Biology

Year 1

SECTION

4

ORGANISMS

DIVERSITY OF LIVING THINGS AND THEIR ENVIRONMENT

Ecology

INTRODUCTION

Living things exhibit a vast diversity of forms, spanning from microscopic life forms such as bacteria to macro-organisms such as whales, elephants, ants and trees. These varied life forms present different structural features which makes them unique from other organisms and adapts them to behaviour and functionalities which distinguish them from others. In this section, you will explore the construction and use of biological keys and the classification of organisms. One important tool which helps taxonomists in identifying the unique features of an organism such as the number or type of legs, wings, and hairy or smooth body are biological keys. You will then narrow the conversation down to hierarchical classification to describe the eight taxa in modern classification to ensure that you acquire the relevant basic skills and competencies in the learning attitude. You will also look into binomial nomenclature, tracing its brief history and dwelling more on some common examples important to the growth of Ghana's economy. This will look at how binomial names are assigned to living things considering factors such as DNA, morphology and behaviour. The section will conclude with discussions on the life processes of Amoeba, Euglena and Spirogyra.

At the end of this section, you will be able to:

- Identify living organisms using biological keys.
- Explain how lower organisms are classified into their taxonomic groups.
- Discuss the life processes and economic importance of the micro-organisms: Amoeba, Euglena and Spirogyra.
- Explain how lower organisms are classified into their taxonomic groups.
- Discuss the life processes and economic importance of the micro-organisms: *Amoeba, Euglena* and *Spirogyra*

Key ideas

- Biological keys are essential tools or convenient systematic information used to identify unknown organisms based on their characteristics.
- Types of biological keys are Numbered keys and Dichotomous keys.
- Couplets are pairs of contradicting statements on the characteristics of an organism to which a yes or no response narrows down to identifying the organism.
- Individual statements of a couplet are called leads.
- Classification is the process of grouping living things into categories based on their shared characteristics and evolutionary relationships. It is a way to organize and understand the diversity of life on Earth.
- Classification typically follows a hierarchical structure, with each level becoming more specific: **Domain, Kingdom, Phylum/Division (in plant taxonomy), Class, Order, Family, Genus and Species.**
- Carolus Linnaeus' system of classification which is in use is mainly based on the structure of organisms. It gives every organism its own distinctive two-part Latin name based on the genus name and species name.
- *Amoeba* is a heterotrophic organism, meaning it feeds on other organisms. It feeds by engulfing its food in a process called phagocytosis. *Amoeba* undergoes cellular respiration to produce energy by breaking down food molecules and using oxygen. *Amoeba* reproduces asexually through a process called binary fission, where the cell divides into two identical daughter cells. Waste products are eliminated from the cell through the cell membrane.
- *Amoeba* can respond to changes in the environment, such as moving towards a food source or away from harmful substances.
- Amoeba is economically important because it assist in maintaining ecological balance, serves as a model organism for scientific research as well as some species being parasitic and or pathogenic.

BIOLOGICAL KEYS, HOW TO MAKE THEM AND HOW TO USE THEM

Biological keys are essential tools in classifying and identifying living organisms when properly constructed and used. Biological keys are like a game of 20 questions for organisms. They give you a series of choices about the creature you're trying to identify. You pick the right answer, and it leads you to the next question. Keep going until the key tells you the name of the organism. It's a helpful tool for figuring out what different plants and animals are called.

NOTE:

A pair of contradicting statements is known as a couplet. Each statement of a couplet is called a lead. Making the correct choice at each level eventually leads to the arrival of the name of the organism.

How do Biological Keys Work?

Biological keys help you identify an organism by giving you a series of choices. When using a biological key, the points discussed below should be considered.

1. *Statements:* The key gives you two statements about the organism.
2. *Choose:* You decide which statement is true for the organism you're trying to identify.
3. *Next step:* Based on your choice, the key will lead you to another set of statements.
4. *Keep going:* You continue choosing statements until the key tells you the name of the organism.

So, in short, biological keys are like a step-by-step guide to identifying organisms.

Types of Biological Keys

1. **Dichotomous keys:** are a tool used to identify organisms. They present you with two choices, or couplets, at a time. Starting with broad characteristics, you select the option that best describes the organism you're examining. As you progress, the choices become more specific, narrowing down the possibilities until you arrive at the correct identification. This step-by-step process makes dichotomous keys a valuable tool for scientists

Consider the following example of a dichotomous key:

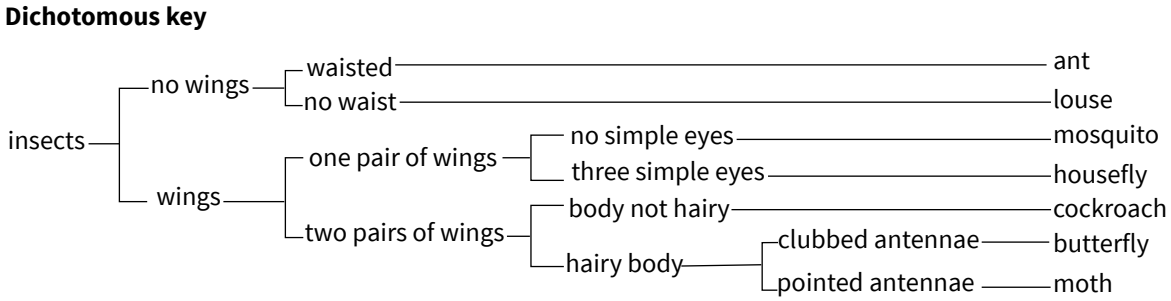


Figure 4.1: An example of a dichotomous key

2. **Numbered keys:** In numbered keys, each statement or couplet is assigned a number. The user chooses the statement that best describes the organism they are identifying, and the corresponding number leads them to the next set of choices. This process continues until the organism is identified. Numbered keys can be more efficient than dichotomous keys, especially for large groups of organisms. They can also be easier to use for beginners, as the numbering system provides a clear structure for example, 1a, 1b, 2a, 2b, etc. Each option leads to another question or statement eventually leading to the identification of the organism.

