**Sub-strand 4.5 Patterns of Evolution**

**Lesson 1: Divergent Evolution**

**Key Learning Outcome:** Students are able to demonstrate understanding of the different patterns of evolution:

* Divergent evolution from common ancestor; homologous structures.

***Lesson 1***

**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 divergent evolution | 1 | Bio4.5.1.1 |  |
| 2 | Identify/State a feature or example of divergent evolution in a given context | 1 | Bio4.5.1.2 |  |
| 3 | Define homologous structures | 1 | Bio4.5.1.3 |  |
| 4 | Identify/State a feature or example of homologous structures in a given context | 1 | Bio4.5.1.4 |  |
| 5 | Outline the features of divergent evolution from common ancestor; homologous structures | 2 | Bio4.5.2.1 |  |
| 6 | Explain how divergent evolution from common ancestor relates to homologous structures | 3 | Bio4.5.3.1 |  |
| 7 | Discuss the impact of divergent evolution from common ancestor to the formation of new species using examples | 4 | Bio4.5.4.1 |  |

**Notes:**

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| Evolution may cause related species to become different (diverge) or unrelated species to become similar (converge).  **Diverge evolution** is the diversification of a single common ancestral species into two or more species that become specialised to occupy different ecological niches. This may be due to the ancestral species spreading out to occupy new habitats with differing conditions. The populations then become genetically isolated, perhaps by geographical barriers.  When an ancestral species diverges into a large number of species occupying separate niches the process is called **adaptive radiation.** In other words, adaptive radiation is a burst of diverse evolution in which a number of related species diverge from a common ancestor to fill a variety of different ecological niches, often in different geographic areas. (An ecological niche in simple terms is the role that members of a species fill within their biological community – e.g. nocturnal, carnivorous birds; warm-water, plankton-eating mammals; desert-dwelling spiny plants.) Each new species in adaptive radiation occupies its own niche, separated from the other species by reproductive isolating mechanisms.  The most famous example of adaptive radiation is that of the Galapagos Island finches described by Darwin. The ancestral blue-black grassquit finch from the South American mainland evolved into 14 species adapted to feed on different types of food such as seeds, buds, and insects.    *Picture retrieved from:* [*https://www.google.com/search?q=galapagos+island+finches+evolve+to+14+species&source*](https://www.google.com/search?q=galapagos+island+finches+evolve+to+14+species&source)  **Homologous structures** (homologous organs) have a similar origin and structure (but often different function). Homologous organs provide evidence for divergent evolution. Similarity of structure despite differences in function follows from the hypothesis that the characteristics of organisms have been modified from the characteristics of their ancestors. The following diagram shows how an original characteristic (the forelimb) has changed as different species evolved. Other examples of homology include the stings of wasps and bees, which are modified ovipositors. Another example include the wings on reptiles (pterodactyl), mammals (bat) and birds all have similar bone structure. They have evolved from a common ancestor. Another factor showing common ancestry is the nearly universal genetic code.    *Picture of homologous structures retrieved from:* [*https://www.mun.ca/biology/scarr/Homology\_of\_forelimbs.htm*](https://www.mun.ca/biology/scarr/Homology_of_forelimbs.htm) |

**LESSON ACTIVITY**

**Question One**

In your own words, define divergent evolution. **(L1)(Bio4.5.1.1)**

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**Question Two**

The two species of *Howea* palm on Lord Howe Island evolved there from a common ancestor between one and two million years ago. Scientists have found that the two *Howea* species grow in the same area.Identify the pattern of evolution (feature of evolution) that could give rise to these two palm species. **(L1) (Bio4.5.1.2)**

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**Question Three**

In your own words, define homologous structures. **(L1)(Bio4.5.1.3)**

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**Question Four**

State an example of homologous structure. **(L1)(Bio4.5.1.4)**

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**Question Five**

Outline the features of divergent evolution from a common ancestor; homologous structures. **(L2)(Bio4.5.2.1)**

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**Question Six**

Explain how divergent evolution from a common ancestor relates to homologous structures. **(L3)(Bio4.5.3.1)**

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**Question seven**

Discuss the impact of divergent evolution from a common ancestor to the formation of new species using examples. **(L4)(Bio4.5.4.1)**

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Roberts, A. & Sinclair, M. (2015). *Level 3 Biology learning book*. ESA Publications: Auckland, New Zealand. pp. 186 – 193.

