UNIT 1 LESSON 9
CLASSIFICATION IN MODEL BIOLOGY

CLASSIFICATION AND SPECIES

OBJECTIVES

- I can explain how organisms are classified into groups, and what a species is.
- I can explain how to use a classification key, and the importance of classifying organisms into groups within larger groups.
- I can describe the classification of organisms based on evidence from their phenotype and cells.
- I can describe the classification, and sometimes reclassification, of organisms based on evidence from their genome.

Keywords

classification	The process of sorting things into groups.
kingdom	A very large group of organisms with only a few features in common, such as all animals or all plants.
genus	A small group of several species.
species	A group of very similar organisms that can reproduce with each other to produce fertile offspring.

Keywords

taxonomy	The practice of classifying.
classification	The process of sorting things into groups.
classification key	A series of questions about the features of organisms that help us to classify them correctly.

Keywords

bacterium	Organism made of a single cell that does not have a nucleus.
animal	Organism made of cells that have a nucleus, but do not have a cell wall and cannot make their own food.
plant	Organism made of cells that have a nucleus, a cell wall and can make their own food.
fungus	Organism made of cells that have a nucleus and a cell wall but cannot make their own food.
kingdom	A very large group of organisms with only a few features in common, such as all animals or all plants.

Keywords

DNA	Deoxyribonucleic acid is a chemical that carries genetic information, and it is the molecule of inheritance.
evolutionary trees	diagrams that show the evolutionary relationships between organisms
gene sequence	the sequence of DNA that codes for a particular protein

Lesson outline

Classification and species

- Differences between organisms
- Classification
- Species and genus

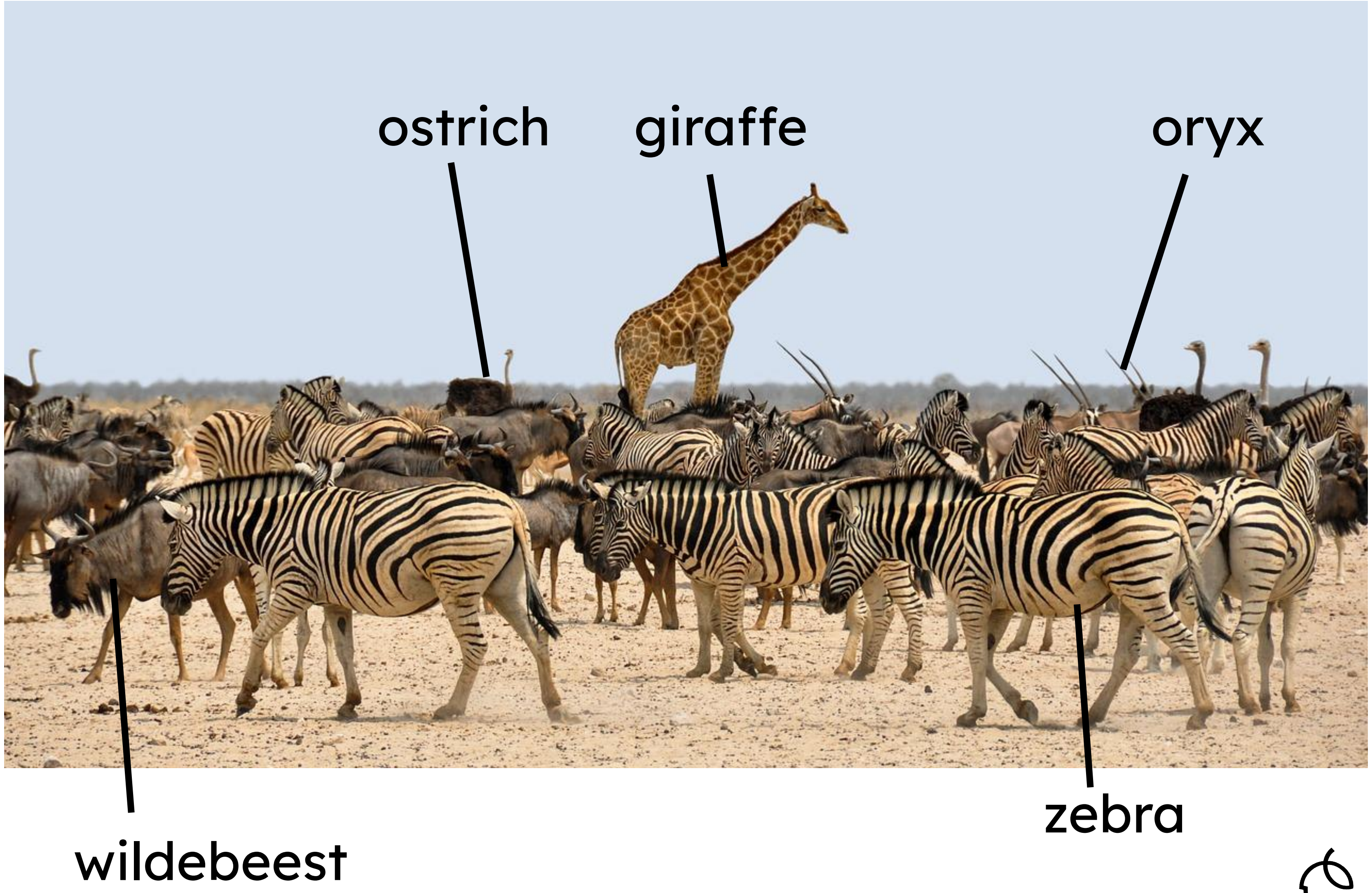
Differences between organisms

Explanation

An organism is a living thing.

There are millions of different types of living organisms on Earth.

How many different organisms can you see in the picture?



Differences between organisms

Explanation

There is enormous variety between different organisms on Earth. For example:

Some organisms walk on four legs and are covered in fur.

Some organisms can make their own food.

Some organisms digest other organisms to get food.

Check

True or false?

A stick and a stick insect are different organisms.

T True ✓

F False

a stick

a stick insect

Justify your answer

a They look very similar and have similar names, so there must not be many differences between them.

b A stick insect has legs for moving around to find food, but a stick is from a tree that has no legs and makes its own food. ✓

Lesson outline

Classification and species

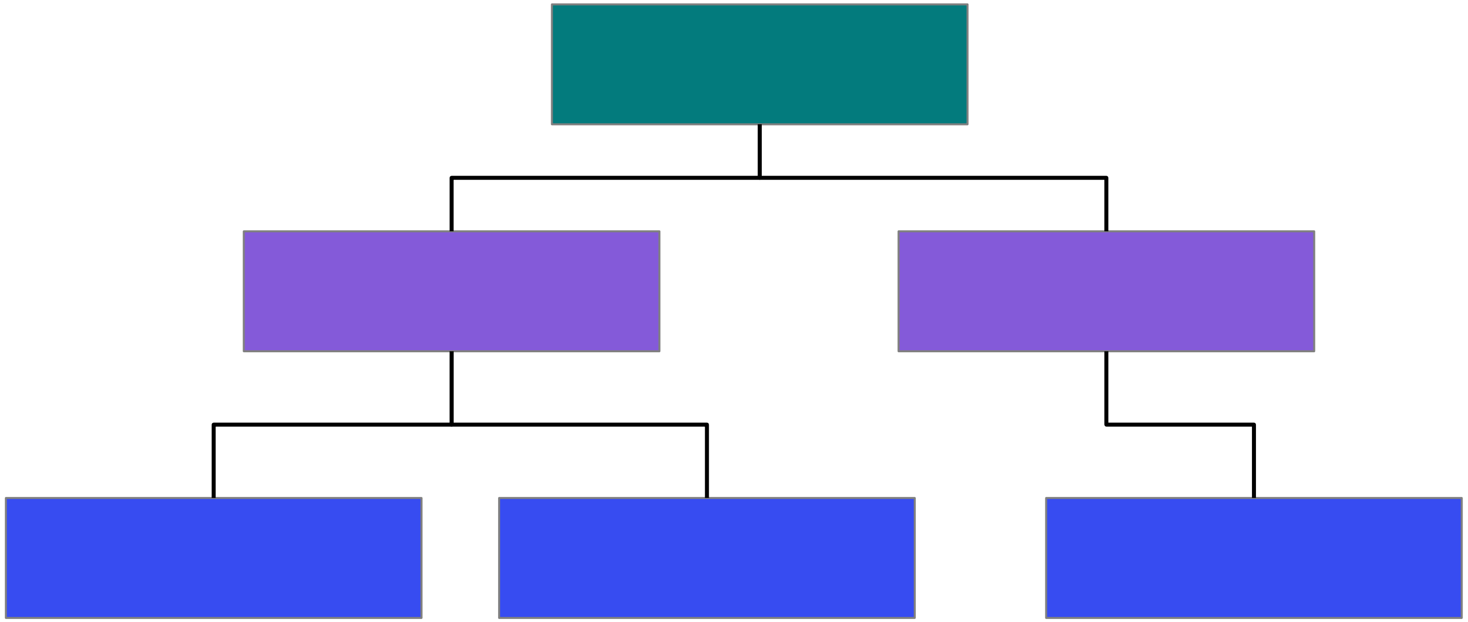
- Differences between organisms
- Classification
- Species and genus

Classification

Explanation

Scientists sort organisms into different groups according to their features.

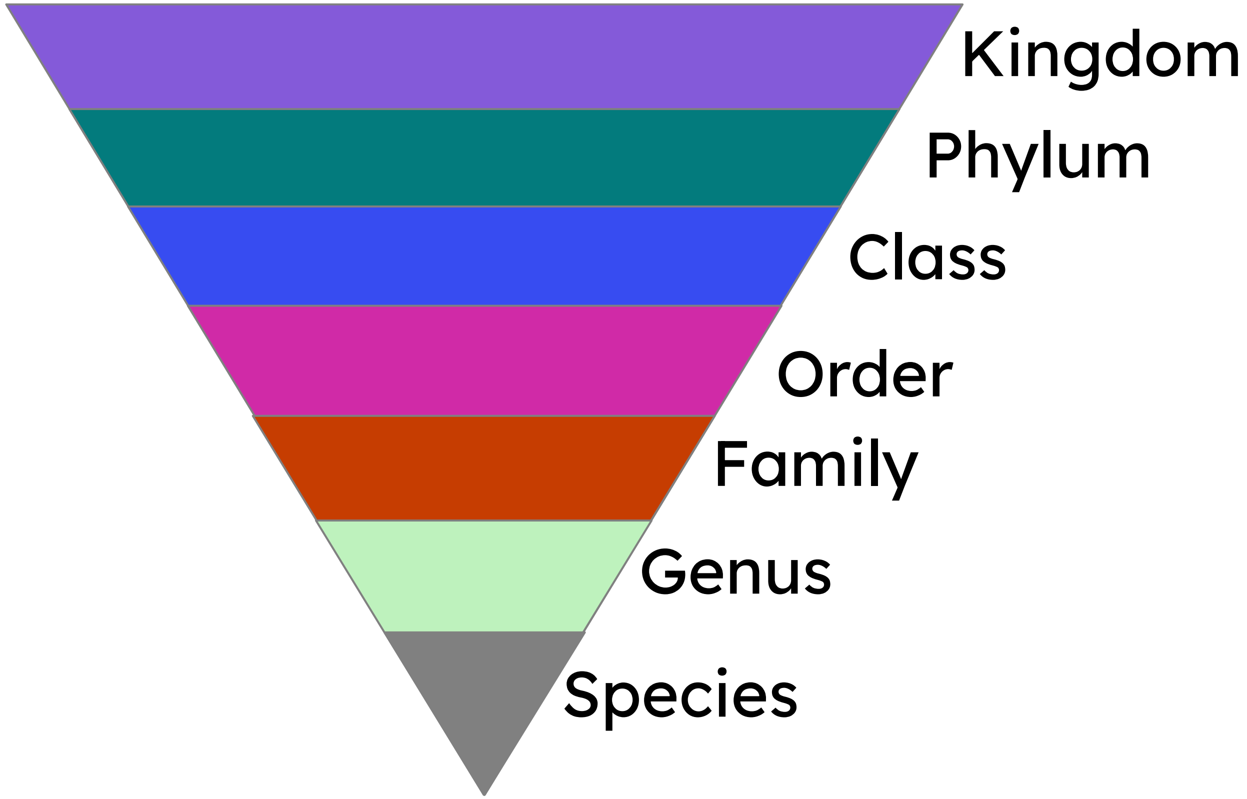
This process is called **classification.**



Classification

Explanation

Scientists classify organisms into different levels:



Organisms in each level have common features.

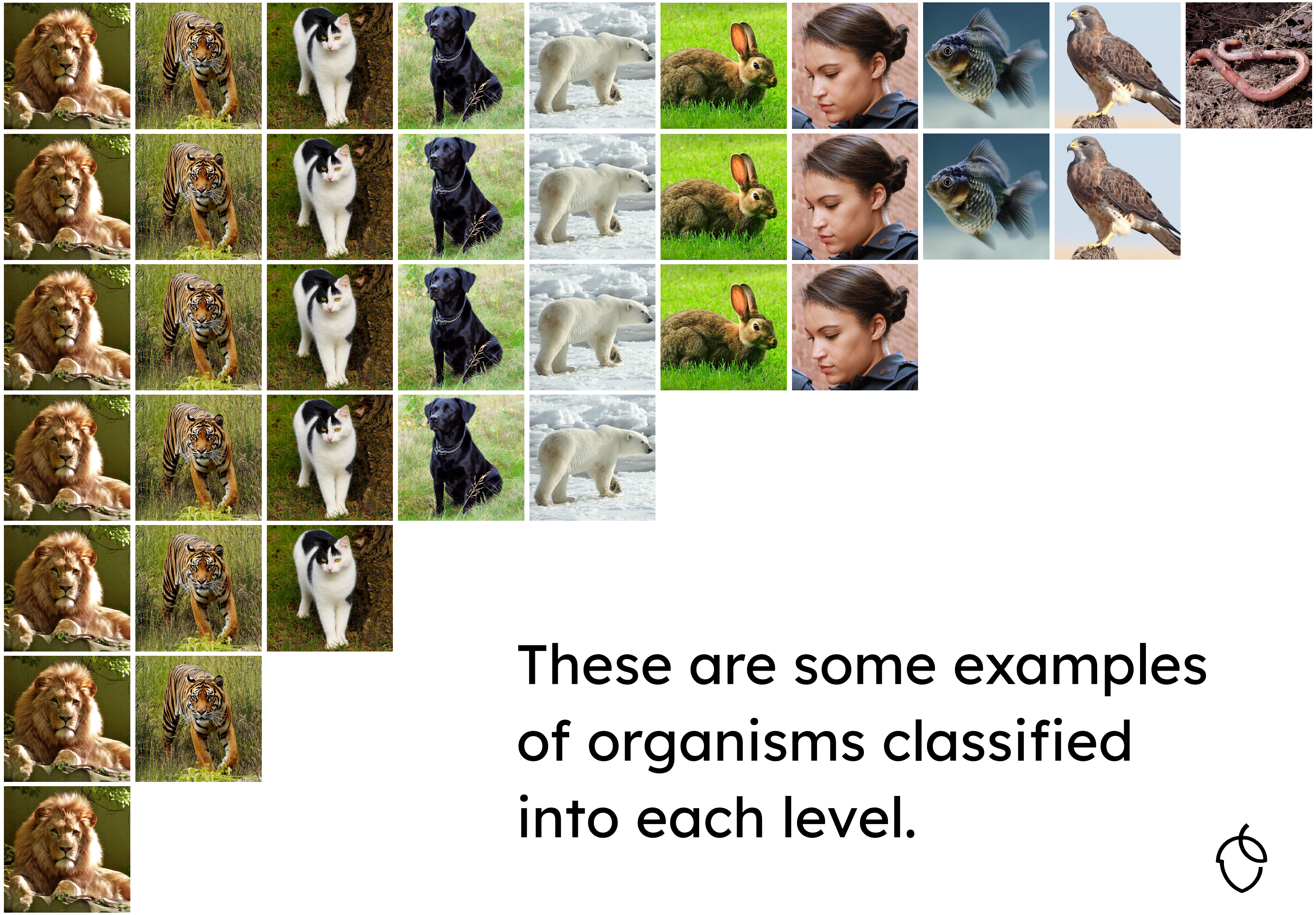
In higher levels, there are: more organisms with fewer features in common.

