B1 Characteristics and classification of living organisms

Introduction

This topic revises and extends knowledge from earlier work on the seven characteristics that are displayed by living organisms. It forms the basis for many other topics covering the separate characteristics in more detail later in the course. It also covers the classification of organisms, which will be referred to in many other parts of the course.

Links to other topics

Topics	Essential background knowledge	Useful links
2 Organisation and maintenance of the organism		2.1 Cell structure and organisation 2.2 Levels of organisation
6 Plant nutrition		6.1 Photosynthesis
7 Human nutrition		7.1 Diet
12 Respiration		12.1 Respiration 12.2 Aerobic respiration 12.3 Anaerobic respiration
13 Excretion in humans		
14 Coordination and response		14.1 Nervous control in humans 14.2 Sense organs 14.5 Tropic responses
16 Reproduction		16.3 Sexual reproduction in plants 16.4 Sexual reproduction in humans

Topic overview

B1.1	**The seven characteristics of living organisms** A sorting activity will help students revise their knowledge of the characteristics of living organisms from earlier work.
B1.2	**Species and classification systems** This activity will help students to understand the term *species*, and to understand the concept of the binomial system for naming organisms and why it is used. **Extended** This activity will also help students to extend their understanding of classification, based on traditional methods as well as using DNA.
B1.3	**Features of organisms** This activity will help students to identify the basic features of cells and the key features used to classify animals and plants, and to group animals within the animal kingdom. **Extended** This activity also provides opportunities to learn the key features of the five kingdoms of organisms, and also the key features for classifying some plants. Students will also be introduced to the basic structure of viruses.

B1.4	**Dichotomous keys** In this activity students will use a dichotomous key to identify organisms. **Extended** Students will also have the opportunity to construct a dichotomous key for organisms.
B1.5	**Consolidation and summary** This activity quickly recaps the ideas encountered in the topic and allows time for students to answer the End of topic questions in the Student Book.

Activity B1.1 Characteristics of living organisms

Learning objectives

- Describe each of the characteristics of living organisms.
- **Extended** Define the seven characteristics of living organisms.
- Explain that not all living organisms show every characteristic all of the time.

Learning outcomes

- Know that living organisms will show some or all of the seven characteristics of life.
- Know that the characteristics of life are: movement, respiration, sensitivity, growth, reproduction, excretion and nutrition.

Common misconceptions

Students are likely to have several misconceptions that will be dealt with in more detail in later topics. For example, they may think that: plants do not respire but only carry out photosynthesis; excretion and egestion mean the same thing; breathing and respiration also mean the same. Briefly correct any misconceptions where necessary, but return to them later to make sure they are sorted properly when the topic is covered in detail.

Resources

Student Book pages 13–15

Files on CD-ROM: Worksheet B1.1_Characteristics

Approach

1. Recap knowledge from earlier work

Introduce the topic by giving students 2 minutes to write down the characteristics shown by all living organisms. Then ask them to compare what they have written with another student to identify the similarities and differences of their answers.

Take examples from around the class to collate a class list of characteristics. Encourage discussion within the class for each new suggestion, before adding anything to the list that the class agrees on.

2. Identifying characteristics

Give students Worksheet B1.1 to work on, either individually or in pairs, to help them clarify the seven key characteristics of living organisms. They could use the cards to create their own list of characteristics, or you could give them the characteristics and ask them to identify which is shown in each example. Students could add one more plant and one more animal example of their own for each characteristic.

3. Create a mnemonic (optional)

Ask students to work on their own or in pairs to create a mnemonic for the initials of the seven characteristics, in whichever order they like.

4. Consolidation: Create a crossword

Ask students to create the clues for a crossword that includes all seven characteristics of living organisms.

Answers

Page 14

1. a) Any suitable answers for human, such as:

movement, walking; respiration, combination of oxygen with glucose to release energy, carbon dioxide and water; sensitivity, vision; growth, increase in height; reproduction, having a baby; excretion, producing urine; nutrition, eating food.

b) Any suitable answers for a specific animal, such as:

movement, crawling; respiration, combination of oxygen with glucose to release energy, carbon dioxide and water; sensitivity, smell; growth, increase in length; reproduction, producing young; excretion, losing carbon dioxide through respiratory surface; nutrition, eating food.

c) Any suitable answers for a plant, such as:

movement, growing towards light; respiration, combination of oxygen with glucose to release energy, carbon dioxide and water; sensitivity, detecting direction of light; growth, increase in height; reproduction, producing seeds; excretion, diffusion of waste products out of leaf for photosynthesis (oxygen) and respiration (carbon dioxide); nutrition, taking in nutrients from soil and making glucose by photosynthesis.

