Classification

- Define the terms *classification, phylogeny* and *taxonomy*.
- Explain the relationship between classification and phylogeny.
- Describe the classification of species into the taxonomic hierarchy of domain, kingdom, phylum, class, order, family, genus and species.
- Outline the characteristic features of the following five kingdoms: Prokaryotae (Monera), Protoctista, Fungi, Plantae, Animalia.
- Outline the binomial system of nomenclature and the use of scientific (Latin) names for species.
- Use a dichotomous key to identify a group of at least six plants, animals or microorganisms.
- Discuss the fact that classification systems were based originally on observable features but more recent approaches draw on a wider range of evidence to clarify relationships between organisms, including molecular evidence.
- Compare and contrast the five-kingdom and three-domain classification systems.

Classification

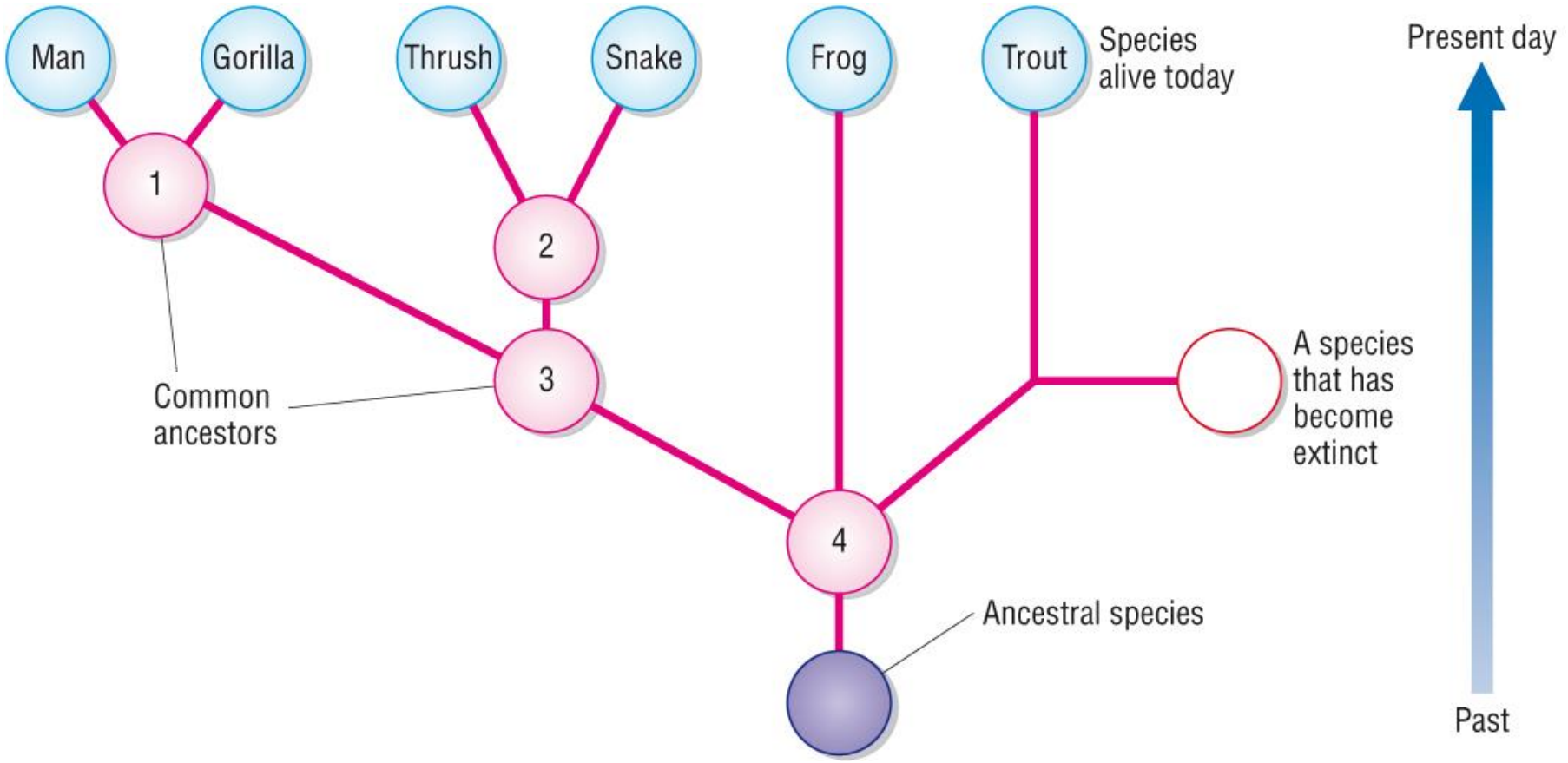
- Placing things into groups.

