DP Biology – B4.2

Ecological niches

- Why does it help organisms to have specialized ways of feeding?
- How do a species' adaptations relate to its role in an ecosystem?

SL statements B4.2.1–13. Textbook pp. 363–379.
Image: a mossy leaf-tailed gecko, camouflaged. Charles J. Sharp, CC BY-SA 4.0.



Objectives for each class

Class	Statements	By the end of the class, you can...
1	B4.2.1–3	Define a niche, compare the oxygen needs of organisms, and identify photosynthetic groups
2	B4.2.4–7	Compare holozoic, mixotrophic and saprotrophic nutrition, and describe the diversity of archaea
3	B4.2.8–9	Use teeth to infer the diet of hominids, and explain adaptations of herbivores and plants
4	B4.2.10–11	Explain adaptations of predators and prey, and how plants in forests reach light
5	B4.2.12–13	Distinguish fundamental and realized niches, and explain competitive exclusion

What is a niche?

B4.2.1

- A **niche** is the role a species plays in its ecosystem
- It includes **biotic** and **abiotic** interactions that influence growth, survival and reproduction
- It also includes how the species obtains food

Key idea

A habitat is where a species lives. A niche is how it lives: what it eats, what eats it, when it is active, and which conditions it can tolerate.

Discussion

Describe the niche of an organism you know well. Include what it feeds on, what feeds on it, and an abiotic condition that limits it.

Oxygen and three groups of organisms

B4.2.2

Group	Relationship with oxygen	Example
Obligate aerobe	Needs oxygen to survive	Humans, most plants and animals
Facultative anaerobe	Grows with oxygen, and can survive without it	Yeast, E. coli
Obligate anaerobe	Cannot tolerate oxygen	Clostridium tetani

Key idea

Tolerance of oxygen is part of a niche. An obligate anaerobe can live only where there is no oxygen, such as deep in soil, in sediments or in a wound. This is why deep puncture wounds carry a risk of tetanus.

Modes of nutrition

B4.2.3–6

Mode	How carbon compounds are obtained	Examples
Photosynthetic	Made using light energy, from carbon dioxide and water	Plants, algae, cyanobacteria
Holozoic	Food is ingested, digested inside, absorbed and assimilated	Most animals
Mixotrophic	Both photosynthesis and feeding	Euglena
Saprotrophic	Enzymes secreted onto dead matter, then products absorbed	Many fungi and bacteria

Common mistake

Fungi are not plants, and they do not photosynthesize. All animals are heterotrophs, although not all feed in the holozoic way: some, such as parasites, absorb their food.

Photosynthetic and holozoic nutrition

B4.2.3–4

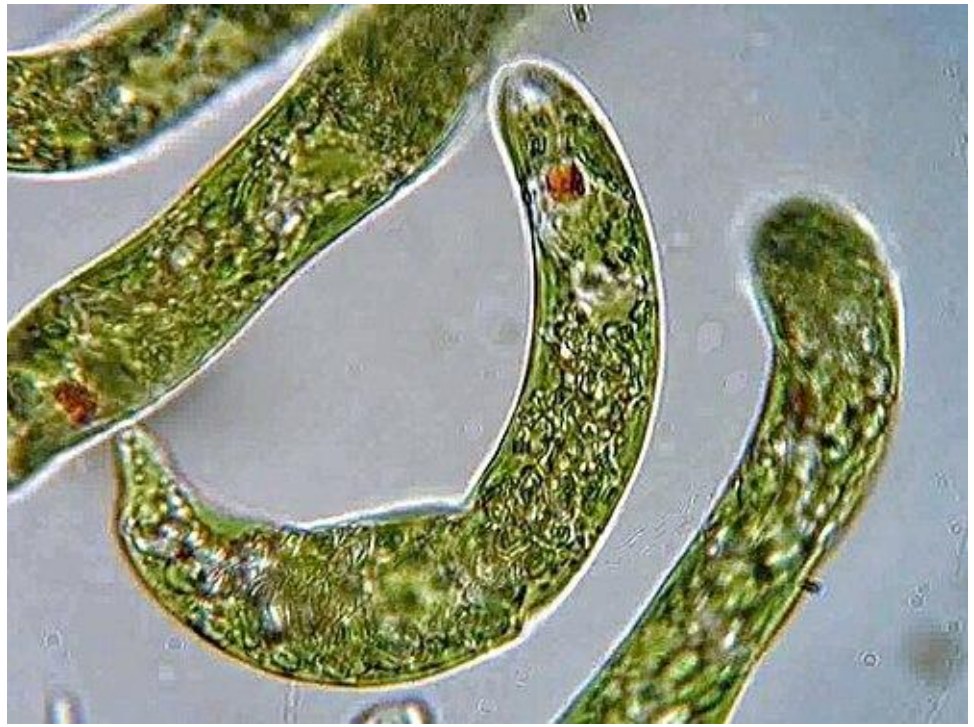
- **Photosynthesis** occurs in plants, eukaryotic algae and several groups of prokaryotes, including cyanobacteria
- Algae such as kelp are not plants, but they make their food in the same way

