RQF LEVEL 4

TORFF402

TOURISM

Interpreting Flora and Fauna

TRAINEE'S MANUAL

August 2024

INTERPRETING FLORA AND FAUNA

2024

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KIGALI-RWANDA

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LIST OF ABBREVIATIONS AND ACRONYMS

CBET: Competence Base Education and Training

PPE: Personal Protective Equipment

RQF: Rwanda Qualification Framework

RS: Rwandan Standard

RSB: Rwanda Standards Board

RTB: Rwanda TVET Board

TVET: Technical and Vocational Education and Training

INTRODUCTION

This trainee's manual encompasses all necessary skills, knowledge and attitudes required to Interpret Flora and Fauna. Students undertaking this module shall be exposed to practical activities that will develop and nurture their competences. The writing process of this training manual embraced competency-based education and training (CBET) philosophy by providing practical opportunities reflecting real life situations.

The trainee's manual is subdivided into units, each unit has various topics, and you will start with a self-assessment exercise to help you rate yourself on the level of skills, knowledge and attitudes about the unit.

A discovery activity is followed to help you discover what you already know about the unit.

After these activities, you will learn more about the topics by doing different activities by reading the required knowledge, techniques, steps, procedures and other requirements under the key facts section, you may also get assistance from the trainer. The activities in this training manual are prepared such that they give opportunities to students to work individually and in groups.

After going through all activities, you shall undertake progressive assessments known as formative and finally conclude with your self-reflection to identify your strengths, weaknesses and areas for improvement.

Do not forget to read the point to remember the section which provides the overall key points and takeaways of the unit.

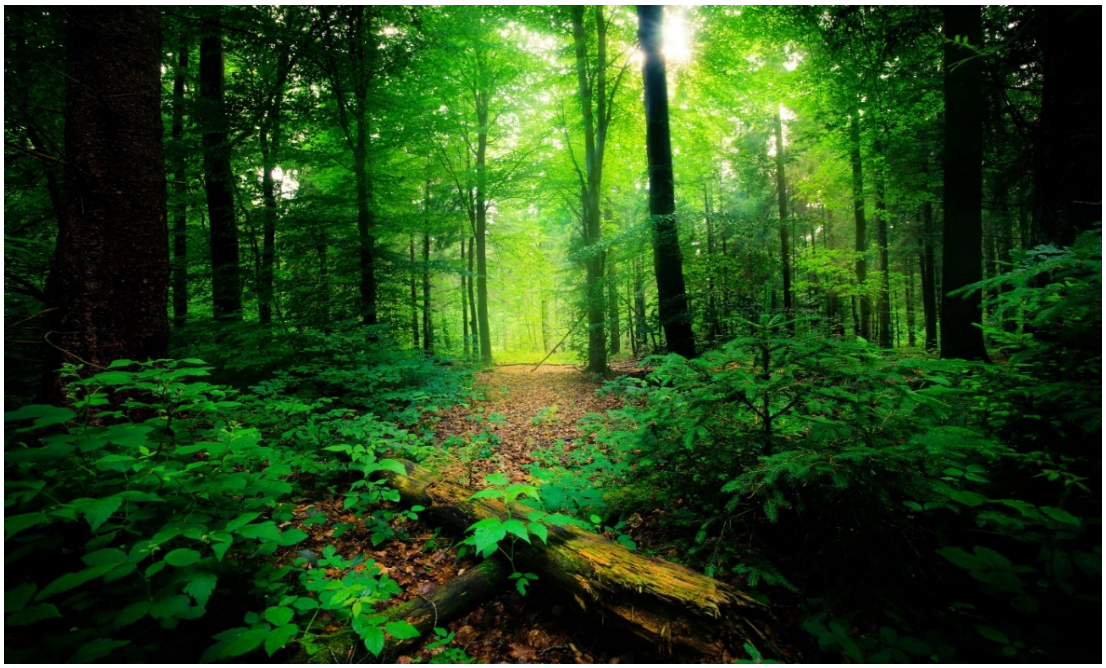
Module Units:

Unit 1: Describe the principles of flora classification

Unit 2: Describe the principles of fauna classification

Unit 3: Describe biodiversity of Rwanda

UNIT 1: DESCRIBE THE PRINCIPLES OF FLORA CLASSIFICATION



Unit summary

This unit provides you with the knowledge, skills and attitudes required to describe the principles of flora classification required to interpret flora and Fauna. It covers the flora categories as per taxonomy, flora families based on spermatophytes classification as well as plants species of touristic sites according to the vegetation stratification.

Self-Assessment: Unit 1

1. Referring to the unit illustrations above discuss the following:
   a. What does the illustrations show
   b. What topics do you think will covered under this unit based on the illustrations
2. Fill in and complete the self-assessment table below to assess your level of knowledge, skills and attitudes under this unit.
   a. There is no right or wrong w ay to answer this assessment. It is for your own reference and self-reflection on the knowledge, skills and attitudes acquisition during the learning process.
   b. Think about yourself: do you think you have the knowledge, skills or attitudes to do the task? How well?
   c. Read the statements across the top. Put a check in a column that best represents your level of knowledge, skills and attitudes.
   d. At the end of this unit, you will assess yourself again.

My experience Knowledge, skills and attitudes	I do not have any experience doing this.	I know a little about this.	I have some experience doing this.	I have a lot of experience with this.	I am confident in my ability to do this.
Describe principles of flora classification					
Explain key terms used in flora classification					
Describe binomial nomenclature of flora					
Explain rules of binomial nomenclature of flora					

My experience Knowledge, skills and attitudes	I do not have any experience doing this.	I know a little about this.	I have some experience doing this.	I have a lot of experience with this.	I am confident in my ability to do this.
Describe the characteristics of kingdom plantae					
Describe divisions of kingdom Plantae					
Describe sub-divisions of spermatophytes					
Describe classes of gymnosperms					
Describe classes of angiosperms					
Identify different types of vegetation					
Demonstrate knowledge of the specific flora in the target area					
Comply with environmental regulations regarding biodiversity					
promote sustainable and environmentally friendly practices towards biodiversity					

Key Competencies:

Knowledge	Skills	Attitudes
1. Explain key terms used in flora classification	1. Describe principles of flora classification	1. Demonstrate knowledge of the specific flora in the target area
2. Identify different types of vegetation	2. Describe the characteristics of kingdom plantae	2. Comply with environmental regulations regarding biodiversity
3. Explain rules of binomial nomenclature of flora	3. Describe binomial nomenclature of flora	3. promote sustainable and environmentally friendly practices towards biodiversity
	4. Describe divisions of kingdom Plantae	
	5. Describe sub-divisions of spermatophytes	
	6. Describe classes of gymnosperms	
	7. Describe autotrophic nutrition, transport in plants and modes of reproduction	

Discovery activity

Task 1

1. **Analyze the pictures below and answer questions related:**

   a. What you see on the pictures above?
   b. What is the difference?
   c. What do you understand by the natural habitats?
   d. Define the word flora.
   e. How main families of flora exist? Mention them.
   f. What is the relationship of Illustration pictures above to Tourism?

2 **Read and answer the questions below:**

a. What do you understand by principles of flora classification
b. Describe binomial nomenclature of flora
c. Describe the characteristics of kingdom plantae
d. Describe divisions of kingdom Plantae, sub-divisions of spermatophytes,

Topic 1.1: Describing flora classification

Activity 1: Problem Solving

Task 2

1. Define the key terms below:
    a. Flora
    b. Classification principles of flora
    c. Kingdom
    d. Phylum
    e. Order
    f. Family
    g. Genus and specie
2. Describe different types of plant family
3. Describe the rules of binomial system and trivial naming
4. Explain the process of plant classification
5. Describe autotrophic nutrition, transport in plants and modes of reproduction

Key Facts 1.1 a: Description of flora classification

- **Introduction to interpretation**

  In the context of tourism, **interpretation** plays a crucial role in enhancing visitors' experiences

  ✓ **Definition and Purpose**:

  Interpretation in tourism refers to a form of communication between those managing a destination or attraction and the tourists visiting it.

  Its purpose is to present and explain various aspects of a destination, such as cultural heritage sites, museums, national parks, and wildlife areas[1].

  Interpretation includes activities like guided tours, educational presentations, guidebooks, brochures, exhibits, and educational signage.

- ✓ **Key Principles**:

  Freeman Tilden, often considered the "father of interpretation," outlined principles that still guide its practice today.

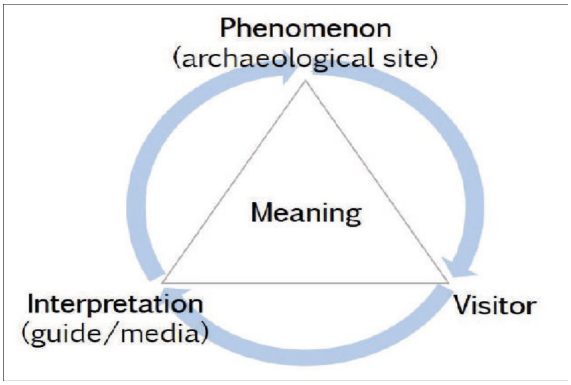
  Interpretation should relate aspects of the place being presented to something personally relevant to tourists.

  It goes beyond factual information, aiming to deepen tourists' understanding and provoke thought.

  Interpretation presents destinations as whole systems, not just isolated elements of interest.

- ✓ **Importance**:
  - Successful interpretation helps tourists connect with the authentic qualities of historic locations.
  - It conveys natural and cultural values, enriching the travel experience and fostering respect for resources.

- ✓ **Interpretational triangle**



- ✓ **Source: adapted from Ludwig (2015).**

  In the context of **National Park Service (NPS)** interpretation, the "interpretational triangle" is a teaching technique that combines with stimulating explanatory content[1]. It involves helping audiences discover the meanings and significance associated with park resources, emphasizing the value of preserving those resources

  The interpretational triangle involves three key components:

- ✓ **Resource Meaning**: The core content related to park resources.
- ✓ **Audience Interest**: Understanding the audience's perspective and interests.

- ✓ **Interpretive Techniques**: Effective methods for conveying information.

  The goal is to facilitate connections between resource meanings and audience interest, ultimately supporting the preservation mission.

- ✓ **Interpretive techniques**
  - Over the Phone Interpretation: Also known as telephonic interpretation, it is adopted when the in-person isn't available for face-to-face.
  - Simultaneous Interpreting: Also known as Conference Interpreting, it is done for the people in the event who have limited English proficiency and need conference interpreters.
  - Video Interpretation
  - Liaison Interpretation
  - Medical Interpretation

  Interpretive techniques are used by writers, speakers, and communicators to create interpretive opportunities.

Key Facts 1.1b: Description of flora classification

- **Key terminologies**
  - ✓ **Flora**

    Refers to all of the plant life within a specified region, time period, or both. "Flora" contains all plant life, including trees, shrubs, grasses, and flowers.

    Scientists have sorted and classified living organisms based on their similarities and differences. This system of classification is called taxonomy.

  - ✓ **Plant taxonomy**

    Plant taxonomy is the science of discovering, identifying, describing, classifying, and naming plants. It is the science of naming, characterizing, and categorizing plants based on their properties, relationships, and evolutionary history. It is one of the major divisions of taxonomy (the study of discovering, describing, classifying, and naming living things). The study of plants is an important branch of botany.

The purpose is to classify the great diversity of plant species into a hierarchical system that reflects their evolutionary links and assists researchers, botanists, horticulturists, and conservationists in better understanding and communicating about plant life.

There are several plants on this planet, each with its own unique morphological and anatomical characteristics and reproduction process. All plants in the Kingdom Plantae are classified according to their traits. Kingdom Plantae is a large category of plants that is subdivided into subcategories. It is critical to have a working knowledge of plants, their functions, and properties.

- **Flora classification principles**

  All plants are classified into a single Kingdom Plantae, which is further subdivided into subgroups. Plants are classified according to a few simple criteria. These include the following:

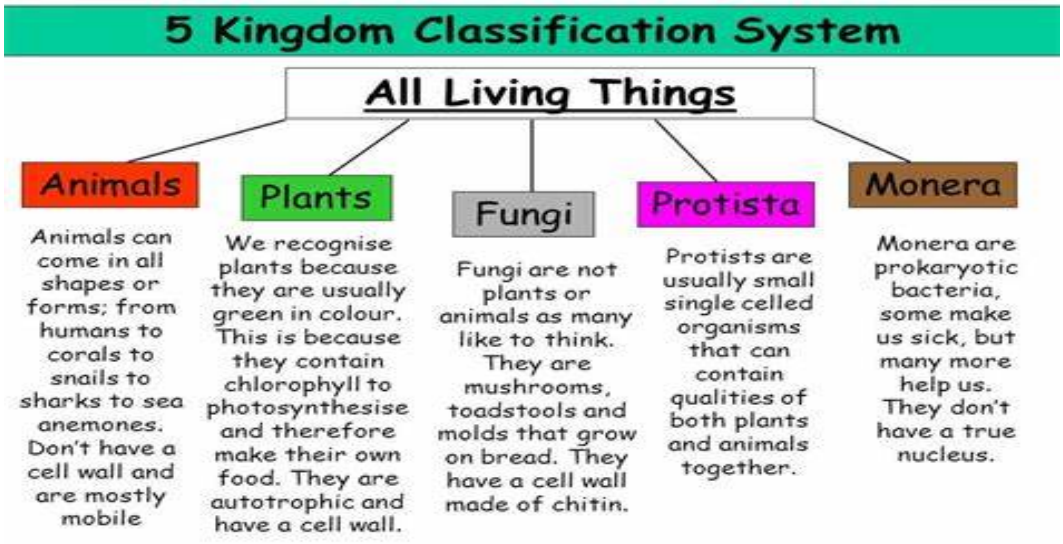
  - ✓ **Plant Body:** The presence or lack of a distinct root, stem, and leaves.
  - ✓ **Vascular System**: The presence or absence of vascular tissues such as xylem and phloem for the transportation of water and other substances.
  - ✓ **Seed Development:** Whether flowers and seeds are present or not. The seeds are either exposed or enclosed within the fruit.

  Each group of plants has distinct and distinctive characteristics that are specific to that group. While thallophytes are the most- green plants, angiosperms have a more complicated assembly and a well-developed vascular and reproductive systems.

- **Plant Classification**

  - ✓ **Kingdom**: (over 275,000 species[1]) kingdom plantae is broken down into smaller divisions based on several characteristics: i) whether they can circulate fluids (like rainwater) through their bodies and need to absorb them from moisture that surrounds them, ii) how they reproduce (by spores or seeds) and lastly iii) their size.

[1] https://www.slideshare.net/slideshow/m11-plant-taxonomy-onlinepdf/255076823#2

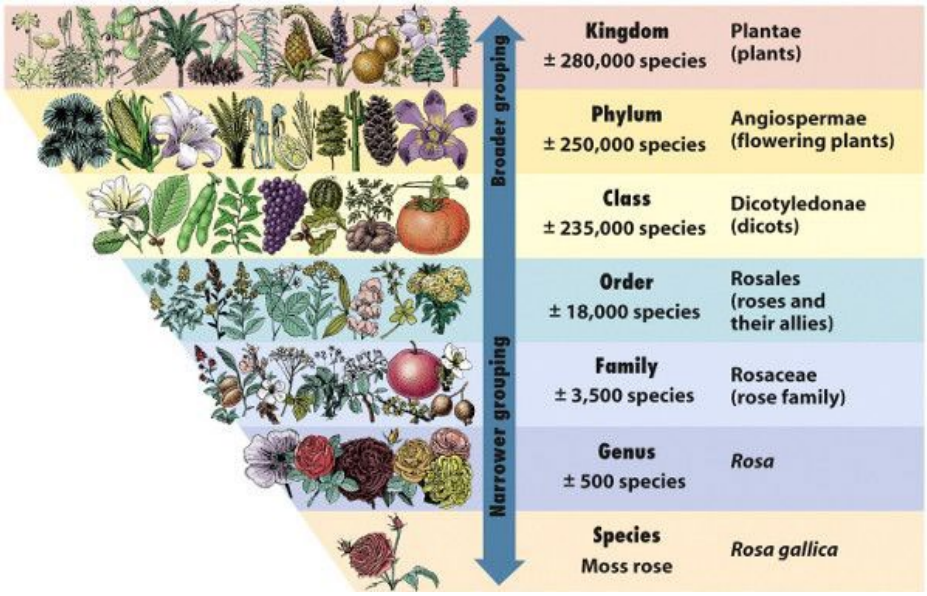


Sources: www.bing.com/search?q=kingdom+classification+chart&FORM=HDRSC1

- **Phylum**: (over 250,000 plants in this category) plants are divided in this category based on whether or not the plant produces seed, they are vascular or non-vascular plants.
- **Class**: (over 235,000 species), plants are divided into two types of classes: Angiospermae and Gymnospermae.
- **Order**: (over 18,000 species) a group of related plant families, classified in the order in which they are thought to have developed their differences from a common ancestor: vegetative structures and/or reproductive structures. Names of orders end in **ales,** eg: order of Rosales (roses and their allies).
- **Family**: Each order is divided into families. These are plants with many botanical features in common: related plants with similar flower parts are grouped together. For instance, the rose family Ros**aceae** consists of plums, apples, strawberries because they all have similar flower structure.
- **Genus**: (over 500 species) this is the normal name that you give a plant. The name of the **Genus** should be written with a capital letter.
- **Species**: this is the highest level that defines an individual plant. Often the name will describe some aspect of the plant: the color of the flowers, size or shape of the leaves, or it may be named after the place where it was found.

  Together the Genus and species name refer to only one plant, and they are used to identify that particular plant.

The species name is an adjective that describe the genus. For example alba means white therefore, **Michelia alba = white champaca** or rubrum means red, therefore **Plumeria rubra= frangipani.**



Source: https://rayon-de-serre.com/blogen/botanical-terms-taxonomy/

- **Description of Binomial nomenclature**
  - ✓ **Binomial nomenclature**[2] (bio = two, nomial = name) is a widely used, formal system of naming a species. The nomenclature consists of two names, both of which are derived from Latin. However, it can be derived from other languages too. Such a name is called a binomial name or a scientific name.

    - **Rules of binomial system**

      There are certain rules to be followed in binomial nomenclature, such as the generic name is always capitalized, while the specific name is not. The **generic name** or the initial part of the name highlights the genus to which an organism belongs and the second part, or **the specific name**, identifies the exact species under which the organism falls, within the genus.

      Also, the entire name is to be italicized. We can understand this system better with an example:

[2]biologydictionary.net/binomial-nomenclature/

Scientific Names of Plants[3]

Listed below are the scientific names of a few common plants:

Common Plant Names with Their Scientific Names					
	Apple	*Malus domestica*		**Cucumber**	*Cucumis sativus*
	Bamboo	*Bamboosa aridinarifolia*		**Curry plant**	*Murraya koenigii*
	Banana	*Musa paradisiaca*		**Drumstick**	*Moringa oleifera*
	Banyan	*Ficus benghalensis*		**Garlic**	*Allium sativum*
	Black Gram	*Plasoes mungo*		**Ginger**	*Zingiber officinale*
	Black Pepper	*Piper nigrum*		**Green Gram**	*Phaseolies aulicus*
	Brinjal	*Solanum melongena*		**Guava**	*Psidium guajava*
	Capsicum	*Capsicum frutescens*		**Henna**	*Lawsonia inermis*
	Carrot	*Daucas carota*		**Horse Gram**	*Dolichos biffoeus*
	Clove	*Syzygium aromaticum*		**Jowar**	*Sorghum vulgare*
	Coriander	Coriandrum sativum		**Lemon**	Citrus limonium
	Cotton	*Gossypium herbaceum*		**Lettuce**	*Lactuca sativa*
	Maize	*Zea mays*		**Pineapple**	*Ananas comosus*
	Mango	*Mangifera indica*		**Potato**	*Solanum tuberosum*
	Mint	*Mentha arvensis*		**Radish**	*Raphanus sativus*
	Money Plant	*Epipremnum aureum*		**Red Gram**	*Cajanus cajan*
	Neem	*Azadirachta indica*		**Sandalwood**	*Santalum album*
	Onion	*Allium cepa*		**Spinach**	*Spinacia oleracea*
	Orange	*Citrus aurantium*		**Tobacco**	Nicotina *tobaccum*
	Tulsi	*Ocimum sanctum*		**Tomato**	*Solanum lycopersicum*
	Turmeric	*Curcuma longa*		**Watermelon**	*Citrullus vulgaris*
				Wheat	*Triticum aestivum*

Source: https://byjus.com/biology/scientific-names-of-animals-and-plants

[3] biologydictionary.net/binomial-nomenclature/

- **Uses Of Scientific Names**[4]

  It has many advantages such as:

  - Classification and organisation – Entities are comprehensively organized which makes understanding and studying characteristics of particular entities easy and organized;
  - Precision and clarity – The names that are given are unique wherein each is given one scientific name, hence avoiding confusion;
  - The scientific names are universally recognized and standardized;
  - Even if species are transferred to another genus on the basis of new knowledge, the names are retained;
  - It helps understand the similarities and differences between various species that belong to the same genera that are helpful in building an association between the two.

✓ **Trivial naming:** Trivial naming refers to a common or vernacular name as distinguished from a scientific name, example: as ***tomato*** for Solanum lycopersicum.

- **Characteristics of Kingdom Plantae** [5]

The plant kingdom has the following characteristic features:

✓ **Autotrophic nutrition in Plants**[6]

Green plants are autotrophs and require chlorophyll, sunlight, oxygen and minerals for preparing their own food hence called primary producers. Plants synthesis their food by using light, carbon dioxide and water.

However, some plants do not contain chlorophyll and depend on other plants for their food through the heterotrophic mode of nutrition. These type of nutrition in plants are referred to as Heterotrophic nutrition in plants, hence are called parasites.

[4] https://www.bing.com/search?q=uses+of+scientific+names&cvid

[6] https://www.bing.com/search?q=uses+of+scientific+names&cvid

✓ **Transport system in plants** [7]

Phloem and xylem tissues are found in the roots, the stem and the leaves. **Phloem tissues** transport food substances such as glucose and amino acids from the leaves to other plant tissues where they are used or stored. **The xylem tissues** transport water and mineral salts absorbed by the roots to different parts of the plant.

✓ **Modes of reproduction** [8]

All living organisms must have offspring if they are to survive as a species on Earth. Two main modes of reproduction are:

- **Sexual reproduction**, where one individual parent takes place when offspring are formed from a single organism, while
- **Asexual reproduction** involves interaction of gametes produced by two sexually mature male and female organisms.

Furthermore, plants cells include a cell wall composed of cellulose, hemicellulose, and pectin.

Plants are immobile, i.e., rooted in one location.

[7] https://byjus.com/biology/transportation-in-plants/
https://www.sciencefacts.net/reproduction-in-plants.html
[8] https://byjus.com/biology/transportation-in-plants/
https://www.sciencefacts.net/reproduction-in-plants.html

Activity 3: Guided Practice

Task 3:

Read the following scenario and perform the tasks as provided

1. Suppose you are requested to participate and help in the description the principles of flora classification for botanical club team at your school and you are supposed to describe the flora classification found in your village.
2. Provide a clear description on:
   a. Plant classification: Kingdom, Phylum, Class, Order, Family, Genus and species
   b. Their binomial nomenclature
   c. Characteristics of kingdom plantae
3. Describe to the club the principles of flora classification you have based on.

Activity 4: Application

Task 4

Read the scenario below and perform the tasks required.

1. Assuming at school, they are planning a study visit for the class of level 3 tourism. On their list to visit is flora and fauna in your community. As a certificate IV student, you have been chosen to describe the flora classification found in your community to guide them.

   Points to elaborate:

   a. The classes of flora that are found in your neighborhood
   b. Description of their binomial nomenclature
   c. Explanation of their characteristics of kingdom plantae and divisions
   d. The available classes, if not what are the reasons?
   e. From your inventory, what are the usage of plants in your community?