Taxonomy

- The study of the principles of classification.
  - Studying the similarities & differences between species.
  - Grouping species according to similarities.
    - Similar species grouped together.
    - Different species grouped separately.

Natural Classification

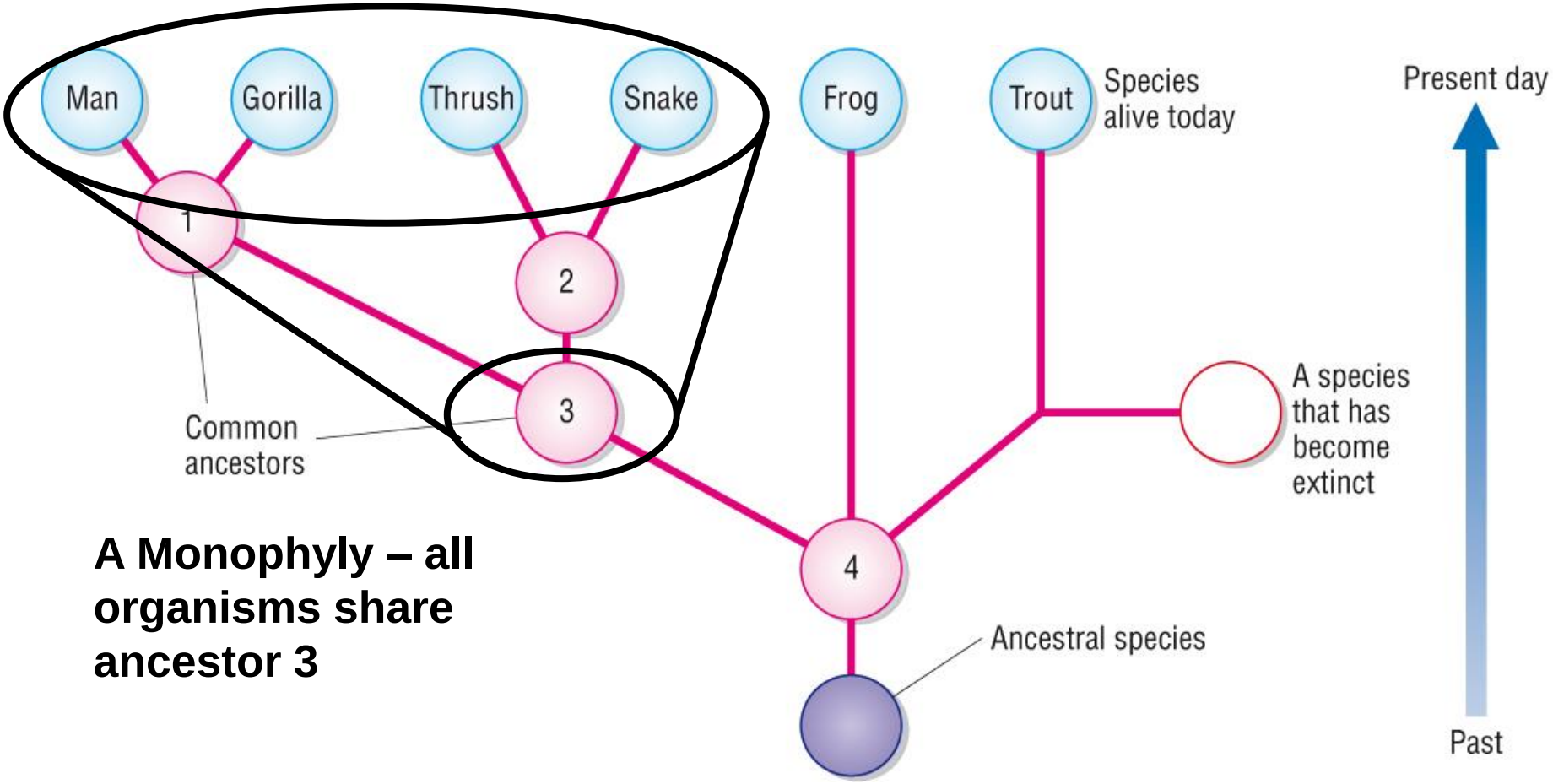
- Basic unit of natural classification is the Species.
  - A group of individual organisms with very similar appearance, anatomy, physiology, biochemistry, behaviour & genetics.
    - Capable of interbreeding to produce fertile offspring.
  - Although individual members do show some variation.



