1 WHAT'S IN A NAME?

AN INTRODUCTION TO CLASSIFYING AND NAMING ORGANISMS

Time recommended: 50 minutes

- The aim of this worksheet is to introduce students to the topics of classification and binomial nomenclature. No previous knowledge of these topics is assumed.
- It may be used as a stand-alone exercise or as a learning experience in preparation for Worksheet 2.
- Suggestions are made for making it activity-based, in which case an extra teaching period (50 minutes to 1 hour) would be needed.
- For notes on the mark scheme see page 8.

WHY CLASSIFY?

Have you ever watched a child playing with Smarties? Very often the child will sort them out into colours. This might seem an obvious and natural thing to do, but it tells us something very interesting about the human brain. The child is indulging in an activity which can be described as **classification**. Suppose you were designing a website for a large company or supermarket. One of your tasks would be to sort out the products into a logical system. More complicated than Smarties, but not really different in essence.

Q1 Suggest what is meant by 'classification'.
putting things (e.g. living organisms) into groups;
members of a group have certain characteristics in common;
accept any other valid point; **2 max**

Q2 Suggest two reasons why such behaviour may be of survival value to humans.
prevents us from being overwhelmed by too much information;
quicker processing of information/increased speed of responses;
increases appropriateness of response;
can ascribe common properties to the groups chosen;
example given, e.g. snakes may be poisonous, dangerous;
accept any other valid point; **2 max**

Q3 Classification systems in the past have often been based purely on what is practically useful. For example, some plants could be classified as medically useful. Suggest **two** other practically useful categories for plants.
poisonous plants;
edible plants;
accept any other valid point; **2 max**

Possible practical activities:

There are many possible classification tasks which could be added here to reinforce the concept of classification. For example, working in small groups, students could:

- Classify a group of plants according to leaf shape. A collection of about 8 to12 leaves from different species should be sufficient to promote a discussion of how to arrange the leaves into groups.
- Alternatives to biological material can be just as useful, e.g. mobile phones; cars; books; supermarket products such as coffee, biscuits, chocolates, sweets. Where necessary photos of such products can be readily collected using digital cameras and computers.
- Explore existing classifications, such as the Amazon website or the website of a large store such as John Lewis.

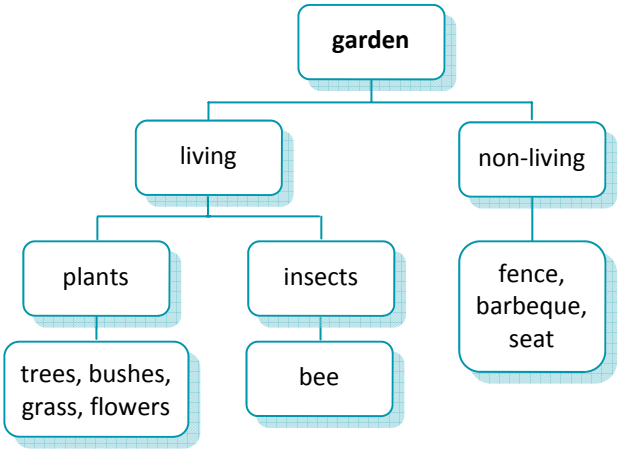
Now imagine walking into a garden. Your brain receives information.

Q4 How does your brain receive this information?
information comes by way of the senses;
sight, hearing, smell, touch, (possibly taste);
brain receives via nervous system/nerve cells; **3**

Is it going to sting me?

Your brain now has to try to make sense of this information - this is going to increase your chances of survival. Immediately the brain's previous experience (memory) tells you there are plants – trees, bushes, grass, flowers. Suddenly, a buzzing insect scares you (is it going to sting you?). Already, without any apparent effort on your part, your brain is **classifying**, like a computer.