2. movement – to reach best place to get food or other conditions favourable for growth
respiration – to release energy from food that can be used for all life processes
sensitivity – to detect changes in the environment
growth – to increase in size until large/mature enough for reproduction
reproduction – to pass genes on to next generation
excretion – to remove harmful substances from body
nutrition – to take in substances needed by the body for growth and reproduction.

Worksheet B1.1

1. movement/sensitivity	2. respiration	3. excretion
4. respiration	5. reproduction	6. growth
7. sensitivity	8. movement	9. nutrition
10. nutrition	11. reproduction	12. sensitivity
13. growth	14. sensitivity	15. reproduction

Activity B1.2 Concept and use of a classification system.

Learning objectives

- Define the term *species*.
- Describe how the binomial system is used to name and classify organisms.
- **Extended** Explain why it is important to classify organisms.
- **Extended** Explain that classification is usually based on similarities of morphology and anatomy.
- **Extended** Describe the use of DNA in classification.
- **Extended** State that organisms which are closely related have DNA that is more similar than organisms which are more distantly related.

Learning outcomes

- Know that a species is a group of organisms with many similar features and can breed with others of the same species to produce fertile offspring.
- Know that the binomial system is used to give organisms a genus and species name that distinguishes them from other species.
- **Extended** Know that classification of organisms helps us to identify evolutionary relationships between them.
- **Extended** Know that the binomial system of naming organisms makes it easier for people working on the conservation of species to be certain they are talking about the same species.
- **Extended** Know that classification used to be based just on the visible features (morphology) and body structure (anatomy) of an organism.
- **Extended** Know that scientists now also use the DNA sequence of organisms to help identify how closely related the organisms are.

Common misconceptions

Classification can be a confusing topic because, although we classify on obvious features, many features of an organism are adapted, and therefore modified, to help it survive in a particular environment. This can result in some species within a group having features more commonly associated with other groups. For example, some species of fish, amphibians and reptiles give birth to live young, a feature more commonly associated with mammals. It is important in this activity, and the next one, that students realise this and look for more than one main morphological or anatomical feature of a species to help identify it.

Resources

Student Book pages 15–18

Files on CD-ROM: Worksheet B1.2a_Morphology and anatomy; Worksheet B1.2b_DNA relationships

Approach

1. Introducing species

Ask students for examples of names of species. Write a selection on the board, encouraging as wide a range as possible of animals, plants, vertebrates, non-vertebrates, etc. Then give students a minute to think of a definition of the term *species* and to write it down on a piece of paper. Ask students to compare their definition with that of a neighbour, and to work together to improve the definition. Ask pairs then to work in fours to produce a better definition, and then in eights if the class is large. Then ask a student from each group to give their agreed definition.

Compare the definitions to identify their similarities and differences. With higher-ability students, discuss the limitations of each definition in terms of how it could be tested. Then compare the definitions with the

one given on page 15 of the Student Book. Point out that, although it is difficult to produce a definition for the term that can be proved, it is a useful working concept for much of biological work.

2. Binomial naming

Give students the common name of a flower, such as *African daisy*, and either provide a range of examples of different plants that bear that name or give students the opportunity to research examples of this. (Wikipedia offers seven genera that may bear the common name of African daisy, but there will be others.) Ask students to suggest why they all have that same common name (e.g. they all bear the features of a *daisy* [a flower with a large central yellow section surrounded by many thin petals] and all originate from Africa). Students could then research some binomial names for African daisy species.

If preferred, use an animal name that covers many species, such as *worm*. However, note that this will cover different classificatory groups, including roundworms, flatworms and nematodes. Adjust the questioning to suit the example but to cover the same learning.

Extended Ask students to suggest what problems might be caused in identification as a result of using common names, such as in a horticulture reference that explains how best to grow and care for plants.

They should use the binomial names to explain the importance of identifying each species uniquely. For example, as different plants need different growing conditions, advice for one species of African daisy may not be suitable for another. This could be extended to consider other situations in which unique identification of a species may be important (such as in breeding, or in the treatment of infection by a particular parasite, e.g. malaria that may be caused by different species of *Plasmodium*).

Extended **3. Morphology and anatomy**

Worksheet B1.2a provides some images of the front limb of four species of mammal. Questions on the sheet ask students to compare the diagrams, to help them understand the difference between the terms *morphology* and *anatomy*.

The final question asks why the anatomy is more similar than the morphology. If students are unsure of the answer, discuss the effect of environment on the form of the body, which they should be able to answer from earlier work on adaptations to the environment. For example, the cat's front limb is adapted for running, the whale flipper for swimming, etc. Explain that all mammals evolved from an ancestor that had a similar structure to their limb. Students should then consider how the limbs evolved from the ancestor's limb and how this accounts for their similarity in anatomy.

