

Science 7–8

Chapter 7 — Biological sciences A: the diversity of life

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Similarities and differences within and between groups of organisms: the requirements for life, and naming and ordering species with the Linnaean hierarchy

What we teach here — VC2S8U01 (Victorian Curriculum F–10 Version 2.0, Science, Levels 7 and 8):

“there are similarities and differences within and between groups of organisms living on Earth; the development and use of classification tools, including dichotomous keys, help order and organise human understanding of the diversity of life” **This subtopic owns the first clause only:** the similarities and differences within and between groups of organisms, the requirements for life, and the naming and ordering of species with the Linnaean hierarchy. The second clause — the development and use of classification tools, including dichotomous keys — belongs to the partner subtopic **7B** (+ split delivery, D6). **In our words:** life on Earth is wonderfully varied — and yet it can be ordered. Organisms in one group are alike but not identical; organisms in different groups differ far more, right down to how they meet the very requirements of life. We sort them by shared features, give every species one two-part scientific name, and nest the groups inside each other in the Linnaean hierarchy — and when a new tool such as the microscope brings new evidence, the ordering is redrawn. **Achievement-standard extract served here (D13):**

“Students explain how biological diversity is ordered and organised.” **Elaborations drawn on:**

VC2S8U01.E01 (considering the reasons for classifying organisms, such as for identification and communication), VC2S8U01.E02 (the differences in ways that selected organisms achieve the common requirements for life), VC2S8U01.E05 (naming and classifying species using the scientific conventions of the Linnaean hierarchy) and VC2S8U01.E07 (researching how classification has changed through improvements in microscopy). **ICIP (D10):** no Aboriginal or Torres Strait Islander content is delivered here. VC2S8U01.E06 is reserved under the ICIP decision and is not taught; see the teacher-facing note at the foot of this subtopic. **Authored from the CD text and the elaboration contexts (D12):** the CD names the similarities and differences and the ordering of diversity, but not the list of life’s requirements nor the rules of naming; the seven requirements come from VC2S8U01.E02’s list, the naming and ordering conventions from VC2S8U01.E05, and the elaborations supply contexts — they are a bank, not a checklist.

Word watch — *species*. The word *species* is used carefully in science. A **species** is a group of organisms whose members can breed with each other and produce young that can themselves breed — eastern grey kangaroos breed with eastern grey kangaroos, and their young can too, so they are one species. For the smallest organisms, such as bacteria, which do not breed the way animals do, a species is named by its structure and chemistry instead. When two organisms are the same species, they are alike but not identical.

Word watch — *respiration*. In everyday talk, *respiration* sometimes just means breathing. In science, breathing and respiration are not the same thing. **Respiration** is the process that releases energy from food inside every living cell, so the cell has energy to do its work. Breathing only moves air in and out of the body; respiration happens in cells — in every cell of a kangaroo, a gum tree and a fungus, all the time. In this subtopic, *respiration* always carries the science meaning.

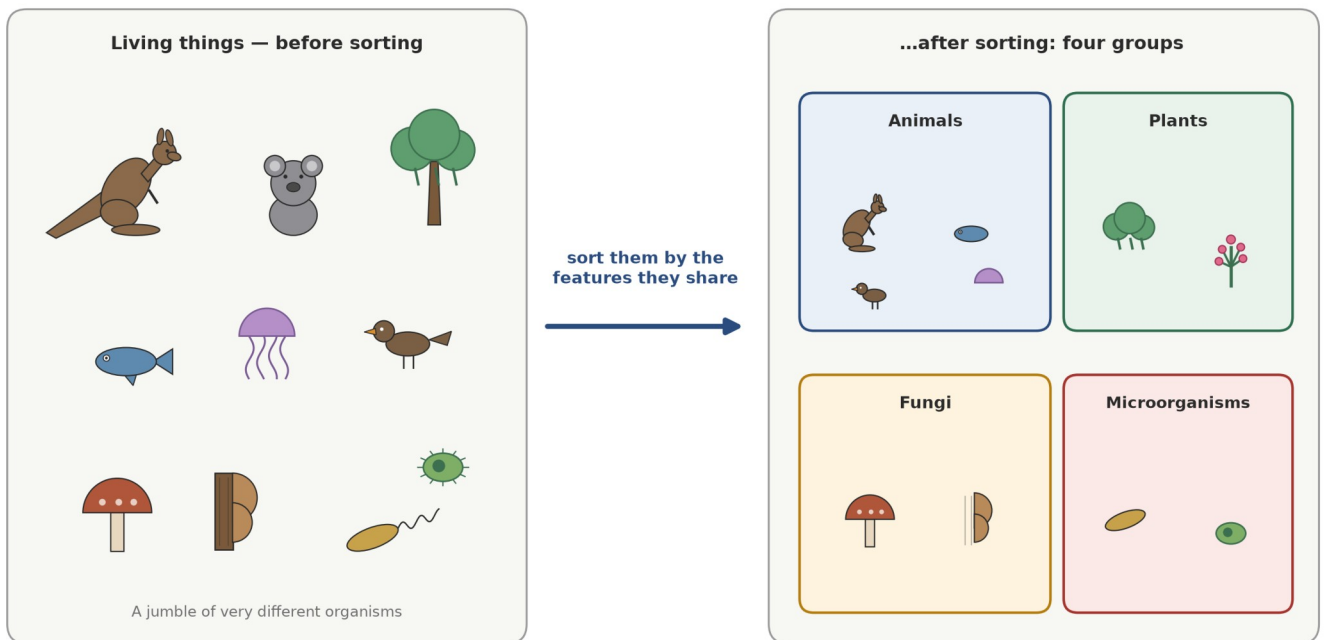
Theory

A jumble of life — and why we sort it (VC2S8U01.E01)

Look at the left-hand panel of the first figure: a kangaroo, a koala, a gum tree, a fish, a jellyfish, a bird, a mushroom, a bracket fungus, a bacterium and a protist. That jumble is a tiny picture of the diversity of life — the variety of organisms living on Earth. The Atlas of Living Australia, the national record of Australian life, held more than 101 million records of where organisms had been seen or collected when this book checked it (retrieved 2026-08-21). Faced with diversity on that scale, scientists sort it into groups.

Sorting is done by **shared features** — things the members of a group have in common. The right-hand panel shows the jumble sorted into four familiar groups: animals, plants, fungi and microorganisms. Why do this at all? Two reasons stand out (VC2S8U01.E01): **identification** — a sorted system lets you work out what an organism you have never seen before is; and **communication** — a scientist in Melbourne and a scientist in another country can share records and know they mean the same organism, because the groups and names are shared too.

Sorting the diversity of life into groups



Members of each group share important features — animals eat and move; plants make their own food; fungi absorb food; microorganisms are single-celled.

Sorting the diversity of life into groups: on the left, a jumble of very different organisms — a kangaroo, a koala, a gum tree, a fish, a jellyfish, a bird, a mushroom, a bracket fungus, a bacterium and a protist; on the right, the same organisms sorted into four boxes — animals, plants, fungi and microorganisms — whose members share important features

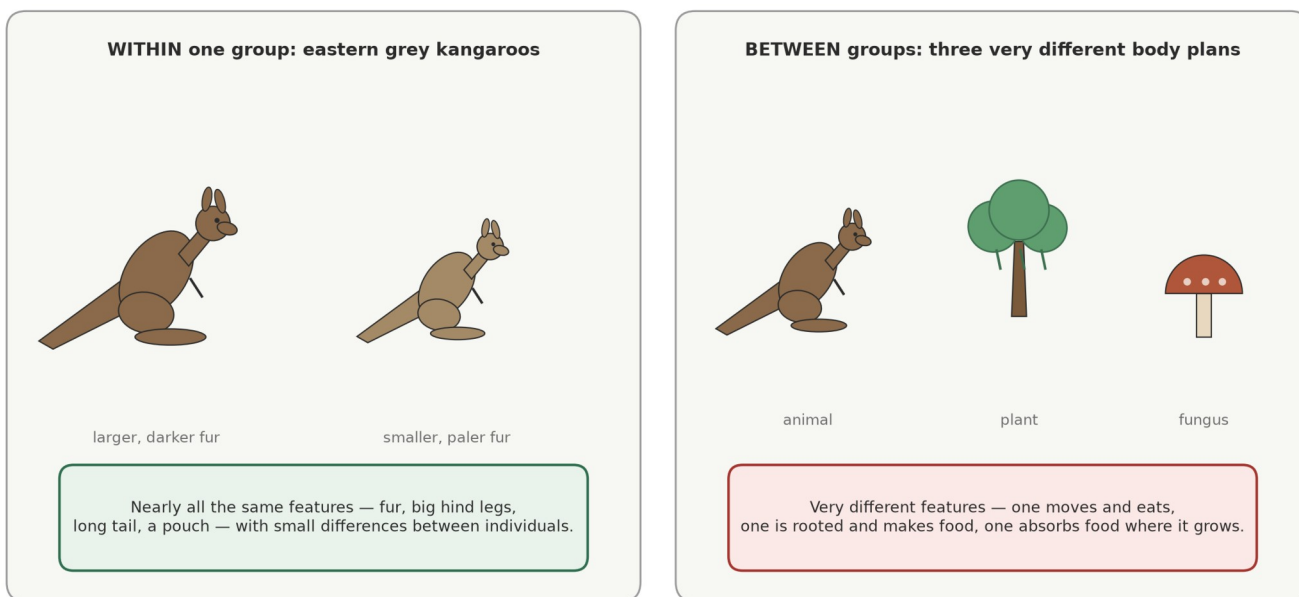
Similarities and differences — within a group, and between groups

The first clause of the content description says there are similarities and differences **within** and **between** groups of organisms. Both words matter.

Within one group — take eastern grey kangaroos — the members are alike but not identical. Two kangaroos share fur, big hind legs, a long thick tail and a pouch, yet one may be larger with darker fur while the other is smaller with paler fur. Those small differences between individuals of the same species are the similarities-and-differences *within* a group.

Between groups the differences run much deeper. Set a kangaroo against a gum tree and a mushroom: one moves about and eats other organisms; one stays rooted and makes its own food; one absorbs food from where it grows. These are differences in body plan and in how life is done — the similarities-and-differences *between* groups.

Similarities and differences — within a group, and between groups



Similarities and differences: on the left, two eastern grey kangaroos of the same species, one larger with darker fur and one smaller with paler fur, sharing fur, big hind legs, a long tail and a pouch; on the right, an animal, a plant and a fungus with very different features — one moves and eats, one is rooted and makes its own food, one absorbs food where it grows

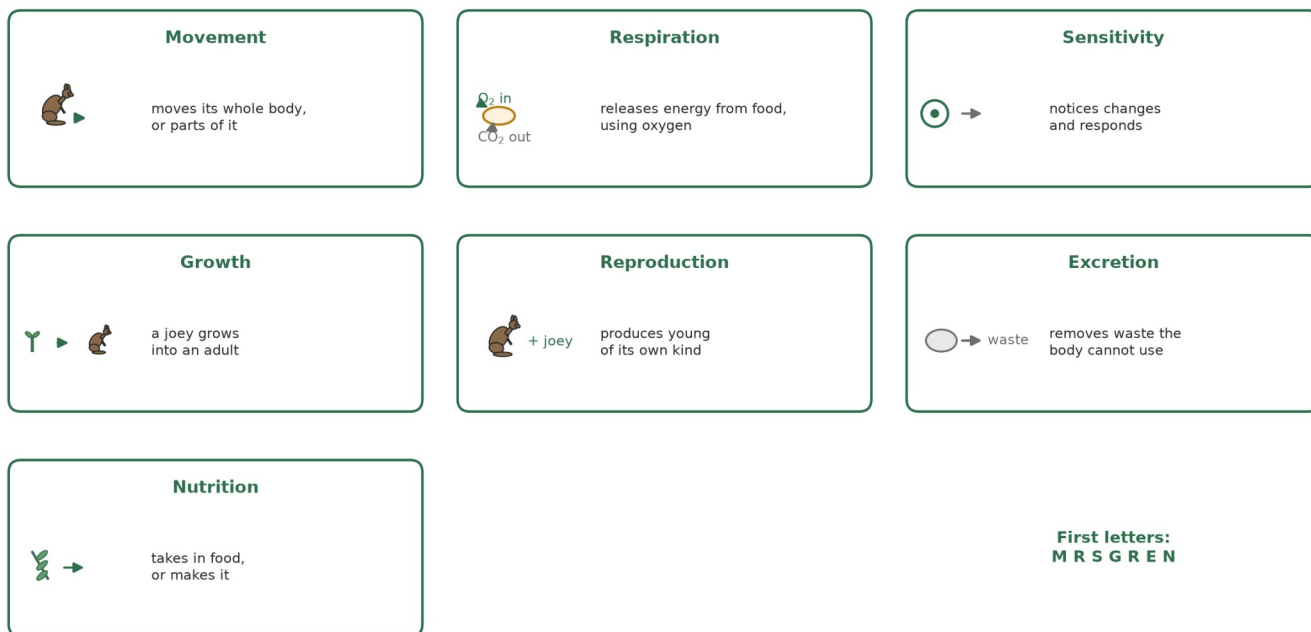
The requirements for life — MRS GREN (VC2S8U01.E02)

Every living thing — kangaroo, gum tree, mushroom, bacterium — must do the same seven jobs to stay alive. They are the **requirements for life**, and their first letters spell **MRS GREN**:

- **Movement** — moving the whole body, or parts of it.
- **Respiration** — releasing energy from food, using oxygen (see the Word watch above: not just breathing).
- **Sensitivity** — noticing changes around the organism and responding to them.
- **Growth** — getting larger and more developed, as a joey grows into an adult.
- **Reproduction** — producing young of its own kind.
- **Excretion** — getting rid of wastes the body cannot use.
- **Nutrition** — taking in food, or making it.

Any organism that does all seven is alive. A car moves and a fire “grows”, but neither does all seven — so neither is alive. The power of MRS GREN is that it is the same list for every group of life. The *ways* the seven jobs get done, though, differ from group to group — and that is the next figure.

The seven requirements of life — every living thing does all seven



Any organism that does all seven is alive. The ways the seven jobs get done differ from group to group — that is the next figure.

