NASCA Biology Materials Draft 1

Topic 1: Biodiversity

Topic 1: Biodiversity

Sub-topic 1: Biodiversity and the biomes of South Africa

Overview

What do you think of when you hear or read the word *biodiversity*?

**Figure 1: Biodiversity** [insert AWB Figure 1: Biodiversity, to the left of the writing that follows below.]

Look at the image on the left.

Use what you know and ideas from the picture to write 3-5 lines in your workbook explaining what you understand by the term *biodiversity* under a heading ‘Introduction to Biodiversity’.

After working through this Unit, you will return to the definition you wrote and add to it or correct it.

There is an enormous variety of different *organisms* [living things such as a plant or animal] on Earth, or in the whole *biosphere* [any place on Earth where living organisms may be found]. Sometimes when biologists talk about biodiversity, they mean the variety of species in the whole biosphere. However, they could limit their description by referring to the biodiversity of a particular areaor *biome* [a particular region where typical groups of organisms live; biomes have particular climatic conditions]. You could refer to the biodiversity that exists within your garden at home or the town or city in which you live. In a rural area, you could talk about the biodiversity of a particular mountain or valley or river.

When biologists use the word *biodiversity* they are talking about *the variety of different species in an area*.

Did you notice that many of the words you have read about so far start with *bio-*? The prefix *bio*- means ‘life’. *Bio*logy is the study of *living* things. When you see a term starting with *bio-* you should recognise that it will refer to life in some way!

South Africa has an extremely rich biodiversity. Over the course of this Topic, you will become more aware of South Africa’s biodiversity by exploring the different biomes of South Africa, and the variety of species in the country. You will also consider threats to biodiversity and conservation efforts.

Unit 1: Definitions of the biosphere and biomes

Unit 1 learning outcomes

By the end of this unit, you should be able to:

1. Define the biosphere as all parts of the Earth on which life can exist.
2. Define a biome as an area with a characteristic climate and main types of vegetation.

Unit 1.1: The biosphere

**Figure 2: The biosphere** [insert AWB Figure 2: The biosphere, to the left of the writing that follows below.]

Before reading further, answer the questions in Figure 2 in your workbook, under a heading you will make called ‘The biosphere’.

Now study Figure 3 and add any new ideas to your understanding of what the biosphere is in your workbook.

**Figure 3: Levels of organisation in the environment** [insert AWB Figure 3: Levels of organisation in the environment]

How did you go with that short activity? Read through the notes that follow now and change your answers as you read, if you think you made any errors. This kind of reading is called *thoughtful reading*. You are paying careful attention to what you are reading and you are including the ideas as you edit your own notes.

The *biosphere* is defined as all parts of the Earth where life exists. Life has been found below the Earth’s surface, on the Earth’s surface, in freshwater rivers and dams, in the oceans, and even in the air. Life can exist almost anywhere on Earth, even in the frozen north and south poles, in very hot volcanoes and in deep caves.

The biosphere depends on energy from the sun. The process of *photosynthesis* [the process whereby green organisms use sunlight energy to make carbohydrates (a complex molecule)] allows living organisms such as plants to store energy in complex molecules. The plants use the stored energy to drive their life processes. Animals eat the plants, and use the stored energy in plants to keep them alive.

Eventually, all living organisms die. Bacteria and fungi (also called decomposers) break down the complex molecules, recycling their components in the environment.

**Figure 4: Energy and matter in the biosphere** [insert AWB Figure 3: Energy and matter in the biosphere]

If you look carefully at Figure 4, you will see that energy can move into and out of the biosphere. Energy from the Sun enters the biosphere. Energy is lost from the biosphere as heat. However, all matter recycles within the biosphere.

[START TEXT BOX]

*What’s the main idea?*

The biosphere is all parts of the Earth where life can exist. The biosphere receives energy from the Sun, but all other requirements for life are recycled within the biosphere.

[END TEXT BOX]

Unit 1.2: Defining biomes

Go back to Figure 3 and remind yourself of where a *biome* fits into the different levels of organisation in the environment. Make a new heading in your workbook called ‘Biomes’. Write down what you understand a biome to be, after reflecting on Figure 3.

A *biome* is a region that is defined by the main type of plant life growing in the area. For example, the main type of plant life may be grass in the Grassland biome, tall trees in the Forest biome, or *succulent* plants [plants that have fleshy leaves, stems or roots]in the Succulent Karoo biome.

The type of plant life in a biome is controlled by the *climate* [the average weather conditions of an area over many years] of the biome. Therefore, a biome is defined by the main type of plant life *and* the characteristic climate of the region. Typical animals will also be found in the biome, linked to the plants that are there as food sources.

Do you need to add to your note on what a biome is in your workbook, after reading the two paragraphs above?

You are now going to watch a video. As you watch the following video, add any new ideas to your understanding of what the biosphere and biomes are in your workbook. Focus on the idea of different levels of organisation.

*Biological Levels in Biology*: <https://www.youtube.com/watch?v=EtWknf1gzKo&t=29s> (Duration 5.10)

[START TEXT BOX]

*What’s the main idea?*

A biome is a region that has a particular type of plant life, which is controlled by climatic conditions.

[END TEXT BOX]

Quick progress check

1. What is missing from the following definition of the biosphere? “The biosphere describes all life on earth.”
2. What is missing from the following definition of a biome? “A biome is a region where certain types of plants can be found.”

Discussion of the progress check

1. This definition is missing the idea that the biosphere is a number of*places or parts of the earth* where living organisms can be found. The biosphere is not only the living organisms themselves, but also the habitats and regions where the organisms are found. It includes the water, the air, the soil etc.
2. This definition is missing the idea that the biome region is controlled by the *climate zone*. The kind of climate that the region experiences will determine the types of plants (and animals) found in the area.

Make sure you are able to define the terms *biosphere* and *biome* before moving on!

Moving on

You have a better understanding of the terms biodiversity, biosphere and biome. Now you will look more closely at biomes.

Unit 2: Factors defining biomes

Now that you have basic definitions of the terms biodiversity, biosphere and biome, in this Unit you will explore factors that define a biome, particularly the biomes in South Africa.

Unit 2 learning outcomes

By the end of this unit, you should be able to:

1. Identify the nine major terrestrial biomes of South Africa on a map of South Africa.
2. Identify the major differences between the terrestrial biomes with reference to climate, soils and main vegetation.
3. Explain the concept of adaptation, with reference to at least one example of a plant from each biome.

Unit 2.1: Biomes of the world

There are nine major biomes in South Africa. Although you are going to focus your studies on South African biomes, you need to realise that there are other biomes around the world that we don’t find in South Africa. You also find biomes that are found in South Africa in other areas of the world.

This video gives you a very general introduction to biomes of the world, a number of which you may recognise, even if we do not have these biomes in South Africa. The biomes of South Africa are not shown in detail in this video, however, watch the video to gain knowledge about biomes all over the world: *Global Biomes and Ecosystems*: <https://www.youtube.com/watch?v=lV51FEOPOB4>

(Duration: 3.58)

Which of the biomes described in the video interest you the most? Why do you think these biomes are interesting? You can note your responses in your workbook, under the heading ‘Biomes’.

If the previous video interested you, when you have more time on hand, you can watch these two videos which take you on a more in-depth tour of biomes of the world:

*Biomes tour part 1:* <https://www.youtube.com/watch?v=dHI_uKVNSAo> (Duration 11.30)

*Biomes tour part 2:* <https://www.youtube.com/watch?v=nTEUYtbVSuY> (Duration 11.06)

Now turn your attention to biomes in South Africa.

Unit 2.2: Climatic and soil factors define a biome

In Unit 1, you learnt that the *climate* [the average weather conditions of an area over many years] controls the type of *vegetation* [plants] in a biome. Two important climatic factors are the temperature in the region and the amount of moisture the biome receives. We often refer to the moisture received as *precipitation* [water that falls from the clouds to the ground in various forms such as rain, dew, hail, snow]. The soil is also often characteristic of the biome. These factors (climate and soil type) define the type of biome.

A biome is not restricted to a particular continent nor is it restricted to a particular *hemisphere* [a half of the earth, usually as divided into northern and southern halves by the equator, or into western and eastern halves by an imaginary line passing through the poles]. This is because a similar climatic condition can occur on different continents and in different hemispheres. If the climatic conditions are similar, it is likely that the vegetation will be similar and therefore, the animal life will also be similar (although actual species will be different). For example, desert conditions can be found on all continents and in both hemispheres. Have a look at Figure 5.

**Figure 5: Desert biomes of the world** [insert AWB Figure 5: Desert biomes of the world]

(Source: https://commons.wikimedia.org/wiki/File:Biome\_map\_13.svg)

The Kalahari desert (Namibia), the Sahara Desert (North Africa), the Great Australian Desert (Australia) and the Gobi Desert (central Asia) are found in different places in the world, but they all belong to the same biome. This is because the climatic conditions, soils and life forms in these deserts are very similar.

South Africa’s *climate* varies across the country from west coast to east coast and from north to south. South Africa also has coastal plains and high mountains, with a high plateau across the centre of the country. The climate is different in each region across South Africa. These varied climatic conditions mean that South Africa has a large diversity of biomes. Some of the climatic variations are:

* The eastern parts of the country receive more rainfall than the west.
* The eastern part of the country receives summer rainfall, while the west receives rain in winter.
* Temperatures in the mountains and the central plateau are more extreme than temperatures in lower-lying coastal areas.

*Soil type* also plays an important role in the vegetation of a biome. Soils that are poor in nutrients tend to have fewer and smaller plants than soils that are rich in nutrients. The amount of *humus* [decaying organic matter] present in the soil greatly affects the kinds of plants that grow in that soil. Humus enriches the soil, particularly with nitrogen, which is essential for healthy plant growth. Some soils are acidic and some are more alkaline. This also affects the kinds of plants that grow in these soils. The size of the particles of soil affect how much water the soil can retain. South Africa has a variety of different soil types. You will learn more about the different soil types in each of the biomes in South Africa later in this Unit.

The graphs that follow in Figure 6 show rainfall and temperature in Durban (east coast) and Cape Town (west coast), which are cities in two different biomes in South Africa. Durban lies in the Indian Ocean Coastal Belt, while Cape Town is in the Fynbos biome. (You will learn more about these biomes later in this Unit.)

**Figure 6 Graphs showing average rainfall and temperature in Durban and Cape Town.** [insert AWB Figure 6: Graphs showing average rainfall and temperature in Durban and Cape Town.**]**

(Source: www.worldweatheronline.com)

Activity 2.1: Analysing temperature and rainfall graphs

Suggested time:

20 minutes

Aim:

Analysing graphs and other sources of data is an important activity of science. You will analyse these graphs in order to better understand the ways in which two aspects of climate: rainfall and temperature, define the biome.

You will need your workbook and pen, pencil and a ruler.

What you will do:

Answer each question carefully in your workbook under the heading Activity 2.1. Use the graphs in Figure 6 to answer the questions.

1. Which city receives more rainfall over the year? How did you work this out?
2. *Compare* [show how two or more things are the same as well as different] the seasonal difference in rainfall pattern between the two cities.
3. Find the three months of the year in each city, when the highest number of rainfall days are experienced.
   1. Which city experiences the most rainy days in these three high rainfall months?
   2. *Describe* [give clear and direct details about a thing or process] in a paragraph how you obtained your results.
4. Which city is hotter during the day during the winter months?
5. Which city experienced colder nights during winter?
6. Would a plant that is not able to tolerate temperatures below 10 °C be able to grow in either city? *Explain* [make something clear and easy to understand; describe meaning in detail] your answer.
7. Would a plant requiring high levels of water during the hot summer months, be able to grow naturally in either city? Explain your answer.
8. Why are there spaces between the bars on the rainfall graphs?
9. What is the independent variable on the temperature graphs? Explain your answer.

Discussion of the activity

In this activity, you had to analyse and interpret graphs showing data. This is an important part of doing science. When you are faced with a ‘*data response question’*, like this one, there are some things you can do to ensure you answer the question well.

1. Make sure you *read* any given information that will help you to make sense of the graphs/data.
2. Carefully study the graphs/data *before* you read the questions. Make sure you know what it is you are looking at. Get clues from the titles of the graphs/data tables, and from any labels or headings in the data.
3. After you have familiarised yourself with the graph/data, move onto the questions. Answer each question in full, supplying reasons when asked for them. *Use* the graph to provide reasons. Refer to the graph in your answer.
4. Read the questions carefully and look at the *verbs* that tell you how you need to answer: you need to explain, describe or compare things, for example. In this activity, you are helped with the meanings of these action verbs, but you need to learn what the words mean and what the expectation is in terms of your answer.
5. Read your answer once you have written it to make sure you have answered what was asked.
6. In a data response type question/activity, expect questions relating to the content/data, as well as questions relating to the graph, variables, scientific method etc.

Exemplar answer

1. Durban receives more rainfall than Cape Town. You referred to the rainfall graphs. The key and the title on the right hand y-axis gives the measure of precipitation (rainfall) in mm. Each bar refers to the number of mm of rain that fell in each month. If you add up the totals of each of the bars (rainfall for one year), you will find that Durban received about 1035 mm of rain while Cape Town received about 525 mm of rain.
2. Both cities receive rain throughout the year, but each city has a definite pattern of higher and lower rainfall months. More rain falls in the winter in Cape Town, whereas more rain falls in summer in Durban. (Note: when comparing things, remember to show how they are similar as well as how they differ.)
3. Durban experiences the most rainy days in the three highest rainfall months. (Remember to describe in detail how you obtained your result.)
4. Durban’s three highest rainfall months are February, January then November. On average, Durban experiences about 18 rainfall days in February, followed by 20 rainfall days in January and about 22 rainfall days in November. This makes a total of 60 rainfall days in Durban during the three highest rainfall months. Cape Town’s highest rainfall months are July, followed by June and August. On average, all three months appear to experience about 16 days of rain each. This means that Cape Town experiences about 48 days of rain in the rainy months.
5. In winter, Durban is hotter than Cape Town during the day.
6. Cape Town experiences colder nights during winter than Durban does.
7. A plant unable to tolerate temperatures below 10 °C would not be able to grow outdoors in Cape Town as the temperature at night in winter drops below 10 °C. It would be able to tolerate minimum temperatures in Durban. However, if the plant is cultivated in a greenhouse, it would be able to survive living in Cape Town, as greenhouses are controlled environments for growing plants.
8. A plant requiring high water levels during hot summer months would probably grow well in Durban, but would not grow well naturally in Cape Town, where there is less rain in summer.
9. There are spaces between the bars on the rainfall graphs because the independent variable (months of the year) is a discontinuous variable. Each month is discrete in terms of data. The spaces between the bars indicate this.
10. The independent variable on the temperature graphs is temperature (measured in °C). This is the variable that the investigator is measuring. It is unknown at the beginning of the investigation and the investigator does not control this variable.

[START TEXT BOX]

*What’s the main idea?*

Climate and soil control the type of vegetation that grows in a biome. South Africa has great diversity of climate and soil types across the country.

[END TEXT BOX]

Unit 2.3: The major terrestrial biomes of South Africa

There are nine major *terrestrial* [on or of dry land; as opposed to *aquatic* which refers to in or of water] biomes in South Africa:

* Fynbos
* Succulent Karoo
* Desert
* Nama Karoo
* Grassland
* Savanna
* Albany Thicket
* Indian Ocean Coastal Belt
* Forest

Most of these biomes are commonly found in other parts of the world. The Albany Thicket and Indian Ocean Coastal Belt are less commonly found globally.

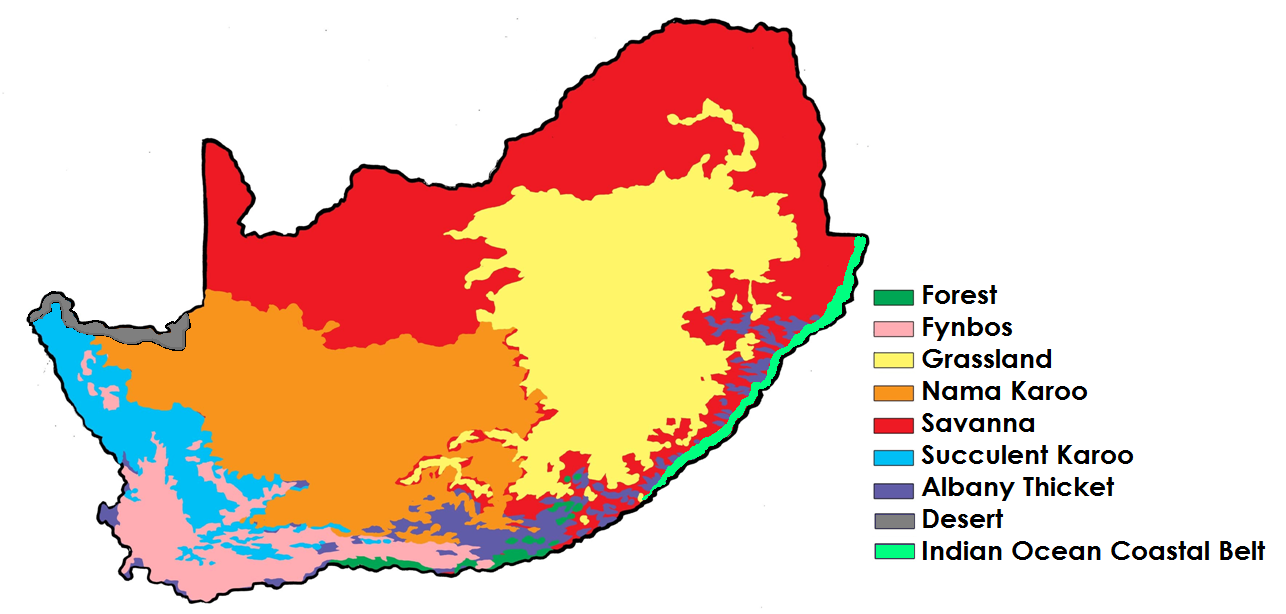
(Your curriculum requires you to study terrestrial biomes only. Don’t forget that South Africa has a very long coastline with the Ocean biome being extremely important. South Africa also has many inland aquatic biomes of great importance.)