Extended **4. Classification using DNA**

Details of DNA structure, replication and mutation are covered in Topic 17. For this activity students need only appreciate that DNA forms the genetic code, and that the code is made of billions of copies of the letters A, T, G and C. The code between individuals of the same species is almost, but not quite, identical. The code is inherited by offspring from their parents. Changes occur due to faults in copying the code during reproduction. The more times the code is copied, the more changes that occur. This is why there are greater differences in the genetic code between individuals of distantly related species than individuals of closely related species.

To help students gain some appreciation of this, give them Worksheet B1.2b, which contains six very small sequences of DNA. Students should compare the sequences and put them in order of how different they are compared with the code from species 1. When scientists carry out real comparisons, they are working with many thousands of letters in the code, which is why the comparison is generally done by computer!

The comparison should put the species into this order, starting with 1: 1, 4, 6, 2, 3, 5. Use this to ask questions such as:

- Which species is most distantly related to species 1? [answer: 3]
- Which species is most closely related to species 3? [answer: 5]

Students should then combine what they have learned in this and the previous task to try to explain why using the base sequence in the DNA code can give a more accurate result than morphology and anatomy in classification.

5. Consolidation: describing a new species

Ask students to imagine they have been shown a new organism that has never been seen before. Give them a few minutes to think about how they would work out whether it was a new species, and how that species might be named. Take examples around the class to elicit the importance of comparing features to known species to identify its relationships and therefore what genus name it should be given.

Answers

Page 17

1. A group of organisms that share many features and that can interbreed and produce fertile offspring.

2. Organisms are grouped according to how similar they are. The more similar their features, the more closely they are grouped, e.g. into species or genus rather than order or class.

3. Any suitable example, such as *Homo sapiens*, showing the two parts of the name, described as the genus name (the first part) and species name (the second part). Each species has a different binomial name.

Extended 4. It can be used to identify evolutionary relationships and it can help identify which species need conservation.

Page 18

Extended 1. Morphology is the study of what organisms look like. Anatomy is the study of the body structure of organisms.

Extended 2. Organisms that have similar features and body structure may be more closely related than those that are more different. The disadvantage is that sometimes body structure and features are strongly affected by the environment, so distantly related organisms may look more similar than closely related organisms.

Extended 3. The sequence of bases in DNA is more similar in organisms that are closely related than in organisms that are more distantly related. So, organisms with a similar DNA sequence have evolved from a more recent ancestor than those with DNA that is more different.

Worksheet B1.2a

1. Similarities: they are all quite long; those of the cat and human clearly bend at the ‘elbow’. Differences: they are very different shapes and are adapted for different purposes – human for grasping and manipulating things, cat for running, whale for swimming, bat for flying.

2. Similarities: they all have a similar arrangement of bones, one in the upper ‘arm’, two in the lower ‘arm’, several in the ‘wrist’ and several that make up separate ‘fingers’. Differences: in the human, the fingers are separate and long; in the cat the ‘fingers/toes’ are short and angled for running; in the whale the upper bones are very short and there are many more ‘finger bones’; in the bat, the ‘fingers’ are very extended to support the membrane of the wing.

3. Anatomy

4. Anatomy is inherited from parents/ancestors. The ancestor of all these species would have had the same basic organisation of bones in their front limb. Adaptations to different kinds of environment have resulted in the evolution of this plan into very different forms (morphs) in the different species shown.

Activity B1.3 Features of organisms

Learning objectives

- List the features shared by all living organisms.
- Identify the main features of plants and animals.
- Describe the main features of groups within the animal kingdom.
- **Extended** Describe the main features of the five kingdoms of organisms.
- **Extended** Describe the main features of groups within the plant kingdom.
- **Extended** Describe the features of viruses.

