BIOZONE

Textbook Lite | Activities | Study Guide

NCEA LEVEL 2 BIOLOGY

INTERNALS

Achievement Standard

2.3

Adaptations of animals

Key terms

Common terms

adaptation
behavioural adaptation
functional group
habitat
niche
physiological adaptation
structural adaptation
taxonomic group

Internal transport

atrium (pl. atria)
blood vessel
bulk flow
circulatory fluid
circulatory system
heart
respiratory pigment
ventricle

Gas exchange

breathing
countercurrent flow
expiration
gas exchange system
inspiration
respiratory gas
respiratory pigment
ventilation

Nutrition

absorption
assimilation
dentition
diet
digestion
enzyme
egestion
gut
ingestion
nutrients

Animals possess structural, physiological, and behavioural adaptations that enable them to carry out the life processes essential to survival in their habitat and exploitation of their niche.

Achievement criteria and explanatory notes

Achievement criteria for achieved, merit, and excellence

☐ A Demonstrate understanding of adaptation of plants or animals to their way of life: Describe the adaptations and identify aspects of the adaptations that enable each organism to carry out its life process(es) in order to survive in its habitat.

☐ M Demonstrate in-depth understanding of adaptation of plants or animals to their way of life: Provide a biological reason that explains how or why the adaptations enable each organism to carry out its life process(es) in order to survive in its habitat.

☐ E Demonstrate comprehensive understanding of adaptation of plants or animals to their way of life: Link biological ideas the adaptations that enable each organism to carry out its life process(es) in order to survive in its habitat. The discussion may involve justifying, relating, evaluating, comparing and contrasting, and analysing and it must include consideration of the two points from below appropriate to your chosen context.

☐ Option 1: Adaptation related to one life process over three taxonomic or functional groups:

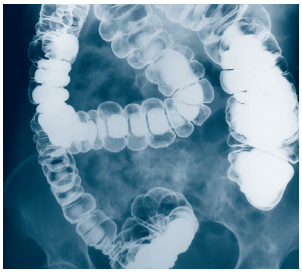
i Compare diversity of adaptation in response to the same demand (e.g. gas exchange) across different taxonomic or functional groups.

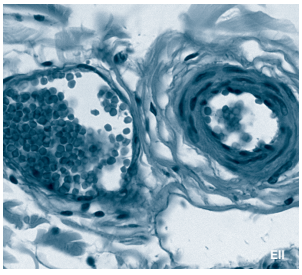
ii Explain limitations and advantages involved in each feature within each organism.

☐ Option 2: Adaptation across two related life processes within one taxonomic or functional group:

i Make connections between two life processes within each organism that enhance the effectiveness of both processes.

ii Explain limitations and advantages involved in each feature.





Explanatory notes

Understanding of adaptation to demonstrate in relation to...

Activity number

☐ 1a One life process over three taxonomic or functional groups of animals, **or**

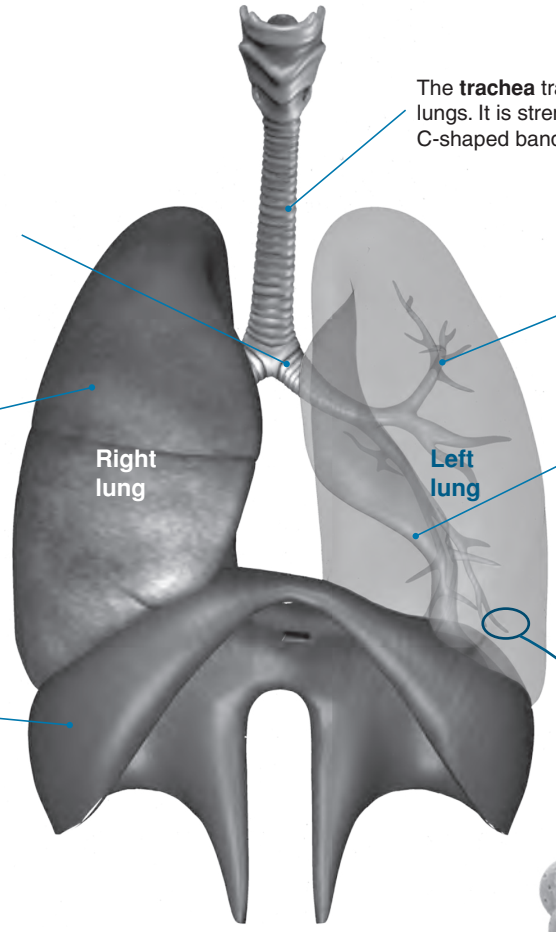
☐ 1b Two related life processes within one taxonomic or functional group