Topic 1.2: Description of divisions of kingdom plantae

Activity 1: Problem Solving

Task 5:

1. Read and answer the questions below:
   a. What do you understand by divisions of kingdom plantae?
   b. Describe each division of the plant Kingdom
   c. How are they different from each other?
   d. Describe Bryophytes
   e. Describe Pteridophytes
   f. Describe Spermatophytes
   g. Describe Gymnosperms
   h. Describe Angiosperms
   i. Describe conifers and pines
   j. Describe monocots and dicots

Key Facts 1.2: Division of Kingdom plantae

- **Divisions of Kingdom Plantae**

  The plant world has been divided into distinct subgroups called divisions. They include the following:

  ✓ **Cryptogams**: Non-flowering and non-seed-bearing plants. Examples include Thallophyta, Bryophyta, and Pteridophyta.

  - **Bryophyta (mosses)**


These are small ***terrestrial*** plants. They show differentiation in the body design, with stem, **leaf-like structures, and root-like** structures. But they do not have

any specialized tissue to conduct water and other substances. They live in damp and sandy habitats and are often referred to as the **amphibians** of the plant kingdom. Examples are *Riccia, Funaria, and Marchanti.*

- **Pteridophyte (ferns)**

These are supposed to be the oldest **vascular** plants. The plant body is differentiated into roots, stem, and leaves, apart from having a specialized tissue for conduction. This tissue helps in the conduction of water and other substances from part of the plant to the other.

These plants produce naked embryos referred to as spores. These plants' reproductive organs are concealed. Marselia and ferns are two examples.

✓ **Phanerogams/spermatophytes:** Also known as a **spermatophyte** are flowering that produce seeds. With a stem, leaves, and roots, the plant body is clearly defined. Seeds are produced by well-differentiated reproductive tissues. Additionally, these plants possess a well-developed vascular system.

Phanerogams are further categorized into two subcategories based on whether the seeds produced are bare or contained. Gymnosperms and Angiosperms are the two types of plants.

Source: spermatophytes grafic - Search Images (bing.com)

- **Gymnosperms:** Gymnosperms are seedless plants. Gymnosperm plants are estimated to number approximately 650 species. Typically, the plants are perennial, evergreen, and woody.

They possess a well-developed circulatory system but lack vessels. Generally, the reproductive organs have the shape of cones or strobilus. Due to the absence of fruit formation, the seeds are referred to as naked. Cycas, Pinus, and Deodar are a few examples.[9]

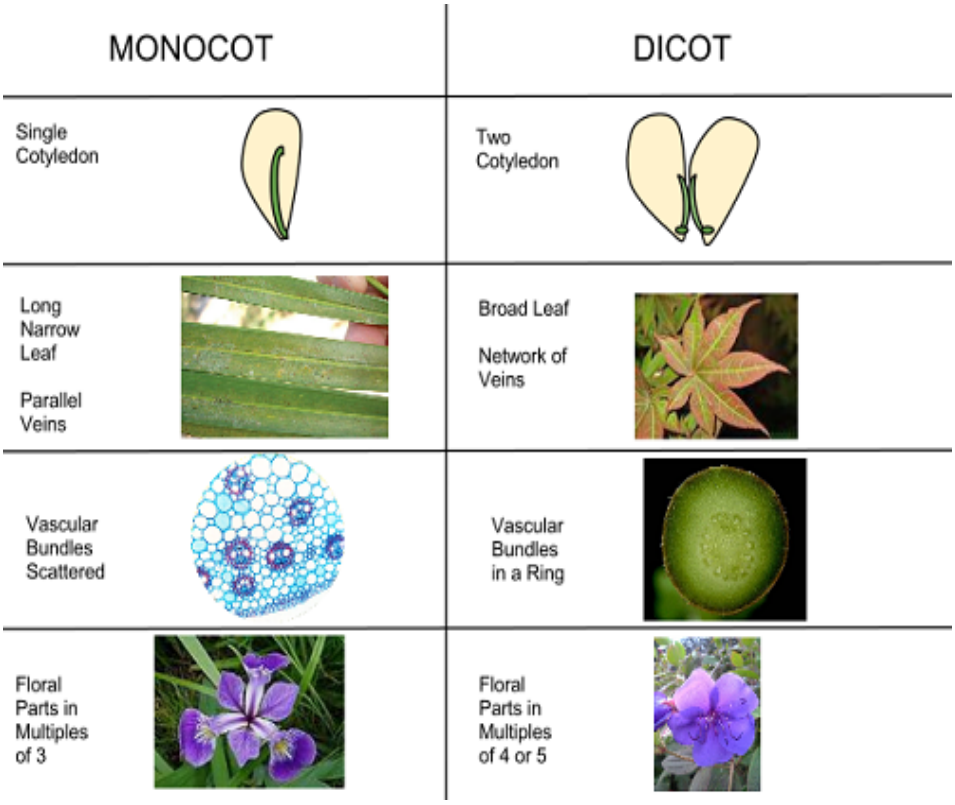
The seeds are not enclosed in an ovary or fruit (conifers and pines)

A tree that bears cones and needle-like or scale-like leaves that are typically evergreen. Conifers are of major importance as the source of softwood, and also supply resins and turpentine.

[9] https://www.britannica.com/plant/gymnosperm

- **Angiosperms:** Angiosperms are flowering plants that produce seeds. Seeds germinate inside tissues that are changed to become the plant's fruit. Additionally referred to as flowering plants, they are abundant in nature. These typically terrestrial plants are annual, biennial, or perennial in nature. With xylem and phloem (*xylem: transports water and mineral salts from the roots up to other parts of the plant, whereas phloem: transports sucrose and amino acids. from the leaves and other parts of the plant*), the vascular system is extremely developed. Additionally, angiosperms have the trait of twofold fertilization. Examples are mustard and pea plants.

Angiosperms are further classified according to their cotyledons (seed leaves) into Monocotyledonous and Dicotyledonous plants. Monocots have seeds with a single seed leaf and complicated vascular bundles. Dicots, on the other hand, have two cotyledons. The vascular bundle is ring-shaped.[10]



[10] https://www.britannica.com/plant/angiosperm

- **Monocotyledons:** have one cotyledon in their seeds.

We differentiate monocots from dicots by various characters like seed structure, leaves, stem and vascular system, roots, flowers, pollen grain, stamen, seedpod, fruit, seed etc

Examples of monocots and dicots

Monocots		Dicots	
Family	**Examples**	**Family**	**Examples**
Amaryllis	Garlic, onion	Solanaceae	tomatoes, potatoes, peppers
Poaceae	corn, wheat, rice,	Brassicacea	Cauliflower, cabbage Broccoli, turnips,
Liliaceae	Asparagus	Fabaceae	Beans, peas, soybeans, clovers,
Others	Sugarcane, palms, lilies, orchids, grasses	Rosaceae Others	Apples, plums peaches, pears, Carrot, celery, parsley

Activity 2: Guided Practice

Task 6:

1. Visit your school compound and list out the plants for each division found in there, by describing the plants falling under:
    a. Bryophytes
    b. Pteridophytes
    c. Spermatophytes
    d. Gymnosperms
    e. Angiosperms
    f. conifers
    g. pines
    h. monocots
    i. dicots

Activity 3: Application

Task 7:

1. Make plants-based research in your local village and report in details to your teacher on the following:
    a. Divisions of Kingdom Plantae
    b. Sub-divisions of Spermatophytes
    c. Classes of gymnosperms
    d. Classes of angiosperms

Topic 1.3: Description of vegetation for touristic importance

Activity 1: Problem Solving

Task 8

1. Reflect and answer the questions below:
   a. Define vegetation
   b. Outline factors that influence the distribution of vegetation
   c. Outline the importance of vegetation
   d. State the relationship between vegetation and human activities.
   e. Describe vegetation for touristic importance
2. Analyze the illustrations below and answer question on it
   a. Identify the type of vegetations in all the pictures
   b. Are they different? How?

Key Facts 1.3: Description of vegetation for touristic importance

- **Types of vegetation**

The term vegetation refers to plant cover, plant community or ground full of different plants. Vegetation can be both man-made vegetation and natural vegetation.

✓ **Natural vegetation** refers to the plants that grow in a given area without human influence. This type of vegetation is not planted. They grow on their own.

✓ **Artificial vegetation** is the vegetation that grows under human influence. Humans plant this type of vegetation for various reasons.

We have 5 major types of vegetation in the world: forest, grassland, tundra, desert and ice sheets.

✓ **Forests**: the most important factor that creates a forest is, of course, the trees. But, for something to be classified as a forest, the density of the trees and their leaves must have the ability to cover the ground, or better to say, to create shade to everything that is underneath them.

Although the vast majority of forests have a mixed population of trees, meaning there is almost always more than one type of tree growing in a particular area, we can also differentiate types of forests. Tropical forests usually grow in the tropics (close to the Earth's equator), while boreal forests generally thrive in much colder conditions (close to the Arctic).

Tropical forest[11]

Boreal forest[12]

✓ **Grassland**: This type of vegetation can be found everywhere on Earth, except for Antarctica, which is way too cold to support the life of plants. Grasslands are vast and flat areas covered with different types of grass.

[11] https://news.sky.com/story/some-tropical-rainforest-leaves-are-becoming-so-hot-they-are-unable-to-photosynthesise-study-finds-12945250

[12] https://earthbuddies.net/boreal-forest-shrinking/

There are two main types of grasslands: temperate and tropical. Temperate grasslands appear in areas where the variations in temperature occur when the seasons change. This means that in temperate grasslands, the vegetation changes accordingly because some species prefer to grow during summertime, while others come to life when it is cold. On the other hand, tropical grasslands, also known as savannas, prefer when it is warm and (mostly) dry throughout the year.


- ✓ **Tundra**: Tundras appear in climate zones where the temperatures are mostly low, and unlike the previous two types of vegetation, their diversity of the population is much smaller. There are two different types of tundras: alpine and arctic.

  Alpine tundras usually have a very distinct border between them and the forests. The weather that supports this vegetation is mostly very cold and harsh, and there is plenty of snow and wind as well. Arctic tundras can be found in the northern hemisphere of Earth, where the lands are mostly frozen throughout the year. There are very few animals that can be found in these areas, but polar bears adapted to very harsh conditions of this vegetation.



[13]

[13] https://de.wikipedia.org/wiki/Tundra

- ✓ **Deserts**: to classify something as a desert, you need to know how much precipitation is present in that area. If there are less than 10 inches of rain that falls any given year, we are talking about deserts: areas of low humidity, extremely high temperatures, and rather low temperatures in the night.

  Plants and animals that live in this type of vegetation have to adapt to these hard conditions, where there is almost no water, and the food resources are scarce. But, every desert on Earth is not full of hot sand. The biggest desert on this planet is actually Antarctica, with nothing but ice covering the ground of the whole continent.[14]


- **Factors that influence the distribution of vegetation**

There are four main factors that influence the distribution of vegetation over the earth.

- ✓ **Climatic factors:** limate is the weather condition in an area over a long period of time. The main elements of climate that influence vegetation include precipitation, temperature, sunlight and wind.
  - **Precipitation:** is the deposit of water in liquid or solid form on the earth's surface from the atmosphere. The type and amount of precipitation influences the type and distribution of vegetation. Areas that receive heavy and well-distributed rainfall throughout the year have forests composed of many tree species, when areas with moderate and seasonal rainfall are dominated by grasslands and areas with low rainfall are dominated by desert and semi-desert vegetation.

[14] https://www.worldatlas.com/articles/5-major-types-of-vegetation-in-the-world.html

- **Temperature:** plays an important role in the growth of vegetation. It determines plant processes such as germination, rate of plant growth, flowering, ripening of fruits and shedding of leaves. Warm conditions encourage rapid growth of plants. Cold conditions slow down the rate of plant growth.
- **Sunlight:** is important to plants for photosynthesis. Long hours of sunlight encourage the growth of many varieties of plants. Areas with fewer hours of sunlight have fewer plants.
- **Wind:** the moisture content and strength of the winds influences plant growth. Warm moist winds contain sufficient moisture. This helps in the formation of rainfall necessary for plant growth.

✓ **Edaphic factors:** This refers to soil particularly with respect to its influence on organisms. Deep well drained soils support a variety of large trees. Soils that are shallow in depth support the growth of shallow rooted plants such as grass.

The pH of the soil also determines the type of plants found in a region. Soils with nutrients and humus support the growth of plants. Soils with few nutrients support very little plant growth.

✓ **Topographic factors:** Topography defines the physical features in a place. The topographic factors include relief, slope and aspect. These factors affect vegetation through soil formation processes, climate, soil moisture and soil nutrients.

- **Relief:** Refers to the difference in elevation between any two points on the earth's surface. The height of the land determines temperature and rainfall. There is an increase in vegetation with an increase in altitude. This is distinct on mountains. The vegetation ranges from grass to forests, bamboo, heath and moorland.
- **Slope Aspect:** Steep slopes experience high rates of soil erosion leading to the development of thin and shallow soils. This results in poor plant growth. Gentle slopes have deep and well drained soils resulting in the growth of thick vegetation and a wide variety of plants. Flat areas are easily waterlogged resulting in the growth of swamp vegetation.

Aspect is the direction of the slope with regards to sunshine and rainfall. Slopes that are exposed to the sun are warm. They support plant growth. The slopes which are not exposed to the sun have fewer vegetation.

- ✓ **Biotic factors:** These are the living organisms, which have an effect on the growth of vegetation.

  These include human beings, animals, bacteria, burrowing animals and insects. Human activities such as deforestation, mining and overgrazing destroy vegetation. Other activities such as agroforestry, reforestation, afforestation and creation of forest reserves result in the development of vegetation.

  Some insects aid in plant pollination. Animals and birds aid in seed dispersal leading to growth and distribution of vegetation. Burrowing animals and earthworms aerate the soil resulting in suitable conditions for plant growth.

- **Importance of vegetation**[15]

  Vegetation plays a vital role in our natural ecosystem and also supports the biosphere in various ways:

  - ✓ **Source of raw materials**

    For industries and food for living, timber used in furniture making, boat making industry, grass used in basketry and weaving, food plants used in the manufacture of food products to name the few and provides a reliable source of food such as edible fruits and nuts can be found from forests such as the tropical rain forests and other planted crops.

  - ✓ **Modification of climate:**

    Trees help in rainfall formation through the process of evapotranspiration. They also absorb excess carbon dioxide from the atmosphere hence reducing the effects of global warming.

  - ✓ **Conservation of soils:**

    Vegetation contributes to soil conservation, acting as anti-erosion agents because their roots bind soil particles together and stop them from being eroded by running water. In addition, the litter from tree leaves act as sponges and protect the ground from being eroded hence conserving the soils.

15

- ✓ **Source of herbal medicine:**

  A handful of herbs and medicines are obtained from different types of vegetation.

- ✓ **Home for wildlife**:

  Forests act as habitats for wild animals and plants. Birds and various other animals and plants collectively attract tourists thus earning the country foreign exchange.

- ✓ **Heart Source of foreign exchange:**

  Vegetation provides products that are sold locally and internationally thus creation of employment opportunities.

- ✓ **Research purposes:**

  Vegetation has offered a fertile ground for various researches. It should be noted that vegetations are used for research and study by students in higher learning institutions.

- ✓ **Diversification of the economy:**

  The exploitation of other vegetation such as trees has led to the diversification of the economy. This has helped to reduce over reliance on agriculture.

- ✓ **Recreational activities**:

  Some types of vegetation are important for recreation purposes. They include forests, grassland savannas and woodlands. They act as hunting grounds for voluntary hunting, picnic sites and nature walk sites. All these are tourist attraction activities that bring in revenue and foreign exchange to the government.

- **Vegetation for tourism importance:**

  There is a great relationship between vegetation and tourism. People have always travelled to destinations they find attractive. Vegetation attracts people for different reasons but mainly most of them travel to places that offer them something they cannot find at home.

  Natural environment has been and still is a major aspect in tourism industry. The components of the environment such as wetlands, forests, wild animals and water bodies attract tourists.

Without vegetation, there would not be tourism activities in some areas. Considering main tourist attractions in EAC countries for example, tourism is based on National Parks.

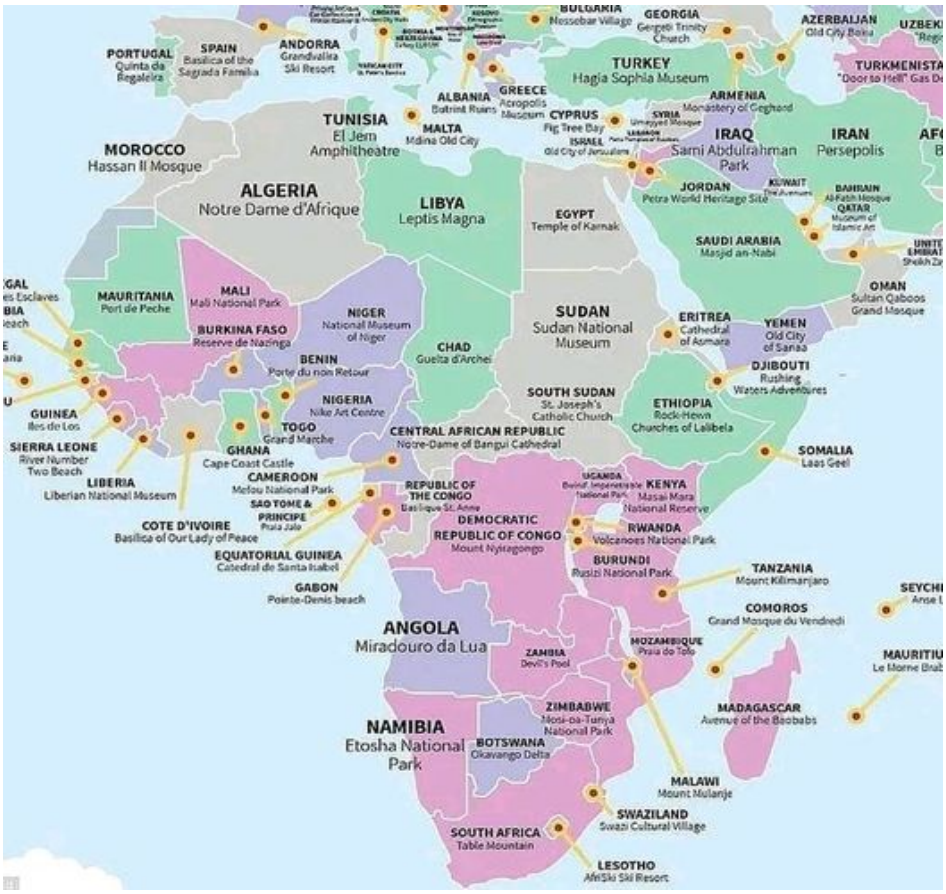
Below is the map highlighting all of the top tourist spots in Africa

Green = historic,

Gray = Religious

Pink = Natural

Purple = Tourist



Source: Iconic Africa, 23 April 2022.

Depending on the type of vegetation distributed all over the world tourism industry boosts and benefits largely from its diversity.

Activity 2: Guided Practice

Task 9:

1. Read and answer the questions that follow:
   a. Explain the factors responsible for the distribution of vegetation.
   b. Examine the importance of vegetation in the socio-economic development of a country.
   c. Distinguish between natural vegetation and artificial vegetation and provide examples in relation to Rwanda.
   d. Rwanda has experienced human exploitation of vegetation, using relevant examples, support this statement.

Activity 3: Application

Task 10:

1. Read and answer the following:
   a. Explain by mapping the different types of the vegetation found in the 5 zones of climate on the world map.
   b. Give reasons why it is important to conserve the vegetation.
   c. Explain the factors that influence vegetation.

Formative Assessment

1. Describe the subdivions of phanerogram
2. What are the subdivions of cryptogam
3. Describe binomial nomenclature in plant Kingdom
4. Mention the types of living organism and differentiate them
5. Which one contributes more in tourism industry development of Rwanda
6. Give 2 examples of:
   a. Spermatophyte plants
   b. Briophytes plants
   c. Thallophyte plants
7. Match the following plants in the column below with their habitat areas for tourism importance.

Plants	Habitat areas
a. Ferns	
b. Acacia tree	
c. Bamboo forest	
d. Colorful orchids	
e. Newtonia	

8. Explain the reasons why should we conserve flora or Plant Kingdom.
9. Identify the 7 main hierarchical levels of living thing classification.
10. What is the largest and the smallest of the living classification?

Points to Remember

- Classification of plants has aided in our understanding of the numerous types of plant species found on the planet, as well as their evolution. Monocots and dicots, as well as Angiosperms and gymnosperms, are used to classify plants. The kingdom Plantae is divided into numerous groups or classifications.
- The flora or plants on the land or in the oceans makes our life possible. Plants are the oxygen producing and carbon dioxide absorbing natural apparatus without which life would not be possible.
- Besides the plants are essential resource for human well-being as they are producers for another living organism.
- Plants are in different types, groups, categories as well as families wherever in the world.
- Vegetation plays a big role for tourism development in some areas in the world.

Self-Reflection

1. Fill in and complete the self-assessment table below to assess your level of knowledge, skills and attitudes after covering this unit.
2. There are no right or wrong ways to answer this assessment. It is for your own reference and self-reflection on the knowledge, skills and attitudes acquisition during the learning process.
3. Think about yourself:
   a. Do you think you have the knowledge, skills or attitudes to do the task?
   b. How well?
4. Read the statements across the top. Put a check in a column that best represents your level of knowledge, skills and attitudes.

My experience Knowledge, skills and attitudes	I do not have any experience doing this.	I know a little about this.	I have some experience doing this.	I have a lot of experience with this.	I am confident in my ability to do this.
Describe principles of flora classification					
Explain key terms used in flora classification					
Describe rules of binomial nomenclature of flora					
Describe the characteristics of kingdom plantae					
Describe divisions of kingdom Plantae					
Describe sub-divisions of spermatophytes					
Describe autotrophic nutrition, transport in plants and modes of reproduction					
Describe classes of gymnosperms					
Describe classes of angiosperms					

My experience Knowledge, skills and attitudes	I do not have any experience doing this.	I know a little about this.	I have some experience doing this.	I have a lot of experience with this.	I am confident in my ability to do this.
Identify different types of vegetation					
Demonstrate knowledge of the specific flora in the target area					
Comply with environmental regulations regarding biodiversity					
promote sustainable and environmentally friendly practices towards biodiversity					

5. Fill in the table below and share results with the trainer for further guidance.

Areas of strength	Areas for improvement	Actions to be taken to improve
1. **2.** **3.**	**1.** **2.** **3.**	**1.** **2.** **3.**

UNIT 2: DESCRIBE THE PRINCIPLES OF FAUNA CLASSIFICATION

Unit summary

This unit provides you with the knowledge, skills and attitudes required to describe principles of fauna classification. It covers kingdoms, phyla and classes of fauna, fauna orders based on shared physical features as well as animal's species for touristic importance.

Self-Assessment: Unit 2

1. Study the unit illustration above and answer the following questions:
   a. What do you see in the illustrations?
   b. How are the various images different?
   c. What topics do you think will be covered in this unit based on the illustration?
2. Fill in and complete the self-assessment table below to assess your level of knowledge, skills and attitudes under this unit.
   a. There are no right or wrong ways to answer this assessment. It is for your own reference and self-reflection on the knowledge, skills and attitudes acquisition during the learning process.
   b. Think about yourself: do you think you have the knowledge, skills or attitudes to do the task? How well?
   c. Read the statements across the top. Put a check in a column that best represents your level of knowledge, skills and attitudes.
   d. At the end of this unit, you will assess yourself again.