Learning outcomes

- Know that all living organisms have cells that are surrounded by a cell membrane. Inside the cell is jelly-like cytoplasm and genetic material in the form of DNA.
- Know that plants are multicellular organisms that make their own food in photosynthesis using light energy. Many of their cells contain chloroplasts where photosynthesis takes place. Their cells are surrounded by a cellulose cell wall.
- Know that animals are multicellular organisms that get their food by eating other organisms. They coordinate their movements using nerves, and most are able to move around.
- Know that vertebrates are animals that have a backbone. Vertebrates include: bony fish that have gills, scales and fins for swimming; birds that have feathers and lay hard-shelled eggs; reptiles that have scaly skin and lay leathery-shelled eggs; amphibians that have gills in early stages and lungs as adults, and lay soft eggs into water; mammals that have hair, give birth to live young and feed them on milk produced by the mother.
- Know that arthropods are invertebrates that have jointed exoskeletons in three main parts. The arthropods include: myriapods (millipedes) that have two pairs of legs per segment; insects that have six legs and one or two pairs of wings; arachnids (spiders and scorpions) that have four pairs of legs; and crustaceans that have three main body parts, although the abdomen may have many segments.
- **Extended** Know that all living cells contain ribosomes. These structures are the site of protein synthesis, including the formation of enzymes that control cell processes such as anaerobic respiration.
- **Extended** Know that viruses are infective particles made of a protein coat surrounding nucleic acid. They do not have a true cell structure and can only reproduce when inside a cell of another organism. So many people think they are not true living organisms.
- **Extended** Know that living organisms can be divided into five kingdoms on their features: animals, plants, fungi, protoctists and prokaryotes.
- **Extended** Know that the plant kingdom contains the ferns, which have frond leaves and produce spores during reproduction, and flowering plants that reproduce using flowers.
- **Extended** Know that flowering plants are divided into monocotyledons, which have leaves with parallel veins and seeds containing one food store, and dicotyledons, which have leaves with branching veins and seeds containing two food stores.
- **Extended** Know that bacteria are microscopic, single-celled organisms that have no nucleus; they have circular chromosomes and some have additional genetic material in plasmids; they have cell walls and some feed off other living organisms.
- **Extended** Know that protoctists are single-celled microscopic organisms. They are eukaryotes because they have a nucleus in their cell.

Common misconceptions

Students are likely to have the general understanding that there are plants (green things with leaves), animals (things that have legs and move) and 'other things' (for which they have no special form of classification except they are 'not' plants or animals). They may need more questioning to help them to distinguish between the 'other things' and to focus on the key features that are used to classify the main groups.

Resources

Student Book pages 19–32

Files on CD-ROM: Worksheet B1.3a_Classification; Worksheet B1.3b Vertebrates; B1.3_tech_notes

Resources for a class practical (see Technician's notes, following)

Approach

1. Introducing cells

In this activity, students need only be introduced briefly to the key features of all cells. More detailed study of the structure of different kinds of cells will be studied in Topic 2.

Ask students to remember what they can about cells, and then ask one student to come to the board and sketch the outline of one cell. Ask other students to suggest other features that could be included, but encourage discussion first on whether the suggested feature is found in *all* cells and so worthy of being included in the sketch. All features drawn should be labelled.

Make sure that the sketch includes the cell membrane, cytoplasm and DNA. (The functions of these features and the presence of other features should be left until Topic 2, although they may be mentioned at this point.) Students should draw a fully labelled sketch of a cell with these features in their workbooks.

Extended Ask students to read the paragraph on enzymes and ribosomes on page 19 of the Student Book, and to consider whether they should add anything more to their labelled sketch. They should then read the section on viruses and make notes that compare the structure of a virus with the structure of a generalised cell, identifying any similarities and differences.

Note that in the Student Book, the distinction between *prokaryote* and *eukaryote* cells is given. Although students are not expected to remember these terms, it may help them to identify the significant difference in structure between these cell types and its effects when considering prokaryotes (bacteria) later in the course, e.g. in the use of antibiotics in Topic 15, and in Topic 20 in relation to genetic engineering.

2. Plants and animals

Give students 2 minutes to write down the key features of plants and animals. Take examples from around the class and ask why each is a key feature. Encourage discussion to highlight differences in understanding. Students could then test their understanding by collecting, or drawing, images of a range of organisms in each group, summarising the key features that the organisms in each group share. Make sure that students include as wide a range of animals and plants as possible, although they are not expected to classify them beyond 'plant' or 'animal' at this point.

Some students may suggest organisms that do not fit into either of these groups (e.g. bacteria, fungi), in which case ask them to suggest why they do not. These other groups are covered elsewhere in this activity.

Extended 3. The five kingdoms

Give students Worksheet B1.3a, which contains a table of characteristics for the five kingdoms of organisms. Ask them to complete the table to show which groups of organisms have each characteristic. Encourage them to add detail to their responses, rather than just a tick or cross.

The completed table is given in the answer section.

4. Classifying vertebrates

Give students Worksheet B1.3b, which shows a selection of vertebrates. Ask students to cut out the images and to group them into the five main groups of vertebrates. They may have difficulty with this, because the images do not all clearly show the main features of the group. Further research will probably be needed to complete the task. Students could use the feature information on pages 25–28 of the Student Book to help them.

