

Achievement Standard 90461

Describe concepts and processes relating to ecology

Biology

2.5

Externally assessed
3 credits

Organisms and their environment

Adaptations

Adaptations are features of an organism that help it to survive. Adaptations are related to the way the organism carries out the life processes – movement, respiration, sensitivity, growth, reproduction, excretion and nutrition, as well as other requirements such as defence.

- Structural adaptations – structures an organism has (eg guard cells on epidermis of a leaf).
- Physiological adaptations – systems, processes or abilities that an organism has (eg ability to make the enzyme cellulase).
- Behavioural (animals) and responses (plants) adaptations – ways of doing things (eg cat lying rolled up tight in cold weather and stretched out in warm weather; plant shoot growth towards light).

Adaptations give one type of organism an advantage over another type of organism and slight differences in the same adaptation give individuals of the species an advantage over others of the same species.

Example

An organism that can fly will be able to feed on the nectar of flowers at the ends of thin branches whereas an organism that can only climb the plant cannot.

An individual with colouration similar to the environment is more likely to be hidden from a predator.

Ecological niche

Ecological niche, the 'role' of an organism, includes many aspects – eg interactions with other organisms and the environment, adaptations and life history.

An organism survives best where environmental conditions of their habitat match their adaptations (**preferred habitat**), but not all organisms are able to live in ideal conditions (eg a seed may land and germinate in an area where environmental conditions are not ideal).

The greater the difference between environmental conditions and an organism's adaptations, the greater the **physiological stress**. If environmental conditions are outside an organism's **limits of tolerance**, the organism will move away or die.

A **limiting factor** is one that constrains growth, reproduction or survival.

An organism's **trophic level** is how it fits into the feeding relationships and contributes to the flow of energy and cycling of nutrients in the ecosystem.

Population patterns

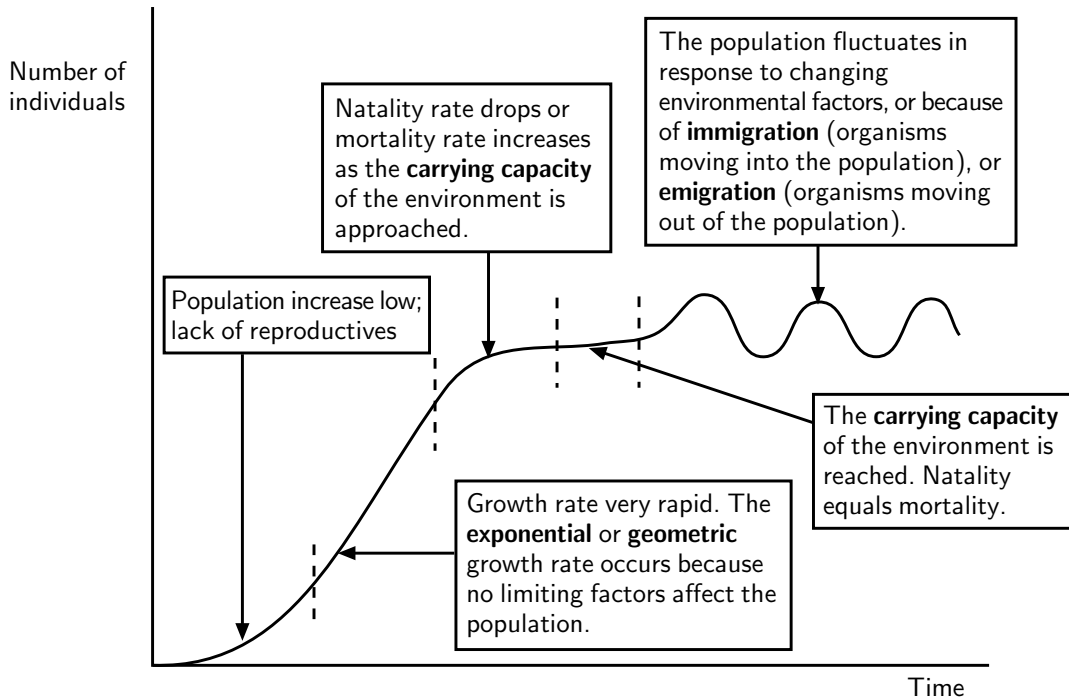
A 'population' includes all individuals of a species in a given area. Population growth and size depend on the balance between:

- Factors that increase population size – birth rate and immigration.
- Factors that decrease population size – death rate and emigration.
- Factors that limit population size – eg food resources, water, space to live, competition, availability of nest sites.

**SAMPLE
REVISION
NOTES**

For a new population in a favourable habitat, numbers initially increase slowly, followed by a rapid increase as greater and greater numbers of individuals reach reproductive age – ‘exponential’ or ‘J-shaped’ population growth.

Increase in numbers slows down as the **carrying capacity** of the environment is reached. Population numbers fluctuate around that size – when resources are plentiful numbers increase; in poor times numbers decrease – this is called ‘S-shaped’ population growth.