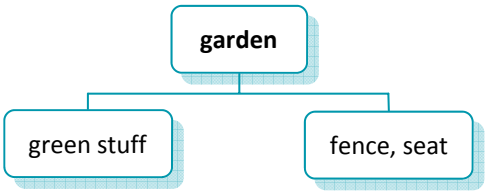
Your classification can be arranged in the form of a **hierarchy** (this is similar to the way the brain processes data). Different people may produce different hierarchies, depending on their experience, but a common response might be:



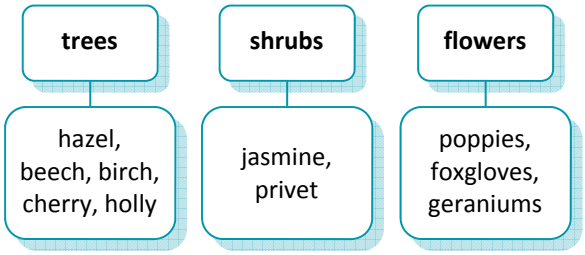
This happens very quickly and mostly subconsciously – we don't often go around classifying consciously.

Q5 What is a hierarchy?
few large groups, many small(er) groups;
large group(s) at top of hierarchy/small(er) groups at bottom;
pyramid shape;
accept any other valid point;
OR
one/few at top, more/larger groups below;
one(s) at top more important;
example given (e.g. in a named institution, government, etc);
accept any other valid point; **2 max**

A person with little experience of plants or gardens might just see a lot of green stuff.



On the other hand a gardener might notice that the borders contain poppies. The gardener's brain would have a far more detailed plant classification, part of which might be:



In fact, the more we look and remember, the more we see and understand.

Possible practical activity:

Devise a hierarchy suitable for the website of one of the following:
a supermarket, a music store, a second-hand car dealer, a mobile phone dealer, a clothes store.

Linnaeus' system of classification

About three hundred years ago, a Swedish botanist and doctor named Carl Linnaeus realised that:

"all the real knowledge we have depends on the METHOD by which we distinguish the similar from the dissimilar. The greater the number of natural distinctions we make, the clearer becomes our idea of things. The more numerous the objects which employ our attention, the more difficult it becomes to form such a method; and the more necessary."

Carl Linnaeus (1707-1778)

Q6 What does Linnaeus mean by distinguishing the 'similar' from the 'dissimilar'? Give an example from the garden hierarchy on page 2.
similar things have certain characteristics in common;
anything that does not share these characteristics is dissimilar;
suitable example from garden hierarchy; e.g. hazel, beech, birch are similar to each other (they are trees), but different from the flowers; **3 max**

In other words, Linnaeus states that the more things we try to distinguish between, the more difficult it becomes to come up with a classification system. The hierarchies become more complicated. But it is still a good idea to distinguish what any given thing is similar to, and what it is not similar to, because that reflects our real knowledge of the world. If all you see in the garden is plants, you are not seeing that, for example, poppies are different to foxgloves. Can you tell the difference between a beech tree and a birch tree or are they just trees to you?

Linnaeus set himself the task of devising a METHOD to:

"join the similar to the similar, and to separate the dissimilar from the dissimilar in nature."

In other words, Linnaeus decided to devise a classification system for living things.

Q7 In deciding which characteristics to use when comparing plants, Linnaeus wrote:

"Others have frequently used the taste, the odour, the size without the proportion; these you will never find used by me…"

Suggest why Linnaeus avoided taste, odour and the size without the proportion when comparing plants.

taste and odour are not (easily) measurable;
taste, odour and size without the proportion are too variable within a species; **2**

Linnaeus' system of classification (his METHOD) used seven major groups: empire, kingdom, class, order, genus, species and variety. Empire is no longer used, and a modern hierarchy is:

kingdom, phylum, class, order, family, genus, species

The largest grouping is the kingdom; the smallest is the species. The members of a species have the greatest similarity; as we progress up the hierarchy from the level of the species, the groups become larger and their members show more variety (are more 'dissimilar'). The classification of humans is as follows:

English name		Group		Latin or Greek name
animals	-	**Kingdom**	-	Animalia
chordates	-	**Phylum**	-	Chordata
vertebrates	-	**Sub -phylum**	-	Vertebrata
mammals	-	**Class**	-	Mammalia
primates	-	**Order**	-	Primates
great apes	-	**Family**	-	Hominidae
Man/humans	-	**Genus**	-	*Homo*
wise	-	**Species**	-	*sapiens*

Notice that the groups have both English and Latin or Greek names. You may be able to think of a good reason for this other than scientists trying to make things complicated! It will be explained later (page 7).

Linnaeus recognised just two kingdoms of living organisms, the plant and the animal kingdoms. Everything else in his classification belonged to the mineral kingdom. The most modern classifications have many more than five kingdoms.