The task could be extended by asking students to find additional examples of each group. Encourage them to find as wide a range of examples as possible. Students should justify their grouping by identifying at least one key feature of the group for each example. It might be appropriate to point out that the variety of forms is related to adaptations of each kind of organism to their environment, and that this can lead to organisms of different groups that live in similar environments showing similar forms, for example dolphins and fish, or bats and birds.

5. Classifying arthropods

Many students may have no understanding of the term *arthropod*. However, they are likely to have encountered examples from several different groups within the classification. Provide a selection of unlabelled images or real-life examples of different arthropods, for example spiders, scorpions, millipedes, insects such as butterflies or wasps, and crustaceans such as crabs or crayfish. First, ask students what the organisms all have in common. They should be able to identify that all the examples have a hard outer skeleton (exoskeleton) and that the skeleton is jointed to allow movement. Contrast the exoskeleton with the internal skeleton of vertebrates. Challenge higher-ability students to consider the advantages and disadvantages of the two types of skeleton. (For example, an exoskeleton provides greater protection against attack, but limits growth and must be shed periodically for growth to continue.)

Then ask students to identify features that could be used to separate the organisms into different groups. This is challenging to do without support if the examples vary a lot in their features. Students could use pages 28–30 in their Student Book to help them. If there is time, students could research other examples for each group. They could sketch their examples, pointing out the main features for identification.

Extended 6. Classifying plants

Gather a range of plants that include some ferns, some eudicotyledons (for example, from the daisy, pea, deadnettle and rose families) and some monocotyledons (from the grass, lily and orchid families). If possible, choose plants that have flowers or spore cases (sporangia) visible, and also include some tree species. Alternatively, give students a selection of images instead of plant material.

Ask students to sort the species according to any features they can identify. They should aim to find one characteristic that will separate the examples into three main groups, and then find other characteristics that appear unique to each group.

Students are most likely to separate the groups first into ferns and flowering plants on general structure, particularly the presence of spore cases or flowers. They should then be able to separate the flowering plants into two main groups based on leaf or vein structure, as monocotyledons usually have long strap-like leaves with parallel veins, whereas the eudicotyledons have branching leaf veins and a wide range of leaf shapes. Among additional distinctive features that students might spot is that monocotyledon flowers have parts (e.g. petals, sepals, stamens) in multiples of three, whereas eudicotyledon flowers have parts in multiples of four or five.

If there is time, students could investigate related areas of interest, such as:

- other features that are characteristic of each group (this includes pollen structure, number of seed leaves in the seed and arrangement of vascular bundles in the stem)
- what *eudicotyledon* means and how it differs from *dicotyledon*
- which group the most important crop plants belong, and why they are so valuable.

Technician's notes

Be sure to check the latest safety notes on these resources before proceeding.

The following resources are needed for the activity on examples of flowering plants:

Samples of flowering plants that include some ferns, some eudicotyledons (for example, from the daisy, pea, deadnettle and rose families) and some monocotyledons (from the grass, lily and orchid families). If possible, choose plants that have spore cases or flowers and also include some tree species.

Alternatively, a selection of images of plant material could be used.

The following resources are needed for the activity on classifying arthropods:

Selection of images or real-life examples of a wide range of arthropods: for example, spiders, scorpions, millipedes, insects such as butterflies or wasps, and crustaceans such as crabs or crayfish.

If using real-life examples, make sure no venomous animals are included and that all animals are treated with care and returned safely to their original environment as soon as possible after the lesson.

Answers

Page 20

1. Cell surrounded by cell membrane (1) containing cytoplasm (1) and DNA. (1)

Extended 2. They are where proteins are made in protein synthesis.

Extended 3. Respiration

Extended 4. Similar: contain genetic material; different: only have a protein coat, not a cell membrane or other features of cells of living organisms

Page 21

1. Plant cells may contain chloroplasts, but animal cells do not.

2. Plants are usually not able to move around freely, but many animals can.

3. It is a plant, because only plant cells contain chloroplasts.

Page 25

Extended 1. Animals, plants, fungi, protoctists and prokaryotes; each kingdom with a suitable example.

Extended 2. Bacterial cells have no nucleus/DNA lying free in the cytoplasm, but animal cells have DNA in the nucleus.

Extended 3. a) Cell walls, cannot move around;

b) no chloroplasts.

Extended 4. Some protoctists contain a chloroplast and can photosynthesise as some plant cells do; others do not have chloroplasts and feed on other organisms, so are more like single animal cells.