My experience Knowledge, skills and attitudes	I do not have any experience doing this.	I know a little about this.	I have some experience doing this.	I have a lot of experience with this.	I am confident in my ability to do this.
Describe taxonomic units of fauna					
Describe Characteristics of Kingdom Animalia					
Identify major phyla of Kingdom Animalia					
Describe class reptilian					
Describe class Amphibia					

My experience Knowledge, skills and attitudes	I do not have any experience doing this.	I know a little about this.	I have some experience doing this.	I have a lot of experience with this.	I am confident in my ability to do this.
Describe class Aves					
Describe class Mammalia					
Describe class Pisces					
Describe animal's species for touristic importance					
Description of amphibian species					
Describe reptile species					
Describe pisces species					
Describe major mammal species					
Identify endangered animal species					
Demonstrate knowledge of the specific fauna in the target area					
Comply with environmental regulations regarding fauna protection					

My experience Knowledge, skills and attitudes	I do not have any experience doing this.	I know a little about this.	I have some experience doing this.	I have a lot of experience with this.	I am confident in my ability to do this.
Promote sustainable and environmentally friendly practices towards biodiversity					

Key Competencies:

Knowledge	Skills	Attitudes
1. Identify animal's species for touristic importance	1. Describe taxonomic units of fauna	1. Cultural sensitivity by respecting and appreciating diverse cultures and customs
2. Identify major phyla of Kingdom Animalia	2. Describe Characteristics of Kingdom Animalia	2. A positive attitude towards understanding tourist needs
3. Identify endangered animal species	3. Describe class reptilian	3. Promoting sustainable and environmentally friendly practices, including fauna protection
	4. Describe class Amphibia	4. Demonstrate knowledge of the specific fauna in the target area
	5. Describe class Aves	5. Comply with environmental regulations regarding fauna protection
	6. Describe class Mammalia	6. Promote sustainable and environmentally friendly practices towards biodiversity

Knowledge	Skills	Attitudes
	7. Describe class Pisces	
	8. Describe animal's species for touristic importance	
	9. Description of amphibian species	
	10. Describe reptile species	
	11. Describe Pisces species	
	12. Describe major mammal species	

Discovery activity:

Task 11:

1. Read and answer the following:
   a. Describe taxonomic units of fauna
   b. Describe Characteristics of Kingdom Animalia
   c. Identify major phyla of Kingdom Animalia
   d. Describe class reptilian
   e. Describe class Amphibia
   f. Describe class Aves
   g. Describe class Mammalia
   h. Describe class Pisces
   i. Describe animal's species for touristic importance
   j. Description of amphibian species
   k. Describe reptile species
   l. Describe Pisces species
   m. Describe major mammal species
   n. Identify endangered animal species

Topic 2.1: Description of kingdom, phyla and classes of fauna

Activity 1: Problem Solving

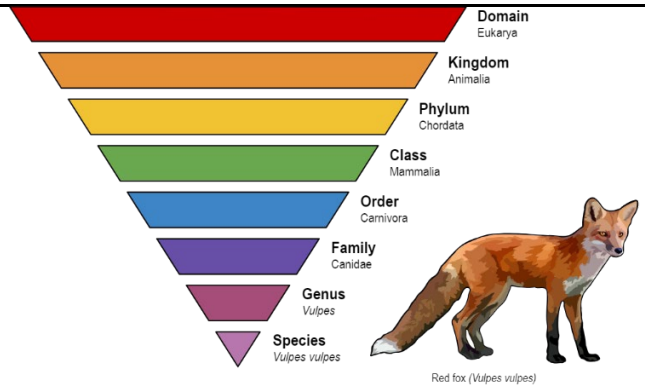
Task 12:

1. Read and answer the following questions
    a. What are principles of fauna classification?
    b. Describe binomial nomenclature for fauna
    c. What do you understand by heterotrophs?
    d. What is the transport characteristic of kingdom animalia?
    e. How is the mode of reproduction in kingdom animalia?
    f. What are the major phyla of Kingdom Animalia?
    g. Describe the characteristics of class reptilian
    h. Describe the characteristics of class amphibian
    i. Describe the characteristics of class Aves
    j. Describe the characteristics of class Mammalia
    k. Describe the characteristics of class Pisces

Key Facts 2.1: Description of taxonomic units of fauna

- **Taxonomic units of fauna**

  The science of classifying organisms is called taxonomy. Every species discovered so far are classified into five kingdoms – one among them is Kingdom Animalia or Animal kingdom. The highest taxon (taxonomic category) is **the kingdom**. In case of animals, it is divided into **phyla** and phyla into smaller categories – **classes**. The class consists of **orders**, which include **families**. Families have **genera** and these consist of species.



- **Principles of fauna classification**

  The more features that a group of animal shares, the more specific that animal classification group is.

  Animal kingdom classification is an important system for understanding how all living organisms are related. Based on the Linnaeus method, species are arranged and grouped based on shared characteristics.

  They bring organisms together in higher and higher taxonomic (systematic) categories, i.e. taxons, starting from the lowest category, which is species. Taxonomic categories are groups of organisms that are related to each other, distinguished from each other by one or more features. Combining organisms into taxonomic categories according to their common features allows for organization of knowledge about them.

- **Description of binomial nomenclature for fauna**

  The Linnaeus Method, also known as Linnaean Taxonomy, creates a hierarchy of groupings called taxa, as well as binomial nomenclature that gives each animal species a two-word scientific name.

  This method of giving scientific names to animals is typically rooted in Latin by combining the genus and species. For example, ***humans*** are classified as *homo sapiens* while **wolves** are *canis lupus.*

- **Scientific names of animals**[16]

  Binomial nomenclature: is the scientific way of naming living things with two words: genus and species.

  Listed below are the scientific names of a few common animals.

Common Animals Names with Their Scientific Names

16

	Ant	*Formicidae*	Indian Cobra	*Naja naja*	
	Arabian camel	*Camelus dromedarius*	parrot	*Psitta ciformes*	
	African elephant	*Loxodonta*	Leopard or panther	*Panthera pardus*	
	Albatross	*Diomedeidae*	Monkey	*Simiiformes* (infraorder)	
	Asian Elephant	*Elephas maximus*	Lion	*Panthera leo*	
	Bat	*Chiroptera*	Lizard	*Squamata*	
	Bird	*Aves*	Rabbit	*Oryctolagus cuniculus*	
	Brown Tree Snake	*Boiga irregularis*	Rat	*Rodentia*	
	Goat	*Capra aegagrus hircus*	Rat snake	*Ptyas mucosa*	
	Buffalo	*Bubalus bubalis*	Rattle snake	*Crotalinae*	
	Butterfly	*Rhopalocera*	Rhesus monkey	*Macaca mulatta*	
	Cat	*Felis catus*	Rhinoceros	*Rhinoceros unicornis*	
	Cheetah	*Acinonyx jubatus*	Sea snake	*Hydrophiinae*	
	Cobra	*Naja*	Sheep	*Ovis aries*	
	Cockroach	*Blattodea*	Snakehead	*Channidae*	
	Cow	*Bos taurus*	Sparrow	*Passer domesticus*	
	Crocodile	*Crocodylus palustris*	Spider	*Araneae*	
	Deer	*Cervidae*	Tiger	*Panthera tigris*	
	Dog	*Canis lupus familiaris*	Tiger Snake	*Notechis scutatus*	
	Dolphin	*Cetacea*	Wolf	*Canis lupus*	
	Eagle	*Accipitridae*	Zebra	*Equus quagga*	
	Elephant	*Elephantidae*	Earthworm	*Lumbricus*	
	fish	*Vertebrata*	Grasshopper	*Caelifera*	
	Red fox	*Vulpes vulpes*	Honey Bee	*Apis*	

Giraffe	*Giraffa camelopardalis*	Pigeon	*Columba livia*
Great horned owl	*Bubo virginianus*	snake	*Serpentes*
Hen	*Gallus gallus domesticus*		
Hippopotamus	*Hippopotamus amphibius*		
Horse	*Equus caballus*		

Table: scientific names of few common animals

Source: Scientific Names of the most common animals and plants (byjus.com)

- ✓ **Characteristics of Kingdom Animalia**[17]

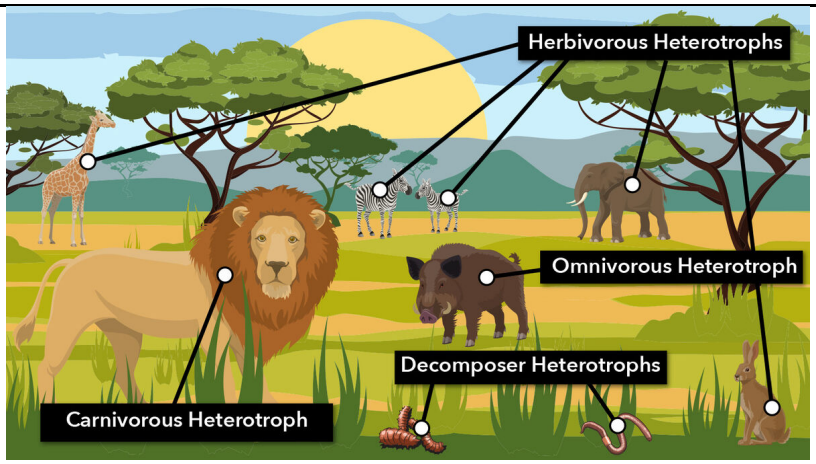
  Members of this kingdom can move and so have locomotion, lack a cell wall and plastids, are heterotrophic since they cannot prepare their own food, have excretory system and sensory organs and reproduction is generally sexual.

- ✓ **Heterotrophic in kingdom Animalia:**

  Animals are heterotrophs, they must consume living or dead organisms since they cannot synthesize their own food; and can be carnivores, herbivores, omnivores, or parasites. This feature distinguishes them from autotrophic organisms, such as most plants, which synthesize their own nutrients through photosynthesis. We have the following types: herbivores (plant eaters), carnivores (meat-eaters) and omnivores (eaters of meat and plants), and detritivores (debris eaters).

- ✓ **Herbivores**: Animals which obtain their nutrition from eating only plants and their materials
- ✓ **Carnivores**: Animals which obtain their nutrition from killing and eating the flesh of other animals.
- ✓ **Omnivores**: Animals which obtain their nutrition from both plants as well animals.
- ✓ **Detritivores**: Animals which obtain their nutrition from dead and decaying matter.

[17] https://www.biologyonline.com/dictionary/kingdom-animalia



✓ **Transport in Kingdom Animalia:**

Transportation in animals is the movement of food, water, and oxygen to different parts of the body. Such a system consists of a circulatory system and excretory system. The main parts of the circulatory system are blood, blood vessels and heart.

Circulatory System: Arteries carry oxygen-rich blood from the heart to various body parts, while veins transport oxygen-deficient blood back to the heart.

Excretion: Waste removal from cells involves processes like urine formation in humans (kidneys, ureter, bladder, urethra). Lower organisms (e.g., amoeba, hydra) excrete waste through diffusion across cell membranes.

✓ **Modes of reproduction**:

Most of the animals reproduce sexually (involves fusion of gametes from opposite sexes) while a few of them reproduce asexually (single parent produces genetically identical daughter cells). For example, Hydra reproduces asexually by means of budding.

Male and female animals copulate for sexual reproduction. Gametes are formed inside organisms. Gametes of opposite sexes fertilise to form zygotes followed by embryological development.

Fertilisation can be external (outside the female body) or internal (inside the female body) which varies among different animals.

Development can be direct (the embryo develops directly into smaller versions of adult forms) or indirect (the embryo develops into adults through intervening larval stages which are morphologically different from the adults). Some animals develop indirectly by forming larvae.

✓ **Identification of major phyla of Kingdom**

An animal phylum is a major taxonomic group within the animal kingdom. It represents a level of classification above class and below kingdom. Phyla (plural of phylum) are based on shared characteristics and evolutionary relationships.

The phyla within the animal kingdom include: porifera, cnidaria, platyhelminthes, nematoda, annelida, mollusca, echinodermata, arthropoda and chordata.

However, we will study only the two major phyla, which is arthropod and chordata.

✓ **Arthropod**: the largest phylum contains invertebrates' animals and includes insects, spiders, crustaceans, and millipedes. Arthropods have jointed appendages and an exoskeleton which, includes such familiar forms as **lobsters, crabs, spiders, mites, insects, centipedes, and millipedes**.

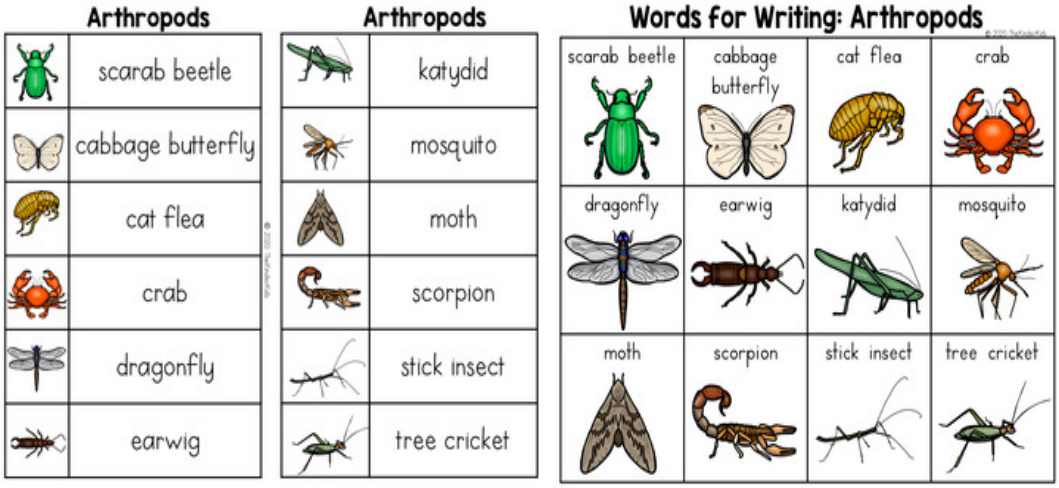


Figure: Examples of arthropod

✓ **Characteristics of arthropods**[18]

- Presence of multiple joints
- Chitinous exoskeleton
- Various segmentation
- Open circulatory system
- Internal organs protected by the chitinous exoskeleton
- Chordata phylum:

Any member of the phylum Chordata, which includes the vertebrates (subphylum Vertebrata), the most highly evolved animals, as well as two other subphyla—the tunicates (subphylum Tunicata) and cephalochordates (subphylum Cephalochordata).

[18] wildlifeinformer.com/characteristics-of-arthropods/

Some classifications also include the phylum hemichordata with the chordates. It is sub-divided into[19]

Vertebrates, or animals with backbones, such as fishes, amphibians, reptiles, birds, and mammals. A human is a vertebrate chordate.

Invertebrates, or animals without backbones, such as lancelets and tunicates. These are the most primitive chordates and live in marine environments.

Lampreys, which are jawless fishes that are parasitic as adults. They belong to the subphylum Vertebrata.

Figure: Examples of Chordata phyla

✓ **Characteristics of chordata phyla**[20]

The phylum chordata includes a diverse group of animals that share several key characteristics:

- **Notochord**: At some point in their life cycle, chordates possess a stiff, dorsal supporting rod called the notochord. This structure provides support and is typically replaced by the vertebral column (backbone) in vertebrates.
- **Dorsal Hollow Nerve Cord**: Chordates have a dorsal hollow nerve cord running along their back. In vertebrates, this develops into the spinal cord and plays a crucial role in transmitting nerve impulses.
- **Pharyngeal Slits**: All chordates have pharyngeal slits, which are openings in the pharynx (throat) region. These slits serve various functions, such as filter-feeding in some species or respiratory exchange in others.

[19] https://byjus.com/biology/phylum-chordata-classification/
[20] bio.libretexts.org/Bookshelves/Introductory_and_General_Biology/General_Biology

- **Post-Anal Tail**: Chordates exhibit a **post-anal tail**, extending beyond the anus. While this tail is more prominent in embryonic stages, it persists in some adult forms (e.g., fish) and aids in locomotion.

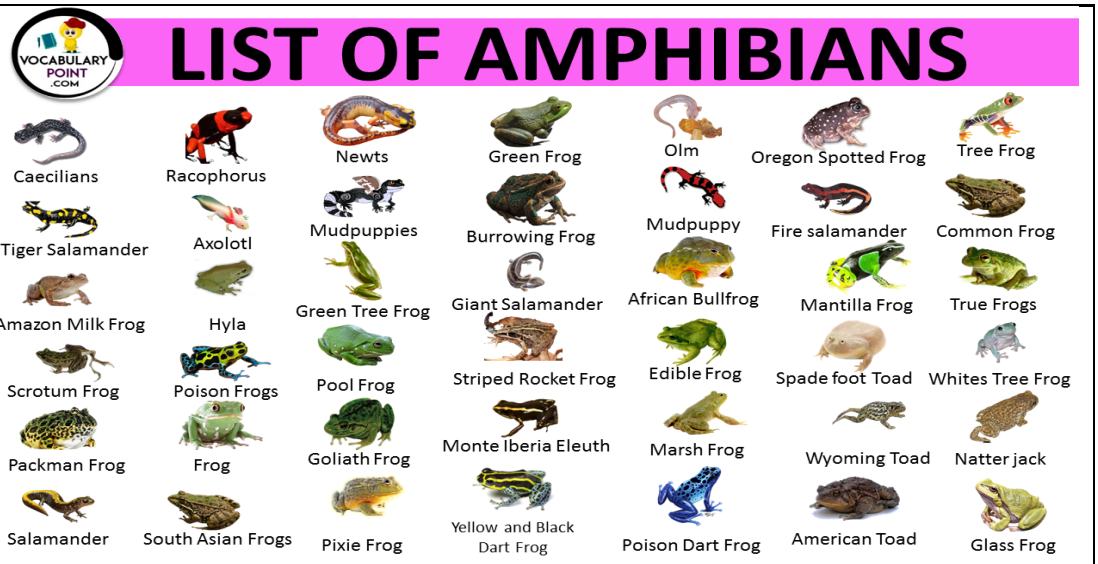
Keep in mind that chordates include not only vertebrates (such as mammals, birds, reptiles, amphibians, and fish) but also two other subphyla: tunicates and cephalochordates. Tunicates are marine animals that often form colonies, while cephalochordates are small, fish-like animals that live partially buried in marine sand and gravel.

- **Description of class reptilians**
  - ✓ **Class of reptilians**:

    Any member of the class Reptilia, the group of air-breathing vertebrates that have internal fertilization, amniotic development, and epidermal scales covering part or all of their body. The major examples are: turtles, tuatara, lizards, snakes, and crocodiles.
  - ✓ **Characteristics of class reptilians**[21]
    - They breathe through lungs
    - They have scales or scutes
    - They are vertebrates
    - They typically have four legs
    - They are cold-blooded (ectothermic)
    - They have cold –blooded body and found in warm region
    - The skin is dry and rough
- **Description of class Amphibians**
  - ✓ **Class of amphibians**[22]**:**

    These organisms fall under the Chordata phylum of the kingdom Animalia. These are multicellular vertebrates that live both on land and water. This class includes about 3000 species. They are the first cold-blooded animals to have appeared on land.

[21] https://testbook.com/biology/reptilia
[22] https://byjus.com/biology/amphibia/



- ✓ **Amphibia characteristics**:
  - They can live both on land and in water.
  - They are ectothermic animals, found in a warm environment.
  - Their body is divided into head and trunk. The tail may or may not be present.
  - The skin is smooth and rough without any scales, but with glands that make it moist.
  - They have a three-chambered heart

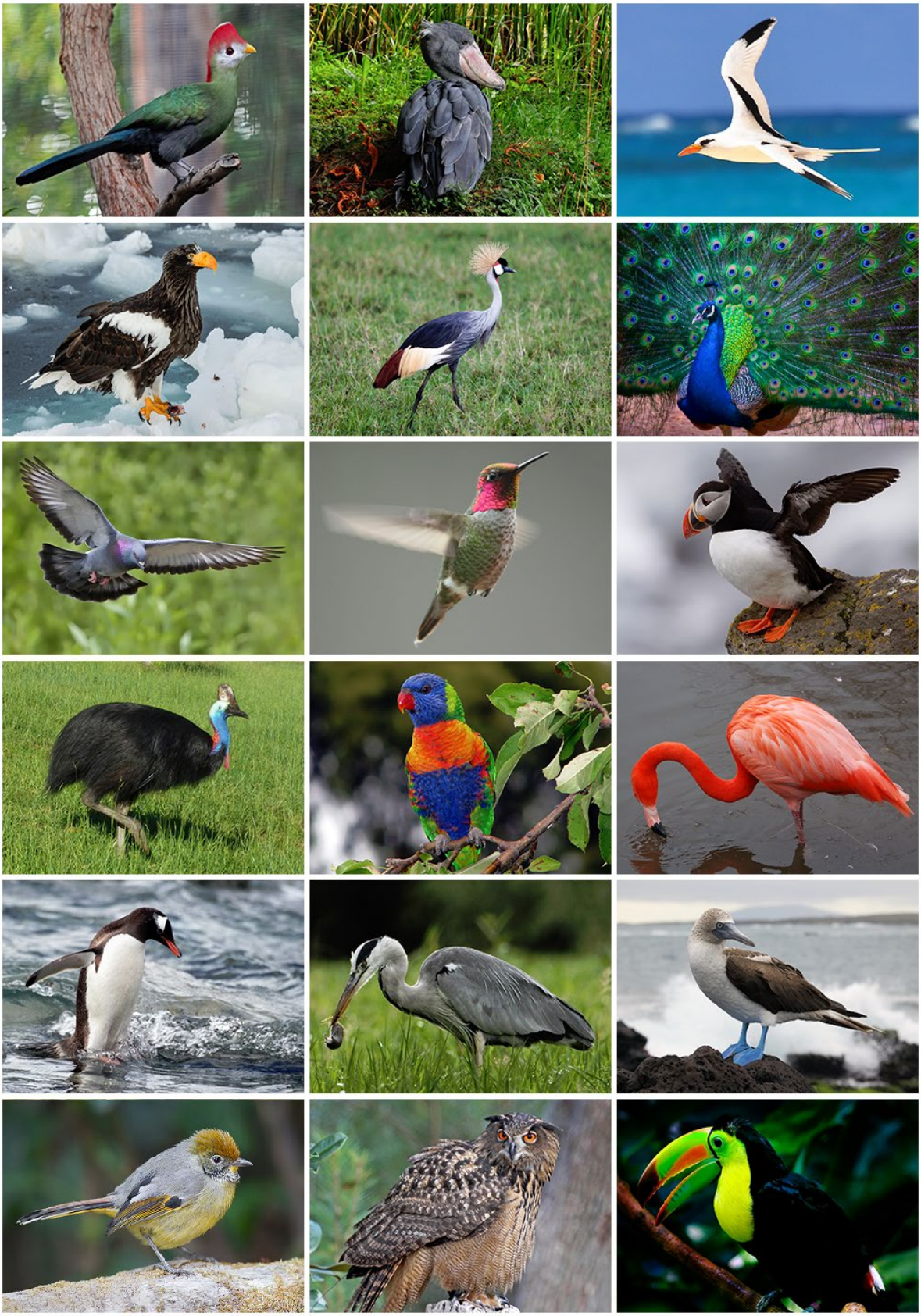
- **Description of Aves class**[23]

  Aves **class**:

  Birds are a group of warm-blooded vertebrates constituting the class Aves. examples of class Aves (birds) from different orders include:

  - ✓ Ostrich (order Struthioniformes)
  - ✓ Rhea americana (order Rheiformes)
  - ✓ North Island Brown Kiwi (order Apterygiformes)
  - ✓ Penguin (order Spheniseiformes)
  - ✓ Stellata (order Gaviiformes

[23] https://www.biologyonline.com/dictionary/aves



[24]*Figure: examples of Aves class*

[24] https://onlineresize.club/2021-club.html

✓ **Characteristics of class Aves**

Commonly known as birds, belongs to the phylum of chordata (chordates), they are:

- Warm-blooded animals;
- Their forelimbs are modified into wings;
- They have well-developed flight muscles that help during the flight;
- Their hind limbs are adapted for walking, hopping, perching, grasping, wading and swimming; and
- There are epidermal scales on their legs.