☐ 2 The ways in which an organism carries out all its life processes, including:
- relationships with other organisms: competition, predation, mutualism, parasitism,
- adaptations to the physical environment.

3 Life processes (for animals) selected from:

42 The Lungs

Key Idea: Lungs are internal sac-like organs connected to the outside air by a system of airways. The smallest airways end in thin-walled alveoli, where gas exchange occurs.



The **trachea** transfers air to the lungs. It is strengthened with C-shaped bands of cartilage.

The trachea divides into two **bronchi**. These are also supported by cartilage bands.

Bronchioles branch from the bronchi and divide into progressively smaller branches. The cartilage is gradually lost as the bronchioles decrease in diameter.

The right lung is slightly larger than the left. It takes up 55-60% of the total lung volume.

The "cardiac notch" in the left lung makes space for the heart.

Oxygen enters the blood from air in the **alveoli**. Carbon dioxide leaves blood and is breathed out.

O_2

CO_2

The **diaphragm** is a dome shaped muscle that is the body's main breathing muscle. When it contracts, it moves down, and air is drawn into the lungs.

The walls of the smallest bronchioles lack cartilage but have a large amount of smooth muscle.

The smallest respiratory bronchioles subdivide into the alveolar ducts from which arise the alveoli.

The **alveoli** are the site of gas exchange. They provide a large surface area (70 m^2) for the exchange of respiratory gases by diffusion between the air in the lungs and the blood in the capillaries. The alveoli deflate after each breath out. A phospholipid **surfactant** helps to prevent collapse of the alveoli by decreasing surface tension.

Alveolar cross section at top of next page

1. What is the purpose of the trachea, bronchi, and bronchioles? _____

_____

2. What is the purpose of the diaphragm? _____

_____

3. (a) Explain how the basic structure of the human gas exchange system provides such a large area for gas exchange:

_____

_____

(b) What is the significance of the close arrangement of alveoli and lung capillaries? _____

_____

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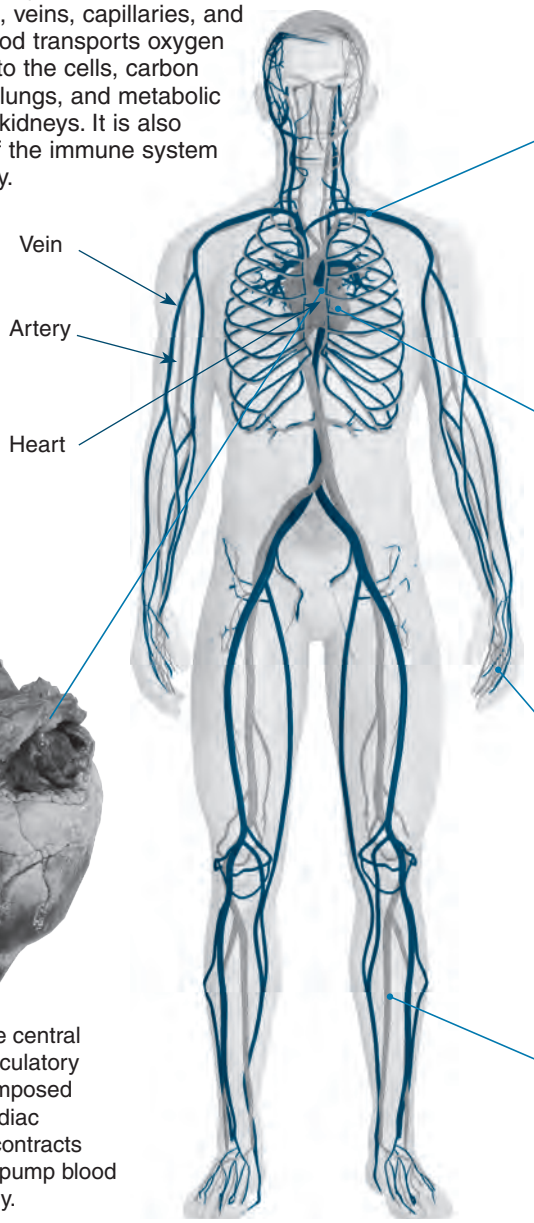
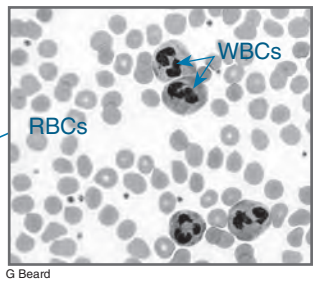
50 The Circulatory System