Page 30

1. Table like the following.

Group	Key body features	Fertilisation	Production of young
bony fish	scaly skin, streamlined shape, fins and tail, gills	external	from eggs
birds	feathers and wings, constant body temperature	internal	from eggs

mammals	hair, mammary glands, constant body temperature	internal	live birth
amphibians	moist skin, metamorphosis between very different young and adult forms	external	from eggs
reptiles	tough scaly skin, varying body temperature	internal	from eggs

2. It is a vertebrate (because it has a backbone) and a bird (because only birds have feathers).

3. They all have a tough exoskeleton.

4. Myriapods have many segments and many legs. Insects have a three-part body with six legs and often two pairs of wings. Arachnids have a two-part body with eight legs. Crustaceans usually have a three-part body with two pairs of antennae on their heads, and they may have swimming legs on the abdomen as well as real legs on the thorax.

Page 32

Extended 1. Similarities: both have chloroplasts and are plants, both have roots and leaves; differences: ferns reproduce using spores, flowering plants reproduce using flowers and seeds.

Extended 2. Dicotyledonous plants have two cotyledons in the seed; monocotyledonous plants have only one. Monocotyledons have long, strap-like leaves with parallel veins; dicotyledons have broad leaves of many shapes with branching veins.

Worksheet B1.3a

	Food source	**Cell wall?**	**Nucleus in cell?**	**Carbohydrate store**	**Single or multi-celled?**
Plants	make own food using light energy from Sun	yes, cellulose	yes	starch or sucrose	multi-celled
Animals	eat other organisms	no	yes	glycogen	multi-celled
Fungi	extracellular digestion of dead or living plant or animal tissue	yes, chitin	yes	sometimes glycogen	some single-celled, some multi-celled
Bacteria	some use photosynthesis, some feed off dead or living tissue	yes, variable	no – chromosome lies free in cytoplasm	no	single-celled
Protoctists	some use photosynthesis, some feed on living organisms or dead matter	some	yes	–	single
Viruses	none	no	no	no	particle (not a cell)

Worksheet B1.3b

mammals: gorilla, bat, pig; birds: condor, stork; reptiles: crocodile, gecko, python; amphibians: frog, salamander; bony fish: angel fish, conger eel.

Activity B1.4 Dichotomous keys

Learning objective

- Use simple dichotomous keys to identify organisms.
- Construct simple dichotomous keys to identify organisms.

Learning outcomes

- Know how to use a dichotomous key to identify organisms.
- Know how to construct a dichotomous key using easily identifiable features to identify organisms.

Common misconceptions

Producing an identification key for organisms is a useful activity, though some students may find it challenging. However, it helps students to understand the structure of a key and offers a good opportunity to practise their skills of identification and classification.

Resources

Student Book page 32–34

Files on CD-ROM: Worksheet B1.4_Identifying herbivores; B1.2_tech_notes

Resources for a demonstration and a class practical (see Technician's notes, following)

Approach

1. Introduction

Ask students to work in pairs – one member of the pair is to think of an organism that has been mentioned in a previous activity, and the other member of the pair has to work out what it is by asking questions to which the answer can only be 'yes' or 'no'. They should use their knowledge of how organisms are classified to help them identify the group to which the organism belongs.

After each student has had a chance to do the questioning, explain that *dichotomous* means 'having two branches' and that yes/no questions are an example of dichotomous questioning. Extend this by showing a group of objects, for example a pencil, a pen, a ruler. Ask students to work in pairs and identify yes/no questions that would distinguish one object from the rest. Take examples from around the class and discuss how well each question identifies a key feature.

Ask students to consider in which situations an identification key might be useful. (Note that the most likely use of a key in their course will be in any field work in relation to food chains and food webs in Topic 19.)

2. A key for identifying herbivores

Explain to students that a dichotomous key uses yes/no types of questions to help identify organisms in the same way as they did with the group of objects in the Introduction.

Worksheet B1.4 has a dichotomous key for identifying some herbivores found on the African savannah, such as on the Serengeti Plain. You will need to provide students with pictures of each of the named herbivores (zebra, eland, oryx, Thompson's gazelle, wildebeest, buffalo, impala), but make sure the pictures do not show the names of the animals.

Students could work in small groups, to encourage discussion of the features and questions. Alternatively, higher-ability students could carry out this activity on their own.

When students have used the key, ask them to compare their results with those of other students and to discuss any differences. Students could consider which questions were most useful, and which caused the most difficulty. For the latter, they could try to think of other questions that might have been more useful.

For higher-ability students, ask them how the structure of a dichotomous key relates to classification as studied in Activity B1.3 Features of organisms. They should be able to identify that, as only one key feature is used at each stage, the key probably will not match with classification, which is usually based on the similarity of a number of key features.