Importance of Biological Keys

Biological keys are useful in so many ways. Some reasons why biological keys are important include;

1. Are crucial in the fields of taxonomy, ecology and biodiversity research.
2. Are used to identify unfamiliar organisms,
3. Are used to describe the features and understand the classification of organisms.
4. Are used to check whether a particular feature is present or absent in an organism.
5. Enable more familiarity with the organisms we have identified.
6. Enable other users to use these keys to identify organisms.
7. The ability to construct a key is an important skill, testing knowledge, understanding and problem-solving skills.
8. It enables researchers to understand the diversity of life on Earth and be able to track changes in the ecosystem over time.

Consider the following example of a simple paired-statement key to identify six common invertebrates.

1
- No legs ---------- go to 2
- Legs ---------- go to 3

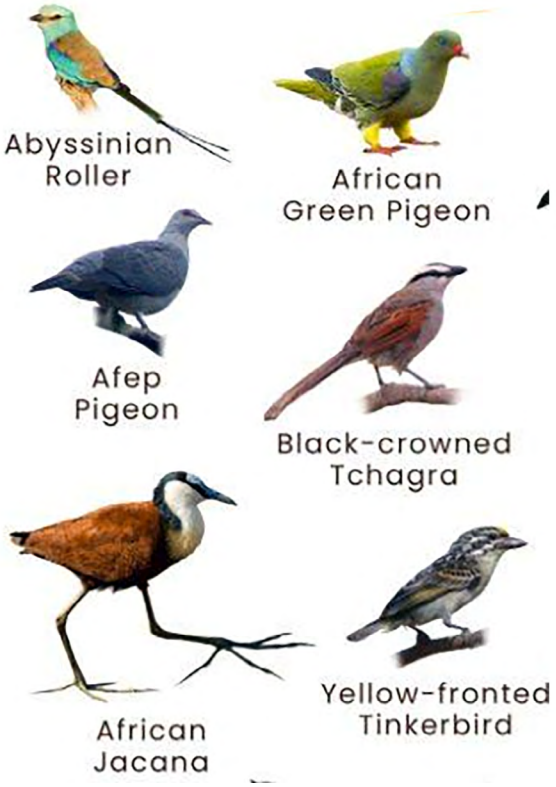
2
- Shell ---------- Snail
- No shell ---------- Slug

3
- Six legs ---------- go to 4
- More than six legs ---------- go to 5

4
- Wings ---------- Bee
- No wings ---------- Springtail

5
- Eight legs ---------- Spider
- Many pairs of legs ---------- **Millipede** *(identified organism)*

Let us consider another example of how a biological key can be used to identify six birds native to Ghana.



1
- Long tail ---------- 2
- Short tail ---------- 3

2
- Brown feathers and black bar on head --------- Black-crowned Tchagra
- Forked tail and bright blue breast feathers -------- Abyssinian Roller

3
- Green feathers---------- African Green Pigeon
- Feathers not green ---------- 4

4
- Legs as long as body with four long toes --------- African Jacana
- Legs shorter than body ---------- 5

5
- Small bird with yellow breast feathers ---------- Yellow-fronted Tinkerbird
- Large bird with dark blue/grey feathers all over -- Afep pigeon (African wood pigeon/Gray wood pigeons)

As well as being useful for identifying organisms and describing their features, keys can be used to help us understand the classification of animals and plants.

The following key enables you to identify the main groups of plants present in the world + fungi, (Fungi are not really plants in the true sense)

Some examples are given in brackets after each group.

1
- No leaves, stems or roots ---------- 2
- Leaves, stems and roots---------- 3

2
- Photosynthetic---------- Algae (seaweed)
- Non-photosynthetic---------- Fungi (toadstools and mushrooms)

3
- No seeds---------- 4
- Seeds---------- 5

4
- Roots and stem with vascular tissue ---------- Ferns
- Simple single leaf or leaves only ---------- Mosses and Liverworts

5
- Naked seeds in a cone---------- Conifers (pine and fir trees)
- Covered seeds, and flowers ---------- 6

6 { One seed leaf ---------- Monocots (grasses)
  { Two seed leaves ---------- Dicots (broad-leaved plants)

How to use the characteristics of everyday materials to identify them.

1. Look for physical attributes such as shape and size e.g. small, flat, round, cylindrical, triangular.
2. Composition e.g. rubber, wood, ceramic, metal.
3. Size e.g. small, big.
4. Uses e.g. carrying, holding, erasing

Activity 4.1: Exploring the Basics of Biological Identification

Now follow the attributes/characteristics given to identify the following materials: **coin, pin, button, rubber/eraser, paperclip, rubber band, cork.**

1. **Small, flat and round**
   - has a hole in the centre (…….)
   - does not have a hole in the centre (……...)
2. **Small and cylindrical** (…….)
   - has a sharp pointed tip (…….)
   - does not have a sharp pointed tip (…….)
3. **Small and spherical** (…….)
   - made of rubber (…….)
   - used for erasing (…….)
   - used for holding things together (…….)
4. **Small and irregularly shaped** (……...)
   - made of a porous material (…….)