Key Idea: The circulatory system is responsible for the transport of nutrients, respiratory gases, and wastes in the blood to and from the body's cells via a network of vessels.

The circulatory system comprises the heart, arteries, veins, capillaries, and blood. The blood transports oxygen and nutrients to the cells, carbon dioxide to the lungs, and metabolic wastes to the kidneys. It is also moves cells of the immune system about the body.



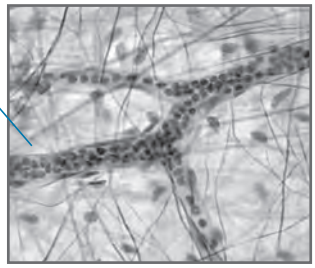
The heart is the central organ of the circulatory system. It it composed primarily of cardiac muscle which contracts rhythmically to pump blood around the body.



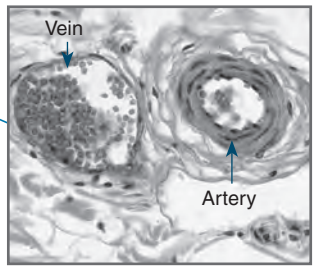
G Beard

Red blood cells (RBCs) carry oxygen to the body's cells. The oxygen binds to the protein haemoglobin, which gives RBCs their colour. The larger white blood cells (WBCs) or leucocytes are part of the immune system and also circulate in the blood.

Blood is a liquid tissue. Blood cells are suspended in a watery material called plasma, which carries dissolved materials, e.g. blood proteins, electrolytes (salts) and nitrogenous waste.



Blood moves through blood vessels, the smallest of which are the capillaries. These are only one cell thick, allowing oxygen and other molecules to easily move out of or into the blood from the cells of the body's tissues.



Blood is transported away from the heart in arteries, blood vessels with thick walls of elastic connective tissue and smooth muscle. Blood returns to the heart in veins, which have thinner walls but a larger lumen (inside space).

1. Name three components of the circulatory system and state their function:

   (a) _____

   _____

   (b) _____

   _____

   (c) _____

   _____

2. (a) Which component of the blood carries oxygen to the body's cells? _____

   (b) Which component of the blood carries metabolic wastes to the kidneys? _____

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55 Circulation and Respiratory Interaction

Key Idea: The circulatory and respiratory systems interact to provide the body's tissues with oxygen and remove carbon dioxide.