In lower levels, there are: fewer organisms with more features in common.

Classification

Explanation

Kingdom	Animal
Phylum	Vertebrate
Class	Mammal
Order	Carnivore
Family	Felidae
Genus	*Panthera*
Species	*Panthera leo*

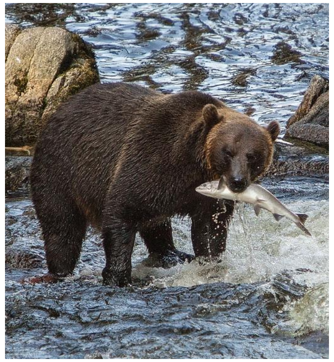


These are some examples of organisms classified into each level.

Classification

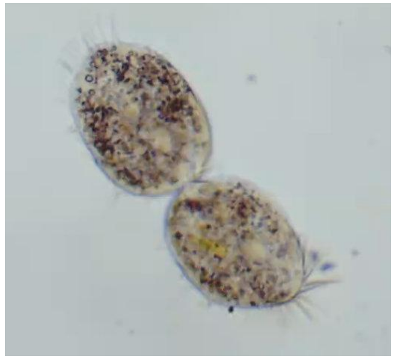
Explanation

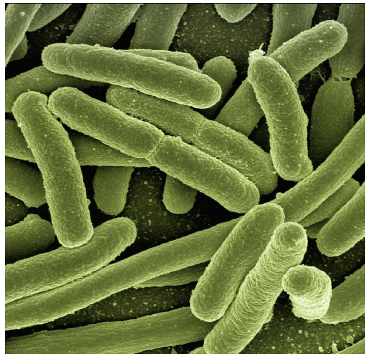
Firstly, scientists classify organisms into very large groups called **kingdoms**. There are kingdoms of:


Animals


Plants


Fungi


Protists


Bacteria

The organisms in each kingdom have basic common features, for example all plants can make their own food.

But they also have many differences in their features for example some plants are evergreen whilst others are deciduous.

Check

Which of the statements best describes the organisms in larger groups such as kingdoms?

- **a** More organisms with many similarities in their features.
- **b** More organisms with few similarities in their features. ✓
- **c** Less organisms with many similarities in their features.
- **d** Less organisms with few similarities in their features.

Classification

Organisms within each kingdom are classified into smaller groups called phyla based on their features.

In the animal kingdom, the phyla are:

Vertebrates

All organisms in the phylum vertebrates have a backbone. This includes mammals, birds, fish, reptiles and amphibians.

Invertebrates

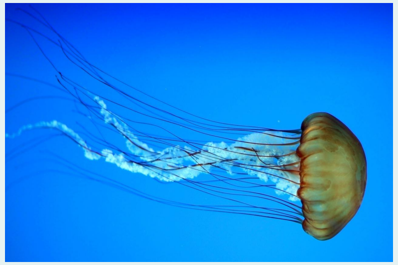
All organisms in the phylum invertebrates do not have a backbone. This includes insects, worms, arachnids and molluscs.

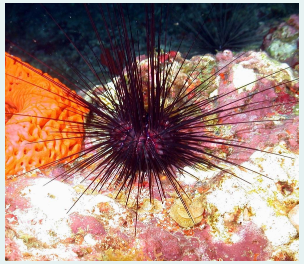
Classification

Check

Katie is a marine biologist. She finds these animals:


fish


jellyfish


sea urchin


seagull


starfish

How would a biologist classify these animals into two phyla?

a Group the organisms with a similar feature, e.g. backbone.

b Group the organisms with a similar habitat.

c Group the organisms with a similar name.

Classification

Explanation

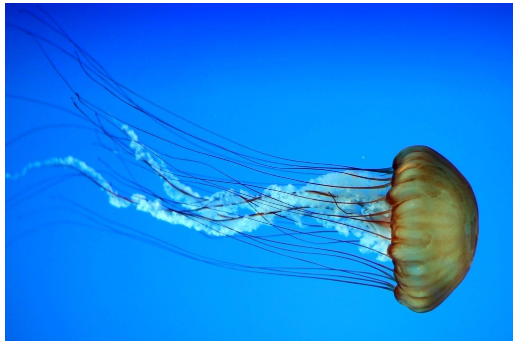
Organisms in a phylum are put into classes, grouping organisms together by general features such as the number of legs they have.

Invertebrate animals are grouped into the following classes:

arthropods

molluscs

annelid worms



coelenterates

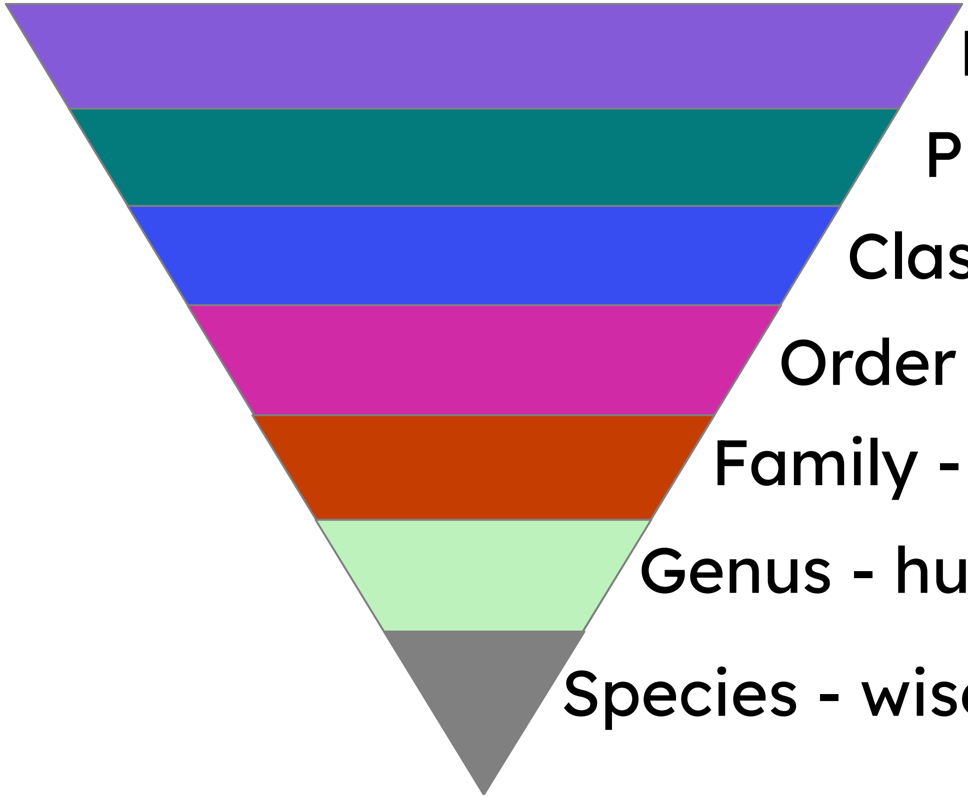
flat worms

echinoderms

Classification

Explanation

Humans are animals, and can be classified using this system:



Kingdom - animal

Phylum - vertebrate (with backbone)

Class - mammals

Order - primates

Family - great apes (hominids)

Genus - human (*Homo*)

Species - wise (*sapiens*)

Classification

Check

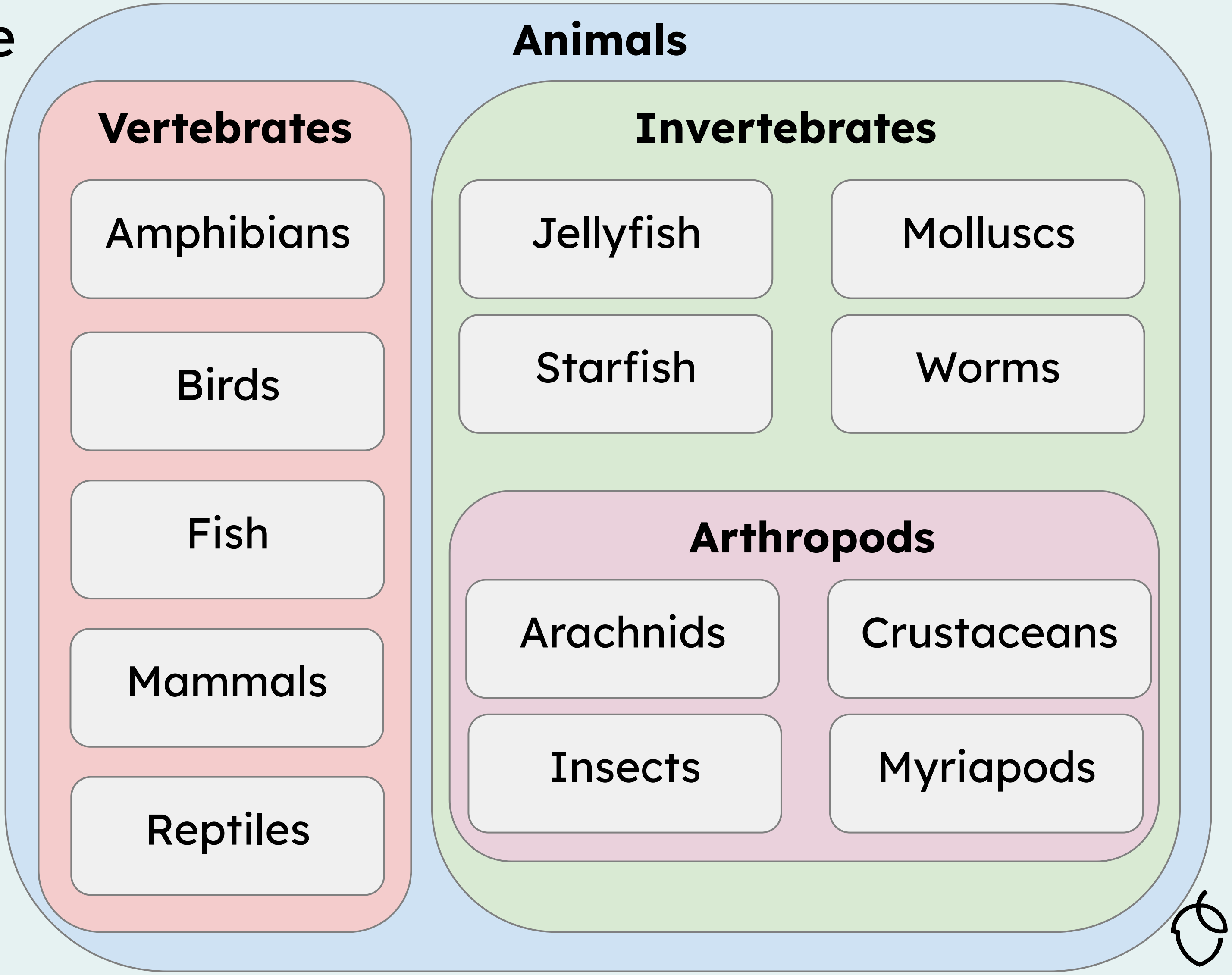
Using the chart, which of these statements are true?

a All animals are vertebrates.

b All insects are invertebrates. ✓

c Jellyfish are a type of fish.

d Fish have more in common with birds than starfish. ✓



Lesson outline

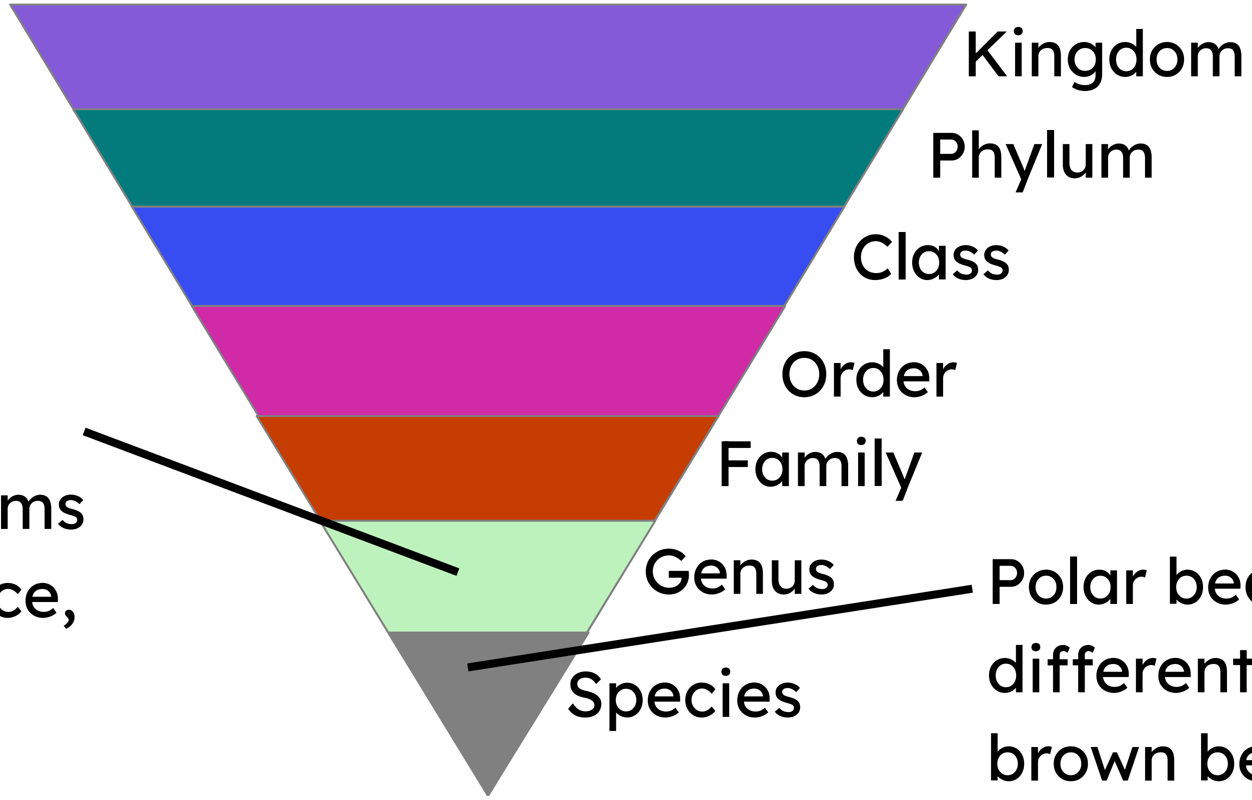
Classification and species

- Differences between organisms
- Classification
- Genus and species

Genus and species

Explanation

As we move through the classification system, we can group and describe an organism in greater detail.



The **genus** collects very similar organisms together. For instance, all bears have the genus ‘Ursus’.

Polar bears are a different **species** from brown bears.

Genus and species

Explanation

A **species** is a group of organisms with very similar features that can reproduce with each other to produce fertile offspring.

Two horses can reproduce to produce fertile horses.

Two donkeys can reproduce to produce fertile donkeys.

If a horse and a donkey reproduce, they produce an infertile mule because they are different species.

Check

True or false?

If a dog and a wolf are bred together, they produce fertile puppies.

Therefore, the dog and wolf are the same species.