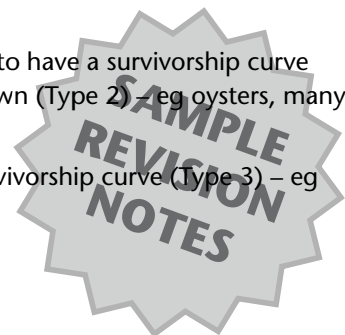
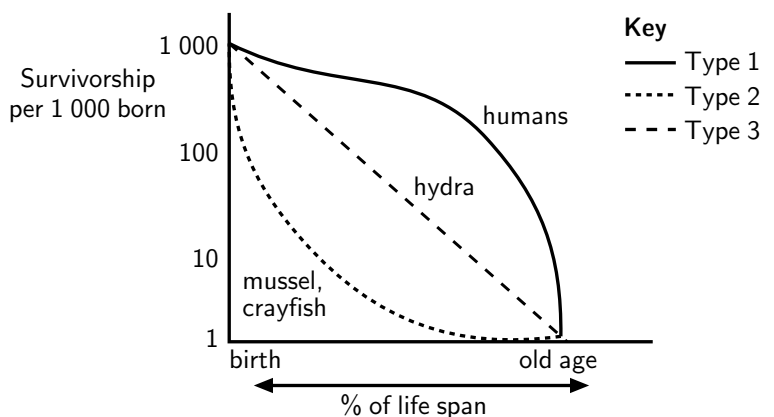
Survivorship

Survivorship (shown in **life tables** and **survivorship curves**) is a measure of how likely an individual is to survive at any point in its lifetime.

Organisms that have few young and provide them with a lot of care tend to have high initial survivorship. The survivorship curve (Type 1) shows this. The line is flat during young and middle age but drops quickly at older age as the death rate increases (eg humans, elephants).

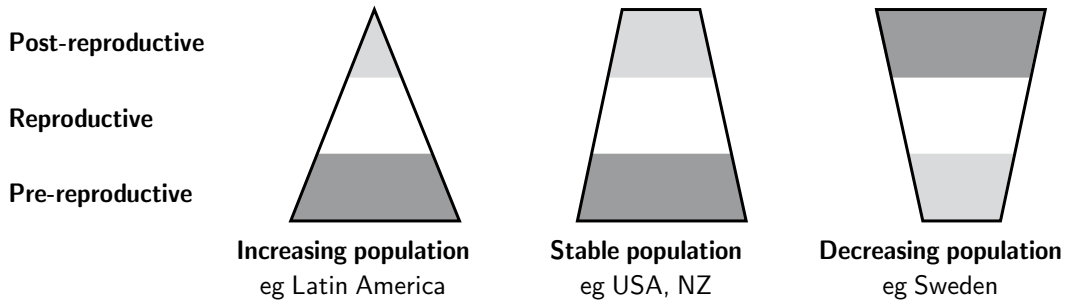
Organisms with large numbers of young provided with little or no care tend to have a survivorship curve that drops quickly during young age then flattens out as death rate slows down (Type 2) – eg oysters, many fish species.

Species with a constant death rate over their life span have a straight line survivorship curve (Type 3) – eg hydra, some lizard species.



Age structure

Age structure is the number of individuals in different age groups (eg pre-reproductive, reproductive and post-reproductive).



Changes in age structure of a population over generations indicates whether the population is increasing, decreasing or staying the same (stable).

Community patterns

Succession

Succession is the changing of species in a community over time.

Succession occurs because each species modifies the environment and makes it possible for another species to grow and (possibly) take over.

Zonation

Zonation is the distribution of species in bands/zones across a habitat caused by patterns in abiotic and biotic environmental factors. Species are found in zones within their tolerance limits. Competition between organisms with similar environmental needs is a major factor in determining zonation patterns.

Examples

Zonation patterns occur in the distribution of:

- Shellfish and algae across a rocky sea shore between high- and low-tide marks. Distribution limits are related to adaptations to the abiotic environment (eg ability to avoid drying out or to tolerate high salt concentrations). The biotic environment (eg competition, predation and grazing) sets low tide distribution limits.
- Organisms from the base to the peak of a mountain – distributions are controlled by altitude, temperature and light.
- Organisms in a lake as the depth changes.
- Moss, algae and lichens around the trunk of a tree.

Stratification

Stratification is the layers of plants, from floor to canopy, found in a forest. Different organisms are found in the different layers.

Organisms in each of the layers modify the environment for organisms in lower layers.

Community inter-relationships

Both organisms can benefit from a relationship.

Example

A plant benefits by having its pollen transferred to other plants – the pollinator benefits because it receives food in the form of nectar from the plant.



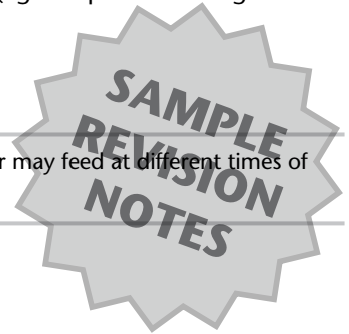
Competition – both organisms are harmed because they both try to use the same resource. Competition between organisms is highest when a resource is in limited supply (eg lack of a mineral in the soil, lack of water in a drought).