Stage in holozoic nutrition	What happens
Ingestion	Food is taken in
Digestion	Large molecules are broken down inside the gut
Absorption	Small molecules pass through the gut wall into the blood
Assimilation	Molecules are used to build the organism's own tissues

Single-celled organisms such as Amoeba take in food by endocytosis, and digest it in vacuoles.

Mixotrophic nutrition

B4.2.5



Euglena. Deuterostome, CC BY-SA 3.0.

- A **mixotroph** can both photosynthesize and feed
- **Euglena** photosynthesizes in light, and it can also feed on particles
- Many mixotrophs are also found in ocean plankton

Type	Meaning
Facultative	Can use either mode, or both
Obligate	Must use both modes to survive

Discussion

What advantage does a mixotroph have in a dim pond that has plenty of bacteria? What might it lose compared with a specialist?

Saprotrophic nutrition

B4.2.6



Fungi on wood. Bernard Spragg, public domain.

- Saprotrophs feed on dead organic matter
- They **secrete enzymes** onto their food
- Digestion takes place **outside** their cells
- They then absorb the products
- They are also called **decomposers**, and they release elements back into ecosystems

Key idea

Without decomposers, dead matter would build up and elements would not be recycled (C4.2).

Diversity of nutrition in archaea

B4.2.7



Grand Prismatic Spring. Jim Peaco, NPS, public domain.

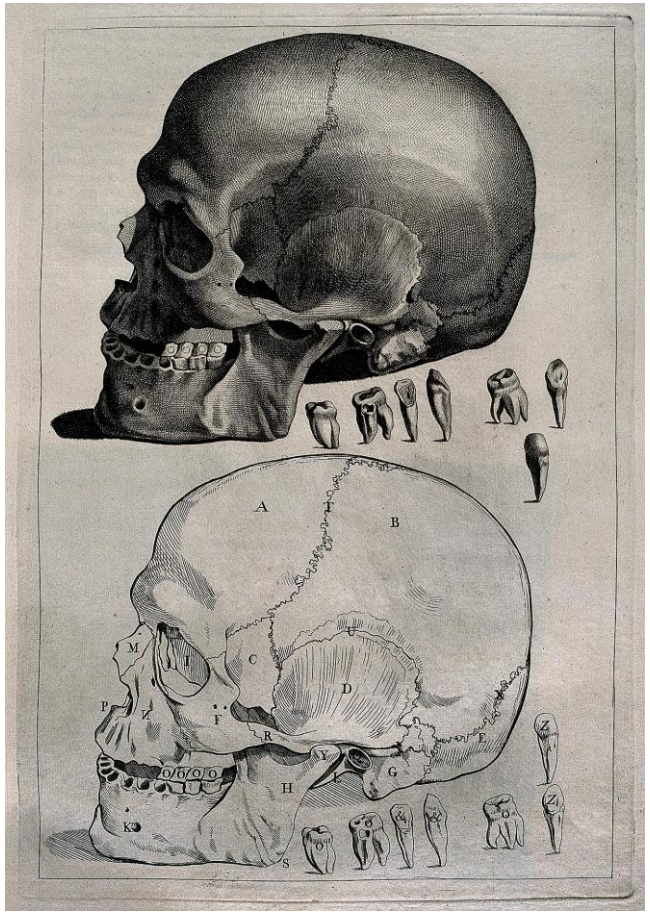
- Archaea are one of the **three domains**, along with bacteria and eukaryotes
- Many live in extreme conditions

Nutrition	How
Photosynthetic	Use light, often with pigments other than chlorophyll
Chemosynthetic	Use energy from oxidizing inorganic chemicals
Heterotrophic	Feed on carbon compounds from other organisms

Common mistake

Archaea are not a type of bacteria. They are unicellular and have no nucleus, as bacteria do, but they form a separate domain.