Just plants and animals?

What is a species?

Linnaeus wrote:

"The species are as numerous as the different forms of plants which exist upon this globe – they produce others similar to themselves but in greater numbers."

A modern definition of a species is:

A group of closely related organisms which are capable of interbreeding to produce fertile offspring

Linnaeus' definition was written before Darwin's theory of evolution by natural selection was published.

Q8 What is meant by 'closely related organisms' in the modern definition of a species?
they share many similar characteristics;
they share a recent common (evolutionary) ancestor; OWTTE **2**

Modern view of Kingdoms and Domains

Until recently we commonly used five kingdoms. These are:

English name	Latin or Greek name
prokaryotes (or bacteria)	Prokaryota or Bacteria
protoctists (or protists)	Protoctista or Protista
fungi	Fungi
plants	Plantae
animals	Animalia

In recent years a new level called the **domain** has been introduced **above** the kingdom in the hierarchy. Classification systems were based originally on observed features, but a wider range of evidence is now used. Molecular evidence is increasingly important as a result of rapid advances in molecular biology. New knowledge gained from DNA studies, such as base sequencing, is particularly important. The evidence suggests that there is a natural evolutionary division of living organisms into three main groups or 'domains'. These are:

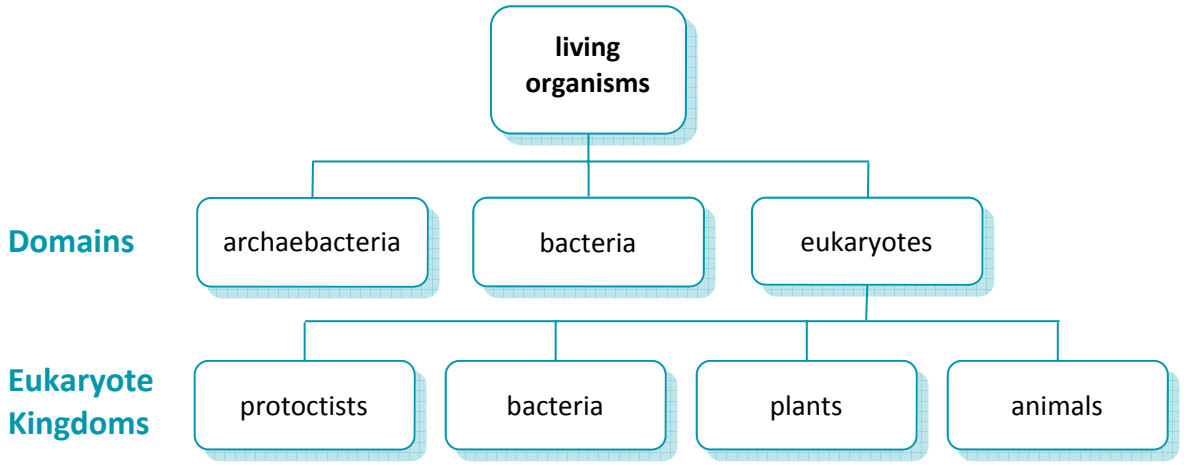
English name	Latin or Greek name
archaebacteria (or archaeans)	Archaebacteria (or Archaea)
bacteria (or eubacteria, meaning true bacteria)	Bacteria (or Eubacteria)
eukaryotes (or eukaryans)	Eukaryota (or Eukarya)

Plants are one of the eukaryote Kingdoms

In addition, DNA evidence suggests we should now divide archaebacteria and bacteria into many different kingdoms.

The **eukaryotes** have four kingdoms, namely the protoctists, the fungi, the plants and the animals. The eukaryotes include all the organisms which have a true nucleus in their cells. Prokaryotic cells do not have a true nucleus. All bacteria (true bacteria and archaebacteria) are **prokaryotes**.

Thus a hierarchy for living organisms could be represented like this:



WHAT IS TAXONOMY and HOW ARE ORGANISMS NAMED?

Linnaeus laid the foundations of modern **taxonomy**, the science of **classification**. Classifying living organisms helps us to get to grips with their huge variety and to understand the underlying similarities and dissimilarities. As we gain further knowledge and understanding, our classification system will continue to change.