Some birds' species found in East African Community (EAC) region

African Fish Eagle Haliaeetus vocifer) African Grey Hornbill(Lophoceros nasutus)

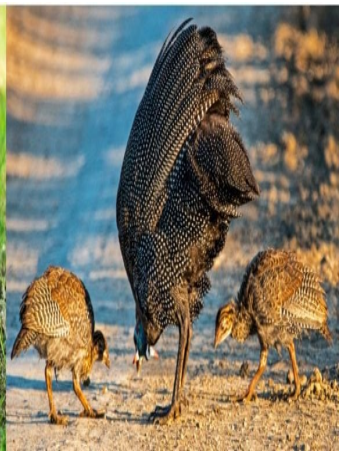
African Paradise Flycatcher(Terpsiphone viridis) African Sacred Ibis(Threskiornis aethiopicus)

Common Hoopoe(Upupa epops)

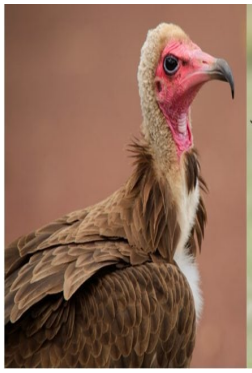
Great BluTuraco(Corythaeola cristata

Grey Crowned Crane(Balearica regulorum)

Hadada Ibis(Bostrychia hagedash)

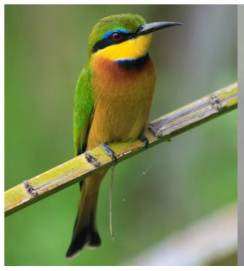


Hamerkop(Scopus umbretta)

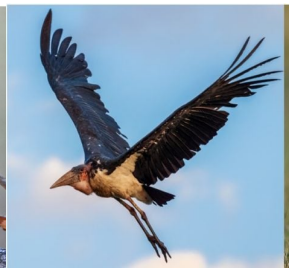


Helmeted Guinea Fowl(Numida meleagris)

Hooded Vulture(Necrosyrtes monachus)

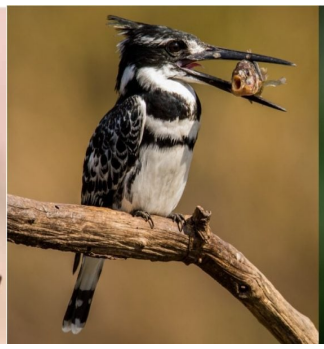


Lilac-Breasted Roller(Coracias caudatus)



Little Bee-Eater(Merops pusillus)

Marabou Stork(Leptoptilos crumenifer)



Pied Crow(Corvus albus)

Pied Kingfisher(Ceryle rudis)

Pin-Tailed Whydah(Vidua macroura)

Speckled Pigeon(Columba guinea

Village Weaver (Ploceus cucullatus)

White-backed Vulture (Gyps africanus)

Woodland Kingfisher (Halcyon senegalensis)

Shelley's Crimsonwing (Bertin Murhabale) Barred Long-tailed Cuckoo (Tasso Leventis)

Purple-breasted Sunbird (John Caddick) Dwarf Honeyguide (Jacques Erard)

Regal Sunbird (Adam Riley) Red-faced Barbet (John Caddick)

Kungwe Apalis (Bradley Hacker) [25] Rwenzori Double-collared Sunbird (Peter Hills)

✓ **Description of mammalia class**

Mammalia class:

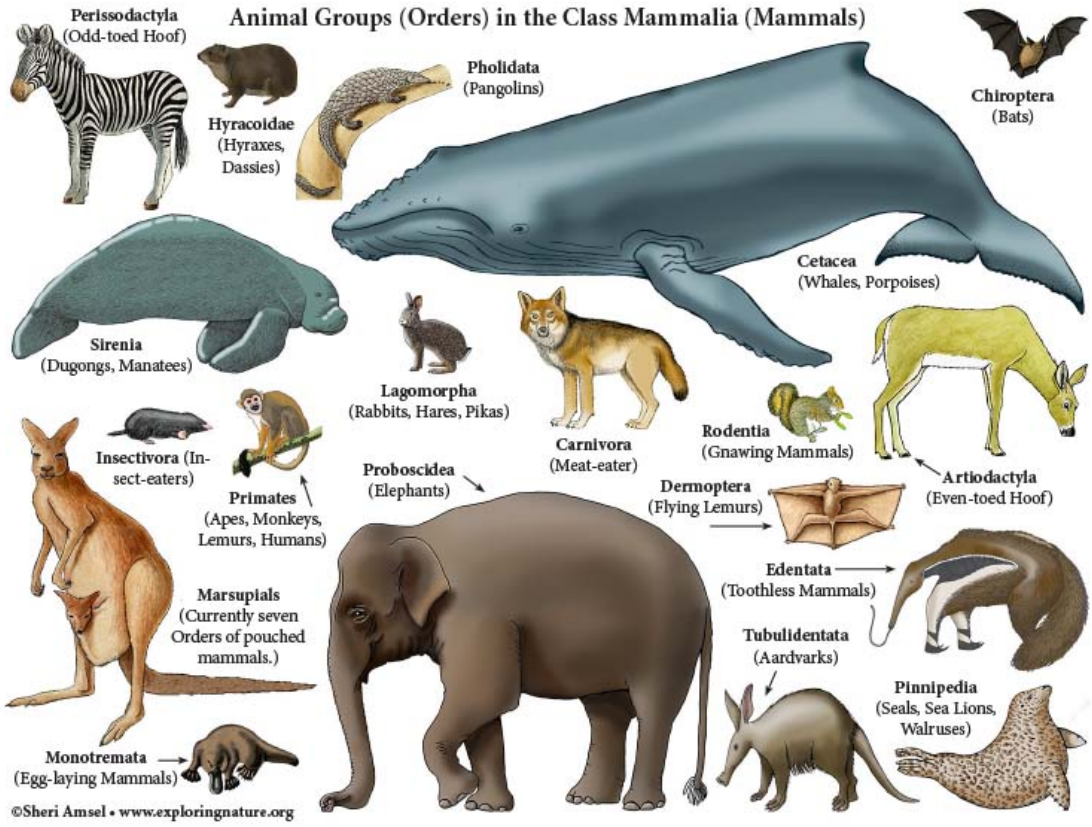
Is a taxonomic class of the phylum Chordata. Mammals are characterized by the presence of milk-producing mammary glands for feeding their young. Moreover, mammals are one of the most evolved species in the animal kingdom categorized under vertebrata.

The Mammals (Class Mammalia) includes everything from mice to elephants, bats to whales. The amazing diversity of mammals is what has allowed them to live in any habitat from desert to arctic to the deep ocean. They live in trees, they live on the ground, they live underground, and in caves.

Some are active during the day (diurnal), while some are active at night (nocturnal) and some are just active at dawn and dusk (crepuscular). They live alone (solitary) or in great herds (gregarious). They mate for life (monogamous) or form harems (polygamous). They eat meat (carnivores), they eat plants (herbivores) and they eat both (omnivores). They fill every niche imaginable.

2525252525252525

Rwanda - African Bird Club



26

Figure: Examples of mammalia class.

✓ **Characteristics of Mammalia class**

The following are distinct characteristics of mammals that separate them from other classes:

- Mammals are warm-blooded animals who give birth to their younger ones.
- They are the most dominant form of animals found in almost all types of habitats
- They have mammary glands that help them produce milk to feed their younger ones
- Presence of region of the brain known as Neocortex
- Their skin possesses oil glands (sebaceous glands) and sweat glands (sudoriferous glands).
- The fur of hair throughout the body which helps animals adapt to their environment.
- They are heterodont, i.e., possess different types of teeth.
- Mammals also possess cervical vertebrae.
- The skull is dicondylic.

[26] https://www.exploringnature.org/db/view/Class-Mammals-4th-Grade-and-up

- The trunk is divided into thorax and abdomen.
- The mammals respire through lungs.
- Good sense of hearing as mammals are aided with 3 middle ear bones
- Mammals have a four-chambered heart. The sinus venous and renal portal system are absent.
- Presence of single-boned lower jaws.
- The brain is well developed divided into cerebrum, cerebellum and medulla.
- They possess 12 pairs of cranial nerves.
- Exhibit one of the most advanced forms of Diaphragms.
- The mammals can lay eggs also known as viviparous.

✓ **Description of class Pisces**

Pisces is a class of aquatic vertebrates found in marine, freshwater, and brackish water. They belong to the phylum Chordata and subphylum Vertebrata.

27

[27] https://www.yaclass.in/p/science-state-board/class-7/basis-of-classification-15155/the-classification-of-organisms-11810/re-f4c4e8da-ce76-461e-a7c7-e6d8c85a21b6

✓ **Characteristics of Pisces**

The characteristics of this class are-

- They have a streamlined body.
- The circulatory system is of close type.
- The body has three regions- head, trunk, and tail.
- The skeleton can be bony or cartilaginous.
- The sexes are separate.
- A well-developed digestive system is present.
- No extraembryonic membranes.
- Fertilization either internal or external.
- The body consists of scales, which acts as an external covering.
- They can be herbivorous, carnivorous, or omnivorous.

✓ **Circulation**

In fishes, the flow of blood is in one direction only. It has a closed circulatory system. Moreover, it consists of a heart with two chambers only. The heart comprises four distinct parts- sinus venosus, the atrium, ventricle, and bulbous arteriosis. The blood is pumped from the heart to the gills. In addition, the blood gets oxygenated in the gills and then flows all over the body.

Reproductive system

The sexual organs are internal. Female fish consists of ovaries and male fished testes. Moreover, the female fish produces eggs and male's sperms. The eggs and sperms fuse i.e. fertilization. However, in most cases, they do not directly do mating. On the other hand, the female fish scatters her eggs in the water and the male ejects its sperms. Therefore, external fertilization happens.

Moreover, in the fishes with internal fertilization, the eggs either hatch internally or are released before hatching.

Activity 2: Guided Practice

Task 13:

1. Read the following and give answers on them
   a. What are the animalia kingdom taxonomic units?
   b. Differentiate arthropods phylum from chordata phylum
   c. How many classes of Animalia kingdom exist? What are they?
   d. Mention any 5 characteristics of mammalia class
   e. Distinguish Heterotrophic in animalia kingdom Vs Autotrophic in Plant Kingdom
   f. Distinguish Transport in Animalia Kingdom Vs transport in Plant kingdom
   g. complete the following tables by using 3 examples for each class of Animalia kingdom

Mammals	Amphibians	Reptiles	Birds	Fish

Activity 3: Application

Task 14:

Read the following statement and answer questions on it

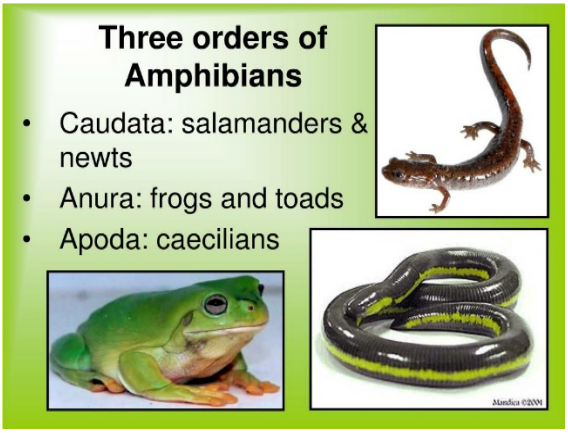
1. "Understanding and classifying the great variety of living species particularly Animalia kingdom, help us better understand how to conserve the diversity of life on earth but today, some of Animalia kingdom in their natural habitats are among endangered species in the world because of different human activities"
   a. In your local community area, conduct research regarding the human activities that lead to the extinction of some Animalia kingdom
   b. From the statement above, make a report of animal living species that has been reported/observed extincted for few years ago.

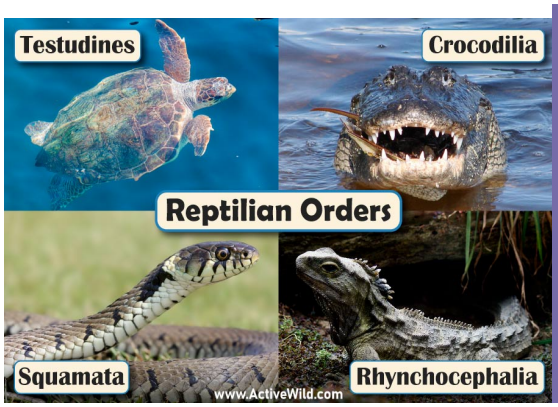
Topic 2.2: Description of Fauna Order

Activity 1: Problem Solving

Task 15

1. Look at illustration below and answer questions on them





a. What you see on the illustrations above
b. Where is the difference between the 4 charts
c. How many fauna orders do you see on the illustrations?
d. Enumerate them
e. How many categories are in Amphibian order
f. Mention two animals names that belong to the mammalia order on the chart
g. Identify two Aves names and two pisces names on the above illustrastons

Key Facts 2.2: Description of fauna orders

- **Description of amphibian order**

The class of amphibian is divided into three modern orders:

Anura, which includes the toads and frogs. They make up nearly 90% of the known amphibian species.

Urodela, which are mainly salamanders. They have tails and limbs of equal size.

Apoda, which comprises the caecilians. They are legless and worm-like.

Albanerpetontidae, which became extinct around 2 million years ago. They were small and lizard-like.

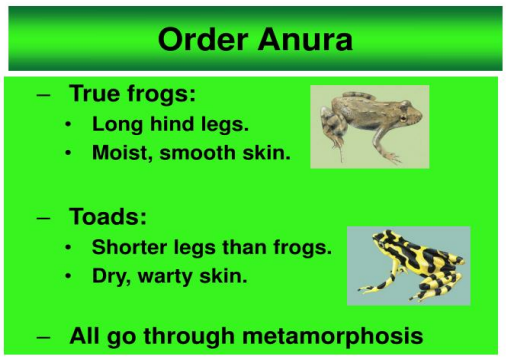


Figure: order Anura (without tail)

Figure: order Urodela (with tail)

Figure: apoda order (legless).

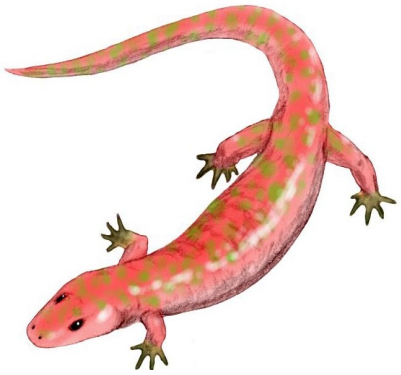


Figure: Albanerpetontidae (extincted)

- **Description of orders of reptiles**

Order of reptiles[28]: include:

- ✓ Crocodilia, which includes crocodiles, alligators, caimans and gharials
- ✓ Sphenodontia, which includes the tuatara
- ✓ Squamata, which includes snakes, lizards and worm lizards

[28] https://www.ck12.org/c/biology/reptile-classification/lesson/Reptile-Classification-BIO/

- ✓ Testudines, which includes turtles, tortoises and other shelled reptiles

Figure: Crocodilia order.

Figure: Sphenodontia order

Figure: squamata.

Figure: testudines

- **Description of Aves order**

Order of Aves: include:

- ✓ Ostrich from order Struthioniformes
- ✓ Rhea americana from order Rheiforme
- ✓ North Island Brown Kiwi from order Apterygiformes
- ✓ Penguin from order Spheniseiformes
- ✓ Stellata from order Gaviiforme

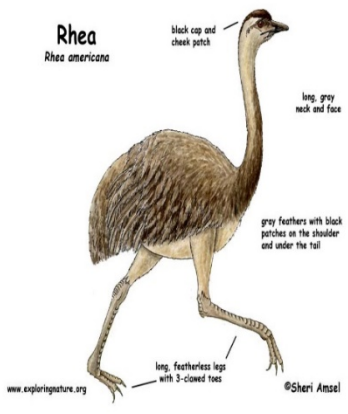


Figure: rhea order

Figure: North island Kiwi

Figure: Pingwee

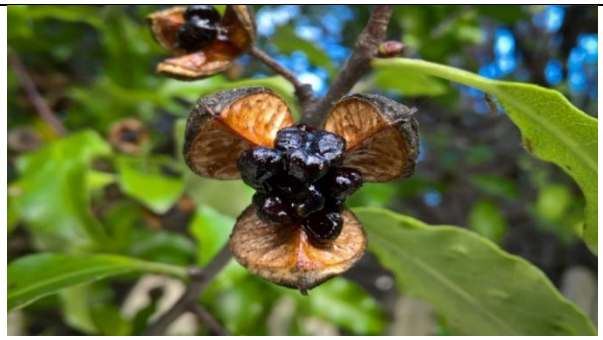


Figure: stellata

- **Description of Mammalia order**

Mammals are divided into three subclasses and twenty-eight orders, the largest orders by number of species are:

- ✓ Rodents
- ✓ Bats
- ✓ Eulipotyphla (including hedgehogs, moles, and shrews)
- ✓ Primates (including humans, monkeys, and lemurs)
- ✓ Even-toed ungulates (including pigs, camels, and whales)

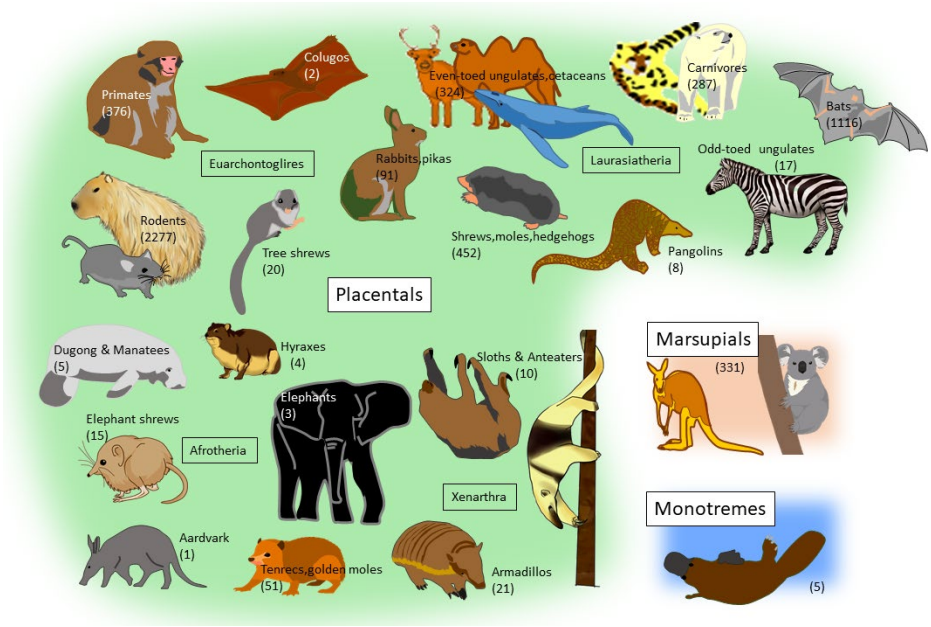


Figure 1: Mammalia

- **Description of pisces order**

Pisces are classified into three categories:[29]

[29] byjus.com/biology/pisces/

- ✓ Placodermi (aphstohyoids)
- ✓ Chondrichthyes
- ✓ Osteichthyes

Placodermi (Aphstohyoids)[30]

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Figure 2: Placodermi

All members of this class are extinct today.

- Their exoskeleton is in the form of shields and the endoskeleton is bony.
- These fish exhibit autodiastylic jaw suspension.
- They survived until the end of the Devonian period.
- The heterocercal caudal fin is present.
- Eg., Climatius, Bothriolepis

Chondrichthyes[32]

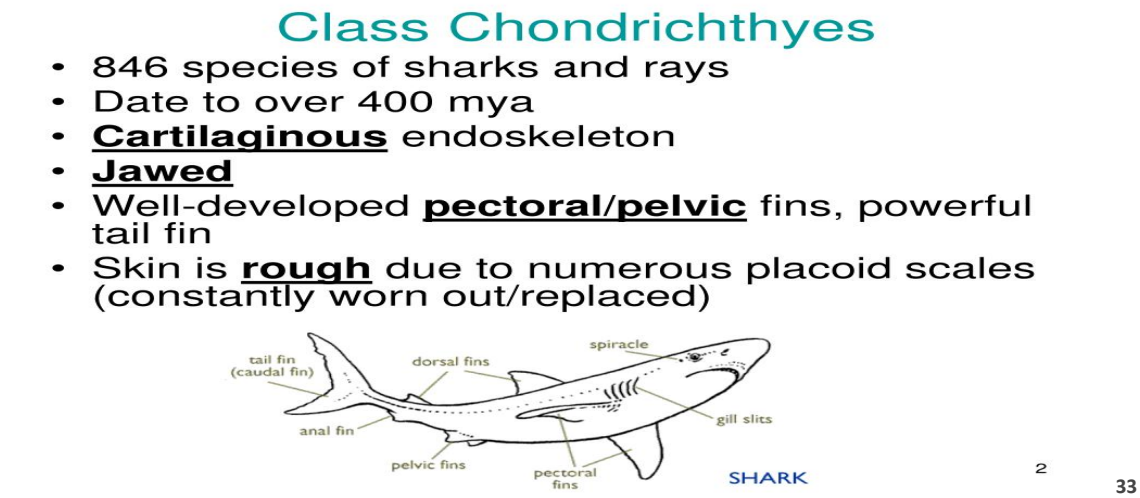


Figure 3: Chondrichthyes

[30] byjus.com/biology/pisces/

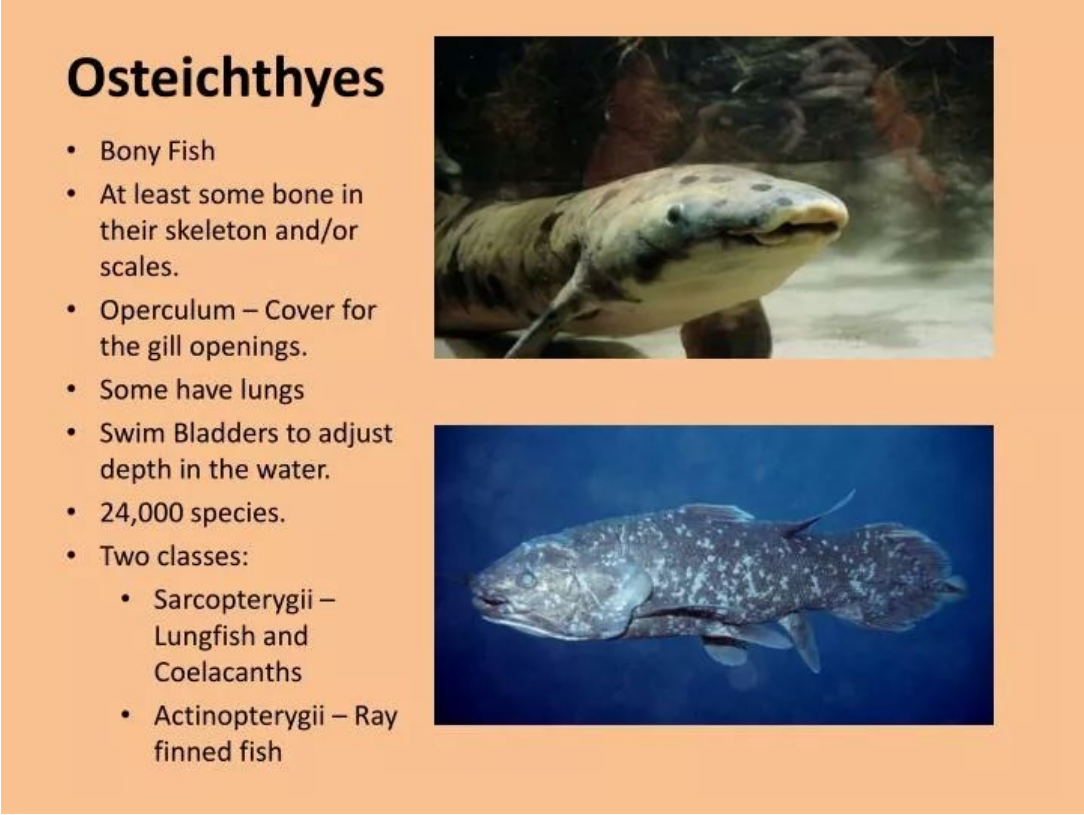
[32] byjus.com/biology/pisces/

[33] Placoderm - Wikipedia

✓ These fish are found only in the marine environment.

- The exoskeleton is like placoid scales.
- The endoskeleton is cartilaginous.
- The jaw suspension is amphistylic.
- Gills are the respiratory organs.
- The caudal fin is heterocercal.
- Claspers are the reproductive organs in males.
- These fish do not have air-bladders.
- These are divided into two sub-classes:
- Selachi
- Bradyodonti eg., Heteroloatas, Scoliodon

Osteichthyes[34]



35

Figure 4: Osteichthyes

✓ These fish are found in marine water, freshwater or brackish water.

- They have a bony endoskeleton.

