Ecological niches

B4.2 · SL and HL

The same tree can support different ecological roles

B4.2: full shared content for SL and HL

Two birds may use different prey, branch positions or feeding times in one habitat. Explain resources, conditions and interactions.

Cover nutrition, oxygen requirements, dentition, herbivory, predation, forest light strategies and competitive niche models.

Numerical examples are invented teaching models; observations alone need not establish causation.

A place, a feeding position and a role differ

Concept	Meaning and evidence
Habitat	The place occupied
Trophic level	A feeding position; only one aspect of a niche
Ecological niche	Resource use, conditions and interactions affecting growth, survival and reproduction
Resource partitioning	Different use can reduce overlap, but does not alone prove competition caused it

Measure relevant dimensions instead of assigning a food label

Niches can vary with season and life stage

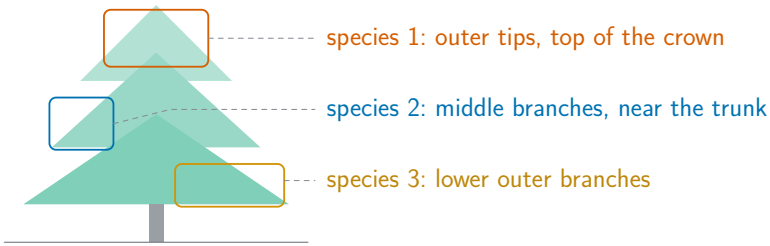
For a bird, compare prey size, feeding time, branch height, nesting sites and temperature tolerance.

For a plant, investigate light, water/mineral use, pollination, competitors and herbivores.

Preferences, resource availability and interactions can explain observed differences.

At several permitted sites, record species identity and confidence, resource category, time, abiotic conditions and observation effort. Select sites without favouring expected results; use non-destructive observations.

Sharing a tree



invented observations: different use can reduce overlap, but does not prove competition caused it

> Different zones reduce competition

Classify oxygen dependence under suitable matched conditions

Category	Growth model
Obligate aerobe	Oxygen needed for sustained growth
Facultative anaerobe	Growth possible with or without oxygen, using suitable pathways
Obligate anaerobe	Growth without oxygen; sufficiently oxygenated conditions inhibit growth
Limit	Neither instant death of every cell nor carbon source follows from the category alone

Use both treatments and check other requirements

1. **Invented growth increases, with/without oxygen.** X = 80/0; Y = 90/35; Z = 0/70.
2. **Interpret.** X fits obligate aerobe; Y facultative anaerobe; Z obligate anaerobe.
3. **Controls.** Match nutrients, starting cells, temperature and time; verify oxygen. A negative treatment can reflect another unmet requirement. Anaerobic respiration and fermentation are different possibilities.

Follow energy and carbon separately

Light energy does not supply sugar atoms

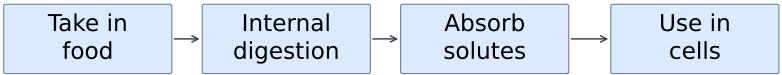
Photosynthetic plants, algae and groups such as cyanobacteria use light energy to support organic synthesis from carbon dioxide.

Water and minerals are essential inputs, but soil minerals are not the main source of organic food carbon.

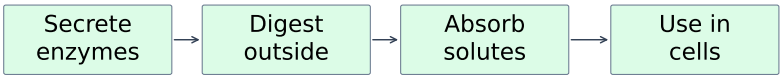
Photosynthetic organisms also respire. Darkness does not stop all metabolism; green colour alone does not reveal every nutritional pathway.

Find where digestion acts before products are absorbed

Animal: holozoic



Decomposer: saprotrophic



Holozoic feeding ingests before internal digestion; saprotrophs secrete enzymes before external digestion.

Distinguish the processes in an animal pathway

Process	Meaning
Ingestion and digestion	Food enters; large molecules are broken into absorbable products
Absorption	Products cross into internal tissues/transport
Assimilation	Absorbed material is used in metabolism and structures
Egestion / excretion	Unabsorbed food leaves / metabolic waste leaves

A partial matter budget is not a growth measurement

1. **Invented input and losses.** 100 organic-food units; 25 egested; five absorbed units later leave as specified metabolic waste.
2. **Balance.** Absorbed = 75. Remaining after that waste = 70.
3. **Limit.** Respiration, maintenance and other transfers still matter. Do not call every remaining unit new biomass or mix matter and energy terms indiscriminately.

Saprotrophs absorb products after extracellular digestion

Not every fungus or bacterium is a decomposer

Saprotrophic fungi/bacteria secrete enzymes onto dead organic material; soluble products cross cell surfaces.

A hypha need not ingest a whole leaf. Decomposition contributes to nutrient cycling.

All animals are heterotrophic, but animal feeding mechanisms and digestive systems are diverse.