- Closely related species can be grouped together.
- Groups can be placed into larger groups.

Phylogeny

- The study of how closely different species are related.
  - The more closely two species are related, the more recently they shared an ancestor & the closer together they appear on the "evolutionary tree".



A Monophyly – all organisms share ancestor 3

- Which are more closely related:
  - Man and Snake, or Thrush and Trout?
- A Monophyletic Group:
  - Contains all organisms sharing a common ancestor

Why do we classify organisms?

- For our convenience
- To make identifying & studying them easier.
- To help us see relationships between them.

When did we start?

- Aristotle attempted to classify organisms in 300BC.
  - He categorised organisms as being either animals or plants.
  - He subdivided the animals into:
    - Living & moving on land
    - Living & moving in water
    - Moving through the air
- He based this on similarities that were observed.
  - How would he have classified the following:

Insects	**Foxes**
Birds	**Fish**
Frogs	**Crocodiles**

Carl Linnaeus (c1760)

- Classified about 70000 organisms according to their visible features.
- Categorised them into ranked taxonomic groups (or Taxa (sing. Taxon)).
- He used five taxa:
  - Kingdom
  - Class
  - Order
  - Genus
  - Species

We now use more taxa as more organisms have been found.

Two kingdoms (plants & animals) were not enough…

- The animal kingdom contained single celled organisms with animal cell features.
- The plant kingdom contained single celled organisms with plant cell features.

- With better microscopes, it was clear that many single celled organisms had features of both plants and animals.

…not only that…

- Fungi are like plants:
  - They don’t move around.
  - They grow into & over the surroundings.
- Fungi are also like animals:
  - They don’t photosynthesise.
  - They digest & absorb organic matter.

…clearly…

- We needed more than two kingdoms.

The Five Kingdoms System

- Animals:
  - Heterotrophic multicellular eukaryotes.
- Plants:
  - Photoautotrophic multicellular eukaryotes.
- Fungi:
  - Saprophytic multi/unicellular eukaryotes.
- Prokaryotes:
  - Unicellular with no nucleus.
- Protoctists:
  - Multi/unicellular eukaryotic organisms that do not fit any of the above.

Animals

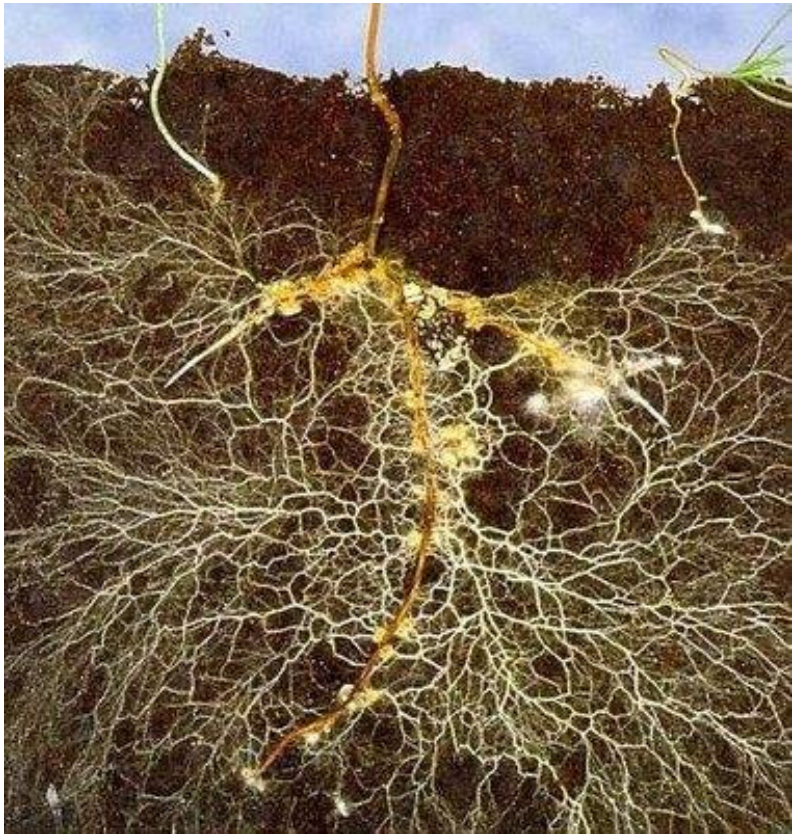
- Heterotrophic multicellular eukaryotes.
- Fertilised eggs develop into a ball of cells.
- Usually mobile.
- No cell walls.