T True ✓ F False

Justify your answer

a Organisms of the same species can reproduce to produce fertile offspring. ✓

b Organisms of the same species can reproduce to produce infertile offspring.

Genus and species

Explanation

All organisms have a binomial name: a **genus** and **species**.

Red admiral butterfly is *Vanessa atalanta*

Wild daffodils are *Narcissus pseudonarcissus*

Fly agaric fungus is *Amanita muscaria*

Genus and species

Explanation

The formatting conventions for genus and species names are:

Genus name has the first letter CAPITALISED

Crocodylus nileticus

Species name is all in lower case

Both names are either in *italics* or underlined

Genus and species

Explanation

These examples show the binomial names incorrectly formatted.

English Oak:
quercus Robur

Common Blackbird:
Turdus Merula

Genus and species

Check

Which example correctly shows the binomial genus and species name for the domestic cat?

a Felis catus

b *Felis Catus*

c *felis Catus*

d Felis catus ✓

Task C Genus and species

Practice

Level	Polar Bear	Brown Bear
Kingdom		
	vertebrate	vertebrate
Class	mammal	
Order		carnivore
Family	ursidae	
		<u>Ursus</u>
Species		

Polar bears (*Ursus maritimus*) and brown bears (*Ursus arctos*) are related.

Complete the table to show how they are classified.

Task C Genus and species

Feedback

Polar bears (*Ursus maritimus*) and brown bears (*Ursus arctos*) are related.

Complete the table to show how they are classified.

Level	Polar Bear	Brown Bear
Kingdom	animal	animal
Phylum	vertebrate	vertebrate
Class	mammal	mammal
Order	carnivore	carnivore
Family	ursidae	ursidae
Genus	Ursus	Ursus
Species	maritimus	arctos

Classifying organisms using a classification key

Lesson outline

Classifying organisms using a classification key

- Classifying organisms
- Using a key to classify organisms
- Importance of classification

Classifying organisms

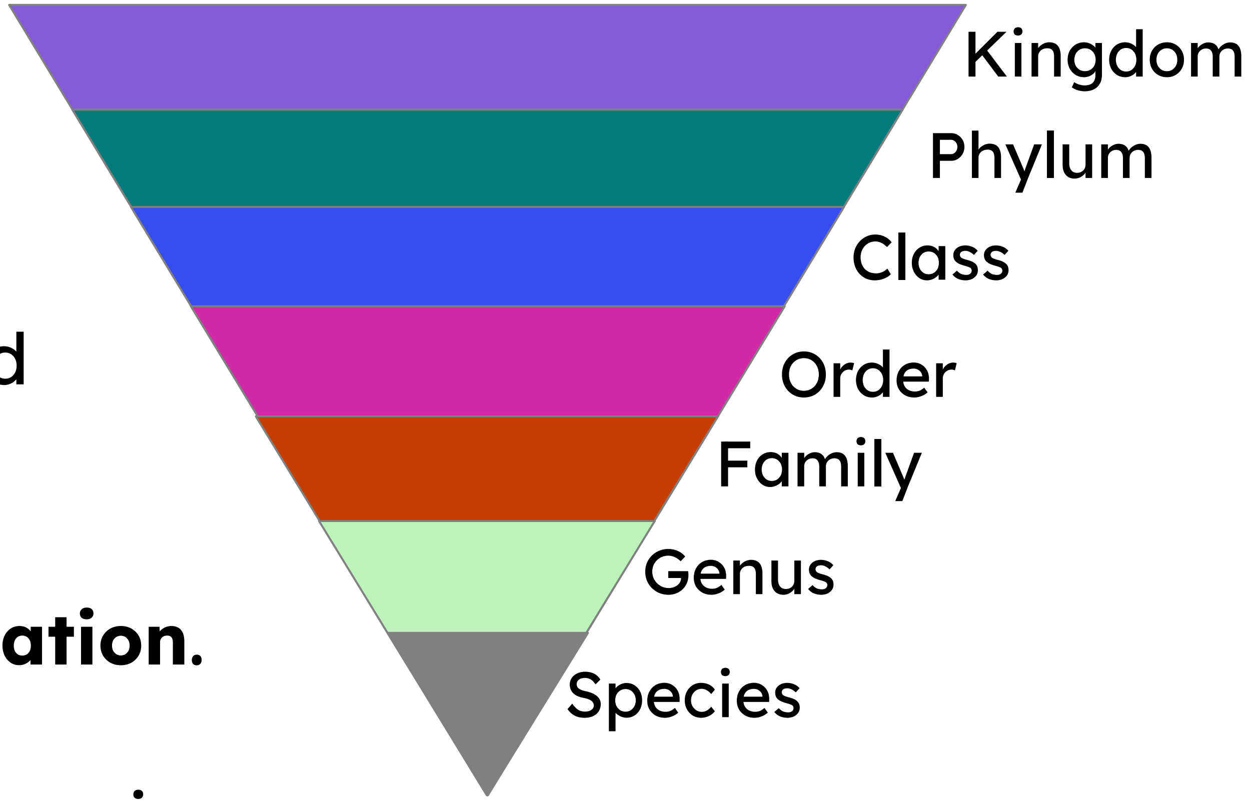
Explanation

Scientists classify organisms according to their features.

The process of classifying is called **taxonomy**.

There are seven levels of **classification**.

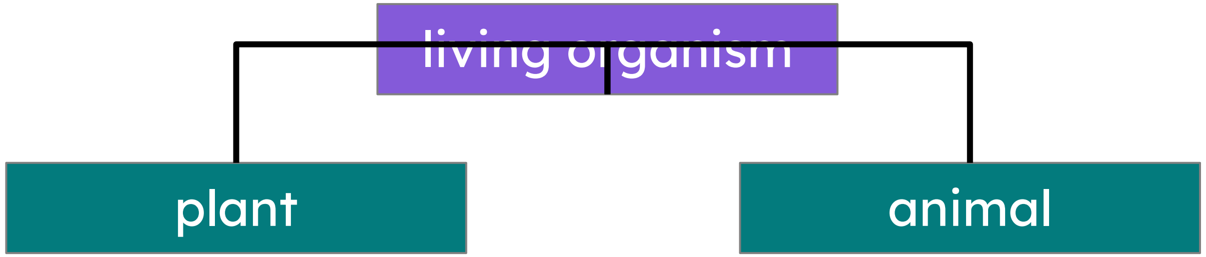
In lower levels, there are fewer organisms with more features in common and fewer differences.



Classifying organisms

Explanation

Animals and plants are both multicellular organisms.



But how do plants and animals differ?

Plants:

- are producers: can make their own food.

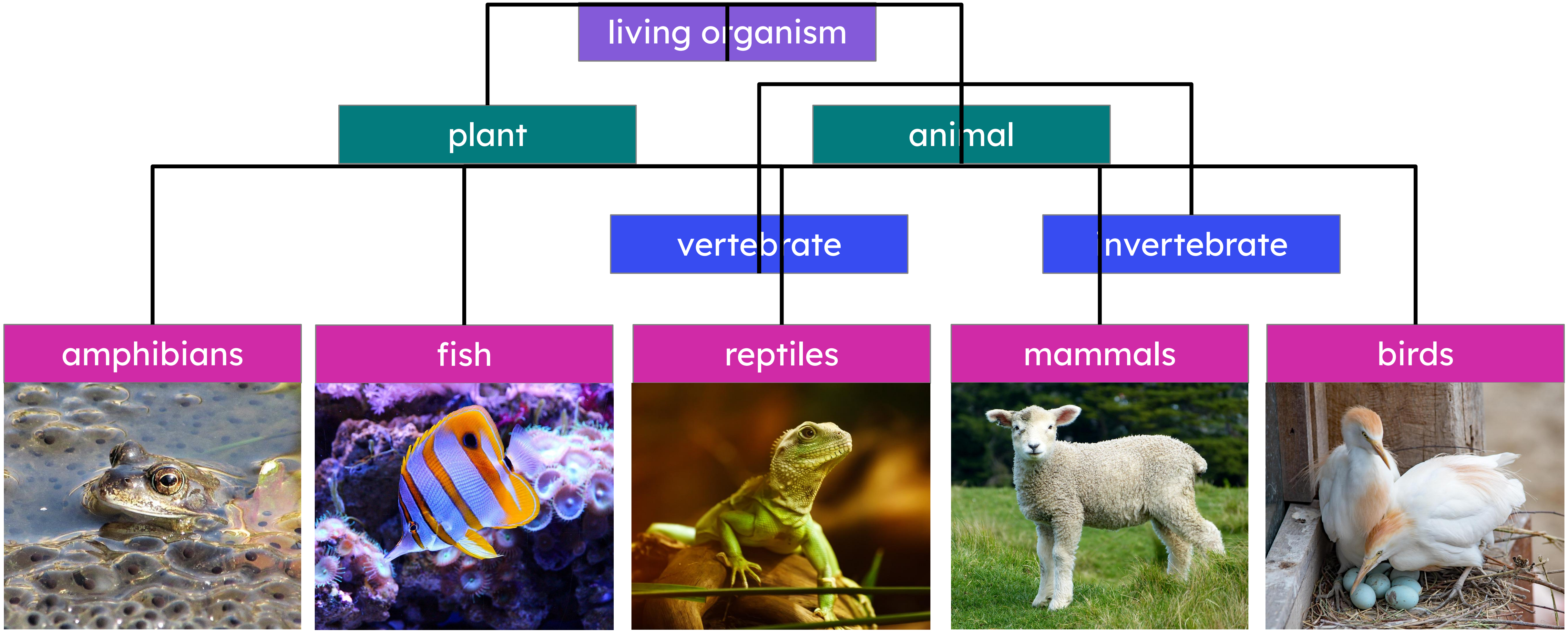
Animals:

- are consumers: eat other organisms for food.

Classifying organisms

Explanation

Consider animal classification:



Classifying organisms

Explanation

All vertebrates have a backbone.

But how do the vertebrates differ?

- animal
  - vertebrate
    - amphibians
    - fish
    - reptiles
    - mammals
    - birds
  - invertebrate

amphibians	fish	reptiles	mammals	birds
cold blooded			warm blooded	
moist skin	wet scales	dry scales	hair/fur	feathers
external reproduction		internal reproduction		
lay jelly-like eggs in water	lay eggs in water	lay eggs with soft shells on land	give birth to live young	lay eggs with hard shells
simple lungs	gills	lungs		

Whose idea about classification is correct?

As we classify from kingdom to species we get more organisms per group.

Aisha

a

There are fewer features in common between organisms as we move from species to kingdom.

Sam ✓

b

Only animals and plants are grouped by the seven classification levels.

Jacob

c

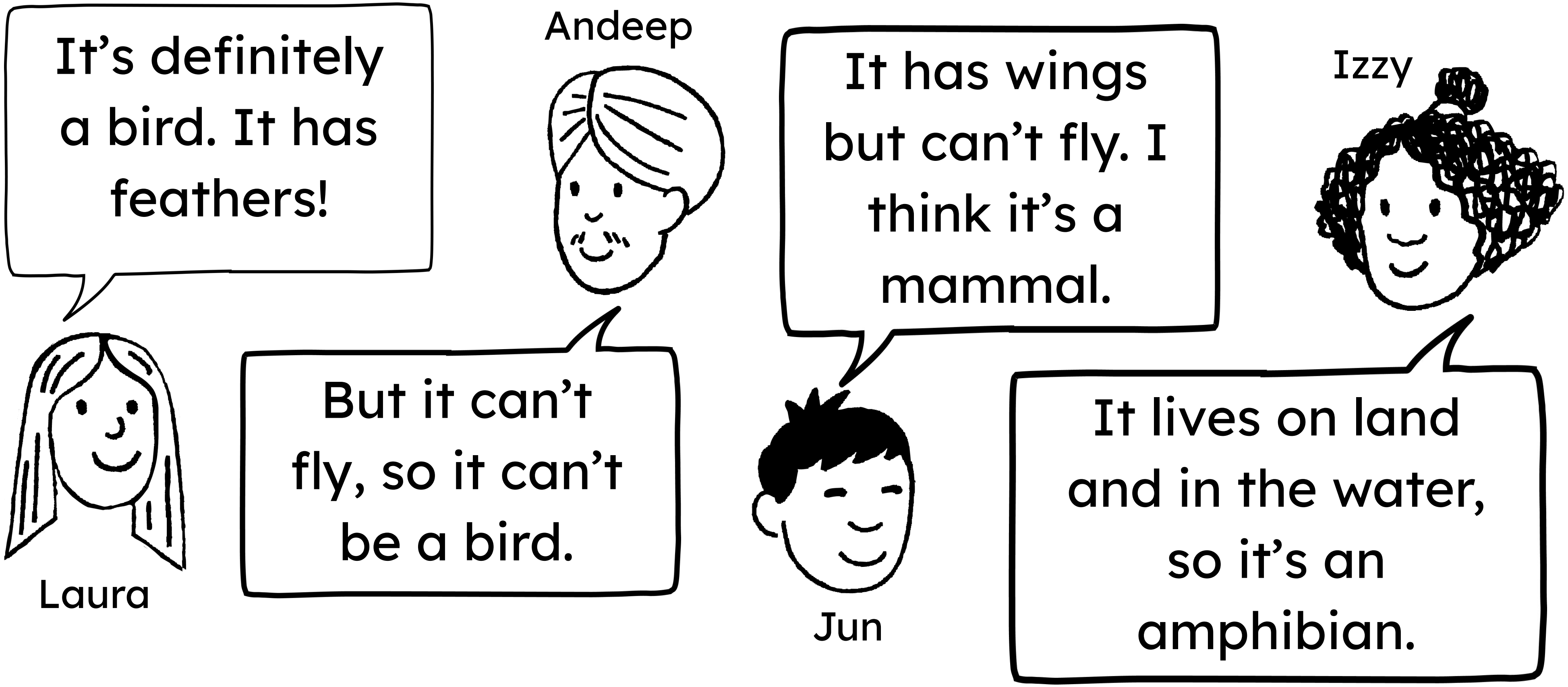
Lesson outline

Classifying organisms using a classification key

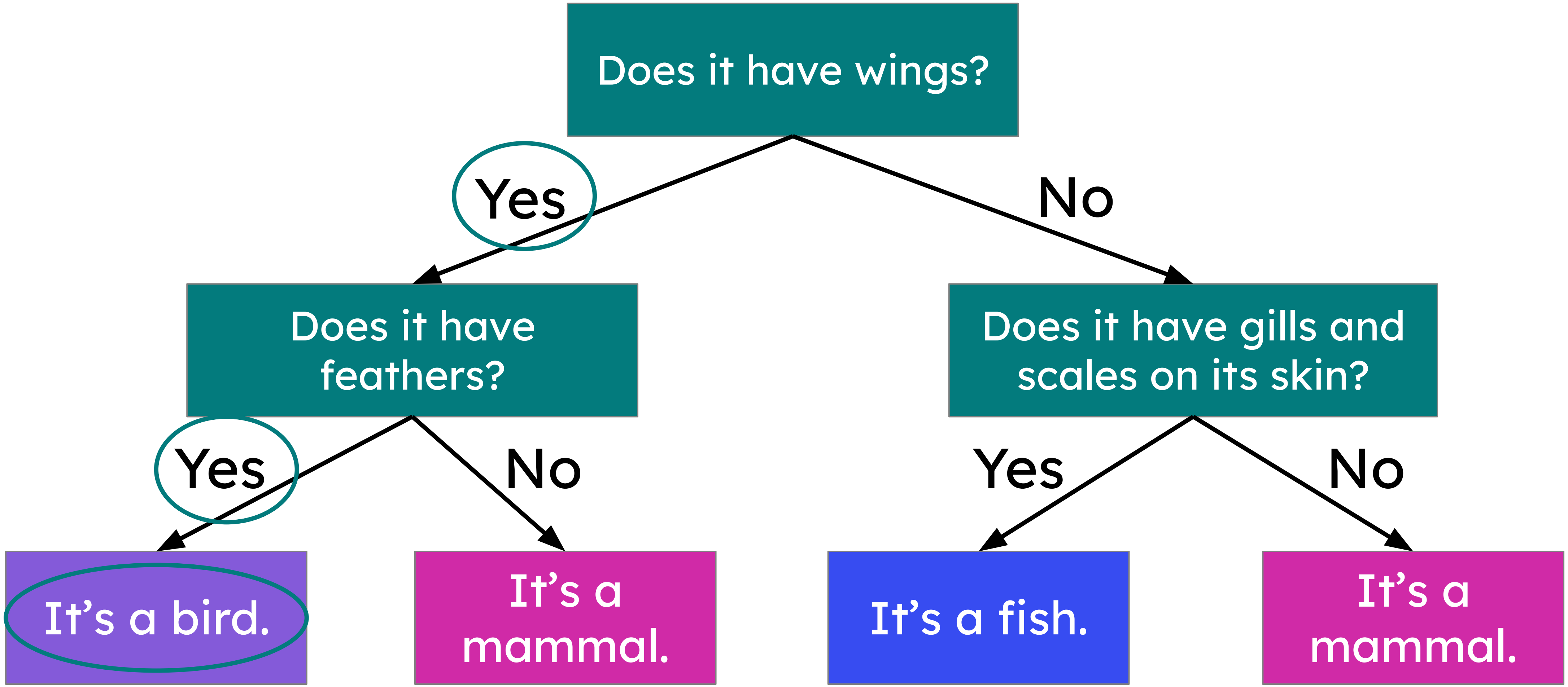
- Classifying organisms
- Using a key to classify organisms
- Importance of classification

Some organisms look like they may belong to several groups.