Euglena gracilis can use photosynthesis and dissolved organics

Heterotrophy need not mean engulfing visible prey

Chloroplasts permit photosynthesis; appropriate organic substrates can be taken up under suitable conditions.

Facultative mixotrophs can change reliance on modes. Obligate mixotrophs need contributions from both under the conditions defining dependence.

Neither indefinite growth in darkness nor a fixed 50:50 carbon split follows for every mixotroph.

A factorial design tests separate and combined contributions

1. **Invented matched increases.** Light/no added organic = 20; dark/organic = 15; light/organic = 32; dark/no organic = 0.
2. **Interpret.** Growth in both single-source conditions supports flexibility when other requirements and viability are controlled.
3. **Limit.** The combined response need not equal 20 + 15: resources and processes interact. Green colour alone is not the experiment.

Do not identify carbon source from energy alone

Invented organism	Energy and carbon pathways
A	Light supplies energy; organic compounds supply carbon: heterotrophic
B	Inorganic oxidation supplies energy; carbon dioxide supplies carbon: autotrophic in the model
C	Organic oxidation supplies energy and organic compounds supply carbon: heterotrophic
Domain diversity	Archaea are distinct from Bacteria/Eukaryota; not all are extreme-habitat organisms or one nutritional type

Compare the whole dentition and its preservation

Hominidae includes humans and extinct relatives

Human incisors bite; canines contribute tearing; premolars/molars crush and grind varied foods. Shape, area, relief and enamel indicate processing capability.

The Smithsonian SK 46 account describes large cheek teeth relative to front-tooth sockets in Paranthropus robustus, supporting substantial plant processing.

A missing tooth is different from a preserved socket. Capability does not specify every meal or prove exclusive herbivory.

A tooth-area ratio does not equal a diet ratio

1. **Invented planar areas.** Model 1: cheek 120, front 30 square millimetres. Model 2: cheek 90, front 45.
2. **Ratios.** $120/30 = 4$; $90/45 = 2$.
3. **Evaluate.** These are area ratios, not plant:meat ratios. Match scale, age and preservation; combine anatomy with wear, isotopes and ecology. Large canines can also serve display or defence.

Connect mouthparts and defences to the feeding mechanism

Feature	Mechanism or limit
Grasshopper mandibles	Cut/crush plant tissue
Aphid stylets	Pierce tissue and withdraw fluid, including phloem sap
Plant physical/chemical defence	Thorns, toughness or hairs resist access; secondary compounds can deter or harm
Herbivore detoxification	Some pathways handle particular compounds, with limits and resource costs

A percentage-point difference is not a relative decrease

1. **Invented supplied comparison.** Mean leaf area lost: 8% with tested compound versus 20% comparison.
2. **Calculate.** Difference 12 percentage points; relative reduction $= 12/20 \times 100 = 60\%$.
3. **Controls.** Leaf age/toughness, exposure and other chemistry must match to isolate the compound. Comparing naturally different species does not isolate one mechanism.

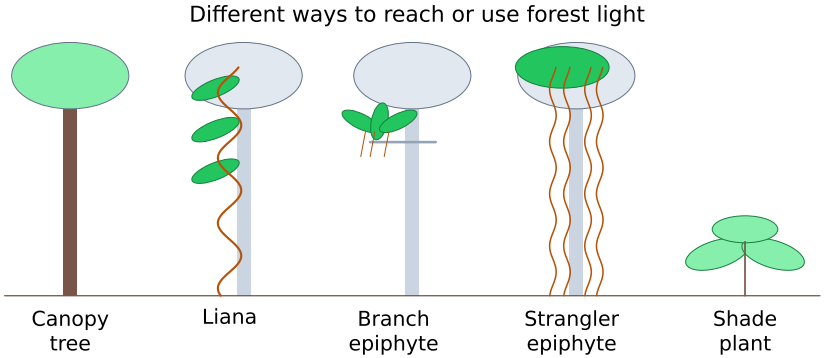
Associate adaptations with a stage and an opposing challenge

Category	Examples and explanation
Physical	Sensory organs find prey; claws/jaws/webs capture; armour or concealment can resist
Chemical	Venom can overcome prey; deterrent substances can reduce attacks
Behavioural	Stalking/ambush or pursuit; prey vigilance, escape or group responses
Trade-offs	Success is probabilistic; vigilance can reduce feeding time and one sensory defence may fail against another predator

Conditional success needs the correct denominator

1. **Invented 100 encounters.** 60 detections; 30 captures; 24 successful kills.
2. **Stage comparisons.** Detection 60%; capture given detection $30/60 = 50\%$; killing given capture $24/30 = 80\%$.
3. **Overall.** $24/100 = 24\%$. Conditional 80% is not overall success.

Compare support, roots and leaf position



The five growth forms are contrasting strategies, not successive stages of one life cycle.

