**  **(Yes / No)** |
| 1 | Define niche differentiation / out-competition / interspecific competition | 1 | Bio1.4.1.1 |  |
| 2 | State the competitive exclusion principle | 1 | Bio1.4.1.2 |  |
| 3 | Identify niche differentiation in a given context | 1 | Bio1.4.1.3 |  |
| 4 | Identify interspecific competition in a given context | 1 | Bio1.4.1.4 |  |
| 5 | Identify out-competition in a given context | 1 | Bio1.4.1.5 |  |
| 6 | Describe the features of competitions | 2 | Bio1.4.2.1 |  |
| 7 | Explain how interspecific competition limits the numbers of a population | 3 | Bio1.4.3.1 |  |
| 8 | Explain how interspecific competition leads to niche differentiation | 3 | Bio1.4.3.2 |  |
| 9 | Explain how interspecific competition leads to species distribution | 3 | Bio1.4.3.3 |  |
| 10 | Discuss how interspecific competition contributes to species redistribution, population numbers and niche differentiation using named examples | 4 | Bio1.4.4.1 |  |

**Notes:**

|  |
| --- |
| Interspecific refers to any relationship between members of different species – includes **commensalism**, **antibiosis**, **mutualism** and **competition**.   * Commensalism is a relationship between members of two different species in which one species benefits (+) and the other species is neutral (0, that is neither benefits nor is harmed). Example: some barnacles cement themselves to the shells of other barnacles. The barnacle gets a substrate to attach to and is able to feed and reproduce while the animal it attaches to is neutral. * Mutualism is a relationship between the members of two different species in which both species benefit (+ and +) to the extent that their reproductive fitness is increased (that is members of each species have a greater chance of surviving to a reproductive stage or produce more offspring than if they were not in the relationship. Example: lichens - a lichen consists of a fungus and alga. Though the alga can and does live independently, the fungus cannot survive without the carbohydrate produced by the alga. * Antibiosis (exploitation) involves a relationship between members of two species in which one benefits (+) while the other is harmed (-). Exploitation includes **herbivory**, **parasitism** and **predation**. A herbivore is an animal that eats plants or parts of a plant. The herbivore benefits and the plant is harmed. Plants have evolved a range of devices that attempt to prevent reduce herbivory. Examples: spines (modified leaves) of cacti; thorns (modified branches) of oranges; prickles (modified hairs) of roses. In parasitism, a parasite (+) lives on and feeds off another living organism (-). There are ectoparasites (live or feed on the outside of the host) and endoparasites (live on the inside of the host). Example of ectoparasite is mosquitoes, and endoparasite tapeworms and roundworms living in the gut. Predation involves a carnivore (+) which hunts, kills and eats another animal (-). Example: all felines (cat family). * Competition involves a relationship between the members of two species in which both are harmed (- and -). The two types of competition may be **interspecific** and **intraspecific.**   **Competition** occurs when resources (e.g. food, water, living space, nest sites) become limited. Competition harmful to the competing species reduces fitness and may act to restrict species’ potential niches. When competition is extreme, one species may out-compete and eliminate the other (**Gause’s competitive exclusion principle**). When the niche of different species overlap (similar niche requirements), **interspecific competition** results (this is shown by the two barnacles in question **4.** following). The greater the niche overlap, the greater the competition. If the niches are sufficiently similar, then Gause’s Principle applies – one species will **outcompete** and eliminate the other. *Such competition provides strong selection pressure for individuals to adapt to occupy slightly different niches, enhancing survival.*  In naturally occurring populations, direct competition between different species (interspecific competition) is usually less intense than competition between individuals of the same species (**intraspecific competition**) because coexisting species have evolved slight differences in their realised niches, even though their fundamental niches may overlap (a phenomenon known as **niche differentiation**). |

1. In your own words, define the following terms: (L1) (SLO#1 - Bio1.4.1.1)

a. niche differentiation: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

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b. interspecific competition: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

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c. out-competition: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

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1. State the competitive exclusion principle. (L1) (SLO#2 - Bio1.4.1.2)

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1. Throughout the world, the introduction of mosquito fish, *Gambusia affinis* is implicated in the decline of endemic fish and amphibian species. *Gambusia* is an aggressive, opportunistic species, with a strong competitive advantage. *Gambusia* are prolific breeders, compete for food and habitat, and prey on the immature stages of native species.

a. Identify the type of competition that may occur between *Gambusia* and amphibian species. (L1) (SLO#4 – Bio1.4.1.4)