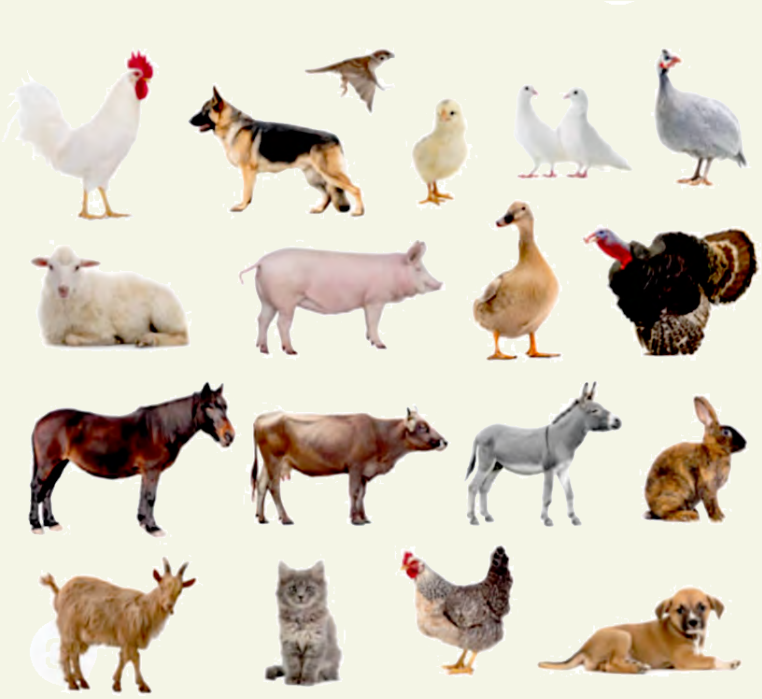
Activity 4.2

1. Collect some leaves from different plants on the school compound and construct a key to identify them by their shape and colour.
   - **a.** How many varieties of plants were you able to identify using the biological keys?
   - **b.** Discuss your results with your colleagues.

Activity 4.3

Search the internet for pictures of some common farm animals in Ghana. Together with a friend, practice constructing a key using the following external features to identify them: colour, size, number of legs, fur, feathers, and mouthpart.

NB: The sample pictures provided can be used where difficulty in accessing the internet is encountered.



Activity 4.4: Making Sense of Diversity

Based on your knowledge of creating keys in **Activities 4.1**, **4.2** and **4.3**, construct a key to identify a group of learners in your class, using visible features only for example, type of hair, gender, left or right-handed, how they fold their arms: left over right or right over left; ear lobes or no ear lobes; tongues rollers or non-tongue rollers? Compare your results with a friend.

EXTENDED READING

Nyavor, C.B. and Sedoh, S. (2000). *Biology for senior high schools* (GAST).(2nd edition, pp.28&29). Unimax Macmillan Ltd.

CLASSIFICATION OF SIMPLE OR LOWER ORGANISMS INTO THEIR TAXONOMIC GROUPS

The early scientists recognised the enormous diversity among living things. Scientists therefore must sort, and group organisms based on differences and similarities to make identification and study of the different types of organisms easier and more systematic. Classification as a procedure is the production of a logical system of categories each containing any number of organisms which allows easier reference to its components.

In the fourth century BC a Greek philosopher and naturalist by the name of Aristotle (384-322 BC) produced a system of classification based on similarities and differences between organisms.

This system was used for about 2000 years before it was replaced by another system advocated by a Swedish botanist named Carolus Linnaeus (1707-1778)

Linnaeus' system of classification which is still in use is mainly based on the structure of organisms. It gives every organism its own distinctive two-part Latin name.

Background of Classification in Lower Organisms

Taxonomy is the scientific classification of living things. It dates back to ancient civilisations such as those of the Greeks (Aristotle) and Roman eras. Living things were classified based on their observable characteristics. However, in the 18th century, a Swedish botanist and physician, Carolus Linnaeus (Carl Linnaeus) developed a more comprehensive system of classification. Linnaeus introduced a hierarchical classification and put organisms into seven taxa (singular is called taxon). It starts from the ***kingdom***, which is a broader and more general group and ends with ***species*** (specific epithet). Specific epithet is made up of closely related organisms. He also introduced the binomial nomenclature, a system that gives two names to an organism, the **genus** name and the **species** name. His system laid the foundation for modern classification. Linnaeus is considered as the father of modern classification. Simple (lower) organisms, like other living things, are classified using a variety of characteristics. Lower living things are prokaryotes (bacteria) and protoctists such as the *Amoeba*, *Euglena* and *Spirogyra*. They also include fungi and some simple plants and animal forms.

Factors Used in Classification of Simple/Lower Organisms

Morphology – This involves physical characteristics or features such as shape, size, colour and structure of the organism. It deals with both the external and internal structures of organisms.

Physiology – It is the grouping of living things based on the functions and processes such as metabolism, reproduction, growth and response to stimuli which occur within them.

Genetic information – This is when living things are classified based on the differences and similarities in their DNA and gene composition. It offers a more accurate and detailed classification of living things.