3. Make your own key

This is an extension to the previous task of using a key, and helps students appreciate the different ways of presenting a dichotomous key.

Ask students to use the content of Worksheet B1.4 and convert it to the same format as the identification key of fruits on page 33 of the Student Book. They could use the pictures provided for the previous task to complete the key.

If students are confident in the way the key is constructed, ask them to use the herbivore pictures (or another set of pictures of organisms) to create their own key. This is not a simple task – it needs careful thought to identify appropriate characteristics to separate out each species. With lower-ability groups, it would be best done as a class activity.

If students create their own keys, they should compare them by trying them out on each other. Encourage discussion on which work best and why, so that students can draw general conclusions on the best approach.

4. Consolidation: definition

Ask students to write a definition for a web answers site or encyclopaedia entry for *dichotomous key*, including where and why it can be useful. They should compare their definition with another student and work together to improve their definition.

Technician's notes

The following resources are needed for the Introduction:

Group of objects such as a pen, a pencil and a ruler

The following resources are needed for the class practical on identifying herbivores:

Pictures of the following animals: zebra, eland, oryx, Thompson's gazelle, wildebeest, buffalo, impala The pictures should be of males and should not show the names of the animals.

Answers

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1. A key that identifies organisms by using questions, where each question has only two possible answers. So with each question a group of different organisms is divided into two groups. This is rather like the branching of a tree.

2. Any two suitable answers, such as: the key may not include sufficient differences between groups to place an organism at species level accurately; individuals vary within a species, so it may be difficult to decide whether an individual does or does not have a particular feature; it might be the wrong time of year to identify particular features: for example, plants don't have flowers at certain times of the year.

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1. So that the user of the key can follow through the questions easily.

2. Any suitable solution that splits the three animals into a group of two and a single animal using one yes/no question, followed by another yes/no question that splits the group of two into two separate species. For example:

Does it have black and white stripes all over the body?	yes – zebra	no – go to next question.
Does it have black stripes?	yes – wildebeest	no – kudu.

Activity B1.5 Consolidation and summary

Learning objectives

- To review the learning points of the topic.
- To test understanding through answering questions.

Learning outcomes

- Be familiar with the knowledge and understanding summarised in the End of Topic Checklist.
- Be able to apply this knowledge and understanding by answering the End of Topic Questions.

Resources

Student Book pages 35–39

Approach

Ask students to answer the End of Topic Questions in the Student Book.

Answers

End of Topic Questions mark scheme

Question	Correct answer	Marks
1	Movement, respiration, sensitivity, growth, reproduction, excretion, nutrition. (1 mark for each correct answer)	7 marks
2	Nutrition and respiration in animals, photosynthesis and respiration in plants	1 mark 1 mark
3	Dry mass is the mass of all the materials used to make the cells and tissues of the body. Water content in the body varies as water is gained and lost, so wet mass is not reliable.	1 mark 1 mark
4	The crystal gains in size as more of the substance in solution attaches to the crystal. This is not true growth because the substance can be lost to solution too, so it is not a permanent increase	1 mark 1 mark
5	Animals are not ‘more alive’ just because they have to move around to get their food, etc. Plants must remain attached to the ground because that is where they get support, water and nutrients, but they move parts of their body. Both plants and animals show all the life processes, so are equally ‘alive’ .	1 mark 1 mark
6	The tree does not move during winter, although the cells may still move. Respiration and therefore excretion may still occur, but at a very slow rate (as gas exchange continues slowly through the bark) Movement, reproduction, growth and sensitivity will not take place during winter As long as the tree can return to a state in which it can carry out all these processes (when leaves grow, during the rest of the year), it is still alive	1 mark 1 mark 1 mark 1 mark