As you work through the rest of this Unit, the following two websites are useful in providing interactive maps and information on the major biomes in South Africa. Refer to these websites to assist you as you work through the information provided in the notes.

*Department of Biodiversity and Conservation Biology, University of the Western Cape*:

<http://planet.botany.uwc.ac.za/nisl/bdc321/ekapa%20cape%20towns%20lowlands/biomes/intro.htm#2>

*South African National Biodiversity Institute:* <http://redlist.sanbi.org/stats.php>



**Figure 7: The major terrestrial biomes of South Africa** [insert AWB Figure 7: The major terrestrial biomes of South Africa]

(Source: Adapted from: https://www.siyavula.com/read/science/grade-10-lifesciences/biosphere-to-ecosystems/08-biosphere-to-ecosystems-03)

<http://redlist.sanbi.org/stats.php>)

Figure 7 is a map showing the major terrestrial biomes in South Africa. You should use the key on the map to familiarise yourself with where each of the biomes is located.

Notice that there are no clear, straight-line boundaries between different biomes. Sometimes bits of one biome are located inside another biome. Remember that the biomes are determined by climatic conditions and soil types. *Altitude* [height above sea level] also plays a role in determining a biome.

To help orientate yourself, use a political map of South Africa and locate some of the major cities in South Africa, such as Cape Town, Durban, Bloemfontein, Tshwane, Johannesburg etc. See which biome these cities fall into on Figure 7.

Activity 2.2: The terrestrial biomes of South Africa

Suggested time:

10 minutes

Aim:

This short activity will help you to familiarise yourself with where the terrestrial biomes of South Africa are located.

What you will do:

You will do this activity in your workbook, under the heading Activity 2.2

Locate each biome using the colour key on the map (Figure 7). Then use the map to answer the following questions.

1. Find approximately where you live on the map. In which biome do you live?
2. Name the three largest biomes in South Africa.
3. Name two biomes that occur only in the western and southern part of the country.
4. Which are South Africa’s smallest and second smallest biomes?

Discussion of the activity

This is a simple activity, requiring you to study the map and the key carefully. If you have a gray-scale printed map, it may be a good idea to source a colour version online at <http://redlist.sanbi.org/stats.php>. The biomes are much easier to locate on a colour map.

Exemplar answer

1. You should be able to use the key to find the biomes on the map. Take your time and work carefully down the list of biomes.
2. Using a political map of South Africa will help you find the different major cities. You can then locate your place on the map easier.
3. The three largest biomes are: Nama Karoo, Savanna, and Grassland
4. The Fynbos and Succulent Karoo biomes are found in the western and southern parts of South Africa only.
5. The Forest biome is the smallest biome, followed by the Desert biome.

[START TEXT BOX]

*What’s the main idea?*

South Africa has nine major biomes.

[END TEXT BOX]

Unit 2.4: Climate, soils and main vegetation in each biome of South Africa

This website address will take you to an extract of a textbook which has excellent colour photos of the different biomes. You will also find some extra information in this textbook to help you as you complete Activity 2.3.

*Life Sciences Grade 10*: <https://www.everythingmaths.co.za/read/science/grade-10-lifesciences/biosphere-to-ecosystems/08-biosphere-to-ecosystems-03>

Other websites dedicated to specific biomes are given at the relevant places in the text.

Activity 2.3 Comparing the terrestrial biomes of South Africa

Suggested time:

60 minutes including reading time

Aim:

This activity will help you to *consolidate* [combine a number of things into a single more effective or coherent whole] all the information you are going to read in these notes on the biomes. Consolidating the information into a *table* [show information in a clear and simple way in rows and columns; ideal for comparisons; for study purposes, use different colours in the table to help you remember] will mean that the work is far easier to revise closer to exams.

What you will do:

You will need access to the internet to consult the sources and find the distribution maps. You will also need your workbook, pen, pencil and ruler.

Do the activity in your workbook under the heading Activity 2.3. You may find it easier to create your table in landscape (i.e. turn your page sideways), or to work on double sheets of A4 paper which you can later attach into your workbook.

Use the map (Figure 7), the notes that describe the different biomes below (Fynbos, Succulent Karoo etc.), as well as the website references given, to build a *summary comparison table*.

Here is an idea for the headings of your table:

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Table comparing the different terrestrial biomes of South Africa** | | | | | | |
| Biome | Distribution | Climate | Soil type/s | Typical plants | Typical animals | Other |
|  |  |  |  |  |  |  |

**Table 1: Suggestion for biome comparison table**

Don’t simply copy all the given notes into your table. You must summarise the information effectively. You can find more information on summarising in the Student Guide.

2.4.1 Fynbos

For more information and excellent photographs:

*South African National Biodiversity Institute:* <http://pza.sanbi.org/vegetation/fynbos-biome>

*Department of Biodiversity and Conservation Biology, University of the Western Cape*: <http://planet.botany.uwc.ac.za/nisl/bdc321/ekapa%20cape%20towns%20lowlands/biomes/fynbos.htm>

Fynbos is our local name for the temperate scrubland biome. It is known by other names in other countries, for example, Australia calls it the mallee, Chile names it the matorral, and in North America it is known as the chaparral. It is known as the maquis in countries surrounding the Mediterranean Sea.

**Distribution**

Fynbos occupies the mountains and coastal lowlands of the Western Cape, and coastal portions of the Eastern Cape Province, to the west of Port Elizabeth.

**Climate**

Fynbos is found in the winter rainfall region of South Africa. The biome has cool, wet winters and hot, dry summers. Annual rainfall varies through the fynbos biome. There are high winds throughout the year. Fire is an important component of this biome and there are intense fires about every 15 years that help maintain the plant community composition.

**Soils**

The soil is very sandy and rocky and it drains well, meaning it does not retain much water. Fynbos soils are extremely low in nutrients, lacking minerals and organic matter. Soil type, together with interactions between climate and fire, determine the boundaries of the fynbos biome.

**Vegetation**

The name fynbos (meaning “fine bush”) refers to the large number of small-leaved evergreen shrubs in this biome. Fynbos vegetation includes many types of protea, erica and restio. These plants have very small, hard leaves, which hold moisture. They have root systems designed to get as much water as possible. The plants are also very well adapted to fires. The fynbos biome has extremely high plant diversity (with almost 9 000 species), approximately 70% of which are *endemic species* [a species that occurs in one particular place and is found nowhere else in the world].

**Fauna** [animal life]

Animals include the Cape sugarbird, protea-seed eater, grysbok, bontebok, Cape gerbil, geometric tortoise and Victoria’s warbler. Baboons, leopards, lynxes, porcupines and eagles are found in the mountains of this biome. *Prolific* [abundant, plentiful] insect life.

2.4.2 Succulent Karoo

For more information and excellent photographs:

*South African National Biodiversity Institute:* <http://pza.sanbi.org/vegetation/succulent-karoo-biome>

*Department of Biodiversity and Conservation Biology, University of the Western Cape*: <http://planet.botany.uwc.ac.za/nisl/bdc321/ekapa%20cape%20towns%20lowlands/biomes/succulentkaroo.htm>

**Distribution**

The Succulent Karoo occurs along the western coast of South Africa, and inland along the northern border of the Fynbos biome.

**Climate**

The Succulent Karoo biome occurs in the dry winter rainfall region of the country. The Succulent Karoo experiences low winter rainfall, with only 20 to 290 mm of rain per year. Winters are cool but frost rarely occurs in this biome. It is extremely hot and dry in summer, with temperatures frequently over 40˚C. Fog occurs along the coast, and this is an important source of water for organisms in the Succulent Karoo. Hot, dry winds blow throughout the year.

**Soils**

The soils of the Succulent Karoo are rich in lime and occur in a thin layer on top of a rock base. They contain little organic matter and are therefore not very fertile.

**Vegetation**

The Succulent Karoo is a *hotspot* [a region with a high level of biodiversity, particularly endemic species] of plant diversity. Over 6 300 species of plants have been recorded, of which 38% are endemic. This biome is characterised by dwarf succulent shrubs, including vygies and stone plants. These succulent plants have thick, fleshy leaves that store water. Grasses grow in the sandy areas.

Many *annual* *plants* [plants that live for one season only] such as daisies flower in the spring. Annual plants survive the dry period in the form of seeds and only germinate after rainfall. This biome is an area of outstanding natural beauty because of the mass flowering of plants in the spring after rains. Many tourists visit the Succulent Karoo biome to see the spring flowers.

**Fauna**

The dassie rat, Namaqua dune mole rat bat eared fox and meerkat, as well as birds such as starlings and the Cape francolin occur here, along with many insects and reptiles.

2.4.3 Desert

For more information and excellent photographs:

*South African National Biodiversity Institute:* <http://pza.sanbi.org/vegetation/desert-biome>

**Distribution**

Although much of South Africa is arid or semi-arid (environments with very little water), only a very small area is classified as true desert. The Desert biome of South Africa occurs in the Northern Cape Province along the lower Orange River valley. This biome includes sandy plains along the Atlantic coast. Further inland, the Desert biome includes the Richtersveld, a rocky and mountainous habitat that is the only arid biodiversity hotspot on Earth.

**Climate**

The Desert biome has a harsh climate. In the summer, temperatures can reach up to 53°C in the daytime, while at night the temperatures are very low. The western portion of the desert biome falls within the winter rainfall zone of South Africa, while the eastern portion is in the summer rainfall zone. Mean annual rainfall ranges from approximately 10 mm in the west to 80 mm inland. Thick fog is an important feature of this biome. The fog is critical for maintaining the high level of biodiversity found in the Desert biome.

**Soils**

The soils in the desert biome of South Africa are not very fertile due to the fact that there is little organic matter. They vary from sand in the west to thin soils on a rock base in the east.

**Vegetation**

The vegetation of the desert biome includes many annual plants – especially grasses – that survive through dry periods in the form of seeds. When rain falls, the seeds of the annual plants germinate and they complete their life cycle quickly before dying.

*Perennial plants* [plants that live for more than two years] are also present. The perennial plants that grow in the desert have adaptations that allow them to survive with very little water. Many of the perennial plants in deserts are succulent, with special structures that allow them to store water in their leaves or roots. One plant species that occurs only in the Richtersveld is the Halfmensboom. Literally translated, the name “half-person tree” because it looks like a human.

**Fauna**

There are many insects, spiders, scorpions and reptiles in this area; many are nocturnal hiding in burrows during the day.

2.4.4 Nama Karoo

For more information and excellent photographs:

*South African National Biodiversity Institute:* [http://pza.sanbi.org/vegetation/nama-karoo-biome](http://pza.sanbi.org/vegetation/desert-biome)

*Department of Biodiversity and Conservation Biology, University of the Western Cape*: <http://planet.botany.uwc.ac.za/nisl/bdc321/ekapa%20cape%20towns%20lowlands/biomes/namakaroo.htm>

**Distribution**

The Nama Karoo is found on the central plateau of the western half of South Africa. This biome falls within the summer rainfall zone and its distribution is determined primarily by rainfall.

**Climate**

The Nama Karoo is an arid to semi-arid region. Rainfall is scarce and varies between about 200 mm per year in the west to over 400 mm per year in the north-east. Rivers in the Nama Karoo only have water in them immediately after rains have fallen. It is very hot in the summer and cold in the winter, with frequent frost.

**Soils**

The soils of the Nama Karoo are rich in lime but form only a thin layer on top of a rock base. They contain little organic matter and are therefore not very fertile.

**Vegetation**

The vegetation of the Nama Karoo consists mostly of grasses and small shrubs. Trees such as *Acacia karoo* occur only along rivers. There is relatively low plant diversity in this biome and fires are rare.

**Fauna**

In the past vast herds of springbok used to migrate through the region in search of water and grazing. These herds were destroyed and replaced with sheep by early settlers who came to the area and began farming. The Nama Karoo is famous for sheep and goat farming. In the main river valleys, people also farm olives, citrus and deciduous fruit.

2.4.5 Grassland

For more information and excellent photographs:

*South African National Biodiversity Institute:* <http://pza.sanbi.org/vegetation/grassland-biome>

*Department of Biodiversity and Conservation Biology, University of the Western Cape*: <http://planet.botany.uwc.ac.za/nisl/bdc321/ekapa%20cape%20towns%20lowlands/biomes/grassland.htm>

**Distribution**

Grassland occurs mainly on the high central plateau and the inland areas of KwaZulu-Natal and the Eastern Cape. The biome extends from sea level to altitudes greater than 3 000 m, with landscapes that vary from flat plains to mountains.

**Climate**

Grassland is found within the summer rainfall zone. Heavy thunderstorms and hail occur during the rainy season. Rainfall ranges from 400 mm to more than 1 200 mm per year. Temperatures are also highly variable throughout the biome. Some areas experience frost and snow during the winter, while other parts are frost-free.

**Soils**

The soils that occur in grasslands tend to be deep and rich in nutrients. Grassland areas are frequently used for agriculture.

**Vegetation**

Grasslands are dominated by grasses and other low-growing plants, including many showy flowers that survive dry periods as underground bulbs. Trees occur only along rivers and protected valleys. Frost, fire and grazing maintain grass dominance and prevent trees from growing in other areas. Plant diversity is high in this biome, with approximately 3 400 plant species occurring in the central grassland region.

**Fauna**

In the past, Grasslands were home to large herds of animals like the black wildebeest, blesbok and eland. Today these animals mainly survive in nature reserves and on game farms. Grasslands are rich in birds, many of which eat seeds, e.g. Black Korhaan, Blue Crane and Helmeted Guinea fowl. Many plant-eating insects. Nearly half of the original Grassland Biome has been ploughed up to plant maize, sunflowers, sorghum and wheat. Grassland also supports livestock farming, including cattle and sheep. Most of Gauteng and the Mpumalanga highveld are found in the Grassland Biome. Much of this region has been developed for mining, industry and urban development.

2.4.6 Savanna

For more information and excellent photographs:

*South African National Biodiversity Institute:* <http://pza.sanbi.org/vegetation/savanna-biome>

*Department of Biodiversity and Conservation Biology, University of the Western Cape*: <http://planet.botany.uwc.ac.za/nisl/bdc321/ekapa%20cape%20towns%20lowlands/biomes/savanna.htm>

**Distribution**

Savanna is the largest biome in South Africa, covering about one-third of the land. Savanna is found in northern regions of the country, including the lowveld and Kalahari, as well as in parts of KwaZulu-Natal and the Eastern Cape.

**Climate**

Savanna occurs in the summer rainfall zone. Summers are wet and winters are dry. This biome receives from 235 mm per year in the west to 1 000 mm per year in the east. The climate is tropical to subtropical, with higher temperatures than the grassland biome. Fires occur frequently.

**Soils**

Savanna soils vary greatly depending on the location. In the dry Kalahari region, soils are sandy and deep. Areas of savanna with higher rainfall tend to have more shallow soils. Soil fertility is generally low.

**Vegetation**

Savanna vegetation consists of a lower layer dominated by grasses, with scattered shrubs and trees. Thorn trees grow throughout the savanna, with baobab and mopane trees in the north. There is high plant diversity, with 3 800 species in the moist savannas and 3 300 in the dry savannas. Climate, fire and grazing maintain the characteristic grass-tree structure of the savanna biome.

**Fauna**

Large game animals such as lion, leopard, cheetah, elephant, buffalo, rhino giraffe, wide range of antelope, plains zebra and numerous birds. Large game reserves like the Kgalagadi Transfrontier Park and the Kruger National Park are found in this region.

2.4.7 Albany thicket

For more information and excellent photographs:

*South African National Biodiversity Institute:* <http://pza.sanbi.org/vegetation/albany-thicket-biome>

*Department of Biodiversity and Conservation Biology, University of the Western Cape*: <http://planet.botany.uwc.ac.za/nisl/bdc321/ekapa%20cape%20towns%20lowlands/biomes/albanythicket.htm>

**Distribution**

Albany Thicket occurs in semi-arid parts of the Eastern and Western Cape provinces. Thicket is sometimes considered part of the savanna biome but recent vegetation classifications have identified it as a distinct biome.

**Climate**

The Albany Thicket biome is found at the transition zone between the winter and summer rainfall regions of South Africa. Rainfall occurs throughout the year, although rain is unpredictable and the totals are relatively low (200 to 950 mm per year). Inland areas experience temperatures exceeding 40˚C in the summer and have frost in the winter. The ocean moderates the extreme temperatures in the coastal parts of this biome. Fog in coastal regions maintains the rich lichen community. Fire is not an essential component of this biome and many of the succulent plant species found here are resistant to burning.

**Soils**

The soils in Albany Thicket vary across the biome, from sand dunes along the coast to deep sandy soils further inland. The soils are typically poor in nutrients.

**Vegetation**

The vegetation of the Albany Thicket is generally dense, with succulent, woody and spiny plants that grow to a height of 2-3 m. Characteristic plant species include euphorbias, aloes and spekboom. Plant diversity is high, with many endemic species.

**Fauna**

Variable animals such as antelope, elephant, monkeys, insects and birds.

2.4.8 Indian Ocean Coastal Belt

For more information and excellent photographs:

*South African National Biodiversity Institute:* <http://pza.sanbi.org/vegetation/indian-ocean-coastal-belt>

**Distribution**

The Indian Ocean Coastal Belt runs from the South Africa-Mozambique border in the north to the mouth of the Great Kei River (near East London) in the south. This biome occupies a narrow coastal strip that extends from sea level to an altitude of approximately 600 m inland. Indian Ocean Coastal Belt has a distinctive vegetation structure and climate that separates it from other biomes.

