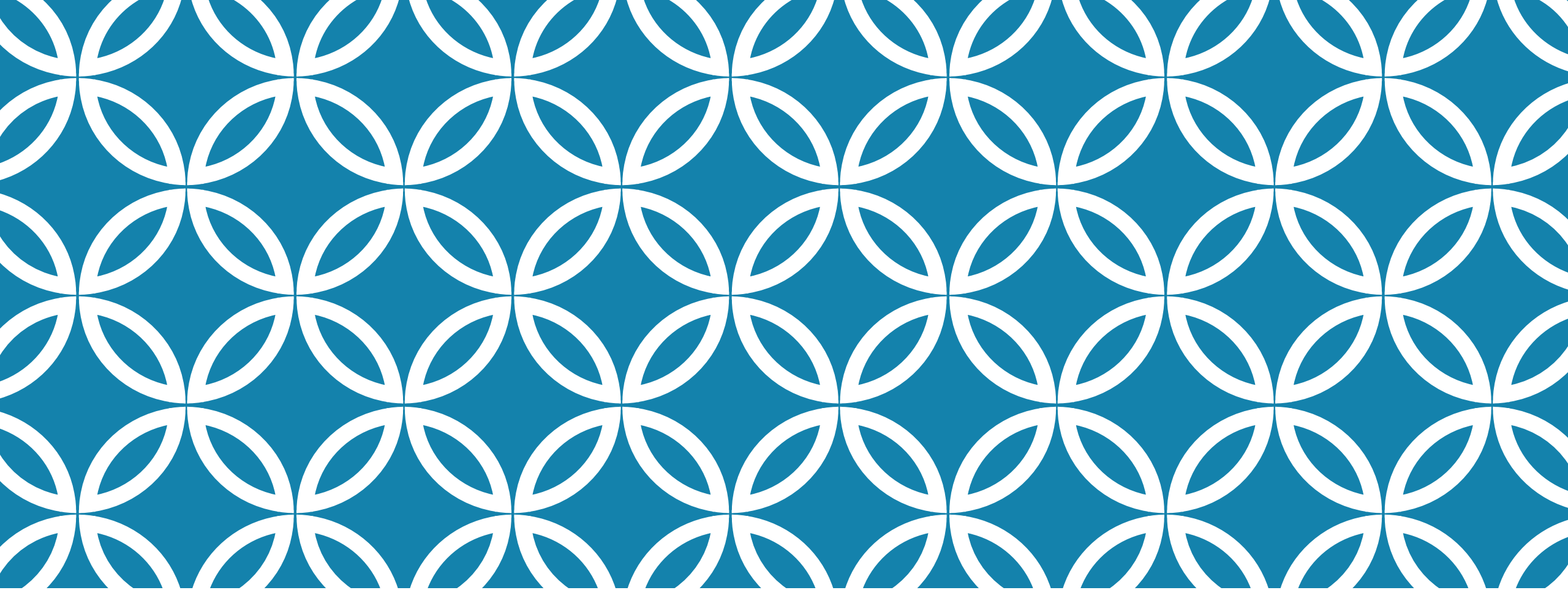


CHAPTER 4.1

Species, Communities and Ecosystems

ECOLOGY

= how living things interact with each other and the environment

Living conditions that affect an organism = **biotic factors**

- (sources of compition (*intra-specific* / *inter-specific*) and predators

Non-living conditions that affect an organism = **abiotic factors**

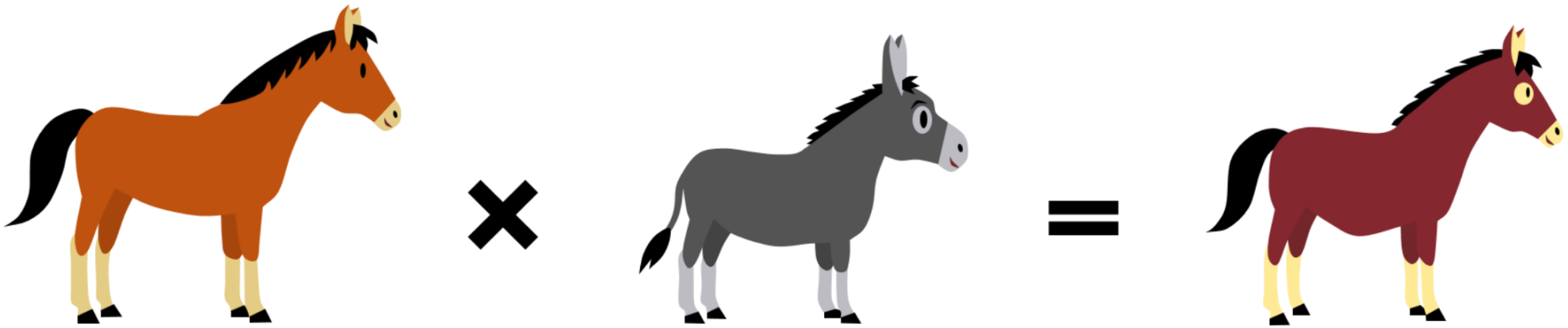
- (temperatures, light, rain, levels of pollution…)

Changes to these conditions → fluctuation of population density …

SPECIES

Groups of organisms that interbreed to produce fertile, viable offspring.

