COMMUNITIES

Content Statements:

C4.1.10	A community as all of the interacting organisms in an ecosystem
C4.1.11	Herbivory, predation, interspecific competition, mutualism, parasitism and pathogenicity as categories of interspecific relationship within communities
C4.1.12	Mutualism as an interspecific relationship that benefits both species
C4.1.13	Resource competition between endemic and invasive species
C4.1.14	Tests for interspecific competition
C4.1.15	Use of the chi-squared test for association between two species
C4.1.17	Top-down and bottom-up control of populations in communities
C4.1.18	Allelopathy and secretion of antibiotics

COMMUNITY

A community is a group of populations living together and interacting with each other within a given area. Communities comprise **all the populations** in an area – including all plants, animals, fungi and bacteria. The members of a community will interact with the abiotic environment (habitat) to form a complex ecosystem.

SPECIES INTERACTIONS

Within a community, interactions between species can be classified based on their effect on those involved:

Herbivory

Herbivores eat only vegetation (e.g. primary consumers). Some may benefit the plant by only eating certain parts (pollinators eating nectar), while others eat to the detriment of the plant (such as cows grazing on grass).

Predation

Predation refers to interactions where one organism (predator) hunts and eats another (prey). Because the predator relies on the prey as a food source, their levels are intertwined. Wolves hunting deer is an example.

Interspecific Competition

Competition is inevitable when two species require the same resources. The competition can be direct (vying for territory) or indirect (consuming a resource to deplete its availability). Lions and hyenas compete for prey.

Pathogenicity (Infections)

Pathogenicity involves an infectious microorganisms living inside or on a host organism and causing disease. **E.g.** *Mycobacterium* causing tuberculosis.

SYMBIOSIS

Symbiosis refers to a **close and persistent** (long-term) interaction between two different species. Symbiotic relationships are defined according to whether the association between species is positive (beneficial) or negative (harmful). Examples of symbiotic relationships include mutualism, commensalism and parasitism.

	Description	Example	Summary
Mutualism	Both species benefit from the interaction	Anemones protect the clownfish, while clownfish provides fecal matter for food	
Commensalism	One species benefits the other is unaffected	Barnacles are transported to plankton-rich waters by attaching themselves to whales	
Parasitism	One species benefits the other is harmed	Ticks and fleas live on the surface of their canine hosts and feed on the host's blood	

Examples of mutualism include root nodules in legumes, mycorrhizae in orchids and zooxanthellae in coral.

Fabaceae are a family of legumes that contain **nitrogen-fixing bacteria** in their root nodules. The bacteria gain sugars from the plant, while the legumes gain nitrates for making compounds (proteins, nucleic acids).

Orchidaceae are a family of flowering plants (orchids) that form associations with fungi called **mycorrhizae**. The fungus gains sugar from the plant, while their hyphae will increase the surface area of the root system.

Coral reefs are formed by polyps that contain **photosynthetic algae** called *zooxanthellae*. The algae carry out photosynthesis, while polyps form calcium carbonate exoskeletons to provides shelter and protection.

CHEMICAL COMMUNICATION

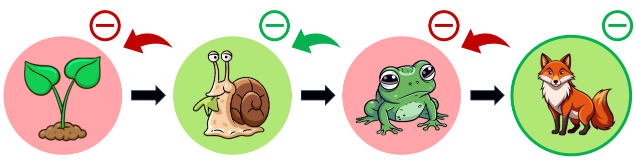
Organisms may be able to exert control over other species in a community by releasing chemicals called secondary metabolites. **Allelopathy** involves the release of chemicals that influence the growth, survival or reproduction of another organism. This interaction can be either positive or negative. Plants may produce these chemicals to control the germination of surrounding plants (e.g. sinigrin by the garlic mustard plant). **Antibiotics** are allelopathic chemicals that inhibit growth of prokaryotic cells (negatively impact bacteria). An example is the release of penicillin from a mould species which prevents cell wall formation in bacteria.

INVASIVE SPECIES

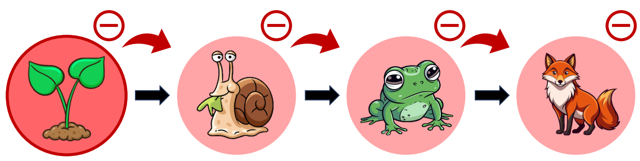
Invasive species are **alien species** that have a detrimental effect on the endemic (native) populations. They will share a fundamental niche with endemic species, but lack predators capable of limiting their survival. The red fox is an invasive species in Australia that is outcompeting the native quoll for shared resources.

POPULATION CONTROL

Population growth can be controlled by either **top-down** factors that are applied to higher trophic levels (such as an invasive species), or **bottom-up** factors that are applied to the producers (nutrient availability). While both types of control can operate at the same time, one is likely to be dominant within a community.



Top-Down Control



Bottom-Up Control

ASSOCIATION TESTS

The type of relationship between two species can be assessed via a number of different research methods:

- Experiments can be conducted under controlled conditions, whereby chosen variables are manipulated
- Field manipulation may involve the removal of one species to determine the impact on another species
- Field observations can also occur, where sites are assessed for the presence or absence of each species

If data has been collected via quadrat sampling, a **chi-squared test** is performed to determine if there is a statistically significant association between the two species (which may suggest interspecific competition).

CHI-SQUARED TEST

The presence or absence of two species of mollusc (limpet and whelk) was recorded in fifty quadrats (1m^2) on a rocky sea shore. The sample sites were random and the following distribution pattern was observed:

Both species present	Limpet only	Whelk only	Neither species found
6 quadrats	15 quadrats	20 quadrats	9 quadrats

Step 1: Construct a contingency table

Contingency tables show the number of quadrats where each species is present or absent (**observed data**).

	Limpet Present	Limpet Absent	Total
Whelk Present	6	20	26
Whelk Absent	15	9	24
Total	21	29	50

Step 2: Construct a table of frequencies

Expected frequencies are calculated as follows: **Expected values = (row total × column total) ÷ overall total**
The data is then processed to work out chi-squared values based on both observed and expected numbers.

	Observed Data (O)	Expected Data (E)	$(O - E)^2 \div E$
Both species found	6	(26 × 21) ÷ 50 = **10.9**	$(6 - 10.9)^2 \div 10.9$ = **2.38**
Only limpet present	15	(24 × 21) ÷ 50 = **10.1**	$(15 - 10.1)^2 \div 10.1$ = **1.59**
Only whelk present	20	(26 × 29) ÷ 50 = **15.1**	$(20 - 15.1)^2 \div 15.1$ = **2.20**
No species found	9	(24 × 29) ÷ 50 = **13.9**	$(9 - 13.9)^2 \div 13.9$ = **1.73**

Step 3: Determine statistical significance

The chi-squared test can be used to determine a critical value via the following formula: $\chi^2 = \sum(O - E)^2 \div E$
This value is then used to identify a **p value**, which indicates the probability the results are due to chance.
The results are considered to be statistically significant (i.e. alternative hypothesis is accepted) if **$p<0.05$***.

Data: $\chi^2 = 2.38 + 1.59 + 2.20 + 1.73 =$ **7.90** (this value must be larger than the critical value when $p<0.05$)

p value (% chance)	0.25	0.1	**0.05**	0.01
Critical value (df = 1)	1.32	2.71	3.84	6.66

The χ^2 value of **7.90** is greater than the critical value at $p<0.05$ (3.84), so results are significant

* The degree of freedom (designates the range at which values will be considered significant) will always be **1** for this type of test