**Climate**

Indian Ocean Coastal Belt has a subtropical climate. It falls within the summer rainfall zone of the country but there is some rainfall throughout the year. Annual precipitation ranges from 800 to 1 300 mm per year, making it the biome with the highest average rainfall. Summers are very hot, while winters are warm and mild. Fires are rare in this biome.

**Soils**

The soils of the Indian Ocean Coastal Belt are generally sands with poor soil development. Many parts of this biome occur on sand dunes or the coastal plain.

**Vegetation**

The Indian Ocean Coastal Belt is a component of the Maputaland-Pondoland-Albany biodiversity hotspot, including both the Maputaland and Pondoland Centres of Endemism. The vegetation includes coastal forest, dwarf shrubland, thicket and grassland. Important plant species include cycads, red-hot pokers, bitter aloe, and bird-of-paradise flower.

**Fauna**

Small mammals such as monkeys, reptiles, birds and insects.

2.4.9 Forest

For more information and excellent photographs:

*South African National Biodiversity Institute:* <http://pza.sanbi.org/vegetation/forests>

*Department of Biodiversity and Conservation Biology, University of the Western Cape*: <http://planet.botany.uwc.ac.za/nisl/bdc321/ekapa%20cape%20towns%20lowlands/biomes/forest.htm>

**Distribution**

Forest is the smallest biome in South Africa. Forests have a patchy distribution along the eastern Escarpment from the Soutpansberg in the north to the Cape Peninsula in the south. South African forests are naturally quite small and fragmented and most cover areas less than 1 km2. Some of the best-known examples of South African forests include the Knysna and Tsitsikamma forests in the southern Cape and Ongoye forest in KwaZulu-Natal.

**Climate**

Forests occur in both the winter and summer rainfall zones, with some forests receiving rainfall throughout the year. The climate is generally temperate, with fairly small changes in temperature between winter and summer. Fires are rare in South African forests because they have high humidity.

**Soils**

The soils of forests are generally fertile, with high amounts of organic matter.

**Vegetation**

Almost all the indigenous trees found in South African forests are evergreen, meaning that they hold on to their leaves year-round. Forests have many different layers. Very tall trees form a canopy; shorter trees form a sub-canopy; and low shrubs, ferns and herbaceous plants grow at ground level, forming the understorey layer. Some of the most important tree species found in forests include yellowwoods and black stinkwood. Although the forest biome is quite small, it has the second richest plant species diversity per unit area, after fynbos.

**Fauna**

Numerous insect species, birds and small mammals such as bushpig, bushbuck and monkeys. The canopy is a perfect habitat for birds such as the Knysna loeries, pigeons and eagle.

Discussion of the activity

You should now have a very comprehensive, well organised table, which will provide you with a good study tool! Tables may take some time to compile, but they are well worth the effort.

Exemplar answer

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Table comparing the different terrestrial biomes of South Africa** | | | | | | |
| Biome | Distribution | Climate | Soil type/s | Typical plants | Typical animals | Other |
| Fynbos | western Cape; coast of Eastern Cape | winter rainfall; cool, wet winters; hot, dry summers | low in nutrients, minerals and organic matter; acidic; sandy rocky soils that do not retain water | predominantly small-leaved evergreen shrubs e.g. protea, erica and restio | many bird species, insects and small mammals such as baboon, grysbok | 70% endemic plant species; threatened by urbanisation and agriculture; fire maintains plant community |
| Succulent Karoo | west coast and inland north of Fynbos biome | dry winter rainfall; extremely hot and dry in summer; fog provides moisture; hot dry winds | rich in lime; thin layer on rock base; little organic matter; not very fertile, arid | dwarf succulent shrubs, including vygies and stone plants; grasses; annuals e.g. daisies | insects, birds, small mammals e.g. dassie rat, dune mole ratbat eared fox, meerkat and reptiles | 38% endemic plant species; tourist attraction in spring |
| Desert | northern Cape along Orange River valley | harsh, arid; temperatures very high during day and very low at night; very little rain; fog provides moisture | sand and thin soils on rock; little organic matter | annuals, grasses, succulents with water storage adaptations | insects and reptiles; many are nocturnal hiding in burrows during the day | extremely arid |
| Nama Karoo | central plateau of the western half of South Africa | semi-arid; summer rainfall; rivers only have water just after rains; very hot in summer and cold in winter; frequent frost | rich in lime; little organic matter | low plant density; grasses, small shrubs, trees along rivers | few animals today; previously large herd of springbok; insects and birds | sheep and goat farming, as well as fruit trees along rivers |
| Grassland | high central plateau, inland KZN and Eastern Cape | high summer rainfall; cold winters with frost and snow in areas | deep; rich in nutrients | grasses and low growing plants; trees along rivers; high plant diversity | in the past, large herds of herbivores; now agriculture: cattle and sheep farming; many birds and insects | regular fires; plants adapted to fire; frequently used for agriculture, mining and urban development |
| Savanna | largest biome in SA; northern regions, lowveld, Kalahari, KZN and Eastern Cape. | summer rainfall, dry warm winters | mainly sandy with low fertility | grasses with scattered trees and shrubs; high diversity with characteristic thorn trees, baobab, mopane | Large game animals such as lion, leopard, cheetah, elephant, buffalo, rhino giraffe, wide range of antelope, plains zebra and numerous birds. | frequent fires; game reserves like the Kgalagadi Transfrontier Park and the Kruger National Park are found in this region |
| Albany thicket | eastern and western Cape | transition between winter and summer rainfall; low rainfall; hot summers, cold winters with frost; fog | soil types vary but mainly sandy; low in nutrients | high plant diversity; dense, with succulent, woody and spiny plants e.g. euphorbia, aloes | variable e.g. antelope, elephant, monkeys; insects and birds | known as subtropical thicket in some books |
| Indian Ocean Coastal Belt | from Mozambique border to eastern Cape, along coastline | subtropical; high summer rainfall although rain all year round; hot summers, warm winters | sandy soils; many dunes | coastal forest, dwarf shrubland, thicket and grassland species; e.g. cycads, red-hot pokers, bitter aloe, and bird-of-paradise flower | small mammals, monkeys, reptiles, birds and insects | referred to as Albany thicket in some books |
| Forest | scattered distribution; well known areas: Knysna and Tsitstikamma, Ongoye in KZN, Limpopo and Mpumalanga | rainfall most commonly experienced throughout year; temperate | fertile soils with high levels of humus | high plant diversity; indigenous evergreen trees, ferns, herbaceous plants | insects, birds and small mammals such as bushpig, bushbuck and monkeys | many indigenous forests have been replaced by plantations of alien trees (e.g. pine trees); harvesting of indigenous forest trees is strictly controlled |

**Table 1: Biome comparison table**

Quick progress check

You have read through many descriptions of the different terrestrial biomes and you have compiled your summary table. But how much information did you absorb and can you remember the details?

Take a few minutes to re-read your comparison table.

Now answer these questions under the comparison table in your workbook.

Choose the biome or biomes that match each of the following descriptions. The first one has been done for you.

1. Most rain falls in the winter

Answer: Fynbos, Succulent Karoo, Desert

1. Fire plays an important part role in these biomes.
2. Winter is very cold with frequent frost.
3. Soils tend to be fertile.
4. Vegetation consists of grass with scattered trees and shrubs.
5. Famous for the colourful flowers in spring.
6. Rain falls mostly in the summer.
7. Mostly in the highveld areas that experience frost in the winter.
8. Fog plays an important role in these biomes.
9. Vegetation consists of evergreen, succulent, spiny trees and shrubs.
10. Annual rainfall is extremely low (10 mm – 80 mm).

Discussion of the progress check

1. Answer is given.
2. Fynbos, savanna, grassland.
3. Grassland, Albany thicket, Nama Karoo.
4. Forest, grassland.
5. Savanna
6. Succulent Karoo
7. Indian Ocean Coastal Belt, Savanna, Grassland, Nama Karoo.
8. Grassland
9. Albany Thicket, Desert, Succulent Karoo.
10. Albany Thicket
11. Desert

[START TEXT BOX]

*What’s the main idea?*

Each biome has characteristic climate, soils and vegetation.

[END TEXT BOX]

Unit 2.5: Adaptations of plants to different biomes

*Adaptations* are special features of organisms that help them to survive in their environment. Plants are adapted to the climate and soils of the biome in which they live.

Make a heading in your workbook: ‘Plant adaptations to different biomes’.

Answer the following question in your workbook, using what you already know:

Why do plants need to be adapted to their environments?

You have seen that several of the terrestrial biomes have harsh climatic conditions such as very hot summers, low rainfall, frost etc. Some of the biomes have poor soils. Plants need to have structures that allow them to cope in these biomes.

Watch this video which explains the very basic information about plant adaptations: *Plant structure and adaptations:* <https://www.youtube.com/watch?v=DGpPHrLF-5M&list=PLwL0Myd7Dk1F0iQPGrjehze3eDpco1eVz&index=49&t=0s> (Duration 8.40)

As you watch the video, stop it occasionally to note down some of the important environmental challenges plants face. What solutions to these challenges are offered in the video?

Now you will turn your attention to the different biomes in South Africa and focus on how the plants are adapted to the conditions in the biomes. You may wish to revisit the websites referred to earlier, and focus your attention on the photographs of the plants in the biomes. See if you can recognise the adaptations (as described in the notes that follow) in the photographs of the relevant plants. You may wish to make simple *annotated sketches* [simple line diagrams with labels and extra explanatory notes that make the diagram more meaningful] in your workbook.

**Fynbos**

Plants of the fynbos biome are adapted to winter rainfall, hot dry summers, poor soils, and fire. Plants are adapted to save water and survive fire.

* The reeds and grass of the fynbos biome have small leaves or no leaves and tough, wiry stems.
* Many of the shrubby plants have small, narrow, rolled leaves.
* The proteas have broad leaves and thick bark. The thick bark helps proteas to survive fires.

**Succulent Karoo Biome**

Plants of the Succulent Karoo are adapted to low rainfall, and very hot, dry summers. The main plants are small succulent shrubs. Vygies are a good example. They have fleshy leaves that store water.

**Nama Karoo Biome**

Plants of the Nama Karoo biome are adapted to little rain, hot summers and cold winters. Frost affects the plants in winter. Most plants are low shrubs and grasses. Many plants lose their leaves when rain does not fall. This is an adaptation to the dry climate.

**Grassland**

Plants of the Grassland biome are adapted to winter frost, fire and grazing. Grasses are well adapted to these conditions. They have an underground stem that can survive fire, frost and grazing. The leaves die off in winter, enabling the plants to survive frost.

**Desert Biome**

Plants of the desert biome are adapted to very harsh climatic conditions. Desert plants are mostly annuals. They survive the dry conditions as seeds. After rain, the seeds germinate quickly and the plant completes its life cycle in a few weeks.

**Savanna**

Plants of the Savanna biome are adapted to low rainfall and fire. Acacia thorn trees are common in South African savanna. They have small leaves that help reduce water loss. The thorns discourage animals from eating them. Some acacias have thick bark that enables the plants to survive fire.

**Albany Thicket Biome**

Plants in the Albany Thicket Biome are adapted to fairly low rainfall. A typical plant of Albany Thicket is the spekboom. It has succulent leaves that store water.

**Forest biome**

Unlike most of the biomes of South Africa, forests receive high rainfall, no frost, and rarely have fires. Forest plants compete for light. Trees such as yellowwood trees grow very tall to reach the light. The trees have a sturdy trunk to support the height of the tree. The leaves are dense on the branches.

**Indian Ocean coastal belt**

The Indian Ocean coastal belt biome is a mixture of grasslands, forest and thicket. Close to the sea, the vegetation is affected by salt spray and wind. A plant that is typical of this biome is the Natal wild banana. It has enormous leaves that tear in the wind. It forms clumps of plants, each plant growing from its underground stem. The clumps protect the plants from the wind.

[START TEXT BOX]

*What’s the main idea?*

Plants are adapted to the climatic conditions of each biome.

[END TEXT BOX]

Activity 2.4: Recognising plant adaptations in a biome

Suggested time:

10 minutes

Aim:

This short activity tests whether you can apply what you have learnt about plant adaptations in a particular biome to an example of a plant.

What you will do:

You will need your workbook and pen.

Write a heading Activity 2.4.

Study Figure 8, the photographs of the halfmens plant (*Pachydodium namaquanum*), and then answer the questions that follow.

This plant is called a ‘halfmens’ because its unusual shape makes it look like a person. The word ‘halfmens’ means half person.

**Figure 8: Photographs of halfmens plants (*Pachypodium namaquanum*)** [insert AWB Figure 8a, b, c: Photographs of halfmens plants]

(Sources:

(a) By Javier Ábalos Alvarez [CC BY-SA 2.0 (https://creativecommons.org/licenses/by-sa/2.0)], via Wikimedia Commons

<https://upload.wikimedia.org/wikipedia/commons/d/d8/Half-men_tree_%28Pachypodium_namaquanum%29_guarding_the_dirt_road.jpg>

(b) By Winfried Bruenken (Amrum) [CC BY-SA 2.5 (https://creativecommons.org/licenses/by-sa/2.5)], from Wikimedia Commons

<https://upload.wikimedia.org/wikipedia/commons/b/be/Pachypodium_namaquanum_PICT2669.JPG>

(c) By Daderot [CC0], from Wikimedia Commons

<https://upload.wikimedia.org/wikipedia/commons/e/e0/Pachypodium_namaquanum_-_Lyman_Plant_House%2C_Smith_College_-_DSC04300.JPG>)

* 1. In which biome/s are you most likely to find this plant? Explain your reasoning.
  2. Analyse the photographs to find adaptations to the biome you named in question 1. List the adaptations. For each adaptation in your list, describe the adaptation with reasons as to why it is an adaptation to the biome.
  3. Traditional hunters in Namibia (where this plant also grows) use the sap from the stem on poison arrows. *Hypothesise* [give a possible explanation for something observed] why having poisonous sap is an adaptation to the biome the plant is found in.

Discussion of the activity

Being able to apply what you have learnt to a real life example, is a very important skill.

Exemplar answer

1. Desert biome (Richtersveld). The photographs depict a dry/arid sandy and rocky region. It can also occur in the Succulent Karoo and Nama Karoo biomes.
2. Swollen stem – water storage in a biome that experiences very little rainfall.

Very few and very small leaves – limits water loss in the dry, hot environment.

Leaves very high up the plant away from ground level – to reduce foraging on the leaves by ground dwelling animals.

Spines on stem and between leaves – discourage herbivorous animals from eating the leaves/stem.

1. If the sap is toxic, it will discourage herbivores from eating the swollen stems where the plant is storing water.

Moving on

You have a better understanding of the factors that control the kind of vegetation in a biome. You have examined the major terrestrial biomes in South Africa and you have reviewed how plants are adapted to the environment. In the next Unit, you will explore one particular biome in a research task. You will also investigate plants that are under threat of extinction.

Unit 3: Exploring the biomes of South Africa

You should now have a very clear understanding of what a biome is and what factors define a biome. You also have made a comprehensive study of the different terrestrial biomes in South Africa. In this unit you will further investigate a particular biome. You will also identify organisms (in particular plants) that are threatened with extinction in some biomes.

Unit 3 learning outcomes

By the end of this unit, you should be able to:

1. Select one South African biome for detailed study (preferably the biome in which you live), collect climatic data, type of soils, altitude, main vegetation and animal life in the biome from Internet sources such as PlantZAfrica.com or books.
2. Describe threats to and conservation of the biome.
3. Write a comprehensive report on the biome, including drawings, photographs, and graphs showing precipitation and temperature records.
4. Explain the classifications of plant species used in the Red List, and illustrate the classifications with reference to the chosen biome (search for Red List on the SANBI website).
5. Explain the concept of sustainability, and investigate one plant in South Africa that is used by humans, and how it should be used sustainably (search for sustainable use of plants on the SANBI website).

Unit 3.1: Researching a biome in South Africa

[START TEXT BOX]

*What’s an assignment?*

The next activity is an assignment that requires you to do independent research. This means that you will need to use books and the internet to examine and explore the given topic.

* You must make rough notes relating to the topic and what you discover from your research. You will then need to select the relevant information and put all this data together (collate it) into a comprehensive report.
* The instructions ask for diagrams, photographs and graphs. Make sure you include these too.
* You must list all the sources and references you used at the end of the report.
* Make sure that your report focuses precisely on what the activity asked you to do. A rubric is given to show how your assignment will be assessed. Make sure that you have addressed all the criteria in the rubric, so that you can obtain the best possible marks!

[END TEXT BOX]

Activity 3.1: Research assignment on a biome

Suggested time:

6 hours

Aim:

To produce a comprehensive report on one biome of South Africa, including drawings, photographs and graphs showing rainfall and temperature records for the biome.

You will need your workbook, pen, pencil and a ruler. You will also need access to the internet and/or the library.

What you will do:

1. Select a biome that you would like to study. It should preferably be the biome in which you live. Name and briefly describe this biome.
2. Collect data about the climate, soils, and altitude of the biome. Some resources you can use are:
   1. Knobel, J. & Bredenkamp, G. 2006. The Magnificent Natural Heritage of South Africa. Roggebaai: Sunbird Publishers.
   2. <http://planet.botany.uwc.ac.za/nisl/bdc321/ekapa%20cape%20towns%20lowlands/biomes/intro.htm#2>
   3. <http://pza.sanbi.org/vegetation>
   4. <http://www.everythingmaths.co.za/science/lifesciences/grade-10/08-biosphere-to-ecosystems/08-biosphere-to-ecosystems-03.cnxmlplus>
   5. You can find tables showing annual rainfall, average minimum and maximum temperatures on the following website:

<https://worldweatheronline.com>

1. Collect information about the main plants growing in your biome and the animals that are found in the biome. Include diagrams, maps, photographs, graphs etc.
2. Collect information about threats to your biome, as well as conservation efforts. You will find suitable information in the first three references listed previously.
3. Write a comprehensive report on the biome you have chosen. Use your own words.
4. Include a list of references you consulted. (If you do not know how to list the references, go to the end of this module and see how different sources are referenced.)