Ecological information – This is the grouping of organisms based on their ecological roles such as their habitat, behaviour and interactions with other living things.

Evolutionary relationships – This involves classification where closely related organisms are grouped based on a common ancestry.

Forms of Classification

1. **Hierarchical Classification** – this is when living things are classified based on nested orders from a broader group to a smaller and specific group. This is the most common type of classification and was used by Linnaeus in classification. Thus, the modern hierarchical taxa from broader groups to the more accurate group are Domain, Kingdom, Phylum/Division, Class, Order, Family, Genus and Species
2. **Cladistics** – This type of classification is based on evolutionary relationships and puts organisms into groups based on shared characteristics, regardless of traditional taxonomic ranks.
3. **Phylogenetic Classification** – This refers to the use of molecular data to reconstruct evolutionary relationships between organisms
4. **Numerical Classification** – This refers to the use of quantitative data such as measurements and statistical analysis to classify organisms based on their similarities.

Natural and Artificial Classification

Natural classification is based on natural relationships among living organisms including their evolutionary history and shared characteristics.

Artificial Classification is based on arbitrary standards chosen for convenience and is often based on easily observable features.

Differences between Natural and Artificial Classification

Feature	Natural Classification	Artificial Classification
Bases of classification	Based on natural relationships such as shared characteristics	Arbitrary criteria chosen by humans
Criteria for classification	Considers overall similarities and evolutionary history.	Considers specific easily observable features chosen
Flexibility	Flexible as more information about the organism becomes available	Less flexible and may not reflect true relationships among living things.
Purpose	Aims to understand natural relationships and diversity of life.	Often used for practical purposes such as identification.

Processes Involved in Classifying Organisms

1. Observation and collection of data on the characteristics of organisms (e.g. genetic, morphological and behavioural data).
2. Comparing the observed characteristics among different organisms to identify patterns (similarities and differences).
3. Sort or group organisms based on shared characteristics to form an initial classification.
4. Arrange groups into hierarchical orders from broad to specific.
5. Validate classifications through further analysis (e.g. through DNA analysis and comparative anatomy) to ensure accuracy.
6. Document scheme of classification (e.g. description of taxa and criteria of classification).
7. Periodic review and revision of classification based on discoveries and evidence.

Importance of Classifying Organisms

1. It provides a systematic way to organise the huge diversity of life.
2. It allows easy communication about organisms among biologists.
3. It allows the identification of endangered species and ecosystems for the conservation of biodiversity.
4. Taxonomy offers a broader understanding of interactions among living things and energy transmission among them through food chains and webs.
5. It allows biologists to predict the characteristic traits, behaviour and ecological interactions of organisms.

Activity 4.5: The Science of Sorting - Exploring Biological Classification

Embark on tours around your school or community to observe and collect data on some simple living things (e.g. lower plants and common invertebrates).

Hint:

- *Choose a location, select a nearby park, garden or even your school compound to explore*
- *Observe and record: Take notes and photographs, record characteristics, habitats and any interesting features of lower living things.*
- *Collect samples*
- *Use field guides, online resources, or textbooks to identify the organisms you have observed and collected.*
- *Analyse and classify with a relevant instrument: Group organisms into plants, fungi, animals, bacteria, protoctist*

Activity 4.6: Basics of Classification

Search from textbooks and available sources (e.g. audio and video documentaries) to understand the basis of classifying lower living things into various taxa.

1. Morphology
2. Physiology
3. Genetic information
4. Ecological information
5. Evolutionary relationships

Activity 4.7: Developing a Classification System

Project Exercises

1. A scientist discovers a new species of animal that has a backbone, four legs, and fur. How would you classify it?
2. A zookeeper receives a shipment of animals from the rainforest, including a creature that has a long tail, and scales and lays eggs. How would you classify it?

Steps to classify a newly discovered simple living organism

a. Collection and observation
b. Literature review
c. Character analysis
d. Phylogenetic analysis
e. Determination of taxonomic rank
f. Binomial nomenclature
g. Description and publication

MAJOR RANKS/TAXA IN HIERARCHICAL CLASSIFICATION

The major ranks/taxa/groups used in the hierarchical system of Classification, from the largest to the smallest taxon are: **Domain, Kingdom, Phylum/Division, Class, Order, Family, Genus and Species.**

1. **Domain and Kingdom:** Organisms are first categorised into one of the three domains: Bacteria, Archaea, or Eukarya. Lower organisms typically fall under the Eukarya domain. Then, they are grouped into one of the major kingdoms, such as Protista, Fungi, Plantae, or Animalia.
2. **Phylum (Division for plants):** Each kingdom is further divided into phyla or divisions (for plants) based on major evolutionary differences. For example, the Animalia kingdom includes phyla like Arthropoda (insects, spiders) and Chordata (vertebrates).
3. **Class and Order:** Within each phylum or division, organisms are grouped into classes and orders based on more specific characteristics. For example, in the Animal Kingdom, cockroaches are insects that belong to the order Blattodea.
4. **Family and Genus:** The next taxonomic levels are family and genus. Families group together related genera. The genus is a more specific category that includes species that are closely related to each other. For instance, the genus *Panthera* includes species like lions, tigers, and leopards.
5. **Species:** The smallest and most specific taxonomic group is species. Species consist of individuals that can interbreed and produce fertile offspring. For example, the species name for cashew is ***Anacardium occidentale***.