Consider a penguin.



We can use a **classification key** to help us classify a penguin.



Using a key to classify organisms

Explanation Check

Use the same classification key to group a bat.

Does it have wings?

Yes No

Does it have feathers?

Yes No

It's a bird.

It's a mammal.

Does it have gills and scales on its skin?

Yes No

It's a fish.

It's a mammal.

Use the same classification key to group a whale.

Does it have wings?

Yes No

Does it have feathers?

Yes No

It's a bird.

It's a mammal.

Does it have gills and scales on its skin?

Yes No

It's a fish.

It's a mammal.

Lesson outline

Classifying organisms using a classification key

- Classifying organisms
- Using a key to classify organisms
- Importance of classification

Importance of classification

Explanation

Classification is both useful and important.

It helps us to organise and make sense of the biodiversity on Earth.

We can monitor and track diversity and conservation efforts.

elephants being monitored

Check

True or false?

Classifying organisms is useful when monitoring biodiversity.

T True ✓

F False

Justify your answer

a It accurately describes the features of an organism which is useful in conservation. ✓

b It explains evolution which is useful in conservation.

Classification at the cellular level

Lesson outline

Classification at the cellular level

- Features of a cell
- Classifying based on cellular features

Check

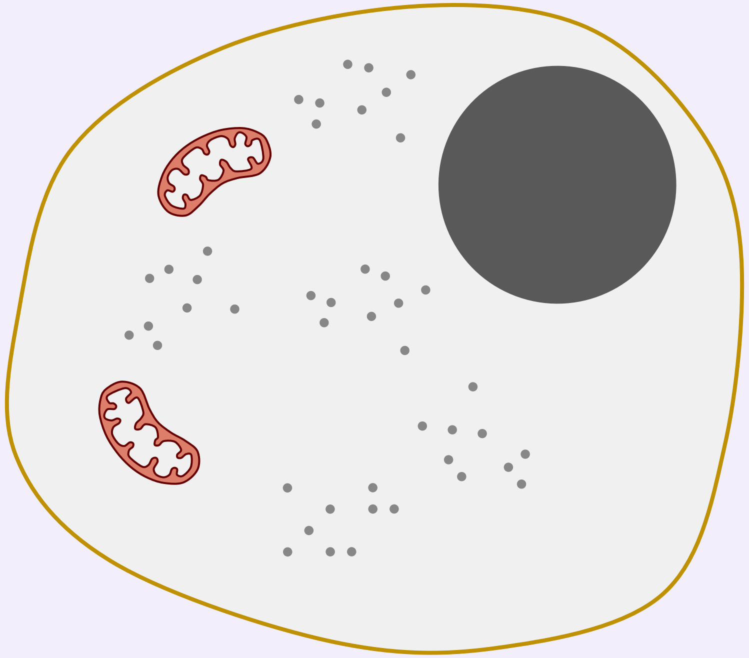
Which of these cell features are present in animal cells?

a cell membrane ✓

b nucleus ✓

c cell wall

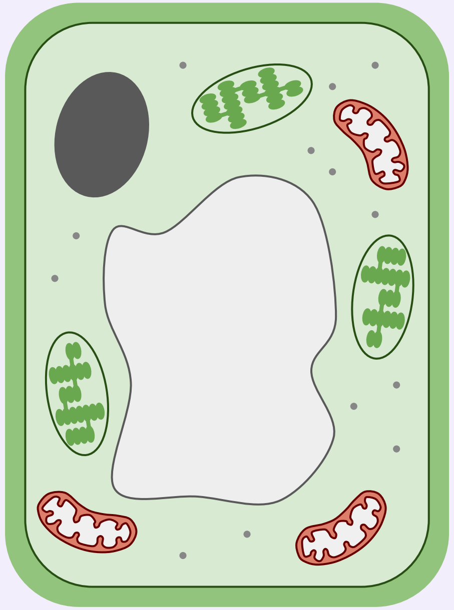
d flagellum



Features of a cell

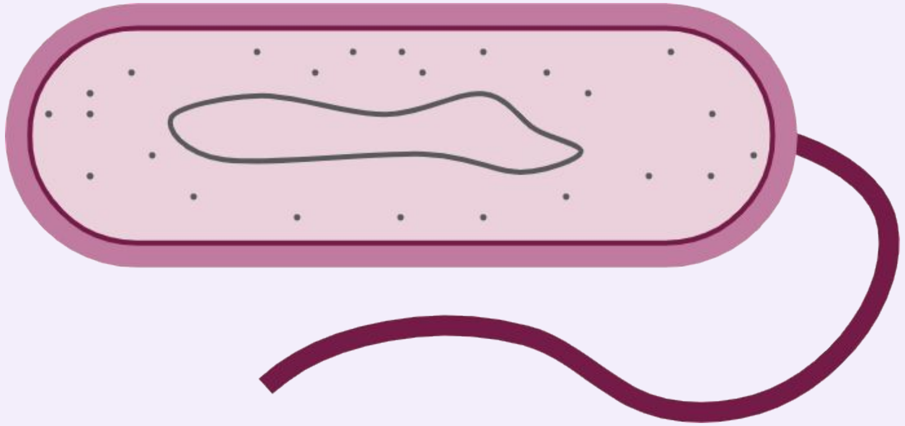
What type of cell am I? I have a cell wall, have small vacuoles, and DNA in a nucleus.

plant



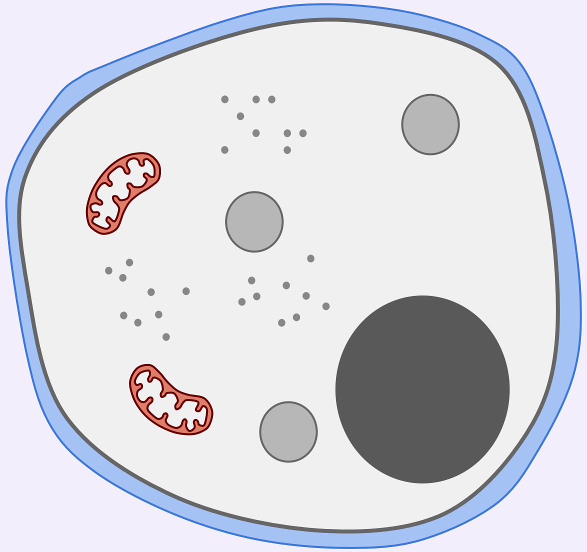
a

bacterium



b

fungal



c ✓

Task A Features of a cell

1) Complete the table to show which cellular features are present in each kingdom.

	Animal	Plant	Fungi	Bacteria
Cells have a nucleus				
Cells have a cell wall				
Cells have chloroplasts and can make their own food				

Task A Features of a cell

Feedback

1) Complete the table to show which cellular features are present in each kingdom.

	Animal	Plant	Fungi	Bacteria
Cells have a nucleus	✓	✓	✓	✗
Cells have a cell wall	✗	✓	✓	✓
Cells have chloroplasts and can make their own food	✗	✓	✗	✗

Lesson outline

Classification at the cellular level

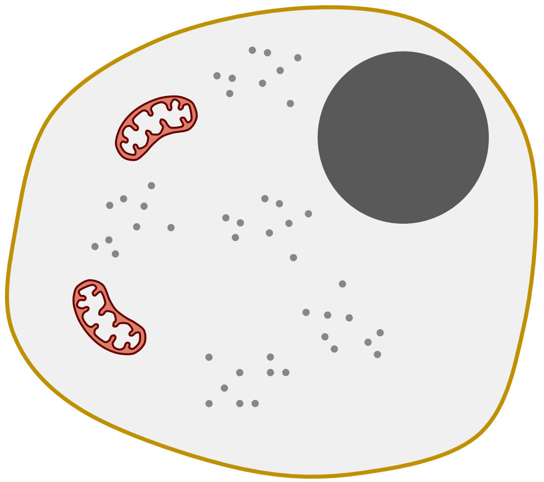
- Features of a cell
- Classifying based on cellular features

Classifying based on cellular features

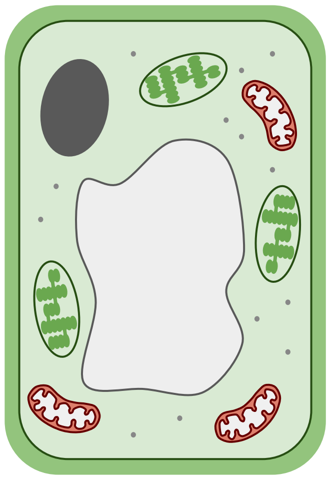
Explanation

We have seen that different groups of organisms have different cell features.

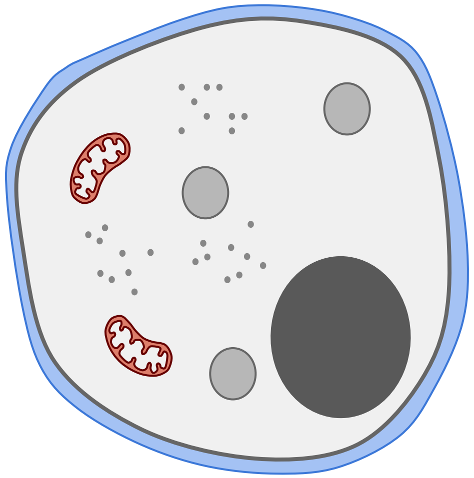
We can use these features to classify organisms into kingdoms.



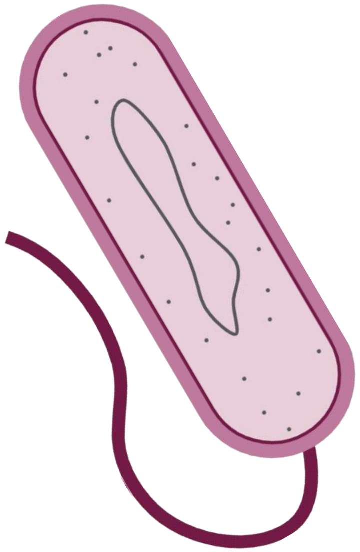
animals



plants



fungi

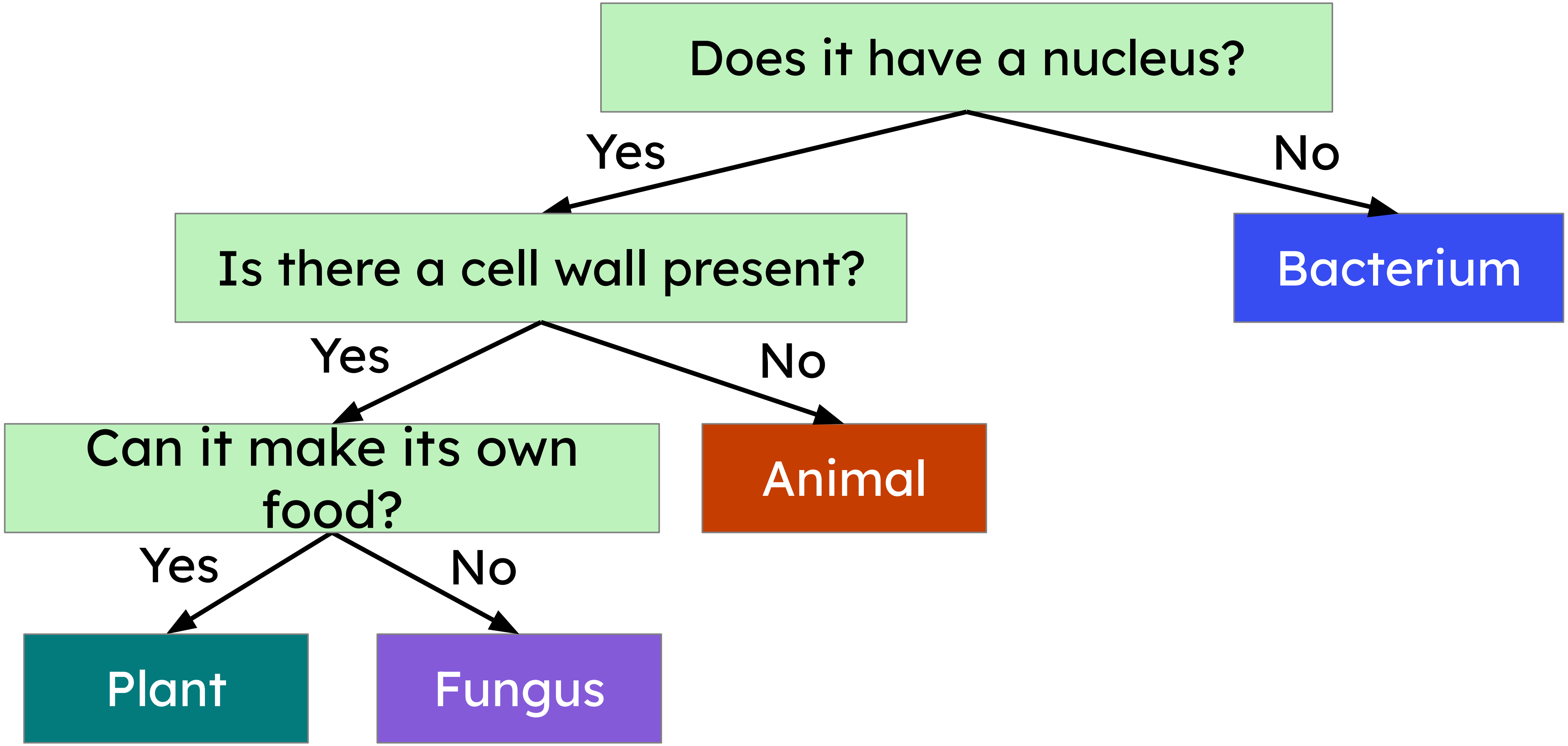


bacteria

Classifying based on cellular features

Explanation

We can use this information to create a classification key.



Classifying based on cellular features

Check

Scientists have discovered a new organism which looks like a green blob! Use the features below to decide whether it is a plant or an animal.