Discussion of the activity

In this activity, you had to research information and present it as your own work, in your own words. You had to reference your sources.

[START TEXT BOX]

*What’s plagiarism?*

Plagiarism is to use another person’s work and to pass it off as your own. This is wrong. It is *unethical* [immoral and dishonest] and illegal [against the law]. You are essentially stealing someone else’s *intellectual property* [thoughts, ideas and work someone has created].

You need to reference and acknowledge ideas you have taken from the work of others carefully. When work is shown to have been plagiarised and large sections of work have been copied without referencing, the work will be penalised and a low mark or even zero may be awarded.

[END TEXT BOX]

Check the rubric to see that you know how your assignment will be assessed.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Aspect of the report | Meets all the requirements | Meets some requirements | Meets a few requirements | Present, but does not meet the requirements | Absent |
| Title | 2 | 1 | 0 | 0 | 0 |
| Map showing the location of the biome | 3 | 2 | 1 | 0 | 0 |
| Description of climate | 5 | 4 | 3 | 1 | 0 |
| Graphs of temperature and rainfall | 5 | 4 | 2 | 1 | 0 |
| Description of soils | 4 | 3 | 2 | 1 | 0 |
| Description of altitude | 3 | 2 | 1 | 0 | 0 |
| Description of vegetation | 5 | 4 | 2 | 1 | 0 |
| Description of animals | 4 | 3 | 2 | 1 | 0 |
| Threats to the biome | 4 | 3 | 2 | 0 | 0 |
| Conservation efforts | 4 | 3 | 2 | 1 | 0 |
| Uses own words; no copying from sources | 3 | 2 | 1 | 0 | 0 |
| References given | 2 | 1 | 0 | 0 | 0 |
| Illustrations are appropriate | 3 | 2 | 1 | 0 | 0 |
| Neat presentation | 3 | 2 | 1 | 0 | 0 |
| TOTAL | 50 |  |  |  |  |

Unit 3.2: Classification of plant species according to the Red List

The Red List is a scientific system designed by the IUCN [International Union for Conservation of Nature] to measure a species’ risk of *extinction* [when no members of a particular species are living]. The purpose of the Red List is to identify species that most need *conservation* [to preserve and protect something]. There are nine categories of the Red List, ranging from Extinct to Not Evaluated. This is a shortened and simplified version, that we will use in this course:

* *Extinct* species no longer live. If a species is extinct from the whole planet, this means no members of the species are alive anywhere. A species might be extinct in the wild, but living in cultivation or captivity. A species may be extinct in a region where it previously occurred.
* *Threatened* species are those that face a high risk of extinction.
* Species of *Conservation concern* are all those categorised as extinct in the wild or extinct in a region through to those where there is insufficient data to categorise them.
* Species are classified as *Least Concern* when they are at low risk of extinction**.** They do not require conservation.

You can search the Red List yourself: *South African National Biodiversity Institute.* Access: <http://redlist.sanbi.org/>

In the 2015 survey, almost 75% of South Africa’s plant species were classified as *least concern.* However, 0,2% were *extinct*, 13,4% were *threatened*, and 11,8% were of *conservation concern*. Most species that need conservation are in the fynbos and succulent karoo biomes, followed by grassland and savanna biomes.

The Red List is important when new developments are planned. Before a development, such as a new industrial site or a new urban area can go ahead, the natural vegetation is evaluated to make sure the development does not affect a threatened species.

The most important threat to plant diversity is loss of habitat, when the natural vegetation is destroyed. Reasons for habitat loss are:

* Developments such as mining, agriculture, urbanisation, roads and forestry;
* Overgrazing;
* Fires that burn the habitat too frequently or at the wrong time of the year;
* Invasive alien plant species that grow faster than indigenous plants;
* Harvesting plants for medicinal purposes and for gardens or collectors;
* Pollution;
* Climate change.

[START TEXT BOX]

*What’s the main idea?*

The Red List is used to identify organisms that are threatened with extinction and therefore need special conservation measures.

[END TEXT BOX]

Activity 3.2: Classifying organisms according to the Red List categories

Suggested time:

10 minutes

Aim:

This short activity will check whether you have understood what you have read about the Red List classification system.

What you will do:

You will do this activity in your workbook, under the heading Activity 3.2

Read each statement. Decide whether the statement indicates that the organism referred to is extinct, threatened, a species of conservation concern or a least concern species.

1. Seventeen of the 243 mammal species in South Africa face a high risk of extinction.
2. The quagga is an animal that looks similar to a zebra. No living quaggas exist anywhere on earth.
3. The hadedah ibis is a bird that is increasing in numbers in urban habitats.
4. Cape vultures are rapidly decreasing in number because of poisoning by farmers and the muthi trade.
5. Baboon colonies are increasing in parts of South Africa.
6. Halfmens plants are decreasing in the desert biome because of plant collecting by people who want the plant growing in their gardens.
7. Pepperbark trees are very valuable for traditional medicine. There are no longer any pepperbark trees growing in the wild in South Africa. This plant is therefore … in the wild.
8. The Common Hook Thorn tree is widespread throughout South Africa.
9. Although locally common, Restio species occur in the fynbos biome which is a biome that needs protection.
10. *Balanites*, or the green thorn tree: A large amount of habitat has been lost in northern KwaZulu-Natal and there is significant bark harvesting for the commercial medicinal plant trade. The plant, though plentiful, shows poor wound recovery. The species is declining and should be monitored.

Discussion of the activity

Read the statements carefully so that you are able to assess each statement according to what you have learnt about the Red List classification categories.

Exemplar answer

1. Threatened
2. Extinct
3. Least concern
4. Threatened
5. Least concern
6. Threatened
7. Extinct
8. Least concern
9. A species of conservation concern
10. A species of conservation concern

Unit 3.3: Sustainable use of plants

What do you currently understand by the term ‘sustainable’? Write down how you would define this word, as it applies to plants, in your workbook, under the heading ‘Sustainable use of plants’. After reading the notes that follow, you will come back to this definition and refine it or correct it, using the knowledge you will have gained.

South Africa has a rich diversity of plant and animal life. However, the Red List shows that more and more species are becoming threatened or near to extinction. The reasons why so many species are becoming threatened were given in the previous section. One way that we can help to save our biodiversity is through *sustainable use of plants*.

Sustainable use of a plant resource means that we use that plant at a rate that enables the species to recover, grow and reproduce. If humans destroy habitats and use plants and animals too quickly, those species will become extinct. We must preserve habitats and not use up plant and animal resources too quickly.

Over 2 000 plant species are used in the traditional medicine trade in South Africa. Most (97,4%) of medicinal plants are classified in the Red List as “Least Concern”. They are being harvested sustainably. The remaining species are classified in the Red List as threatened, near extinction, or extinct.

Among the threatened species are the 24 species of cycads that occur in South Africa. These plants grow slowly, and have a very slow reproductive rate. Cycads are threatened by the trade in medicinal plants, but even more threatened by people who collect them to sell to the overseas market or to grow them in their own gardens. Because of their slow growth and reproductive rates, harvesting cycads is not sustainable.

**Figure 9: *Encephalartos woodii*, a species of cycad that is extinct in the wild. This specimen is cultivated in the Durban Botanical Gardens.)** [insert AWB Figure 9: *Encephalartos woodii*, a species of cycad that is extinct in the wild. This specimen is cultivated in the Durban Botanical Gardens**.**]

(Source: Purves, M., CC BY-SA 3.0, <https://commons.wikimedia.org/w/index.php?curid=17974140>)

Remember to go back to your original definition of sustainable and refine or correct it, based on what you have learnt.

[START TEXT BOX]

*What’s the main idea?*

Sustainable use of plants means that we use the plants at a rate that allows the plants to recover, grow and reproduce. If we do not use plants sustainably, many species will become extinct.

[END TEXT BOX]

Summary assessment

1. Give the correct scientific term for each description.

1. All parts of the Earth where life can exist.
2. An area that has a characteristic climate and type of vegetation.
3. A special feature of an organism that allows it to survive in a particular climate.
4. Species that face a high risk of extinction.
5. Species that no longer exist anywhere on the planet.
6. Red List category of species that maintains healthy populations.
7. A way of using organisms so that they can recover, reproduce and continue to exist on Earth. (7)

2. Match the biome in Column A with the correct description in Column B.

|  |  |
| --- | --- |
| Column A | Column B |
| 2.1 Fynbos | 1. Characteristic vegetation is grassland with scattered trees. |
| 2.2 Forest | 1. Winter rainfall area, with great diversity of plants. |
| 2.3 Desert | 1. Area with summer rainfall; mostly at high altitude. |
| 2.4 Albany Thicket | 1. Winter rainfall area along the west coast of South Africa. |
| 2.5 Savanna | 1. Summer rainfall area along the east coast of South Africa. |
| 2.6 Nama Karoo | 1. Area with rainfall all year round and thick bush. |
| 2.7 Succulent Karoo | 1. Sandy area that receives very little rainfall. |
| 2.8 Grassland | 1. Small patches of large trees in areas with fertile soils. |
| 2.9 Indian Ocean Coastal Belt | 1. Semi-desert biome with small shrubs and grasses |

(9)

3. Explain what each of the following statements means:

1. Pepperbark trees are extinct in the wild.
2. Fynbos plants are adapted to their climatic conditions.
3. The white rhinoceros is classified as Threatened. (6)

4. Read the following information and the case study that follows:

[START TEXT BOX]

*What’s a case study?*

A case study is an example of a problem in real-life. What this means is that some problem is presented to you, not simply as a straightforward set of questions to answer, but in the context of a real-life situation. You are meant to read through the information from the real-life situation and then answer the questions given, which will address, and possibly suggest solutions to the problem.

[END TEXT BOX]

Christopher was very concerned about the taxi rank just outside his village. He noticed that there were no places for litter to be thrown, so people were throwing papers, plastic bags, bottles and other litter on the ground. There were no toilets, so people were urinating in a stream that ran past the taxi rank and defecating in the bushes around the taxi rank. Taxi drivers would park their taxis off the road killing grass and other plants. If the taxi drivers stayed in the area overnight, they broke branches of trees to use for fires. According to what Christopher had learnt, this area was showing signs of serious degradation. He decided that he would do something about the problem as a school project.

Now answer the following questions:

1. What is the current situation at Christopher’s taxi rank in terms of short-term and long-term risks (to people and the environment)? (4)
2. Christopher decided to inform the public about the situation at the taxi rank. Who needs to be informed of the risks? How could he go about informing the public? How could he go about bringing about changes he thinks are necessary? (4)

5. Study the passage below.

*Exploitation of indigenous plants*

*There are many indigenous plants in South Africa which are used for traditional medicinal and nutritional purposes. Many people generate income from the use of these plants. But there is not always a plan that promotes sustainable use of these plant resources. As a result, there is a high risk that indigenous plants may be overexploited for medicinal and nutritional purposes. The over-harvesting of the African potato is an example of a threat to indigenous plants.*

Write a short essay in which you describe at least four ways in which overexploitation of indigenous plants impacts on the environment. Explain four appropriate management strategies that can reduce such over-exploitation. (20)

[50]

[START TEXT BOX]

*What’s an essay?*

Essays are a means to communicate information in a number of paragraphs written in a logical order. To write a successful essay, follow these easy steps:

* Read the topic carefully to understand what is required. Analyse what is required, to avoid including irrelevant information.
* Draw up a mind-map. This will help you to plan your essay and choose the relevant facts that must be included. After you have your mind-map, number the paragraphs in a specific order so that the content of your essay will flow from one thought to the next.
* Remember to include an introduction and a conclusion. The introduction will inform the reader of what you will be discussing. Use the topic as a guideline. The conclusion will inform the reader that you have in fact discussed the topic. Use the conclusion to tie up all the content paragraphs by briefly summarising the content or expressing a point of view.

In a scientific essay, marks are allocated for scientific fact and not for ‘flowery’ or creative language.

Do’s and don’ts for excellent essay writing:

* Do use short sentences that express a fact clearly. When discussing a point, ensure you provide a statement and a reason. In other words, qualify each statement you make.
* Do break ideas into paragraphs. Never number paragraphs in the essay. Make sure that each paragraph contains oneidea or thought only.
* Do punctuate carefully.
* Don’t use diagrams in your essay, unless asked for them.
* Don’t use bullet points in an essay. You must write sentence after sentence.

The most common mistake that learners make is to write their essay without actually answering the question that was asked. Read the essay question very carefully. Think about what the assessor wants you to answer in the essay. Sometimes, students see only the topic or subject of the essay, and ignore what the examiner wants them to do with that topic. They write all the facts they know about the topic, without answering what the examiner asked them.

[END TEXT BOX]

Exemplar answer

1. Terminology

1. biosphere
2. biome
3. adaptation
4. threatened
5. extinct
6. least concern
7. sustainable

(7)

2.

|  |  |
| --- | --- |
| Column A | Column B |
| 2.1 Fynbos | B Winter rainfall area, with great diversity of plants. |
| 2.2 Forest | H Small patches of large trees in areas with fertile soils. |
| 2.3 Desert | G Sandy area that receives very little rainfall. |
| 2.4 Albany Thicket | F Area with rainfall all year round and thick bush. |
| 2.5 Savanna | A Characteristic vegetation is grassland with scattered trees. |
| 2.6 Nama Karoo | I Semi-desert biome with small shrubs and grasses |
| 2.7 Succulent Karoo | D Winter rainfall area along the west coast of South Africa. |
| 2.8 Grassland | C Area with summer rainfall; mostly at high altitude. |
| 2.9 Indian Ocean Coastal Belt | E Summer rainfall area along the east coast of South Africa. |

(9)

3.

1. There are no pepperbark trees left growing in the wild. (2)
2. Plants growing in the fynbos biome have special characteristics that enable them to survive in those climatic conditions. (2)
3. The white rhinoceros is at risk of becoming extinct. (2)

4. There are no model answers here – you have to interpret the situation in your own way, however, some guidance is given below:

1. Short-term risks: Littering, possible spread of disease due to wastes, the stream could carry pollutants into the water sources for the village.

Long-term risks: Land degradation could result in loss of biodiversity and soil erosion. (4)

1. This needs to be done sensitively so that people do not feel they are being attacked, however they need to see that with small changes, they can still run a business, but not harm the environment and other humans. Maybe Christopher needs to have a meeting with the taxi owners. They can then work on ways of parking the taxis and not causing damage to the soil and plants. Maybe local businesses can be approached to pave the area and place rubbish bins and toilets on the land. They could even make special bricked areas for fires. Posters can be made by local school children to advertise how the area is being protected and the benefits of the conservation project to the public. Alien or invasive trees in the area could be identified as sources for firewood, and indigenous trees could be labelled and protected. (4)

5. There are no model answers here – you have to interpret the situation in your own way, however, some guidance is given below. Bullets are only shown for how marks are allocated. An essay would not include bullets.

Impact on environment

* Plants can become extinct/lead to loss in biodiversity
* Food chains/webs can be destroyed
* Shortage of food
* Could lead to degradation of the environment
* Erosion of ground surface if too many plants are removed
* Increase run-off of water
* Destroy habitats of many organisms
* Alien plant invasion
* Upset the balance of oxygen and carbon dioxide/global warming

(4 points articulately stated: 4 x 2 = 8 marks)

Management practices to reduce over-exploitation

* Sustainable harvesting – over-exploitation must not be allowed
* Research- done to look at reproductive cycle/alternative source of active ingredient /cloning
* Legislation- control harvesting
* Penalties for breaking legislation
* Education/campaign - impact and consequences of over-exploitation
* Establish nurseries/seed banks - to replace plants harvested
* Establish more nature reserves - to conserve indigenous plants
* Controlling exploitation- of indigenous plants by international companies
* Provision of free/cheaper food - to reduce dependence on indigenous plants

(4 points articulately stated: 4 x 2 = 8 marks)

(16 for content; 1 mark for introduction; 1 mark for conclusion; 2 marks for logical flow of paragraphs = 20 marks)

[50]

Key learning points

The Sub-topic Biodiversity and the Biomes of South Africa focussed on the following key points:

* South Africa has an extremely rich biodiversity.
* The biosphere is all parts of the Earth where life can exist. The biosphere receives energy from the Sun, but all other requirements for life are recycled within the biosphere.
* A biome is a region that has a particular type of plant life, which is controlled by climatic conditions.
* Climate and soil control the type of vegetation that grows in a biome. South Africa has great diversity of climate and soil types across the country.
* South Africa has nine major biomes.
* Each biome has characteristic climate, soils and vegetation.
* Plants are adapted to the climatic conditions of each biome.
* The Red List is used to identify organisms that are threatened with extinction and therefore need special conservation measures.
* Sustainable use of plants means that we use the plants at a rate that allows the plants to recover, grow and reproduce. If we do not use plants sustainably, many species will become extinct.

Moving on

You have completed the Sub-topic: Biodiversity and the biomes of South Africa. In the next Sub-topic, the focus will be on principles of classification of biodiversity.

Topic 1: Biodiversity

Sub-topic 2: Principles of classification

Overview

By now, you have learnt that the biosphere is home to an enormous range of living things.

This Sub-topic focuses on the two related concepts of *biodiversity* and *classification*. You will examine what is meant by these concepts. You will look in more detail at the biodiversity of South Africa. You will investigate questions such as: Why are organisms named the way they are? Why do we need classification systems? What different kinds of organisms are there in the biosphere?

Write a heading in your workbook ‘Biodiversity and classification.’