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b. Identify which organism outcompetes the other in the competition between *Gambusia* and the endemic fish. (L1) (SLO#5 – Bio1.4.1.5)

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c. Explain how interspecific competition limits the numbers of the endemic fish population. (L3) (SLO#7 – Bio1.4.3.1)

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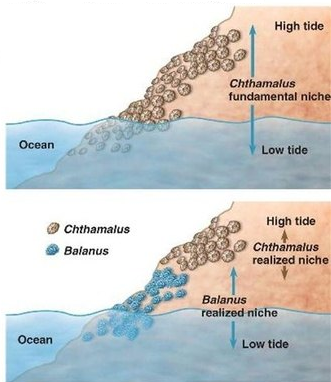
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1. The diagram below shows the location of two species of barnacle – the small *Chthamalus stellatus*, and the large *Balanus balanoides*, on the intertidal rocky shore.



*Picture retrieved from:*

<https://www.quora.com/Why-do-overlapping-niches-lead-to-competition>

1. Identify an example of niche differentiation in the diagram above. (L1) (SLO#3 -Bio1.4.1.3)

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1. Describe the features of competitions between the two species of barnacles. (L2) (SLO#6 – Bio1.4.2.1)

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1. Explain how interspecific competition leads to niche differentiation. (SLO#8 – Bio1.4.3.2)

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1. Explain how interspecific competition leads to the distribution of the *Chthamalus species.* (L4) (SLO#9 – Bio1.4.3.3)

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1. Discuss how interspecific competition contributes to the two species of barnacle’s redistribution, population numbers and niche differentiation. (L4) (SLO#10 – Bio1.4.4.1)

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### Lesson Activity 1.4B

**The specific learning outcomes (SLO) targeted in this activity are provided below:**

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| --- | --- | --- | --- | --- |
| **SLO#** | **Specific Learning Outcomes:** *Students are able to* | **Skill level** | **SLO code** | **Achieved**  **(Yes / No)** |
| 11 | Describe the features of predator-prey relationships | 2 | Bio1.4.2.2 |  |
| 12 | Explain how predator-prey relationships contribute to cycles acting to control numbers and distribution of both predator and prey species | 3 | Bio1.4.3.4 |  |
| 13 | Discuss the impacts of a number of predator-prey relationships working together within a population on: population numbers, food availability, and species distribution. | 4 | Bio1.4.4.2 |  |

**Notes:**

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
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| **Predator-prey relationships**  Predation – behaviour in which an animal hunts and kills another animal for food. Predation display specific adaptations to this; their prey display counter-adaptations to reduce risk of successful predation (an example of co-evolution). Predator is advantaged (+) and prey disadvantaged (-); an example of exploitation.  Prey adaptations include defences to escape detection or ward off predators:   |  |  |  | | --- | --- | --- | | **The same adaptations can be used by both predators and prey:** | **Predator examples:** | **Prey examples:** | | Camouflage | Tawny (yellow, orange) hair of lions, green of praying mantis. | Green grasshoppers, brown colour and shape of stick insects, crabs decorated with seaweed. | | Cryptic colouration | Stripes of tigers, spots of leopards. | Spotting/dappling of many young (e.g. chicks of black-backed gulls, fawns of deer). | | Eye positioning | Eyes of front of head – e.g. mammalian predators and birds of prey. | Eyes at side of head – mammalian herbivores. | | Speed / strength / stamina | Cheetahs, lions, wolves. | Equines (horse family), deer and antelopes. | | Poison | Venomous snakes. | Cane toads. | | Teamwork | Co-operative hunting by packs of lions, wolves | Group defence – e.g. herd animals such as bison, musk oxen; mobbing birds. |   Warning colouration occurs in a great variety of animals and indicates to predators that the animal is unpalatable (e.g. monarch caterpillars and butterflies – see photos on Lesson Activity 1.1A question 3), or harmful (e.g. bees and wasps that sting), toxic (e.g. poison dart frogs of South America), venomous (many species of coral snakes).  Predators are important controlling factors on prey populations (stopping overpopulation and subsequent population crashes, which may result in evolutionary bottlenecks), and typically the prey killed are weak or old individual (i.e. ‘less fit’) so their genes are removed from the gene pool. In this manner, predators are important selecting agents.  Predator numbers are always lower than prey population numbers; in population cycles in simple ecosystems (e.g. arctic – snowshoe hare and lynx), increase/decrease of predator population typically lags behind that of prey population. |