The feature…	… suggests it's a plant	… suggests it's an animal	… does not help you decide
It is green			✓
It does not have roots			✓
It does not have fur			✓
It does not have legs			✓
It is soft and squidgy			✓

Classifying based on cellular features

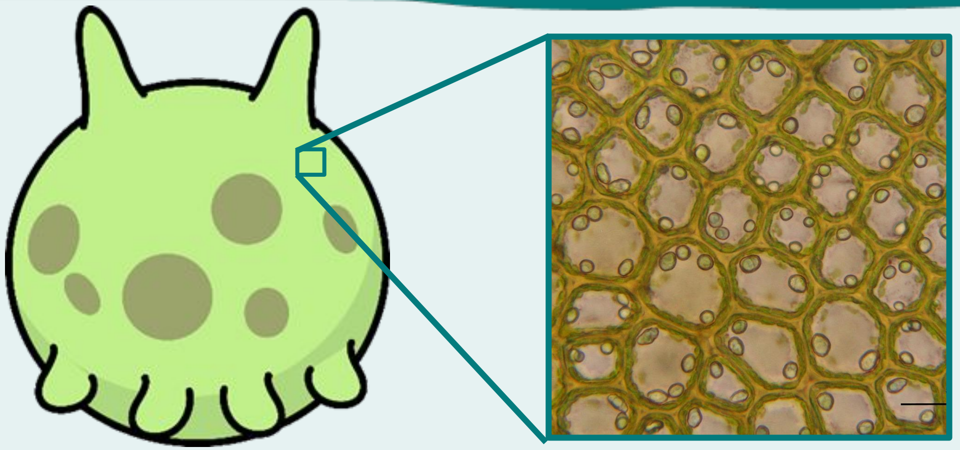
It is possible to group an organism into its correct kingdom very quickly using the features found in cells.

It offers a more precise method of classifying organisms than by appearance alone.

Classifying based on cellular features

Check

Now use the questions about cell features to decide whether it is a plant or an animal.



The feature…	… suggests it's a plant	… suggests it's an animal	… does not help you decide
Its cells have a cell wall	✓		
Its cells can make their own food	✓		
The cells contain chloroplasts	✓		

Classification into kingdoms and domains: sub-cellular evidence

Lesson outline

Classification into kingdoms and domains: sub-cellular evidence

- Linnaean classification
- Binomial naming system
- The three-domain system

Linnaean classification

Explanation

Carl Linnaeus (1707 - 1778), the Swedish botanist, is often called the father of the modern classification system.

He started sorting organisms that have similar **phenotypes** into groups and naming them.

Carl Linnaeus
(1707 - 1778)

Linnaean classification

Explanation

Linnaeus identified three large groups from nature that he called **kingdoms**.

Linnaeus's original kingdoms:

plant kingdom

animal kingdom

mineral kingdom

Linnaeus revised his work to remove a kingdom. Which kingdom did he remove and why?

Check

What is the name of the 18th Century botanist who developed a system for classifying living things?

a Charles Darwin

b Gregor Mendel

c Jean-Baptiste de Lamarck

d Carl Linnaeus ✓

Linnaean classification

Check

How did Linnaeus classify organisms?

a by their genotypes

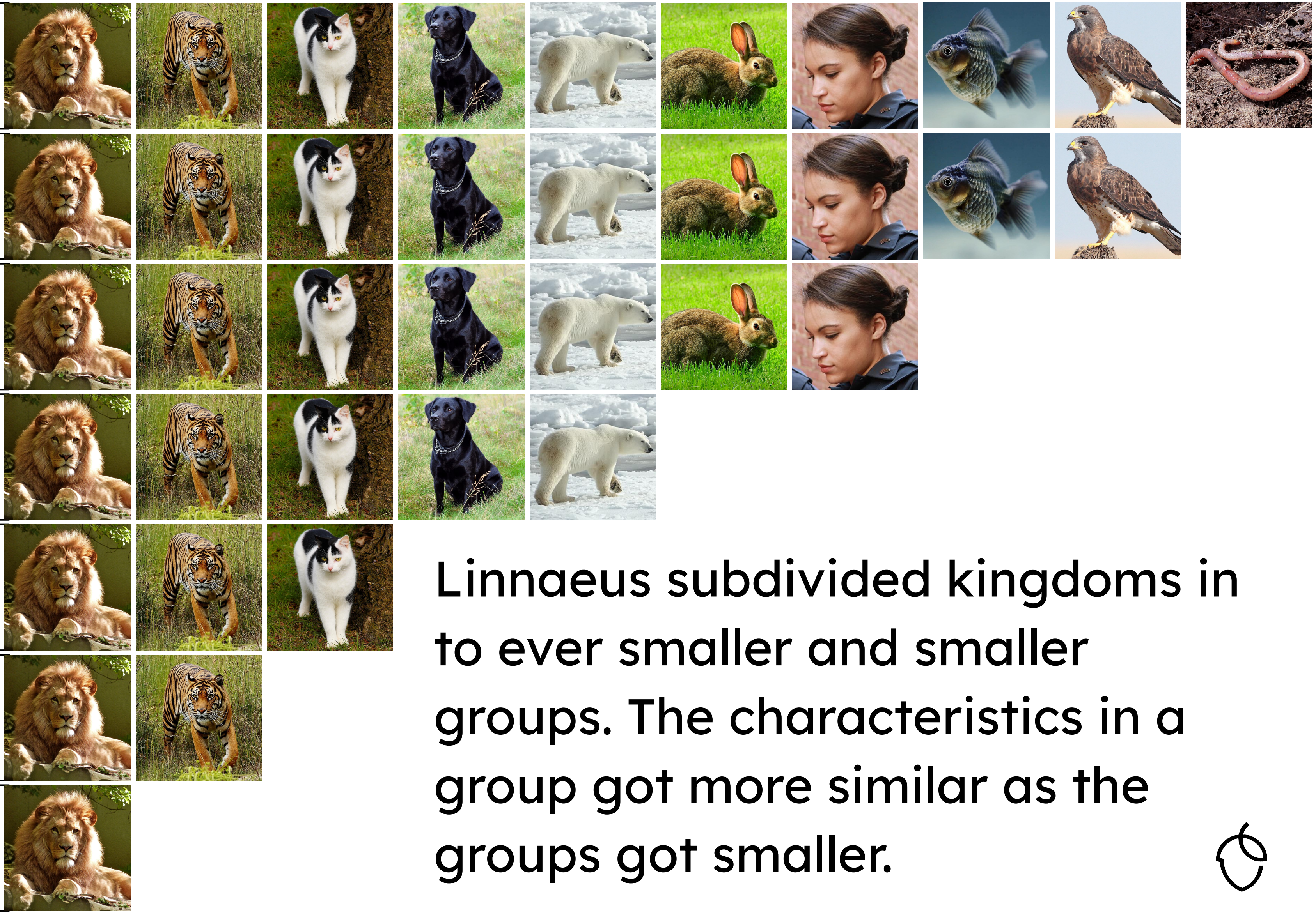
b by their names

c by their phenotypes ✓

Linnaean classification

Explanation

Kingdom	Animalia
Phylum	Chordata
Class	Mammalia
Order	Carnivore
Family	Felidae
Genus	*Panthera*
Species	*leo*



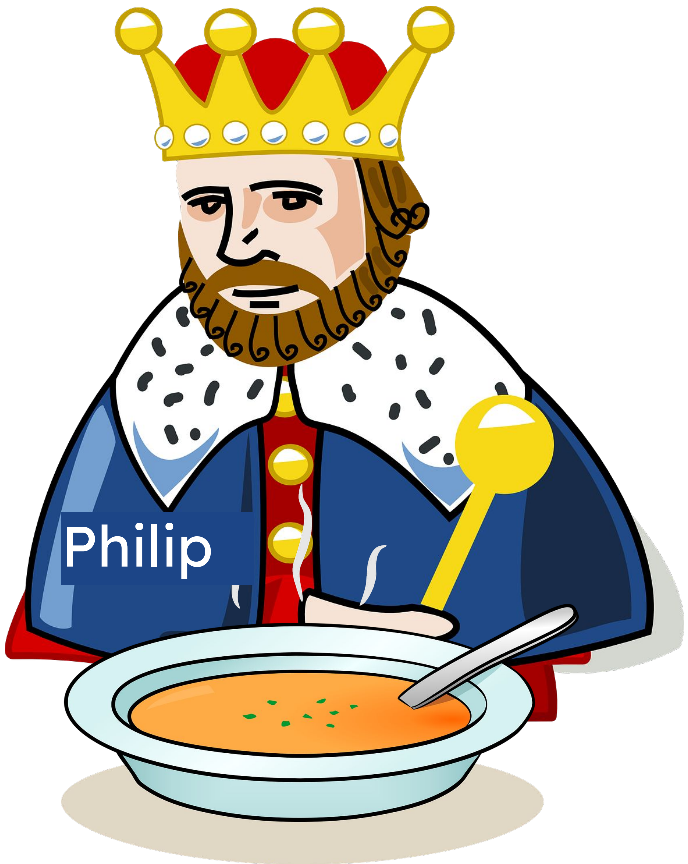
Linnaeus subdivided kingdoms in to ever smaller and smaller groups. The characteristics in a group got more similar as the groups got smaller.

Linnaean classification

Explanation

If is good to remember the names and order of the Linnaean classification groups. Using a mnemonic can help:

Kingdom	King
Phylum	Philip
Class	Came
Order	Over
Family	For
Genus	Good
Species	Soup

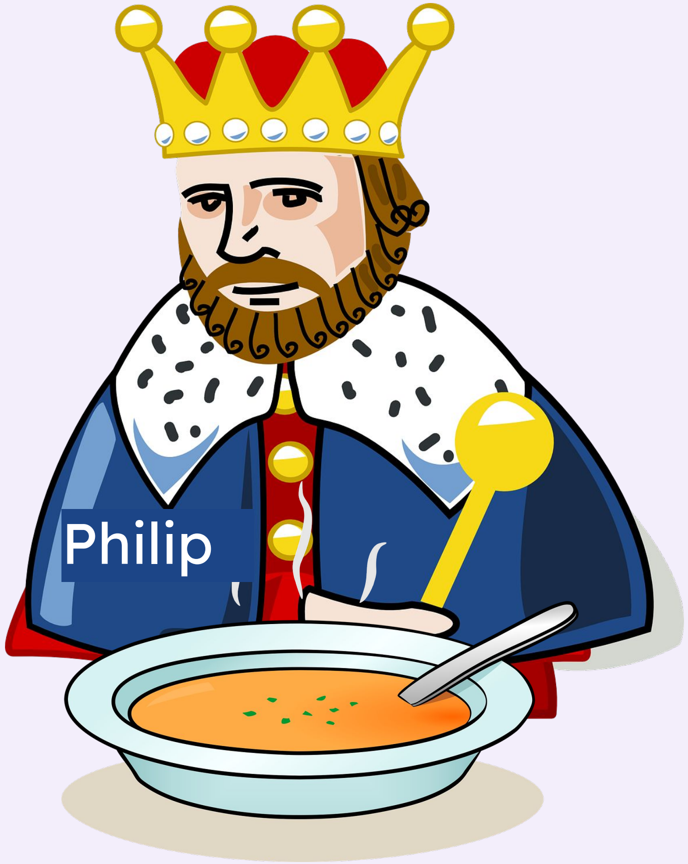


Linnaean classification

Check

Which group in the classification system is missing?

Kingdom	King
Phylum	Philip
Class	Came
Order	Over
Family	For
Genus	Good
Species	Soup

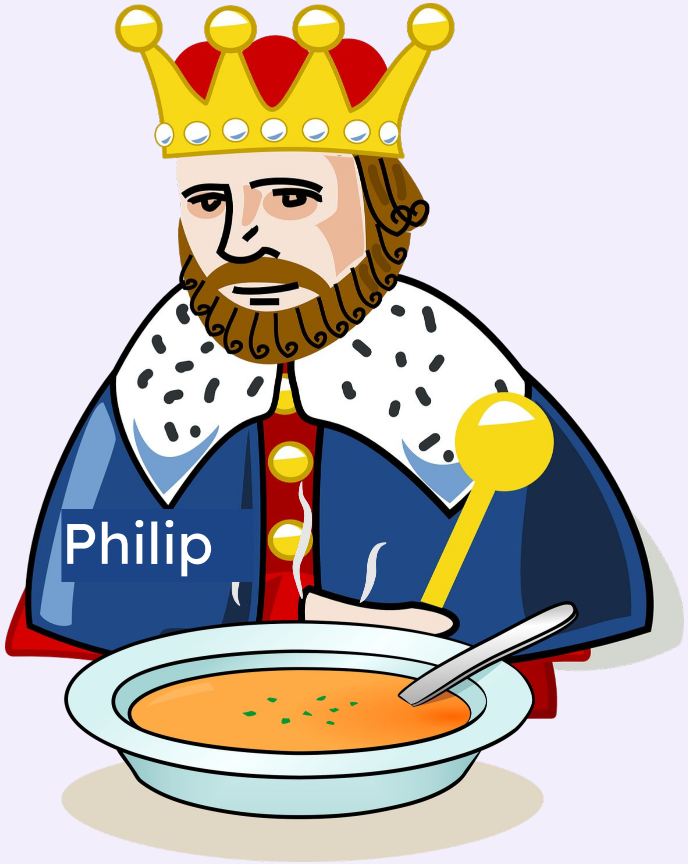


Linnaean classification

Check

Which group in the classification system is missing?

Kingdom	King
Phylum	Philip
Class	Came
Order	Over
Family	For
Genus	Good
Species	Soup

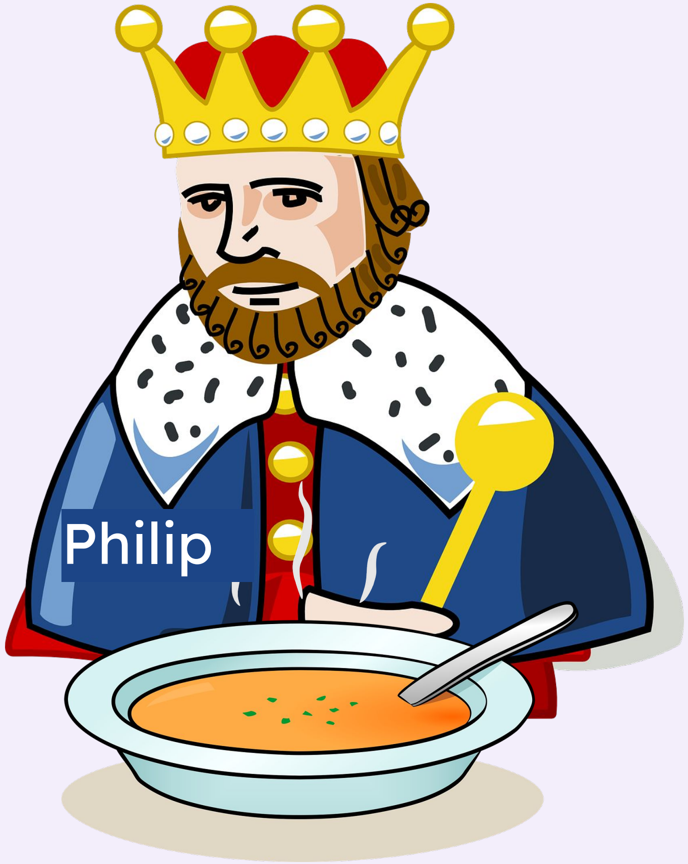


Linnaean classification

Check

Which groups in the classification system are missing?