The seven requirements of life (MRS GREN), each in a box with a small picture: movement, respiration with oxygen in and carbon dioxide out, sensitivity, growth, reproduction, excretion with waste leaving, and nutrition — every living thing does all seven

The same requirements, met in different ways (VC2S8U01.E02)

Set three very different organisms side by side — an eastern grey kangaroo, a mountain ash (*Eucalyptus regnans*, Victoria's tallest tree) and a bracket fungus — and check the same three requirements against each.

- **Movement:** the kangaroo hops from place to place on powerful hind legs; the mountain ash stays rooted, but its leaves turn to face the light and its seeds travel on the wind; the fungus grows out across the wood, and its spores drift away to start new fungi.
- **Gas exchange (part of respiration):** the kangaroo breathes with lungs — oxygen in, carbon dioxide out; the tree swaps gases through tiny pores in its leaves; the fungus takes in oxygen and gives out carbon dioxide through its whole surface, like an animal.
- **Nutrition:** the kangaroo eats grasses and other plants; the mountain ash makes its own food in its leaves using sunlight (the food-making process met in full in subtopic 8B); the fungus cannot make food — it breaks down dead wood and absorbs the food from it.

One list of requirements; three completely different ways of meeting them. That is exactly what the elaboration means by “the differences in ways that selected organisms achieve the common requirements for life” — and those differences are some of the features scientists use when they sort the diversity of life into groups.

The same requirements of life — met in different ways

requirement of life	Eastern grey kangaroo an animal 	Mountain ash a plant — Victoria's tallest tree 	Bracket fungus a fungus, growing on dead wood 
Movement	Hops from place to place on powerful hind legs.	Stays rooted in one place; its leaves turn to face the light and its seeds travel on the wind.	Grows out across the wood; its spores drift away to start new fungi.
Gas exchange (part of respiration)	Breathes with lungs — oxygen in, carbon dioxide out.	Swaps gases through tiny pores in its leaves.	Takes in oxygen and gives out carbon dioxide through its surface, like an animal.
Nutrition	Eats grasses and other plants.	Makes its own food in its leaves, using sunlight (photosynthesis).	Cannot make food — breaks down dead wood and absorbs the food from it.

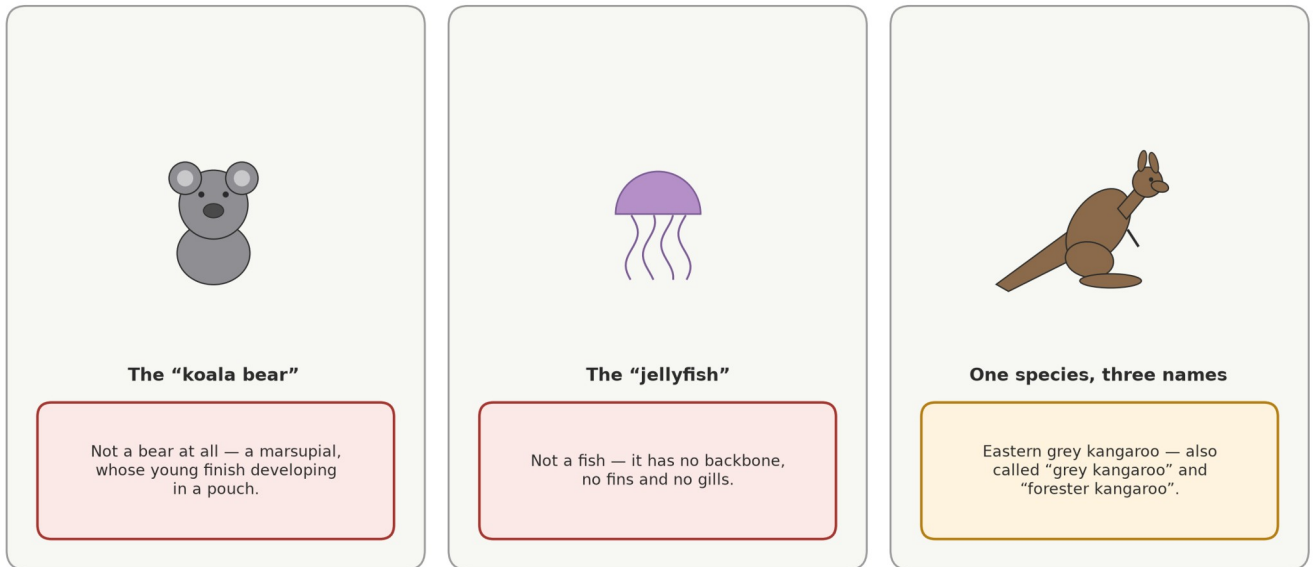
One list of requirements, many ways of meeting them — differences between the groups of life.

The same requirements of life met in different ways by an eastern grey kangaroo, a mountain ash and a bracket fungus: movement (hopping; leaves turning to the light and seeds on the wind; growing across the wood), gas exchange (lungs; tiny leaf pores; the whole surface) and nutrition (eating plants; making its own food in sunlight; breaking down dead wood and absorbing the food)

The trouble with common names (VC2S8U01.E01)

Common names feel friendly, but they mislead in at least three ways. A common name can **say something false**: the “koala bear” is not a bear at all — it is a pouched mammal, whose young finish developing in a pouch, while true bears are mammals of a quite different kind. The “jellyfish” is not a fish — it has no backbone, no fins and no gills. A common name can also **vary from place to place**: the one species most of Victoria calls the eastern grey kangaroo is also called “grey kangaroo” and “forester kangaroo” in other places. Add the many languages of the world and one species can carry dozens of common names — which is exactly the identification-and-communication problem VC2S8U01.E01 points at.

Three ways common names mislead



Common names vary from place to place and can say something false. A scientific name gives each species exactly one name, used worldwide.

Three ways common names mislead: the “koala bear” is not a bear at all but a pouched mammal; the “jellyfish” is not a fish — it has no backbone, no fins and no gills; and one species, the eastern grey kangaroo, also goes by “grey kangaroo” and “forester kangaroo” in different places

The two-part scientific name (VC2S8U01.E05)

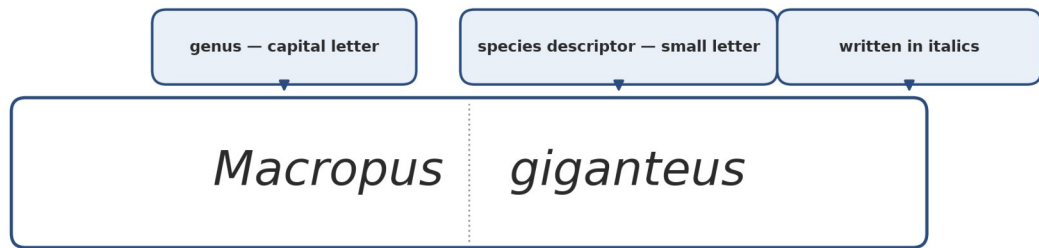
The fix is a system designed in the 1700s by the Swedish scientist **Carl Linnaeus**: every species on Earth gets exactly one **scientific name**, made of two parts, used worldwide. The eastern grey kangaroo’s name is *Macropus giganteus*.

The conventions (VC2S8U01.E05) are the rules that make the name work:

- The first word is the **genus** — the group of closely matched species — and takes a **capital letter**: *Macropus*.
- The second word names the **species** itself and takes a **small letter**: *giganteus*.
- The whole name is **written in italics** when printed, and **underlined** when written by hand (the underline standing in for italics).
- The name is based on Latin or Greek, so it reads the same in every language.
- After first use, the genus may be shortened to its capital: *M. giganteus*.
- The name of the person who first described the species, and the year, may follow in plain type: *Macropus giganteus* Shaw, 1790.

One species, one name, understood everywhere — the communication problem solved.

The two-part scientific name — binomial nomenclature



- Based on Latin or Greek, so it reads the same in every language.
- Underline the name when writing by hand (the italic's stand-in).
- After first use, the genus may be shortened: *M. giganteus*.
- The describer and year may follow: *Macropus giganteus* Shaw, 1790.

Every species on Earth gets exactly one such name — the system designed by Carl Linnaeus in the 1700s.

*The two-part scientific name of the eastern grey kangaroo, *Macropus giganteus*: the genus *Macropus* takes a capital letter, the second word *giganteus* takes a small letter, and the whole name is written in italics; notes add that the name is based on Latin or Greek, is underlined when written by hand, may be shortened to *M. giganteus* after first use, and may carry the describer and year — Shaw, 1790*

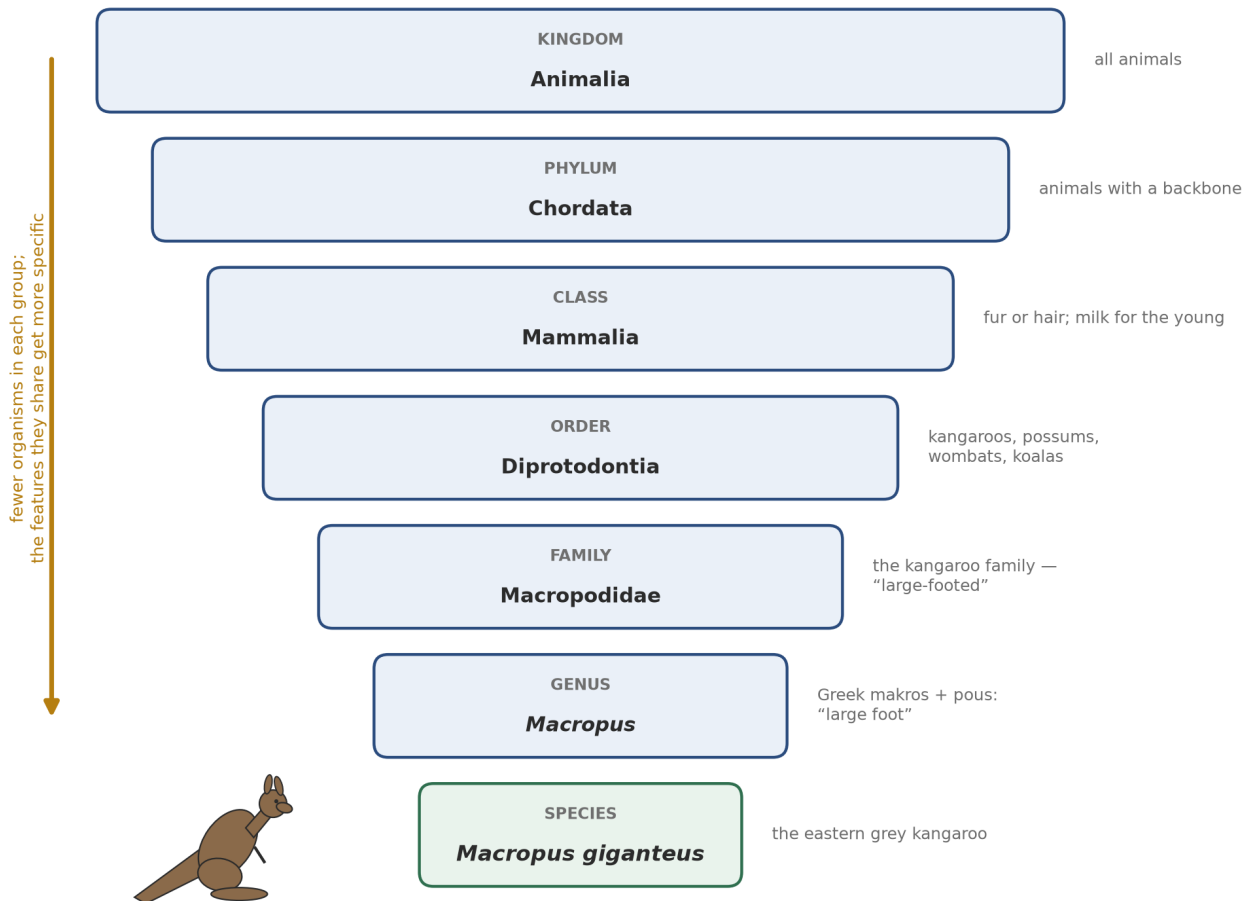
The Linnaean hierarchy — groups within groups (VC2S8U01.E05)

Naming each species is only half of Linnaeus's system. The groups themselves are ordered into a **hierarchy** — an ordered system of groups within groups, like boxes within boxes. The Linnaean hierarchy has seven ranks, largest to smallest:

kingdom → phylum → class → order → family → genus → species

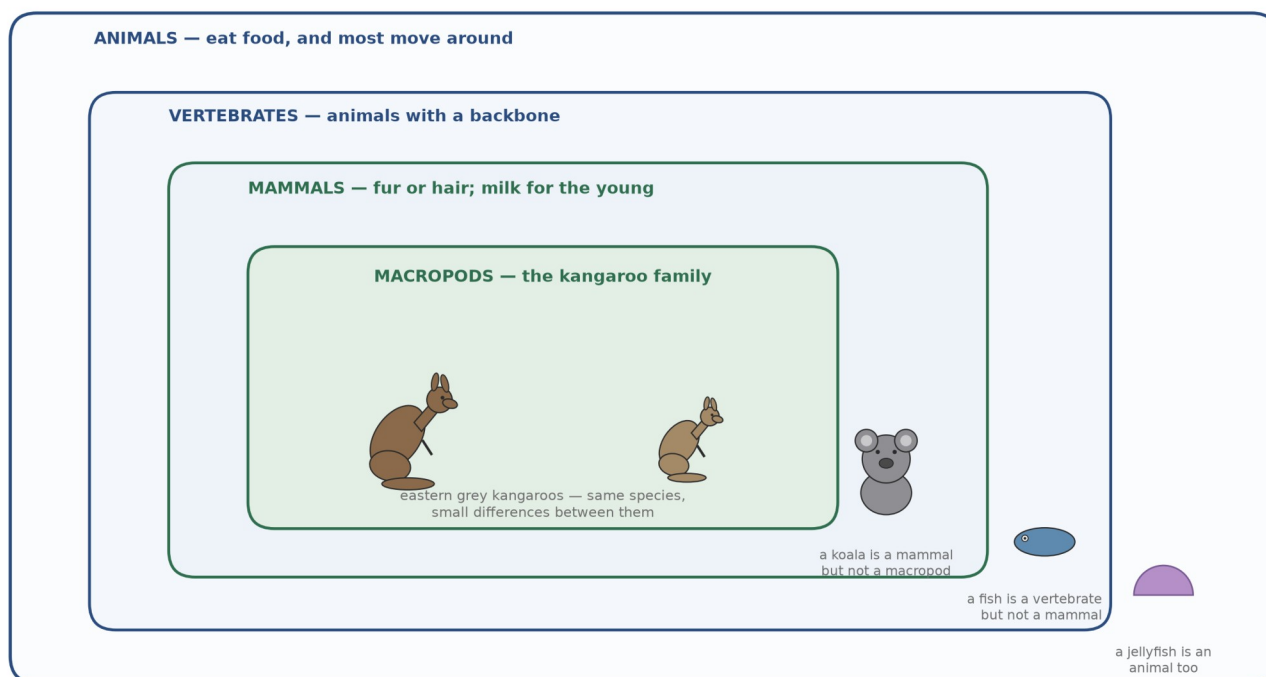
Read down the ladder for the eastern grey kangaroo: it sits in the kingdom **Animalia** (all animals), the phylum **Chordata** (animals with a backbone), the class **Mammalia** (fur or hair, and milk for the young), the order **Diprotodontia** (kangaroos, possums, wombats, koalas), the family **Macropodidae** (the kangaroo family, “large-footed”), the genus ***Macropus*** and the species ***Macropus giganteus***. At each step down, the group holds fewer organisms, and the features the members share get more specific. The nested-boxes figure shows the same idea as boxes: macropods sit inside mammals, mammals inside vertebrates, vertebrates inside animals. A koala is in the mammals box but outside the macropods box; a fish is in the vertebrates box but outside mammals; a jellyfish is in the animals box but outside vertebrates. Where an organism sits — and which boxes it is outside — is information.