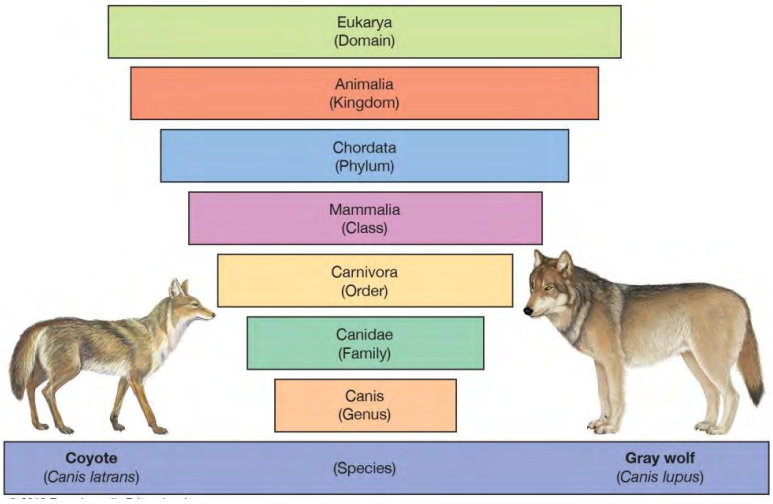


Figure 4.2: Classification of two species in the Kingdom Animalia

Classify *Amoeba Proteus* as an Example of Single-Celled Organism

1. **Domain**: Eukarya (It has cells with nuclei)
2. **Kingdom**: Protista (It is a unicellular eukaryote)
3. **Phylum**: Amoebozoa (Organism that moves by internal cytoplasmic flow)
4. **Class**: Tubulinea (It is a tubular *Amoeba*)
5. **Order**: Euamoebida (It is a type of tubulinea)
6. **Family**: Amoebidae (It is a type of *Amoeba*)
7. **Genus**: *Amoeba* (It belongs to the genus *Amoeba*)
8. **Species**: *proteus* (The specific species name)

Characteristics of Taxa

1. Organisms with shared characteristics are placed in the same taxa.
2. Numbers decrease down the taxon whilst shared characteristics increase down it.
3. Organisms put in the species group can interbreed to produce fertile offspring.
4. The introduction of binomial nomenclature at the genus and species level ensures uniformity in classification.

IDENTIFY KEY FEATURES OF THE BINOMIAL NOMENCLATURE

Binomial Nomenclature

Organisms are given a unique scientific name using the binomial nomenclature, which combines the genus name and the species name. For example, humans are *Homo sapiens*, where "Homo" is the genus and "sapiens" is the species. This system was introduced and used by Carolus Linnaeus (Carl Linnaeus) in the 18th century. The two-part names are represented in italics when in text or printed material and are underlined separately when hand-written. The generic name begins with a capital letter, followed by the species name (species epithet), which begins with a small letter. In some cases, the organism may have been domesticated. In such instances, the organism is usually given a three-part name. The first name is the genus, the second is the species, and the last is the sub-species name. In texts and writing, the same rules are applied. The genus name begins with a capital letter, while the species and sub-species names begin with small letters. One important usage of binomial nomenclature is that it allows

biologists to communicate smoothly about organisms with limited or no barriers in communication.

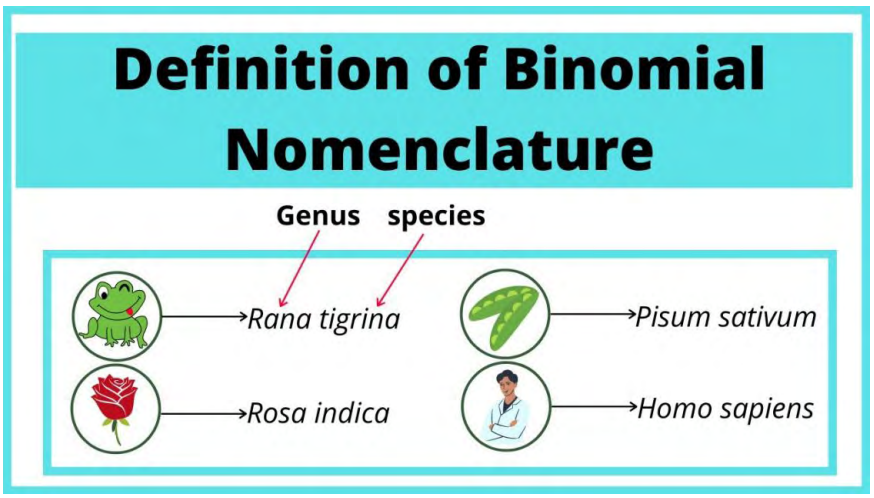


Figure 4.3: Definition of Binomial Nomenclature

Some common examples of organisms and their binomial names are provided below.