- Kingdom
- Phylum
- Class
- Order
- Family
- Genus
- Species



4) The Madagascan fossa was originally classified as a cat.

a) Suggest why it was classified as a cat.

b) Give one piece of evidence that shows that the fossa is not a cat.

fossa

Feedback

4) The Madagascan fossa was originally classified as a cat.

a) Suggest why it was classified as a cat.

fur, whiskers, eye position, teeth

b) Give one piece of evidence that shows that the fossa is not a cat.

different ear shape, face shape or body shape

fossa

Lesson outline

Classification into kingdoms and domains: sub-cellular evidence

- Linnaean classification
- Binomial naming system
- The three-domain system

Binomial naming system

Explanation

Linnaeus introduced the binomial naming system.

The binomial naming system gives each organism a two part name. The first part is their genus, the second part is their **species.**

Panthera leo

Homo sapien

Cryptoprocta ferox

Binomial naming system

Explanation

The formatting conventions for genus and **species** names are:

genus name has the first letter capitalised

Crocodylus niloticus

both names are either in italics or underlined

species name is all in lowercase

Binomial naming system

Explanation

These examples show the binomial names formatted incorrectly.

English oak:
quercus Robur

common blackbird:
Turdus Merula

Binomial naming system

Check

Which example correctly shows the binomial genus and species name for the domestic cat?

Felis catus

a *Felis Catus*

b *felis Catus*

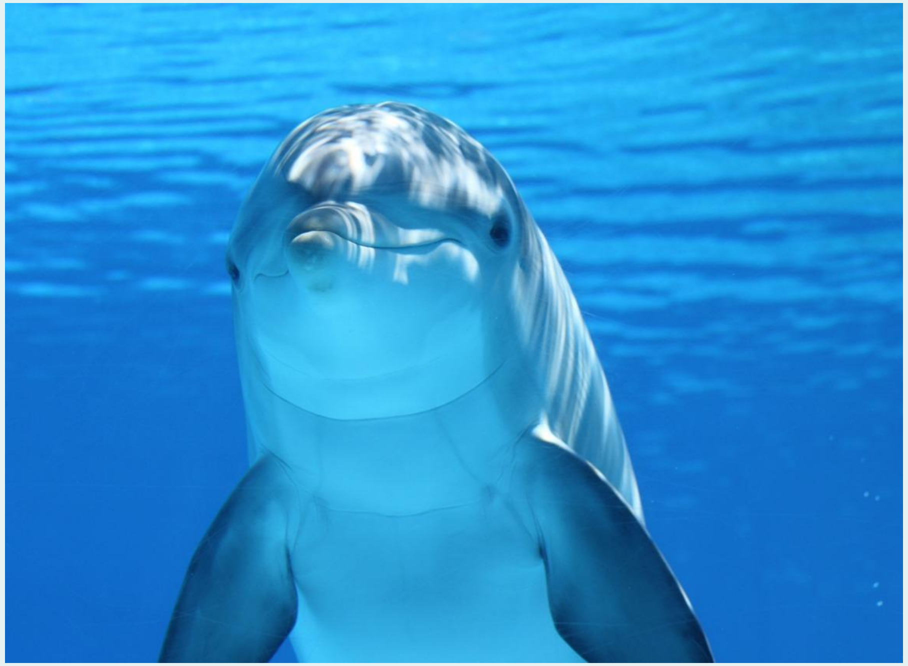
c Felis catus ✓

Binomial naming system

Check

Which example correctly shows the binomial genus and species name for the common dolphin?

Delphinidae delphis



a *Delphinidae Delphis*

b *Delphinidae delphis* ✓

c <u>Delphinidae Delphis</u>

Task B Binomial naming system

Practice

level	lion	tiger
Kingdom		
		chordata
Class	mammalia	
		carnivora
Family	Felidae	
Species		

Lions (*Panthera leo*) and tiger (*Panthera tigris*) are closely related.

Complete the table to show how they are classified.

Task B Binomial naming system

Feedback

level	lion	tiger
Kingdom	Animalia	Animalia
Phylum	chordata	chordata
Class	mammalia	mammalia
Order	Carnivora	carnivora
Family	Felidae	Felidae
Genus	Panthera	Panthera
Species	leo	tigris

Lions (*Panthera leo*) and tigers (*Panthera tigris*) are closely related.

Complete the table to show how they are classified.

Lesson outline

Classification into kingdoms and domains

- Linnaean classification
- Binomial naming system
- The three-domain system

The three-domain system

Explanation

Since Linnaeus, modern scientific methods such as microscopy and gene sequencing have refined classification.

microscopy

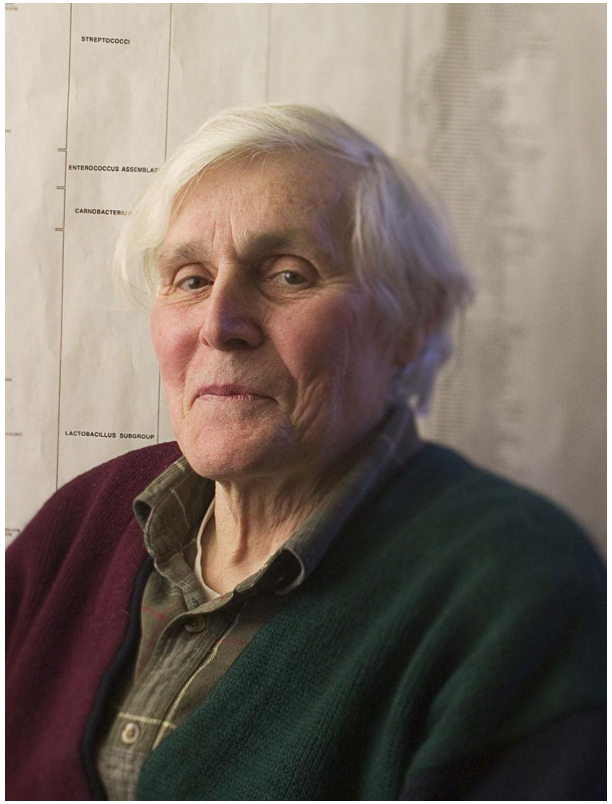
gene sequencing

The three-domain system

Explanation

Classification systems based on new techniques in microscopy and DNA sequence comparisons were developed by scientists, including Carl Woese (1928-2012).

Woese was an American microbiologist who developed the use of DNA sequences to refine classification.

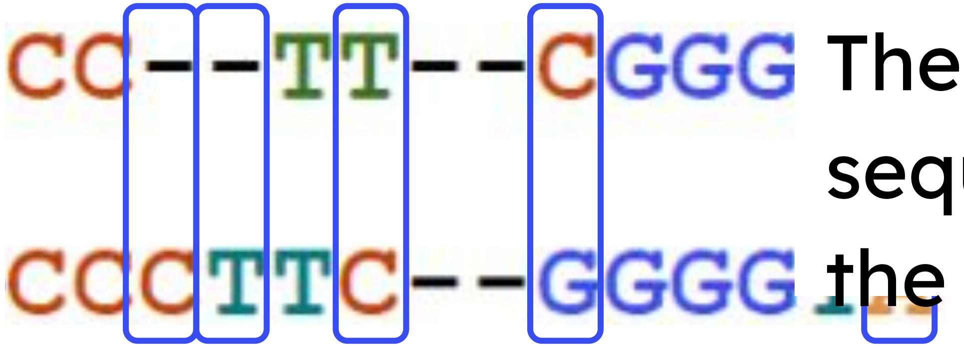


Carl Woese (1928-2012)

The three-domain system

Woese compared the DNA sequences of different bacterial species.

If species are more closely related, their gene sequences exhibit fewer differences.



The more differences in gene sequences, the more distantly related the species.

The three-domain system

Explanation

Using evidence from gene sequencing, Woese introduced **domains**, which are a higher classification above kingdoms. Domains divide living organisms into:

Eukaryota (includes all animals, plants, fungi and protists)

Bacteria (true bacteria)

Archaea (primitive bacteria living in extreme environments)

The three-domain system

Explanation

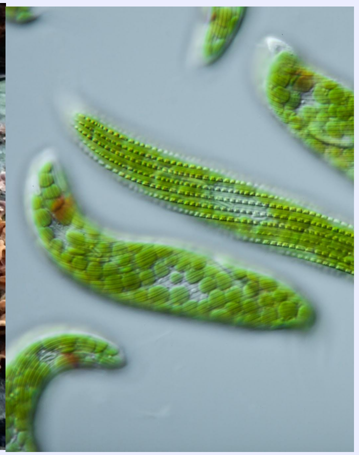
There are domains of eukaryotes (animals, plants, fungi and protists), bacteria and archaea (both prokaryotic).

Eukaryota

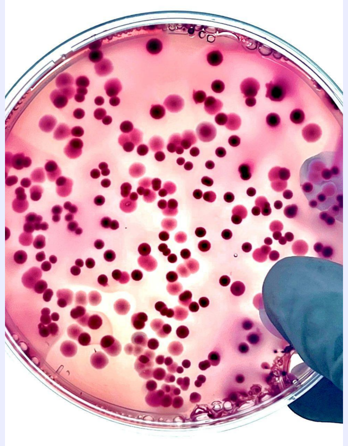

animal kingdom


plant kingdom

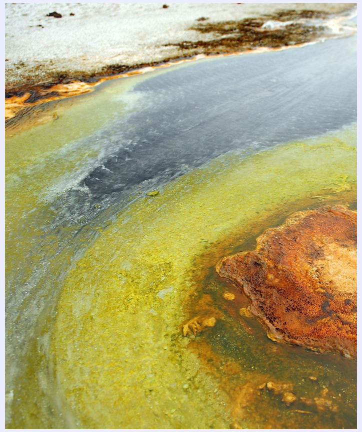

fungi kingdom


protist kingdom

Bacteria


bacteria kingdom

Archaea


archaea kingdom

The three-domain system

Check

Who developed the 'three-domain system' of classification?

a Carl Linnaeus

b Charles Darwin

c Carl Woese ✓

The three-domain system

Check

What evidence did Carl Woese use when developing the three-domain system of classification?

a phenotypic characteristics

b genetic similarities and differences ✓

c binomial names

The three-domain system

Check

Which domain is the common frog in?

- **a** eukaryota ✓
- **b** bacteria
- **c** archaea

The three-domain system

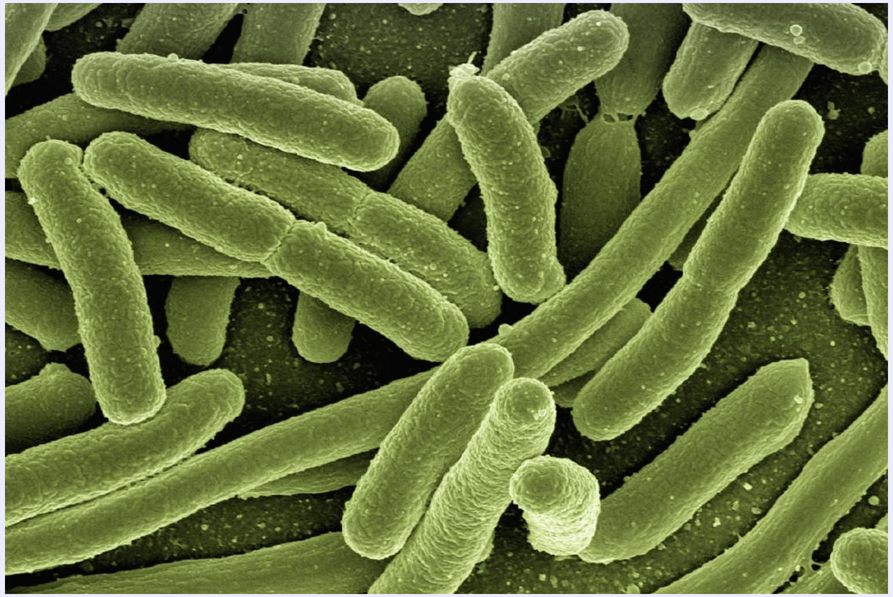
Check

Which domain is the *E. coli* in?

a eukaryota

b bacteria ✓

c archaea



E. coli

The three-domain system

Check

Which domain is the euglena in?

- **a** eukaryota ✓
- **b** bacteria
- **c** archaea

euglena

Task C The three-domain system

Practice

1) Fill in the gaps to complete the sentences.

You can only use the words eukaryota, bacteria and archaea to fill the gaps.

a) ___________ contains four kingdoms.

b) ___________ are primitive bacteria that live in extreme environments.

c) ___________ and ___________ contain one kingdom.

d) Extremophiles are ___________.

e) Plants and animals are ___________.

f) Yeast and protists are ___________.

g) *E. coli* are ___________.

Task C The three-domain system

Feedback

1) Fill in the gaps to complete the sentences.

You can only use the words eukaryota, bacteria and archaea to fill the gaps.

a) Eukaryota contains four kingdoms.
b) Archaea are primitive bacteria that live in extreme environments.
c) Archaea and bacteria contain one kingdom.
d) Extremophiles are bacteria.
e) Plants and animals are eukaryota.
f) Yeast and protists are eukaryota.
g) *E. coli* are bacteria.

Classification and reclassification: genetic evidence

Lesson outline

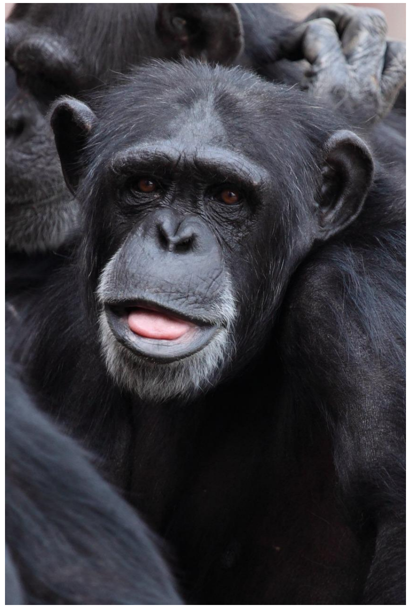
Classification and reclassification: genetic evidence

- Evolutionary trees
- Gene sequencing

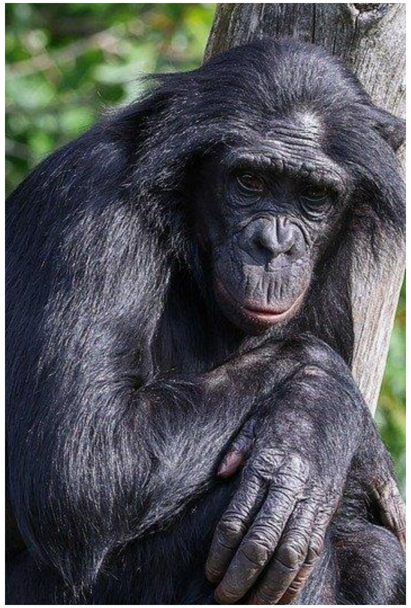
Evolutionary trees

Explanation

Linnaean classification relied on superficial similarities in the phenotype of organisms.

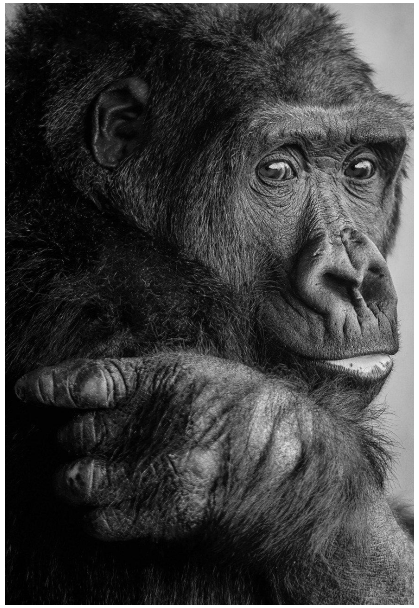


chimpanzee



bonobo

human



gorilla

orangutan

the five members of the *Hominidae* family

Evolutionary trees

Explanation

The classification system provides information about evolutionary relationships.