To understand a little more about biodiversity, you are going to view some videos. As you watch the videos, pause frequently (e.g. after a concept has been introduced) to note down any ideas in your workbook that will help you develop your understanding of biodiversity.

Start with this video:

*Biodiversity Definition:* <https://www.fuseschool.org/communities/147/contents/1133> (Duration 4.12)

After watching the video, click on the word that is correct in each sentence:

1. The areas with the greatest biodiversity tend to be located close to the poles/equator.

2. Today, we are seeing a general decline/increase in biodiversity globally.

3. Invasive species positively/negatively affect the local biodiversity of an area.

4. Humans are seen as the most/least important factor causing loss of biodiversity today.

5. Areas that have suffered loss of biodiversity, generally can/cannot be rehabilitated allowing biodiversity to once again increase.

Move onto this video, and again pause to note down any ideas in your workbook to add to your understanding of biodiversity. *Why does biodiversity matter to me?* <https://www.fuseschool.org/communities/147/contents/1337> (Duration 4.51)

The title of this video was “Why does biodiversity matter to me?”

Answer that question now in your workbook, using your own words. (Don’t simply write down the words spoken in the video!)

The word ‘biodiversity’ means the number of different species in an area. There is an enormous variety of different species of organisms on Earth, or in the whole biosphere.

**Figure 10: Pie chart showing biodiversity** [Insert AWB Figure 10 Pie chart showing biodiversity]

It is estimated that there are probably over 5 million species of living organisms on Earth. However, at this point, only about 1.5 million have been identified and described. The *pie chart* in Figure 10 gives you an idea of the range of different species that have already been identified and described. You can see that by far, insects are the most *prolific* [plentiful, abundant] life forms on Earth, although some scientists have suggested that there might be more different types of bacteria than there are insects – we just haven’t discovered them yet!

[START TEXT BOX]

*What’s a pie chart?*

A pie graph is a circular graph that shows quantities as percentages of a whole. The complete circle represents the total or 100%. The circle is divided into sectors (like the pieces of a pie). Each sector (piece) of the circle represents a percentage of the total. It shows the relative portion of each of the parts. Later in Unit 1, you will focus on ways of displaying biodiversity. Remember that the pie chart is a good way of showing the proportions of different kinds of organisms.

[END TEXT BOX]

Sometimes when biologists refer to biodiversity, they mean the variety of species in the whole biosphere. However, they could limit their description by referring to the biodiversity of a particular biome or ecosystem.

When we talk about biodiversity, we do not mean the number of individual organisms in an area, but rather the number of different *species*.

**Figure 11: Biodiversity vs population density** [insert AWB Figure 11: Biodiversity vs population density]

In Figure 11, let’s imagine that each coloured block represents an organism. Organisms of the same colour belong to the same species. Which ecosystem has a greater biodiversity? Which has more individual organisms in it (population density).

Ecosystem 1 has more organisms in it. It has a greater population density. However, although the population density is lower in Ecosystem 2, Ecosystem 2 has a greater biodiversity than Ecosystem 1. This is because there are five different species in Ecosystem 2, while there are only 3 different species in Ecosystem 1.

Unit 1: The extent of biodiversity

Unit 1 learning outcomes

By the end of this unit, you should be able to:

1. Demonstrate awareness of the extent of biodiversity in South Africa.
2. Represent biodiversity of the most abundant groups of plants and animals in the form of graphs and charts.
3. Define a species using the biological species concept.

Unit 1.1: The biological species concept

In the overview to this sub-topic, you read the word *species* a number of times.

What precisely do we mean when we talk about a *species*? Write down what you currently understand the word ‘species’ to mean, in your workbook, under a heading: ‘The biological species concept’.

Watch the following two videos. When you come to a point in each video where the term ‘species’ is explained, make notes in your workbook. Correct or refine your original definition of the term.

*What is a species?* [www.fuseschool.org/communities/147/contents/1136](http://www.fuseschool.org/communities/147/contents/1136) (Duration 4.49)

*What is a species?* <https://www.youtube.com/watch?v=9fOfFlMe6ek> (Duration 6.52)

You will have realised from watching the videos, that this idea of a *species* is quite a complex one!

A species is a group of organisms that can interbreed with each other to produce fertile offspring that in turn can breed.

**Figure 12: Different breeds of dogs** [Insert AWB Figure 12: Different breeds of dogs; can be inserted fairly small next to the text]

(Source: By Mary Bloom, American Kennel Club <https://creativecommons.org/licenses/by-sa/4.0>)

Although members of a species tend to look similar, there can be great variation in physical appearance. Figure 12 show a variety of different dog breeds. However, even if the members of a species show physical variation, they can recognise each other as potential mates and produce fertile offspring. All dogs can interbreed; this means that in spite of the huge physical variation, they are all one species.

In the past, when scientists wanted to decide if two individuals belonged to the same species, they would look at the physical characteristics only. Nowadays, with advances in technology, scientists also look at the DNA of the organisms when considering if two individuals belong to the same species. (DNA is the material that makes genes. Genes control the characteristics we inherit. Members of a species share a pool of genes. In Topic 2: Genetics and heredity, you will learn about DNA in detail. In Topic 3: Evolution, you will learn more about the gene pool of a species.)

Go back to your notes, and make sure that you have an accurate understanding of the term ‘species’ recorded in your workbook. Much work that you will do later in this module depends on your understanding of this key concept.

[START TEXT BOX]

*What’s the main idea?*

Species are groups of organisms that share many characteristics and can reproduce successfully.

[END TEXT BOX]

Unit 1.2: Biodiversity in South Africa

How well do you know South African biodiversity?

Make a heading in your workbook ‘Biodiversity in South Africa’.

Make a table in your workbook that looks like this:

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Common name | I recognise this name | I have seen a picture of this organism | I have seen this organism in real life | Another name for this organism is… |
|  |  |  |  |  |

1. Write down all the names of the following organisms, in the first column (Common name), making 17 rows.

African elephant, cycad, shaggy ink cap, lappet faced vulture, Outeniqua yellowwood tree, king protea, white rhinoceros, vygie, blue wildebeest, puff adder, earthworm, great white shark, common octopus, citrus swallowtail, sea anemone and clown fish, tuberculosis bacterium.

These are all organisms that occur in South Africa.

1. Next to the names you wrote down, tick in the next column if you *recognise* the name of this organism.
2. Tick in the next column if you have *seen a picture* of this organism.
3. Tick in the next column if you have seen the organism in *real life*.
4. Are there any of the organisms that you call by a different name (e.g. in your main language)? Add the name you use for these organisms to the table in the last column. (You will come back to this idea of what we name organisms in Unit 2.)

Now have a look at pictures of these organisms.

**Figure 13: Biodiversity of South Africa** [Insert AWB Figure 13: Biodiversity of South Africa]

(Source: various creative commons photographs)

1. When you saw the pictures, did you recognise any of the organisms that you previously did not recognise by name? Revise the table by adding new ticks.

This video *South Africa – Kruger National Park:* <https://www.youtube.com/watch?v=mkMFHnQ6EBI> (Duration 45.16) is not a compulsory video to watch, as it is rather long. However, it gives you another perspective of the wide range of plants and animals in South Africa.

South Africa has greater biodiversity than most countries. As you have learnt, this is largely because there are different biomes with different climates across the country. There is a variety of land forms, such as mountains, high altitude plains, low altitude plains, swamps, lagoons, and coastal areas. South Africa covers about 1% of the total land surface of the world, but about 10% of the known bird, fish and plant species in the world can be found in South Africa.

Most reference books give data for southern Africa, which includes all countries south of the Zambezi and Cunene Rivers. Southern Africa includes South Africa, Namibia, Botswana, Zimbabwe and the southern part of Mozambique. This area has:

* 20 300 species of flowering plants
* 354 mammal species
* 951 bird species
* 517 reptile species.
* 115 amphibian species.
* Over 80 000 insect species

**Indigenous, endemic and exotic species**

In your workbook, write down what you understand by these three terms.

**Figure 14: Indigenous, exotic and endemic species** [Insert AWB Figure 14]

(Sources: elephant: <https://pixabay.com/en/elephant-africa-okavango-delta-55255/>, bugweed: Peter Greenwell https://creativecommons.org/licenses/by-sa/3.0; seahorse: Brian Gratwicke - https://commons.wikimedia.org/w/index.php?curid=26365501)

*Indigenous* species belong to a particular area. They have not been brought from anywhere else or introduced to the area. Many animals and plants that are indigenous to South Africa also occur in other parts of Africa. For example, elephants, lions and giraffe are indigenous to South Africa, but they also occur in other African countries. Bugweed is a plant that was introduced to South Africa from South America. It is *exotic* to South Africa. *Endemic* species belong to a particular area, but they do not occur anywhere else on earth. Each biome that you studied in Subtopic 1 has a number of endemic plant species. The Cape Seahorse shown in Figure 14 is endemic to the Knysna area. It is also at great risk of extinction, because it is only found in a few river mouth areas around Knysna.

Now go back to your workbook and correct and refine your original definitions of the terms indigenous, exotic and endemic.

[START TEXT BOX]

*What’s the main idea?*

Biodiversity is the number of different species in an area. Indigenous species belong to a particular area. Exotic species have been introduced from another area. Endemic species belong to a particular area and are not found anywhere else in the world.

[END TEXT BOX]

Unit 1.3: Displaying biodiversity

Go back to Figure 10 at the beginning of this Sub-topic. You saw that a pie chart could be used to show the relative proportions of the different groups of organisms on earth. There are many other ways of displaying biodiversity in tables and graphs.

Activity 1.1: Displaying biodiversity in tables and graphs

Suggested time:

30 minutes

Aim:

This activity provides you with practice interpreting tables and graphs, and drawing graphs representing biodiversity. In particular, you will be using *bar graphs* to illustrate data.

[START TEXT BOX]

*What’s a bar graph?*

(Bar graphs are discussed in the Student Manual. Look at the example in the Student Manual to help you understand this note.)

A bar graph uses bars of different lengths to compare different amounts. The numbers are shown on the Y-axis in sequence and the items being compared are written under each bar, along the X-axis.

Bar graphs are used when the information on the X-axis does not form a continuous series of data. The independent variables on the X-axis are not numbers and do not form a sequence; they are non-continuous, usually separate discrete or distinct things, such as colours, types of animals, cities etc. Because the items are discrete or non-continuous, spaces are left between the bars.

When constructing a bar graph, ensure the following:

* Spaces of equal intervals must occur between the bars.
* The bars must all be of equal width.
* Do not attach the first bar to the Y-axis.
* When asked to construct two bar graphs on the same system of axes, place the two bars next to each other, shade in one of the sets of data and include a key.

[END TEXT BOX]

What you will do:

You will need your workbook, pens, pencils and ruler. Work through the activity as directed.

Vertebrates are animals that have a backbone. There are four groups of vertebrates that live on land: Mammals, Birds, Reptiles and Amphibians. Southern Africa has a rich biodiversity of each group of Vertebrates.

**Table 2: Biodiversity of each group of terrestrial vertebrates in Southern Africa**

|  |  |
| --- | --- |
| Vertebrate group | Number of species |
| Reptiles | 517 |
| Birds | 951 |
| Amphibians | 115 |
| Mammals | 354 |

The same information can be shown on a bar graph.

**Figure 15: Bar graph showing biodiversity of terrestrial vertebrates in Southern Africa** [insert AWB Figure 15]

1. Study the graph and answer the questions that follow:
   1. Which group of vertebrates has the greatest biodiversity? How did you know this?
   2. Which group of vertebrates has the least biodiversity? How did you know this?
   3. Which is the dependent variable and where is this data shown?
   4. Why has a bar chart been used to display this data? Explain your answer using features of the graph to justify your comments.
2. The table below shows the diversity of four groups of plants that are common in South Africa.

|  |  |
| --- | --- |
| Plant group | Number of species |
| Aloe | 150 |
| Acacia | 56 |
| Protea | 29 |
| Fig | 34 |

**Table 3: Biodiversity of four plant groups common in South Africa**

Draw a bar graph illustrating this information. (Hint: always use at least half a page for graphs and diagrams.)

Discussion of the activity

When you are asked to *interpret* information from a graph, you must read and analyse the information from the graph. Use the graph to back up or justify comments you make.

When you draw a graph, you need to ensure that certain criteria are met: the graph must have a heading, the axes must be correctly allocated (independent variable on the x-axis and dependent variable on the y-axis), the axes must be appropriately scaled and the data must be correctly plotted in the body of the graph.

Exemplar answer

1.

1. Birds have the greatest biodiversity. The bar for birds reaches the highest on the graph, representing the greatest number of species.
2. Amphibians have the lowest biodiversity. The bar representing amphibians is the smallest, indicating the lowest number of species.
3. The dependent variable is the number of species, shown on the y-axis.
4. A bar chart has been used because the information on the x-axis does not form a continuous series of data. The independent variable is groups of vertebrates and therefore is non-numerical. The data is represented by vertical bars that do not touch each other.

2. [insert AWB Figure 16: Bar graph showing biodiversity of four plant groups in South Africa Ensure that the following criteria are present in your graph:

Title

X and y-axes correctly allocated and labeled

Axes are scaled appropriately

Bars correctly plotted

Spaces between bars

[START TEXT BOX]

*What’s the main idea?*

Biodiversity of an area can be represented in tables and graphs for easy understanding and interpretation.

[END TEXT BOX]

Moving on

Now that you have investigated the extent of biodiversity, you are going to focus on how biodiversity is classified.

Topic 1: Biodiversity

Sub-topic 2: Principles of classification

Unit 2: Taxonomic levels

You have been focusing on biodiversity to this point. You will now turn your attention to the *classification of biodiversity*.

Unit 2 learning outcomes

By the end of this unit, you should be able to:

1. Apply the nested hierarchical classification system to classify species according to genus, family, order, class, phylum (animals) or division (plants), kingdom.
2. Correctly use the binomial system of naming species.

Unit 2.1: What is classification?

Write a heading in your workbook: ‘What is classification?’ Turn to the next page.

Write the question ‘What is taxonomy?’ Turn to the next page.

Write the question ‘Why do we need a way of classifying living things on earth?’ Turn to the next page.

Write the question ‘How are living things classified?’

You now have four blank pages, each headed with a different question.

Now, answer each question to the best of your ability, with the knowledge you currently have.

Once you have completed that task, you are going to watch some videos that introduce the concept of classification. As you watch the videos, pause frequently to add to and refine your answers to the four questions posed above.

*The taxonomy of candy!* <https://www.youtube.com/watch?v=t3amU3RrX9g> (Duration 6.31)

*Taxonomy: Life’s Filing System* <https://www.youtube.com/watch?v=F38BmgPcZ_I> (Duration 12.15)

*Classification of living things*: <https://www.youtube.com/watch?v=R61GoO8j048>

(Duration: 12.56)

Now read through the notes that follow. If you come across something that will add to the notes you have already made in your workbook, use the new ideas to supplement (add to) what you have already recorded. Also, correct any mistakes you may have made.

*Classification*is sorting objects into groups according to their similarities or features that they share. Classification is a way of organising things. When you classify things, you put them into groups or ‘classes’ because they have certain characteristics in common. Classifying things is something we do all the time without thinking because it helps us to see patterns and to keep things organised. People classify things to make it easier to understand and find them.

You use classification everyday at home! Classifying and grouping things in the kitchen makes it easier for you to find them again.

**Figure 17: Classification in the kitchen** [Insert AWB Figure 17]

If you wash and dry the dishes after a meal, you will probably put the cutlery (knives, forks, spoons) in one place, the plates in another and the cups and saucers somewhere else. This means that you will find them easily next time you need these items. It also makes your kitchen more organised. Even a visitor in your home would be able to find the cups and plates and cutlery.

Imagine walking into a supermarket to do some shopping and all the goods were displayed randomly on the shelves! Shop owners display their goods in groups of similar items, in order to make shopping far easier. All the fresh vegetables are in one area, all the baked goods in another area, all tinned foods in another area etc.

Classifying simplifies a situation. You find things more easily if they are organised.

When early scientists began to observe the large numbers of organisms on earth, they placed them into groups that shared key similarities. Classification allows us to create order out of the large number of living organisms on the Earth.

[START TEXT BOX]

*What’s the main idea?*

Classifying means grouping objects that share certain similarities. Classification allows us to create order out of large numbers of objects.

[END TEXT BOX]

Unit 2.2: Classifying living organisms

When you watched the videos earlier, you were introduced to ways in which scientists classify living things. You are now going to focus more closely on this idea.

Scientists use a classification scheme called a *nested hierarchy*. Think of a nested hierarchy as being like a box within a bigger box, within an even bigger box up to the largest box of all. Each box contains more and more organisms up to the biggest box of all, which is all living things on earth.

**Figure 18: Russian nesting dolls called matrioshkas** [insert AWB Figure 18]

Figure 18 shows the concept of a nested hierarchy, using traditional Russian dolls that fit into each other.

* The smallest unit of a nested hierarchy is a *species*. All members of a species share many characteristics. They can breed together.
* Two or more species share a number of characteristics. They are placed in the same *Genus*. Different species of the same genus cannot breed together.
* Two or more Genera (plural of genus) share some characteristics. They are placed in the same *Family*.
* Two or more Families share some characteristics. They are placed in the same *Order*.
* Two or more Orders share a few characteristics. They are placed in the same *Class*.
* Two or more Classes share a few key characteristics. They are placed in the same *Phylum*. Plants have *Divisions* instead of *Phyla*(plural of Phylum).
* Two or more phyla share some key characteristics. They are placed in the same *Kingdom*.

**Figure 19: Classification of four species of Hyaena using the main classification groups** [Insert AWB Figure 19. If possible, insert on a page of its own in landscape mode. If this is not possible, please make as large as possible of the portrait page.]