- **Intra-specific competition** is between organisms of the *same* species – strongest because the organisms have the same requirements and similar adaptations (eg beech trees competing for light, two pairs of fantails competing for nesting sites).
- **Inter-specific competition** is between organisms of two *different* species (eg competition for light between a beech tree seedling and a pepper tree).

Slight differences in adaptations reduce inter-specific competition.

Example

Species that are similar may have slightly different mouth parts or beak sizes, or may feed at different times of the day or night, or may feed at different levels in a forest.



Exploitation

Exploitation occurs when one organism uses another for food.

- **Predation** – a predator catches and eats a prey organism. Predators have adaptations to locate, catch and ingest prey (eg mammal predators have eyes at the front of their heads to judge distances easily). Predators often catch the old, young, weak, sick or injured members of a population.
- **Parasitism** – a parasite organism lives inside/outside a host organism. The parasite feeds directly on the host/food it contains. Parasites are often very specific and will only feed on one type of host.

Some parasites kill their host.

Example

The parasitic wasp *Meteorus* lays its eggs inside the body of an armyworm caterpillar. The eggs hatch and the larva of the wasp eats the caterpillar then emerges out of the dead caterpillar's body as an adult wasp. This controls the population numbers of armyworm.

Questions – Organisms and their environment

Question One: Little Blue Penguin

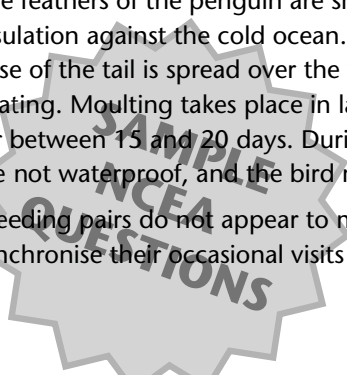
Read the information below to help you answer the questions:

The Little Blue Penguin (Kororā) forages at sea between dawn and dusk. It can dive down to a depth of 30 m.

In water, a penguin propels itself with its flippers and steers with its tail and feet. A Little Blue Penguin rests on the water's surface by stretching its flippers for stability.

The feathers of the penguin are small and densely layered, providing insulation against the cold ocean. Oil released from a gland at the base of the tail is spread over the feathers, providing a waterproof coating. Moulting takes place in late summer and autumn, and lasts for between 15 and 20 days. During this time, the penguin's feathers are not waterproof, and the bird must remain out of the water.

Breeding pairs do not appear to meet at sea, yet they successfully synchronise their occasional visits to burrows prior to breeding.



1. Describe the penguin's **ecological niche**.

The Little Blue Penguin has many adaptations to help its survival. There are **structural, behavioural and physiological adaptations**.

2. Use the information provided above to describe an example of a structural adaptation and a behavioural adaptation. (An example of a physiological adaptation has been provided for you.)

Structural adaptation	Behavioural adaptation	Physiological adaptation
		Oil which is secreted by the gland at the base of the tail.

3. Explain **how** the secretion of oil from the tail gland **aids** the survival of the penguin in the water.



2.5 Nutrient cycles, Flow of energy and Biodiversity (page 50)

Question One: Southern ocean food-web

1. Energy from the sun enters this food web via photosynthesis of the phytoplankton. (A)
2. The food chain to the baleen whale is only three steps (phytoplankton, krill, baleen whale), whereas to the toothed whale it is four steps (eg phytoplankton, krill, squid, toothed whales). (A) More energy is lost due to respiration from the four steps than from the three steps, so the food chain to the baleen whale is more energy efficient. (M)
3. The food web shows that eight primary consumers use krill as a food source (A); therefore, a wide range of organisms depend on the protein and vitamins found in krill. Each of these organisms has other organisms further along a food chain that are indirectly dependent on the krill. If humans were to over-fish the krill population, it would mean that the population numbers of a large number of organisms would be reduced, with numbers of seals and penguins, and the organisms that feed on them, being likely to be most affected. (M) Removal of large numbers of an organism that has links to so many other species would have major impacts on the stability of this ocean food web. With the removal of krill, there will be a change in feeding pressure on the zooplankton because there are fewer krill to feed on it. Because the krill are removed, there will be more feeding pressure on the zooplankton from other organisms (that would have fed on the krill) which are now feeding on the zooplankton. The removal of krill is likely to cause an increase in numbers of phytoplankton, as there are far fewer krill feeding on them. The numbers of organisms would fluctuate until a new balance is established. This adjustment will be major, as krill are at the beginning of food chains.

A probable, long-term effect of the over-fishing is the reduction of the biodiversity in the area, as removal of such an important species in large numbers will cause major changes in the balance within the ecosystem, because over-fishing will remove a large amount of the biomass present at or near the beginning of the food chain. This will result in a reduction in the numbers of different species present in the Southern Ocean. (E)

Question Two: Trees and Carbon

During photosynthesis, trees remove carbon dioxide from the atmosphere and fix it into carbon compounds (such as glucose) (A); which can then be converted into a range of other chemicals (eg starch, protein). The carbon in these chemicals is then passed onto other organisms in the food chain in the form of food. The trees and other organisms, including decomposers, carry out respiration that releases the carbon back into the atmosphere as carbon dioxide. (M)