Table 4.1: Some Important Animals in Ghana/Africa and Their Binomial Nomenclatures

Common name	Genus name	Species name	Sub-species name
Chicken	*Gallus*	*Gallus*	*domestica*
Goat	*Capra*	*Aegagrus*	*hircus*
Sheep	*Ovis*	*Aries*	--------
Dog	*Cannis*	*Lupus*	*familiaris*
Rhesus monkey	*Macaca*	*Mulatta*	--------
Human	*Homo*	*Sapiens*	--------

Table 4.2: Some Important Crops Grown in Ghana and Their Nomenclatures

Common name	Genus name	Species name
Cassava/Manioc	*Manihot*	*esculenta*
Maize	*Zea*	*mays*
Rice	*Oryza*	*sativa*
Shea butter	*Vitellaria*	*paradoxa*
Cocoa	*Theobroma*	*cacao*

Factors That Influence Binomial Names Assigned to Species

1. Scientific accuracy; for example, the binomial of the giant panda was changed from the raccoon family to the bear family (thus, based on genetic evidence.
2. Consistency and clarity in communication; this allows biologists from different regions and specialties to communicate effectively.
3. International acceptance; for example, the gray wolf is internationally accepted as *Canis lupus*.
4. Cultural and historical norms and origin of species; for example, the Ethiopian bamboo is named *Oxytenanthera abyssinica*, reflecting the historical name of Ethiopia (that is Abyssinia).
5. Taxonomic revision; for example, the discovery of a new species of flowering plant, Ethiopian/African pepper) in the rainforests of Ghana led to the adoption of the binomial name, *Xylopia aethiopica* to reflect its status as a distinctive species.
6. Formal nomenclature rules; for example, the binomial name for the lion, *Pantera leo*, follows the rules in the International Code of Zoological Nomenclature.

Significance of Binomial Nomenclature

1. Taxonomic ranks ensure organisms with shared characteristics are placed on the right taxa.
2. Numbers decrease down the taxon whilst shared characteristics increase.
3. Binomial nomenclature ensures uniformity in naming and identifying living things amongst biologists the world over.

EXTENDED READING

Click on the links below to learn more about classification of living things and binomial nomenclature.

- Classification of Living Things (youtube.com)
- GCSE Biology - Classification #80 (youtube.com)

THE LIFE PROCESSES AND ECONOMIC IMPORTANCE OF AMOEBA PROTEUS

Amoeba proteus

Amoeba proteus is a protozoan commonly found on the bottom mud or on the underside vegetation in freshwater, ponds, ditches, lakes, springs, and slow-running streams. It is found mostly in comparatively clean ponds with extremely oxygenated freshwater. It is also found in large "food webbed ecosystems" that incorporate many algae and plants. It is usually sheltered under the sides of lotus ponds or dwells near the bottom of the pond. It moves and feed with pseudopodia (singular: pseudopodium) (pseudo= false podos=leg).

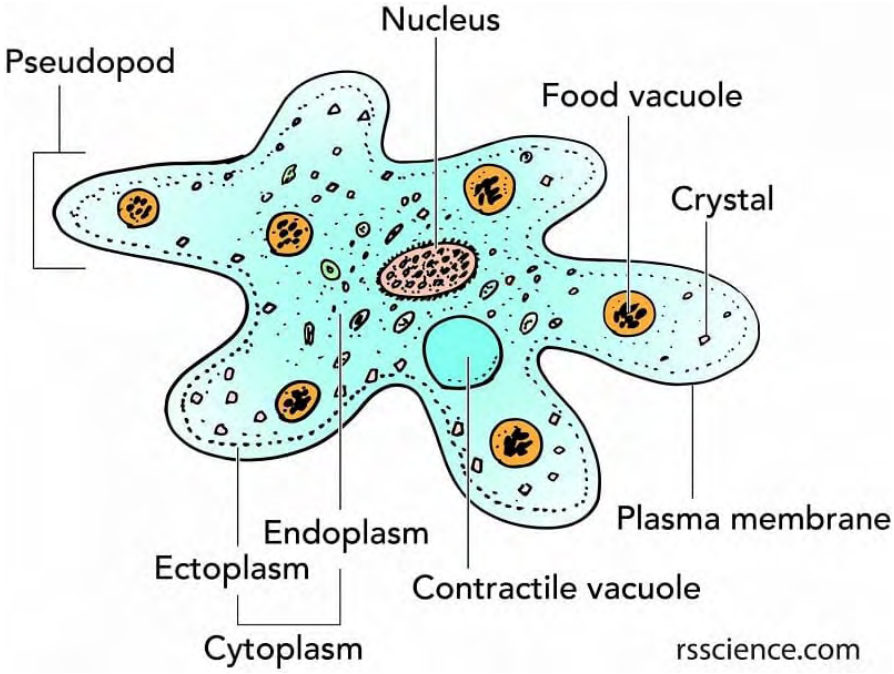


Figure 4.4 : Structure of Amoeba proteus. Image Source: Rs' Science.

Life Processes in *Amoeba proteus*

1. **Nutrition**: *Amoeba* is a heterotrophic organism, meaning it feeds on other organisms. .Amoeba is generally carnivorous and feeds by phagocytosis. It captures food, such as algae, bacteria, flagellates, ciliates and other organic matter by surrounding them with its pseudopods (false feet) and forming a food vacuole. The food is then digested and absorbed within the cell.
2. **Respiration**: *Amoeba* undergoes cellular respiration to produce energy by breaking down food molecules and using oxygen. Amoeba has no special respiratory organs. It has no respiratory pigments. Respiration occurs in it

by the process of diffusion through the general body surface (plasmalemma) which is permeable to the oxygen gases dissolved in the surrounding water.

3. **Reproduction**: *Amoeba* reproduces asexually through a process called binary fission (Binary fission in Amoeba)**,** where the cell divides into two identical daughter cells. They reproduce approximately every two days and, their reproduction rate is dependent on the species and environmental conditions.