[34] byjus.com/biology/pisces/
[35] https://www.slideserve.com/said/osteichthyes

- Autostylic jaw suspension.
- They have no claspers.
- The gills are covered with an operculum.
- The air bladders are present in most of them.
- They are further divided into two sub-classes:
- Crossopterygii
- Actinopterygii
- Eg., Proptopterus, Lepidosir.

Activity 2: Guided Practice

Task 16:

From the illustrations below answer question on

1. Analyze the illustrations below and answer questions on them

1

2

3

4

5

6

a. In which fauna order the above animals belong to

ANIMALS	FAUNA ORDER
NO 1	……
NO4	……
NO5	…….
NO2	……..
NO6	……
NO2	……

Activity 3: Application

Task 17:

1. Read the scenario and perform the task:

KIGALI safaris LTD operating in Nyagatare district, received a request from MAKERERE finalist university students who are conducting a research based on different fauna kingdom orders. They want to visit Rwanda to get more experience. And they will spend four (4) days in Rwanda researching on it in different animals' habitats, as one of the knowledgeable persons on fauna and flora, describe for them the orders of kingdom fauna.

You are required to describe the following:

a. Amphibian order
b. Reptile order
c. Pisces order
d. Mammalia order

Topic 2.3: Describing animals' species for touristic importance

Activity 1: Problem Solving

Task 18

1. Respond to the below questions
   a. Describe amphibian species
   b. Describe amphibian species characteristics
   c. Describe amphibian species Geographical location
   d. Describe amphibian species Importance to tourism
   e. Describe reptile species
   f. Describe reptile species characteristics
   g. Describe reptile species geographic location
   h. Describe reptile species Importance
   i. Describe Pisces species
   j. Describe Pisces species characteristics
   k. Describe Pisces species geographic location
   l. Describe Pisces species importance
   m. Describe major mammal species
   n. Describe major mammal characteristics
   o. Describe major mammal geographic location
   p. Describe major mammal importance
   q. Identify endangered animal species

Key Facts 2.2 a: Describing animals' species for touristic importance

- **Description of amphibian species**

  Amphibians are a diverse group of cold-blooded vertebrates that include frogs, toads, salamanders, and newts. They typically have moist, permeable skin and undergo metamorphosis (from aquatic larvae to terrestrial

✓ **Amphibian species**

Common amphibian species include:

- Common frogs and common toads: found in various habitats, including wetlands and forests.
- Palmate newts (Lissotriton helveticus): small newts often seen near water bodies.
- Great crested newts (Triturus cristatus): strictly protected and facing conservation challenges

✓ **Characteristics of Amphibians**

The characteristics of the organisms present in class amphibia are as follows:

- These can live both on land and in water.
- They are ectothermic animals, found in a warm environment.
- Their body is divided into head and trunk. The tail may or may not be present.
- The skin is smooth and rough without any scales, but with glands that make it moist.
- They have no paired fins. Unpaired fins might be present.
- They have two pairs of limbs for locomotion.
- They respire through the lungs and skin. Gills might be present externally in some adults.
- The heart is three chambered.
- The kidneys are mesonephric. The excretory material includes ammonia and urea.
- They possess ten pairs of cranial nerves.
- The lateral line is present during their development.
- The sexes are separate and fertilization is usually external. However, in salamanders, the fertilization is internal.
- Development is indirect with metamorphosis.
- Breeding occurs in water. The copulatory organs are absent in males. i.e frogs, Salamanders.

- ✓ **Amphibians and their geographical location**

  Amphibians live in many different habitats. They can be found in:

  - Ponds and streams,
  - Lakes and wetlands,
  - Deserts and rainforests,
  - Underground habitats,
  - Arboreal habitats.

  In each of these environments, amphibians have adapted to the environmental conditions in order to survive. It is amazing that such a small creature can thrive in so many places. It shows us how adaptive nature can be when it comes to finding a home.

- ✓ **Amphibians' species importance:**

  They play a crucial role in our ecosystems and have significant importance in various aspects as follows:[36]

  - **Bio Wildlife Tourism and Conservation**: w**ildlife-based tourism,** including amphibian viewing, is on the rise. It provides a powerful tool for countries to grow their economies while protecting biodiversity and meeting Sustainable Development Goals. Engaging tourists in wildlife conservation and injecting money into local communities living near wildlife is essential[3].
  - **Food Chain and Animal Models**: Amphibians are part of the food chain, providing resources for various animals, from snakes to raptors.
  - **Research**: they also serve as valuable animal models for laboratory research.
  - **Diversity and Ecosystem Health**: Amphibians contribute to the health of ecosystems, including forests and wetlands. These habitats support fishing, timber industries, and recreational activities, which collectively contribute billions of dollars to the economy. They act as regulators of the food web and nutrient cycling, maintaining ecosystem balance[2].
  - **Conservation Challenges**: Unfortunately, amphibians are declining rapidly, especially in Latin America and the Caribbean, partly due to factors like chytrid

[36] https://armi.usgs.gov/importance-of-amphibians.php

fungal disease. Efforts to protect amphibians are critical for maintaining ecosystem balance and preserving biodiversity[4].

In summary, promoting sustainable wildlife tourism and conserving amphibians are essential for both economic growth and environmental well-being.

- **Describing reptile species**

Reptiles are a fascinating group of air-breathing vertebrates. They include:

- ✓ **Turtles**: characterized by their protective shell.
- ✓ **Tuatara**: a unique reptile found only in New Zealand.
- ✓ **Lizards**: diverse group with various body shapes and sizes.
- ✓ **Snakes**: legless reptiles adapted for a wide range of habitats.
- ✓ **Crocodiles**: large, semi-aquatic reptiles with powerful jaws
- ✓ **Extinct Reptiles**: Apart from living reptiles, there were many diverse groups that are now extinct. For example, pterosaurs, plesiosaurs, and non-avian dinosaurs disappeared during the Cretaceous–Paleogene extinction event.

- **Characteristics of reptile species**

- ✓ **Ectothermic Metabolism**:

  Reptiles are ectothermic, which means their body temperature depends on the external environment. Unlike mammals, they don't regulate their body heat internally.

- ✓ **Amniotic Development**:

  Reptiles lay amniotic eggs, which have a protective membrane (the amnion) that surrounds the embryo. This adaptation allows them to reproduce on land.

- ✓ **Epidermal Scales or Bony Plates**:

  Their skin is covered with scales or bony plates. These structures provide protection and help prevent water loss.

- **Geographical location of Reptiles species[37]**

Reptiles inhabit a wide variety of habitats across the globe. They can be found on every continent except Antarctica. Here are some examples of their preferred environments:

[37] https://flexbooks.ck12.org/cbook/ck-12-biology-flexbook-2.0/section/12.18/primary/lesson/reptile-ecology-bio/

- ✓ **Turtles**: Many turtles live in the ocean, while others inhabit freshwater bodies or terrestrial ecosystems.
- ✓ **Lizards**: Lizards are primarily terrestrial, but their habitats range from deserts to rainforests and from underground burrows to the tops of trees[1].
- ✓ **Crocodilians**: Crocodiles and alligators thrive in freshwater environments such as swamps, rivers, and lakes

- **Reptiles' species importance**

  Reptiles play a crucial role in ecosystems and have significance for both the environment and humans. Here are some key points:[38]

  - ✓ **Preventing Overpopulation:**

    Reptiles are part of the food chain, helping control prey populations. By keeping smaller animal populations in check, they prevent overpopulation. Young reptiles serve as food for hungry predators, maintaining balance in the ecosystem.

  - ✓ **Pest Control:**

    Some reptiles, like venomous snakes and benign species, help control insect and rodent populations. Crocodiles and alligators prevent fish overpopulation in coastal regions and wetlands, maintaining healthy aquatic ecosystem.

  - ✓ **Carrion Cleanup:**

    Reptiles, including the Komodo dragon, play a role in clearing dead animals (carrion) from the environment. Their scavenging behavior helps maintain ecosystem cleanliness.

  - ✓ **Human Interactions:**

    Reptiles have cultural significance. For example, turtles are considered delicacies, and reptile scales are fashionable in many cultures. Snake venom is used to derive vaccines, highlighting their importance in medicine.

  - ✓ **Bio-Indicators:**

    Reptiles act as bio-indicators, reflecting the quality of the ecosystem. Their presence or absence can signal environmental change

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- ✓ **Reptile species importance for Tourism**

  The relationship between herpetofauna (amphibians and reptiles) and tourism is complex and dynamic. Let's explore both the positive and negative impacts:

  - **Positive Impacts**:
    - **Conservation Awareness**: Reptile tourism, including wildlife safaris and reptile-themed attractions, raises awareness about conservation efforts.
    - **Economic Contribution:** Reptile-related tourism contributes to local economies by attracting nature enthusiasts from around the world.
    - **Educational Experiences** : Guided tours allow visitors to witness reptiles up close, fostering appreciation and understanding of these incredible creatures[1].
  - **Negative Impacts**:
    - **Habitat Destruction**: Tourism can lead to habitat destruction, affecting reptile populations.
    - **Disturbance**: Increased human activity disrupts reptile habitats and behaviors.

- **Description of Pisces species**

  Pisces species: also known as fish, belong to the class of aquatic vertebrates. Here are some classifications:

  - ✓ **Placodermi (Agnathans):** An extinct group of armored fish.
  - ✓ **Chondrichthyes (Cartilaginous Fish):** Includes sharks, rays, and chimaeras.
  - ✓ **Osteichthyes (Bony Fish):** The largest group of fish, including most familiar fish species

- **General Characteristics of Pisces species**
  - ✓ **Aquatic**: Pisces are permanently aquatic, living in freshwater, marine, or brackish water.
  - ✓ **Gills for Respiration**: They respire through gills.
  - ✓ **Body Shape**: Typically streamlined and spindle-shaped, divided into head, trunk, and tail.
  - ✓ **Fins**: Fins (paired or unpaired) assist in locomotion.
  - ✓ **Exoskeleton**: Covered by dermal scales, denticles, or bony plates.

- ✓ **Endoskeleto**: Made of cartilage or bone tissue.

- **Pisces geographical location**

  Pisces, which refers to fish, inhabit a variety of aquatic environments. They can be found in freshwater, marine, or brackish **water.**

  Their streamlined bodies and fins allow them to swim efficiently, and they exhibit diverse feeding habits—ranging from herbivorous to carnivorous. While some species thrive in oceans, others inhabit rivers, lakes, and even estuaries[39].

- **Importance of Pisces species**

  Pisces species play crucial roles in aquatic ecosystems. Here are some of their importances:

  - ✓ **Ecological Balance**: Fish help maintain ecological balance by controlling prey populations and serving as prey for other animals. They contribute to nutrient cycling and energy flow within ecosystems.
  - ✓ **Food Source**: Fish are a vital food source for humans and other animals. They provide essential nutrients, including protein, omega-3 fatty acids, and vitamins.
  - ✓ **Biodiversity**: The diversity of fish species contributes to overall biodiversity. Each species occupies a unique niche, enhancing ecosystem resilience.
  - ✓ **Indicator Species**: Fish health reflects water quality. Monitoring fish populations helps assess environmental conditions and pollution levels.

- **Pisces species importance for tourism**:

  The connection between Pisces species (fish) and tourism:

  - ✓ **Ecotourism and fishing**: Many tourists are drawn to destinations known for their diverse fish populations. Ecotourism activities such as snorkeling, scuba diving, and fishing trips allow visitors to appreciate marine biodiversity and observe fish species in their natural habitats
  - ✓ **Aquariums and marine parks**: Tourists often visit aquariums and marine parks to see various fish species up close. These attractions educate visitors about fish biology, behaviour, and conservation efforts.

[39] https://www.toppr.com/guides/biology/pisces/

- ✓ **Sport fishing**: Some tourists specifically seek out destinations for recreational fishing. Whether it's freshwater or saltwater fishing, the presence of abundant fish species attracts anglers.
- ✓ **Cultural significance**: In certain cultures, fish hold symbolic or religious importance. Tourists may participate in fish-related rituals, festivals, or ceremonies.
- ✓ **Conservation Awareness**: Tourism can raise awareness about the need to protect fish habitats and conserve endangered species. Responsible tourism practices promote sustainable fishing and habitat preservation.

- **Description of major mammal species**

A **mammal** is a vertebrate animal belonging to the class Mammalia. They are characterized by several unique features

- ✓ Notable mammalian orders include:
- ✓ **Rodents**: The largest order, including mice, rats, and squirrels.
- ✓ **Bats**: The only flying mammals.
- ✓ **Primates**: Humans, monkeys, and lemurs.
- ✓ **Even-Toed Ungulates**: Pigs, camels, and whales.
- ✓ **Carnivora**: Cats, dogs, and seals.

- **General characteristics of mammals**
  - ✓ **Milk-Producing Mammary Glands:** Mammals have specialized mammary glands that produce milk for feeding their young
  - ✓ **Neocortex Region of the Brain** This part of the brain is associated with higher cognitive functions.
  - ✓ **Three Middle Ear Bones**: These bones aid in hearing
- **Mammals Geographical location**

Mammals inhabit diverse regions across the globe. Let's explore their geographical distribution:

- ✓ **By Continent**: mammals are found on every continent, from the icy expanses of Antarctica to the lush rainforests of South America. Notable examples:
  - **Africa**: Home to iconic mammals like lions, elephants, and giraffes.
  - **Asia**: Tigers, pandas, and snow leopards roam its vast landscapes.
  - **North America**: Bison bears and raccoons thrive here.

- **Australia**: Known for unique marsupials like kangaroos and koalas.
- **South America**: jaguars, capybaras, and anteaters inhabit its diverse ecosystems.
    - **By Country:** some mammals have a global distribution, adapting to various habitats. Examples include rats, mice, and certain bat species.
    - **Cosmopolitan Mammals:** some mammals have a global distribution, adapting to various habitats. Examples include rats, mice, and certain bat species.

- **Importance of Mammals species**

Mammals play a significant role in ecosystems, contributing to their overall health and functioning. Let's explore why mammals are important:

- ✓ **Biodiversity and Ecosystem Stability:** Mammals contribute to biodiversity by adding variety and richness to species within habitats. They help maintain ecosystem stability by regulating populations of other organisms and controlling food webs.
- ✓ **Pollination and Seed Dispersal**: Some mammal species, like bats and certain primates, are essential pollinators. They transfer pollen from one flower to another, aiding plant reproduction. Mammals assist in seed dispersal by consuming fruits and excreting seeds in different locations. This helps plants colonize new areas and maintain genetic diversity.
- ✓ **Pest Control**: Certain mammals, such as bats and rodents, act as natural pest controllers. They prey on insects and rodents, preventing crop damage and disease spread.
- ✓ **Nutrient Cycling** Mammals contribute to nutrient cycling by consuming plants and other organisms**.**
- ✓ **Food Chains and Trophic Cascades** Mammals are key players in food chains and trophic cascades. Their presence or absence can impact other organisms within an ecosystem.
- ✓ **Human Health and Medicine** Many medications and treatments are derived from compounds found in mammalian species.

  Understanding mammalian contributions to human health is crucial.

- ✓ **Cultural and Economic Significance**: Mammals hold cultural value in folklore, art, and literature They contribute to tourism and provide economic benefits through activities like wildlife watching and hunting.

- **Mammalia species importance for tourism**

The relationship between mammals and tourism is multifaceted, with both positive and negative impacts. Let's explore this further:

- ✓ **Marine Mammals and Whale Watch in** Marine mammal-based ecotourism, including whale watching, is a well-established industry. It represents a significant economic activity for many coastal communities[1].
- ✓ **Importance of Sustainable Wildlife Tourism** Wildlife tourism is a powerful tool for countries to grow and diversify their economies while protecting biodiversity.
- ✓ **Post-COVID-19 Outlook** The global tourism industry faced unprecedented challenges due to the pandemic.

Key Facts 2.2b: History of animal tourism

- **Introduction**

Animals are an integral and important part of human life. It is clear that when traveling, tourists often choose places where animals are present. They look for places with wild animals more often.

Wildlife tourism is a huge market and can promote local livelihoods, education and conservation. Opportunities to see and interact with wild animals abound in many tourist destinations around the world, from taking a sloth selfie or feeding a crocodile, to riding an elephant or cuddling a tiger cub, tourists are offered a whole host of experiences by a wide range of facilities and individuals.

Wildlife tourism has many different aspects; safaris in national parks, gorilla trekking, elephant riding, petting, and posing with young wild cats.

Around 110 MILLION people visit wildlife tourist attractions around the globe each year. (World Animal Protection)[40]

- **History of Animal Tourism**

  Animal tourism dates back to Ancient Rome (at least) Capturing and transporting live animals from far away was a way to display wealth and power. Many of them were killed in live hunting shows for amusement. In the Colosseum, there were often animal fights with tigers, lions, and elephants.

  During this time, Romans discovered that elephants could do tricks. These elephants were often shackled and "trained" in between the animal fights for shows what would later be termed as a Circus.

  The fascination with exotic animals continued to the 20th century, with a focus on African safari animals. "Big game" including hunting the Big 5 animals. Even U.S. President Theodore Roosevelt traveled to Africa to hunt game. The animals collected were for the National Museum.

  In the next few decades, zoos and aquariums became more popular. According to The Rose-Tinted Menagerie by William Johnson, dolphins showed their potential as entertainers when one was pushing a pelican feather across the water.

  When the staff threw the feather, the dolphin brought it back. Captive dolphins quickly became entertainers. Over time, this exploitation included other species.

  Illegal trafficking of exotic species is still quite common today. People who have tigers as pets are seen as wealthy and have animal entertainment (Tiger King, anyone?).

- **Forms of Animal Tourism**

  There are a number of types of animal tourism – zoos, aquariums, sanctuaries, orphanages, interactions with wild animals, circuses, shows, sales of exotic animals, photos with exotic animals (such as selfies with tigers), and trophy hunting. Any type of tourism that focuses on human interactions generally is considered a form of unethical animal tourism.

  Many experiences though, can put an animal's welfare at risk and maybe even your own. Often unwillingly and without knowing it, ecotourism is the only form of wildlife

tourism that is ecologically sound, requiring a two-way link between itself and environmental conservation.

Ecotourism embodies the essential principle of symbiotic relationships between varying interests enabling environmental protection resulting both from and in enhanced standards of living for local populations, continued profits for the industry, sustained visitor attraction and revenue for conservation.

Ecotourism relies on the beauty and diversity of nature; it is evident it should not deplete or degrade those resources and thus prejudice its own future. Tourism can also act as a catalyst and even provide finance for improvement of essential services. It has been recognised that as people realise the benefits of ecotourism, support for conservation increases.

The advent of ecotourism provides the conservation community with an opportunity to demonstrate first hand to a growing audience the connections between the health and preservation of protected ecosystems and the global environment.

- **Identification of endangered animal species**

  Endangered animal species list[41]

Common Name	Scientific Name	Conservation Status
African forest elephant		Critically Endangered
Amur Leopard	*Panthera pardus orientalis*	Critically Endangered
Black Rhino	*Diceros bicornis*	Critically Endangered
Bornean Orangutan	*Pongo pygmaeus*	Critically Endangered
Cross River Gorilla	*Gorilla gorilla diehli*	Critically Endangered
Eastern Lowland Gorilla	*Gorilla beringei graueri*	Critically Endangered
Hawksbill Turtle	*Eretmochelys imbricata*	Critically Endangered
Javan Rhino	*Rhinoceros sondaicus*	Critically Endangered
Saola	*Pseudoryx nghetinhensis*	Critically Endangered

[40] https://directionallychallengedtraveler.com/what-is-animal-tourism/
[41] https://www.worldwildlife.org/species/directory?direction

Sumatran Elephant	*Elephas maximus sumatranus*	Critically Endangered
Sumatran Orangutan	*Pongo abelii*	Critically Endangered
Sumatran Rhino	*Dicerorhinus sumatrensis*	Critically Endangered
Sunda Tiger	*Panthera tigris sondaica*	Critically Endangered
Vaquita	*Phocoena sinus*	Critically Endangered
Western Lowland Gorilla	*Gorilla gorilla gorilla*	Critically Endangered
Yangtze Finless Porpoise	*Neophocaena asiaeorientalis ssp. asiaeorientalis*	Critically Endangered
African savanna elephant	*Loxodonta africana africana*	Endangered
African Wild Dog	*Lycaon pictus*	Endangered
Asian Elephant	*Elephas maximus indicus*	Endangered
Black-footed Ferret	*Mustela nigripes*	Endangered
Blue Whale	*Balaenoptera musculus*	Endangered
Bluefin Tuna	*Thunnus Thynnus*	Endangered
Bonobo	*Pan paniscus*	Endangered
Bornean Elephant	*Elephas maximus borneensis*	Endangered
Chimpanzee	*Pan troglodytes*	Endangered
Fin Whale	*Balaenoptera physalus*	Endangered
Galápagos Penguin	*Spheniscus mendiculus*	Endangered
Ganges River Dolphin	*Platanista gangetica gangetica*	Endangered
Green Turtle	*Chelonia mydas*	Endangered
Hector's Dolphin	*Cephalorhynchus hectori*	Endangered

Humphead Wrasse	*Cheilinus undulatus*	Endangered
Indian Elephant	*Elephas maximus indicus*	Endangered
Indus River Dolphin	*Platanista minor*	Endangered
Irrawaddy Dolphin	*Orcaella brevirostris*	Endangered
Monarch Butterfly	*Danaus plexippus*	Endangered
Mountain Gorilla	*Gorilla beringei beringei*	Endangered
North Atlantic Right Whale	*Eubalaena glacialis*	Endangered
Red Panda	*Ailurus fulgen*	Endangered
Sea Lions	*Zalophus wollebaeki*	Endangered
Sea Turtle	*Cheloniidae and Dermochelyidae families*	Endangered
Sei Whale	*Balaenoptera borealis*	Endangered
Sri Lankan Elephant	*Elephas maximus maximus*	Endangered
Tiger	*Panthera tigris*	Endangered
Whale	*Balaenoptera, Balaena, Eschrichtius, and Eubalaen*	Endangered

Source: endangered species list - Search (bing.com)

Activity 2: Guided Practice

Task 19:

1. Read the below questions and answer them
   a. Describe the positive impacts of amphibian species on tourism?
   b. Describe the tourism activities that have negative impacts on mammalia species
   c. Make a list of 5 endangered animal in Rwanda as tourism destination
   d. Which animals' species that live in the rainforest?
2. Identify at least 3 native species (at least 5 for the advanced option) from each category to act as indicator species, including endangered species as appropriate. Species affected by urban-related threats such as residential and commercial development, transportation and service corridors, and pollution should be prioritized
3. Map the observed species throughout the city. Make a report of animal living species that has been reported/observed extincted for few years ago.

Key Facts 2.2 c: Endemic species in Rwanda

Rwanda is home to several fascinating endemic animal species. Here are a few notable ones:

✓ **Checklists of endemic species of Rwanda**[42]

Species	Number	Common names	Scientific names
Mammals species	2	**Hill's Horseshoe Bat** **Rwandan Shaggy Rat**	Rhinolophus hilli (Chiroptera - Rhinolophidae) Dasymys rwandae (Rodentia - Muridae)
Birds species	0		
Reptile species	0		
Amphibians species	4	**Jackie's Reed Frog**	Hyperolius jackie (Anura – Hyperoliidae Hyperolius rwandae (Anura – Hyperoliidae

[42] checklist of endemic species of rwanda - Search (bing.com)

		Rwanda Long Reed Frog **Fischer's Caecilian** **Nyungwe Squeaker**	Boulengerula fischeri (Gymnophiona – Herpelidae Arthroleptis nyungwensis (Anura - Arthroleptidae
Freshwater species	3	**Bulera Haplo** **Rwandese Carp** **Rwasa Barb**	aplochromis erythromaculatus (Cichliformes Cichlidae Labeobarbus platystomus (Cypriniformes Cyprinidae Labeobarbus ruasae (Cypriniformes Cyprinidae)
Swallowtail & Nymphalid Butterfly Species 2	2	**Unmarked Acraea** **Montane Orange Dryad**	Acraea turlini (Nymphalidae) Bebearia dowsetti (Nymphalidae)
Primates' species		**Mountain Gorilla** **Golden Monkey** **Chimpanzee**	(Gorilla gorilla beringei) Cercopithecus mitis kandti Pan troglodytes schweinfurthii

✓ **Biodiversity in Albertine Rift Region** [43]

Biodiversity of the Albertine rift valley.

