DP Biology – B4.1

Adaptation to environment

- How do a species' adaptations relate to its habitat?
- Why do ecosystems in the same land biome resemble each other?

SL statements B4.1.1–8. Textbook pp. 341–362.
Image: marram grass on a sand dune. W.carter, CC0.



Objectives for each class

Class	Statements	By the end of the class, you can...
1	B4.1.1–2	Describe a habitat, and explain how plants are adapted to sand dunes and mangrove swamps
2	B4.1.3–4	Explain how abiotic variables affect distribution, and use transect data to find a range of tolerance
3	B4.1.5–6	State the conditions needed for coral reefs, and use climate to explain where biomes occur
4	B4.1.7–8	Explain why biomes have similar communities, and describe adaptations to hot deserts and tropical rainforests

Habitat

B4.1.1

- A **habitat** is the place where an organism, population, species or community lives
- A description can include its geographical location, its physical location, and the type of ecosystem
- A **microhabitat** is a small, specific location within a habitat, such as under a rotting log

Example

The habitat of the African savanna elephant: grassland and open woodland in sub-Saharan Africa.

Activity

Write a short description of the habitat of a species you know, including where it lives geographically and physically, and the ecosystem type.

Adaptation to the abiotic environment

B4.1.2

Biotic factors	Abiotic factors
Living: predators, food, competitors, parasites	Non-living: temperature, water, light, pH, salinity

Key idea

An adaptation is a heritable trait that suits an organism to its environment. Each habitat has abiotic challenges. Consider what these are on sand dunes, in mangrove swamps or high in the mountains.

Alpine plants

Edelweiss and moss campion face strong UV, low temperature and shortage of water. White woolly hairs reflect radiation and trap warm air. Low, cushion-like growth reduces exposure to wind. How does each feature help the plant to survive?

Grass on sand dunes

B4.1.2



Marram grass. W.carter, CC0.

Feature	How it helps
Leaves that roll up	Trap moist air, so less water is lost
Stomata in pits	Reduce water loss by transpiration
Thick waxy cuticle	Reduces water loss
Deep and spreading rhizomes	Reach water and hold the sand
Solutes in cells	Help water uptake in salty conditions

The challenge

Sand holds little water, drains rapidly and contains few minerals. Salt spray makes it harder to take up water by osmosis, and strong wind increases water loss.

Trees in mangrove swamps

B4.1.2



Pneumatophores. Katja Schulz, CC BY 2.0.



Red mangrove roots. S. Hillebrand, USFWS, public domain.

Feature	How it helps
Pneumatophores	Roots that grow up into air, supplying oxygen to waterlogged roots
Stilt roots	Arching roots that support the tree in soft mud
Salt glands in leaves	Remove excess salt
Thick, waxy leaves	Reduce water loss

The challenge

Soil is waterlogged, anaerobic and salty, and the soft mud moves with the tide.

Abiotic variables and distribution

B4.1.3

Group	Abiotic variables affecting distribution
Plants	Temperature, water, light, soil pH, salinity, mineral nutrients
Animals	Temperature, water, breeding sites, food supply, territory

- Maps of where a species lives reflect these factors
- A species has adaptations that give it a **range of tolerance** for each variable

Key idea

Inside the range of tolerance, an organism can survive and reproduce. Towards each limit, it is under stress. Beyond the limits, it cannot survive.

Tolerating a limiting factor

B4.1.4

Zone	Lower limit	Optimum	Upper limit
Numbers present	None or few	Most	None or few
State of organisms	Stressed	Thriving	Stressed

Limiting factor

A limiting factor is the one that restricts the distribution or growth of a species. For a plant at the top of a shaded slope this might be light. For a plant on a salty shore it might be salinity. A species can have a wide range of tolerance for one factor, and a narrow range for another.

Using a transect

B4.1.4

1. Run a tape across a change in conditions, from open ground into shade
2. At regular intervals, place a quadrat and record species and their numbers
3. Measure the abiotic variable, such as light, with a sensor at each point
4. Plot both against distance to look for a **correlation**

Limit of the method

A correlation does not show that the variable causes the distribution. Another factor may change along the transect too.

Practical

Collect your own transect data at school, in a natural or semi-natural area. Identify a range of tolerance for one plant.