***Lesson 2: Convergent Evolution***

**Key Learning Outcome:** Students are able to demonstrate understanding of the different patterns of evolution:

* convergent evolution; analogous structures

**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 convergent evolution | 1 | Bio4.5.1.1 |  |
| 2 | Identify/State a feature or example of convergent evolution in a given context | 1 | Bio4.5.1.2 |  |
| 3 | Define analogous structures | 1 | Bio4.5.1.3 |  |
| 4 | Identify/State a feature or example of analogous structures in a given context | 1 | Bio4.5.1.4 |  |
| 8 | Describe the features of convergent evolution; analogous structures | 2 | Bio4.5.2.2 |  |
| 9 | Explain how convergent evolution relates to analogous structures | 3 | Bio4.5.3.2 |  |
| 10 | Compare and contrast divergent and convergent evolution | 3 | Bio4.5.3.3 |  |
| 11 | Discuss the impact of convergent evolution from a common ancestor to formation of new species using examples | 4 | Bio4.5.4.2 |  |

**Notes:**

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| Another pattern of evolution or evolution feature is **convergent evolution**. In convergent evolution, species have different (unrelated or very distantly related) ancestral starting points, but they evolve similar adaptations because they occupy similar ecological niches. These **ecological equivalents** have an adaptation that performs the same or a similar function – e.g. fins/flippers of birds (penguin), mammals (dolphins), reptiles (turtles), and fish (sharks) are all used to propel the organism through the water.    *Picture retrieved from:* [*https://www.reddit.com/r/excreationist/comments/1qti6p/convergent\_evolution\_of\_the\_finsflippers\_oc/*](https://www.reddit.com/r/excreationist/comments/1qti6p/convergent_evolution_of_the_finsflippers_oc/)    Convergent evolution results in **analogous structures**, where body structures or whole organisms look very similar but have different ancestral origins. In other words organs that have the same function because of similar selection pressures, but have different structure, are analogous organs – e.g. wings of birds and insects.  C:\Users\User\Pictures\bird and insect wing.PNG  *Picture retrieved from:* [*https://www.google.com/search?q=wings+of+insects+and+birds+pictures*](https://www.google.com/search?q=wings+of+insects+and+birds+pictures)  They do not have a common ancestor. Analogous organs provide evidence for convergence evolution.  Other examples:   * streamlined body shape of sharks, dolphins, ichthyosaur, and penguin     *Picture retrieved from:* [*https://slideplayer.com/slide/8011195/*](https://slideplayer.com/slide/8011195/)   * the eyes of octopus (cephalopods) and humans (vertebrates)     *Picture retrieved from:* [*https://www.reddit.com/r/interestingasfuck/comments/6ifcn6/our\_similarity\_with\_cephalopod\_eyes\_despite\_our/*](https://www.reddit.com/r/interestingasfuck/comments/6ifcn6/our_similarity_with_cephalopod_eyes_despite_our/)   * the mouthparts of bloodsucking bugs and flies. |

**Lesson Activity**

**Question One**

In your own words, define convergent evolution. **(L1)(Bio4.5.1.1)**

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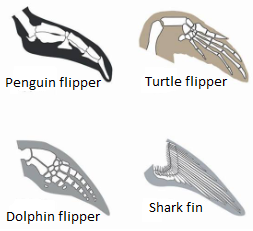
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**Question Two**

State the pattern of evolution (feature of evolution) for each of the following diagrams.