The Linnaean hierarchy — ordering the eastern grey kangaroo



*The Linnaean hierarchy worked for the eastern grey kangaroo as a ladder of seven ranks from kingdom to species — **Animalia, Chordata, Mammalia, Diprotodontia, Macropodidae, Macropus, Macropus giganteus** — with fewer organisms in each group and the shared features getting more specific towards the bottom*

Groups within groups — each smaller group shares more features



Groups within groups as boxes within boxes: animals contains vertebrates, vertebrates contains mammals, mammals contains macropods; a jellyfish is an animal but not a vertebrate, a fish is a vertebrate but not a mammal, a koala is a mammal but not a macropod, and two eastern grey kangaroos of the same species sit in the innermost box

How close is close? — reading the ranks

The rank at which two organisms first part company tells you how much they have in common. The eastern grey kangaroo and **Leadbeater's possum** (*Gymnobelideus leadbeateri*), Victoria's faunal emblem, share four ranks — kingdom, phylum, class and order: both are diprotodontians. They part company at family: the possum belongs to a different family from the kangaroos. So the two are alike in many deep ways — fur, milk, and the order's body plan — yet clearly different animals. The koala tells the same story: same order as the kangaroo, different family. Now set the kangaroo against the **weedy seadragon** (*Phyllopteryx taeniolatus*), Victoria's marine emblem: the two share only kingdom and phylum, parting company as early as class — one is a mammal with fur and milk, the other a fish with fins and gills. Sharing four ranks means sharing far more features than sharing two. The hierarchy is not just an ordering; it is a measure of similarity.

New tools, new evidence — how classification changed (VC2S8U01.E07)

The ordering above was not written in one go, and it was never finished. It has been revised again and again as new evidence arrived (VC2S8U01.E07).

About 350 BCE, the Greek thinker **Aristotle** sorted animals into two groups — “with blood” and “without”. In 1735, **Linnaeus** began the modern system with two kingdoms — plants and animals — and his two-part names. Then the microscope opened a hidden world. In 1665, **Robert Hooke** looked at thin cork and saw tiny boxes, which he called “cells” — the first look at living structure up close. In the 1670s, **Antonie van Leeuwenhoek** turned his single-lens microscope on a drop of pond water and saw living things too small to see with the naked eye — a whole invisible diversity of life.

Classification had to make room for that diversity. In 1969, **Robert Whittaker** published the **five-kingdom system**: fungi, which absorb their food, left the plants; the single-celled groups gained kingdoms of their own (some books call the bacteria kingdom “Monera”). Then in 1990, **Carl Woese** and his co-workers compared the fine detail inside cells

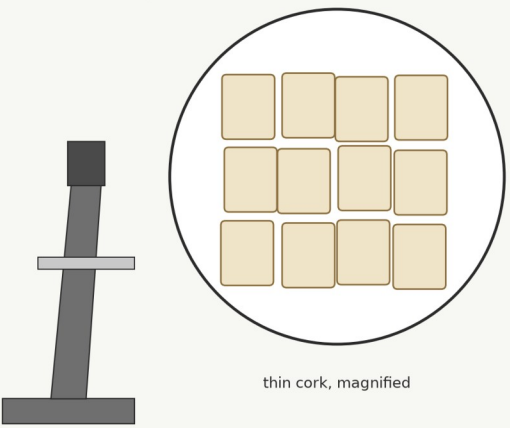
and showed that the “bacteria” were really two very different groups — so the top level of classification was redrawn **above** the kingdoms, as the **three-domain system**: Bacteria, Archaea (single-celled organisms that often live in extreme places such as hot springs and very salty lakes) and Eukarya (organisms built from cells with more complex inner structure — animals, plants, fungi and protists).

Notice *why* the system changed each time: not opinion, not fashion — new evidence from better instruments and finer observations. That is how scientific knowledge changes (Chapter 1).

New tools, new evidence: the microscope opens a hidden world

Robert Hooke, 1665

saw cork as tiny boxes — and called them “cells”

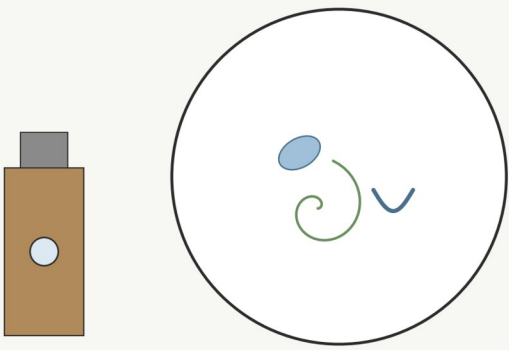


thin cork, magnified

a simple microscope

Antonie van Leeuwenhoek, 1670s

saw living “animalcules” — life too small to see



a single-lens microscope

a drop of pond water, magnified

Classification had to make room for a whole invisible diversity — two kingdoms would not do forever.

New tools, new evidence: Robert Hooke in 1665 saw thin cork as tiny boxes and called them cells, using a simple microscope; Antonie van Leeuwenhoek in the 1670s used a single-lens microscope to see living things in a drop of pond water too small to see with the naked eye — a hidden diversity classification had to make room for

The five-kingdom system (Whittaker, 1969)

Animals



eat other organisms;
most move around

Plants



make their own food
using sunlight

Fungi



absorb food from dead
or decaying matter

Protists



mostly single-celled;
water and damp places

Bacteria



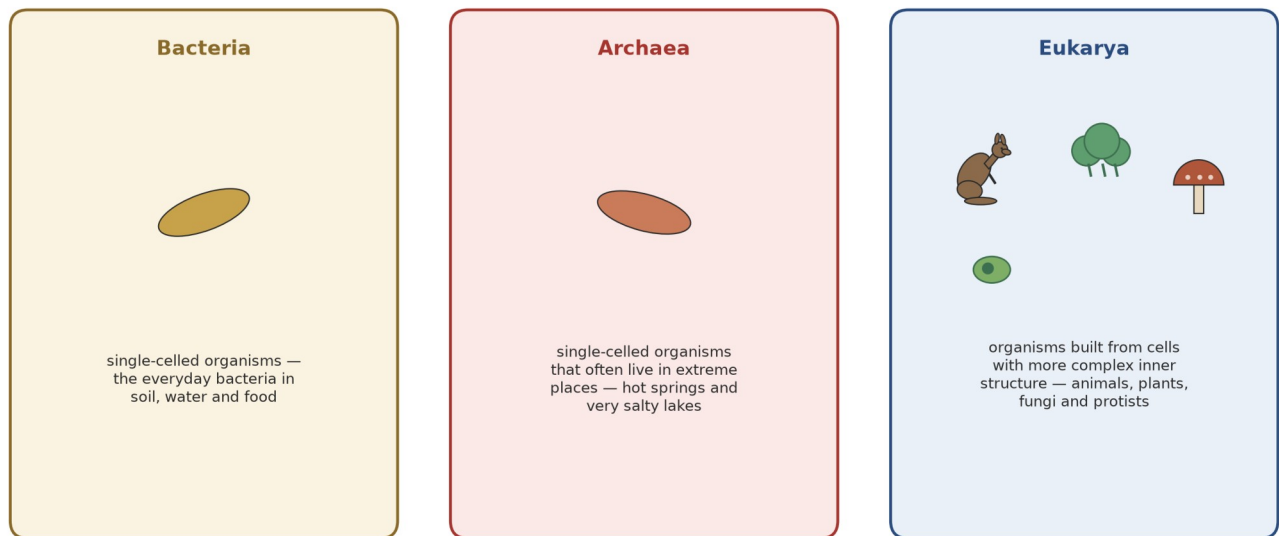
the smallest cells;
found almost everywhere

Some books call the bacteria kingdom “Monera”. The five-kingdom system was itself later revised — see the three-domain system.

The five-kingdom system (Whittaker, 1969): animals eat other organisms and most move around; plants make their own food using sunlight; fungi absorb food from dead or decaying matter; protists are mostly single-celled, in water

and damp places; bacteria are the smallest cells, found almost everywhere — with a note that some books call the bacteria kingdom Monera

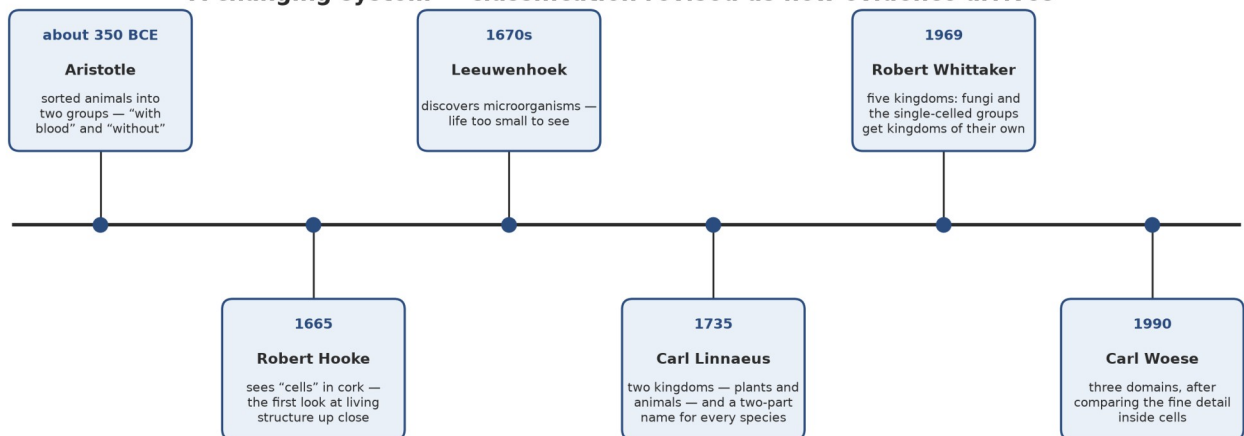
The three-domain system (Woese, 1990)



Comparing the fine detail inside cells showed that “bacteria” were really two very different groups — so the top level of classification was redrawn above the kingdoms.

The three-domain system (Woese, 1990): Bacteria — the everyday single-celled organisms of soil, water and food; Archaea — single-celled organisms that often live in extreme places such as hot springs and very salty lakes; Eukarya — organisms built from cells with more complex inner structure, including animals, plants, fungi and protists

A changing system — classification revised as new evidence arrives

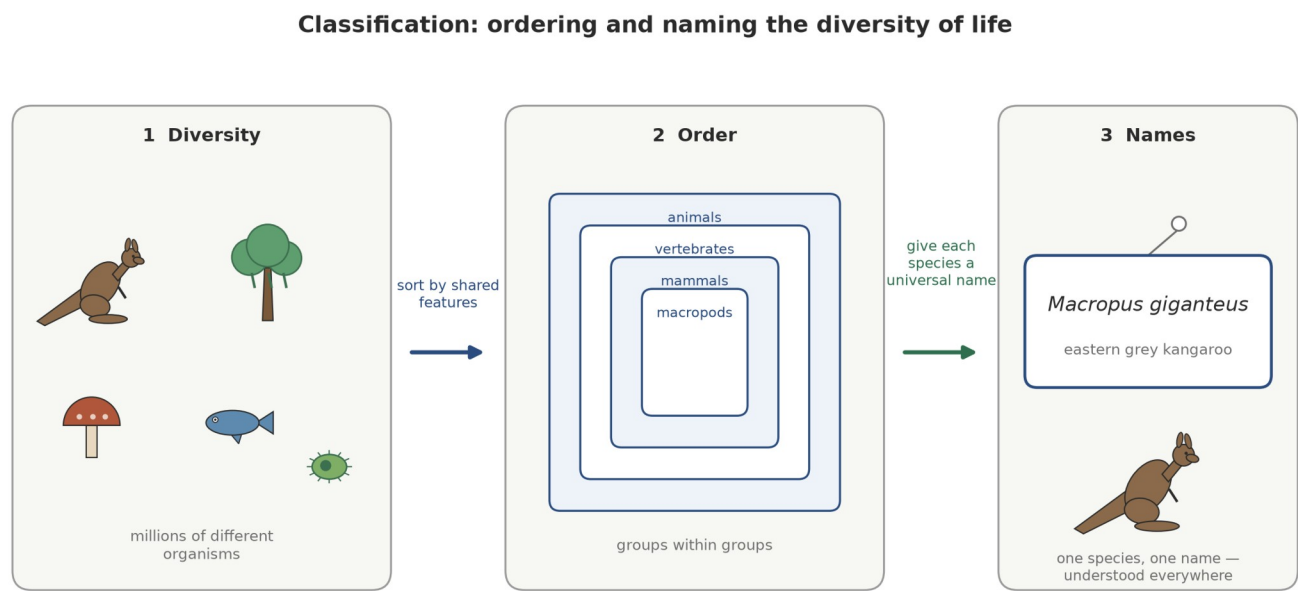


Each revision came from new evidence — better instruments and finer observations — never from opinion. That is how scientific knowledge changes (Chapter 1).