1. Describe the features of predator-prey relationships. (L2) (SLO#11 – Bio1.4.2.2)

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1. Explain how predator-prey relationships contribute to cycles which act to control the numbers and distribution of both predator and prey species. (L12) (SLO#12 – Bio1.4.3.4)

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1. Discuss the impacts of a number of predator-prey relationships working together within a population on population numbers, food availability, and distribution. (L4) (SLO#13 – Bio1.4.4.2)

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## Sub-strand 1.5 Intraspecific Interactions

**Key Learning Outcome:** Students are able to demonstrate understanding of intraspecific interactions and ways in which these interactions influence survival in the niches:

* advantages (e.g. co-operative behaviour such as hunting / defense / detecting predators; finding food; parental care; mate availability) and disadvantages (e.g. increased intraspecific competition / aggressive encounters) of group living.
* social organization; hierarchies (linear and complex); advantages (reduction of serious aggression; controlled access to resources) and disadvantages (uneven access to resources); dominance and submissive behaviours in maintaining hierarchies
* territory and home range.
* Reproductive behaviour: r and k strategies; monogamous and polygamous mating; courtship, mating, and parental care.

### Lesson Activity 1.5A

**The specific learning outcomes (SLO) targeted in this activity are provided below:**

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| **SLO#** | **Specific Learning Outcomes:** *Students are able to* | **Skill level** | **SLO code** | **Achieved**  **(Yes / No)** |
| 1 | Define *r* and *k* strategies/ monogamous and polygamous mating | 1 | Bio1.5.1.1 |  |
| 2 | Identify *r* or *k* strategies in a given context | 1 | Bio1.5.1.2 |  |
| 3 | Identify monogamous or polygamous mating in a given context | 1 | Bio1.5.1.3 |  |
| 7 | Describe the features of *r* and *k* strategies | 2 | Bio1.5.2.2 |  |
| 8 | Explain how reproductive behaviour influence survival | 3 | Bio1.5.3.2 |  |
| 9 | Discuss how the different reproductive behaviours (*r* and *k* strategies; monogamous and polygynous mating; courtship, mating, and parental care) work together to influence the survival of a named species, using examples | 4 | Bio1.5.4.1 |  |
| 10 | List the advantages and disadvantages of different types of parental care | 2 | Bio1.5.1.6 |  |

**Notes:**

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| **Reproductive strategies**  All organisms spend a lot of energy on reproduction, but while some invest little energy on each fertilised egg, others devote massive resources to rearing a small number.  There are different types of reproductive strategies.   * **K-strategy and r-strategy**. The reproductive effort of K-strategists is devoted to raising a few, cared-for offspring with very high energy input per egg/offspring. For example, crocodiles not only build a nest, but also defend it against intruders, and help the young reach the water. The reproductive effort of r-strategists is devoted to producing large numbers of (uncared-for) offspring with very low energy input per egg/offspring. For example, most sharks produce large yolky eggs protected by a horny shell, but after they deposit them on weed, the female gives them no further help. Neither reproductive strategy is ‘best’ – each is the best for the individuals within the species that employs it. * **Courtship** can be defined as a succession of signals that are exchanged between male and female, and which culminates (ends) in mating.   Vocal – e.g. crickets, grasshoppers, many birds.  Visual – e.g. most birds; may be elaborate  Chemical – as in many moths  Mating signals  Touch – e.g. web-weaving spiders; the male signals to the female by giving a characteristic pattern of vibration of the web’s silk threads.  In most species of animal, the two sexes come together briefly and go their separate ways after fertilisation. Where both parents care for the young (most birds), courtship may be prolonged. A long-lasting relationship between a particular male and female is called a **pair bond.** There are a number of functions of courtship.   * The attraction of a mate of the same species. * In animals which lay shelled eggs or in those which produce live young. The egg must be fertilised inside the boy of the female. * When courtship is very prolonged, the male and female sexual systems are brought to a state of readiness at the same time. * Selection of the ‘best’ mates (sexual selection). * Because even closely related species usually have different mating signals, courtship helps to prevent interspecific mating which is wasteful of resources, since even if zygotes are formed they are usually less viable. * **Parental care**   Parental care increases the survival chances of each offspring. Because it costs energy, it decreases the chances of survival of the parent. Provided that, on average, two offspring survive, and organism will have ‘held its own’ in its contribution to the gene pool even if its efforts in raising its young contribute to its own death.  Amongst birds and mammals the extent of parental care varies considerably. According to their stage of development at birth or hatching, two general types of young can be recognized.   * **Altricial young** enter the outside world blind and helpless, and are characteristics of animals whose young are well protected, such as tree-nesting birds (e.g. blackbird), rats and mice. * **Precocial young** are born in an advanced state and are able to run, e.g. many ground nesting birds such as pukeko, ducks, and godwit. Though precocial chicks receive some protection, they are not fed by the mother. This enables the female to produce more eggs, though mortality from predator is higher because the chicks live on the ground. Mammals with precocial young include most large herbivores. These have young that cannot easily be hidden from predators and so have to be able to run virtually immediately after birth. Examples are sheep and horses. * **Monogamous and polygamous mating** * **Monogamy** is defined as one male mating with one female, forming a ‘pair bond’. The bond may last for a single nesting, an entire breeding season, several successive breeding seasons, or life (e.g. some owls and parrots pair for life). * **Polygamous** mating is a mating system in which each animal mates with more than one partner. The three types are polygynous, polyandry, and polygynandry. In polygynous situation, a male mates with more than one female and therefore enhances his reproductive success. For their part, the females mate with the strongest male and therefore their offspring will have beneficial genes. In this type of mating behaviour there usually an alpha male. The majority of polygamous birds are ground-nesters; for example, ostriches and pheasants which produce precocial young. * Polyandry refers to when a female mates with more than one male. Crickets and grasshoppers are examples of polyandrous animals. * Polygynandry refers to an organized social system where several males and females in the group mate with each other. For examples: pukeko birds and a number of primates. |