Plants

- Photoautotrophic multicellular eukaryotes.
- Cells have cellulose cell wall.

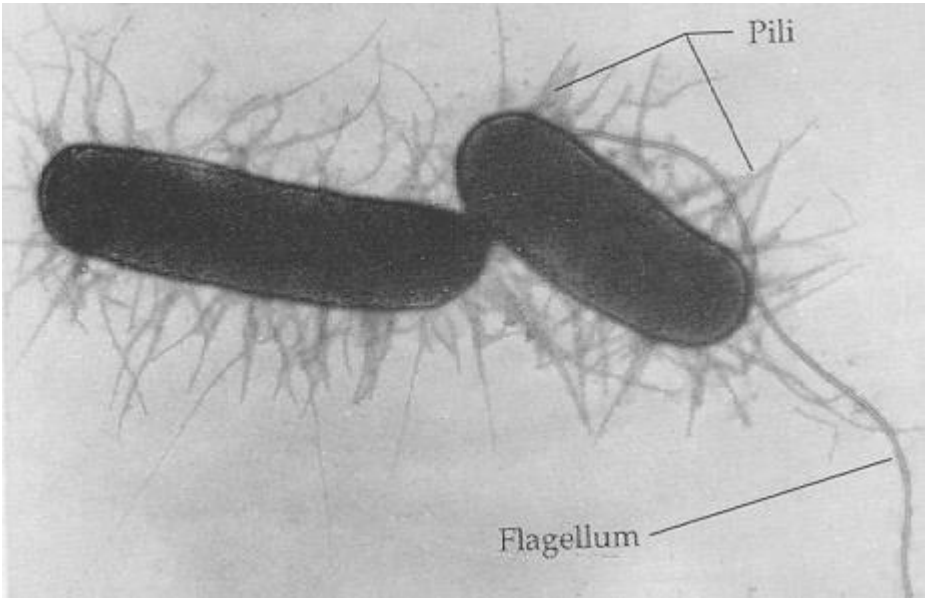
Fungi

- Saprophytic multi/unicellular eukaryotes.
- Body consists of a network of strands – hyphae.
- Cytoplasm is surrounded by a polysaccharide wall – Chitin.



Prokaryotes

- Small, unicellular with no nucleus.
- Circular DNA with no histones.
- No membrane-bound organelles.
- Respiration carried out on membrane folds – mesosomes.



Protoctists

- Multi/unicellular organisms that do not fit any of the above.
- Eukaryotic.
- Wide variety of forms.
- Have plant-like or animal-like features.
- Heterotrophic or Autotrophic

Recent Classification Systems

- Better techniques have recently produced more detailed evidence:
  - Physiology
    - Study of how organisms work.
  - Biochemical Analyses
    - Study of chemical structure of biological molecules.
  - DNA Analyses
    - Comparing DNA sequences.

Physiology

- Body systems that work in similar ways suggest the organisms are more closely related.
  - Eg:
    - Muscle action
    - Gas exchange methods

Biochemistry

- Certain biochemicals are found in all living organisms.
- But they may not be identical:
  - Proteins may differ in some of their amino acids.