Taxonomy involves two things:

- **classification** - deciding what groups to have
- **nomenclature** - naming the groups

Binomial nomenclature

As well as changing the way living things were classified, Linnaeus also changed the way they were named. He introduced a simpler method. This involved giving every organism two names, a genus (with a capital letter) and a species (with a lower case letter). He used the Latin language for the names. For example, humans have the two names *Homo* (the genus) and *sapiens* (the species). These names are written in italics to indicate that they are in Latin. This is rather like our system of giving people a first name and a surname. Each species has its own unique binomial which is the same throughout the world, thus avoiding confusion.

Q9 Which of your two names (first name and surname) is equivalent to the genus and which to the species?
first name is equivalent to species, surname to genus; **1**

This system of giving every organism two names is called **binomial nomenclature**:
bi – two
nom – name
The **binomial** for humans is therefore *Homo sapiens*.

Why Latin (and Greek)?

Why use Latin – surely it makes things more complicated?

In North America there is a bird with a red breast which is called a robin. It's much bigger than 'our' robin in Britain. In fact, it's a different species. This can obviously be confusing. There are many similar examples of common animal and plant names referring to different species in different places. The advantage of Latin is that it is international. Its use goes back to the Romans who conquered most of Europe and North Africa. It is not surprising that their language, Latin, continued to be used long after the decline of their empire. It became the convenient international language of science, philosophy, religion and diplomacy throughout the Middle Ages and well into the eighteenth century. Educated men such as Linnaeus wrote their books and letters in Latin. About half the words we use in everyday life come from Latin.

The other great civilisation of the western world that preceded the Romans was that of ancient Greece. The study of Roman and ancient Greek cultures came to be an essential part of a so-called 'classical education'. Well educated people were therefore taught both Latin and ancient Greek, and words derived from these two ancient languages were, and still are, used frequently in science, continuing the tradition of using an international language.

Translating names

Try not to be put off by the common use of Latin and Greek words in science. Translating them into English can help you understand that they are usually describing quite simple ideas. Here are some examples:

word	Latin (L) or Greek (G)	English translation	example
eu	G	true	eukaryote
karyote	G 'karyon'	nucleus	eukaryote
pro	G	before, in front of	prokaryote
proto	G 'protos'	first	protoctist
ctist	G	a settler, founder	protoctist
archae	G 'archaios'	ancient	archaebacteria
fungus	L	mushroom	fungus
phylum, phylo	G 'phylon'	a tribe, race	phylum, phylogeny
-geny or -gen	G 'genesis'	origin	phylogeny

Q10 Modern classification systems tend to use a **phylogenetic** approach. Using the table above to help you, predict what is meant by this.
the origin of a tribe/race;
putting into groups/classifying, living organisms/groups of organisms/species/groups of species;
according to their evolutionary history; **2 max**

MORE ABOUT LINNAEUS AND THE LINNEAN SOCIETY

Linnaeus' most famous book, *Systema Naturae* (Nature's systems) was published in 1735. In 1753 he published *Species Plantarum* in which the binomial system for plants was used for the first time. Altogether there were 12 editions of *Systema Naturae*. He used the binomial system for animals for the first time in the famous 10th edition, published in 1758.

Linnaeus became famous in his lifetime. Like Darwin, he was a great naturalist, and received letters and specimens from all over the world. He became Professor of Botany in the University of Uppsala in Sweden. In 1784, Linnaeus' widow sold his collection to an English collector, Sir James Edward Smith. The **Linnean Society** was founded by Smith in 1788, and both Smith's and Linnaeus' collections are kept by Society. The Society has now created digital images of all of Linnaeus' collections and these are available for viewing online. The online Linnaean collection contains 14,231 plants, 3,198 insects, 1,564 shells and 168 fish.

Q11 Suggest why it is still useful to keep Linnaeus' specimens.

a species may become extinct;
provides a permanent record of what a species is like;
any changes occurring within a species (over time) may be detected;
variation within a species can be estimated by comparing specimens with standard specimens in the collection;
educational/research resource for academics;
educational/research resource on-line;
may be useful, e.g. for climate change studies;
accept any other reasonable suggestion;

4 max

Total 25 marks

Notes on mark schemes:
; indicates award of 1 mark
text in brackets is not required for the mark
/ means alternative responses
OWTTE: or words to that effect
words underlined are essential

Educational resources from the Linnean Society of London

For more information contact:

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