1. In your own words, define the following terms: (L1) (SLO#1 – Bio1.5.1.1)

a. r strategy: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

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b. k strategy:\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

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c. monogamous mating:\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

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d. polygamous mating: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

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1. For each of the following examples, identify whether it is r or k strategy. (L1) (SLO#2 – Bio1.5.1.2)

a. A giant clam releases millions of eggs into the surrounding water. These will be fertilized by sperm released by other clams in the area. The massive numbers of resulting planktonic larvae will be severely reduced by plankton feeding animals.

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b. Although most mammals give birth to well-developed offspring, they are dependent on their mother for nourishment via suckling milk, as well learning valuable behaviours.

c. Turtles bury their eggs in the ground, after which they abandon them.

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d. In most crabs, the female carries the fertilised eggs around with her for some time, after which the larvae are released to complete their development in the plankton.

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1. For each of the following examples, identify whether it is monogamous or polygamous mating. (L1) (SLO#3 – Bio1.5.1.3)

a. In most birds, each male mate with only one female in one breeding season. This is because the demands of incubation and feeding are so great that the female cannot rear a clutch on her own.

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b. In most mammals, males mate with more than one female in one season. Provided that the female can rear the young on her own it is in the interests of the male to leave her and to mate with other females.

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1. Describe the features of r and k strategies. (L2) (SLO#7 - Bio1.5.2.2)

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1. List the advantages and disadvantages of the different types of parental care. (L2) (SLO#10 – Bio1.5.2.3)

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1. Explain how reproductive behaviours influence survival. (L3) (Bio1.5.3.2)

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1. Find out (Google or from the internet) the reproductive behaviours of dolphins and clams then discuss how the different reproductive behaviours (*r* and *k* strategies; monogamous and polygynous mating; courtship, mating, and parental care) work together to influence their survival. (L4) (Bio1.5.4.1)

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### Lesson Activity 1.5B

**The specific learning outcomes (SLO) targeted in this activity are provided below:**

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| **SLO#** | **Specific Learning Outcomes:** *Students are able to* | **Skill level** | **SLO code** | **Achieved**  **(Yes / No)** |
| 1 | Define social organisations | 1 | Bio1.5.1.1 |  |
| 5 | List the advantages and disadvantages of group living | 2 | Bio1.5.2.1 |  |
| 6 | Explain how group living influence survival of members group | 3 | Bio1.5.3.1 |  |
| 13 | Discuss the evolution of group living and evaluate whether group living continues to be an advantage under changing social and environmental conditions | 4 | Bio1.5.1.3 |  |
| 18 | Define territory and home range | 1 | Bio1.5.1.5 |  |
| 19 | Explain how the establishment of territory and home range increases survival of a species | 3 | Bio1.5.3.4 |  |