Compare ways to position foliage

Growth form	Mechanism and resource pathway
Canopy tree	Invests in a supporting trunk to raise a crown
Liana	Climbs existing support while retaining its own soil connection
Branch epiphyte	Uses a host as support but obtains its own water/nutrients
Strangler epiphyte	Establishes on a host, sends roots toward ground and can compete as it grows

Shade tolerance is a physiological strategy, not no light

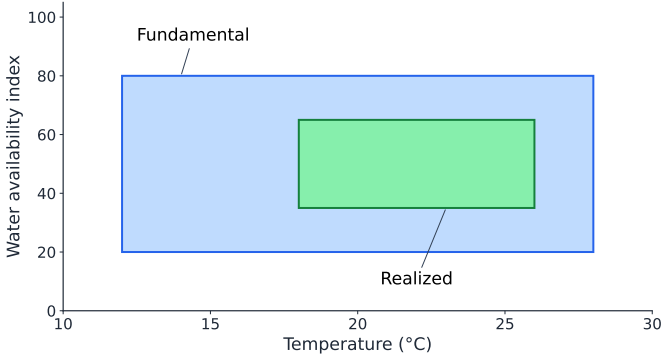
A forest-floor plant still needs an energy supply

Shade plants can persist with low light through suitable photosynthetic/respiratory characteristics and leaf form.

Broad leaves intercept light but also cost resources and lose water; physiology and architecture matter together.

Support alone is not proof of parasitism. Not every epiphyte is a strangler, and not every forest plant must reach the canopy.

Read the inner region as a competition-focused model



Competition can restrict realized use within a potential region; other interactions and history also matter.

Remove restrictive competition without removing essential partners

Potential persistence is defined by the model's assumptions

A fundamental niche describes potential persistence based on tolerances and resources under stated conditions. It does not remove necessary food or partners.

Realized niche describes actual extent of use under interactions. Competition can exclude or restrict use of otherwise suitable conditions.

Facilitation, dispersal, disturbance, history and detection affect field occupancy too. One smaller-region diagram is not a universal proof that all interactions harm the species.

Test a competitive effect with a matched comparison

Use supplied models or approved non-destructive evidence

Compare focal resource use with/without a competitor while matching abiotic conditions and resources.

Expanded use when competition is reduced supports a restriction effect; indirect changes and time still matter.

Replicate and consider alternative explanations. Do not introduce competitors or remove native species simply to demonstrate a model.

Unequal populations do not yet prove permanent exclusion

A conditional model predicts an outcome over time

Under stable, uniform, closed, resource-limited conditions, sufficiently complete competitors may prevent one population maintaining itself.

Competition can also restrict both realized niches; resource differences and changing conditions can permit coexistence.

Finite unequal counts are insufficient to distinguish eventual exclusion, stable coexistence and transient dynamics.

Observed overlap is not a competition coefficient

1. **Invented feeding counts.** A: 18, 9, 3; B: 3, 9, 18; each total 30.
2. **Proportions.** A = 60/30/10%; B = 10/30/60%. All three categories are shared.
3. **Defined comparison only.** Sum of smaller category proportions = 10 + 30 + 10 = 50%. This describes observed overlap, not causal competitive intensity.

One category cannot identify the narrower-niche specialist

Require whole distributions and meaningful sampling coverage

$14/35 = 40\%$; $5/50 = 10\%$. The comparison concerns one specified category.

Other categories, resource availability and niche dimensions are unknown; overall specialization cannot be ranked from this alone.

Keep the mode, mechanism, denominator and evidence level explicit.

Attempt all thirteen handout questions before checking

Explain pathways and evaluate inference

Classify oxygen requirements and nutritional modes; distinguish energy/carbon, internal/external digestion and mixotrophic flexibility.

Interpret tooth ratios, plant defences, conditional predation success and forest light strategies.

Evaluate competitive niche models and feeding-overlap data without inferring causes or breadth from one category.

Check the numerical comparisons

1. **Matter and teeth.** $120 - 30 = 90$ absorbed; $90 - 6 = 84$ after specified waste, not all new biomass. Tooth-area ratios: $150/30 = 5$ and $100/50 = 2$, not diet fractions.
2. **Leaves and encounters.** $15\% \to 6\%$ loss: nine points, 60% relative reduction. Detection 50%; capture given detection 40%; killing given capture 75%; overall 15%.
3. **Feeding.** C 40/20/40%; D 10/30/60%; defined overlap $10 + 20 + 40 = 70\%$. This is not competition intensity or proof of which species is the specialist.

Check yourself

Keep the model's conditions with the conclusion

Identify the process before naming a nutritional mode. Carbon, energy and oxygen are separate classifications.

A dietary capability is not an exact meal; a field absence is not an exact tolerance boundary.

Require time, replication and alternative explanations before turning overlap or unequal numbers into a competitive-exclusion claim.