Circulatory system

Function

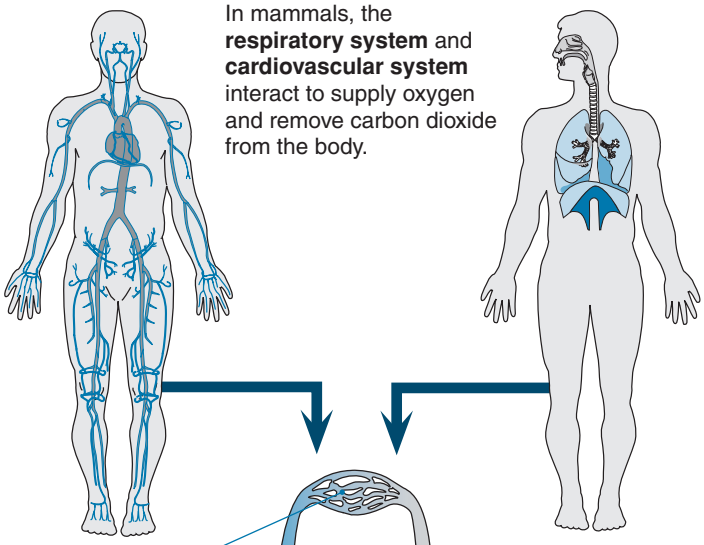
Delivers oxygen (O_2) and nutrients to all cells and tissues. Removes carbon dioxide (CO_2) and other waste products of metabolism. CO_2 is transported to the lungs.

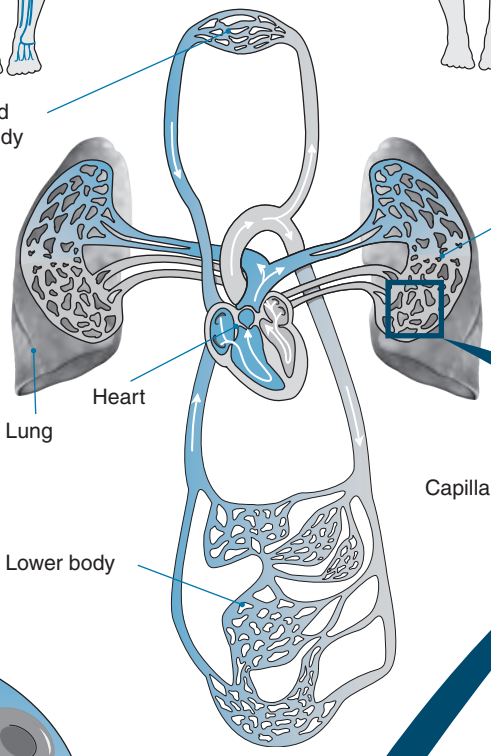
Components

- Heart
- Blood vessels:
  - Arteries
  - Veins
  - Capillaries
- Blood

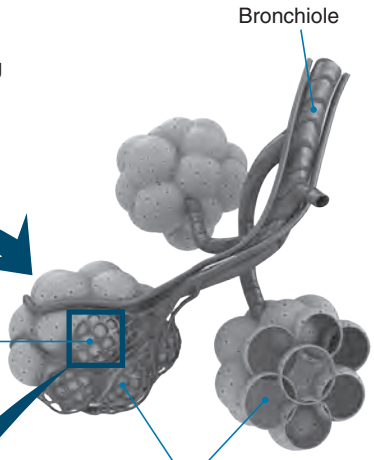
Interaction between systems

In mammals, the **respiratory system** and **cardiovascular system** interact to supply oxygen and remove carbon dioxide from the body.