As you descend through each level of classification, the number of species in the group decreases.

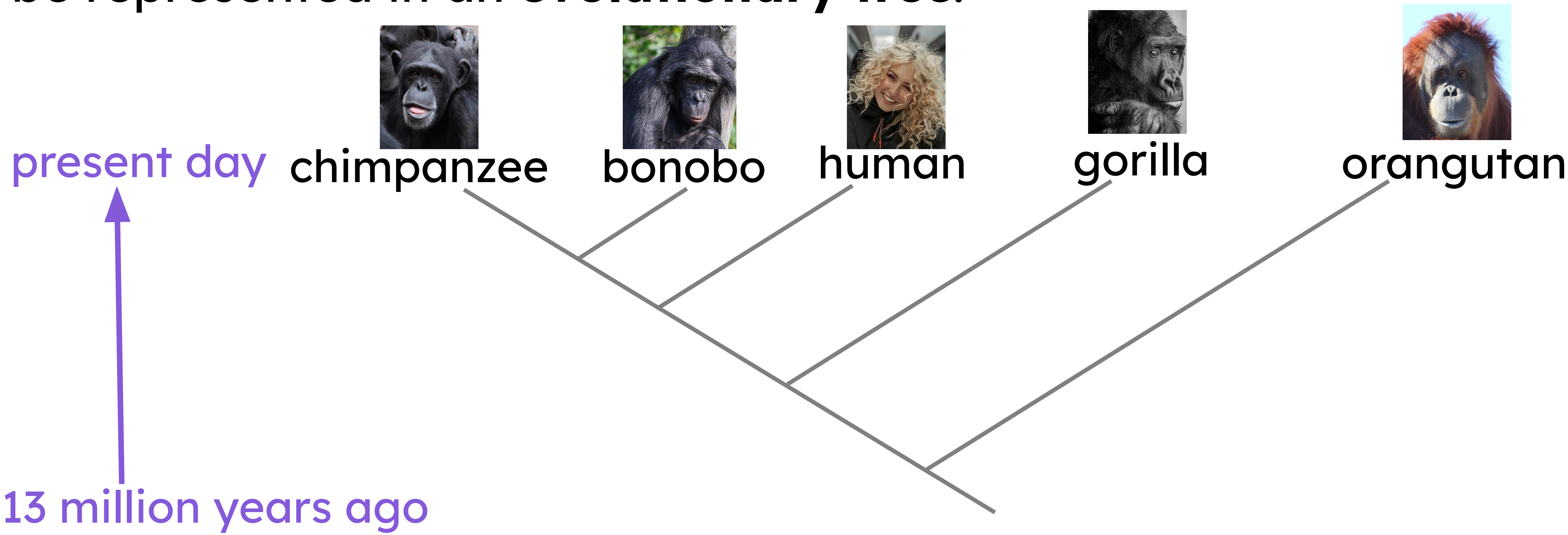
Two species within the same genus probably share a recent common ancestor in their evolutionary history.

Group	Santiago tortoise	Wolf volcano tortoise
Domain	*Eukaryota*	*Eukaryota*
Kingdom	*Animalia*	*Animalia*
Phylum	*Chordata*	*Chordata*
Class	*Reptilia*	*Reptilia*
Order	*Testudines*	*Testudines*
Family	*Testudinidae*	*Testudinidae*
Genus	*Chelonoidis*	*Chelonoidis*
Species	*darwini*	*becki*

Evolutionary trees

Explanation

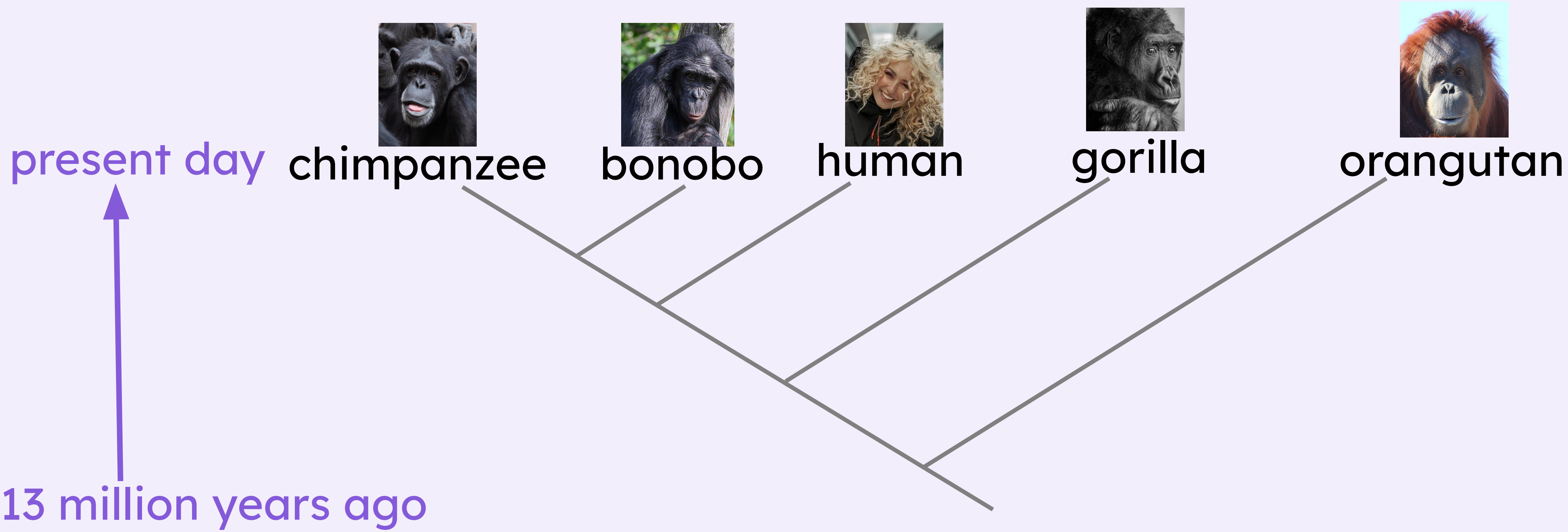
The evolutionary relationships between organisms can be represented in an **evolutionary tree**.



evolutionary tree showing the relationship between the *Hominidae* family

Evolutionary trees

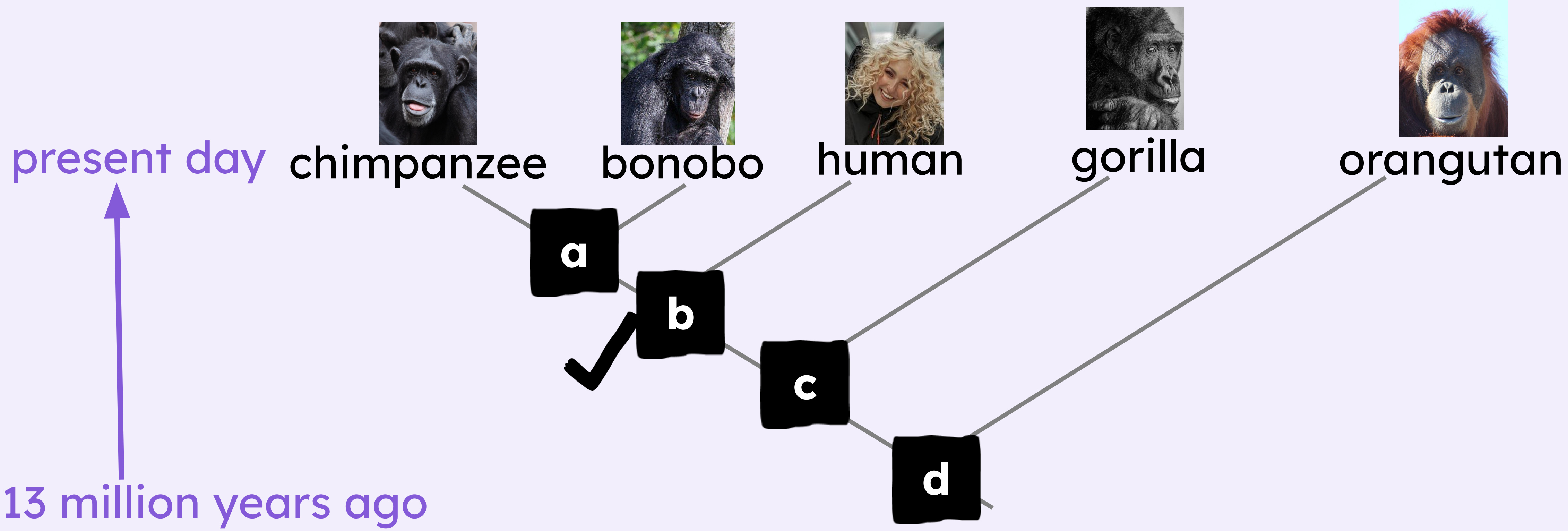
The model shown in the diagram below is an evolutionary *tree.*



Evolutionary trees

Check

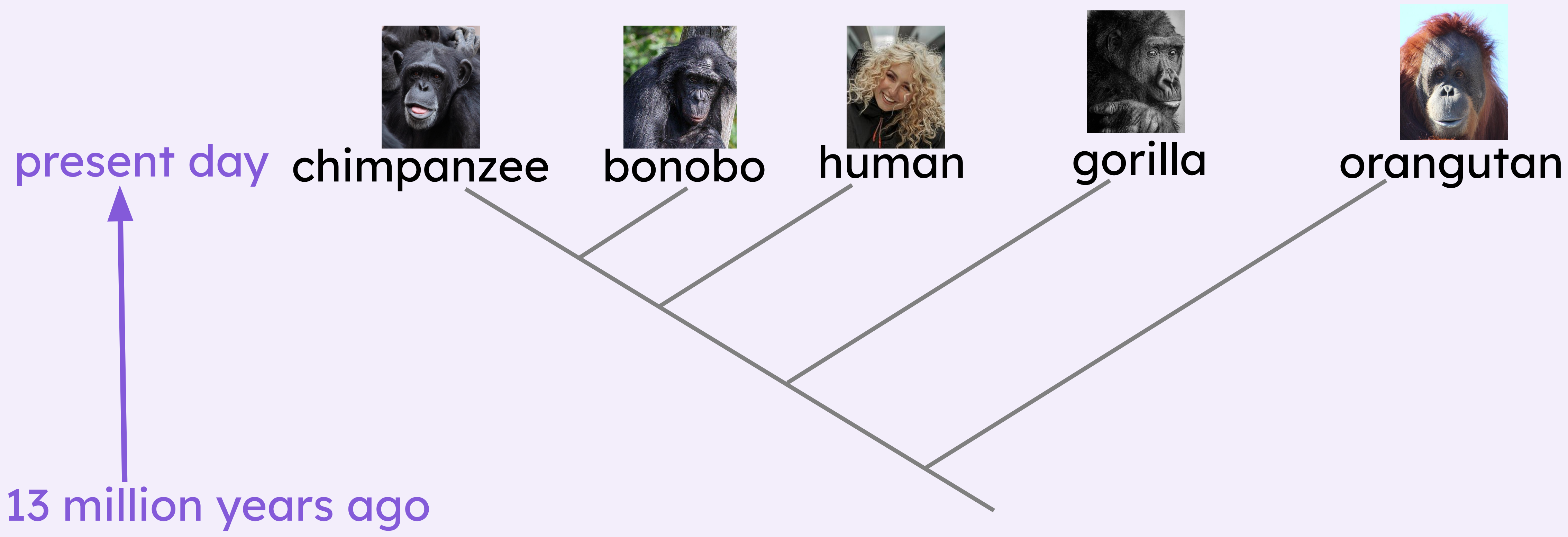
Which letter represents the common ancestor of chimpanzees, bonobos and humans?



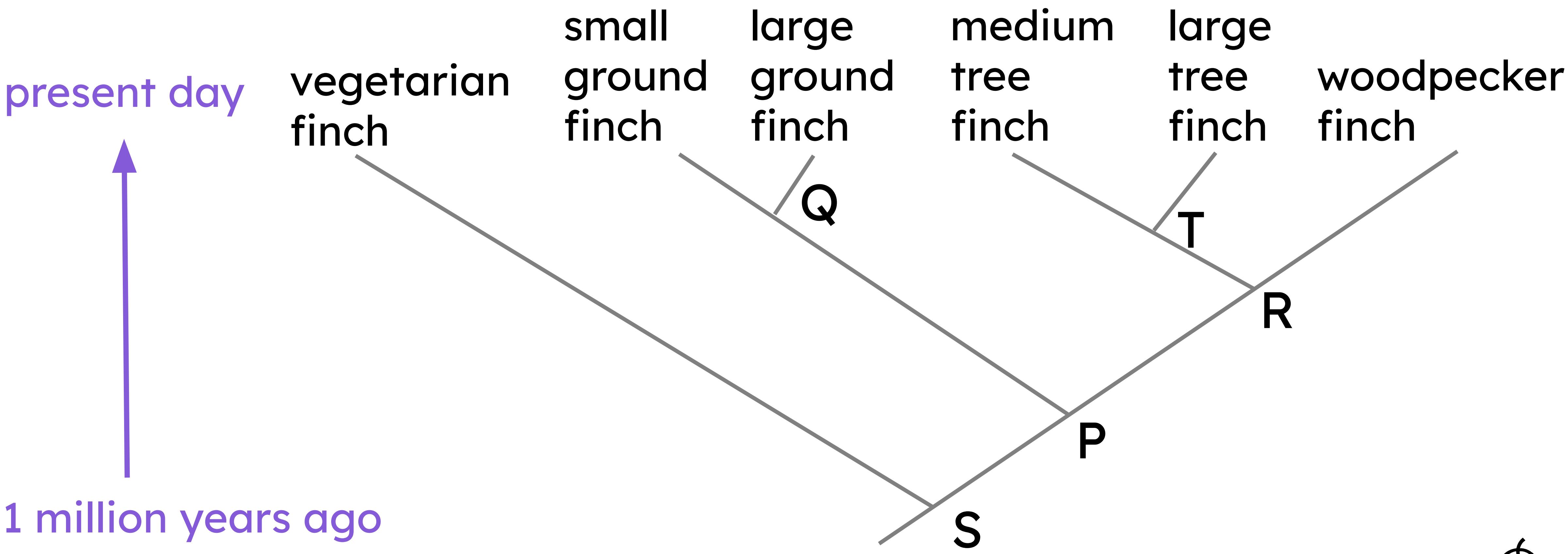
Evolutionary trees

Check

Which two hominids share the most recent common ancestor? *chimpanzees and bonobos*



Use this evolutionary tree to answer the following questions.



Task A Evolutionary trees

Practice

1) Which finch is least closely related to all the others?

2) Which two finches share the most recent common ancestor?

3) Which letter represents the common ancestor to all the ground and tree finches?

Feedback

1) Which finch is least closely related to all the others?

vegetarian finch

2) Which two finches share the most recent common ancestor?

small ground finch and large ground finch

3) Which letter represents the common ancestor to all the ground and tree finches?