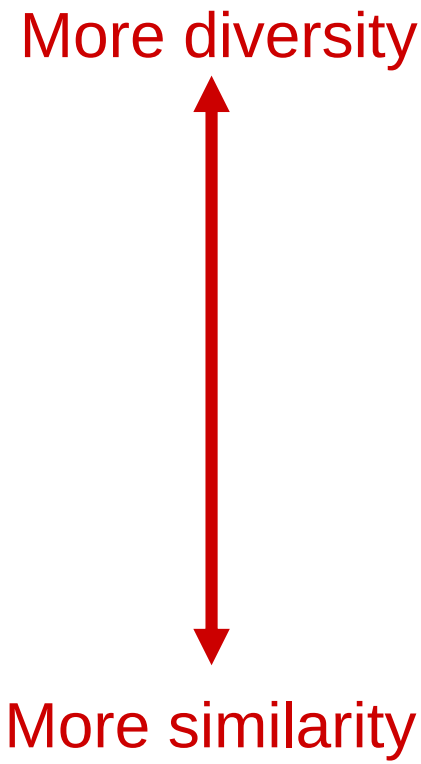
- Eg: Cytochrome c (protein used in respiration).
  - The more differences in the 1º structure, the less related the organisms.

DNA Analysis

- By sequencing the DNA of an organism we can judge its similarity to other organisms.
  - The more similar the DNA base sequence, the more related the organisms.

Current Classification System

- 8 taxa:
  - Domain
  - Kingdom
  - Phylum (pl. Phyla)
  - Class
  - Order
  - Family
  - Genus (pl. Genera)
  - Species



The Three Domain System

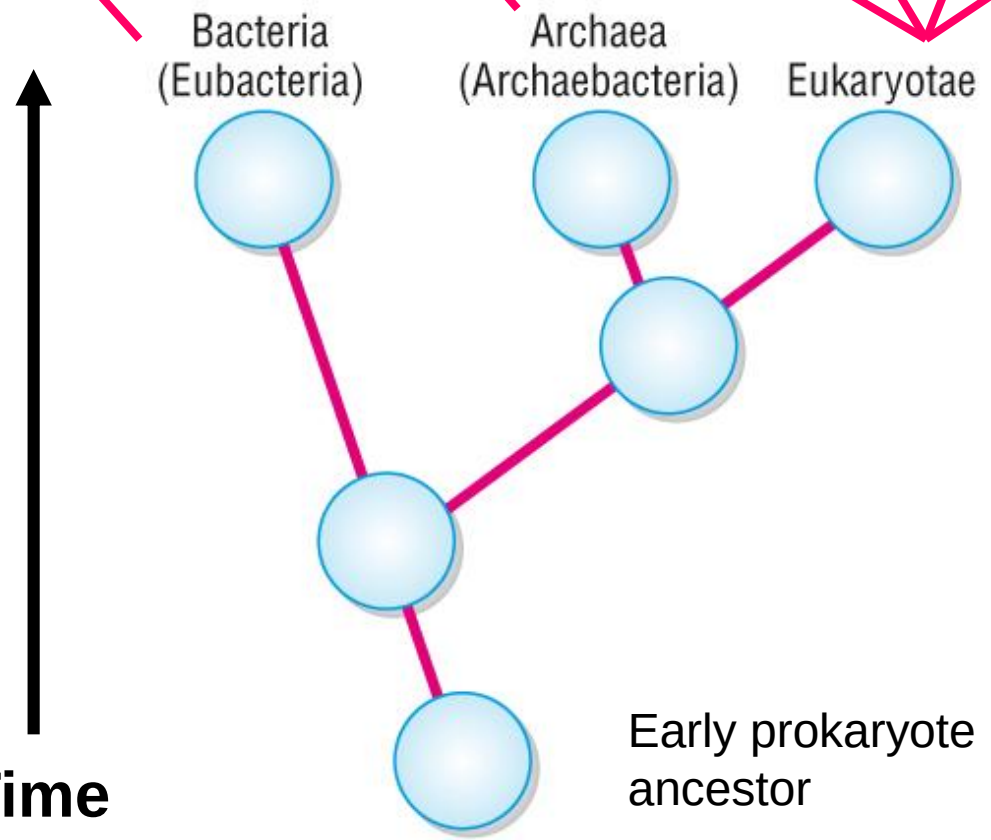
- Carl Woese (1990) suggested splitting the prokaryotes into two groups.
  - Bacteria (Eubacteria)
  - Archaea (Archaebacteria)
    - He based his ideas on rRNA sequencing evidence.