- Hybrid species = infertile offspring of two distinct species



Species: Horse

2n = 64 ; n = 32

Species: Donkey

2n = 62 ; n = 31

Hybrid: Mule

2n = 63 ; n = ✗

PANTHERA HYBRIDS

	Tigress ♀	**Lioness ♀**	**Jaguaress ♀**	**Leopardess ♀**
Tiger ♂	Tiger ♂ Tigress ♀	Tigon ♂ Tigoness ♀	Tiguar ♂ Tiguaress ♀	Tigard ♂ Tigardess ♀
Lion ♂	Liger ♂ Ligress ♀	Lion ♂ Lioness ♀	Liguar ♂ Liguaress ♀	Lipard ♂ Lipardess ♀
Jaguar ♂	Jagger ♂ Jaggress ♀	Jaglion ♂ Jaglioness ♀	Jaguar ♂ Jaguaress ♀	Jagupard ♂ Jagupardess ♀
Leopard ♂	Leoger ♂ Leogress ♀	Leopon ♂ Leoponess ♀	Leguar ♂ Leguaress ♀	Leopard ♂ Leopardess ♀

PANTHERA HYBRIDS

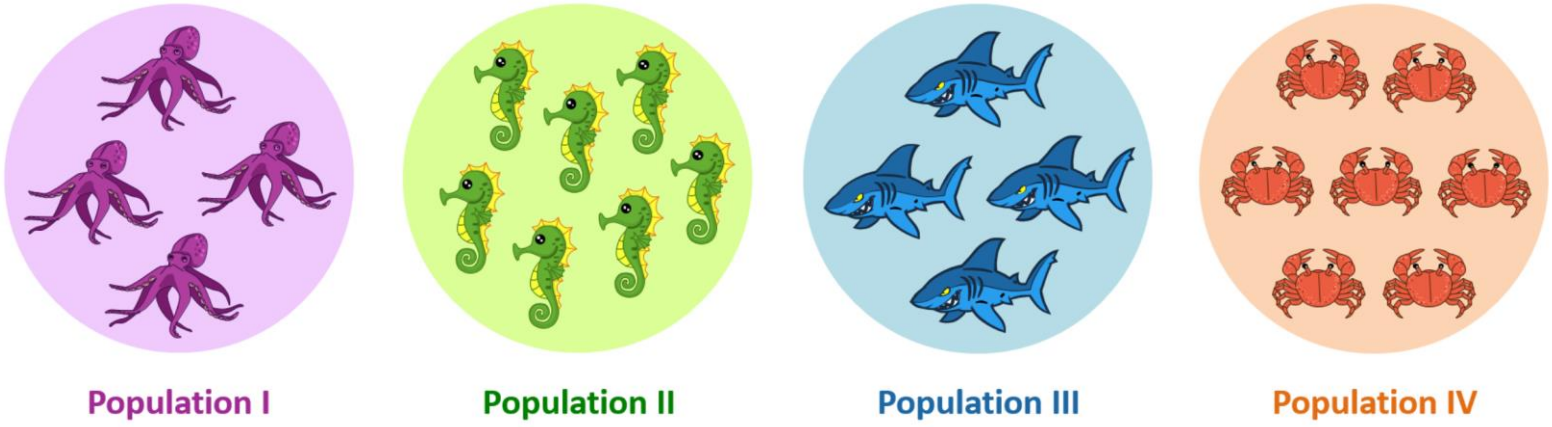
Jaglion

Lepon

Liger

POPULATION

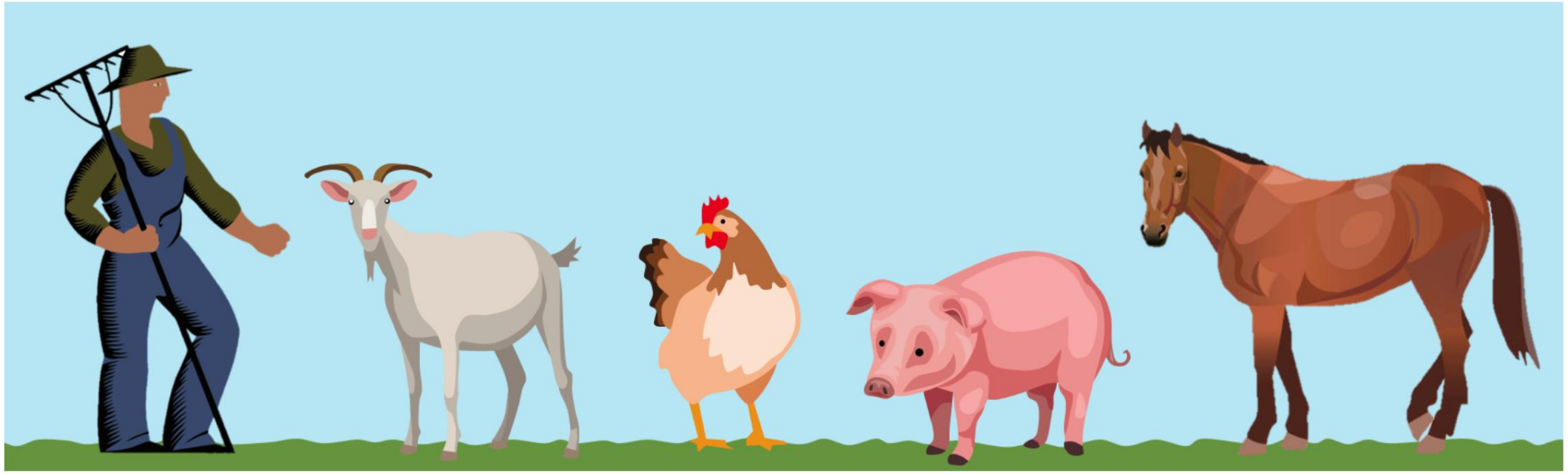
= group of organisms of the same species living in the same area at the same time.