We can illustrate the nested hierarchy as a tree diagram. Figure 19 shows a classification tree for animals. We can use the classification tree to give the full classification for the Spotted hyaena. Follow the steps in Figure 19. Start at the bottom of the tree to get the correct idea.

* The spotted hyaena, *Crocuta* *crocuta,* is a species that belongs to the genus *Crocuta.*
* The genera *Crocuta, Proteles* and *Hyaena* belong to the Family Hyaenidae.
* The families Hyaenidae, Viverridae, Felidae, Canidae and other families belong to the Order Carnivora.
* The orders Carnivora, Insectivora, Cetacea, Chiroptera and other orders belong to the Class Mammalia.
* Classes Mammalia, Pisces, Amphibia, Reptilia and Aves belong to the Phylum Chordata.
* Phylum Chordata, Arthropoda, Mollusca, Annelida and other phyla belong to the Kingdom Animalia.

The names of the levels of classification are written in Latin. This is done so that everyone in the world will use the same names. The scientific way of writing the full classification of a species is from the largest category to the smallest. The scientific classification of a spotted hyaena is therefore:

Kingdom: Animalia

Phylum: Chordata

Class: Mammalia

Order: Carnivora

Family: Hyaenidae

Genus: *Crocuta*

Species: *Crocuta* *crocuta*

Before you continue with the next activity, watch the following videos which will reinforce what you have been learning about classifying organisms.

*How are organisms classified?* <https://www.fuseschool.org/communities/147/contents/1127> (Duration: 3.10)

*Classification*: <https://www.youtube.com/watch?v=DVouQRAKxYo> (Duration: 7.41)

*Classification of living things*: <https://www.youtube.com/watch?v=vqxomJIBGcY> (Duration: 3.59)

[START TEXT BOX]

*What’s the main idea?*

The classification scheme for living organisms is a nested hierarchy. It has seven main levels: Kingdom, Phylum, Class, Order, Family, Genus and Species.

[END TEXT BOX]

Activity 2.1: Interpreting the classification of hyaenas

Suggested time:

15 minutes

Aim:

You will need your workbook and pen, pencil and a ruler.

What you will do:

Refer to Figure 19 and answer the following questions:

1. To which genus do the brown hyaena and the striped hyaena belong?
2. To which family do the genera *Hyaena, Crocuta* and *Proteles* belong?
3. Name three families that belong in the order Carnivora.
4. To which class does the order Carnivora belong?
5. How many classes in the phylum Chordata? What are the names of these classes?
6. To which kingdom does the phylum Chordata belong?
7. If you were thinking about the idea of nested boxes ranging from larger boxes that held smaller boxes, which group would be the largest group (or box) in this classification system and which is the smallest group (or box)?
8. Which organism is more closely related to the brown hyaena, the striped hyaena or the spotted hyaena? Give a reason for your decision.

Discussion of the activity

Please do not worry about learning the Latin names for hyaenas and other organisms! The names are given as an example. In a test or exam, you will be provided with this information. You need to be able to *apply* the underlying concepts of how we classify organisms.

Exemplar answer

1. *Hyaena*
2. Hyaenidae
3. Viverridae, Felidae and Canidae well as the family Hyaenidae
4. Mammalia
5. There are five classes: Mammalia, Pisces. Reptilia, Amphibia, Aves
6. Animalia
7. Kingdom is the largest group (box) and species is the smallest group (box).
8. The striped hyaena is more closely related to the brown hyaena than the spotted hyaena. The brown and striped hyaena are placed in the same genus. The spotted hyaena is in a different genus.

Unit 2.3: The binomial naming system

In Activity 2.1, did you notice that each of the hyaena species has two names? The first name is the name of the genus, and the second name is the name of the species. The full scientific name of each hyaena is:

* Aardwolf: *Proteles cristatus*
* Brown hyaena: *Hyaena brunnea*
* Striped hyaena: *Hyaena hyaena*
* Spotted hyaena*: Crocuta crocuta*

Why do we have this system of naming organisms?

**Figure 20: Secretary bird** [insert AWB Figure 20]

(Source: <https://pixabay.com/en/secretary-bird-raptor-predator-1630314/>

<https://pixabay.com/en/egypt-serpentaire-sagittariidae-1545672/>)

This is a bird found in South Africa as well as in other African countries.

If you are English speaking, you will say that this is a Secretary Bird. If you speak Afrikaans, you will call it the Sekretarisvoël. isiXhosa speakers will call it Ingxangxosi. iNtungunono is its isiZulu name. In Tswana it is called Tlhamê. In Southern Sotho, it would be called Koto-li-peli, but in Northern Sotho it is Thlame. And those are just some of the names South Africans have for this animal! There are other African names for this bird, as well as French, Italian, German and even Japanese names for it. Which name should we use?

Its English common name is thought to come from the crest of long quill-like feathers, which give the bird the appearance of a secretary with pens tucked behind his or her ear. Another hypothesis is that "secretary" is a mispronunciation of the Arabic saqr-et-tair or "hunter-bird."

Scientists from all over the world do research on this bird and need to name it in such a way that they cannot mistake or misidentify the Secretary Bird as any other bird. To avoid confusion, scientists use a biological name for each species that has been identified and described. The scientific or biological name for the Secretary Bird is *Sagittarius serpentarius.*

Why does the scientific name for this bird look so strange? Why is it so hard to pronounce? The two words come from Latin, an ancient language that was spoken centuries ago in Europe and was used by scientists, doctors and other academic people as a common language for communication between people of different nationalities and home languages. Today we still use the Latin (and sometimes Greek) names as scientific names. Even new species that are discovered are given Latin or Greek names. (Greek was also a language of learning and academia many hundreds of years ago.)

The first name, which is the genus name, is ‘*Sagittarius*’. This is Latin for ‘archer’, perhaps comparing the Secretary Bird's quill feathers on its head to a quiver of arrows. The second name, the species name, ‘*serpentarius’* is Latin for serpent or snake; this describes the bird's skill as a hunter of snakes.

When these names are used to identify the Secretary Bird, scientists from all over the world, irrespective of their home language, will know precisely which bird is being referred to.

This system of biological naming is called *binomial nomenclature*.

‘Nomenclature’ means naming system and ‘binomial’ means two names.

Why do scientists use two names when identifying an organism? Who invented this system?

Watch these videos to see if you can answer the above questions in your workbook.

*What is taxonomy?* <https://www.youtube.com/watch?v=aiC_Z8Za7wc> (Duration 2.13)

*An introduction to taxonomy*: <https://www.youtube.com/watch?v=NRVJyUZoQow> (Duration: 5.47)

A Swedish scientist, Carolus Linnaeus (1707–1778), invented the binomial system. He did this because at that time, organisms’ names were long and clumsy descriptions. They were also in different languages. The same organism was called by many different names and it was very confusing for scientists. Linnaeus wanted to standardise and simplify the naming systems.

Linnaeus gave every type of organism one species name, and one group name called the genus (plural genera). A genus is a group of very similar species, given the same generic name. A genus never has two species with the same species name. Every binomial is unique. Linnaeus published books on plants and on animals in the mid 18th century, using his system of naming. He said that once a name is given it must not be changed. These books were the beginning of a worldwide system of naming species. Linnaeus was so convinced that his naming system was a good idea that he even changed his own name! His birth name was Carl von Linné which he Latinised to Carolus Linnaeus. Would you go that far for your science?

Did you notice, when you read about the hyaena and the secretary bird, that the genus name and the species name were both written in italics? If you write the names by hand, you *must* underline the names.

There are two rules for writing the scientific name of a species:

1. The genus name must begin with a capital letter. The species name must begin with a lower case letter.
2. The name must be written in italics or it must be underlined.

Go back to your notes in your workbook and make sure you have not broken this biological rule!

Quick progress check

Have you understood what you have learnt? Can you apply the binomial rules?

Draw up a copy of the following table in your workbook.

Correct the scientific names of each species that are written incorrectly.

|  |  |
| --- | --- |
| Common name | Scientific name |
| Giraffe | *Giraffa Camelopardis* |
| African elephant | Loxodonta africana |
| Southern African Python | *Python* natalensis |
| Natal cycad | *encephalartos Natalensis* |
| Ostrich | *Struthio camelus* |
| Human | Homo Sapiens |

Discussion of the progress check

Check your work to see if you understand how to name organisms.

|  |  |
| --- | --- |
| Common name | Scientific name |
| Giraffe | *Giraffa camelopardis* |
| African elephant | Loxodonta africana |
| Southern African Python | *Python natalensis* |
| Natal cycad | *Encephalartos natalensis* |
| Ostrich | *Struthio camelus* |
| Human | *Homo sapiens* |

[START TEXT BOX]

*What’s the main idea?*

Each species has two names: first the name of the genus, and second, the name of the species. This is called the binomial naming system.

[END TEXT BOX]

Moving on

You have looked at why classification systems are needed and how they work. In the next unit, you will study how scientists have organised all living things into five major kingdoms.

Topic 1: Biodiversity

Sub-topic 2: Principles of classification

Unit 3: Characteristics of the five kingdoms

You have learnt how and why scientists classify biodiversity. In this unit you will learn more about the five kingdom classification system.

Unit 3 learning outcomes

By the end of this unit, you should be able to:

1. Distinguish among the five kingdoms according to shared characteristics of organisms within each kingdom:

* Monera: prokaryotic, unicellular, autotrophic, heterotrophic or saprotrophic;
* Protista: eukaryotic, unicellular or simple multicellular, autotrophic or heterotrophic;
* Fungi: eukaryotic, having chitin in the cell walls, unicellular or simple multicellular, saprotrophic;
* Plantae: eukaryotic, having cellulose in the cell walls, multicellular, most having differentiated tissues, autotrophic;
* Animalia: eukaryotic, with no cell walls, multicellular, most having differentiated tissues, heterotrophic.

Unit 3.1: Classification systems

Originally, biologists, including Linnaeus, said that there were two kingdoms of living organisms: the Plant Kingdom and the Animal Kingdom.

Over time, as biologists learned more about other organisms, they added kingdoms in recognition of basic differences they discovered among organisms. For example, during Linnaeus’s time, the microscope had not been invented so Linnaeus did not know about the existence of many different kinds of *micro-organisms* [very tiny organisms that either cannot be seen with the naked eye or cannot easily be seen with the naked eye]. Once micro-organisms were discovered, a new classification system with three kingdoms for plants, animals and micro-organisms had to be developed.

In the early 1970s, Robert Whittaker proposed that there are actually five Kingdoms. The five-kingdom system is based on

* the structure of the cells,
* the way of feeding,
* whether the organisms consist of one cell or many cells, and
* where they live (in water or on land).

Based on his observations, Whittaker identified five kingdoms:

* Monera (bacteria)
* Protista
* Fungi
* Plantae
* Animalia

**Figure 21: The five kingdom classification system** [insert AWB Figure 21]

**Figure 22: Examples of organisms in the five kingdoms** [ insert AWB Figure 22]

[START TEXT BOX]

Note on the terms *prokaryote* and *eukaryote*:

(pronounced *pro-carry-ot* and *you-carry-ot*)

You are a eukaryote! This means that in your cells, the DNA which makes your *linear* [strands with two ends] chromosomes, is enclosed in a membrane inside the cell organelle called a nucleus. You have other organelles in your cells, such as mitochondria that make energy available to the cell, that are also surrounded by a membrane. Organelles perform different functions for the cell. A prokaryote, on the other hand, does not have membranes inside the cell. The DNA floats loosely in the cytoplasm, and there are no membrane-bound organelles. Both cell types have ribosomes, although prokaryote ribosomes are smaller than eukaryote ones. You will learn in Topic 2 that ribosomes are important organelles that help the cell make proteins. Prokaryote cells tend to be smaller than eukaryote cells too.

[END TEXT BOX]

As new information was discovered about cells, scientists found new ways to investigate the similarities between organisms, for example by identifying and comparing the chemicals such as DNA and RNA, the carbohydrates that make up cell walls and the enzymes involved in metabolic activities such as the making of proteins in cells. During the late 1970s an American microbiologist, Carl Woese, discovered some micro-organisms that live in exceptionally hot habitats such as hot springs and volcanic vents. At first these micro-organisms were identified as bacteria. Woese soon discovered that the chemistry of these micro-organisms is very different to the chemicals and functioning of bacteria. He put these micro-organisms into a different group called the Archaebacteriameaning ‘very ancient bacteria’**.** Other types of Archaebacteria have also been found in salty habitats such as salt marshes and salt lakes, as well as in the oceans. It was difficult to know where to put these micro-organisms in the five kingdom classification, as they were prokaryotic, but very different to bacteria.

In 1990 Woese suggested a new way to classify living organisms by grouping the kingdoms into three groups called *domains*. Each domain contains several different kingdoms. In this new classification system, animals, plants, fungi and protists are kingdoms in the Eukaryota domain because they all have cells with a nucleus. The Bacteria and Archaea are Prokaryota. However, they differ greatly in their chemistry and so are placed in two different domains.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| All living organisms | | | | | |
| Domain Bacteria | Domain Archaea | Domain Eukarya | | | |
| Many kingdoms | Many kingdoms | Kingdom Protista | Kingdom Fungi | Kingdom Plantae | Kingdom Animalia |
| Prokaryotes | | Eukaryotes | | | |

**Table 4: The three domain classification system**

Quick progress check

Have you understood what you have learnt?

Answer the following questions:

1. Into which Domain and Kingdom would you place the group of heterotrophic multicellular organisms whose cells have nuclei but no cell walls?
2. Into which Domain and Kingdom would you place the group of autotrophic multicellular organisms whose cells have nuclei and cell walls?
3. Into which Domain and Kingdom would you place the heterotrophic organisms whose cells have nuclei and cell walls?
4. Who was the inventor of the system of binomial nomenclature?.
5. Which is a fairly recently discovered domain of prokaryotes that has organisms in it more ancient than bacteria?
6. What do we call a group of similar species?
7. What is the smallest unit of classification?
8. In the Five Kingdom system, into which Kingdom are all prokaryotes placed?
9. In both the Domain system of classification and the Five Kingdom system of classification, how many kingdoms of eukaryotes are there? Name them.
10. You discover an organism with the following characteristics: it lives in freshwater where it swims around rapidly; it is unicellular with a proper nucleus; it eats algae. Into which Domain and Kingdom would you place it?

Before you check the answers to these questions, watch the two videos on classification. Then go through the questions again, to make sure you have answered correctly.

*Kingdoms: The Classification System:*  <https://www.fuseschool.org/communities/147/contents/1344> (Duration: 4.00)

*Five kingdom classification:* <https://www.youtube.com/watch?v=MBJp3CCqrxg> (Duration: 8.17)

You can also follow these links to read more about classification systems and the five kingdom system and see excellent photographs of the different organisms in each kingdom:

*Classification Schemes:* <https://www.siyavula.com/read/science/grade-10-lifesciences/biodiversity-and-classification/09-biodiversity-and-classification-03>

*Five Kingdom System:* <https://www.siyavula.com/read/science/grade-10-lifesciences/biodiversity-and-classification/09-biodiversity-and-classification-04>

Discussion of the progress check

Check your answers to see if you understand how the classification systems work.

1. Domain: Eukarya; Kingdom: Animalia
2. Domain: Eukarya; Kingdom: Plantae
3. Domain: Eukarya; Kingdom: Fungi
4. Carolus Linnaeus
5. Domain: Archaea
6. Genus
7. Species
8. Monera
9. Four: Protista, Fungi, Plantae and Animalia
10. Domain: Eukarya; Kingdom: Protista

[START TEXT BOX]

*What’s the main idea?*

In the Five Kingdom classification system, prokaryotes such as bacteria fall into the Kingdom Monera. The other eukaryotic kingdoms are: Protista, Fungi, Plantae and Animalia.

[END TEXT BOX]

The story of how classification systems have changed over time helps us to understand that scientific ideas change over time. As new information becomes available, scientists often have to modify what they had originally proposed or suggested. This shows that science is *tentative* – it changes over time with new knowledge. Sometimes the new ideas are very different to the old ideas and we have to discard our old ideas. Other times, the new ideas can be incorporated into our existing knowledge. (You learnt about the tentative nature of scientific knowledge in the Nature of Science Module. You can refer back to that module if you need to revise this issue.)

Unit 3.2: Distinguishing characteristics of the five kingdoms.

In this section, you will review some of the *distinguishing characteristics* of organisms belonging to the five kingdoms.

Write a heading in your workbook: ‘Distinguishing characteristics of the five kingdoms’.

Under the heading, explain what you think is meant by the heading.

Earlier in this unit, you learnt that when you classify things, you put them into groups or classes because they have certain *characteristics in common*. These characteristics are distinctive features or properties. They are qualities that make something unique. In biology, we call these properties *distinguishing characteristics*. They are qualities that help us place organisms in different groups and also tell the groups apart from each other.

In Unit 3.1, you learnt about two types of organisms, based on their cell structure: prokaryotes and eukaryotes. In order to make sure you understand what distinguishing characteristics are (and remind you about prokaryotes and eukaryotes!), you will do this short activity in your workbook.

Activity 3.2: Prokaryotic vs eukaryotic cells

Suggested time:

20 minutes

Aim:

This activity will help you to consolidate what you understand about prokaryotes and eukaryotes as well as what distinguishing characteristics are.

What you will do:

You will need your workbook and pen, pencil and a ruler.

Watch these videos:

*Prokaryotic vs Eukaryotic cells:* <https://www.fuseschool.org/communities/147/contents/1525> (Duration: 3.15)

*Prokaryotic vs eukaryotic cells:* <https://www.youtube.com/watch?v=Pxujitlv8wc&list=PLwL0Myd7Dk1F0iQPGrjehze3eDpco1eVz&index=9&t=0s> (Duration: 5.27)

Look at the two diagrams in Figure 23.