**Notes:**

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| **Intraspecific competition**  Because individuals of the same species resemble one another more closely than members of different species, intraspecific competition would be expected to be more intense than interspecific competition. The resources compete for include: mates, nesting sites, breeding territories, food, minerals, and space. Intraspecific competition has the following important features: directly or indirectly, it always results in a decrease in the reproductive rate of the population; only resources that are in limited supply relative to their requirements are competed for; and it operates in a density-dependent manner i.e. as numbers increase, either mortality (death rate) increases or natality (birth rate) decreases, or more often, both. The ultimate ‘aim’ of all organisms is to pass on their alleles to the next generation. In many animals competition for females is aggressive. In some animals the female ‘judges’ the quality of a male’s alleles by his appearance – this is sexual selection by the female. Bright colours may render a male more conspicuous to predators. However, advantage given in attracting a mate outweighs this, bright colours will still be selected for.  **Territory**  Territory is an area occupied by an animal and defended against others. Typically, a territory has a defined boundary, delineated by scent, dung, etc. The territory boundary may be patrolled by the holder of a territory. Territory is distinct form a home range, which may surround the territory and is not defended. Typically, a home range is where an animal forages for food and water if these are not supplied in its territory. A territory can serve a variety of purposes and exist for varying duration.   * A territory may represent a source of food and be defended all the year round. * It can be a site in which to build a nest and rear young. * It may simple be a place where males mate with females.   Territorial behaviour is a special case of contest competition – the area containing the resource is defended, rather than the resource itself. In some animals, a territory may be defended by a group.  The limit to the number of territories available limits the size of the population. Since having a territory tends to prevent overcrowding, it results in population size being regulated at a level that the food supply can usually support.  **Social dominance – hierarchical behaviour**  Territory is only one way by which resources are distributed within a population. In many species which live in groups, resources are shared, but not on ‘fair’ basis. Certain individuals are of higher rank because they consistently have the best access to food and mates. The commonest form of social **dominance** is the **linear hierarchy** (**pecking order**) in which an ‘alpha’ individual dominates all other members of the group, while a ‘beta’ animal dominates all except the alpha, and so on. The strongest most dominant animal is the alpha male, and all are subordinate to him. He has responsibilities, such as deciding when and where the group will move. This dominance order or social hierarchy, is established competitively. Once in place, it cuts down competition and tension in the group. Dominance is not always confined to males (in pukeko, males and females each have their own hierarchy). Dominance is maintained by posture and display. For examples:   * Making oneself look big with a mane, fluffed-up feathers, quick bites, standing on hind legs, and loud snarls. * Baboons have white eyelids which the alpha male flashes to keep order. * Dogs and wolves show aggression and dominance by baring their teeth, erecting hair on their hackles or shoulders, sticking up their ears and tails, standing upright, and looking directly at their opponent.   A subordinate responds with appeasement gestures or submissive behaviours which inhibit the other animal from attacking. For examples:   * Making oneself look small, lowering the head and eyes, and tucking the tail between the legs. * Young puppies roll on their back.   **Significance of social dominance**  In an established hierarchy there is minimal conflict, and it is often implied that the function of social dominance is for the ‘good of the species’. However, it is individuals that are selected in evolution, not groups.  How then does social dominance evolve? The advantages of high rank are obvious – with more food and better access to mates, a dominant male leaves more offspring than a subordinate one. If the prospects for the omega animal at the bottom are so much poorer, why do they remain in the group? The answer is that even for the omega individuals, there is a slim prospect of eventual reproduction if one or more of the dominant animals die. For an outcast, the prospects of reproduction may be nil. Lower-order animals also benefit by being members of a group – a group means reduced risk of predation, greater chance of obtaining food, etc.  **Social Organisation**  All behaviour appears to have its roots in the underlying genetic program of the individual. These innate behaviors may be modified by interactions of the individual with its environment, such as the experiences it is exposed to and its opportunities for learning. The behavioral adaptations of organisms affect their fitness (their ability to survive and successfully reproduce) and so are the products of natural selection. A behavior that leads to greater reproductive success should become more common in a species over time. Few animal species lead totally solitary lives. For examples:   * Many invertebrates (e.g. hermit crabs) are solitary animals, with occasional, random encounters. Some animals may be drawn together at feeding sites. * Tigers are solitary and territorial animals, living and hunting alone. A male will remain with a female for 3-5 days during the mating season.   Many live in cooperative groups for all part of their lives. Social animals comprise groups of individuals of the same species, living together in an organized fashion. They divide resources and activities between them and have a mutual dependence (i.e. they do not survive or successfully reproduce outside the group). For examples:   * Schooling fish and herds of mammals are examples of animals that form groups of a loose association. There is no set structure or hierarchy to the group. The grouping is often to provide mutual protection. * Family groups may consist of one or more parents with offspring of various ages. The relationship between parents may be a temporary, seasonal one or may be life-long. * Some insects (e.g. ants, termites, some wasp and many bee species) form colonies. The social structure of these colonies ranges from simple to complex, and may involve castes (social group, classes) that provide division of labor. * Primates such as chimpanzees and baboons have evolved complex social structures. Organized in terms of dominance hierarchies, higher ranked animals within the group have priority access to food and other resources.  |  |  | | --- | --- | | **Advantages of groups** | **Disadvantages of groups** | | * Safety in numbers and group defence. * Groups needed for learning and passage of ‘culture’. * Specialization of functions within group possible (e.g. bees, baboons – males take up defensive roles, females protect young, etc.). * Proximity (closeness, nearness) and choice of mates increased. * Cooperative food gathering, e.g. small carnivores can catch larger game. * Increased efficiency in locomotion, e.g. geese in V-formation. * Groups can modify their environment, e.g. woodlice clump to increase humidity, social insects build hives, and penguins huddle for warmth. | * Increase in numbers means more competition, many groups need to keep on the move. Isolation suits relatively immobile species and where food source not concentrated but widely (and thinly) dispersed. * Increased opportunity for conflict, need behaviours that ritualize and minimize aggressive behaviours. * More contact between individuals means greater likelihood of spread of parasites and disease. | |