Teeth and diet in the Hominidae



Human skull. Wellcome, CC BY 4.0.

Species	Teeth	Likely diet
Homo sapiens	Small teeth, incisors and canines	Omnivore
Homo floresiensis	Large premolars, strong jaw, smaller molars	Mainly tough plants, some meat
Paranthropus robustus	Very large, flat molars; strong jaw	Tough plants

Practice

Examine 3D models or a digital collection of skulls. Infer diet from the teeth. What can digital models show well, and what do they miss?

Herbivores: adaptations for feeding on plants

B4.2.9



Monarch caterpillar. Public domain.

- Insects with biting and chewing mouthparts, such as caterpillars, eat leaf tissue
- Insects with piercing mouthparts, such as aphids, feed on phloem sap
- Ruminants have broad, flat teeth and microbes in their gut to digest cellulose

Example: aphids

An aphid pushes a long, thin stylet into a stem. It secretes the enzyme pectinase, which breaks down pectin between cell walls, and reaches phloem. Sap under pressure then flows into the aphid.

Plants: resisting herbivores

B4.2.9



Foxglove. Public domain.



Castor bean plant. Public domain.

- **Physical**: spines and stinging hairs
- **Chemical**: toxic secondary compounds in seeds and leaves
- Foxglove makes heart-affecting toxins, and castor bean seeds contain ricin

An arms race

Some herbivores have evolved ways of detoxifying these toxins, such as enzymes or gut microbes. Plants and herbivores therefore evolve in response to each other.

Predators and prey

B4.2.10



Wolf. NPS, public domain.



Leaf-tailed gecko. C. J. Sharp, CC BY-SA 4.0.

Type	Predators	Prey
Physical	Sharp teeth and claws, keen senses	Camouflage, shells, spines
Chemical	Venom	Toxins, bad taste, warning colours
Behavioural	Hunting in groups, ambushing	Living in groups, alarm calls, hiding

Activity

For any predator and prey in your local area, suggest one chemical, one physical and one behavioural adaptation. Explain how each one would raise survival.

Reaching light in a forest

B4.2.11



Monkey ladder vine. Gh5046, public domain.



Epiphytes on a tree. James St. John, CC BY 2.0.

Plant form	How it reaches or uses light
Canopy trees	Grow a long, strong trunk to reach full light
Lianas	Root in the ground and climb up trees
Epiphytes	Grow on branches, without touching the soil
Strangler figs	Start high on a tree, then send roots down
Shade plants	Survive in low light on the forest floor

These strategies produce layers in a forest: this answers the second guiding question.

Fundamental and realized niches

B4.2.12

Niche	Meaning
Fundamental	The potential of a species, based on its adaptations and tolerance limits
Realized	The actual extent of a species, when competing with others

Example: barnacles

One barnacle species could live on both the upper and lower parts of a rocky shore. This is its fundamental niche. In practice, a stronger competitor excludes it from the lower shore, so it is found only on the upper shore. This is its realized niche. Removing the competitor lets it spread lower down.

Competitive exclusion



Red squirrel. Jojo, CC BY-SA 3.0.



Grey squirrel. PierreSelim, CC BY 3.0.

- No two species in one area can occupy the same niche for long
- One outcome: one species eliminates the other
- Other outcome: both are restricted to part of their fundamental niche

Example: squirrels

Grey squirrels were brought to Britain from North America. They have largely replaced the native red squirrel, except in some northern areas and in forests where they do less well.

Example: Paramecium

Grown alone, two Paramecium species both thrive. Grown together in a flask, one of them dies out. Sketch what the two graphs of numbers would look like.

Check that you can explain

1. What a niche includes
2. Obligate and facultative groups
3. Modes of nutrition, with examples
4. Mixotrophs and saprotrophs
5. Why archaea have diverse nutrition
6. How teeth show diet
7. Herbivore adaptations and plant defences
8. Predator and prey adaptations
9. How forest plants reach light
10. Fundamental and realized niches
11. Competitive exclusion

Exit activity: 5 minutes

On your own and without notes. Hand this in as you leave.

1. State the difference between an obligate anaerobe and a facultative anaerobe.
2. Describe saprotrophic nutrition.
3. Distinguish between a fundamental and a realized niche.

Image credits

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