COMMUNITIES

= groups of populations that live within a given area and interact.

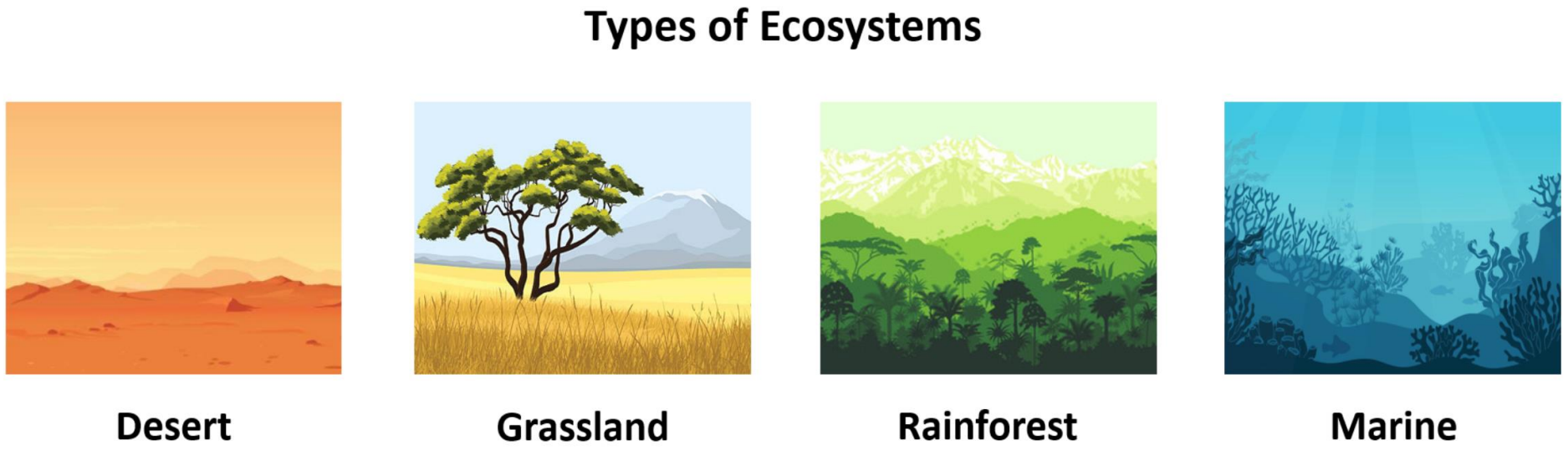
The environment in which a species lives (its normal location) is called habitat.



ECOSYSTEM

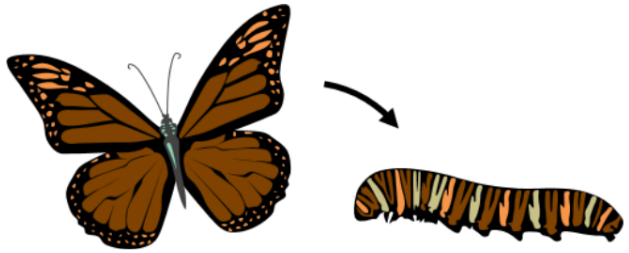
= all the communities within a given environmental region

- Includes biotic factors (communities) and abiotic factors (habitat)



