

Populations and communities Define population (IB wording).	Populations and communities How is one population of a species distinguished from another?
Populations and communities What is sampling error?	Populations and communities What does a large standard deviation of quadrat counts indicate?
Populations and communities Lincoln index: what do M, N and R stand for?	Populations and communities Give three assumptions of the Lincoln index.
Populations and communities Which organisms suit capture-mark-release-recapture?	Populations and communities Define carrying capacity.

By reproductive isolation: members of one population rarely or never breed with members of the other.

An interacting group of organisms of the same species living in an area. Members normally breed with each other.

Wide variation between quadrats: the population is spread unevenly (clumped).

The difference between the estimate of population size from a random sample and the true size of the whole population.

Marks are not lost and do not harm or change behaviour; marked animals mix randomly; no significant births, deaths or migration between samples.

M = number caught and marked first; N = total caught in the second sample; R = number of marked individuals recaptured.
Estimate = $(M \times N) \div R$.

The maximum population size of a species that an environment can support.

Motile animals, which move in and out of quadrats, such as beetles, snails and small mammals.

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Name three density-dependent factors.

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How do density-dependent factors control population size?

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Why does a population grow exponentially at first?

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How do you test growth against an exponential model?

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Name the phases of a sigmoid growth curve (IB).

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Which organisms are recommended to model sigmoid growth?

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Give an example of intraspecific cooperation.

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Define community.

By negative feedback: their effect grows with density, raising death rate or lowering birth rate, pushing numbers back towards carrying capacity.

Competition for limited resources, increased risk of predation, and the transfer of pathogens or pests in dense populations.

Plot population size on a logarithmic y-axis against time on a linear x-axis: exponential growth gives a straight line.

Abundant resources, little competition, few predators or pathogens, so birth rate far exceeds death rate.

Yeast (cell counts or turbidity) and duckweed (frond counts).

Exponential phase, transitional phase, plateau phase at the carrying capacity. No lag phase is expected.

All of the interacting organisms in an ecosystem: all the populations in an area, including plants, animals, fungi and bacteria.

Grey wolves hunting in packs; meerkats acting as sentinels; emperor penguins huddling for warmth.

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Name the six categories of interspecific relationship.

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Define mutualism.

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Root nodules in Fabaceae: benefit to each partner?

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Mycorrhizae in Orchidaceae: benefit to each partner?

Populations and communities

Zooxanthellae in hard corals: benefit to each partner?

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Why does an introduced species become invasive?

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Name three approaches to testing for interspecific competition.

Populations and communities

Why does better success without a second species not prove competition?

An interspecific relationship that benefits both species.

Herbivory, predation, interspecific competition, mutualism, parasitism and pathogenicity.

Orchid: sugars and mineral ions from the fungus, essential for seedlings. Fungus: carbon compounds (sugars) from the adult orchid once it photosynthesises.

Plant: fixed nitrogen (ammonium) from *Rhizobium*. Bacteria: sugars from photosynthesis and a protected site in the nodule.

It has a competitive advantage over endemic species in resource acquisition, often lacking its natural predators and pathogens, so it spreads.

Coral: sugars and oxygen from photosynthesis. Zooxanthellae: CO₂, ammonia and a protected, well-lit position.

Other factors could explain the difference; competition is indicated but not proven.

Laboratory experiments, field observations by random sampling, and field manipulation by removal of one species.

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Chi-squared for two species: how is an expected value calculated?

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Name a real predator-prey case study.

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Distinguish top-down and bottom-up control.

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Give an example of top-down control.

Populations and communities

What is allelopathy?

Populations and communities

Give an example of antibiotic secretion.

Transfers of energy and matter

Distinguish open and closed systems.

Transfers of energy and matter

Give two ecosystems not sustained by sunlight.

Canada lynx and snowshoe hare: Hudson's Bay Company fur records show roughly 10-year cycles, with lynx peaks after hare peaks.

Expected = (row total × column total) ÷ grand total. Degrees of freedom = 1; critical value at $p = 0.05$ is 3.84.

Sea otters eat sea urchins; without otters, urchins increase and destroy kelp forests.