A timeline of classification revised as new evidence arrives: about 350 BCE Aristotle sorts animals into two groups; 1665 Robert Hooke sees cells in cork; the 1670s Leeuwenhoek discovers microorganisms; 1735 Carl Linnaeus names two kingdoms and gives every species a two-part name; 1969 Robert Whittaker’s five kingdoms; 1990 Carl Woese’s three domains — each revision coming from new evidence, never from opinion

Pulling it together

Start with the diversity of life — millions of different organisms. Sort it by shared features and it becomes order: groups within groups, from kingdoms down to species. Give each species one universal scientific name and the order can be communicated everywhere on Earth. That is what the achievement standard asks you to explain: how biological diversity is **ordered and organised**. The similarities and differences within and between groups are the evidence; the Linnaean hierarchy and the two-part name are the ordering; and the whole system stays open to revision whenever new evidence arrives. (The other half of VC2S8U01 — using and building classification tools such as dichotomous keys — is subtopic 7B.)



*Summary of the subtopic in three panels: diversity — millions of different organisms — is sorted by shared features into order — groups within groups, from animals down to macropods — and each species is given a universal name, *Macropus giganteus* for the eastern grey kangaroo: one species, one name, understood everywhere*

Words to know in 7A

Word	What it means here
organism	any living thing — an animal, plant, fungus or microorganism
diversity of life	the variety of organisms living on Earth
classification	sorting organisms into groups by the features they share
requirements for life	the seven jobs every living thing does — movement, respiration, sensitivity, growth, reproduction, excretion, nutrition (MRS GREN)
respiration	the process that releases energy from food inside living cells
sensitivity	noticing changes around the organism and responding to them
excretion	getting rid of wastes the body cannot use
nutrition	taking in food, or making it
species	a group of organisms whose members can breed with each other and produce young that can themselves breed
genus	a group of closely matched species; the first word of a scientific name
scientific name	the two-part Latin-or-Greek name every species gets,

Word	What it means here
	used worldwide
Linnaean hierarchy	the ordered system of groups within groups: kingdom, phylum, class, order, family, genus, species
kingdom	the largest rank of the Linnaean hierarchy taught here
phylum	the rank inside a kingdom; members share a body plan
class	the rank inside a phylum
order	the rank inside a class
family	the rank inside an order
vertebrate	an animal with a backbone
evidence	observations that support or change a scientific idea

Worked examples

Example 1 — scaffolded

Four descriptions each name one of the seven requirements of life. Name each requirement.

Working	Comment
1. “A kangaroo turns towards the sound of a dingo and hops away.” — sensitivity .	Noticing a change (the sound) and responding to it (turning, hopping) is sensitivity.
2. “A bracket fungus breaks down dead wood and absorbs the food from it.” — nutrition .	Taking in food — here, absorbing it after breaking wood down — is nutrition.
3. “A joey in the pouch gains weight week by week until it leaves the pouch.” — growth .	Getting larger and more developed over time is growth.
4. “A gum tree gets rid of wastes by packing them into old leaves that fall.” — excretion .	Removing wastes the body cannot use is excretion — plants do it too.

Example 2 — scaffolded

The seven ranks of the Linnaean hierarchy, and the eastern grey kangaroo’s place in them, are in the ladder figure.

Working	Comment
(a) Largest to smallest: kingdom → phylum → class → order → family → genus → species .	The ladder reads top to bottom; each rank sits inside the one above it.
(b) The two ranks that make the scientific name are the genus and the species : <i>Macropus giganteus</i> — capital first word, small second word, italics.	The name is the bottom two ranks of the ladder, written by the conventions.
(c) Going down the ladder, the number of organisms in each group gets smaller , and the features the members share get more specific .	Kingdom holds all animals; the species holds one kind of kangaroo — fewer organisms, sharper features.

Example 3 — unscaffolded

Explain why any two organisms placed in the same **family** must also be in the same **order**, while two organisms in the same order need *not* be in the same family. Use the nested-boxes idea and one named example for each half of your answer.

The family box sits *inside* the order box, so anything placed in a family box is automatically inside the order box around it: every macropod (family Macropodidae) is therefore a diprotodontian (order Diprotodontia) — same family forces same order. The order box, though, holds more than one family box: the eastern grey kangaroo and Leadbeater’s possum share the order Diprotodontia but sit in different families. ∴ same family ⇒ same order, but same order ⇏ same family — the hierarchy is groups within groups, and a larger box never forces one particular smaller box.

Example 4 — unscaffolded

A classmate says: “*Classification is settled — once scientists name the groups, the system never changes.*” Evaluate this claim using **two** named revisions from this subtopic.

The claim is wrong. (1) The microscope revealed life that the two-kingdom system had no room for — Hooke’s cells and Leeuwenhoek’s pond-water living things — and in 1969 Whittaker’s five-kingdom system moved fungi out of the plants and gave the single-celled groups kingdoms of their own. (2) In 1990, Woese’s comparison of the fine detail inside cells split the “bacteria” into two very different groups, redrawing the top level as three domains above the kingdoms. ∴ the system has changed repeatedly — and each change followed new evidence from better instruments, never opinion, which is exactly how scientific knowledge changes (Chapter 1).

Practice questions

Scaffolded

Q1. Define each of the following, as the words are used in this subtopic: (a) organism; (b) classification; (c) genus; (d) species.

Q2. Answer the following about the requirements for life. (a) List the seven requirements for life (MRS GREN). (b) State what the science meaning of *respiration* is, and how it differs from breathing.

Q3. Four descriptions each name one requirement of life. Name it. (a) A weedy seadragon’s fins move in a current, drifting the animal a little further along the weed. (b) A mountain ash seedling becomes a 90 m tree. (c) A female kangaroo produces a joey. (d) Every cell of a swimming bird releases energy from food, using oxygen.

Q4. Answer the following about the Linnaean hierarchy. (a) Write the seven ranks in order, largest to smallest. (b) Write the scientific name of the eastern grey kangaroo, following all three conventions. (c) State what the first word of that name, *Macropus*, labels.

Q5. Use the within-and-between figure. (a) State one feature shared by the two eastern grey kangaroos (a similarity within the group). (b) State one way the two kangaroos differ (a difference within the group). (c) State one difference between the kangaroo, the gum tree and the mushroom (a difference between groups).

Q6. Use the common-names figure. (a) State two different ways common names mislead, with the example from the figure for each. (b) State the naming rule that fixes the “one species, three names” problem.

Unscaffolded

Q7. Choose **two** of the seven requirements for life. For each, explain how the eastern grey kangaroo and the mountain ash achieve it in *different* ways. (*Draws on VC2S8U01.E02.*)

Q8. A jellyfish has no backbone, no fins and no gills. Using the nested-boxes figure, explain which boxes a jellyfish sits in and which box it must sit outside, and why it is still an animal.

Q9. “All macropods are mammals, but not all mammals are macropods.” Explain why this sentence must be true, using the nested-boxes idea and one named organism that is a mammal but not a macropod.

Q10. The eastern grey kangaroo and Leadbeater’s possum share kingdom, phylum, class and order, and part company at family. The kangaroo and the weedy seadragon part company at class. Explain what that tells you about the features the possum and kangaroo share, compared with the seadragon and kangaroo.

Q11. Explain how the microscope changed biological classification, naming what Hooke (1665) and Leeuwenhoek (1670s) each saw and why what they saw forced the old two-kingdom system to grow. (*Draws on VC2S8U01.E07.*)

Q12. The five-kingdom system (Whittaker, 1969) was later followed by the three-domain system (Woese, 1990). (a) Name the group that sat *above* the kingdoms in the three-domain system, and the three names it holds. (b) Explain why the top level of classification was redrawn.

Q13. A student says: “*Scientists keep changing the classification system, so the system cannot be trusted.*” Evaluate this claim, using the idea of evidence from this subtopic and one named revision.

Q14. Two eastern grey kangaroos stand in a paddock: same species, yet one is larger with darker fur. Explain how two organisms can be the same species and still differ, and why the differences between those two kangaroos are small compared with the differences between a kangaroo and a bracket fungus.

Answers

Q1. (a) Any living thing — an animal, plant, fungus or microorganism. (b) Sorting organisms into groups by the features they share. (c) A group of closely matched species; the first word of a scientific name. (d) A group of organisms whose members can breed with each other and produce young that can themselves breed. **Q2.** (a) Movement, respiration, sensitivity, growth, reproduction, excretion, nutrition. (b) Respiration is the process that releases energy from food inside living cells; breathing only moves air in and out of the body. **Q3.** (a) Movement. (b) Growth. (c) Reproduction. (d) Respiration. **Q4.** (a) Kingdom → phylum → class → order → family → genus → species. (b) *Macropus giganteus* — capital genus, small second word, italics (underline by hand). (c) The genus — the group of closely matched species. **Q5.** (a) Any one: fur; big hind legs; long tail; a pouch. (b) Any one: size; fur colour. (c) Any one: the kangaroo moves and eats, the tree is rooted and makes its own food, the fungus absorbs food where it grows. **Q6.** (a) Any two: a common name can say something false — the “koala bear” is not a bear; the “jellyfish” is not a fish; a common name can vary from place to place — one species also called “grey kangaroo” and “forester kangaroo”. (b) Every species gets exactly one scientific name, used worldwide. **Q7.** Any two, correctly contrasted, e.g. movement: the kangaroo hops on hind legs, the mountain ash stays rooted but its leaves turn to the light and its seeds travel on the wind; nutrition: the kangaroo eats plants, the tree makes its own food in its leaves using sunlight; gas exchange: lungs against leaf pores. **Q8.** The jellyfish sits in the animals box but outside the vertebrates box (and so outside mammals and macropods too); it is still an animal because it shares the animals’ features — it eats other organisms and moves — and “animal” does not require a backbone. **Q9.** The macropods box sits inside the mammals box, so everything in the inner box is in the outer one — all macropods are mammals; the mammals box holds organisms outside the macropods box, e.g. the koala, so not all mammals are macropods. **Q10.** The possum and kangaroo share four ranks, so they share many deep features (fur, milk, backbone, the order’s body plan); the seadragon and kangaroo share only two ranks, so they share far fewer features — the later the parting, the more in common. **Q11.** Hooke saw cork as tiny boxes — cells; Leeuwenhoek saw living things in pond water too small to see; the old two-kingdom system (plants and animals) had no room for this hidden diversity, so new kingdoms had to be added for the single-celled groups and for fungi. **Q12.** (a) The domain — Bacteria, Archaea, Eukarya. (b) Comparing the fine detail inside cells showed the “bacteria” were two very different groups; new evidence required a new top level. **Q13.** Wrong view of change: each revision (e.g. Whittaker’s five kingdoms after microscopy revealed the single-celled diversity, or Woese’s three domains) followed new evidence from better instruments — a system that improves with evidence is more trustworthy, not less. **Q14.** Members of one species can breed with each other and are alike in the species’ features (fur, hind legs, tail, pouch) yet not identical — small differences such as size and fur colour vary between individuals; between groups, the differences are in body plan and in how the requirements of life are met (eating and moving against absorbing food), which are far deeper than size or shade.

Fully-worked solutions

Q1. (a) An **organism** is any living thing — an animal, plant, fungus or microorganism (1 mark). (b) **Classification** is sorting organisms into groups by the features they share (1 mark). (c) A **genus** is a group of closely matched species; it is the first word of a scientific name (1 mark). (d) A **species** is a group of organisms whose members can breed with each other and produce young that can themselves breed (1 mark).

Q2. (a) The seven requirements for life are **movement, respiration, sensitivity, growth, reproduction, excretion and nutrition** — MRS GREN (2 marks — all seven for 2, five or six for 1). (b) **Respiration** is the process that **releases energy from food inside living cells; breathing only moves air in and out of the body**, while respiration happens in cells (2 marks — one per part).

Q3. (a) **Movement** — the fins move the body (1 mark). (b) **Growth** — the seedling becomes a large tree (1 mark). (c) **Reproduction** — producing young of its own kind (1 mark). (d) **Respiration** — releasing energy from food, using oxygen, in cells (1 mark).

Q4. (a) **Kingdom → phylum → class → order → family → genus → species** (2 marks — all seven in order for 2, one slip for 1). (b) ***Macropus giganteus*** — capital M, small g, italics (underlined by hand) (2 marks — name correct plus all three conventions). (c) The first word labels the **genus** — the group of closely matched species (1 mark).

Q5. (a) Any one shared feature: **fur; big hind legs; long tail; a pouch** (1 mark). (b) Any one difference within the group: **size; fur colour** (1 mark). (c) Any one difference between groups: **the kangaroo moves and eats other organisms; the gum tree is rooted and makes its own food; the mushroom absorbs food where it grows** (1 mark).

Q6. (a) Any two, each with its example (2 marks — one each): **a common name can say something false** — the “koala bear” is not a bear (or: the “jellyfish” is not a fish); **a common name can vary from place to place** — the eastern grey kangaroo is also “grey kangaroo” and “forester kangaroo”. (b) The rule: **every species gets exactly one scientific name, used worldwide** (1 mark).

Q7. Any two requirements, each correctly contrasted (2 marks per requirement — one per organism’s way). E.g. **movement**: the kangaroo **hops from place to place on powerful hind legs**, while the mountain ash **stays rooted, its leaves turning to the light and its seeds travelling on the wind**. **Nutrition**: the kangaroo **eats grasses and other plants**, while the mountain ash **makes its own food in its leaves using sunlight**. **Gas exchange**: the kangaroo **breathes with lungs**, while the tree **swaps gases through tiny pores in its leaves**.