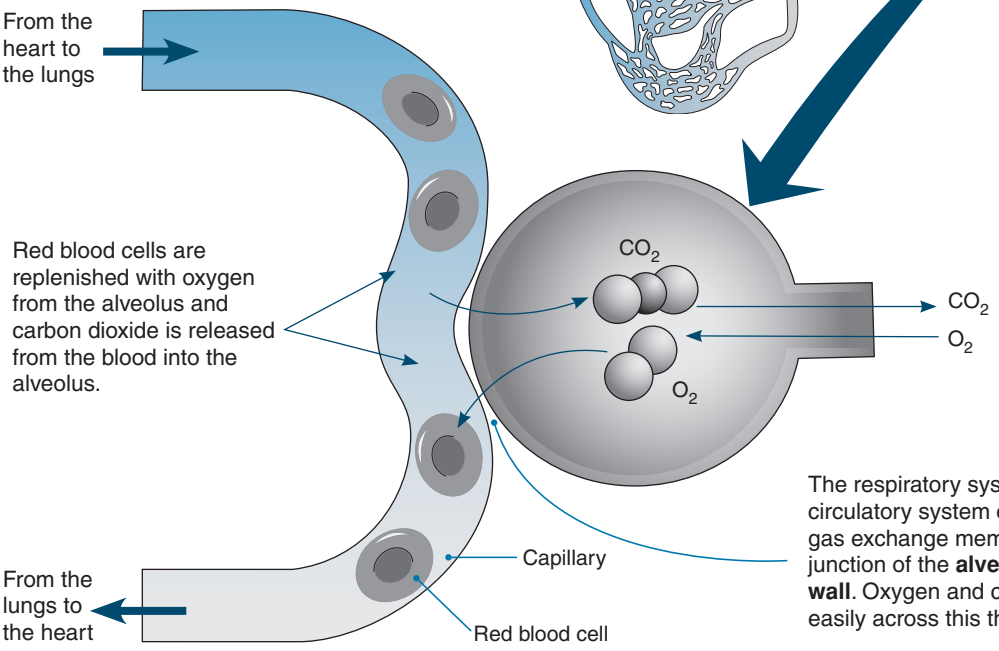




Oxygen (O_2) from inhaled air moves from the lungs into the circulatory system and is transported within red blood cells to the heart. The heart pumps the blood to the body where O_2 is released and carbon dioxide (CO_2) is picked up. The blood returns to the heart and is pumped to the lungs where CO_2 is released into the lungs to be breathed out.



The airways of the lungs end at the **alveoli**, the microscopic air sacs that enable gas exchange.



Red blood cells are replenished with oxygen from the alveolus and carbon dioxide is released from the blood into the alveolus.

The carbon dioxide released from the blood exits the body during exhalation. Inhalation brings in fresh air, containing oxygen.

The respiratory system and the circulatory system come together at the gas exchange membrane formed by the junction of the **alveolus** and the **capillary wall**. Oxygen and carbon dioxide diffuse easily across this thin barrier.

Respiratory system

Function

Provides surface for gas exchange. Moves fresh air into and stale air out of the body.

Components

- Airways:
  - Pharynx
  - Larynx
  - Trachea
- Lungs:
  - Bronchi
  - Bronchioles
  - Alveoli
- Diaphragm

KNOW
LINK 42
LINK 50

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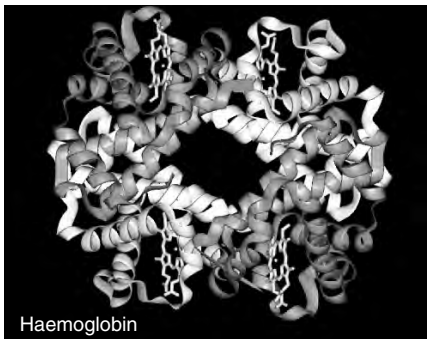
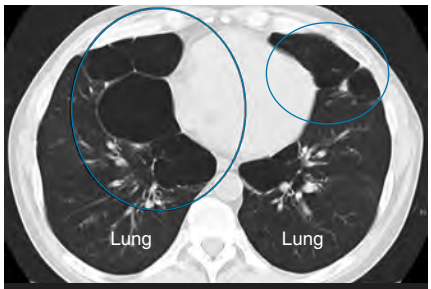
The body's response to exercise illustrates the close link between the circulatory and respiratory systems. During exercise, breathing rate increases to provide more oxygen, which is carried by the circulatory system to supply ATP for working muscles. Heart rate increases to increase the rate at which oxygen is delivered to the tissues and carbon dioxide is returned to the lungs.