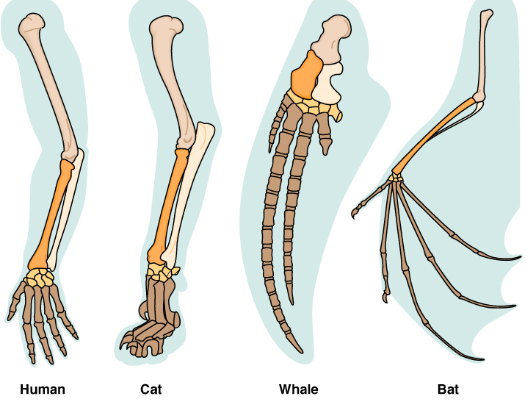
**(L1)(Bio4.5.1.2)**

a.



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b.



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**Question Three**

In your own words, define analogous structures. **(L1)(Bio4.5.1.3)**

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**Question Four**

Beside each of the following, state whether the structures are analogous or homologous.

**(L1)(Bio4.5.1.4)**

1. Bird wing and human arm. \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
2. Lungs of mammals and trachea (air tubes) of insects. \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
3. Bat wing and butterfly wing. \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
4. Fantail’s eye and cow’s eye. \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
5. Wing of a bee and wing of a finch. \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**Question Five**

Describe the features of convergent evolution; analogous structures. **(L2)(Bio4.5.2.2)**

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**Question six**

Explain how convergent evolution relates to analogous structures. **(L3)(Bio4.5.3.2)**

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**Question Seven**

Compare and contrast divergent and convergent evolution. **(L3)(Bio4.5.3.3)**

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**Question Eight**

Compare and contrast divergent and convergent evolution. **(L4)(Bio4.5.4.2)**

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**Lesson 3: Co-evolution**

* co-evolution

**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 co-evolution evolution | 1 | Bio4.5.1.1 |  |
| 2 | Identify/State a feature or example of co-evolution in a given context | 1 | Bio4.5.1.2 |  |
| 12 | Describe the features of co-evolution | 2 | Bio4.5.2.3 |  |
| 13 | Discuss the interplay of divergent, convergent and co-evolution in the establishment of new organisms and new species | 4 | Bio4.5.4.2 |  |

**Notes:**

|  |
| --- |
| Another pattern of evolution or evolution feature is **co-evolution**. Co-evolution is reciprocal evolutionary change, that is, a change in the trait of one species acts as a selection pressure for a change in a trait of another (unrelated) species.  Example:  An evolutionary change in the structure of a plant might act as a selection pressure to bring about a change in a herbivore that eats the plant. This change in the herbivore then acts as a selection pressure for a change in the structure in the plant to reduce herbivory, and so on.  Co-evolution is more likely when different species interact with one another (features of co-evolution):   * predator and prey * parasite and host * species that compete for food, shelter, nesting sites * species that have a mutualistic (symbiotic) relationship * pollinators and angiosperm plants. |

**Lesson Activity**

**Question One**

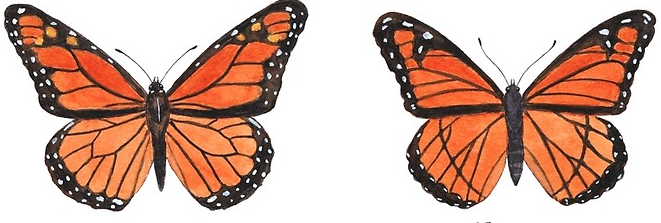
In your own words, define co-evolution evolution. **(L1)(Bio4.5.1.1)**

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**Question Two**

Mimicry is common in various groups of animals and is an example of one of the patterns of evolution. Study the diagram then state the pattern of evolution or the evolution feature.

**(L1)(Bio4.5.1.2)**



Viceroy (mimic)

Monarch (model)

*Picture retrieved from:*

[*https://www.google.com/search?q=monarch+and+viceroy+butterfly+pictures*](https://www.google.com/search?q=monarch+and+viceroy+butterfly+pictures)

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**Question Three**

Describe the features of co-evolution. **(L2)(Bio4.5.2.3)**

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**Question Four**

Discuss the interplay of divergent, convergent and co-evolution in the establishment of new organisms and new species. **(L4)(Bio4.5.4.3)**

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