If diversity was synonymous with richness, then the Albertine rift would among the richest of the regions.

The Albertine Rift or Africa's Western Rift Valley is one of the most biodiverse regions of the African continent and an important one for global conservation. With more

[43] The Albertine rift valley Uganda and Africa (ellingtonsafaris.com)

than half of Africa's birds, 40% of Africa's mammals and about 20% of its amphibians and plants, it contains more vertebrate species than anywhere else on the continent. It also conserves more threatened and endemic species than any other region of Africa, and as a result is a Biodiversity Hotspot, a Global 200 Ecoregion and an Endemic Bird Area. Conservation international also listed the Albertine Rift as one of the world's most **endangered spaces**, based on levels of species endemism and rates of habitat destruction. Human population density in the Albertine Rift is also high with over 1000 people per square kilometer in some areas of the Rift. The Rift has also been a region of great conflict over the past 40 years with civil wars in Uganda, Rwanda, Burundi and the Democratic Republic of Congo (DRC) leaving out Tanzania as the only survival of the conflict.

This juxtaposition of high human population density, high levels of poverty, conflict and high biodiversity means that there are many challenges for conservation in the region. In addition to the Albertine rift valley, experience, you can also have a Queen Elizabeth National park safari.

✓ **In summary** [44] Here are those some key points about its richness:

- **Species Diversity**:
  - The Albertine Rift contains more vertebrate species than anywhere else on the African continent.
  - It hosts over 50% of Africa's bird species, 40% of its mammals, and about 20% of its amphibians and plants[12].
  - Notably, it has a high level of endemism, meaning many species are found only in this region[3].
- **Threatened Species**:
  - Within the mountain forest habitats of the Albertine Rift, numerous species are threatened with global extinction.
  - Over 50% of birds, 39% of mammals, 19% of amphibians, and 14% of reptiles and plants found in mainland Africa occur here3.

[44] Copilot with GPT-4 (bing.com)

- In summary, the Albertine Rift is a crucial area for global conservation due to its remarkable biodiversity and unique species composition.

✓ **International Union for Conservation of Natur (IUCN) Red list**[45]

International Union for Conservation of Nature (IUCN) Red List of Threatened Species is the world's most comprehensive inventory of the global conservation status of biological species. It was founded in 1964 and uses a set of criteria to evaluate the extinction risk of thousands of species and subspecies. The IUCN Red List is used by governmental bodies, non-profit organizations, businesses and individuals.

The IUCN Red List of Threatened Species is a vital resource for assessing the global conservation status of animals, fungi, and plants. Established in 1964 by the International Union for Conservation of Nature (IUCN), it provides comprehensive information on species' health and risk of extinction. Here are some key points:

- **Extinction Risk Categories**: The IUCN Red List classifies species into nine categories based on their risk of global extinction:
  - Not Evaluated
  - Data Deficient
  - Least Concern
  - Near Threatened
  - Vulnerable
  - Endangered
  - Critically Endangered
  - Extinct in the Wild
  - Extinct
- **Current Status**: As of now, the Red List includes **128,918 species**, out of which **35,765 (28%)** are threatened with extinction. Certain groups face higher risks:
  - **Amphibians**: 41% are threatened.
  - **Sharks**: 31% are at risk.
  - Corals: 33% face increased extinction risks since 1990
- **Conservation Decisions**: Beyond being a list, the Red List informs conservation decisions by providing data on range, population size, habitat, threats, and conservation actions. It's a critical tool for safeguarding our planet's biodiversity

[45] Microsoft Copilot in Bing

Activity 3: Application

Task 20:

1. Measure animal species diversity in your area for tourism importance.
2. Select at least 3 of the following taxonomic categories:
   a. Aves
   b. Mammals
   c. Aquatic animals and molluscs (cnidaria, porifera, fish, molluscs)
   d. Invertebrates
   e. Herpetofauna (reptiles and amphibians)
3. Are there endangered animal species in Rwanda? If yes, make a research inventory about the endangered animal species which are in the following area
   a. Volcanoes National Park
   b. Akagera National Park
   c. Nyungwe National Park
   d. Swampy areas
   e. Water bodies
4. In your local community area, conduct research regarding the human activities that lead to the extinction of some Animalia kingdom

Formative Assessment

1. Complete the table below

Animal species	2 characteristics	Geographical location
Mammals species		
Amphibian species		
Reptiles species		
Aves species		
Pisces species		

2. Describe the endangered animal species in the world
   a. Identify any 8 endangered animals in EAC parks
   b. Identify any 5 endangered animals that are found in Rwanda national parks
   c. which measures that can be taken for the protection and conservation of endangered animals?
3. In which kingdom order the following animal belong to:
   a. Cat
   b. Crocodile
   c. Rwenzoli Turraco
   d. Tortoise
2. In your local community area, what are the common human activities that lead to the extinction of some Animalia kingdom.
3. Elaborate and set some rules and regulation for Animalia kingdom protection in your community for tourism importance.

Points to Remember

- Science called systematics deals with classification of organisms.
- Species name (scientific name) of an organism consists of two parts. The first one is the generic name, and both of them together - are the species name.
- The layout (system) of taxonomic categories is hierarchical. The lowest taxonomic category is species. Further categories in case of animals are, respectively, the genus, the family, the order, the class, the phylum and the kingdom.
- Animals are classified based on their characteristics. Some are also heterotrophic, in general, they digest their food within the internal chambers which again distinguish them from algae and plants. Another elite character of these species is that they are motile.
- They obtain their energy either by feeding on plants or on other animals. There are millions of species which have been identified, few share similar characteristics while others differ drastically.

Self-Reflection

1. Read the statements across the top. Put a check in a column that best represents your level of knowledge, skills and attitudes.

My experience Knowledge, skills and attitudes	I do not have any experience doing this.	I know a little about this.	I have some experience doing this.	I have a lot of experience with this.	I am confident in my ability to do this.
Describe taxonomic units of fauna					
Describe Characteristics of Kingdom Animalia					

My experience Knowledge, skills and attitudes	I do not have any experience doing this.	I know a little about this.	I have some experience doing this.	I have a lot of experience with this.	I am confident in my ability to do this.
Identify major phyla of Kingdom Animalia					
Describe class reptilian					
Describe class Amphibia					
Describe class Aves					
Describe class Mammalia					
Describe class Pisces					
Describe animal's species for touristic importance					
Description of amphibian species					
Describe reptile species					
Describe Pisces species					
Describe major mammal species					
Identify endangered animal species					
Demonstrate knowledge of the					

My experience Knowledge, skills and attitudes	I do not have any experience doing this.	I know a little about this.	I have some experience doing this.	I have a lot of experience with this.	I am confident in my ability to do this.
specific fauna in the target area					
Comply with environmental regulations regarding fauna protection					
Promote sustainable and environmentally friendly practices towards biodiversity					

2. Fill in the table above and share results with the trainer for further guidance.

Areas of strength	Areas for improvement	Actions to be taken to improve
1. **2.** **3.**	**1.** **2.** **3.**	**1.** **2.** **3.**

[46]*Figure 5: Rwanda biodiversity*

Unit summary

This unit provides you with the knowledge, skills and attitudes required to describe the biodiversity of Rwanda. It covers the identification of biodiversity of Rwanda, identification of animals, plants, habitats and diversity as well as the threats and solutions to the biodiversity.

46 https://www.google.com/search?sca_esv=95803ec0b5ee4893&sca_upv=1&sxsrf=ADLYWIKZS7Yza21rv6xkbzHvzjZnJlMfoQ:1724065489758&q=nyungwe+canopy+walk&udm=2&fbs=AEQNm0A-2qeMemLzzt_2BVemHLFNuCSl5jMwuDXSDytcTb5xOFugulBwSVKrCaczAYRUt2Z5_be3-rr2W2-c6mcvRLEB79gttjDEYYlNaDN3XV48HCF9aiW_cZgs7qBByuiXW1Zo_HGzjlICv6nAFUxV5m5ITc56bA8_NgrwpyxqQ73ReBQxgyE&sa=X&ved=2ahUKEwjdpNi49ICIAxXLSvEDHQLVKbQQtKgLegQIDBAB&biw=1280&bih=593&dpr=1.5#vhid=gSwTvH2Y14k5gM&vssid=mosaic

Self-Assessment: Unit 3

1. Study the unit illustration above and answer the following questions:
   a. Describe what you are seeing in the illustration?
   b. What do you think will be covered in this unit based on the illustration?

2. Fill in and complete the self-assessment table below to assess your level of knowledge, skills and attitudes under this unit.

   a. There is no right or wrong w ay to answer this assessment. It is for your own reference and self-reflection on the knowledge, skills and attitudes acquisition during the learning process.
   b. Think about yourself: do you think you have the knowledge, skills or attitudes to do the task? How well?
   c. Read the statements across the top. Put a check in a column that best represents your level of knowledge, skills and attitudes.
   d. At the end of this unit, you will assess yourself again.

My experience **Knowledge, skills and attitudes**	**I do not have any experience doing this.**	**I know a little about this.**	**I have some experience doing this.**	**I have a lot of experienc e with this.**	**I am confident in my ability to do this.**
Explain key terms					
Identify types of biodiversity in Rwanda					
Differentiate types of ecosystems					
Description of Rwanda vegetation					
Key animals of tourism importance					
Explain the types of animal and plant habitats					

My experience Knowledge, skills and attitudes	I do not have any experience doing this.	I know a little about this.	I have some experience doing this.	I have a lot of experience with this.	I am confident in my ability to do this.
Describe forests habitat					
Describe aquatic habitat					
Describe grasslands habitat					
Describe deserts habitat					
Describe wetlands habitat					
Describe mountainous and polar habitat					
Explain threats to biodiversity					
Describe environmental degradation					
Describe Deforestation					
Describe climate change					
Describe land use					
Identify isolations to the threats faced by biodiversity					
Describe afforestation					
Describe Environmental conservation					

My experience Knowledge, skills and attitudes	I do not have any experience doing this.	I know a little about this.	I have some experience doing this.	I have a lot of experience with this.	I am confident in my ability to do this.
Describe Leave no trace principles					

Key Competencies

Knowledge	Skills	Attitudes
1. Explain key terms	1. Differentiate types of ecosystem	1. Comply with environmental regulations regarding biodiversity
2. Identify types of biodiversity in Rwanda	2. Description of Rwanda vegetation	2. Promote sustainable and environmentally friendly practices towards biodiversity
3. Explain key animals of tourism importance	3. Describe forests habitat	
4. Explain the types of animal and plant habitats	4. Describe aquatic habitat	
5. Explain threats to biodiversity	5. Describe grasslands habitat	
6. Identify isolations to the threats faced by biodiversity	6. Describe deserts habitat	
	7. Describe wetlands habitat	
	8. Describe mountainous and polar habitat	
	9. describe environmental degradation	

Knowledge	Skills	Attitudes
	10. Describe deforestation	
	11. Describe climate change	
	12. Describe land use	
	13. Describe afforestation	
	14. Describe Environmental conservation	
	15. Describe leave no trace principles	

Discovery activity

Task 21:

1. Read the questions below and answer them.

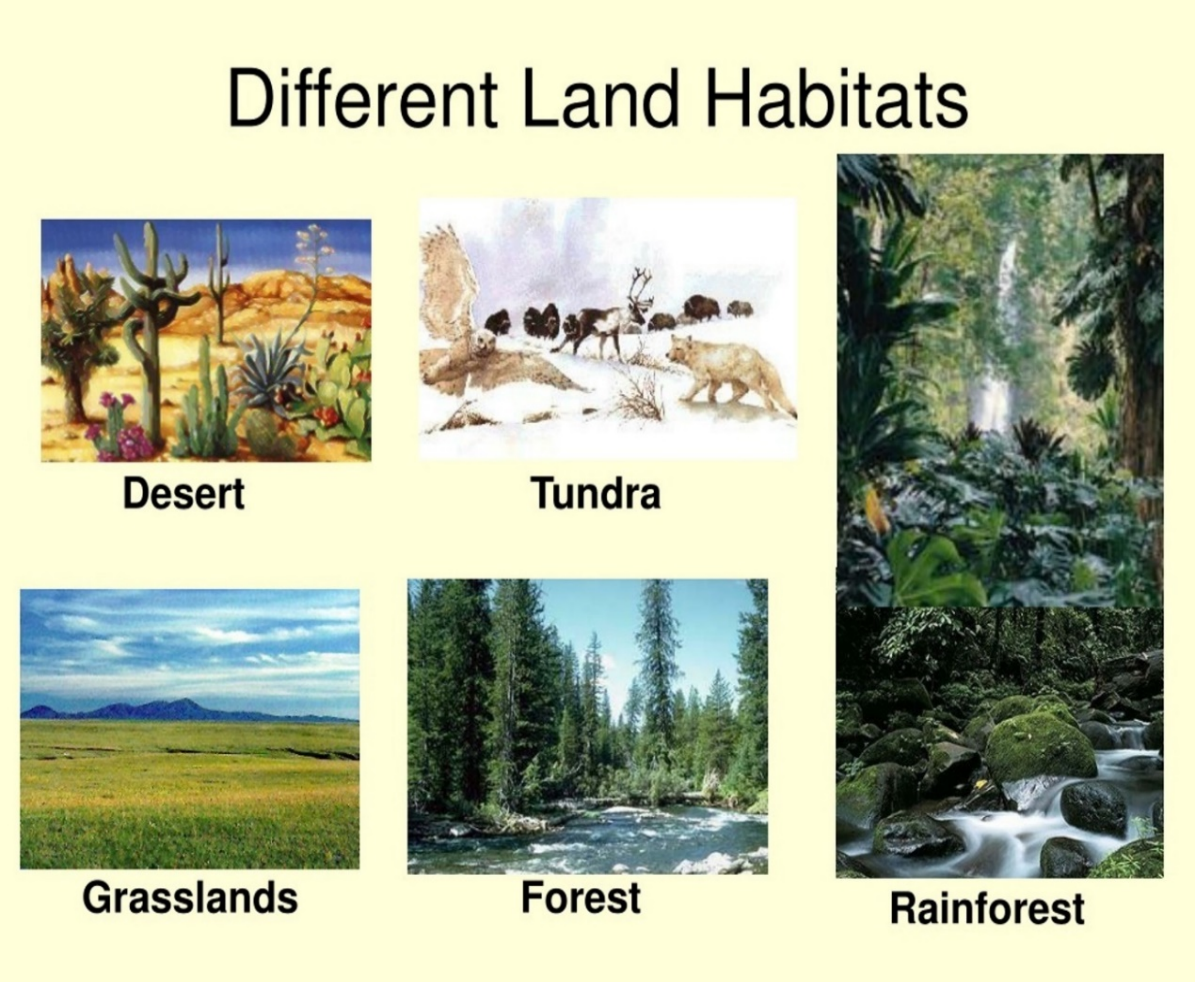
   a. Identify types of biodiversity in Rwanda
   b. Differentiate types of ecosystems
   c. Describe Rwanda vegetation
   d. What are the key animals of tourism importance in Rwanda
   e. Describe forests habitat
   f. Describe aquatic habitat
   g. Describe grasslands habitat
   h. Describe deserts habitat
   i. Describe wetlands habitat
   j. Describe mountainous and polar habitat
   k. Describe threats to biodiversity in Rwanda
   l. Describe mechanisms in place to eradicate/reduce the threats faced by biodiversity in Rwanda

Topic 3.1: Identifying biodiversity of Rwanda

Activity 1: Problem Solving

Task 22:

1. Analyze the illustration below and answer the questions on it.



a. Describe the above habitats
b. What are among the above habitats exist in Rwanda?
c. What do not exist in Rwanda and what could be the reasons?
d. What kind of other habitats exist in Rwanda which are not mentioned on the picture?

Key Facts 3.1: Classification of biodiversity of Rwanda

- **Definition of Key terms**.[47]
  - ✓ **Ecology** is the branch of biology that studies how organisms interact with their environment and other organisms.
  - ✓ **Ecosystem:** refers to a geographic area where living thing or biotic factors and non-living thing or abiotic factors, work together to create a bubble of life.
  - ✓ **Biodiversity** represents the variety of life on Earth, including the full range of ecosystems, species, and genes
  - ✓ **Biomes:** refers to the community of plants and animals that occur naturally in an area, often sharing common characteristics specific to that area.
  - ✓ **Wildlife**: refers to animals and plants that grow independently of people, usually in natural conditions.
  - ✓ **Habitat:** refers to a natural home or environment of an animal, plant, or other organism.
  - ✓ **Genetic:** refers to the study of genes and inheritance in living organisms.
- **Types of biodiversity**

  Biodiversity can be defined as the variability of life expressed at the ecosystem, species and genetic levels. It provides a large number of goods and services that sustain our lives. Biodiversity is the combination of life forms and their interactions with each other and with the rest of the environment that has made the earth a uniquely habitable place for humans (SCBD 2000). The biodiversity we see today is the fruit of billions of years of evolution, shaped by natural processes and, increasingly, by the influence of humans.

  The term **biodiversity** was given by Edward Wilson. **Biodiversity** is a combination of two words **'bio'** and **'diversity"**.[48]

[47] https://documents.worldbank.org/en/publication/documents-reports/documentdetail/344901481176051661/biodiversity-offsets-a-user-guide
[48] https://www.embibe.com/exams/importance-of-biodiversity

- **There are 4 main types of biodiversity**
  - ✓ **Genetic Diversity:** Is the combination of different genes found within a population of a single species, and the patterns of variation found within different populations of the same species.

Figure: genetic diversity: corn

Source: genetic diversity of corn crops - Search Images (bing.com)

Figure; genetic diversity in giraffe

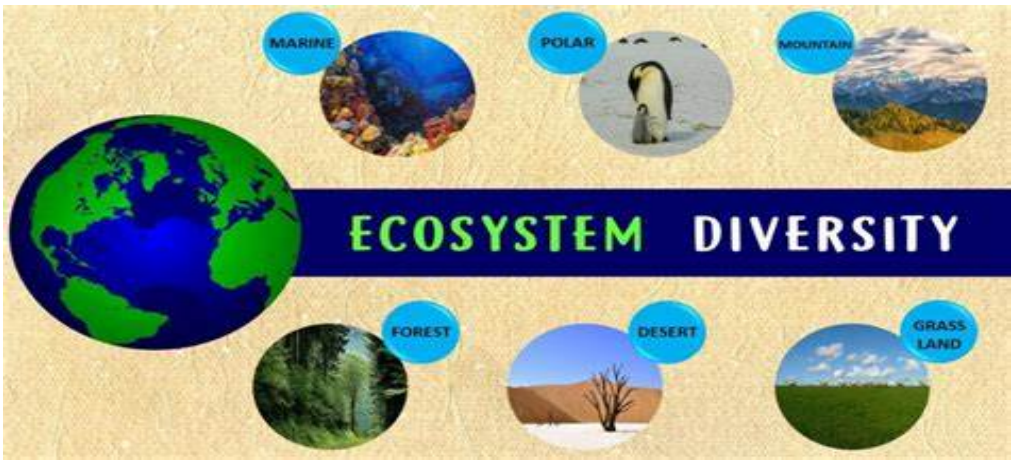
Source: genetic diversity examples in animals - Search Images (bing.com)

- ✓ **Species diversity:** The variety and abundance of different types of organisms which inhabit an area.

Figure; species diversity in animals / Figure: species diversity in plants

Source: species diversity images - Search (bing.com)

- ✓ **Ecological diversity (Ecosystem):** This is the variety of habitats that occur within a region, or within the mosaic of patches found within a landscape.



Figure;: Ecological diversity

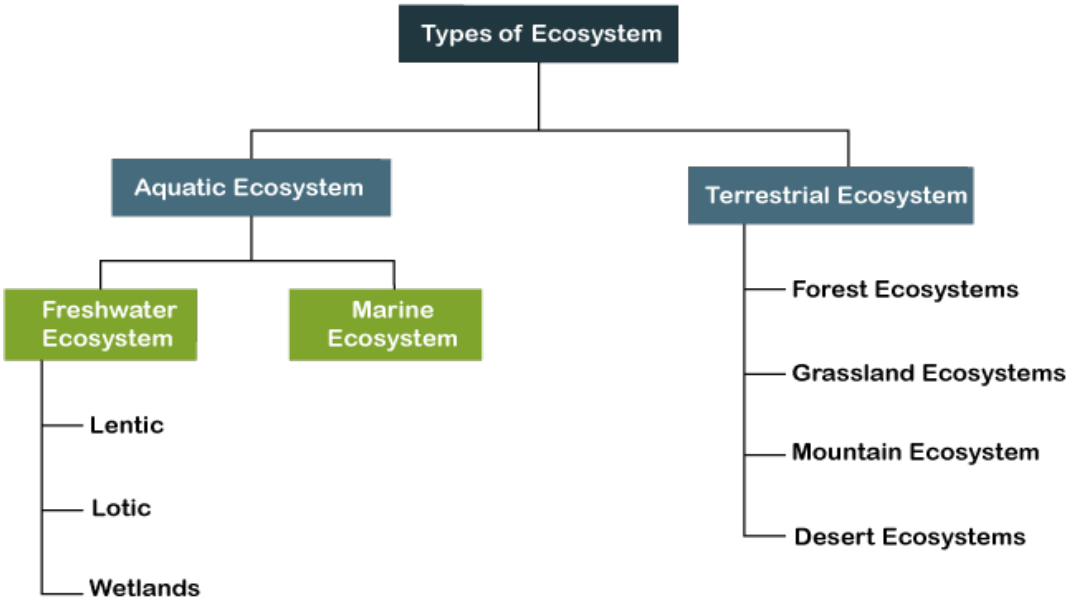
Source: species diversity images - Search (bing.com)

- ✓ **Functional diversity:** Refers to the variety of biological processes, functions, and characteristics of organisms in an ecosystem. Functional diversity affects the ecosystem and the biodiversity of a particular niche. Some examples of functional diversity include the role of different traits on ecosystem functioning, the patterns of species co-occurrence, community assembly, and understanding species competitive abilities.

Functional diversity is a component of biodiversity that generally concerns the range of things that organisms do in communities and ecosystems.

- **Types of ecosystems**

  There are different types of ecosystems based on different climates, habitats, and life forms. This means that ecosystems can typically be divided into hundreds and thousands of smaller systems. However, all such types generally fall into one of the following two categories: aquatic ecosystem and terrestrial ecosystem



Source: https://www.javatpoint.com/types-of-ecosystem

✓ **Terrestrial ecosystem:**

Terrestrial ecosystem refers to all such ecosystems which are mainly located on land. Although the presence of water in these ecosystems is measured, they are entirely land-based and exist on land. More specifically, a low and sufficiently needed amount of water is located in terrestrial ecosystems. The low amount of water separates these ecosystems from aquatic ecosystems. Besides, terrestrial ecosystems typically have temperature fluctuations in both seasonal and diurnal climates. It is also a specific factor that makes these ecosystems different from aquatic ecosystems in similar environments.

Furthermore, the availability of light is somewhat higher in terrestrial ecosystems than in aquatic ecosystems. The reason for this is that the climate in the land is relatively more transparent than water.

Due to entirely different light availability and temperature in terrestrial ecosystems, they have diverse flora and fauna. Terrestrial ecosystems include various ecosystems distributed around different geological zones.

Terrestrial ecosystems are mainly classified into the following types:

- ✓ **A forest ecosystem**

Is an ecosystem where many organisms live together with the environment's abiotic components. There are much different flora and fauna in this ecosystem. This usually means that the forest ecosystem has a high density of living organisms that live with non-living abiotic elements. The forest ecosystem usually includes various plants, microorganisms, animals, and other species.

Forests are significant carbon sinks and participate in controlling and balancing the overall temperature of the Erath. Changes in the forest ecosystem affect the entire ecological balance, and severe changes or destruction of forests can also kill the whole ecosystem. Forests are generally classified into tropical deciduous forests, tropical evergreen forests, temperate deciduous forests, temperate forests, and Taig.