Copy the table below Figure 23 into your workbook.

Based on the structure of the cell in each diagram, decide which of the distinguishing characteristics apply to each picture. Complete the table.

**Figure 23: Prokaryotic and eukaryotic cells** [insert AWB Figure 23]

(Source: adapted from <https://en.wikipedia.org/wiki/Cell_(biology)#/media/File:Celltypes.svg>)

|  |  |
| --- | --- |
| Feature | Prokaryote or eukaryote or both? |
| membrane-enclosed organelles such as mitochondria |  |
| ribosomes |  |
| cytoplasm |  |
| circular strand of DNA as a chromosome |  |
| linear chromosomes of DNA |  |
| chromosomes enclosed in a nuclear membrane to form a nucleus |  |
| cell wall may be present |  |
| cell membrane is present |  |
| the smaller of the two cell types |  |

**Table 5: Comparing eukaryote and prokaryote cells**

Now use the table to write down the distinguishing characteristics of prokaryote cells and eukaryote cells.

Discussion of the activity

You were able to write up your lists of distinguishing characteristics once you completed a comparison table.

Exemplar answer

|  |  |
| --- | --- |
| Feature | Prokaryote or eukaryote or both? |
| membrane-enclosed organelles such as mitochondria | eukaryote |
| ribosomes | both |
| cytoplasm | both |
| circular strand of DNA as a chromosome | prokaryote |
| linear chromosomes of DNA | eukaryote |
| chromosomes enclosed in a nuclear membrane to form a nucleus | eukaryote |
| cell walls may be present | both |
| cell membrane is present | both |
| the smaller of the two cell types | prokaryote |

**Table 5: Comparing eukaryote and prokaryote cells**

Distinguishing characteristics of prokaryote cells:

* no membrane-enclosed organelles
* no nucleus
* circular strand of DNA as a chromosome
* smaller than eukaryote cells

Distinguishing characteristics of eukaryote cells:

* membrane-enclosed organelles
* nuclear membrane around a nucleus
* linear chromosomes
* larger than prokaryote cells

Notice that you did not include the features that the two cell types have in common. They both have cell membranes, ribosomes and cytoplasm. Therefore, these characteristics cannot be used to tell the two cell types apart. They are not distinguishing characteristics.

Ready to move on? Refine or correct your definition of distinguishing characteristics in your workbook, and then continue!

Activity 3.2: Comparing the distinguishing characteristics of the five kingdoms

Suggested time:

45 minutes

Aim:

This activity will help you to consolidate all the distinguishing characteristics of the five kingdoms into a comparison table.

What you will do:

You will need your workbook and pen, pencil and a ruler. (You may find it easier to create your table in landscape (i.e. turn your page sideways), or to work on double sheets of A4 paper which you can later attach into your workbook.)

You are going to read through the notes on the distinguishing characteristics of the five kingdoms of organisms. You will also watch some videos.

In your workbook, you will summarise what you are learning into a large comparison table. (If you need to be reminded of how to produce a comparison table, check back to Sub-topic 1, Unit 2, Activity 2.4, where you compiled a comparison table as a consolidation of what you were learning.)

Here is an idea for the headings of your table, although you may wish to add in columns of your own:

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Table comparing the distinguishing characteristics of the five kingdoms** | | | | | | |
| Kingdom | Prokaryote or eukaryote | Unicellular or multicellular | Form of nutrition | Examples | Any other interesting fact/s |
|  |  |  |  |  |  |

**Table 6: Comparison of the distinguishing characteristics of the five kingdoms**

Don’t simply copy all the given notes into your table. You must summarise the information effectively.

3.2.1 Kingdom Monera

The kingdom Monera consists of *unicellular* [single-celled] microscopic organisms. They can only be seen with a microscope. The most common organisms in this kingdom are the *bacteria (singular bacterium)*. They have simple cells, with no membrane-enclosed organelles. They have one chromosome that is a ring of DNA, called a *nucleoid*. There is no membrane around the chromosome. The cells are *prokaryotic*.

Many bacteria have a slime capsule around the outside of a cell wall. Inside the cell wall is the plasma membrane. The plasma membrane is often folded into membrane structures called *mesosomes*. Some mesosomes carry pigments and can photosynthesise, while others are able to convert glucose into ATP. Other mesosomes are able to fix nitrogen.

Some bacteria are able to move. Some of the *motile* forms have a few *flagella* (singular = flagellum) which are long whip-like structures that revolve rapidly to drive the bacteria forward. Other motile bacteria have many smaller hair-like structures called *fimbriae* (singular = fimbria) which help them move. Sometimes, bacterial cells form long chains, but each cell can survive on its own.

**Figure 24: A generalised bacterium** [insert AWB Figure 24]

(Source: adapted from <https://en.wikipedia.org/wiki/File:Prokaryote_cell_diagram.svg>)

Bacteria obtain their nutrition in many different ways.

* Some Monera contain membranes that carry out photosynthesis. They are *autotrophic*.
* Some Monera feed by secreting enzymes into the food and absorbing the digested material. They are *saprotrophic*.
* Some Monera are *parasites* living on or in other organisms. They are *heterotrophic* because they do not make their own food, but rely on other organisms for their nutrition.

Watch the following videos on bacteria and the Kingdom Monera to learn more:

*Structure of bacteria*: <https://www.fuseschool.org/communities/147/contents/1336> (Duration: 2.57)

*Bacteria: The Good, The Bad, The Kinda Gross*: <https://www.youtube.com/watch?v=kxM_9DL2GYw&list=PLwL0Myd7Dk1F0iQPGrjehze3eDpco1eVz&index=48&t=0s> (Duration 4.39)

Add what you have learnt about the Kingdom Monera to your comparison table now.

3.2.2 Kingdom Protista

Watch these videos before you start to read the notes:

*Introduction to the Protists:* <https://www.youtube.com/watch?v=0-6dzU4gOJo> (Duration: 3.11)

*Protists:* <https://www.youtube.com/watch?v=-zsdYOgTbOk> (Duration 4.11)

See what you can already write into your summary table.

Now read the notes and complete the table for Protista.

The kingdom Protista consists of microscopic unicellular organisms, however, there are also some large very simple *multicellular* algae (seaweeds). Larger protista have a simple structure with no specialised *tissues* [a group of cells that perform a particular function, e.g. muscle tissue]. All their cells are very similar.

**Figure 25: Examples of Protista** [insert AWB Figure 25]

(Sources: adapted from: <https://commons.wikimedia.org/wiki/File:Ciliate_collage.jpg>; <https://en.wikipedia.org/wiki/Protozoa#/media/File:Protozoa_collage_2.jpg>; https://en.wikipedia.org/wiki/Protist#/media/File:Protist\_collage\_2.jpg)

Watch this video to help you understand the difference between unicellular and multicellular organisms: *Unicellular vs multicellular*: <https://www.fuseschool.org/communities/147/contents/2013> (Duration: 3.17)

The Protist cell has a *nuclear membrane* around its chromosomes, and it has membrane-bound organelles such as mitochondria. Protist cells are therefore *eukaryotic*.

The Protista are divided into two groups:

* Plant-like protists are single-celled organisms that contain chlorophyll and have a cell wall. They obtain their energy by photosynthesis. They live mainly in water and often make stagnant or slow moving water go green in colour. Seaweeds and freshwater algae such as *Chlamydomonas* are members of this group.
* Animal-like protists are single-celled organisms with no chlorophyll and no cell wall. They feed by *ingesting* [consuming] other organisms or absorbing organic substances through the cell membrane. They live mainly in water or as parasites in other organisms. They may cause diseases if they are parasitic. Malaria and bilharzia are caused by protist parasites. *Amoeba* and *Paramoecium* are members of this group.

Protists have a variety of ways of obtaining nutrition:

* Some species are autotrophs, e.g. algae (freshwater algae and seaweeds).
* Some species are heterotrophs, e.g. protozoa such as *Amoeba*.
* Some species are saprotrophs (e.g. slime moulds).
* Some species are parasites that can cause serious diseases in animals including humans.

3.2.3 Kingdom Fungi

Fungiare multicellular organisms that have *chitin* [a kind of carbohydrate that strengthens the cell walls, also found in crab shells for example] in their cell walls. Their cells are eukaryotic. Some fungi are single-celled organisms (e.g. yeast), while others are multicellular (e.g. mushrooms). The body of a fungus is made of microscopic threads called *hyphae*. The hyphae (singular: hypha) mass together into a *mycelium* (plural: mycelia).

Fungi live on land or in water. Fungi cannot photosynthesise. They are heterotrophic. Fungi store their excess food in oil droplets and as a carbohydrate called *glycogen*. Animals store their food in cells in the same way.

Most species are saprotrophs, which play an important role in decomposing dead organisms. Some species are parasites that feed on living organisms. Athlete’s foot and ringworm are examples of parasitic fungi that affect humans.

**Figure 26: Examples of fungi** [insert AWB Figure 26]

(Source: https://commons.wikimedia.org/wiki/File:Fungi\_collage.jpg)

Watch this video to learn more about Fungi. Add what you learn to your comparison table.

*What are fungi?* <https://www.youtube.com/watch?v=70LA0mijzCM> (Duration: 2.28)

3.2.4 Kingdom Plantae

Plants are multicellular organisms. The cells are organised into tissues such as support tissue, conducting tissue and storage tissue. The cells are eukaryotic and have a cell wall composed of cellulose.

**Figure 27: Examples of plants** [insert AWB Figure 27]

(Source: https://en.wikipedia.org/wiki/Plant#/media/File:Diversity\_of\_plants\_image\_version\_5.png)

Plants live on land. Many simpler plants, such as mosses and even ferns, are reliant on water for reproduction. Other plants, such as seed bearing gymnosperms (cone bearing plants such as pine trees) and angiosperms (flowering plants), are not reliant on water for reproduction. Simpler plants also have less developed water transport and support tissue, so they tend to be smaller. Plants with well developed transport and support tissue can grow to extremely tall heights.

All species of the Kingdom Plantaeare autotrophic and make their food by photosynthesis. They store their food as starch. Plants cannot move from one place to another.

Watch the following videos and then complete your comparison table:

*Plant classification:* <https://www.fuseschool.org/communities/147/contents/1644> (Duration: 3.13)

*Plant structure and adaptations:* <https://www.youtube.com/watch?v=DGpPHrLF-5M&list=PLwL0Myd7Dk1F0iQPGrjehze3eDpco1eVz&index=49&t=0s> (Duration: 8.40)

3.2.5 Kingdom Animalia

Try and complete this row in your comparison table *before* you watch the video or read the notes!

Now watch these videos:

*Kingdom Animalia*: <https://www.youtube.com/watch?v=ROgsunixPF0> (Duration: 2.16)

*Animal Classification:* <https://www.fuseschool.org/communities/147/contents/1341> (Duration: 3.58)

Animals are multicellular organisms. They have eukaryotic cells with no cell wall. The cells are organised into different tissues, such as muscles, skin, and nerves. There is a wide variety of body plans within the Kingdom Animalia.

All animals are heterotrophic. Some are saprotrophic and some are parasitic. They are all dependent on other organisms for their nutrition.

Some animal species live on land, while others live in water. With the exception of sponges, animals can move from one place to another.

**Figure 28: Examples of animals** [insert AWB Figure 28]

(Source: https://en.wikipedia.org/wiki/File:Animal\_diversity.png)

Complete your comparison table now.

Discussion of the activity

You may have decided to add extra columns to your comparison table such as: component of cell walls, motility (whether or not the organism can move around) etc.

You should now have a comprehensive comparison table, which will be useful when you revise this work.

Exemplar answer

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Table comparing the distinguishing characteristics of the five kingdoms** | | | | | | |
| Kingdom | Prokaryote or eukaryote | Unicellular or multicellular | Form of nutrition | Examples | Any other interesting fact/s |
| Monera | prokaryote | unicellular | autotrophic, saprotrophic or heterotrophic | bacteria | some can move using flagella or fimbriae; often have a slime capsule around the cell wall |
| Protista | eukaryote | unicellular; some simple multicellular forms but no organisation into tissues | autotrophic, saprotrophic, heterotrophic, some are parasites | algae, seaweeds, *Amoeba, Paramoecium* | many can move, parasitic forms can cause disease, some have cell walls, others only cell membranes |
| Fungi | eukaryotic | unicellular and multicellular forms; hyphae form mycelia | heterotrophic, saprotrophic or parasitic, food stored as oil droplets and glycogen | mushrooms, yeasts, rusts | cannot move, cell walls with chitin |
| Plantae | eukaryotic | multicellular, various tissues exist which are less developed in simpler plants and well developed in other plants | autotrophic, food stored as starch | mosses, ferns, pine trees, daisies | cannot move, cell walls have cellulose |
| Animalia | eukaryotic | multicellular, various tissues and a variety of body plans | heterotrophic, some are saprotrophic and some are parasitic | sponges, jellyfish, snails, insects, earthworms, fish, amphibians, reptiles, birds and mammals | two main groups exist: invertebrates and vertebrates; no cell walls |

**Table 6: Comparison of the distinguishing characteristics of the five kingdoms**

[START TEXT BOX]

*What’s the main idea?*

All living organisms can be classified into one of five Kingdoms: Monera, Protista, Fungi, Plantae or Animalia.

[END TEXT BOX]

Activity 3.3: Practical activities

Suggested time:

30 minutes to write up the activity; do the activity over a few days

Aim:

These are two simple practical activities that will give you an opportunity to observe Protista and Fungi.

What you will do:

Activity 3.3.1: Observing and investigating the behaviour of Protista

You will need:

* a small empty glass jar (an old clean peanut butter or mayonnaise bottle for example)
* some pond, river or dam water
* black paper
* scissors
* sticky tape

Cut a piece of black paper so that it covers the outside of the jar. Now cut some holes in the paper.

**Figure 29: Preparing the jar for the activity** [insert AWB Figure 29, can be fairly small in line with text]

Fill the jar with pond water, seal it and attach the black paper with the holes in it to the outside of the jar with sticky tape. Put the jar on a windowsill in full sunlight.

After a few hours of sunlight, remove the jar from the windowsill and remove the black paper.

1. What do you observe?
2. What is the aim or hypothesis of this investigation?
3. What variable were you testing?
4. What other variables can you identify? How did you control them? Were they well controlled? Reasons.
5. Identify any limitations associated with this investigation.
6. Give reasons for what you observed.
7. What do your results tell you about the motility of protistans? Explain your answer.

Activity 3.3.2: Cultivating Fungi

You will need:

* 1 thick slice of bread
* 1 slice of cheese
* 1 soft fruit (e.g. plum, peach)
* 3 clear plastic bags (sandwich / freezer bags)
* masking tape and marking pen
* If you have a magnifying glass, or can borrow one, this will allow you to see the fungi more clearly.

Slightly dampen the bread, cheese and fruit by sprinkling them with a bit of water. Do not make them very wet. Leave the food out on a table overnight. The next morning, put each piece of food in its own plastic bag. Loosely fold the top of the bag over.

Observe your samples every day over the next few days and record what you see. You may use diagrams as well as words to describe your observations.

Communicate your observations. You may do this in any meaningful way. You may decide to use tables, diagrams, a daily diary with written notes, etc. Make sure your report is easy to read, neat and accurate.

Discussion of the activity

It is very exciting to observe organisms that you may never have considered important previously. Write up your observations and practical reports neatly.

Exemplar answers

3.3.1

1. You should observe patches of green where the holes were – indicating the presence of photosynthetic protista.
2. To demonstrate that photosynthetic protista can move to areas of light/Show the presence of green organisms in pond water/Light has an effect on the behaviour of protista etc. Any reasonable ideas.
3. This will depend on the hypothesis that you state and what the focus is of the investigation, in your opinion. Light is a variable.
4. Heat, for example is another variable. It is very difficult to control this variable as the windowsill is likely to be warm-hot. Use of a fan to keep the heat down could be one way you control the variable.
5. Does not demonstrate the behaviour of non-photosynthetic or heterotrophic protistans; it focuses only on the autotrophic algae.
6. The protista moved to the areas where the holes were in the black paper i.e. to areas where sunlight was allowed through to shine into the water. The protista moved to the patches of sunlight so they could photosynthesise.
7. Protista are able to move in the water. This is shown by the fact that there were no patches of green initially and after the exposure of limited areas of sunlight, the protista moved to these patches of sunlight.

3.3.2

Did you

* make diagrams of what you saw?
* measure the size of the mycelial growth?
* describe the way the fungi spread?
* describe colour changes?
* compare the growth of the fungi on the different foods?

Do you think you grew more than one type of fungus? Reasons?

Summary assessment

1. Refer to Figure 19 when you answer this question. The first one has been done for you.
   1. The striped hyaena, the hedgehog and the tortoise belong to the same ………….

Answer: Phylum

* 1. The brown hyaena and the striped hyaena belong to the same ………….
  2. The aardwolf, the cat and the whale belong to the same ……………
  3. The spotted hyaena and the aardwolf belong to the same ………….
  4. The frog, the aardwolf, the bat and the butterfly belong to the same …………
  5. The brown hyaena and the jackal belong to the same …………….. (5)

1. Choose the correct answer for each of the following questions.

2.1 What does “classification” mean to biologists?

1. Naming organisms.
2. Sorting organisms into groups that share certain similarities.
3. Identifying organisms.
4. Describing organisms.