Q8. The jellyfish sits **inside the animals box but outside the vertebrates box** — and therefore outside the mammals and macropods boxes too (1 mark). It is still an animal because it **shares the features that define the animals box** — **it eats other organisms and moves about** — and being an animal does not require a backbone (1 mark).

Q9. The **macropods box sits inside the mammals box**, so every organism in the inner box is also in the outer one — all macropods are mammals (1 mark). The mammals box also holds organisms **outside** the macropods box — e.g. **the koala**, a mammal that is not a macropod — so not all mammals are macropods (1 mark).

Q10. The possum and the kangaroo **share four ranks** (kingdom to order), so they share **many deep features** — **fur, milk, a backbone, the diprotodont body plan** (2 marks). The seadragon and the kangaroo **share only two ranks** (kingdom and phylum), parting at class, so they share **far fewer features** — **a backbone, but not fur or milk** (1 mark). The later two organisms part company in the hierarchy, the more they have in common.

Q11. **Hooke (1665)** saw thin cork as tiny boxes and named them **cells** — the first look at living structure up close (1 mark). **Leeuwenhoek (1670s)** saw **living things in pond water too small to see with the naked eye** (1 mark). The old **two-kingdom system (plants and animals)** **had no room** for this hidden diversity, so the single-celled groups — and later fungi — needed kingdoms of their own: the system grew because **new evidence arrived** (1 mark).

Q12. (a) The rank above the kingdoms is the **domain**, holding **Bacteria, Archaea and Eukarya** (1 mark). (b) The top level was redrawn because **comparing the fine detail inside cells showed the “bacteria” were really two very different groups** — **new evidence required a new ordering**, not anyone’s opinion (2 marks).

Q13. The claim gets the science backwards (1 mark). Each revision followed **new evidence from better instruments** — e.g. **Whittaker’s five kingdoms (1969)** came after microscopy revealed the single-celled diversity and the separate ways of fungi (or: **Woese’s three domains, 1990**, from comparing the fine detail inside cells) (1 mark). A system that changes *because* the evidence improves is a system getting closer to the truth — that is why it can be trusted, which is how scientific knowledge changes (Chapter 1) (1 mark).

Q14. Members of one **species can breed with each other and produce young that can breed**, and they share the species’ features — **fur, big hind legs, long tail, a pouch** — yet are **not identical**: small differences such as **size and fur colour** vary between individuals; that is the similarity and difference *within* a group (2 marks). Between groups the differences run far deeper — a kangaroo **moves and eats**, a bracket fungus **absorbs food from dead wood** — differences in body plan and in how the requirements of life are met, which are much greater than size or shade (1 mark).

Sources

Web sources below were retrieved 2026-08-21.

- Atlas of Living Australia, home page — the national record of Australian life, showing 101,540,359 records of organisms at retrieval. ala.org.au
- Atlas of Living Australia, Biodiversity Information Explorer — the accepted taxonomy of *Macropus giganteus* (Shaw, 1790): kingdom Animalia, phylum Chordata, class Mammalia, order Diprotodontia, family

Macropodidae, genus *Macropus*; and of *Eucalyptus regnans* F.Muell. (mountain ash): kingdom Plantae, family Myrtaceae. bie.ala.org.au

- Victoria State Government, “Victoria’s State Emblems” — Leadbeater’s possum (*Gymnobelideus leadbeateri*), the faunal emblem; the weedy seadragon (*Phyllopteryx taeniolatus*), the marine emblem; the common heath (*Epacris impressa*), the floral emblem. vic.gov.au
- Linnaeus, C., *Systema Naturae* (1735) and *Species Plantarum* (1753) — the two-kingdom system and the two-part naming of species.
- Hooke, R., *Micrographia* (1665) — cork seen as tiny boxes, named “cells”.
- Leeuwenhoek, A. van, letters of the 1670s — living “animalcules” in pond water.
- Whittaker, R. H., “New concepts of kingdoms of organisms”, *Science* 163, 150–160 (1969). DOI 10.1126/science.163.3863.150
- Woese, C. R., Kandler, O. & Wheelis, M. L., “Towards a natural system of organisms: proposal for the domains Archaea, Bacteria, and Eucarya”, *PNAS* 87, 4576–4579 (1990). DOI 10.1073/pnas.87.12.4576
- Aristotle, *History of Animals*, c. 350 BCE — sorting animals into “with blood” and “without”.

Elaboration contexts used: VC2S8U01.E01 (reasons for classifying — identification and communication), VC2S8U01.E02 (differences in ways selected organisms achieve the common requirements for life), VC2S8U01.E05 (Linnaean naming and ordering conventions) and VC2S8U01.E07 (classification changed through improvements in microscopy). VC2S8U01.E03 and VC2S8U01.E04 (dichotomous keys) belong to subtopic 7B.

Teacher-facing note — reserved elaboration (not student text). VC2S8U01.E06, the elaboration that investigates Aboriginal and/or Torres Strait Islander Peoples’ systems of classifying organisms and how these systems differ from the Linnaean system, is reserved under the ICIP decision (D10; CONTENT_POLICY rule 1): no Aboriginal or Torres Strait Islander content is delivered in this book. The Linnaean system is taught here on its own terms; no comparison with Indigenous classification systems is attempted.

Classification tools: using, building and modifying a dichotomous key

What we teach here — VC2S8U01 (Victorian Curriculum F–10 Version 2.0, Science, Levels 7 and 8):

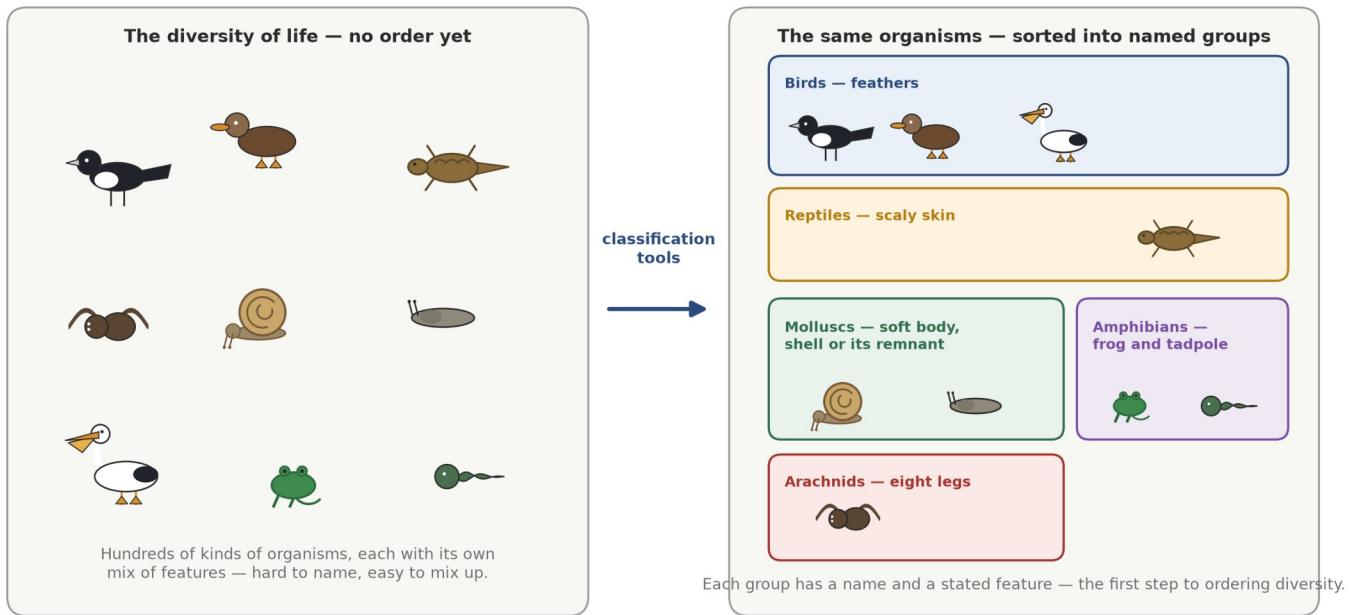
“there are similarities and differences within and between groups of organisms living on Earth; the development and use of classification tools, including dichotomous keys, help order and organise human understanding of the diversity of life” **This subtopic owns the second clause only:** the development and use of classification tools, including dichotomous keys, and how they order and organise human understanding of the diversity of life. The first clause — similarities and differences within and between groups — belongs to the partner subtopic 7A (+ split delivery, D6). **In our words:** life on Earth comes in a huge variety, and a dichotomous key is a tool that keeps that variety in order — one two-choice step at a time. Here we use a key that is provided for us, build a key of our own, and fix a key when a new organism turns up and the key breaks. **Achievement-standard extract served here (D13):** cited by reference to the header of the owner subtopic 7A, where the extract appears in full. **Elaborations drawn on:** VC2S8U01 . E03 (using provided dichotomous keys to identify organisms surveyed on a field trip) and VC2S8U01 . E04 (creating and modifying a dichotomous key to classify organisms into groups, and groups within groups). **Authored from the CD text and the elaboration contexts (D12):** the CD names the tool but not its parts or its rules; the couplet structure, the building steps and the fixing steps taught here are the standard form of a dichotomous key, and the two elaborations above supply the field-trip context and the key-building context. **ICIP note (D10):** elaboration VC2S8U01 . E06, on Indigenous classification knowledge, is reserved to subtopic 7A and is not taught here; in line with the book’s front-of-book note, Aboriginal and Torres Strait Islander content is not covered in this subtopic.

Word watch — *dichotomous*. The word *dichotomous* comes from two Greek words meaning “cut in two”. A **dichotomous** key always offers exactly two choices at every step — never three, never one. That is the whole trick of it: a chain of two-choice questions that ends at one name.

Theory

Why life needs ordering

Picture a class field trip to the school dam. In one hour the survey finds six very different organisms: a duck paddling, a magpie calling, a snail on a reed, a spider under a rock, a bobtail skink sunning itself, and a slug in the leaf litter. (*A simulated survey, written for practice.*) Left as a jumble, the six are just a list. Sorted into groups by a visible feature, they start to make sense — the feathered ones together, the eight-legged one apart, the shell-carriers together. A group name is a handle: it lets anyone — your class, a ranger, a scientist in another state — check the same organisms against the same groups and get the same answer.

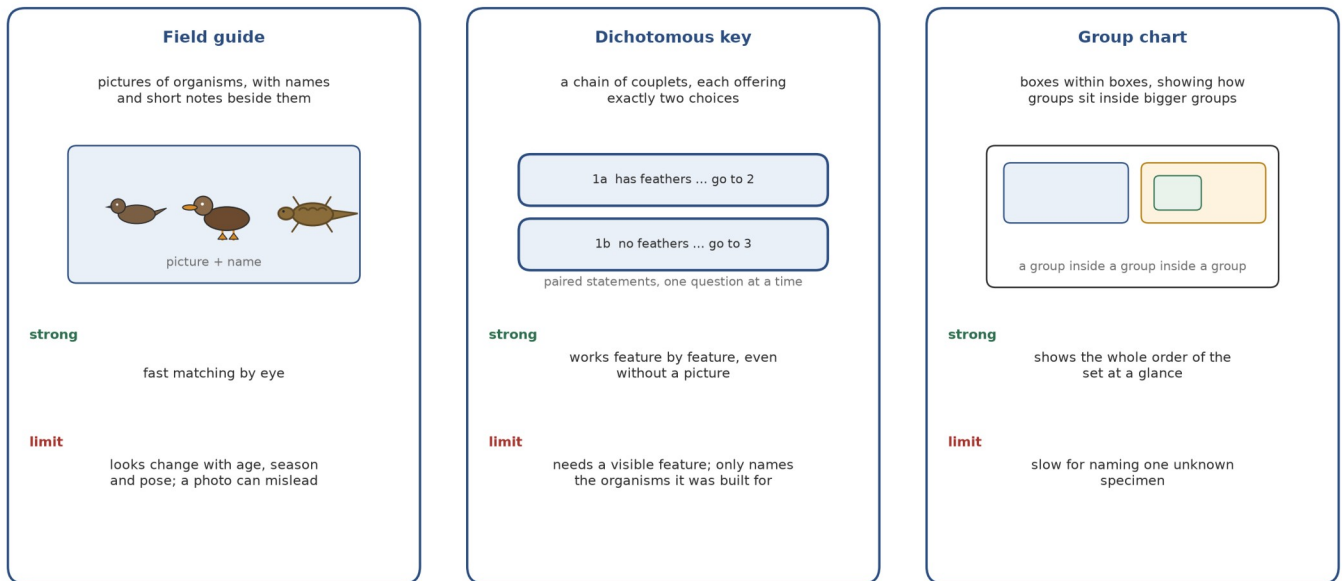


Nine organisms — the dam survey's six plus three more — sorted into five feature groups: birds by feathers (magpie, duck and pelican), reptiles by scaly skin (a bobtail lizard), molluscs by a soft body with a shell or its remnant (snail and slug), arachnids by eight legs (a huntsman spider), and amphibians shown as a frog and its tadpole

Three tools for ordering life

Scientists have more than one tool for this job. A **field guide** is a book of pictures with names and short notes, and you name an organism by matching it with a picture by eye. A **group chart** draws boxes within boxes, showing how small groups sit inside bigger ones. And a **dichotomous key** is a chain of two-choice steps that works feature by feature, even when there is no picture to match. Each tool has a strength and a limit; the tool this subtopic builds skill with is the dichotomous key.

Three classification tools — each orders diversity in its own way



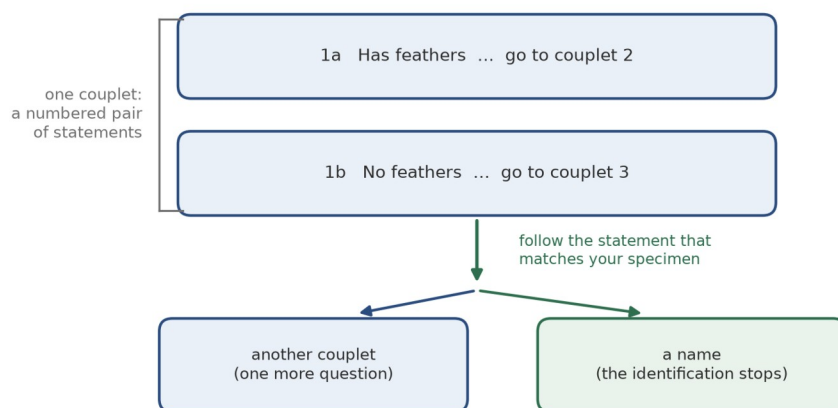
The dichotomous key is this subtopic's tool — but scientists and rangers often use two or more tools together.