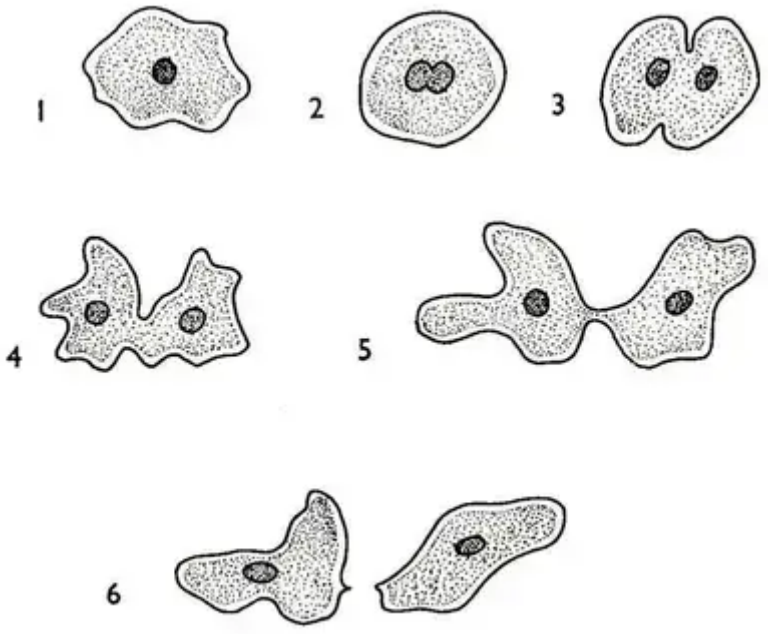


Figure 4.5: Binary Fission in Amoeba

4. **Excretion**: Waste products are eliminated from the cell through the cell membrane. Water balance is maintained by osmoregulation (Click to read more on the topic)
5. **Response to Stimuli**: *Amoeba* can respond to changes in the environment, such as moving towards a food source or away from harmful substances. They have the simplest cell signalling patterns that help detect the external and internal stimuli in the environment such as chemicals, light, and heat.

The Economic Importance of *A. Proteus*

1. They assist in nutrient recycling by consuming microorganisms such as bacteria and algae to maintain ecological balance.
2. They serve as model organisms in scientific research in areas such as cytology, genetics and microbiology.
3. They form an important component of the food chain of an ecosystem.

4. They serve as indicator species in a habitat, as the changes in amoebae populations are an indication of interference in water quality levels.
5. Some species of Amoeba are parasitic and pathogenic and cause diseases to humans and damage to crops. For example, *Entamoeba hystolitica* causes amoebic dysentery

Activity 4.8: Beyond the Microscope -Practical Importance of Amoeba

Undertake the following activities with your friends.

1. Scrap decaying vegetation from the bottom of a pond. Allow scrapping to settle down in a wide-mouth container. Observe the sediment under a binocular microscope and sort with the help of a fine pipette the different kinds of Amoebae.
2. Boil decaying weeds or other organic substances such as hay, twigs, dry leaves, and seeds for 15 minutes with a sufficient amount of fresh water. After boiling, filter the water and allow the filtrate to cool. To this filtrate, add new Amoeba-rich water drops and allow to multiply for 2 to 3 days and observe under the light microscope.
3. Put some pond water, mud, and leaves in 100 ml of water containing a few grains of wheat. Observe a sample of the water under the light microscope.
4. Boil four or five grains of wheat in 100 ml of distilled water for 10 minutes and cool for a few days; to this add some Amoebae from the first culture and cover with a glass plate; in ten days observe a sample under the light microscope.
    a. Draw what you have observed in your sketchbook
    b. Record your observation.

THE LIFE PROCESSES AND ECONOMIC IMPORTANCE OF *EUGLENA VIRIDIS*

Euglena Viridis is a solitary and free-living freshwater flagellate found in great numbers in stagnant freshwater ponds, pools, ditches, and slowly running streams, etc., containing a considerable amount of vegetation. It is fairly active and often found at various depths below the surface of the water. They can easily be found in ponds in well-maintained gardens, containing decaying nitrogenous organic matter, such as faeces of animals, leaves and twigs. It multiplies rapidly and forms green scum on the water surface (like algal blooms)under favourable conditions.

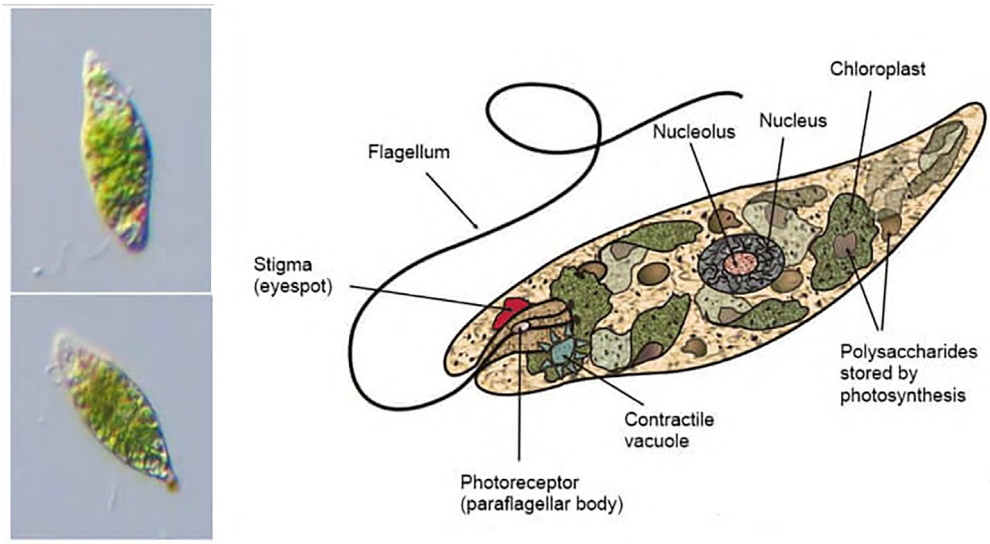


Figure 4.6: Euglena diagram.

