Adaptations

4.7.1.4 · Biology · revision notes

Adaptations are features that help an organism survive in the conditions where it normally lives. Expect to classify adaptations as structural, behavioural or functional, and to explain the features of plants, animals and microorganisms (including extremophiles) from information you are given.

Key facts

- Adaptation = a feature that helps an organism survive in its normal conditions
- Behavioural = actions (e.g. migration, huddling)
- Small surface area to volume ratio → less heat lost (cold places)
- Extremophile = lives in extreme conditions of temperature, pressure or salt concentration
- Structural = body features (e.g. thick fur, spines)
- Functional = processes inside the body, such as metabolism and reproduction (e.g. concentrated urine)
- Large surface area to volume ratio → more heat lost (hot places)
- Example extremophile: bacteria in deep sea vents

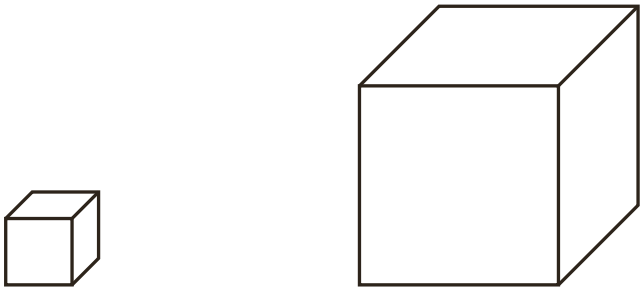
Notes

Three types of adaptation

- An **adaptation** is a feature that helps an organism survive in the conditions where it normally lives.
- **Structural**: features of the body, e.g. thick fur, sharp claws, a thick waxy cuticle on leaves, camouflage colouring.
- **Behavioural**: the way an organism acts, e.g. migrating to warmer places in winter, being active at night to avoid the daytime heat, huddling together to keep warm.
- **Functional**: processes inside the body, such as metabolism and reproduction, e.g. a desert animal producing very little sweat and very concentrated urine to save water, or a mammal lowering its metabolic rate while it hibernates.

Hot, cold and dry places

- Cold: thick fur or a layer of fat insulates the body. A large body with small ears has a **small surface area to volume ratio**, so less heat is lost.
- Hot: large ears and thin fur increase heat loss. A **large surface area to volume ratio** helps an animal lose heat.



1 cm cube
SA 6 cm², V 1 cm³
SA : V = 6 : 1

3 cm cube
SA 54 cm², V 27 cm³
SA : V = 2 : 1

A bigger body has a smaller surface area to volume ratio, so it loses heat more slowly: useful in the cold.

- Dry (plants): spines instead of broad leaves and a thick waxy cuticle reduce water loss; long or widespread roots absorb as much water as possible; swollen stems store water.
- Camouflage, such as white fur in snow or sandy colours in a desert, helps animals hide from predators or approach prey unseen.
- Mimicry: a harmless animal that looks like a dangerous one, e.g. a hoverfly with wasp-like yellow and black stripes, is avoided by predators, so it is less likely to be eaten.

Extremophiles

- **Extremophiles** are organisms that can live where conditions are extreme: very hot, under very high pressure, or very salty (high salt concentration). Some also live in very acidic conditions.
- Example: bacteria living around deep sea vents survive very high temperatures and pressures.
- Their enzymes and other proteins keep working in conditions that would denature the enzymes of most organisms.

Answering adaptation questions

- Name the feature, then say how it helps in that environment, e.g. 'thick fur traps air, which insulates the body, so less heat is lost'.

How to answer each type of question

Classify an adaptation

1 mark each | Grade 4

1. A body feature you could see or measure is structural.
2. Something the organism does is behavioural.
3. A process inside the body is functional.

Example. Classify each adaptation of a camel as structural, behavioural or functional.
(a) Long eyelashes that keep sand out of its eyes.
(b) Producing very concentrated urine.
(c) Resting in the shade during the hottest part of the day.

Model answer.

(a) Structural (1)
(b) Functional (1)
(c) Behavioural (1)

Explain how features help an animal survive

2 marks per feature | Grade 5

1. Identify the problem in the habitat (cold, heat, lack of water, predators).
2. Name the feature.
3. Explain how the feature solves the problem, using 'so' or 'which'.

Example. Arctic foxes live in very cold places. They have thick fur, which is white in winter, and small ears.
Explain how **two** of these features help the Arctic fox to survive. (4 marks)

Model answer.

Any two features explained, for example:
Thick fur traps air / insulates the body (1), so less heat is lost (1).
White fur camouflages the fox against snow (1), so it can approach prey without being seen (1).
Small ears have a small surface area (1), so less heat is lost from them (1).

Suggest how a plant is adapted to a dry habitat 3 marks **Grade 6**

1. Think about getting water (roots), storing water (stems) and losing less water (leaves, cuticle, stomata).
2. Match each feature in the information to one of these.
3. Explain each feature; do not just list them.

Example. Marram grass grows on sand dunes, where the sand holds little water. In dry weather its leaves roll up, with the stomata on the inside of the roll. Its roots can grow more than a metre deep. Suggest how these features help marram grass to survive.

Model answer. Rolled leaves trap moist air around the stomata / expose less surface to the air (1), so less water is lost by evaporation from the leaves (1). Deep roots can reach water far down in the sand (1).

Explain how extremophiles survive 2 marks **Grade 7**

1. Name the extreme condition (temperature, pressure or salt concentration).
2. Explain that their enzymes and proteins are not denatured in that condition, so their reactions can continue.

Example. Some bacteria live in hot springs at 80 °C.
Suggest why most organisms cannot survive at this temperature, but these bacteria can.

Model answer. In most organisms, enzymes are denatured at 80 °C / their active sites change shape (1). These bacteria have enzymes that keep their shape at high temperatures, so reactions such as respiration can continue (1).

Don’t lose marks

- Listing features without explaining how each one helps the organism survive.
- Saying the organism 'adapted itself' or 'chose' to change. Adaptations come about by natural selection over many generations.
- Mixing up surface area with surface area to volume ratio: in the cold, a small ratio reduces heat loss.
- Calling migration or huddling a structural adaptation. They are behavioural.
- Writing that extremophiles 'live in extreme places' without naming the condition (temperature, pressure or salt).

More tips

Memory tricks

- S-B-F: Structural = what it looks like, Behavioural = what it does, Functional = what goes on inside.
- Big and round keeps heat around: large, compact bodies have a small surface area to volume ratio.
- For every feature, ask 'so what?': feature → effect → how that helps survival.

Exam technique

- Explain questions usually give 1 mark for the feature and 1 mark for how it helps. Always pair them up.
- Unfamiliar organisms are common. The clues you need are usually in the question.
- Use scientific words: insulation, camouflage, surface area to volume ratio, water loss, denatured.

What each grade needs

What you need to be able to do, from the first marks up to the top grade.

Grade 3

Define an adaptation

A feature that helps an organism survive in the conditions where it normally lives.

Grade 4

Classify adaptations as structural, behavioural or functional

Structural means body features, behavioural means what it does, and functional means processes inside the body.

Grade 5

Define an extremophile and give an example

An organism that lives in extreme conditions of temperature, pressure or salt concentration, e.g. bacteria in deep sea vents.

Grade 5

Explain unfamiliar adaptations from given information

Use the description or data to link each feature to a specific survival problem in that habitat.

Grade 6

Explain adaptations to hot, cold and dry environments

Link each feature to heat loss or water loss, e.g. spines instead of leaves reduce water loss.

Grade 7

Explain adaptations using surface area to volume ratio

A large, compact body has a small surface area to volume ratio, so it loses heat more slowly.

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