Three classification tools side by side — a field guide of pictures and names, a dichotomous key of paired statements, and a group chart of boxes within boxes — each card listing what the tool is, where it is strong and where its limit lies

The couplet — the key's moving part

Every step of a dichotomous key is a **couplet**: a numbered *pair* of statements, such as 1a and 1b, that offers exactly two choices. The organism you are trying to name is the **specimen**. You read both statements, check the specimen, and follow the one that matches; the other statement is dropped and never used again for that specimen. A statement either ends at a name, or ends at a **go-to** — an instruction such as “go to 3” that sends you on to the next couplet. Following go-tos from couplet 1 until a statement ends at a name is called **tracing** the key, and the chain of choices you took is the **path**.

The parts of a dichotomous key — one step, called a couplet



The rule the name says

dichotomous =
"divided into two"
Every couplet offers exactly
two choices — never three,
never one.

Followed for one specimen



No feathers.

Take 1b.

The other statement (1a)
is dropped and never used again.

A key is a chain of couplets: match one statement, follow it, and repeat until a name is reached.

The anatomy of a couplet: one numbered pair of statements, 1a and 1b, offering exactly two choices; the statement that matches the specimen is followed with its go-to, while the other statement of the pair is dropped and never used again for that specimen

Using a provided key (E03)

Here is a provided key for the six organisms of the dam survey.

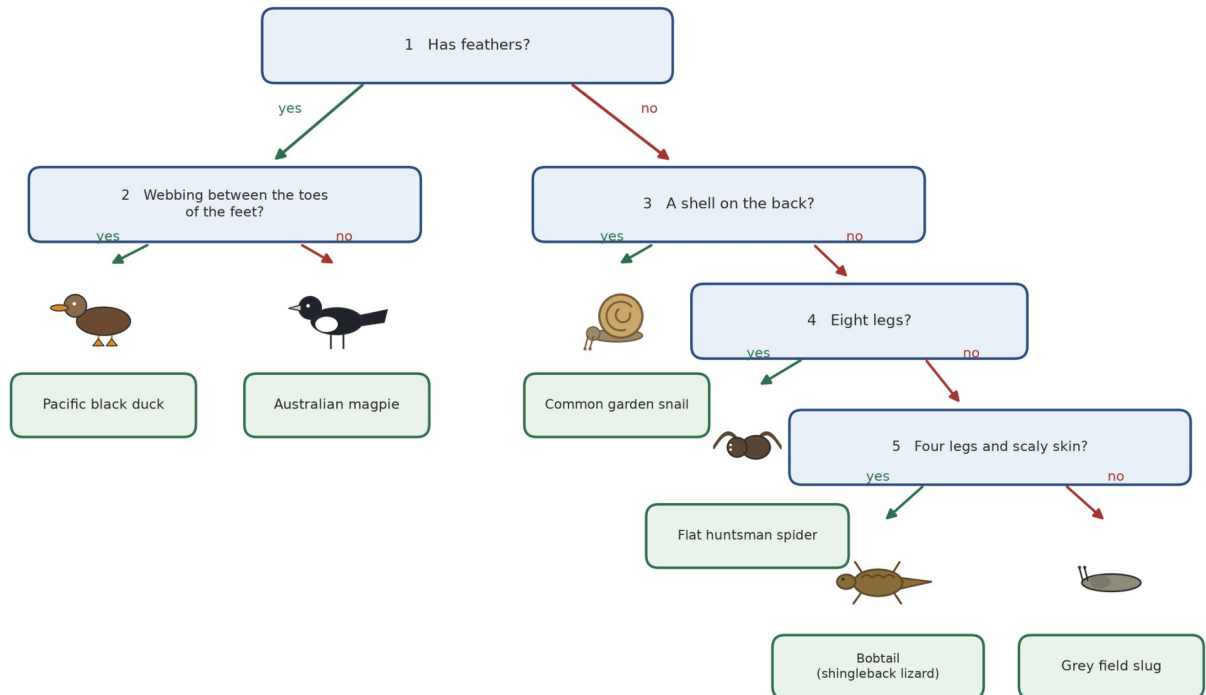
The provided key — six animals of the school dam (simulated survey)

1.
 - (a) The animal has feathers. ... **go to 2**
 - (b) The animal has no feathers. ... **go to 3**
2.
 - (a) There is webbing between the toes. ... **Pacific black duck**
 - (b) There is no webbing between the toes. ... **Australian magpie**
3.
 - (a) There is a shell on the back. ... **common garden snail**
 - (b) There is no shell on the back. ... **go to 4**
4.
 - (a) The animal has eight legs. ... **flat huntsman spider**
 - (b) The animal does not have eight legs. ... **go to 5**
5.
 - (a) The animal has four legs and scaly skin. ... **bobtail (shingleback lizard)**
 - (b) The animal has no four legs and no scaly skin. ... **grey field slug**

To use the key, always start at couplet 1, take the one statement that matches the specimen, and repeat until a statement ends at a name. A snail, for example, has no feathers, so 1b sends us to 3; there is a shell on its back, so 3a names it the common garden snail. The path is written 1b → 3a.

A dichotomous key to six animals of a school dam survey

Simulated survey for practice — all six species live in Victoria; each couplet asks about a feature you can see.



Start at couplet 1. Take the one statement that matches the animal you are looking at, and follow it — keep going until a name appears.

The dam key drawn as a branching tree: couplet 1 splits on feathers, then webbed toes, a shell on the back, eight legs, and four legs with scaly skin, every branch ending at exactly one animal's name

Using the key — tracing one specimen, step by step

1a	Has feathers ... go to 2
1b	No feathers ... go to 3
2a	Webbing between the toes of the feet ... Pacific black duck
2b	No webbing between the toes ... Australian magpie
3a	A shell on the back ... Common garden snail
3b	No shell on the back ... go to 4
4a	Eight legs ... Flat huntsman spider
4b	Not eight legs ... go to 5
5a	Four legs and scaly skin ... Bobtail (shingleback lizard)
5b	No legs ... Grey field slug

The specimen found by the dam

What we can see:
no feathers
no legs
a coiled shell on the back

Couplet 1 — feathers? No → take 1b

↓

Couplet 3 — a shell on the back? Yes → take 3a

↓

3a names the specimen — stop.

Identification: Common garden snail

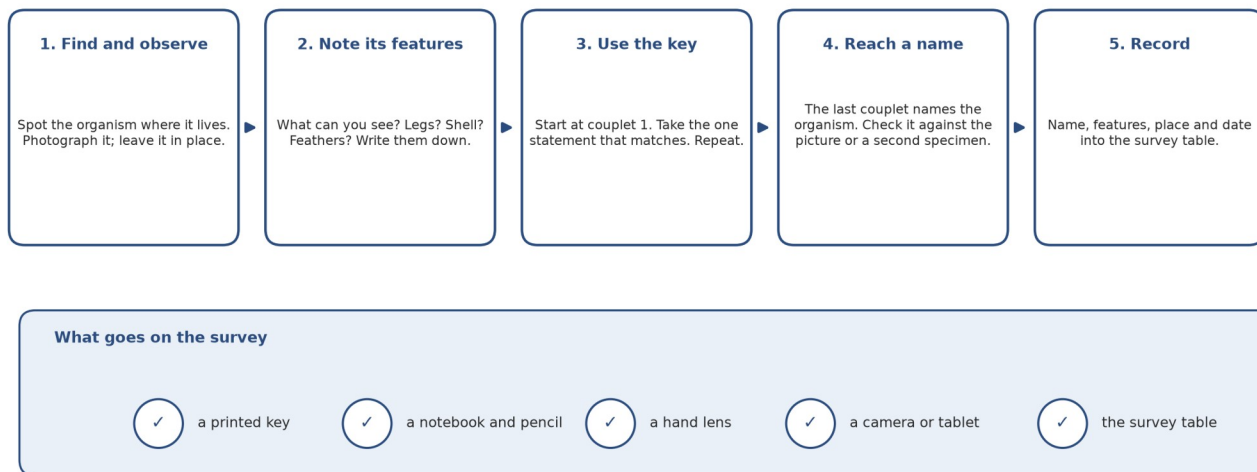
Only two couplets were needed — the key never asked couplets 4 and 5 of this specimen.

The green statements are the two that matched — one per couplet, and only one of the pair.

A worked trace of the dam key: a specimen with no feathers and a shell on its back follows 1b then 3a and is named the common garden snail; the statements not taken are shown left behind and unused

On a field trip, using the key is one step in a wider routine: find and observe the organism where it lives, note the features you can see, run the key, check the name against a picture or a second specimen, and record the name, the features, the place and the date. The field rules are simple: look with your eyes, a hand lens and a camera — do not pick organisms up; wash hands afterwards; and work only where the school has permission to be.

The field-survey routine — using a provided key outdoors



Field rules (subtopic 3B): look with your eyes, a hand lens and a camera — do not pick organisms up; wash hands afterwards; and work only where your school has permission to be.

The field-survey routine in five steps — find and observe, note its features, use the key, reach a name, record — above a kit list: a printed key, a notebook and pencil, a hand lens, a camera or tablet, and the survey table

Building a key (E04)

A key is built, not found. The set below is six leaves from the schoolyard (*a simulated survey, written for practice*): white clover, silky oak, kangaroo grass, silver banksia, ivy-leaf violet and red gum. Building a key for them takes five steps.

Building a key — five steps, shown on six plants of the schoolyard

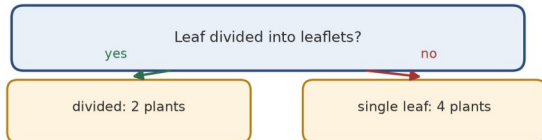
Step 1 — Gather the organisms to key



Step 2 — List the features you can observe

- one leaf, or divided into leaflets?
- if divided: how many leaflets?
- edge: with teeth, or without?
- shape: long and narrow, heart-shaped, strap-like?
- veins: parallel, or branching?

Step 3 — Choose one feature that splits the set in two



Step 4 — Split each group again, with a new feature



Step 5 — Test the key on every organism it must name

Run each of the six plants through the finished key. A good key brings every one of them to its own name, and to no other.

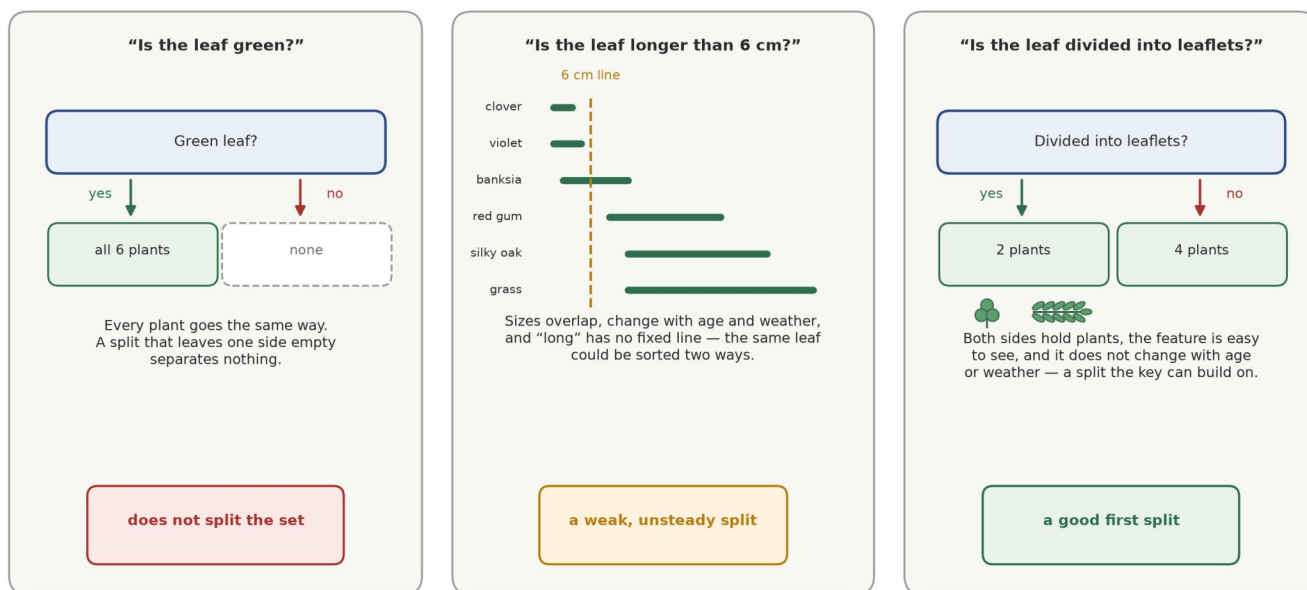
If one plant lands at the wrong name — or two plants land at the same name — a couplet must be repaired (modifying the key, below).

The Maths interlock (VC2M7SP04, VC2M8SP04): a key is an algorithm — a sequence of steps and decisions that sorts by attribute, and it can be tested the way an algorithm is.

Building a key in five steps, shown on six schoolyard plants: gather the organisms to key; list the features you can observe; choose one feature that splits the set in two; split each group again with a new feature; and test the finished key on every organism it must name

The step that decides most is the first couplet. A good first question splits the set into two groups that each hold at least one organism, using a feature that is easy to see and steady — it does not change with age or weather. Judging three candidates for the plant set shows the rule at work.