Oxygen is transported in red blood cells by the protein haemoglobin. In the capillaries of the lungs (high oxygen), haemoglobin binds oxygen tightly. In the tissues, higher carbon dioxide levels cause haemoglobin to release its oxygen. Carbon dioxide is carried in the blood as carbonic acid ($CO_2 + H_2O \rightarrow H_2CO_3$). In the lungs, the carbonic acid dissociates back into CO_2 and water.



In emphysemic lungs, normal tissue has been replaced by large spaces (circled)

James Heilman, MD cc 3.0

Diseases of the respiratory system affect the ability of the circulatory system to supply oxygen to the body's cells and remove CO_2. For example, emphysema (shown in X-ray of chest cavity above) reduces the ability of the lungs to provide enough oxygen to meet needs. This leaves a person short of breath and with very little energy because oxygen delivery to the tissues is inadequate.

1. (a) What happens to the rate of blood flow during exercise? _____

   (b) What happens to the breathing rate during exercise? _____

   (c) How do the circulatory and respiratory systems interact to accommodate the extra oxygen requirements of an exercising person?

2. Explain how a lung disease affects the body, including the circulatory system: _____

3. (a) At which point in the body do the respiratory and circulatory systems directly interact? _____

   (b) Explain what is happening at this point: _____

4. In your own words, describe how the circulatory system and respiratory system work together to provide the body with oxygen and remove carbon dioxide:

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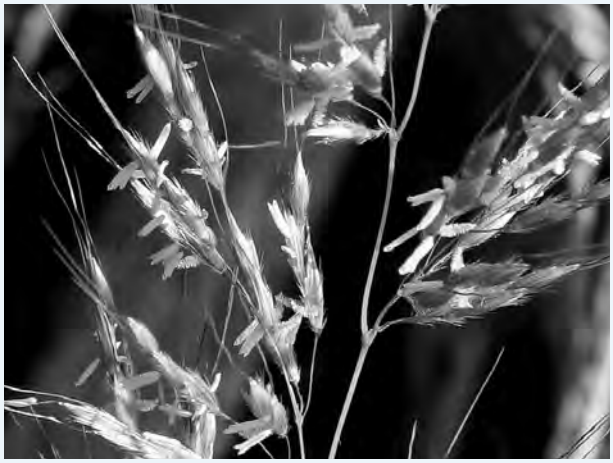
72 Comparing Insect and Wind Pollination

Key Idea: Insect and wind pollinated plants differ in where they invest their energy for pollen dispersal.

Insect pollinated flowers	Wind pollinated flowers
Large brightly coloured petals to attract insect pollinators.	Small petals, usually pale or dull green.
Often sweetly scented.	No scent.
Contain nectaries to produce nectar as a reward for pollinators.	No nectaries.
Pollen is often sticky, to ensure it in securely attached to pollinators.	Pollen is small and light to be carried to by the wind.
Moderate to small amounts of pollen produced.	Pollen produced in vast amounts to ensure at least some grains reach another plant of the same species.
Anthers and stigma inside the petals and place to ensure pollinators brushes against them.	Anthers and stigma extend beyond the petals.
Stigma has a sticky coat to ensure pollen sticks to it.	Stigma is feathery or net-like.



Hardyplants

1. Using the photographs and the table above to help you, contrast wind and insect pollinated flowers with respect to each of the following characteristics. For each, give reasons for the differences observed:

   (a) Appearance of the flowers: _____

   _____

   _____

   (b) Production of scent and nectar: _____

   _____

   _____

   (c) Position of the reproductive parts (stigma, stamens): _____

   _____

   _____

2. Where do insect pollinated plants put their energy for pollen dispersal compared to wind pollinated plants?_____

   _____

   _____

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99 Environment Determines Community Patterns

Key Idea: A community pattern is influenced by the local environment including climate and geological features.