- ✓ **Grassland ecosystems**

Are referred to as those ecosystems where the number of trees is low. These ecosystems mainly consist of grasses, shrubs, and herbs. That means grasses are the primary vegetation in these ecosystems, along with legumes that typically belong to the composite family.

Grassland ecosystems are commonly situated in both the tropical and temperate regions globally; however, they have distinct variations. Examples of these ecosystems include the savanna grasslands and temperate grasslands. They are home to various grazing animals, insectivores, and herbivores.

- ✓ **Mountain Ecosystems**:

As the name suggests, the mountain ecosystem is characterized by mountainous regions where the climate is usually cold, and rainfall is low. Due to these climate changes, these ecosystems have a wide variety of habitats where various animal

and plant species are found. The high-altitude areas of mountainous regions have a cold and harsh climate. This is the reason why only treeless alpine vegetation is found in these ecosystems. Animals found in these ecosystems usually have tick fur coats to protect them from cold climates.

Besides, mainly coniferous trees exist on the lower slopes of the mountains. Examples of mountain ecosystems include mountain tops in Arctic regions. They are covered with snow for most of the year.

- ✓ **Desert ecosystems**

Exist worldwide and cover about 17 percent of desert areas. These are areas where annual rainfall is usually measured less than 25 mm. Due to fewer trees and land of sand, sunlight intensifies in these ecosystems. This is why these ecosystems have incredibly high temperatures and low availability of water. However, the nights are quite cold.

The Desert ecosystem has unique flora and fauna. Plants grow with small amounts of water and conserve water's possible amount in their leaves and stems. For example, the spiny-leafed cactus is a type of desert plant that has the characteristic of storing water using a stem. Similarly, animals are also adopted to the condition of desert ecosystems. Some common animals are camels, reptiles, a diverse range of insects and birds.

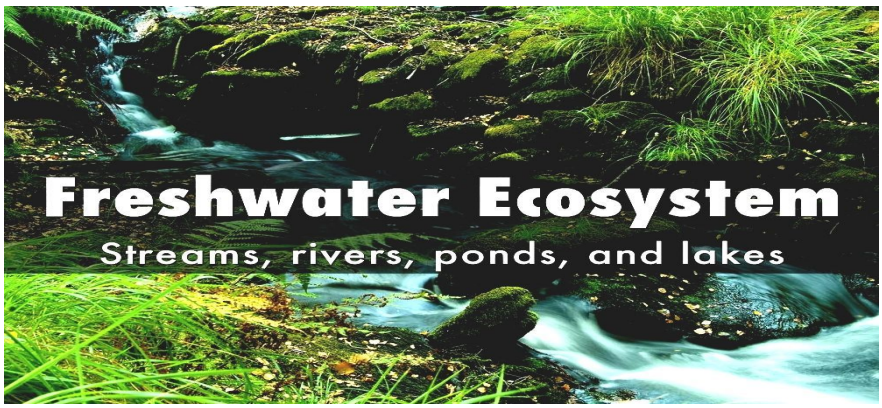
- ✓ **Aquatic ecosystem**

Aquatic ecosystems refer to all such ecosystems that are primarily located on or inside water bodies. The nature and characteristics of all living and non-living organisms in the aquatic system are determined based on the environment surrounding their ecosystem. Organisms in these ecosystems interact with other organisms in aquatic and terrestrial ecosystems.

Source: aquatic ecosystems photos - Search Images (bing.com)

The aquatic ecosystem is mainly sub-divided into the following types:

- **The freshwater ecosystem** is one of the essential ecosystems for humans and other organisms living on land. This is because this ecosystem is a source of drinking water. Additionally, it also helps in providing the necessary energy and water for transportation, recreation, etc. Freshwater ecosystems mainly include lentic, lotic, and wetlands.
    - **Lentic**: Water bodies that are moving slowly or are still in some places come under lentic. For example, ponds, lakes, pools, etc. Lakes are known as large water bodies and are surrounded by land.
    - **Lotic**: Water bodies that are moving at a fast pace fall under a lotic. For example, streams and rivers.
    - **Wetlands**: Environments characterized by soils saturated with water for a long time fall under wetlands.
    - The freshwater ecosystem is the smallest type of ecosystem among the major types of ecosystems. There is usually no salt content in the freshwater ecosystem. Besides, it consists of many insects, small fish, amphibians, and various plant species. Plants help provide oxygen through photosynthesis and also provide food for the organisms living in this ecosystem.



- **Marine ecosystems:** are usually characterized by the presence of salt content. These ecosystems have a higher salt content than the freshwater ecosystem. Moreover, they are known as the largest type of ecosystem on Earth. It usually includes all the oceans and their parts. Besides, marine ecosystems have a distinctive flora and fauna, which support greater biodiversity than freshwater ecosystems. This type of ecosystem is essential for both marine and terrestrial environments.

  In particular, this ecosystem includes salt marshes, lagoons, coral reefs, estuaries, intertidal zones, mangroves, seafloor, and deep seas. Salt marshes, mangrove forests, and sea-grass meadows are said to be among the most productive ecosystems. Coral reefs are known to provide adequate quantities of food and shelter to most marine inhabitants worldwide.

Source: marine ecosystem photos - Search Images (bing.com)

- **Current state of biodiversity in Rwanda**

  Although Rwanda is a small country, it has a remarkable variety of ecosystems and of flora and fauna. Its location at the heart of the Albertine Rift eco-region in the western arm of the Africa Rift Valley is a contributory factor. This region is one of Africa most

biologically diverse regions. It is home to some 40 per cent of the continent mammal species (402 species), a huge diversity of birds (1,061 species), reptiles and amphibians (293 species), and higher plants (5,793 species) (Chemonics International Inc. 2003, MINITERE 2005).

- ✓ **Introduction of alien species**

  The water hyacinth Eichhornea crassipes which was introduced as an ornamental plant. It has since has invaded lakes in Rwanda from Muhazi to Rweru from the River Nyabarongo, and even reached Lake Victoria through Akagera River. The water hyacinth has invaded several lakes in the Akagera complex. Lake Mihindi has now been completely covered by this plant (MINITERE 2003).

  The water hyacinth is a major biodiversity problem in the inland water ecosystem of the Lake Victoria Basin.

  Lantana camara, also introduced as an ornamental plant, has become a weed and in some areas a habitat for tsetse flies.

  Other documented introductions include fish such as Astatoreochromis alluandi, Schilbe mystus and Cyprinus carpio introduced into Lake Mugesera; these have spread to all the water bodies of the Akagera complex. There is also Protopterus aethiopicus introduced in Lake Muhazi in 1989 which is considered by many as invasive (Chemonics International Inc. 2003, MINITERE 2003b).

  In the last few years, uncontrolled introduction of plants has been taking place. In some instances they are propagated without undertaking enough studies on their ecology. Such plants include Macadamia, Moringa, Neem, mulberry-trees, and recently Jatropha for bio-fuels. These introductions are made without meeting the phytosanitary and confinement requirements in ISAR field trials. This may lead to the introduction of invasive species or other pathogens in Rwanda.

- ✓ **Opportunities provided by biodiversity**

  There are a multitude of anthropocentric benefits from biodiversity in the areas of agriculture, science and medicine, industrial materials, ecological services, in leisure, and in cultural, aesthetic and intellectual value. There are many benefits that are obtained from natural ecosystem processes.

Some ecosystem services that benefit society are air quality, climate moderation (global, regional and local CO2 sequestration), water purification, disease control, biological pest control, pollination and prevention of erosion. Along with those come non-material benefits that are accrued from ecosystems: spiritual and aesthetic values, knowledge systems and the value of education that we obtain today.

- ✓ **Economic and livelihood support**

Through domestication and direct harvesting from the wild, Rwandans derive food, medicines and a wealth of other products from biodiversity and genetic resources. The range of agro-biodiversity found around the country contributes significantly to livelihoods, food security and poverty alleviation due to their superior adaptation to the local environmental conditions and are likely to contribute more even in the future. For instance the value of ecological goods and services provided by Nyungwe forest is estimated at a minimum US$ 285 million a year, with the major beneficiaries being ELECTROGAZ, Regideso Burundi, the Public Offices in Charge of Tea and Coffee (OCIR), the Rwanda Tourism Board Offices (ORTPN), tour operators, the rice farmers cooperative in Bugarama and the global community (Masozera 2008).

With a large number of flowering plants and its richness in orchid species, Rwanda can develop its horticulture sector. In 2009 flowers are projected to earn the country US $0.57 million in exports and over the three year period (2008-2010) the value of flower exports is projected to increase by an average of 23 per cent per year (MINECOFIN 2007).

There are also emerging opportunities for biodiversity including the carbon credit market. Stored carbon in Nyungwe Forest is valued at an estimated US$ 162 million a year, whereas watershed protection services, water supply for irrigation, human consumption and industries, as well as flood protection are worth at an estimated US$ 117 million annually (Masosera 2008). The monetary value of biodiversity maintenance amounts to US$ 2 million, and recreation and tourism is good for at minimum US$ 3.3 million a year.

- ✓ **Tourism opportunities**

  Nature-based tourism is one of the fastest growing tourism sectors worldwide and in Africa (UNEP 2006). Although a non-traditional export sector for Rwanda, tourism has the potential to contribute significantly to the country export base. From a negligible base of a less than US$5 million in 2002, tourism receipts hit US$33 million in 2006 and are on track to exceed this figure in 2007 (ROR 2007). It is worth noting that Rwandan tourism is mainly based on visits in national park, with the Volcanoes National Park, the most visited park. The rich biodiversity of Rwanda, including bird-watching provide an opportunity for the development of the tourism sector in Rwanda

- ✓ **Research and medicinal purposes**

  Genetic resources can be used as biochemical precursors in the synthesis of pharmaceutical and agricultural products and in cosmetics. Examples of genetic resources of interest includes the Prunus africana found in Nyungwe which serves as a basis for prostate cancer, Aloe vera which widespread in Rwanda and is used in the pharmaceutical and cosmetic industry, and other medicinal trees and plant species.

  As shown before, the biodiversity of Rwanda has not been exhaustively studied and there are opportunities for research in new taxa or new species and also for bio-prospecting. For example there are some components of biodiversity used for traditional medicine or other uses that need to be documented.

Activity 3: Guided Practice

Task 23:

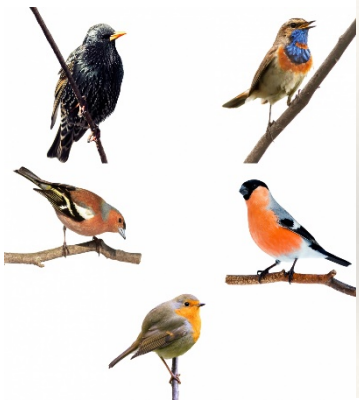
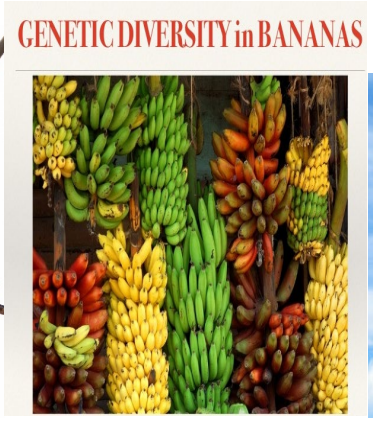
1. Analyse the pictures below and answer by TRUE or FALSE



A) Genetic diversity (….) **B) Species diversity (….)** **C) Mangrove ecosystem (….)**

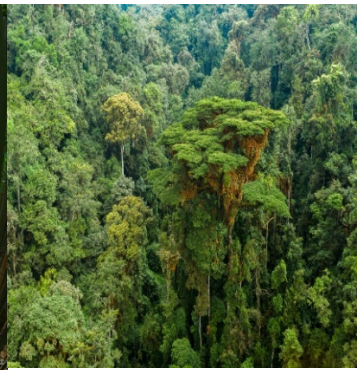


D)Aquatic ecosystem (….) **E) Grassland ecosystem (….)** **F) Ecological ecosystem (….)**

G) Genetic diversity (….) **H) Species diversity (….)** **I) Species diversity (….)**





J) Bamboo thicket(……) **Accassia tree (……..)** **Tropical Rainforest (…….)**

2. Describe each item of the ecosystem and where they are located in Rwanda

Important birding areas in Rwanda[49]

There are 7 main important birding areas in Rwanda include:

Kigali City

The countries in East Africa are blessed with incredible opportunities for birding. In the case of Rwanda or even Uganda, birdwatching can start as soon as you come out of the airport or even in the large cities. Urban Birding in Kigali is suitable for those who have limited time to venture into the countryside or visit the major national parks.

Nyarutarama

Nyabarongo

Mount Kigali.

Nyandungu Eco-park

Nyungwe National Park

Nyungwe National park is the largest and oldest montane forest in Africa. There are over 300 species of birds found on the forest.

The Bigugu Mountain in the forest is one of the best spots for observing the birds as they feed on the tree canopies.

Gisakura tea estate which is a favorite of the birds. The Red-collared Babbler is arguably the most popular and attractive species in Nyungwe National Park.

canopy walk. The canopy walkway in Nyungwe forest is 160 meters long and is built on top of the trees giving you an aerial view of the vast forest and its creatures.

Kamiranzovu swamp

[49] important birding areas in rwanda - Search (bing.com)

Akagera National Park

Akagera National Park is a collection of lakes, wetlands, rolling hills and savannah which combine to attract 310 species of birds. The park lies in the north eastern side of the country close to the border with Tanzania. The best birding sports are

Around Lake Ihema

The African Starling is arguably the most beautiful bird in Akagera. They have amazing feathers which change color and glitter in the mid-day sun. Spotting this bird is one of the highlights of a birding safari in Akagera.

Volcanoes National Park[50]

This park is more famous for gorilla trekking, golden monkeys and hiking one of the volcanoes like Karisimbi. However, this does not change the fact that it is one of the best places for birding in Rwanda. About 200 species can be found in the park. 27 of them can only be seen here while in Rwanda while 16 are endemic to the volcanoes in the Virunga ranges of mountains.

Gishwati-Mukura National Park

This is Rwanda's newest national park and is found in the Northwestern part of Rwanda. Even before it became a national park, Gishwati was known as Rwanda's prime spot for birding with 395 species on offer. Some of them include the Martial Eagle, Purple-breasted Sunbirds, Red-throated Alethe, Regal Sunbirds, Ruwenzori Batis, Ruwenzori Turaco, Strange Weaver, Stripe-breasted Tit and the Grey Crowned Crane. Most of the species are forest dwellers or those endemic to the Albertine Rift.

Lake Kivu

Lake Kivu is more known for its beautiful beaches, islands and as one of the best places for sport fishing sport in Rwanda. It is easy to forget that the Lake is a top birding destination in its own right. The natural beauty of the lake and its islands attract White-breasted Cormorants and Pied Kingfishers. Thousands of migratory birds can be sighted feeding round the lake during certain months of the year together with the residents. For a complete birding experience in Lake Kivu, you must visit

[50] important birding areas in rwanda - Search (bing.com)

Nkora Island. Nkora Island is a small fishing village with an amazing collection of water birds and even cave bats. You will also get to mingle with the local fishermen and learn about how they make ends meet.

Wetlands, marshes and Nyabarongo River

10 percent of Rwanda is made up wetlands, swamps and marshes. The major wetlands and marches include

Rugezi, Akanyaru . These wetlands provide naturel feeding and nesting grounds for the birds because they keep away most predators while also proving insects and frogs for food. The Rugezi Marsh is a top birding destination and the only RAMSAR site in Rwanda. The marsh covers an area of about 6,734 hectares, and is host to about 43 bird species including the Grauners Swap Warbler, Papyrus Genolek, Papyrus Yellow Walber and Thick Billed Seedeater. As you go southwards from the marsh, you will find open waters in what is Lake Nyagafunzo. This lake is a birders paradise in its own right. It offers opportunities to spot the Lesser Jacana and White-backed Duck.

The wetlands in Nyabarongo river are not well known but offer wonderful birding opportunities. The Nyabarongo river is a tributary of the great river Nile and empties its waters on river Akagera which then flows to Lake Victoria. Other wetlands and marshes that host birding sanctuaries are those

In Bugesera District and Akanyaru.

Akanyaru wetlands are found along the border with Burundi. They stand out for their floating vegetation and papyrus swamps. Here you can spot the about 54 species of birds including the lesser kestrel, Madagascar squacco Heron, pallid harrier and the endangered papyrus Gonolex.

Activity 3: Application

Task 24:

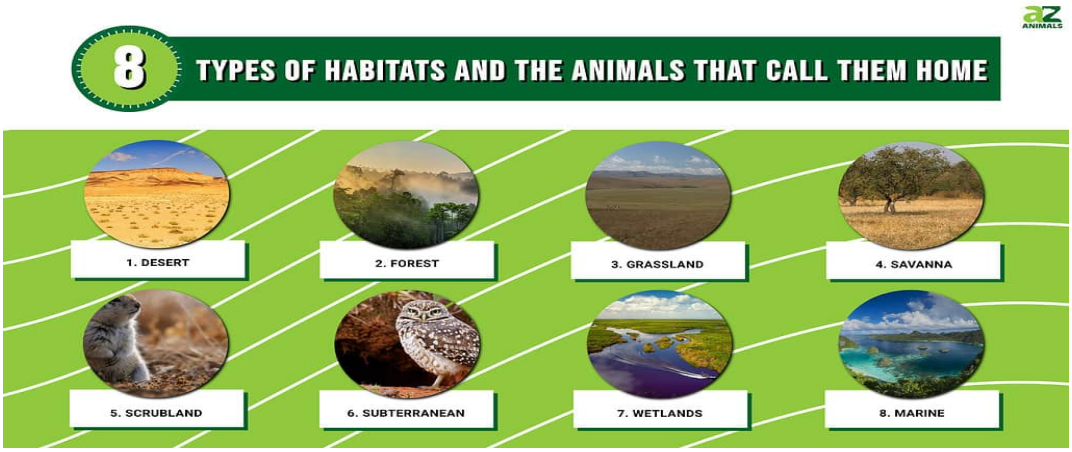
1. Pick one of ecosystem within and/or outside of Rwanda and share how it is relevant in our lives and the significance it has to local community
2. Conduct research on the various types of ecosystems found in Rwanda
3. Demonstrate the relationship between ecosystem types and life on the earth
4. Using a ball of string, create links between the different plants, animal, insect on dependency for food, shelter and competition.
5. Demonstrate the level of dependency on the survival of some organism species within an ecosystem

Topic 3.2: Identifying animals and plants habitats

Activity 1: Problem Solving

Task 25:

1. Analyse the illustrations below and answer questions on them



   a. The above images are habitats and animal, can they be found in Rwanda biodiversity?

   b. How many types of animal and plants habitats exist in Rwanda?

   c. Differentiate them from the illustration

2. Answer the questions below using the illustrations that follow

   a. Among the animals below, select major 5 of tourism importance

   b. Identify their habitats

   c. Explain their role in tourism development

Key Facts 3.2: Identification of animals and plants habitats

- **Rwanda main ecosystems and habitats for tourism importance**

The Albertine Rift is considered to have the highest species richness in Africa. It is considered a biodiversity hotspot containing more endemic mammals, birds, butterflies, fish and amphibians than anywhere else in Africa. Habitats supporting such an array of biodiversity are very varied. Being at the heart of the Albertine Rift, Rwanda's habitats are equally varied, ranging from afro-montane ecosystems in the northern and western regions to lowland forests, savannah woodlands and savannah grasslands in the southern and eastern regions. There are other habitats around volcanic hot springs and old lava flows, especially in the northern and western part of the country. Rwanda also has several lakes and wetlands which are rich in different species. Though not yet well surveyed, all these ecosystems host a rich variety of fauna and flora and micro-organisms.

Besides these natural ecosystems, as an agrarian country, Rwanda agro-ecosystems comprise cultivated land, agro-pastoral areas, grassland, grazing and fallow land (MINITERE 2003a).

✓ **Plants habitats**

Flora: Rwanda harbours very diverse flora due to a considerable geo-diversity and a climatic gradient from west to east. The number of vascular plants is estimated at around 3000 species originating from the different bio-geographical regions (Fischer and Killmann 2008).

Rwanda constitutes the eastern limit for plants from the Guineo-Congolian region. An example of these plants is the Thonningia sanguinea (Balanophoraceae), widespread in Western and Central Africa. It is only found in the Cyamudongo forest in western Rwanda. Plants from the afromontane region are confined to higher altitudes, such as the orchid Disi robusta found in Nyungwe forest. The Eastern African savannah elements comprise the Zambezi floral region, and most these plants are found in the Akagera National Park and its surroundings (Fischer and Killmann 2008).

About 280 species of flowering plants from Rwanda are considered to be endemic to the Albertine Rift. Of these endemic species, about 20 are restricted to Rwanda, 50 species confined to Rwanda and Eastern Congo and 20 species found only in Rwanda and Burundi. Twenty one species are found additionally in the forests of western Uganda, eastern Congo, Rwanda and Burundi. Examples of these distribution types are Impatiens bequaertii (Balsaminacea), Impatiens mildbraedii (Balsaminacea), Monathotaxis orophila (Annonaceaa) or Liparis harketii (Orchidaceae) (Fischer and Killmann 2008).

Rwanda has 56 local endemic flowering plants, out of which 47 are confined to Nyungwe National Park (including Cyamudongo forest). Examples of these plants are the recently discovered species Impatiens nyungwensis Eb.Fisch., Detchuvi & Ntaganda, (Balsaminaceae) Afromomum wuertii Dhetchuvi & Eb. Fisc (Zingiberaceas), Diaphananthe delepierreana Lebel & Geerinck (Orchidaceae) and Ypsilopus liae Delpierre and Lebel (Orchidaceae) all endemic to Nyungwe National Park (Fischer and Killmann 2008). The number of these newly discovered species shows that the number of plant species found in Rwanda is far from being totally known.

The afro-montane ecosystems comprised of the Volcanoes and Nyungwe National Parks, Gishwati and Mukura Natural Forests, and other small forests found at the Congo-Nile Ridge, is varied and rich in plant species.

The biodiversity in the lowlands of the eastern part of Rwanda comprises mainly savannah with grasses, bushes and trees, mountain rainforests in the Akagera National Park and gallery forests in the eastern part of Rwanda.

Gallery forest around lakes and other water bodies are mainly found in the Akagera complex, where they cover almost 163 hectares (Twarabamenye and Gapusi 2000 in MINITERE 2003a). The flora of these forests comprise 66 species including Acacia kirkii, Acaccia polycantha, Acacia sieberana, Albizia gummifera, Cordia Africana, Crotonmacrostachis, Dombeya burgessia, Dombeta kirkii, Erythria absysniica,

Newtonia buchananii and Techlea nobilis. There are also some rare or threatened species such as Impantiens irvingii, Markhamia lutea, Eulophia guineensis and Pterygota mildbraedii, considered a fossil plant (MINAGRI 1998).

Rwanda is a landlocked country in East Africa with a topography characterised by steep hills and high mountains.

Rwanda's natural wetland, forest, and savannah ecosystems provide a wide range of services that increase the climate resilience of local communities, such as erosion control and flood mitigation.

Most of the plant species found in these forests are used in traditional medicine and some plants reveal important biochemical extracts. This is the case with Blighia unijugata, Grewia forbesi, Rhus vulgaris, Pterygota mildbraedii and Ficus species (MINITERE 2003a).

With more than 104 flower species, wetlands and aquatic ecosystems are also rich in biodiversity. Some lakes such as Kivu, Bulera and Ruhondo are poor in macrophytes (MINITERE 2003a). About 50 species of plankton are found in these

ecosystems distributed in the following families: Chlorophyceae, Cynaphyceae, Pyraphytes, Bacillariophyceae, Cynophyceae, Pyrophytes, Euglenophyceae, and Diatomophyceae. There are reports of colonization of Nymphea nouchalii and Nymphea lotus in the lakes of the eastern region. The Water hyacinth (Eicchornia crassipes) presents a big threat to the biodiversity of these lakes. The flora is dominated by Cyperus papyrus. Some of these lakes are associated with gallery forests with the dominating species being those of the genuPhoenix, Bridelia, Ficus, Aeschynomene and Echinochloa. Ferns are also found and in some places there are Echinochloa pyaramidalis.