Choosing the first question — three candidates, judged



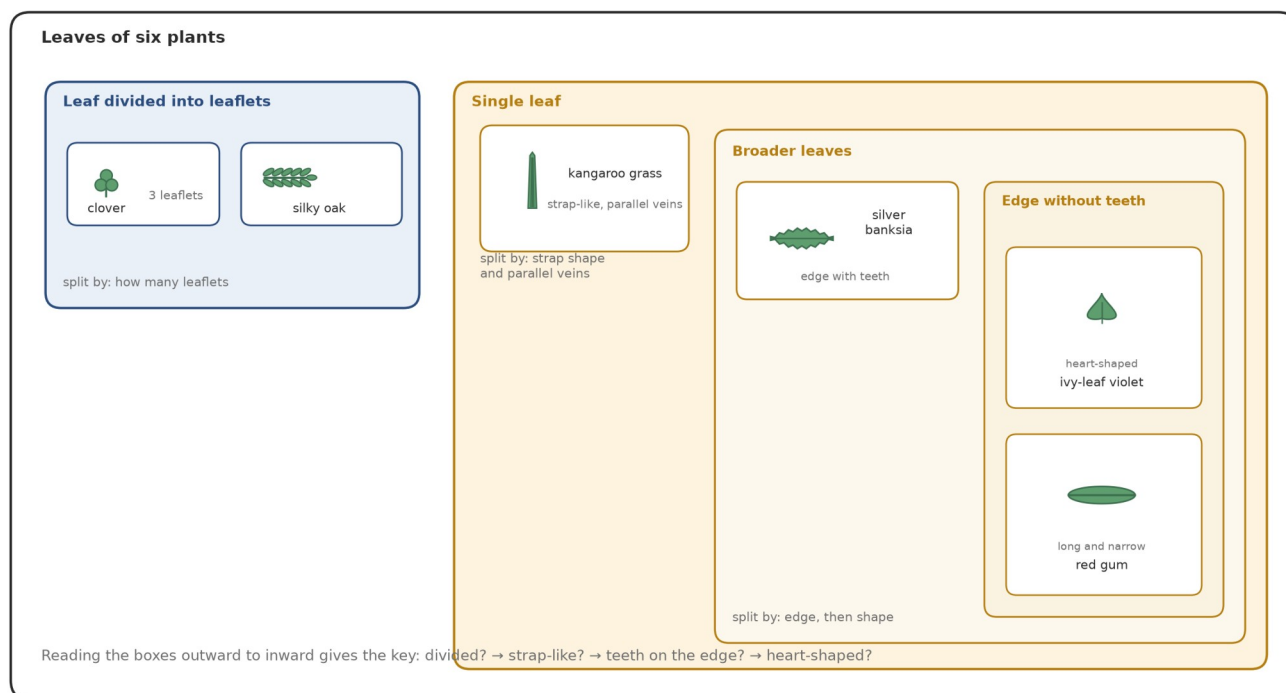
A good couplet splits the set into two non-empty groups, using a feature that is observable and steady.

Three candidate first questions for the plant key judged side by side: "Is the leaf green?" sends all six plants the same way and does not split the set; "Is the leaf longer than 6 cm?" is a weak, unsteady split because sizes overlap; "Is the leaf divided into leaflets?" is a good first split because both sides hold plants and the feature is steady

Each couplet nests a smaller group inside a bigger one — groups within groups. The finished plant key below does the full sorting, and the group chart shows the same nesting as boxes within boxes.

The built key — six leaves of the schoolyard

1.
 - (a) The leaf is divided into leaflets. ... **go to 2**
 - (b) The leaf is a single blade, not divided. ... **go to 3**
2.
 - (a) Three rounded leaflets on one stalk. ... **white clover**
 - (b) Many leaflets in pairs along a middle stalk. ... **silky oak**
3.
 - (a) A long strap-like blade with parallel veins. ... **kangaroo grass**
 - (b) A broader blade. ... **go to 4**
4.
 - (a) The edge of the blade has teeth. ... **silver banksia**
 - (b) The edge of the blade is smooth, without teeth. ... **go to 5**
5.
 - (a) The blade is heart-shaped. ... **ivy-leaf violet**
 - (b) The blade is long and narrow, not heart-shaped. ... **red gum**



Groups within groups: the six plants nested in boxes — the divided leaves in one box, the single leaves in a bigger box that holds the strap-like grass apart from the broader leaves, and within the broader leaves the toothed-edge banksia apart from the smooth-edged violet and red gum — so that reading the boxes outward to inward gives the key's couplets in order

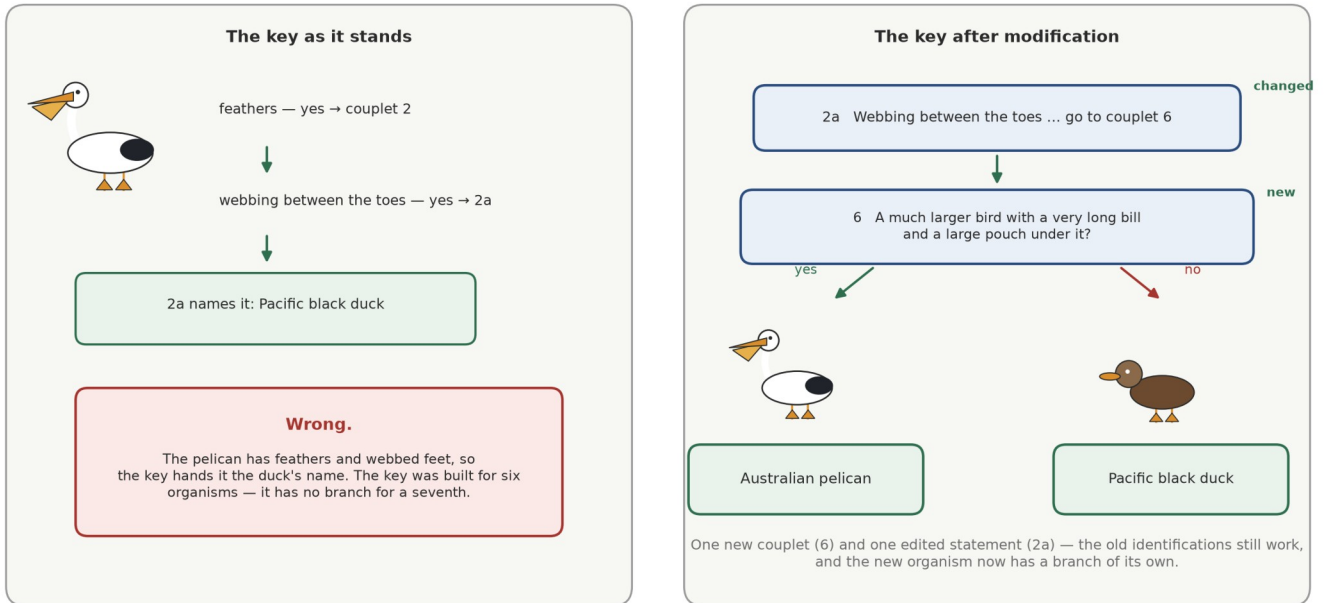
Modifying a key when a new organism turns up

A key only names the organisms it was built for. A week after the dam survey, an Australian pelican lands on the water. It has feathers, so the key sends it to couplet 2; it has webbed feet, so 2a names it Pacific black duck — a wrong name. The key has not failed by breaking its own rules; it has met an organism outside its set. The fix is a **modification**: edit 2a so web-footed birds go on to a brand-new couplet 6, and let couplet 6 split the pelican from the duck by features any observer can see.

- 2 (a) There is webbing between the toes. ... **go to 6** (*edited*)
- 6 (a) A much larger bird, with a very long bill and a large pouch under it. ... **Australian pelican** (*new*)
(b) A smaller bird, with a short, flat bill and no pouch. ... **Pacific black duck** (*new*)

After any modification, every organism in the set is run through the key again — the duck must still land on the duck, and every other name must still hold. A key is a working tool: when new evidence turns up, the tool is repaired, and the repair is tested.

Modifying the key — an Australian pelican lands on the dam



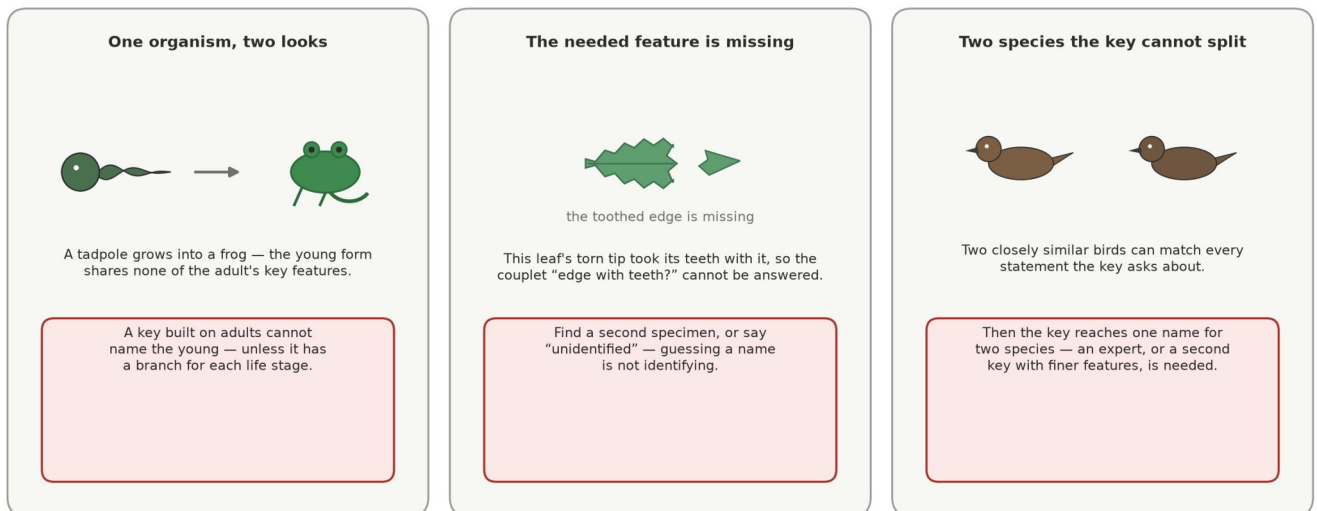
Keys are modified when a new organism turns up, when a feature was recorded wrongly, or when a specimen varies — a key is a tool that grows with its users.

Modifying the dam key when an Australian pelican arrives: the old couplet 2a sent every web-footed bird to the Pacific black duck, so 2a is edited to go to a new couplet 6, which splits the pelican from the duck by size, bill length and the pouch under the bill

Where a key can fail — three checks every user makes

Even a well-built key has limits, and a careful user checks for the three classic ones. First, one organism can have two looks: a tadpole and a frog are the same organism, yet a key built on adult frogs cannot name the young form unless it carries a branch for each life stage. Second, the needed feature can be missing: a leaf with a torn tip has lost the very teeth the couplet asks about, so the honest answers are a second specimen or “unidentified” — guessing a name is not identifying. Third, two species can be look-alikes: if two closely similar birds match every statement the key asks about, the key reaches one name for two species, and an expert or a second key with finer features is needed.

Three limits of a dichotomous key — what every user must check

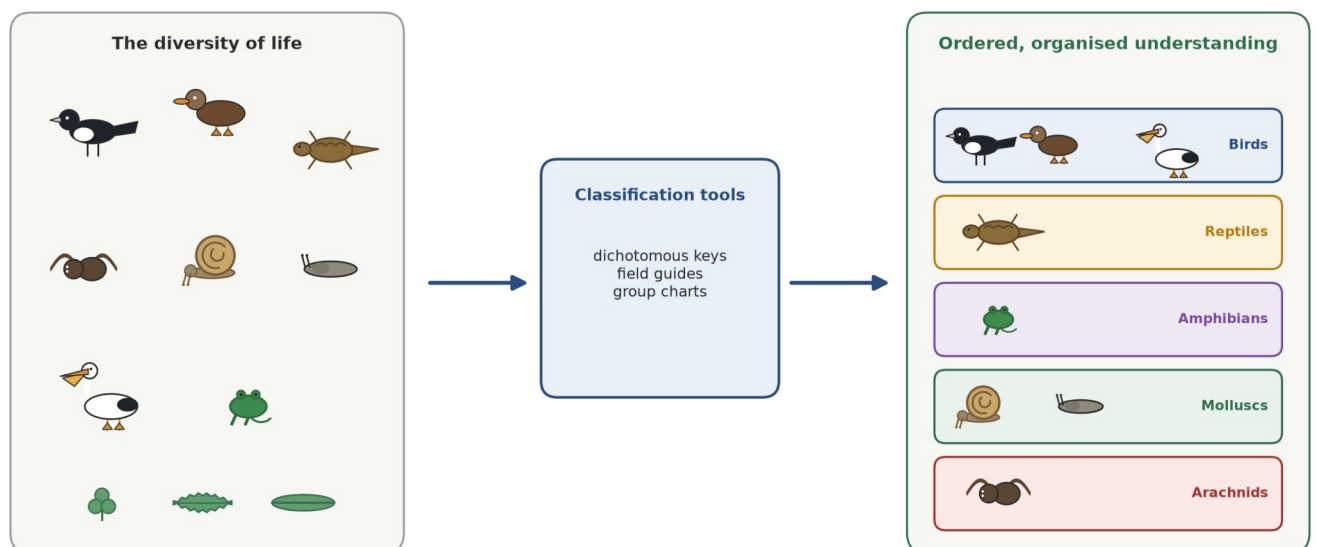


A key is only as good as its couplets and its set — evaluating where it fails is part of using it (subtopic 5A).

Three limits of a dichotomous key, each with the check a careful user makes: a tadpole grows into a frog, so one organism can have two looks; a torn leaf is missing the toothed edge the couplet asks about; and two look-alike birds can match every statement, so one name reaches two species

Ordering understanding

Set the three skills of this subtopic — using a provided key, building a key, and modifying a key when new evidence arrives — against the dam survey's jumble, and the second clause of the CD is exactly what you see. The diversity of life is the jumble; the classification tools are the keys, guides and charts; and the outcome is ordered, organised understanding — groups everyone can check and names everyone can share. The order is human-made and improveable: as new organisms are found and new features checked, keys are built, used and repaired, and our understanding of the diversity of life stays organised without ever being finished.



The development and use of classification tools, including dichotomous keys, helps order and organise human understanding of the diversity of life — the second clause of VC2S8U01 in one picture.