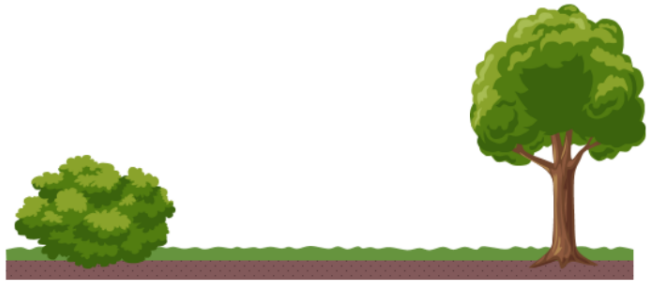
SUMMARY

Species
Organisms that can interbreed

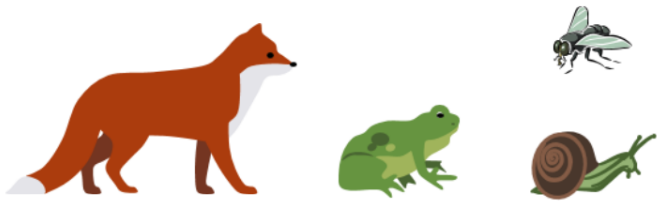


Population
Members of a single species

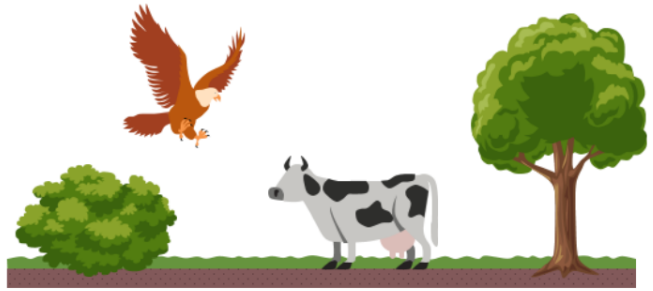
Habitat
Area where a species lives



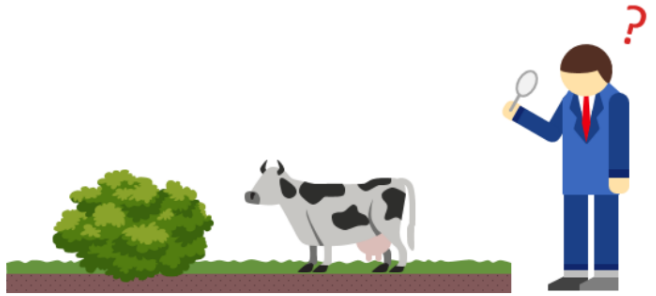
Community
Groups of different populations



Ecosystem
Community and environment



Ecology
The study of ecosystems



Ecology

the study of relationships between living organisms and between organisms and their environment

Population

A group of organisms of the same species living in the same area at the same time

Ecosystem

A community and its abiotic environment

non-living

Community

A group of populations living and interacting with each other in an area

Habitat

The environment in which a species normally lives

(the location of a living organism)

Species

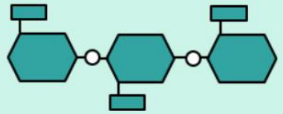
A group of organisms that can interbreed to produce fertile offspring

NUTRITION

Uptake of energy and materials from environmental sources

- Occurs via autotrophic (self source) or heterotrophic (other source) method

AUTOTROPHIC		
Method	**Photosynthesis**	**Chemosynthesis**
Energy	 *sunlight*	 *inorganic molecules*
Material	*inorganic biomolecules (e.g. CO_2)*	

HETEROTROPHIC	
Method	**Via Ingestion / Absorption**
Energy	 *organic (e.g. sugars)*
Material	*organic macromolecules*

NUTRITION

Mixotrophs = both forms according to need

MIXOTROPHS: EXAMPLES

Euglena sp.

MIXOTROPHS: EXAMPLES

Venus flytrap (Dionaea muscipula)

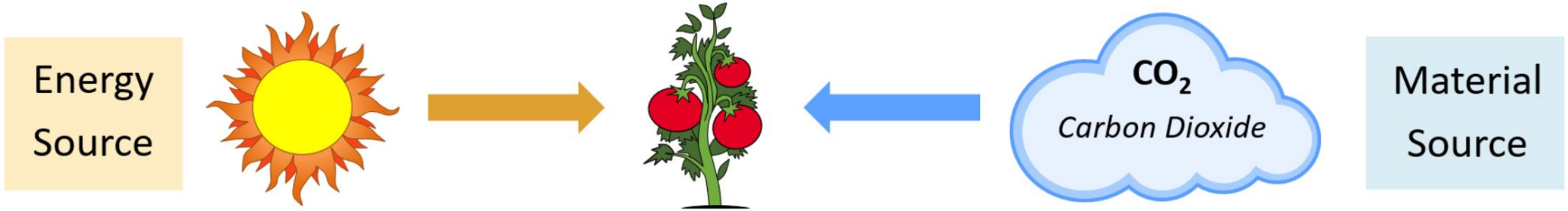
AUTOTROPHS

Synthesize organic molecules (food) from simple inorganic substances

Making their own organic compounds = **producers**

Inorganic nutrients obtained from water, air and soil

- Most autotrophs will derive energy from sunlight (*photosynthesis*) = photoautotroph
- Some get energy from inorganic redox reactions (*chemosynthesis*) = chemoautotroph



HETEROTROPHS

Obtain organic molecules from other organisms via acts of feeding

- Organic material = originally synthesized by autotrophs (producers)

Heterotrophs classified according to their feeding pattern.