The agro-ecosystems have food crops species like Sorghum, Phaseolus vulgaris, Eulisine corocan, Colocasia antigonum, Zea mays, Oryza sativa, Triticum sp., Hordeum vulgare, Pisum sativum, Soja hispada, Arachis hypogea, Ipomea durcis, Irish potatoes, Manihot esculenta and the banana (Musa). They are also commercial crops like coffee, tea and pyrethrum. The agricultural production systems also accommodate many related wild species, the most common being Eragrostis sp., Bidens pilosa, Digitaria sp., Conyza sumatrensis, Cyperus sp. There are also plant forage crops including Tripsacum laxum, Setaria sp, Desmodeum sp. Pennisetum purpureum, Mucuna pruriensis, Cajanus cajan Calliandra calothyris, Leucaena diverifolia, and Sesbania sesban (MINITERE 2003a).

Tree species found in Rwanda include Ficus thoningii, Euphorbia tirucalli, Erythrina abyssinica, Verminia amygdalena, Dracaena afromontana, among others. The first afforestation efforts took place between 1920 and 1948 during which time Eucalyptus was introduced. Other species introduced later included Pinus sp, Callistris sp, Grevillea robusta, Cedrella sp, and Cupressus. (MINITERE 2003a).

- ✓ **Animal habitats**

  Rwanda shelters 151 different types of mammal species, eleven of which are currently threatened and none of which are endemic. Among them are the primates (14 to 16), with half of the remaining world population of mountain gorillas (Gorilla gorilla berengei).

The gorillas are found in the Volcanoes National Park. Others includes the owl-faced monkey (Cercopithecus hamlyni), the mountain monkey (Cercopithecus hoesti) in Nyungwe, the Chimpanzee (Pan troglodytes) in Nyungwe and Gishwati, and the Golden monkey (Cercopithecus mitis kandti) found in Volcanoes National Park. There are also 15 species of antelope, and a wide diversity of species such as buffalo, zebra, warthog, baboon, elephant, hippopotamus, crocodile, tortoise and rare species such as the giant pangolin (Chemonics International Inc. 2003, MINITERE 2005).

Rwanda is one of the top birding countries with 670 different birds having been recorded. Four of species of birds in Rwanda are threatened with extinction: the shoebill (Balaeniceps rex) found in Akagera; Grauer rush warbler (Bradyptrus graueri) found in Volcanoes National Park in Nyungwe and in the swamps of Rugezi; the Kungwe apalis (Apalis argentea) found in Nyungwe; and the African or Congo barn owl (Phodilus prigoginei) found along Lake Kivu (Chemonics International Inc. 2003).

Animal races bred in Rwanda are mixed with native and non-native races. These include cattle (Ankole, Sahiwal, Frison, Alps brown and the Australian Milk Zebu), goat (Alpine and Anglonubian), sheep (Karakul, Merinos and Dorper), pig (Large white and Landrace, Pirain), poultry (Leghorn, Rhodes Island Red, Derco, Sykes and Anak), fish (Tilapia and Clarias) (MINITERE 2003 a).

Fish species found in aquatic ecosystems comprise Haplohcromis, Synodontis, Barbus, Labeo, Tilapiines, and Clarias species. Raimas moorei and Limnothrissa miodon were introduced into Lake Kivu at the end of the 1950s (MINITERE 2003a).

✓ **Ecosystems and tourism**

This rich biodiversity is mainly conserved in protected areas (three national parks, natural forests, wetlands). These cover almost 10 per cent of the national territory while the rest of the country is densely populated.

The Volcanoes National Park is home to about 30 per cent of the global population of Mountain Gorilla (Gorilla gorilla beringei). It has other 115 mammals species, including the golden monkey (Cercopithecus mitis kandti), elephants, buffaloes, 187 bird species, 27 species of reptiles and amphibians and 33 arthropod species. CITES consider Rana anolensis, Chameleo rudi and Leptosiaphos grauer endangered (MINAGRI 1998, Chemonics International Inc. 2003). It has also 245 plants, 17 of which are threatened; and 13 species of orchids including Disa starsii, Polystachya kermessia, Calanthes sylvatica, Chamaengis sarcophylla, Cyrtorchis arcuata, Habenaria praestans, Stolzia cupuligera, Eulophia horsfallii, among others (Chemonics International Inc. 2003).

Nyungwe National Park has 75 species of mammals, including 13 species of primates with some on the IUCN Red list such as the Eastern Chimpanzee (Pan troglodytes schweinfurthii), owl-faced guenons, (Cercopithecus hamlyni) and the Angolan Colobus monkey (Colobus angolensis ruwenzorii). The national park is also

considered an African Important Bird Area (IBA) with 285 bird species comprising 25 endemic to the Albertine Rift (Plumptre et. al. 2002, Fischer and Killmann 2008). Of the 1,200 plant species inventoried in the Nyungwe National Park - 265 species were trees and shrubs and of these 24 are endemic to the Albertine Rift. Among the plant species in the park, 5 species of trees and 6 species of grass are endemic to the park. These include Oricia renieri, Pentadesma reyndersii, Pavetta troupinii, Psychotria palustris and Tarenna rwandensis. The flora of the park also comprises 148 species of orchids, of which 19 are endemic (MINITERE 2005). The following species of orchids found on the CITES list are also found in the park: Diaphananthe

biloba, Disa eminii, Disperis kilimanjarica, Euggelingia ligulifolia, Eulophia horsfallii, Polystachya fabriana, Polystachya hastate and Tridactyle anthomaniaca (MINITERE 2005).

The wildlife in the Akagera National Park comprises 90 species of mammals, 530 bird species and 35 fish species. The most threatened species are rhinoceros, large carnivores, particularly lions. Many species in the Akagera National Park are protected by the CITES convention such as Loxodonta africana (African elephant), Sincerus caffer (buffalo), Panthera leo (leopard) and Tragelaphus spekii (sitatunga). (MINITERE 2003a, MINITERE 2005). The flora of the Akagera National Park is diverse and 6 species of orchids are recorded.

The grass savanna is dominated by Themeda triandra and Hyparrhenia sp. accompanied with normal species like Sporobolus pyramidalis and Botriochloa

insculpta. Acacias are the most trees found in the forest savannah, and the following species are recorded: Acacia senegal, A. Sieberiana, A. polyacantha campylacantha, A.gerardii and A. brevispica. Species of Combretum are also found in the park (MINITERE 2005).

Natural forests are rich in fauna species. Gishwati forest includes species such as Pan troglodytes schewinfurthii, Colobus angolensis ruwenzorii, Potamochoerus porcus, Cephalophus nigrifons, Dendrohyrax arboreus, Felis serval and Felis aurata (MINAGRI 2002 in Munanura et. al, 2006). The Tree squirrel (Funisciurus pyrrhopus), Rwenzori sun squirrel (Heliosciurus ruwenzori), Ground hog (Thryonomys swinderianus) and the jackal species (Canus spp.) are found in Mukura forest. Makura is also rich in birds with 59 species recorded, among them 7 Albertine Rift endemic species: Tauraco johnstoni, Apalis personata, Apalis Ruwenzori, Cynnyris regia, Zoothera tanganjicae, Bradypterus graueri and Parus fasciiventer (Munanura et. al. 2006).

Rugezi wetland is habitat to an endangered bird and hosts 60 per cent of the global population of Grauers swap-warbler (Bradypterus graueri). It is also habitat to 19 bird species, including two species of Threskiornithidae, protected by CITES. Apart from Clarias liocephalus and Haplochromis sp., the wetland is not rich in fish species.

A low number of mammals are also identified: several species of Muridae, Tragelaphus spekei and Aonyx capensis. (MINITERE 2003a). The orchid Disa stairsii, a specie protected by CITES is also found in Rugezi wetland (MINITERE 2003b).

- **Gishwati-Mukura Landscape Biosphere Reserve**

The Gishwati-Mukura Landscape Biosphere Reserve is a significant area for biodiversity conservation in Rwanda. It comprises the Gishwati Forest Reserve and the Mukura Forest Reserve. These reserves are home to a variety of endemic and endangered species, making them crucial habitats for preserving Rwanda's unique wildlife. One of the key primate species protected within the reserve is the Eastern Chimpanzee, known for their intelligence and social behavior. The Golden monkey, with its vibrant colors, is another remarkable primate species that finds refuge in this biodiverse reserve.

However, the Gishwati-Mukura Landscape Biosphere Reserve is more than just a conservation area. It also plays a vital role in supporting sustainable economic activities for local communities. The reserve promotes agriculture practices that prioritize conservation, such as silvopastoralism and agroforestry, which blend livestock farming and tree planting. These methods help to maintain the ecological balance while allowing communities to sustain their livelihoods.

Tourism is another significant economic activity supported by the Gishwati-Mukura Landscape Biosphere Reserve. Visitors are drawn to the reserve's breathtaking landscapes and diverse wildlife. The revenue generated from tourism not only contributes to the conservation efforts but also funds community development projects. These initiatives focus on improving infrastructure, education,

and healthcare, ensuring that the benefits of conservation extend to the local communities and promote their overall well-being.

In summary, the Gishwati-Mukura Landscape Biosphere Reserve plays a vital role in biodiversity conservation in Rwanda. It protects endangered primate species and supports sustainable economic activities for local communities.

By prioritizing both conservation and community development, the reserve showcases a successful model for coexistence and progress in the pursuit of a sustainable future.

Apart from these places of in-situ conservation, there are also some cases of ex-situ conservation mainly for flora. These include herbaria in some institutions (Institute of Scientific and Technological Research (IRST) and Karisoke Research centre), an arboretum and seed bank as follows:

- ✓ Institut des Sciences Agronomiques du Rwanda (ISAR) has an arboretum in Huye district (Ruhande) established in 1933 containing 205 mostly indigenous plus other introduced species. It is considered the best arboretum in Africa.
- ✓ ISAR has also a seed centre started in 1978 which projected Rwanda into the Organisation for Economic Corporation and Development (OECD) seed scheme in 1993. There are only two other African countries in this entry which includes Madagascar in 1998. Ghana and Uganda are being considered for entry possibly by Sept 2008. This seed centre also serves as a gene bank collection containing both crop and tree species and also medicinal species. The collections are kept at 4oC.
- ✓ There is a national herbarium at IRST which is supposed to include all plants species in Rwanda. Karisoke.

Activity 2: Guided Practice

Task 26:

Visit a wildlife habitat nearby your local area and make an inventory on the animals and plants habitat found there for tourism importance

Activity 3: Application

Task 27:

RDB, tourism department wants to make a census on the specific number of animals species for tourism importance that are found in different natural habitats, assume you have been hired to make that inventory by performing as follows:

1. Describe the specific number of all common animals for tourism importance in the following Rwanda habitats:
    a. Nyungwe National Park
    b. Akagera National Park
    c. Volcanoes National park

Topic 3.3: Identifying threats and solutions to the biodiversity

Activity 1: Problem Solving

Task 28

Read the statement and answer to questions on it

1. "The human population requires resources to survive and grow, and many of those resources are being removed unsustainably from the environment. The five main threats to biodiversity are habitat loss, pollution, overexploitation, invasive species, and climate"

   a. Identify at least 5 biodiversity threats in your area?

   b. What are the major causes of biodiversity loss?

   c. What should you do to isolate the threats to biodiversity?

   d. Explain the reasons why climate change can lead to biodiversity loss?

   e. What is the role of biodiversity to living organism species?

2. Match the elements from column A with those of column B

A (Threats)	B (solutions)
Climate change	Promote responsible consumption and trade.
Invasive species	Protect and restore habitats that act as carbon sinks
Habitats degradation	Prevent their introduction through stricter biosecurity measures.
Overexploitation	Restore degraded ecosystems.
Pollution	Reduce air, water, and soil pollution.
Epidemics	Laboratory Networks

Key fact 3.3 Threats and solutions to the biodiversity

- **Environmental Status in Rwanda:**

  Rwanda's environmental status faces both challenges and opportunities. The country's rich natural resources and diverse ecosystems are under increasing pressure due to population growth, urbanization, and economic development. However, Rwanda's commitment to sustainable development and conservation efforts has driven positive changes, such as reforestation programs, sustainable agriculture practices, and the protection of critical habitats.

  Efforts to address environmental challenges in Rwanda have resulted in notable achievements. For example, Rwanda has made significant progress in restoring and expanding forest cover through tree planting campaigns and community-led initiatives. The country's commitment to renewable energy has led to the development of solar and hydroelectric power projects, reducing reliance on fossil fuels and contributing to climate change mitigation. Additionally, Rwanda's commitment to sustainable tourism has led to the protection of natural areas and the promotion of responsible tourism practices.

  Despite these achievements, ongoing efforts are necessary to address environmental threats and enhance the country's environmental management and conservation practices. By strengthening the legislative and institutional frameworks, promoting sustainable land-use practices, and raising awareness about environmental challenges and opportunities, Rwanda can continue to make significant progress towards a more sustainable and ecologically resilient future.

- **Threats to Rwanda's Biodiversity**

  Despite conservation efforts, Rwanda's biodiversity faces several threats. Habitat loss, poaching, environmental degradation, and human-wildlife conflict pose significant challenges that need urgent attention to protect Rwanda's rich natural heritage.

  ✓ **Habitat Loss**

  Habitat loss is a pressing concern for Rwanda's biodiversity. Deforestation, driven by agriculture expansion and urbanization, is rapidly diminishing natural habitats. The

encroachment of human activities into previously undisturbed areas has resulted in the fragmentation and destruction of essential ecosystems, displacing native flora and fauna.

- ✓ **Poaching and Illegal Wildlife Trade**

Poaching and the illegal wildlife trade continue to jeopardize Rwanda's unique wildlife populations. Some species, such as the iconic mountain gorillas, are especially vulnerable. Despite conservation efforts and strict regulations, the demand for wildlife products persists, threatening the survival of numerous species.

- ✓ **Environmental Degradation**

Environmental degradation, including soil erosion and water pollution, has detrimental effects on Rwanda's ecosystems. Unsustainable agricultural practices, improper waste management, and industrial activities contribute to soil degradation and water contamination, compromising the health of plants, animals, and aquatic life.

- ✓ **Human-Wildlife Conflict**

Human-wildlife conflict is a growing issue in Rwanda, particularly between farmers and wildlife. As communities expand and encroach further into natural habitats, conflicts arise due to crop raiding and livestock predation by wildlife. These conflicts not only impact human livelihoods but also lead to retaliatory measures against wildlife, exacerbating the threats to biodiversity.

It is imperative to address these threats to ensure the long-term survival of Rwanda's biodiversity. Conservation efforts, stronger regulations, community engagement, and sustainable land management practices can play a crucial role in mitigating these challenges.

Threat	Description
Habitat Loss	Deforestation, agricultural expansion, and urbanization leading to the destruction and fragmentation of natural habitats.
Poaching and Illegal Wildlife Trade	Targeting of wildlife species for their body parts, skins, or trophies, driven by demand for exotic pets, traditional medicine, and luxury goods.
Environmental Degradation	Soil erosion, water pollution, and degradation of natural resources due to unsustainable practices and industrial activities.
Human-Wildlife Conflict	Conflict arising from competition for resources between humans and wildlife, leading to negative impacts on both livelihoods and biodiversity.

The table below illustrates the impacts of biodiversity change on various ecosystem services:

Ecosystem Service	Impact of Biodiversity Change
Clean Water Availability	The loss of forests and wetlands can result in reduced water quality and quantity, affecting human health and increasing the cost of water treatment.

Pollination	The decline in pollinator populations, such as bees and butterflies, can lead to reduced crop yields and impact food production.
Nutrient Cycling	The loss of biodiversity can disrupt nutrient cycling processes, affecting soil fertility and agricultural productivity.
Tourism	Biodiversity loss can negatively impact the tourism sector, as visitors are attracted to diverse and pristine natural environments.
Cultural Practices	Biodiversity holds deep-rooted value for local communities and their traditional practices, contributing to cultural identity and well-being.

The impacts of biodiversity change on ecosystem services are far-reaching and underscore the importance of conserving and protecting biodiversity for the benefit of both nature and humanity.

- ✓ **Climate Change**

  Long-term shifts in Earth's climate impact biodiversity. Rising temperatures affect species' populations, distribution, and even individual traits. For instance, some birds and insects now migrate and mate earlier due to warmer conditions, affecting breeding success. Climate change also alters ecosystems, expanding desert areas and disrupting their functions1.

- ✓ **Pollution**

  Contaminants harm ecosystems and species. Air, water, and soil pollution disrupt natural processes, affecting biodiversity. For example, chemicals can harm aquatic life and reduce genetic diversity1.

Figure: Air pollution Source: pollution images - Search Images (bing.com)

- ✓ **Invasive Species**

  Increased mobility and trade introduce non-native species to new areas. These invaders outcompete native species, disrupt ecosystems, and reduce biodiversity2.

source: invasive photos - Search Images (bing.com)

- ✓ **Overexploitation:** Unsustainable harvesting of resources (e.g., overfishing, excessive logging) depletes species populations. This threatens biodiversity and disrupts ecosystem balance3.

Source: overexploitation - Search Images (bing.com)

- ✓ **Epidemics:** Disease outbreaks can devastate species. For instance, fungal diseases have caused declines in amphibian populations worldwide.

Source: epidemic photo - Search Images (bing.com)

- **Isolations to the threats faced by biodiversity**

  Biodiversity faces several threats, and addressing them is crucial for the health of our planet. Here are some solutions to counter the above threats:

  - ✓ **Afforestation:** Rwanda is struggling to establish forests or stand of trees in an area where there was no recent tree cover. As well as re-establishing forest that have either been cut down or lost due to natural causes, such as fire, storm, etc.
  - ✓ **Environmental conservation:** Rwanda's vision for 2050 is to be a carbon-neutral and climate-resilient economy. Our Climate Action Plan aims to reduce emissions by 38% by 2030 compared to business as usual. That is why Rwanda has put the environment at the heart of its development agenda for more than two decades.

    So, for climate change mitigation, Rwanda is committed to implement policies that reduce greenhouse gas emissions, protect and restore habitats that act as carbon sinks as well as support climate-resilient species and ecosystems.

    Sustainable Resource Use: **i**mplement sustainable harvesting practices, enforce regulations to prevent overhunting and overfishing and promote responsible consumption and trade.

    Pollution Control: **r**educe air, water, and soil pollution, support clean energy alternatives and advocate for stronger environmental regulations.

  - ✓ **Habitat Conservation and Restoration:** this consists of protect natural habitats through conservation efforts, restore degraded ecosystems and Create wildlife

corridors to connect fragmented habitats. inscribing Nyungwe National Park on UNESCO World Heritage List is one example among many.

- ✓ **Leave no trace principles**: promotes the saying leave what you find and respect wildlife by preserving the past, leaving rocks, plants and other natural objects as you find them, avoiding introducing or transporting non-native species: clean boot soles, kayak hulls and bike tires off between trips and not building structures, furniture or dig trenches.
- ✓ **Invasive Species Management:** by monitoring and controlling invasive species, preventing their introduction through stricter biosecurity measures.
- ✓ **Epidemics management:** by (i) setting up **s**urveillance systems, which rapidly detect and report cases through robust surveillance systems and monitor outbreaks to identify patterns and assess risks; (ii) laboratory networks to establish accurate diagnostic capabilities for the identification of the cause of illness. And (iii) sharing genetic sequences of emerging viruses globally to inform responses; and Training workforce, having in place a pool of skilled workforce to identify, track, and contain outbreaks and strengthen public health capacities for effective response.

Activity 2: Guided Practice

Task 29:

1. For the purpose of biodiversity protection and sustainability
    a. Conduct research on the activities that lead to wildlife habitats degradation in your local community
    b. Set some rules and regulation in your local area
    c. Make a report about animals and plants habitats found in your district.
2. Identify different biodiversity threats and their solutions
3. Give ways that one can use to prevent overexploitation.

Activity 3: Application

Task 30:

1. Assume you are working for RDB on the project of biodiversity conservation, research and make report on the major causes of Rwanda biodiversity loss.
2. Assess the environmental threats and Opportunities
3. Make an inventory and report the endangered genetic diversity in our country
4. Suggest any 5 measures to apply in order to protect major ecosystems on the Earth

Formative Assessment

1. What are the types of biodiversity existing? Differentiate them by using examples
2. Which rules and regulation that the government has set for wildlife habitats conservation
3. Describe the common key animals for tourism importance in Rwanda
4. What are the causes of wildlife habitats degradation in Rwanda
5. Differentiate 3 main types of vegetations and give examples
6. Identify 5 main types of wildlife habitats of Rwanda and their respective animals for tourism importance.

a. Explain the term: “big five animals”

b. What is their habitat?

7. What are the major causes of biodiversity loss?
8. Suggest any 3 solutions to each cause of biodiversity threats

Points to Remember

- Biodiversity is the **variety of all living things and their interactions**: including animals, plants, fungi, and microorganisms like bacteria that make up our natural world, each of these species and organisms work together in ecosystems to maintain balance and support life. Biodiversity changes over time as extinction occurs and new species evolve.
- There are three levels of diversity: species, genetic, and ecosystem diversity.
- Rwanda has diverse ecosystems that range from humid montane and planted forests to savannahs, water resources and wetlands. The country has the largest **mountain rainforests** in Africa, which is home to closed canopy forests, bamboo thickets and open flower-filled marshes.
- The major threats to biodiversity are *climate change*, *habitat loss and degradation*, *pollution*, *invasive species*, *over-exploitation* and *epidemics and they are*. Some solutions to all threats for the conservation of biodiversity.
- Rwanda's commitment to integrating biodiversity into urban planning for sustainable, green cities is essential for the conservation of its unique wildlife and natural resources. Through the establishment of protected areas, active community engagement, and collaboration on an international scale, Rwanda has achieved significant progress in biodiversity conservation.
- Rwanda has the potential to sustain its success, promoting green infrastructure and implementing sustainable practices. By embracing these opportunities, Rwanda can pave the way for a sustainable and vibrant future.

Self-Assessment: Unit 3

My experience Knowledge, skills and attitudes	I do not have any experience doing this.	I know a little about this.	I have some experience doing this.	I have a lot of experience with this.	I am confident in my ability to do this.
Explain key terms					
Identify types of biodiversity in Rwanda					
Differentiate types of ecosystems					
Description of Rwanda vegetation					
Key animals of tourism importance					
Explain the types of animal and plant habitats					
Describe forests habitat					
Describe aquatic habitat					
Describe grasslands habitat					
Describe deserts habitat					
Describe wetlands habitat					
Describe mountainous and polar habitat					
Explain threats to biodiversity					

My experience Knowledge, skills and attitudes	I do not have any experience doing this.	I know a little about this.	I have some experience doing this.	I have a lot of experience with this.	I am confident in my ability to do this.
Describe environmental degradation					
Describe deforestation					
Describe climate change					
Describe land use					
Identify isolations to the threats faced by biodiversity					
Describe afforestation					
Describe Environmental conservation					
Describe Leave no trace principles					

Self-Reflection

1. Fill in the table above and share results with the trainer for further guidance.

Areas of strength	Areas for improvement	Actions to be taken to improve
1. **2.** **3.**	**1.** **2.** **3.**	**1.** **2.** **3.**

Summative assessment

- **Integrated situation**

  Rirenga safaris is a tourism company located in Kicukiro district, Niboye sector, KK 80 Kigali. The company received a request from Richardson family of five (5), two (2) adults, and three (3) children of twelve (12) years from Scotland. They want to visit Rwanda to get experience about flora and fauna. They will spend four (4) days in Rwanda, as there is absence of someone who use to do it you are hired to describe for them biodiversity of Rwanda and the principles of flora and fauna classification.

  Tasks:

  1. Interpret to them the main components of Rwanda biodiversity
  2. Make an inventory report to them about Rwanda flora classification and their habitats
  3. Help them conduct research regarding Rwanda fauna classification and their habitats

  Instructions

  The required time is three (3) hours

  Materials, tools and equipment are provided by the company

  Right attitudes are considered while performing the tasks

Resources

Tools	Pens, Writing pads
Equipment	Globe, Maps, Computers, GPS, Binoculars, first aid box, vehicle, boat, walk talkie, camera, laser pointer
Materials/ Consumables	Guide books, Maps, Internet connectivity, National Park brochures

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