2.2 The scientist who introduced the five-kingdom classification system was ..

1. Charles Darwin
2. Carolus Linnaeus
3. Carl Woese
4. Robert Whitaker

2.3 The correct order of taxonomic categories from largest to smallest is …..

1. Species, genus, family, order, class, phylum, kingdom
2. Genus, species, kingdom, class, order, family, phylum
3. Phylum, order, class, kingdom, genus, family, species
4. Kingdom, phylum, class, order, family,  genus, species

2.4 The correct way of writing the scientific name for a spotted hyaena is …

1. *Crocuta crocuta*
2. *Crocuta Crocuta*
3. Crocuta crocuta
4. *Crocuta* crocuta

2.5 *Encephalartos natalensis* and *Encephalartos princeps* are two types of cycads. The two

cycads belong to the same:

1. Species
2. Ecosystem
3. Genus
4. Biome (10)

3. Explain the difference between each pair of terms.

3.1 Indigenous and endemic

3.2 Prokaryote and eukaryote

3.3 Extinct and Threatened

3.4 Monera and Protista (8)

4. Each description in the table below fits one or more of the Kingdoms. Choose the

Kingdom/s that match each description.

|  |
| --- |
| **Descriptions** |
| 4.1 Includes autotrophic organisms. |
| 4.2 Organisms that have eukaryotic cells. |
| 4.3 Photosynthetic organisms that live on land. |
| 4.4 Unicellular organisms that have no nuclear membrane. |
| 4.5 Eukaryotic organisms that have no tissues. |
| 4.6 Prokaryotic one-celled organisms. |
| 4.7 Bodies are made up of hyphae. |
| 4.8. Multicellular organisms that can move around. |
| 4.9. Includes saprotrophic organisms. |

(15)

5. Re-draw the following mindmap and insert the kingdoms into the gaps.

**Figure 30: Characteristics of the five kingdoms [**insert AWB Figure 30]

6. Study Figure 31 and answer the questions that follow.

**Figure 31: Classification of dogs and cats [**insert AWB Figure 31]

6.1 If you were thinking about the idea of nested boxes ranging from larger boxes that held smaller boxes, which group would be the largest group (or box) in this classification system and which is the smallest group (or box)?

6.2 There is a group larger than the one you have indicated in 6.1, that is not shown in this diagram. What is the name of this general group? If you included this larger group in this classification scheme, what would the name of this group be, given the organisms being classified?

6.3 Which group in the classification system is just smaller than an Order?

6.4 How many other species of organisms are shown to be very closely related to a lion?

6.5 Which organism is more closely related to a domestic dog: a wolf or an African Wild Dog? Give a reason for your answer.

6.6 Are jackals more closely related to African Wild dogs or to Wild cats? Give a reason.

(7)

7. Originally, Fungi were classified in the Plant Kingdom. Evaluate the decision to move them into their own kingdom by justifying why they are not plants. (6)

[60]

Exemplar answer

1.

* 1. Answer is given
  2. Genus
  3. Class
  4. Family
  5. Kingdom

1.6 Order (5)

2.

* 1. B
  2. D
  3. D
  4. A

2.5 C (10)

3.

3.1 Indigenous means belonging to a particular geographic area. Endemic means occurring in a particular geographic area and nowhere else on earth.

3.2 Prokaryote means a cell that has no nuclear membrane, and no membrane-bound

organelles.

Eukaryote means a cell that has a nuclear membrane and membrane-bound organelles.

3.3 Extinct means there are no more of that species left in an area or in the world. Threatened

means there are a few individuals, but the species may become extinct if not protected.

3.4 Monera are prokaryotic, unicellular organisms. Protista are eukaryotic, unicellular or simple

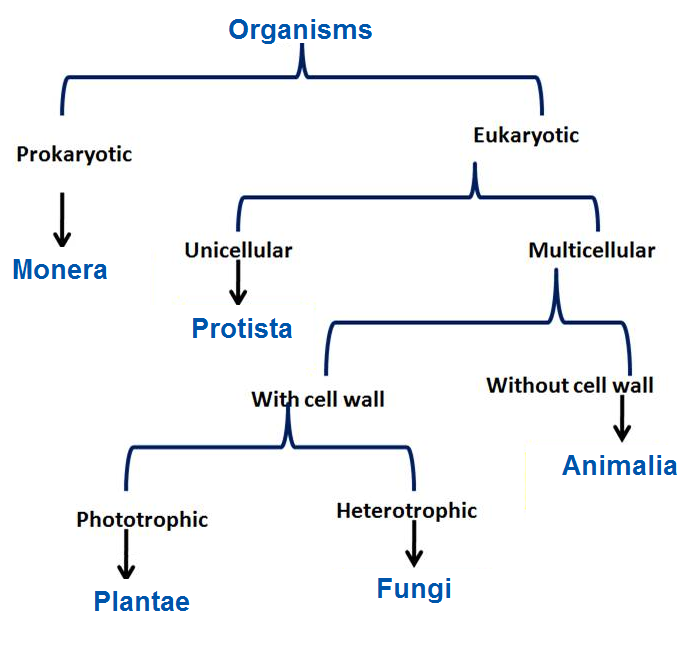
multicellular organisms. (8)

4.

|  |
| --- |
| **Descriptions** |
| 4.1 Monera, Protista, Plantae (3) |
| 4.2 Protista, Fungi, Plantae, Animalia (4) |
| 4.3 Plantae (1) |
| 4.4 Monera (1) |
| 4.5 Protista (1) |
| 4.6 Monera (1) |
| 4.7 Fungi (1) |
| 4.8. Animalia (1) |
| 4.9. Monera, Fungi (2) |

(15)

5.

 (5)

6.

6.1 phylum = largest; species = smallest (2)

6.2 Kingdom: Animalia (2)

6.3 Family (1)

6.4 3 (1)

6.5 Wolf; domestic dogs and African Wild dogs belong to different genera, however, wolves and dogs belong to the same genus, Canis. (2)

6.6 Jackals more closely related to Wild dogs than Wild cats. This is because although jackals and wild dogs belong to separate genera, they belong to the same family (Canidae) and wild cats belong to the family Felidae. (3) (11)

7. Fungi are not plants, because:

* they are heterotrophic and cannot make their own food;
* they do not possess the same type of tissues that plants have;
* their cell walls are made from chitin and not cellulose;
* they do not store food as starch but as oil droplets and glycogen.

However, they are also not animals, because:

* they are usually attached to a substrate and are not motile;
* they do not possess the same kinds of tissues that animals have;
* they have cell walls around their cells.

For these reasons, Fungi are placed in their own kingdom. (6)

[60]

Key learning points

The Sub-topic Principles of classification focussed on the following key points:

* Species are groups of organisms that share many characteristics and can reproduce successfully.
* Biodiversity is the number of different species in an area.
  + Indigenous species belong to a particular area.
  + Exotic species have been introduced from another area.
  + Endemic species belong to a particular area and are not found anywhere else in the world.
* Biodiversity of an area can be represented in tables and graphs for easy understanding and interpretation.
* Classifying means grouping objects that share certain similarities. Classification allows us to create order out of large numbers of objects.
* The classification scheme for living organisms is a nested hierarchy. It has seven main levels: Kingdom, Phylum, Class, Order, Family, Genus and Species.
* Each species has two names: first the name of the genus, and second, the name of the species. This is called the binomial naming system.
* In the Five Kingdom classification system, prokaryotes such as bacteria fall into the Kingdom Monera. The other eukaryotic kingdoms are: Protista, Fungi, Plantae and Animalia.
* Monera are prokaryotic, unicellular organisms that are autotrophic, heterotrophic or saprotrophic organisms.
* Protista are eukaryotic, unicellular or simple multicellular organisms that are autotrophic or heterotrophic.
* Fungi are eukaryotic organisms that have chitin in their cell walls. They are unicellular or simple multicellular, saprotrophic organisms.
* Plantae are eukaryotic organisms that have cellulose in their cell walls. They are multicellular, and most plants have tissues. They are autotrophic.
* Animalia are eukaryotic organisms with no cell walls. They are multicellular, and most animals have tissues. They are heterotrophic.

Moving on

We tend to be more aware of members of the Plantae and Animalia kingdoms, as these organisms are relatively large and we come into contact with them often. However, micro-organisms are extremely interesting! If you enjoyed learning about Protista, you may enjoy watching this video. It shows a hunting battle between two heterotrophic, unicellular protistans, *Amoeba* (the blob-like organism) and *Stentor* (the tube-shaped organism with the cilia at one end)*.* Imagine this battle going on in a pond or river near you! Before the video starts, guess which organism will win the battle? Who will become lunch? Or does ‘lunch’ manage to escape leaving only part of itself behind?

*Amoeba meets Stentor:* <https://www.youtube.com/watch?v=FcCvhYmjaXE> (Duration: 6.30)

You have completed the Sub-topic: Principles of classification. In the next Sub-topic, the focus is on the history of life on Earth.

Topic 1: Biodiversity

Sub-topic 3: The history of life

Overview

So far in this Topic, we have focussed on biodiversity at the level of the diversity of biomes in South Africa, and the diversity of species living on Earth at present. Diversity has another dimension: time.

The diversity of living organisms we see around us at present is about 10% of the biodiversity that has existed in the past.

This Sub-topic focuses on the organisms that have existed on earth for at least 3 500 million years as well as the main events in the history of the Earth.

Unit 1: Earth has an extremely long history

Unit 1 learning outcomes

By the end of this unit, you should be able to:

1. Construct a timeline showing key events in the history of life on earth.

We know that different species of organisms existed in the past, because their remains are preserved as fossils.

*Fossils* are the preserved remains of once-living organisms, or preserved traces left behind by living organisms. Examples of fossils are fossilised bones, wood, footprints, tree resin and even faeces. Fossils tell us about the kinds of life that existed in the past.

**Figure 32: Fossils are evidence of organisms that lived millions of years ago** [insert AWB Figure 32]

(Source: Adapted from: <https://pixabay.com/en/shell-fossil-old-ancient-stone-219665/>; <https://pixabay.com/en/fish-reprint-fossils-historically-1093863/>; <https://pixabay.com/en/fossil-pine-cone-rock-geology-265082/>; <https://pixabay.com/en/fossils-bone-lizard-fossil-255547/>)

How old is life on Earth?

Scientists have found ways of measuring the age of fossils. We know that the Earth formed about 4,6 billion years ago. The oldest fossils of living things are at least 3,5 billion years old. They are bacterial cells. Scientists have discovered some even older fossils that suggest that life may have evolved even earlier.

For the next 2 billion years, bacteria were the only life forms on Earth. Eukaryotic cells evolved about 1,4 billion years ago. At first, life existed only in the oceans. From about 540 million years ago, diversity expanded. The first fish evolved about 460 million years ago. The first land plants evolved about 420 million years ago.

Table 7 shows some significant events in the history of life on Earth. It shows the approximate dates that various groups of organisms evolved.

|  |  |
| --- | --- |
| Some important events and when they occurred in the history of life | |
| Event | Time in millions of years ago (mya) |
| First bacteria | 3 500 mya |
| First eukaryotes | 2 100 mya |
| First fish | 460 mya |
| First land plants | 420 mya |
| First amphibians | 370 mya |
| First reptiles | 340 mya |
| First mammals | 230 mya |
| First birds | 195 mya |
| First flowering plants | 141 mya |
| First pre-humans | 5 mya |

**Table 7: Some important events in the history of life**

[START TEXT BOX]

*What’s with millions and billions?*

How many millions are equal to 1 billion?

A million is equal to a thousand thousands (1,000 x 1,000 = 1 000 000).

A billion is equal to a thousand millions (1,000 x 1,000,000 – 1 000 000 000).

So looking at the numbers in Table 7, the first bacteria occurred 3 500 million years ago, which is the same as saying 3.5 billion years.

[END TEXT BOX]

Let’s try and get a better idea of how much time is represented by a million years, to get a better understanding of the time frames in Table 7.

You can hold your breath for 10 seconds, can’t you? Easy!

Could you hold your breath for 100 seconds? How long is 100 seconds? 1.7 minutes! Maybe you *can* hold your breath that long.

How about 1 000 seconds…could you hold your breath for a 1 000 seconds? That’s 16.7 minutes! You definitely can’t hold your breath that long!

What about 1 000 000 seconds? How long is 1 million seconds? Can you believe – it’s 11.5 days!

If you wanted to count to 1 million, 1 second per number, for 24 hours a day, it would take you about 12 days.

There are 32 million seconds in a year and 5 days!

So how many days is one billion seconds? (That’s 1 000 000 000 seconds.) It’s 31.7 years.

Starting to get an idea of how big a million and a billion are?

What about this…

If you had one million millilitres of water – would you drink it? bath in it? swim in it? And what about a billion millilitres?

Well, 1 ml of water is about two drops of water. 5ml of water is a teaspoonful.

What if you had a 1 000 ml of water? That’s pretty easy; it’s one litre of water.

What about 10 000 ml of water? Easy…10 litres. That would be about a basin of water to wash dishes.

What about 100 000 ml of water? That’s 100 litres. An average bath holds about 180 litres at overflow level, so you would probably bath in about 100 litres comfortably (not if you were saving water though!).

So 1 000 000 ml of water? That’s 1 000 litres. We’re looking at the size of a small swimming pool of water.

And 1 billion millilitres? That’s a million litres. An Olympic sized swimming pool holds 2.5 million litres. That’s a lot of drops!

Here’s another idea.

The average workbook or exam pad page has 32 lines.

Draw 125 dots on each line! (You can actually do this if you like!)

Your 1 page will then have 4 000 dots on it.

How many pages will have 10 000 dots? Don’t draw them all, but you’re looking at 2.5 pages.

How many pages will have 100 000 dots? That’s 25 pages, right?

And a million dots? 250 pages! Your average exam pad has 100 pages, so we’re talking about 2 and a half exam pads for 1 million dots.

What about 1 billion dots? 250 000 pages! That’s 2500 exam pads!

A million and a billion are very large numbers! Scientists who work with geological time and fossils, work in millions and billions of years.

Activity 1.1: Constructing a timeline to represent the main events in the history of life on Earth

Suggested time:

45 minutes

Aim:

By constructing this timeline, drawn to scale, you will gain a better understanding of the time frames between the major events in life’s history.

[START TEXT BOX]

*What’s a timeline?*

A timeline is a graphical or diagrammatic representation of a period of time, on which important events are marked in chronological order. That means that the events are arranged along a line in the time order that they happened. It is important that time is marked on the line. The units of time will vary depending on what you are illustrating. Time could be shown in hours (as in a diary), days (as in a calendar) or years. It is important to show the units of time along the timeline to scale, so that an accurate idea of lengths of time can be seen on the timeline. You can also add pictures to a timeline. You can search on the internet for examples of timelines to get an idea of what they look like and how they are used.

[END TEXT BOX]

What you will do:

You will need your workbook, pens, pencils and ruler.

Watch the following videos that give you some idea of the history of life on Earth.

As you watch the videos, make notes on ideas for constructing a timeline.

*The evolution of life on Earth:* <https://www.youtube.com/watch?v=H2_6cqa2cP4> (Duration: 2.19)

*History of the Earth in 5.5 minutes:* <https://www.youtube.com/watch?v=8qnnoePeHlk> (Duration: 5.50)

*The History of Life on Earth:* <https://www.youtube.com/watch?v=sjE-Pkjp3u4&feature=share&list=PL8dPuuaLjXtNdTKZkV_GiIYXpV9w4WxbX> (Duration: 13.36)

These websites are also useful:

*Important events in the history of life:* <https://evolution.berkeley.edu/evolibrary/article/evo_13>

*Comparing the history of life to a clock:* [*https://www.biologycorner.com/worksheets/comparing\_life\_history.html*](https://www.biologycorner.com/worksheets/comparing_life_history.html)

Discussion of the activity

If you are still unsure about how to go about constructing the timeline, here is an idea:

Single ply toilet paper comes in rolls that are divided into sections called sheets. Each roll has 500 sheets of toilet paper. If you make one sheet = 5 million years, one toilet roll will give you 2 500 million years of history. Since most of the history of life took place in the last 500 million years, you can unroll 100 sheets, and leave the rest of the paper rolled up. You can attach the toilet paper to a long wall (or one wall in a room, and make the timeline go around the room) with sticky tape or Prestik. You will need some large sticky labels as well.

1. The first sheet is the last 5 million years of the history of life. Attach a label to the sheet: “5mya: first pre-humans”.
2. Count in 5s from the first sheet until you reach 140-145 mya. This sheet is the time at which the first flowering plants evolved. Label the sheet: “141 mya: first flowering plants”.
3. Count in 5s from the 140 mya to the 195 mya mark. The first birds evolved about 195 mya. Label that sheet: “195 mya: first birds”.
4. Keep working in this way until you have labelled all the events shown in Table 7, except the first eukaryotes and the first prokaryotes. Stick a label on a toothpick near the beginning of the toilet paper to mark the first eukaryotes. The first prokaryotes would be a long distance before this mark and we don’t show them on this scale.
5. You can add pictures that you print from the internet to your timeline to add interest.

Exemplar answer

Take photographs of your completed timeline.

Use this rubric to check your timeline.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Rubric to assess timeline | | | | | |
| Criterion | Missing : 0 marks | Poor: 1 mark | Fair: 2 marks | Good: 3 marks | Excellent: 4 marks |
| All the events in Table 7 have been recorded on the timeline. |  |  |  |  |  |
| Chronological order is correct. |  |  |  |  |  |
| The timeline is correctly scaled. |  |  |  |  |  |
| The timeline is well constructed and easy to read. |  |  |  |  |  |
| Attention to presentation: illustrations, spelling etc. |  |  |  |  |  |

[20]

If you enjoyed the videos and have some time, this is a worthwhile and interesting, although much longer video to watch: *The Story of Earth and Life:* <https://www.youtube.com/watch?v=57merteLsBc> (Duration 1.30.00)

[START TEXT BOX]

*What’s the main idea?*

Living organisms have existed on earth for 3 500 million years.

[END TEXT BOX]

Key learning points

The Sub-topic The history of life focussed on the following key point:

* Living organisms have existed on earth for 3 500 million years.

Moving on

This is the last Sub-topic in the Topic Biodiversity. You will now move onto the next Topic: Genetics and Heredity.