- **Consumers**: feed on living or recently decayed organisms
- **Scavengers**: feed on decaying biomass
- **Detritivores**: feed on non-living organic matter
- **Saprotrophes**: break down organic material (*decomposition*)

CONSUMERS

Ingest organic matter from living or recently killed organisms

DETRITIVORES

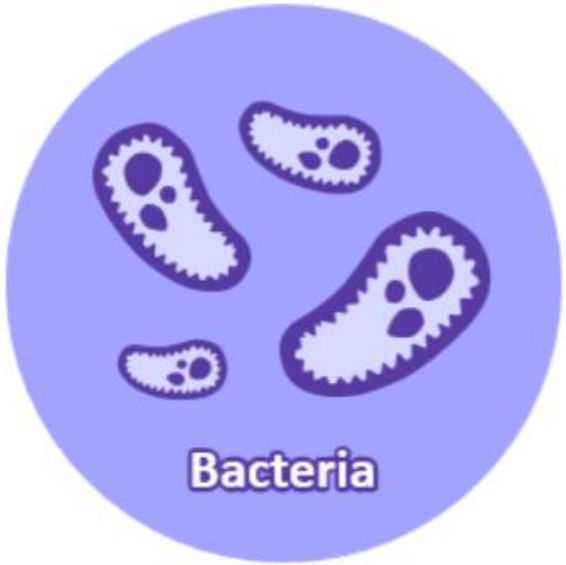
Obtain nutrients from non-living organic material (detritus)

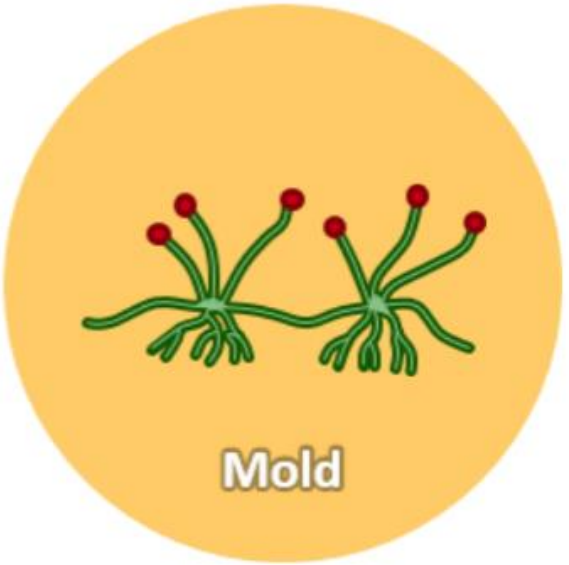
- Detritus = fecal material or decaying leaf litter in soil (humus)