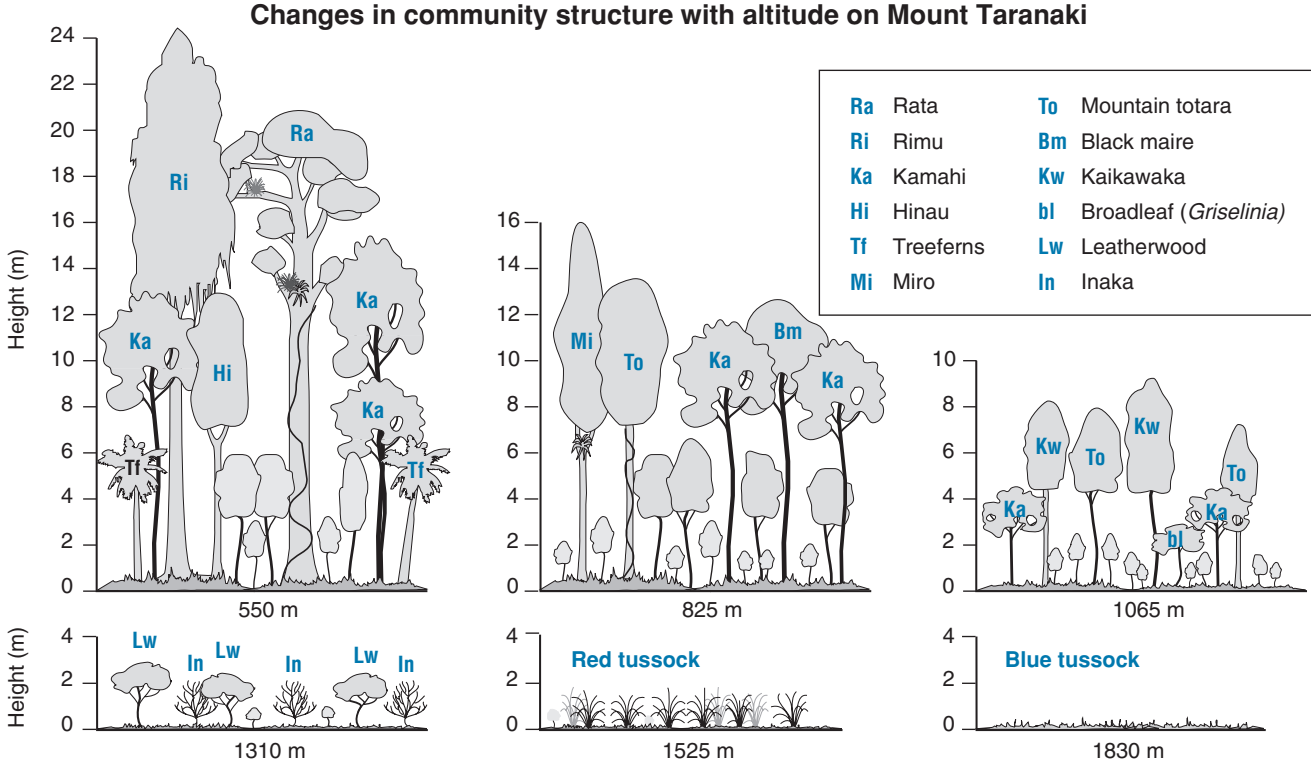
▶ Abiotic (physical) and biotic (living) factors both influence community patterns. The community structure on Mount Taranaki changes with altitude, and is heavily influenced by abiotic factors. The final composition of the community is influenced not only by climate, but also by rock type, soil composition, drainage, and aspect. Biotic interactions also play a role in community structure, influencing the distribution and abundance of species within their tolerance range.

Photo: Phil Bendle

C.Gemmill

Mt Taranaki's height, location, and classic shape allows a person to walk from lowland rainforest to scree slopes in just a few hours.