1. In your own words, define the following terms:

a. social organisation: (L1) (SLo#1 – Bio1.5.1.1)

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b. territory: (L1) (SLo#1 – Bio1.5.1.5)

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c. home range: (L1) (SLo#1 – Bio1.5.1.5)

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1. List the advantages and disadvantages of group living. (L2) (SLO#5 – Bio1.5.2.1)

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1. Explain how group living influence the survival of group members. (L3) (SLO#6 – Bio1.5.3.1)

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1. Explain how the establishment of territory and home range increases survival of a species. (L3) (SLO#19 – Bio1.5.3.4)

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1. Discuss the evolution of group living and evaluate whether group living will continue to be an advantage under changing social and environmental conditions. (L4) (Bio1.5.4.2)

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### Lesson Activity 1.5C

**The specific learning outcomes (SLO) targeted in this activity are provided below:**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **SLO#** | **Specific Learning Outcomes:** *Students are able to* | **Skill level** | **SLO code** | **Achieved**  **(Yes / No)** |
| 4 | Identify/state a feature or an example of social organisation in a given context | 1 | Bio1.5.1.4 |  |
| 11 | Describe the features of different types of social organisations | 2 | Bio1.5.2.4 |  |
| 12 | Outline the reasons for different types of social organisations | 2 | Bio1.5.2.5 |  |
| 14 | Describe the features of social organization in terms of hierarchies and dominance and submissive behaviours | 2 | Bio1.5.2.6 |  |
| 15 | Outline the advantages and disadvantages of different types of social organisations | 2 | Bio1.5.2.7 |  |
| 16 | Explain how dominance and submissive behaviours maintain hierarchies social organisation | 3 | Bio1.5.3.3 |  |
| 20 | Discuss the social organisations of a number of species living together within an area and how these organisations support survival or threaten extinction, and how do members of these species cope | 4 | Bio1.5.4.3 |  |

1. In chickens, the alpha individual dominates all other members of the group, while a beta individual dominates all except the alpha, and so on. State the feature of social organisation in chickens. (L1) (SLO#4 – Bio1.5.1.4)

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1. Describe the features of the different types of social organisations. (L2) (SLO#11 – Bio1.5.2.4)

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1. Outline the reasons for the different types of social organisations. (L2) (SLO#12 – Bio1.5.2.5)

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1. Outline the advantages and disadvantages of different types of social organisations. (L2) (SLO#2 - Bio1.5.2.7)

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1. Describe the features of social organisation in terms of hierarchies, dominance and submissive behaviours. (L2) (SLO#14 - Bio1.5.2.6)

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1. Explain how dominance and submissive behaviours maintain hierarchies in social organization. (L3) (SLO#16 – Bio1.5.3.3)

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1. Discuss the social organisations of a number of species living together within an area and how these organisations support survival or threaten extinction, and how do members of these species cope. (L4) (Bio1.5.4.3)

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