Recall the Five Kingdoms System

- Animals:
  - Heterotrophic multicellular **eukaryotes**.
- Plants:
  - Photoautotrophic multicellular **eukaryotes**.
- Fungi:
  - Saprophytic multi/unicellular **eukaryotes**.
- Prokaryotes:
  - Unicellular with no nucleus.
- Protoctists:
  - Multi/unicellular **eukaryotic** organisms that do not fit any of the above.

Former Prokaryotes

Kingdoms **Eubacteria** **Archaebacteria** **Fungi** **Animals** **Plants** **Protoctists**



3 Domains

Differences that separate Bacteria from Archaea & Eukaryotes

- Bacteria have:
  - Different cell membrane structure.
  - Flagella with different structure.
  - Different enzymes for producing RNA.
  - Lack of histones.
  - Different DNA replication mechanism.

Similarities between Archaea & Eukaryotes

- Similar enzymes for producing RNA.
- Similar mechanisms for DNA replication.
- Presence of proteins attached to DNA.

- **The Three Domain system is now widely accepted.**

Classifying Species

- It’s easier to classify an organism into its domain or kingdom.
- Much harder to place it into a family or genus.
  - Much more detailed descriptions are needed as the organisms become more similar/

For example…

Taxa	**Named taxonomic groups**		
Domain	Eukaryotae	Eukaryotae	Eukaryotae
Kingdom	Animalia	Animalia	Animalia
Phylum	Chordata	Chordata	Arthrodopa
Class	Mammalia	Mammalia	Insecta
Order	Primate	Primate	Diptera
Family	Hominidae	Hominidae	Drosophilidae
Genus	Homo	Gorilla	Drosophila
Species	*sapiens*	*gorilla*	*melanogaster*
Common name	**Human**	**Gorilla**	**Fruit Fly**

Naming Organisms

- Before Linnaeus, species were identified using common names or long descriptions.
- This system was rubbish:
  - Different people called the same organism by different common names.
  - Some common names were used for many different species.

Binomial System

- Carl Linnaeus developed a system where each organism is identified by two Latin names.
  - Latin is (was) a universal language.
  - The two names are the genus and species names (general/specific).
  - So..

Homo sapiens

Make it stand out (underlined or *italicised*)

Capital initial letter for genus name.

Lower case initial letter for genus name.

Can abbreviate it *H. sapiens*

Identifying Organisms

- Why?
  - An Environmental Impact Assessment (EIA) needs to be carried out before any land development goes ahead.
    - Need to know what species are present in the area.
  - Great crested newts (*T. tristatus*) are a protected species.
    - Illegal to handle, catch, possess these without a license.
    - Illegal to cause them harm or disturb their habitat.

Identifying Organisms

- How?
  - Use a dichotomous key.
    - Series of questions with just two answers (yes/no).
    - Each answer leads to the next question.
    - At the end the organism is identified.

    - Choose an item from the following and see if someone else can identify it.