The diversity of life drawn as a jumble of organisms on the left, passed through classification tools in the middle, becoming ordered understanding on the right: birds, reptiles, amphibians, molluscs and arachnids each standing in their own labelled group

Words to know in 7B

Word	What it means here
classification tool	a tool — a key, a guide or a chart — that keeps the diversity of life in order
dichotomous key	a key that sorts organisms by offering exactly two choices at every step
couplet	a numbered pair of statements in a key, offering exactly two choices
specimen	the organism you are trying to name
go-to	an instruction such as “go to 3” that sends you on to the next couplet
path	the chain of choices taken through a key, written as 1b → 3a
feature	a part or quality of an organism that you can observe, used by a couplet
leaflet	one of the small blades a divided leaf is split into
toothed edge	a leaf edge with small teeth along it, like a saw
strap-like	long and narrow, like a strap or a grass blade
survey	an organised look at what lives in a place, with what is found written down
mollusc	a soft-bodied animal, most with a shell or its remnant — the snail and slug group
arachnid	an eight-legged animal — the spider group
reptile	a scaly-skinned animal with backbones — the lizard group here
amphibian	the frog group: young live in water, adults usually on land
life stage	one of the different looks an organism has as it grows, like tadpole and frog
look-alike	one of two species so similar that a key cannot split them

Worked examples

Example 1 — scaffolded

Three specimens from the dam survey are described by their features. Use the provided key to name each one. (*Draws on VC2S8U01.E03.*)

Working	Comment
Specimen A: feathers yes, webbing no. Couplet 1a → 2; couplet 2b → Australian magpie .	Feathers send it to couplet 2; no webbing between the toes picks 2b, which ends at a name.
Specimen B: no feathers, shell on the back. Couplet 1b → 3; couplet 3a → common garden snail .	No feathers sends it to couplet 3; the shell picks 3a — the same path as the trace in the Theory section, 1b → 3a.
Specimen C: no feathers, no shell, eight legs. Couplet 1b → 3; 3b → 4; 4a → flat huntsman spider .	Two go-tos and then a name: the eight legs pick 4a. The path is 1b → 3b → 4a.

Example 2 — scaffolded

Build the opening of the key to the six schoolyard plants: choose the first couplet, then write couplet 2 for the group that lands on its yes side. (*Draws on VC2S8U01.E04.*)

Working	Comment
(a) Couplet 1: “Is the leaf divided into leaflets?” Yes: white clover, silky oak. No: the other four.	Both sides hold plants, and leaflets are easy to see and steady — a good first split, unlike “green?” or “longer than 6 cm?”.
(b) Couplet 2: (a) “Three rounded leaflets on one stalk” → white clover; (b) “Many leaflets in pairs along a middle stalk” → silky oak.	The two divided plants differ in how many leaflets they carry and how they sit, so one couplet separates them and both statements end at a name.

Example 3 — unscaffolded

A surveyor brings back notes on one specimen from the dam: *no feathers; no shell on the back; not eight legs; four legs; dry scaly skin*. Name the specimen and give the full path through the provided key. (*Draws on VC2S8U01.E03.*)

No feathers takes the specimen 1b → 3; no shell takes it 3b → 4; not eight legs takes it 4b → 5; and four legs with dry scaly skin matches 5a. ∴ the specimen is the **bobtail (shingleback lizard)**, and the path is 1b → 3b → 4b → 5a — four couplets, one name.

Example 4 — unscaffolded

A week after the survey, a student finds an eastern long-necked turtle at the dam. Run it through the provided key, state what goes wrong, and write the modification — the edit and the new couplet — that puts it right. (*Draws on VC2S8U01.E04; modifying a key is repairing a tool when new evidence turns up.*)

The turtle has no feathers, so 1b sends it to 3; it carries a shell on its back, so 3a names it common garden snail — a wrong name, because couplet 3 was built before any turtle was in the set. The fix: edit 3a to “... go to 6”, and add couplet 6: (a) “The shell is hard, with four legs and a long neck coming out of it” → eastern long-necked turtle; (b) “The shell is a coiled shell on a soft body” → common garden snail. ∴ the modification is one edit plus one new couplet, and afterwards all seven organisms must be run through the key again so that every old name still holds.

Practice questions

Scaffolded

Q1. Define each of the following, as the words are used in this subtopic: (a) couplet; (b) specimen; (c) dichotomous; (d) go-to.

Q2. Answer the following about the provided dam key. (a) Which couplet sorts the animals by feathers? (b) Where does statement 1b send you? (c) Name the couplets in which *both* statements end at a name, not a go-to. (d) How many choices does every couplet offer?

Q3. A surveyor’s notes read: *feathers — yes; webbing between the toes — no*. (a) Name the organism. (b) Give the path through the key.

Q4. The plant key begins “Is the leaf divided into leaflets?” (a) Write that couplet in full, with its two go-tos. (b) List the plants on the yes side. (c) List the plants on the no side.

Q5. The group chart nests boxes within boxes. (a) Name the boxes that hold the silver banksia, from the smallest box outward. (b) Read the boxes outward to inward and list the four questions the key asks, in order.

Q6. A key can fail in classic ways. (a) Explain why a key built on adult frogs cannot name a tadpole. (b) A leaf’s torn tip has taken its teeth with it. State two honest things a user can do.

Un scaffolded

- Q7.** Use the provided dam key on a specimen with *no feathers, no shell, not eight legs, and no four legs with scaly skin*. Give the full path and the name, and state one feature you could check against a picture to confirm the name.
- Q8.** A student offers “Is the leaf longer than 6 cm?” as the first couplet of the plant key. Evaluate the offer, giving two reasons.
- Q9.** The no side of couplet 1 of the plant key holds four plants: kangaroo grass, silver banksia, ivy-leaf violet and red gum. Write couplets 3, 4 and 5 that bring each of the four to its own name.
- Q10.** This subtopic speaks of “groups within groups”. Explain in your own words what the phrase means, using one example from the plant chart.
- Q11.** A white-faced heron — a bird with long legs, a long dagger-like bill and *no* webbing between the toes — is surveyed at the dam. Run it through the provided key, state the wrong name it reaches, and write the modification (the edit and the new couplet) that fixes the key.
- Q12.** A student scoops up a tadpole and runs it through the provided dam key. (a) Give the path the tadpole takes and the name the key reaches. (b) State what this result shows about the key’s set.
- Q13.** Two closely similar birds match every statement the key asks about, so the key reaches one name for two species. Explain why guessing between the two is not identifying, and give two things a careful user can do instead.
- Q14.** The content description says the development and use of classification tools, including dichotomous keys, helps order and organise human understanding of the diversity of life. Using what this subtopic taught about using, building and modifying a key, explain that claim in two or three sentences.
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Answers

Q1. (a) A numbered pair of statements in a key, offering exactly two choices. (b) The organism you are trying to name. (c) Cut in two: offering exactly two choices at every step. (d) An instruction such as “go to 3” that sends you on to the next couplet. **Q2.** (a) Couplet 1. (b) To couplet 3. (c) Couplets 2 and 5. (d) Exactly two. **Q3.** (a) Australian magpie. (b) 1a → 2b. **Q4.** (a) 1 (a) The leaf is divided into leaflets ... go to 2; (b) The leaf is a single blade, not divided ... go to 3. (b) White clover and silky oak. (c) Kangaroo grass, silver banksia, ivy-leaf violet and red gum. **Q5.** (a) The toothed-edge card inside “Broader leaves”, inside “Single leaf”, inside the whole set. (b) Divided into leaflets? → strap-like with parallel veins? → teeth on the edge? → heart-shaped? **Q6.** (a) A tadpole is the young form of the frog and shares none of the adult’s key features, so a key built on adults has no statement that matches it. (b) Any two: find a second specimen; record “unidentified”; (checking against a picture or an expert also accepted). **Q7.** Path 1b → 3b → 4b → 5b; grey field slug; check the soft grey body with no shell and no legs against the picture. **Q8.** Weak: sizes overlap (a banksia leaf could be either side), size changes with age and weather, and “long” has no fixed line — the same leaf could be sorted two ways, so the split is unsteady. **Q9.** 3: strap-like blade with parallel veins → kangaroo grass / broader blade → go to 4. 4: edge with teeth → silver banksia / edge smooth → go to 5. 5: heart-shaped → ivy-leaf violet / long and narrow → red gum. **Q10.** Each couplet puts a smaller group inside a bigger one; e.g. the smooth-edged group (violet, red gum) sits inside the broader-leaves group, which sits inside the single-leaf group. **Q11.** Wrong name: Australian magpie (1a → 2b). Fix: edit 2b to “... go to 6”; new couplet 6: (a) long legs and a long dagger-like bill → white-faced heron; (b) short legs and a small bill → Australian magpie. **Q12.** (a) 1b → 3b → 4b → 5b, “grey field slug” — a wrong name. (b) The key’s set holds no young forms; a key only names the organisms it was built for. **Q13.** Guessing picks a name the key did not earn, so the record cannot be checked or trusted; instead: record “unidentified”, ask an expert, or use a second key with finer features (any two). **Q14.** Using a key puts each surveyed organism into an ordered group with a shared name; building a key chooses the groups and nests them as groups within groups; modifying a key repairs the order when new evidence turns up — so the tool keeps our understanding of diversity ordered and organised.

Fully-worked solutions

Q1. (a) A **couplet** is a numbered pair of statements in a key, offering exactly two choices (1 mark). (b) The **specimen** is the organism you are trying to name (1 mark). (c) **Dichotomous** means cut in two — offering exactly two choices at every step (1 mark). (d) A **go-to** is an instruction such as “go to 3” that sends you on to the next couplet (1 mark).

Q2. (a) **Couplet 1** sorts by feathers (1 mark). (b) Statement 1b sends you **to couplet 3** (1 mark). (c) In **couplets 2 and 5** both statements end at a name (2 marks — one each). (d) Every couplet offers **exactly two** choices (1 mark).

Q3. (a) Feathers yes sends the specimen 1a → 2; webbing no picks 2b: the **Australian magpie** (1 mark). (b) The path is **1a → 2b** (1 mark).

Q4. (a) 1 (a) *The leaf is divided into leaflets ... go to 2*; (b) *The leaf is a single blade, not divided ... go to 3* (1 mark). (b) Yes side: **white clover and silky oak** (1 mark). (c) No side: **kangaroo grass, silver banksia, ivy-leaf violet and red gum** (1 mark).

Q5. (a) From the smallest box outward: the banksia’s own card, inside “**Broader leaves**”, inside “**Single leaf**”, inside the whole set of six (2 marks). (b) Outward to inward the questions are: **divided into leaflets? → strap-like with parallel veins? → teeth on the edge? → heart-shaped?** (2 marks).

Q6. (a) A tadpole is the **young form** of the frog and shares **none of the adult’s key features**, so a key built on adults has no statement matching it — one organism, two looks (2 marks). (b) Any two: **find a second specimen; record “unidentified”** — guessing a name is not identifying (2 marks — one each).

Q7. No feathers: 1b → 3; no shell: 3b → 4; not eight legs: 4b → 5; no four legs with scaly skin: 5b — the path is **1b → 3b → 4b → 5b** and the name is the **grey field slug** (2 marks — one for the path, one for the name). A confirming feature: the **soft grey body with no shell and no legs**, checked against the picture or a second specimen (1 mark).

Q8. The offer is **weak** (1 mark). Two reasons, any two of: the size ranges **overlap**, so a banksia leaf could land on either side; leaf size **changes with age and weather**; and “long” has **no fixed line**, so the same leaf could be sorted two ways by two users — a first couplet must be steady as well as splitting (2 marks — one per reason).

Q9. Couplet 3: (a) *A long strap-like blade with parallel veins* → kangaroo grass; (b) *A broader blade ...* go to 4 (1 mark). Couplet 4: (a) *The edge of the blade has teeth* → silver banksia; (b) *The edge is smooth, without teeth ...* go to 5 (1 mark). Couplet 5: (a) *The blade is heart-shaped* → ivy-leaf violet; (b) *The blade is long and narrow, not heart-shaped* → red gum (1 mark). Each plant lands at its own name, and no two plants share a name.

Q10. A key never just lists groups; each couplet puts a **smaller group inside a bigger one** (1 mark). In the plant chart, the smooth-edged group (ivy-leaf violet, red gum) sits inside the broader-leaves group, which sits inside the single-leaf group, which sits inside the whole set — so every group is a group within a group (1 mark).

Q11. The heron has feathers, so 1a sends it to 2; it has no webbing, so 2b names it **Australian magpie** — wrong (1 mark). The modification: **edit 2b** to “... go to 6”, and **add couplet 6**: (a) *Long legs and a long dagger-like bill* → white-faced heron; (b) *Short legs and a small pointed bill* → Australian magpie (2 marks — one for the edit, one for the new couplet). Afterwards the whole set is traced again so every old name still holds.

Q12. (a) No feathers: 1b → 3; no shell: 3b → 4; not eight legs: 4b → 5; no four legs with scaly skin: 5b — the path is **1b → 3b → 4b → 5b**, and the key names the tadpole **grey field slug**, a wrong name (2 marks — one for the path, one for the wrong name). (b) It shows the key’s **set holds no young forms**: a key only names the organisms it was built for, so a careful user records the tadpole as unidentified by this key, not as a slug (1 mark).

Q13. Guessing picks a name **the key did not earn** — the path gives no check, so the record cannot be trusted or repeated by anyone else (1 mark). Two careful moves, any two of: **record “unidentified”**; **ask an expert**; **use a second key with finer features** (2 marks — one each).

Q14. Any three linked points (1 mark each): **using** a provided key places each surveyed organism into an ordered group with a name everyone can share; **building** a key chooses the features that make the groups and nests them as groups within groups, so the whole order of the set can be checked; and **modifying** a key repairs that order when new evidence turns up, so the understanding stays organised without being finished. Together the tools turn a jumble of life into ordered, organised understanding.

Sources

No web sources are cited in this subtopic.

The dam survey (six animals) and the schoolyard plant set (six leaves) are **simulated surveys written for practice**; the species are real Australian organisms, but no actual field survey is reported here.

Elaboration contexts used: VC2S8U01.E03 (using provided dichotomous keys to identify organisms surveyed on a field trip) and VC2S8U01.E04 (creating and modifying a dichotomous key to classify organisms into groups, and groups within groups).