<table>
<tr><td>7 a)</td><td>The unique part is leo, which is the species name</td><td>1 mark</td></tr>
<tr><td>7 b)</td><td>The Panthera part is the genus name, which is shared with other closely related species.</td><td>1 mark</td></tr>
<tr><td>8 a)</td><td>They look very alike.</td><td>1 mark</td></tr>
<tr><td>8 b)</td><td>They would breed and produce fertile offspring.</td><td>1 mark</td></tr>
<tr><td>8 c)</td><td>Compare their DNA sequence
if it is very similar then they are the same species.</td><td>1 mark
1 mark</td></tr>
<tr><td>9</td><td>You would have to study it carefully to identify all the key features that could be used for putting it into a group.
You would then have to compare those features with the key features of each of the classificatory groups and decide which group it matched best.</td><td>1 mark
1 mark</td></tr>
<tr><td>10 a)</td><td>The student has chosen a feature for grouping the animals that is an adaptation to the way the animals live / that is not the result of evolution from the same ancestor.</td><td>2 marks</td></tr>
<tr><td>10 b)</td><td>They each have key characteristics that they share with other animals in each class and all the organisms in the two classes have a bony backbone, so they are classified together in the Chordata.</td><td>2 marks</td></tr>
<tr><td>11 a)</td><td>They share parts of their DNA sequence because they share an ancestor in the past.</td><td>1 mark</td></tr>
<tr><td>11 b)</td><td>The order of similarity (starting with the most similar) is chimpanzee, mouse, chicken, fly.
This suggests that chimpanzees and humans shared an ancestor more recently in the past than humans and mice, and with mice more recently than with birds, and with birds more recently than with insects.</td><td>1 mark
1 mark</td></tr>
<tr><td>12 a)</td><td>cell membrane, cytoplasm, DNA</td><td>3 marks</td></tr>
<tr><td>12 b)</td><td>Two from: chloroplasts, cell walls, vacuole.</td><td>2 marks</td></tr>
<tr><td>13</td><td>They both have chloroplasts in their cells
and they are both multicellular.</td><td>1 mark
1 mark</td></tr>
<tr><td>14</td><td>Gives birth to live young/young in the womb supported by placenta
young fed on milk made in mammary glands.</td><td>1 mark
1 mark</td></tr>
<tr><td>15 a)</td><td>Octopus and bee.
Dog and shark.</td><td>1 mark
1 mark</td></tr>
<tr><td>15 b)</td><td>Octopus and bee not vertebrates (no backbone); dog and shark are vertebrates (have backbone).</td><td>1 mark</td></tr>
<tr><td>16</td><td>Viruses, bacteria, protoctists.</td><td>2 marks</td></tr>
<tr><td>17</td><td>
<table>
<tr><th>Animals</th><th>Plants</th><th>Fungi</th><th>Protoctists</th><th>Prokaryotes</th></tr>
<tr><td>eukaryote cell</td><td>eukaryote cell</td><td>eukaryote cell</td><td>eukaryote cell</td><td>prokaryote cell (no nucleus)</td></tr>
<tr><td>multicellular</td><td>multicellular</td><td>multicellular</td><td>single-celled</td><td>single-celled</td></tr>
<tr><td>nervous system</td><td>chloroplasts</td><td>hyphae and mycelium</td><td></td><td></td></tr>
</table>
(1 mark for identifying the features of each kingdom)
</td><td>5 marks</td></tr>
</table>

18 a)	Have cell walls and a central vacuole in their cells, like plants. don't move around as animals usually do at some point in their life.	1 mark 1 mark
18 b)	Cannot photosynthesise as plants do, have different food store (glycogen not starch).	1 mark 1 mark
19 a)	reproduction	1 mark
19 b)	movement – viruses cannot move on their own respiration – viruses do not break down food to release energy sensitivity – viruses do not sense and respond to stimuli growth – viruses do not grow in the sense of increasing their mass excretion – viruses do not produce substances, so they cannot excrete nutrition – viruses do not take in nutrients for conversion into other substances	1 mark 1 mark 1 mark 1 mark 1 mark 1 mark
19 c)	Viruses should be classified as living organisms because they are able to reproduce, which is one of the life processes.	1 mark 1 mark
19 d)	Viruses should not be classified as living organisms because they only show reproduction when they take over the reproductive processes in another cell and they do not show any of the other life processes.	1 mark 1 mark
20	Is the fruit broadly spherical in shape? – other shape Is the outer surface soft or rigid? – soft Is the flesh sweet or starchy? – sweet	1 mark 1 mark 1 mark
21 a)	Any two suitable advantages such as: simplicity – looking at only one thing at a time does not need complicated equipment so can be used in the field.	1 mark each max. of 2 marks
21 b)	Any suitable disadvantage, such as the feature under consideration must be present in all organisms from a specific group.	1 mark
22 a)	ii) is the most useful question.	1 mark
22 b)	There are other organisms that have wings, e.g. bats and insects, and others that lay eggs, e.g. reptiles.	1 mark
23	Any suitable key that uses number of petals, visibility/number/arrangement of stamens, visibility/number/arrangement of stigmas, colour, as features to separate the flowers first into groups and then into single species using yes/no questions. For example: a Are the petals red – yes – go to b no – go to c b Are the stigmas and stamens visible? – yes – **hibiscus** no – **rose** c Does the flower have more than six petals? – yes – **daisy** no – **poppy**	1 mark for dichotomous questions 1 mark for key that is effective
	Total:	79 marks