Conditions for coral reefs

B4.1.5



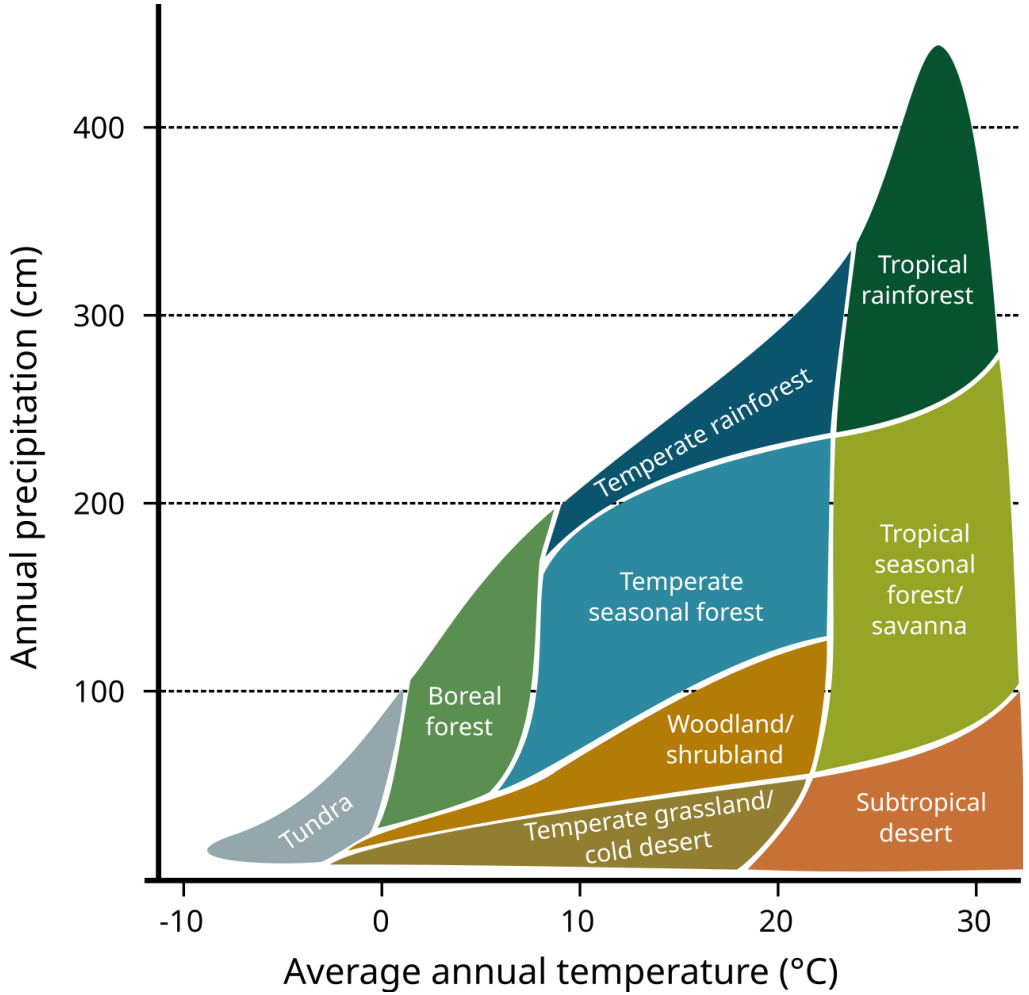
Coral reef. Jim Maragos, public domain.

Factor	Condition	Why
Depth	Shallow, mostly under 25 m	Light reaches algae
pH	Above 7.8	Allows calcium carbonate to form
Salinity	Around 35 parts per thousand	Avoids osmotic problems
Clarity	Clear water	Light can pass through
Temperature	About 23–29°C	Suits corals and algae

Key idea

Corals are animals that have a mutualistic relationship with algae, the zooxanthellae, living in their tissues. The algae photosynthesize, and so reef-building corals need the conditions under which they can do so.

Climate determines land biomes



Biomes by temperature and rainfall. Navarras, CC0.