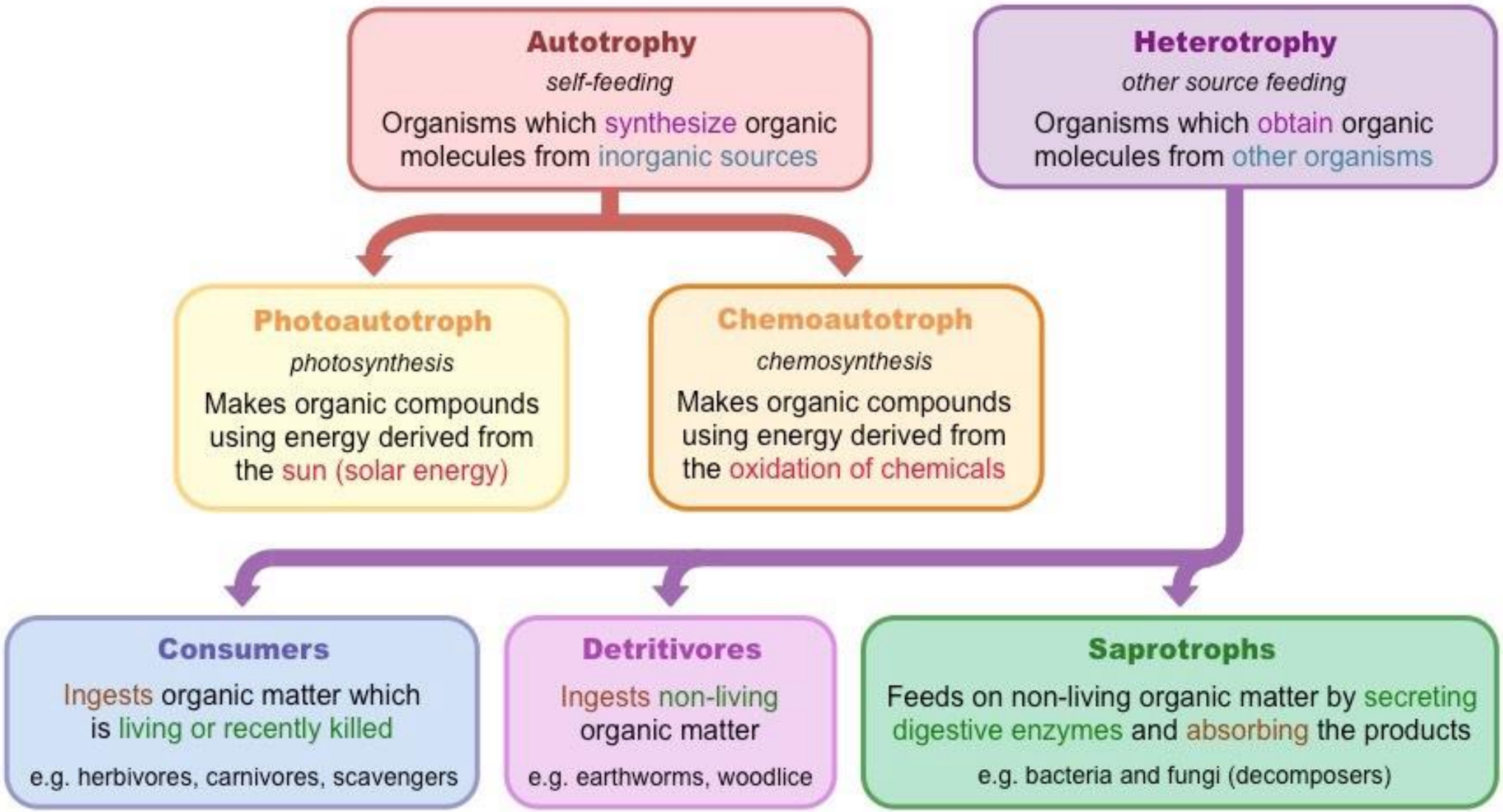
SAPROTROPHS

Live on (or in) dead organisms and secrete digestive enzymes into it

- Enables them to absorb the products of digestion (they are **decomposers**)






Autotrophy
self-feeding
Organisms which synthesize organic molecules from inorganic sources
Heterotrophy
other source feeding
Organisms which obtain organic molecules from other organisms
Photoautotroph
photosynthesis
Makes organic compounds using energy derived from the sun (solar energy)
Chemoautotroph
chemosynthesis
Makes organic compounds using energy derived from the oxidation of chemicals
Consumers
Ingests organic matter which is living or recently killed
e.g. herbivores, carnivores, scavengers
Detritivores
Ingests non-living organic matter
e.g. earthworms, woodlice
Saprotrophs
Feeds on non-living organic matter by secreting digestive enzymes and absorbing the products
e.g. bacteria and fungi (decomposers)

Classifying organisms based on their nutrition

Which group of organisms in the carbon cycle converts carbon into a form that is available to primary consumers?

A. Decomposers

B. Saprotrophs

C. Detritus feeders

D. Producers

Classifying organisms based on their nutrition

Slime moulds (*Acrasiomycota*) are protoctists. They feed on decaying organic matter, bacteria and protozoa. Which of the terms describes their nutrition?

I. Detritivore
II. Autotroph
III. Heterotroph

A. I only

B. I and II only

C. I and III only

D. I, II and III

The scarlet cup fungus (*Sarcoscypha coccinea*) obtains its nutrition from decaying wood by releasing digestive enzymes into the wood and absorbing the digested products. Which of the following terms describe(s) the fungus?

I. Autotroph
II. Heterotroph
III. Saprotroph

A. III only

B. II and III only

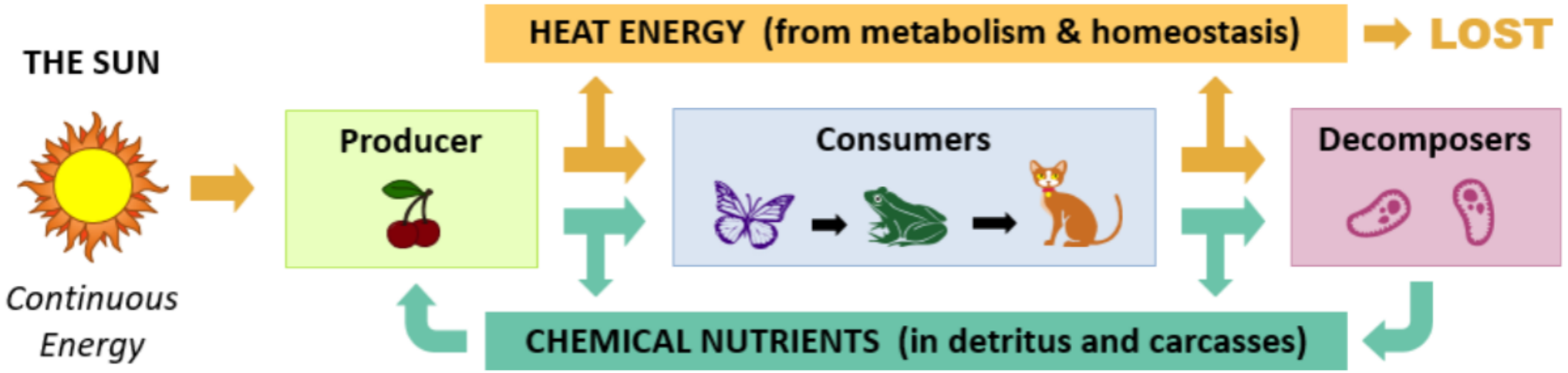
C. I and III only

D. I, II and III

CLOSED ECOSYSTEMS

There are two main conditions required for the sustainability of an ecosystem:

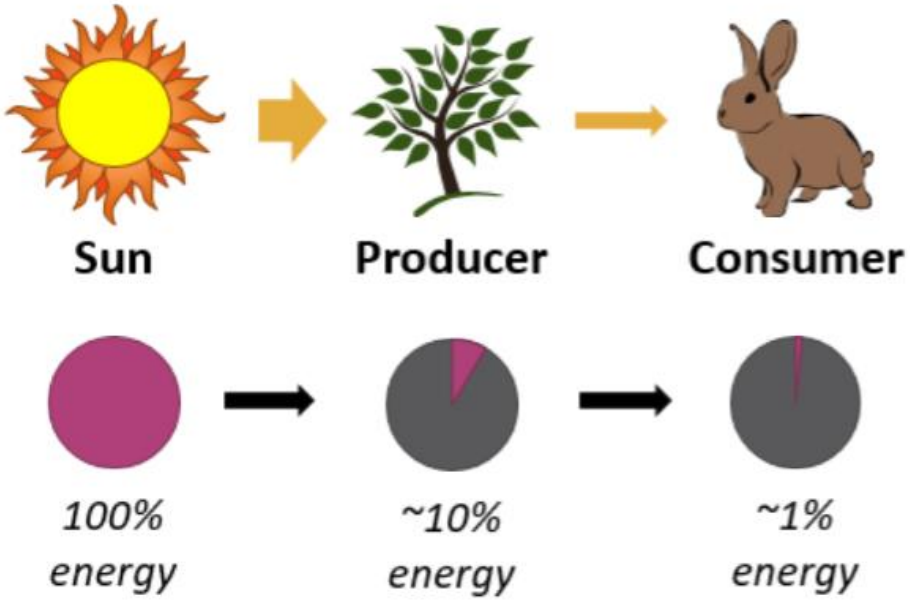
- *Energy influx* – sunlight provides an initial energy source for most communities
- *Nutrient cycling* – saprotrophic decomposers recycle nutrients in ecosystems



ECOLOGICAL SUSTAINABILITY

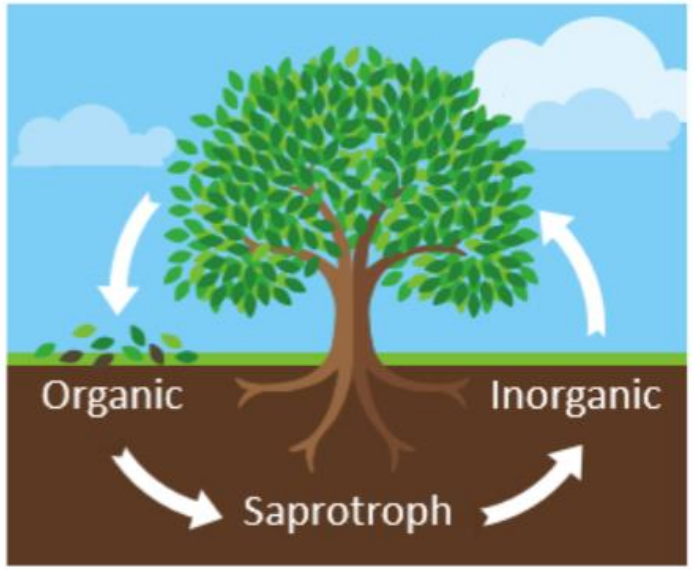
Energy is **lost** from ecosystems *(heat)*

and must be continuously replaced



Nutrients are continuously **recycled**

by decomposers *(organic → inorganic)*



MESOCOSMS

Mesocosms are enclosed environments that allow a small part of a natural environment to be observed under controlled conditions (e.g. sealed terrariums)

Mesocosms are set up in transparent containers

- This allows the light to enter and the heat to exit

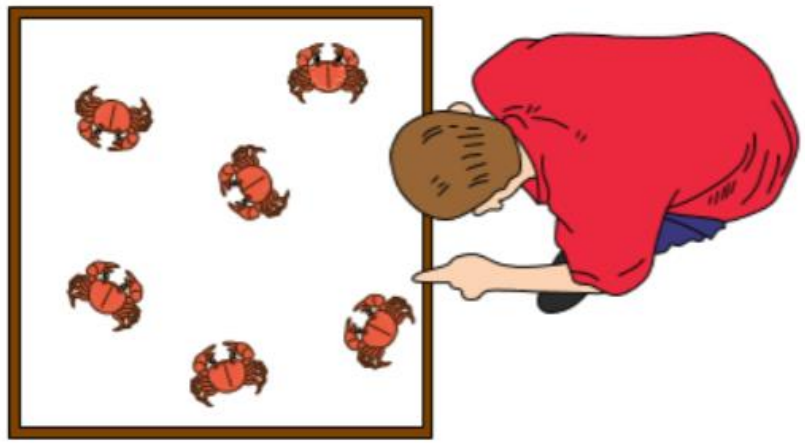
Aquatic systems are typically more successful