Changes in community structure with altitude on Mount Taranaki



1. The diagram above illustrates the changes in the structure of the vegetation communities on Mount Taranaki at six different altitudes. Only major species present are labelled. Study the profile and answer the following:

(a) Describe a general trend in the height of the vegetation with increasing altitude: _____

_____

(b) Describe a general trend in vegetation diversity (number of species) with increasing altitude: _____

_____

(c) Describe the change in community structure (species presence/absence) between 550 m and 825 m: _____

_____

_____

_____

(d) Describe the change in community structure (species presence/absence) between 1065 m and 1310 m: _____

_____

_____

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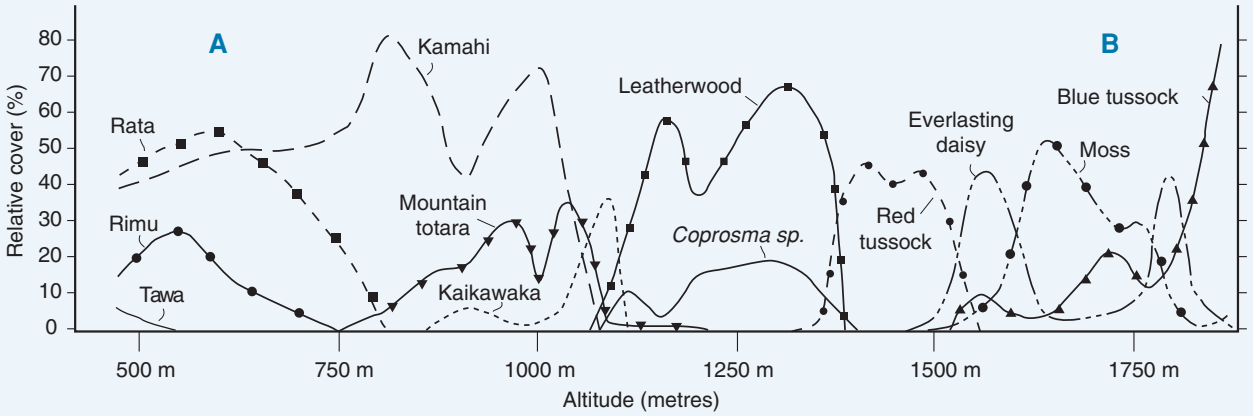
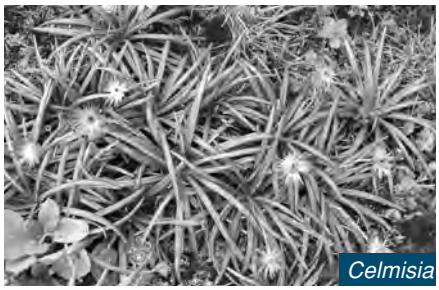
Changes in species abundance with altitude on Mount Taranaki



Emergent trees	Canopy trees	Shrubs & scrub	Tussocks	Herbfield
Rimu Rata Tawa	Kamahi Mountain totara Kaikawaka	Leatherwood *Coprosma sp.*	Red tussock	Everlasting daisy Moss Blue tussock

The alpine herb fields (above) of Mt Taranaki are dominated by herbaceous plants. Mountain and everlasting daisies, and the leathery-leaved hebe *Forstera* are common.



Introduced browsers, primarily hares in the tussocklands, preferentially eat palatable native plant species. This allows less palatable species, such as mountain daisies (*Celmisia*) to flourish.

New Zealand montane and alpine areas have few insect pollinators. Flowering plants in these regions have generalised pollination systems, so that many insect species can pollinate them.

All photos on this page: C. Gemmill

2. The graph above shows the changes in species abundance with increasing altitude. The various species fall into categories (e.g. emergents) according to their size and stature.

   (a) Mark on the diagram (with vertical lines) the upper limits (highest altitude) of: the emergent trees, canopy trees, shrub/scrub, and tussock:

   (b) State the lower altitude limit of the herbfield species: _____

   (c) Identify the single most abundant species in each of the following catergories:

   Emergent trees: _____ Canopy trees: _____ Shrub/scrubs: _____

   (d) Identify the species with the greatest tolerance to high altitude and suggest why it becomes more abundant at the upper end of its range:

   _____

   _____

   (e) Identify the species present at sample points **A** and **B** above:

   Point A: _____ Point B: _____

3. Explain how the activities of introduced species might alter natural communities composition on Mt. Taranaki:

   _____

   _____

   _____

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