Top-down: limited by consumers at the level above (predators). Bottom-up: limited by resources from below (nutrients, producers).

Penicillium secretes penicillin, which inhibits bacterial cell wall synthesis, deterring competing bacteria.

Release by a plant of chemicals that inhibit germination or growth of nearby plants, e.g. juglone from black walnut.

Caves (e.g. Movile Cave) and deep-ocean hydrothermal vents below light penetration, sustained by chemoautotrophs.

Open: energy and matter can enter and exit (ecosystems). Closed: only energy can pass in and out.

Transfers of energy and matter

How is a scientific law different from a theory?

Transfers of energy and matter

What do arrows in a food chain show?

Transfers of energy and matter

Where do decomposers get their energy?

Transfers of energy and matter

How does chemical energy pass along a food chain?

Transfers of energy and matter

Define autotroph (IB wording).

Transfers of energy and matter

Name an example of a chemoautotroph and its energy source.

Transfers of energy and matter

Define heterotroph (IB wording).

Transfers of energy and matter

How do both autotrophs and heterotrophs release energy?

The direction of transfer of energy and biomass, from the organism eaten to the organism that eats it.

A law is a generalised principle describing a pattern and allowing predictions; it does not explain it, unlike a theory.

A consumer feeds on the organism at the previous stage, taking in its carbon compounds and the chemical energy in them.

From carbon compounds in dead organic matter: faeces, dead parts of organisms and dead whole organisms.

Iron-oxidising bacteria: energy from oxidising iron(II) ions (Fe^{2+}) to iron(III) ions (Fe^{3+}).

An organism that uses an external energy source to synthesise carbon compounds from simple inorganic substances.

By oxidation of carbon compounds in cell respiration.

An organism that uses carbon compounds obtained from other organisms to synthesise the carbon compounds that it requires.

Transfers of energy and matter

Name the trophic levels in order.

Transfers of energy and matter

What are the units on an energy pyramid?

Transfers of energy and matter

Can one organism occupy more than one trophic level?

Transfers of energy and matter

Give three causes of energy loss between trophic levels.

Transfers of energy and matter

When is heat produced in cells?

Transfers of energy and matter

Why are there few trophic levels?

Transfers of energy and matter

Define primary production and give its units.

Transfers of energy and matter

Why is secondary production lower than primary production?

Energy per unit area per unit time, e.g. $\text{kJ m}^{-2} \text{yr}^{-1}$.

Producer, primary consumer, secondary consumer, tertiary consumer.

Not all organisms or parts are eaten; not all food is digested (faeces); energy converted to heat in respiration.

Yes: many organisms have a varied diet and occupy different trophic levels in different food chains.

Large energy losses at each transfer leave too little energy to support a further level; biomass falls, energy per gram does not.

Both when ATP is produced in cell respiration and when ATP is used, because energy transfers are not 100% efficient.

Carbon compounds are converted to CO_2 and water in cell respiration, so biomass is lost before it reaches heterotrophs.

Accumulation of carbon compounds in biomass by autotrophs; $\text{g m}^{-2} \text{yr}^{-1}$ (mass of carbon per area per time).

Transfers of energy and matter

Which three processes recycle carbon in a carbon cycle diagram?

Transfers of energy and matter

When is an ecosystem a carbon sink?

Transfers of energy and matter

Name the carbon stores whose combustion releases CO₂.

Transfers of energy and matter

Explain the annual fluctuation in the Keeling Curve.

Transfers of energy and matter

What causes the long-term rise in the Keeling Curve?

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How do photosynthesis and aerobic respiration depend on each other?

Transfers of energy and matter

Which elements are recycled in ecosystems?

When photosynthesis exceeds respiration, giving a net uptake of CO₂.

Photosynthesis, feeding and respiration (plus combustion).

CO₂ falls in the northern summer (photosynthesis > respiration) and rises in winter (respiration > photosynthesis).

Biomass, peat, coal, oil and natural gas.

Respiration uses O₂ produced by photosynthesis; photosynthesis uses CO₂ produced by respiration.

Combustion of fossil fuels (and deforestation), releasing CO₂ faster than it is removed.

All elements required by living organisms, not just carbon; decomposers play a key role.