P

Lesson outline

Classification and reclassification: genetic evidence

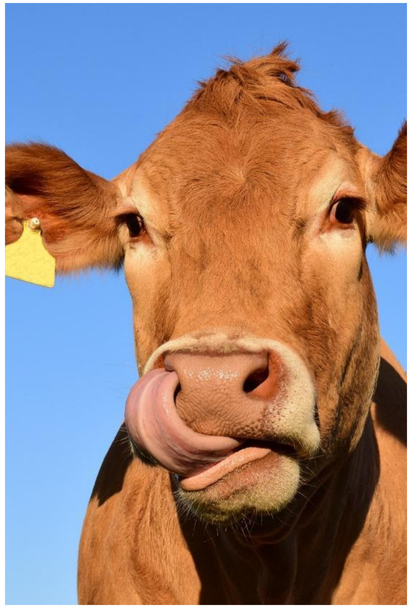
- Evolutionary trees
- Gene sequencing

Gene sequencing

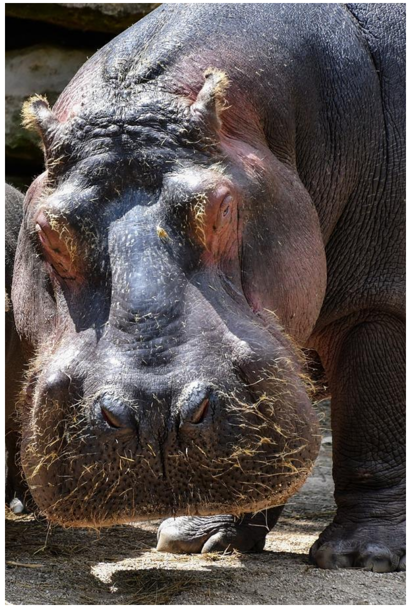
Explanation

Gene sequences change very slowly over time. By comparing similarities and differences between the gene sequences of different species, we can determine which ones are the most closely related.


whale


cow


tapir


hippo


zebra

Which of these mammals do you think are most closely related?

Gene sequencing

Explanation

This table show the **DNA** sequence from one very small section of one gene from three different mammals.

baleen whale	A	G	A	G	C	C	C	T	T	G	A	A	A	A	T
toothed whale	A	G	A	G	C	C	C	T	T	G	A	A	A	A	T
cow	T	G	A	G	C	G	C	C	T	G	A	A	A	A	T

We can see similarities in the DNA sequences.

differences in the DNA sequences.

Gene sequencing

Explanation

By looking at **gene sequences**, we can start to identify evolutionary relationships. This has helped us to reclassify organisms that we didn't previously know were related.

baleen whale	A	G	A	G	C	C	C	T	T	G	A	A	A	A	T
toothed whale	A	G	A	G	C	C	C	T	T	G	A	A	A	A	T
cow	T	G	A	G	C	G	C	C	T	G	A	A	A	A	T
hippo	A	G	A	C	C	G	C	C	T	G	A	A	A	A	T

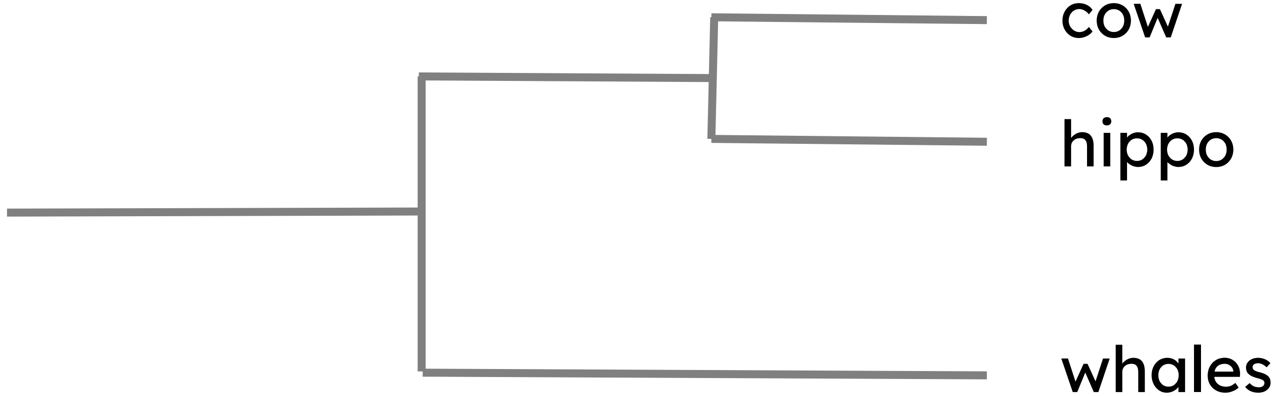
From these gene sequences we can see that cows and hippos are related each other and also to whales.

Gene sequencing

Explanation

We can start to use this information to draw **evolutionary trees.**

baleen whale	A	G	A	G	C	C	C	T	T	G	A	A	A	A	T
toothed whale	A	G	A	G	C	C	C	T	T	G	A	A	A	A	T
cow	T	G	A	G	C	G	C	C	T	G	A	A	A	A	T
hippo	A	G	A	C	C	G	C	C	T	G	A	A	A	A	T



Gene sequencing

Check

How many difference are there between the gene sequences of the whales and the cow?

a 2

b 3 ✓

c 12

d 15

baleen whale	A	G	A	G	C	C	C	T	T	G	A	A	A	A	T
toothed whale	A	G	A	G	C	C	C	T	T	G	A	A	A	A	T
cow	T	G	A	G	C	G	C	C	T	G	A	A	A	A	T
hippo	A	G	A	C	C	G	C	C	T	G	A	A	A	A	T

Gene sequencing

Check

How many difference are there between the gene sequences of the cow and the hippo?

a 2 ✓

b 3

c 12

d 15

baleen whale	A	G	A	G	C	C	C	T	T	G	A	A	A	A	T
toothed whale	A	G	A	G	C	C	C	T	T	G	A	A	A	A	T
cow	T	G	A	G	C	G	C	C	T	G	A	A	A	A	T
hippo	A	G	A	C	C	G	C	C	T	G	A	A	A	A	T

Gene sequencing

Check

How many difference are there between the gene sequences of the whales and the hippo?

- **a** 2
- **b** 3 ✓
- **c** 12
- **d** 15

baleen whale	A	G	A	G	C	C	C	T	T	G	A	A	A	A	T
toothed whale	A	G	A	G	C	C	C	T	T	G	A	A	A	A	T
cow	T	G	A	G	C	G	C	C	T	G	A	A	A	A	T
hippo	A	G	A	C	C	G	C	C	T	G	A	A	A	A	T

Task B Gene sequencing

Practice

Compare the DNA sequences of the cow, tapir, hippo and the zebra to the two whales.

baleen whale	A	G	A	G	C	C	C	T	T	G	A	A	A	A	T
toothed whale	A	G	A	G	C	C	C	T	T	G	A	A	A	A	T
cow	T	G	A	G	C	G	C	C	T	G	A	A	A	A	T
tapir	A	A	C	A	C	C	C	T	C	A	A	C	A	A	C
hippo	A	G	A	C	C	G	C	C	T	G	A	A	A	A	T
zebra	A	A	C	A	C	C	C	T	C	A	A	C	A	A	C

1) Highlight differences between the whales and the other mammals.

Task B Gene sequencing

Feedback

Compare the DNA sequences of the cow, tapir, hippo and the zebra to the two whales.

baleen whale	A	G	A	G	C	C	C	T	T	G	A	A	A	A	T
toothed whale	A	G	A	G	C	C	C	T	T	G	A	A	A	A	T
cow	T	G	A	G	C	G	C	C	T	G	A	A	A	A	T
tapir	A	A	C	A	C	C	C	T	C	A	A	C	A	A	C
hippo	A	G	A	C	C	G	C	C	T	G	A	A	A	A	T
zebra	A	A	C	A	C	C	C	T	C	A	A	C	A	A	C

1) Highlight differences between the whales and the other mammals.

2) Find two mammals with the same DNA sequence.

3) What does this information tell us about these pairs of mammals?

2) Find two mammals with the same DNA sequence.

baleen whale and toothed whale

zebra and tapir

3) What does this information tell us about these pairs of mammals?

The whales are more closely related to each other than they are the other mammals.

The zebra and the tapir are more closely related to each other than they are to the other mammals.

4) Count the number of differences in the DNA sequences between the whales and the other mammals.

Species	Order	Number of differences
toothed whale	Cetacea	N/A
baleen whale	Cetacea	N/A
hippo	Artiodactyla	
cow	Artiodactyla	
tapir	Perissodactyla	
zebra	Perissodactyla	

Task B Gene sequencing

Feedback

4) Count the number of differences in the DNA sequences between the whales and the other mammals.

Species	Order	Number of differences
toothed whale	Cetacea	N/A
baleen whale	Cetacea	N/A
hippo	Artiodactyla	3
cow	Artiodactyla	3
tapir	Perissodactyla	7
zebra	Perissodactyla	7

5) Looking at the number of DNA differences, which mammal species are most closely related to whales?

6) Artiodactyla are hoofed mammals with even number of toes on each foot and Perissodactyla have odd numbers of toes. What does the DNA evidence suggest about the evolutionary relationship of whales to these mammals?

Task B Gene sequencing

Feedback

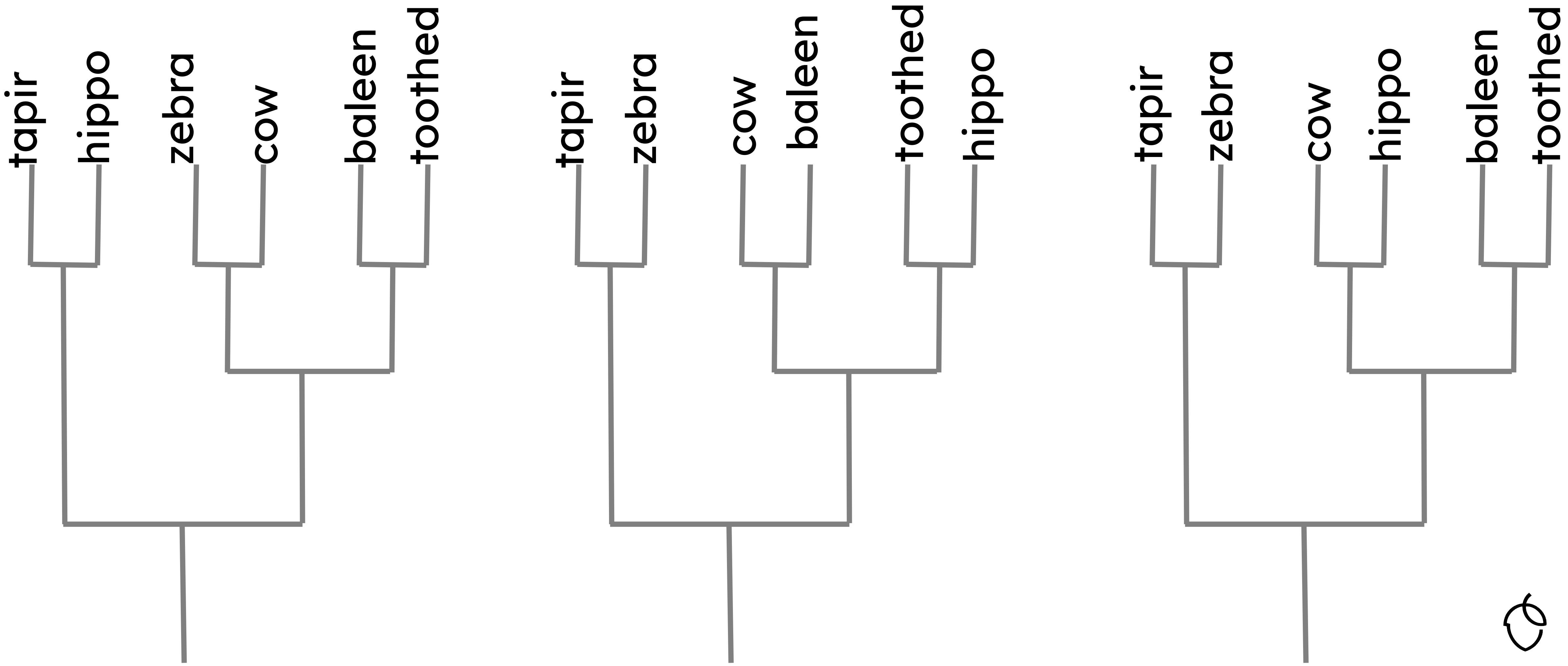
5) Looking at the number of DNA differences, which mammal species are most closely related to whales?

the hippo and the cow

6) Artiodactyla are hoofed mammals with even number of toes on each foot and Perissodactyla have odd numbers of toes. What does the DNA evidence suggest about the evolutionary relationship of whales to these mammals?

Whales evolved from an ancestor with even numbers of toes on each hoof.

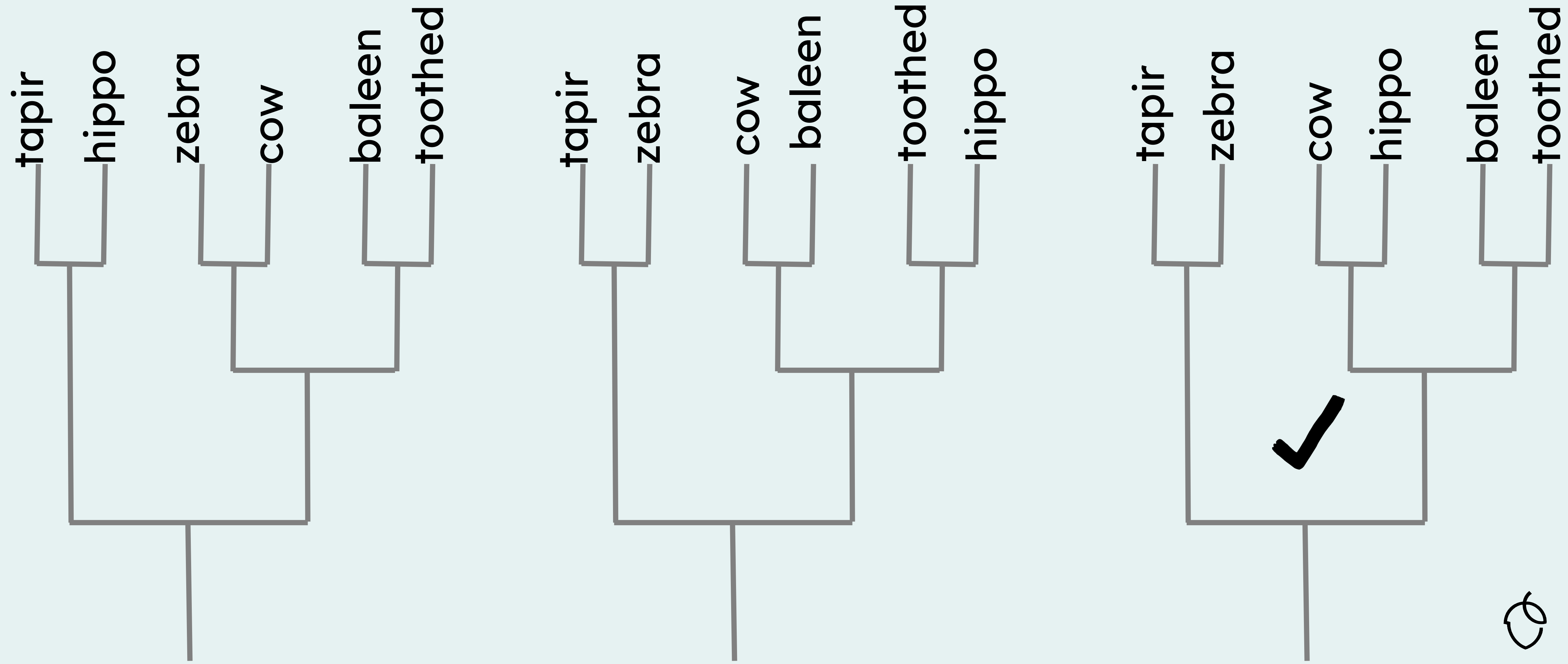
7) Which of these evolutionary trees best fits the DNA evidence?



Task B Gene sequencing

Feedback

7) Which of these evolutionary trees best fits the DNA evidence?



END