Tin can

Deer

Paramecium

Rock

Ant

Dandelion

Oak tree

Robin

Bicycle

Clam

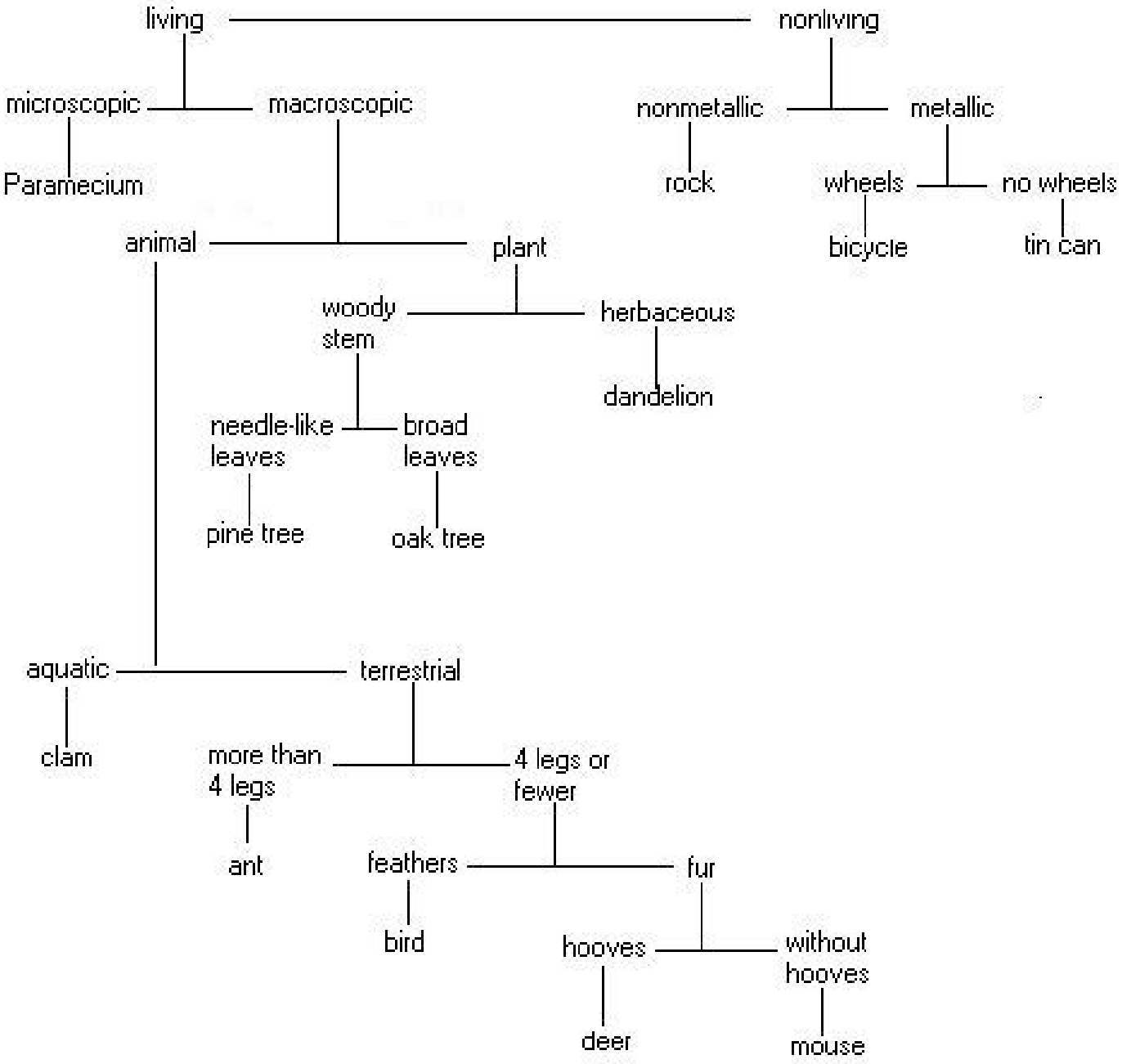
Mouse

Pine tree

Can be written

1. a. Object is living.....go to 4.
1. b. Object is nonliving.....go to 2.
2. a. Object is metallic.....go to 3.
2. b. Object is nonmetallic.....ROCK.
3. a. Object has wheels.....BICYCLE.
3. b. Object does not have wheels.....TIN CAN.
4. a. Organism is microscopic.....PARAMECIUM.
4. b. Organism is macroscopic.....go to 5.
5. a. Organism is a plant.....go to 6.
5. b. Organism is an animal.....go to 8.
6. a. Plant has a woody stem.....go to 7.
6. b. Plant has a herbaceous stem.....DANDELION.
7. a. Tree has needle like leaves.....PINE TREE.
7. b. Tree has broad leaves.....OAK TREE.
8. a. Organism lives on land.....go to 9.
8. b. Organism lives in water.....CLAM.
9. a. Organism has 4 legs or fewer.....go to 10.
9. b. Organism has more than 4 legs.....ANT.
10 a. Organism has fur.....go to 11.
10 b. Organism has feathers.....ROBIN.
11 a. Organism has hooves.....DEER.
11 b. Organism has no hooves.....MOUSE.

Or graphical



Can you produce you own key?

- Identify people in this classroom.