- Drainage not an issue and have better aeration

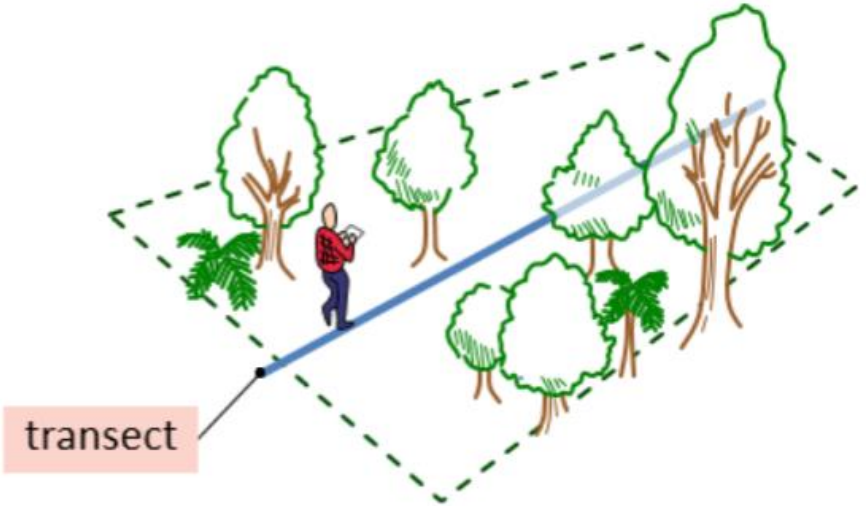
ECOLOGICAL MEASUREMENTS

Biotic conditions (e.g. species distribution) in open ecosystems can be measured:

Quadrats are rectangular frames of known dimensions *(used for sampling)*



Transects are straight lines along a defined abiotic gradient *(elevation)*



CHI SQUARED TEST

The presence or absence of two species of scallop was recorded in fifty quadrats ($1m^2$) on a rocky sea shore

The following distribution pattern was observed:

- 6 quadrats = both species
- 15 quadrats = king scallop only
- 20 quadrats = queen scallop only
- 9 quadrats = neither species

DATA

		Queen Scallop (*A. opercularis*)		
		Present	Absent	**Total**
King Scallop (*P. maximus*)	Present			
	Absent			
	Total			

1) IDENTIFY HYPOTHESIS

- *Null hypothesis (**H_0**)*: There is **no** significant difference between the distribution of two species (i.e. distribution is random)

- *Alternative hypothesis (**H_1**)*: There **is** a significant difference between the distribution of species (i.e. species are associated)

2) CONSTRUCT TABLE OF FREQUENCIES

Expected frequencies are calculated according to the following formula:

- *Expected frequency = (Row total × Column total) ÷ Grand total*

2) CONSTRUCT TABLE OF FREQUENCIES

		Queen Scallop (*A. opercularis*) 		
		Present	Absent	**Total**
King Scallop (*P. maximus*) 	Present			
	Absent			
	Total			

3) APPLY THE CHI-SQUARED FORMULA

The formula used to calculate a statistical value for the chi-squared test is as follows:

$$\chi^2 = \sum \frac{(O - E)^2}{E}$$

Where: $\sum$ = Sum ; O = Observed frequency ; E = Expected frequency

These calculations can be broken down for each part of the distribution pattern to make the final summation easier

3) APPLY THE CHI-SQUARED FORMULA

			Queen Scallop (*A. opercularis*)	
			Present	Absent
King Scallop (*P. maximus*)	Present	O		
		E		
		$\frac{(O-E)^2}{E}$		
	Absent	O		
		E		
		$\frac{(O-E)^2}{E}$		

4) DETERMINE THE DEGREE OF FREEDOM

In order to determine if the chi-squared value is statistically significant a degree of freedom must first be identified

The degree of freedom is a mathematical restriction that designates what range of values fall within each significance level

The degree of freedom is calculated from the table of frequencies according to the following formula:

$df = (m - 1)(n - 1)$

Where: m = number of rows ; n = number of columns

When the distribution patterns for two species are being compared, the degree of freedom should always be 1

5) IDENTIFY P VALUE

apply the value generated to a chi-squared distribution table → determine if results are statistically significant

- significant = less than a 5% probability ($p < 0.05$) the results are attributable to chance

df	p values for Chi-Square (χ^2) distribution							
	0.90	0.75	0.50	0.25	0.10	0.05	0.025	0.01
1	0.016	0.102	0.455	1.320	2.706	3.841	5.024	6.635

statistically significant

When df = 1, a value of greater than 3.841 is required for results to be considered statistically significant ($p < 0.05$)

RESULTS

A value of 7.90 = above a p value of 0.01→ less than a 1% probability results are caused by chance

→ difference between observed and expected frequencies are statistically significant

→ null hypothesis is rejected and the alternate hypothesis accepted:

Alternate hypothesis (H1): There is a significant difference between observed and expected frequencies

Because the two species do not tend to be present in the same area, we can infer there is a negative association between them

PRACTICE QUESTION

Two species of fir tree are found along the coast of Southern California.
These two tree species are the Grand Fir (Abies grandis) and the Noble Fir (Abies procera).
Their distribution patterns were establsihed via 150 quadrat samples, yielding the following results:

25 = both present ; 30 = Noble Fir only ; 45 = Grand Fir only ; 50 neither present

Activity: *Use the chi-squared test to determine if these two plant species show association.*