- **Temperature** and **rainfall** are the two main factors
- For any given temperature and rainfall pattern, one type of natural ecosystem is likely to develop
- The graph lets you predict the biome from a climate

Activity

A site has a mean temperature of 25°C and about 3,000 mm of rain per year. Which biome is likely to develop there?

Six biomes

B4.1.7

Biome	Temperature	Rainfall	Plant community
Tropical forest	High all year	High all year	Very high plant diversity
Temperate forest	Warm summers, cold winters	Moderate	Broad-leaved trees, losing leaves in winter
Taiga	Short summers, long cold winters	Low to moderate	Conifers
Grassland	Warm summers, cold or dry seasons	Low to moderate	Grasses, few trees
Tundra	Very cold; short summers	Low	Low plants, no trees
Hot desert	Very hot days	Very low	Sparse, with stores of water

Why biomes look alike around the world

B4.1.7



Tundra in Alaska. USFWS, public domain.



Siberian taiga. V. Argenberg, CC BY 4.0.

- Similar conditions lead to similar selection pressures
- This is **convergent evolution**

Key idea

Tundra plants in Canada and Russia are not closely related, in many cases, yet they share many features: they are low to the ground and grow slowly. Each biome has similar communities, because abiotic conditions are alike and because of convergent evolution. This answers the second guiding question.

Adaptations to hot deserts

B4.1.8



Saguaro. Angwinar, CC0.



Fennec fox. Drew Avery, CC BY 2.0.

Species	Adaptations
Saguaro cactus	Stores water in a thick stem; spines for leaves; wide shallow roots
Fennec fox	Large ears lose heat; active at night; thick fur on its paws

The challenge

Very hot days, cold nights, little water and thin soil. Fennec foxes get most of their water from their food.

Adaptations to tropical rainforests

B4.1.8



Spider monkey. 25 OClock, CC0.



Monstera. Cliff, CC BY 2.0.

Species	Adaptations
Spider monkey	Long limbs and a gripping tail for moving through trees
Poison dart frog	Toxins and warning colours deter predators
Philodendron and other climbers	Climb to reach light; large leaves; drip tips



Blue poison dart frog. A. Pingstone, public domain.

The challenge

High temperature, high humidity and rainfall, low light under a dense canopy, and intense competition and predation. Note how many adaptations here relate to light and biotic factors.

Check that you can explain

1. What a habitat is
2. Adaptations in sand dune grasses and mangrove trees
3. How abiotic variables affect plants and animals
4. Range of tolerance, and how to use transect data
5. Conditions for coral reef formation
6. How rainfall and temperature determine biomes
7. Convergent evolution in biomes
8. Named adaptations to hot deserts and tropical rainforests

Exit activity: 5 minutes

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

1. State two abiotic variables that affect the distribution of plants.
2. Explain how pneumatophores help a mangrove tree.
3. Explain why tundra plants on different continents look alike.

Image credits

Marram grass on dune at Nørre Vorupør Strand.jpg – W.carter – CC0

Black Mangrove Pneumatophores – Flickr – treegrow.jpg – Katja Schulz from Washington, D. C., USA – CC BY 2.0

Close view of red mangrove roots.jpg – Steve Hillebrand, U.S. Fish and Wildlife Service – Public domain

Coral reef fish pacific blue tan paracanthurus hepatus.jpg – Jim Maragos, U.S. Fish and Wildlife Service – Public domain

Climate influence on terrestrial biome.svg – Navarras – CC0

Tundra landscape (6763177589).jpg – USFWSAlaska – Public domain

Lake Baikal, Pine forest, Siberian taiga, Siberia, Russia.jpg – Vyacheslav Argenberg – CC BY 4.0

Saguaro Cactus In Arizona, Sonoran Desert-2013.jpg – Angwinar – CC0

Fennec Fox Vulpes zerda.jpg – Drew Avery – CC BY 2.0

Spider monkey on tree.jpg – 25 OClock – CC0

Blue poison dart frog arp.jpg – Adrian Pingstone (Arpingstone) – Public domain

Swiss Cheese Plant (Monstera deliciosa) (2858303740).jpg – Cliff from Arlington, Virginia, USA – CC BY 2.0

All from Wikimedia Commons (commons.wikimedia.org, search the file name). Some images are cropped. CC licences: creativecommons.org/licenses