Fun fact:

Euglena viridis (Gr.,eu, true+ glene, eyeball or eye pupil+L., Viridis, green) is a unicellular green organism with an eye-like photoreceptive structure. It is phytoflagellate as it possesses both chloroplasts as well as flagella. It is autotrophic in sunlight but becomes heterotrophic in the dark.

Life Processes of *Euglena viridis*

1. **Nutrition**: *Euglena viridis* is a unique organism as it can be both autotrophic (capable of photosynthesis) and heterotrophic (eats other plants or animals). Euglena is the connecting link between the Plant and Animal kingdom. So, they have the characters of both plants as well as animals. The mode of nutrition in E. viridis is mixotrophic., the nutrition is accomplished either by autotrophic or holophytic as well as saprophytic or saprozoic.

a. Autotrophic or holophytic nutrition. It is the chief mode of nutrition in Euglena. Like a true plant, it can manufacture its food in the presence of sunlight, by the process of photosynthesis with the help of chlorophyll present in the chloroplast. Euglena remains an autotroph so long as it is in light and is provided with essential inorganic compounds. At times when pond water becomes polluted with dead and decaying organic matter, it switches over to a saprozoic mode.

b. Saprophytic or saprozoic nutrition. In prolonged darkness, Euglena loses its chlorophyll and green colour. It becomes etiolated, that is, becomes pale and white, yet it continues to live and perform all the life activities. In the absence of sunlight, Euglena lives by the saprophytic or saprozoic methods, which means the products of decaying organic matter dissolved in surrounding water are absorbed through its general body surface(mainly through the pellicle). Euglena secretes digestive enzymes that are typically animal-like in nature. Generally, the chloroplast lost in the dark is regained in the light.

i. Pinocytosis has also been observed to take place at the base of the reservoir for the intake of protein and other large molecules.

2. **Photosynthesis**: *Euglena* contains chloroplasts which allow it to perform photosynthesis and produce its food in the presence of sunlight.
3. **Respiration**: *Euglena* undergoes cellular respiration to derive energy from the breakdown of food molecules in the presence of oxygen (aerobic). It respires with the help of free oxygen dissolved in water, which diffuses through the pellicle. During the daytime, a good amount of oxygen is liberated in the process of photosynthesis which is utilised for respiration. As a result of oxidation reactions, water and carbon dioxide are formed as by-products. In sunlight, this carbon dioxide is utilised for photosynthesis, but in the dark, it is liberated to the outside by diffusion through the general body surface.
4. **Reproduction**: *Euglena*. reproduces asexually through binary fission, like *Amoeba*. It can also undergo a form of sexual reproduction called **conjugation**, where genetic material is exchanged between two individuals. They reproduce by longitudinal binary fission under favourable conditions. The longitudinal binary fission is always symmetrogenic(i.e., the parental Euglena divides into two daughter individuals, where one is the plane mirror image of the other).

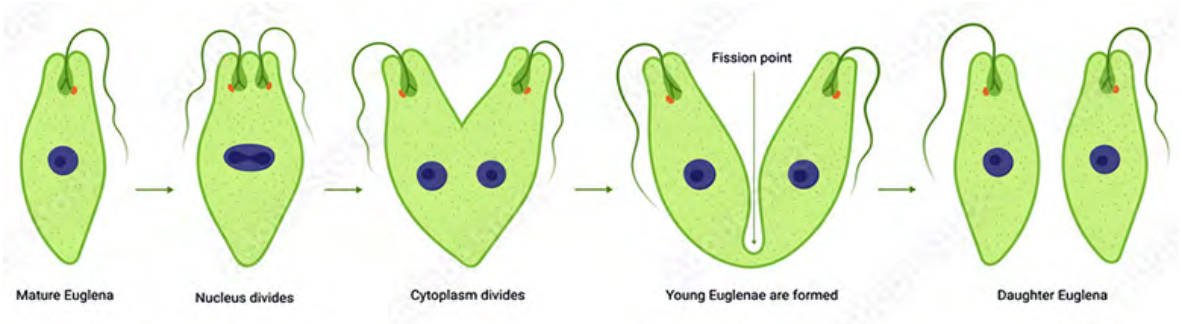


Figure 4.7: Binary fission in Euglena (Asexual reproduction)

5. **Excretion and Osmoregulation**: Waste products are eliminated through the pellicle, a semi-rigid outer covering. The removal of excess water from the body is known as osmoregulation. In Euglena, the removal of excess water entering the body by osmosis is performed by contractile apparatus. In E. viridis, the contractile apparatus consists of a large contractile vacuole surrounded by numerous small accessory vacuoles. The cytoplasm secretes the excessive water into this smaller vacuole which, in turn, drains into the larger vacuoles. The larger vacuole finally empties into the reservoir. The process involves the diastole (increase in volume) and systole (decrease in volume) of the large contractile vacuole. In diastole, the contractile vacuole is filled with water, while in systole it is emptied to throw its water into the reservoir. From the reservoir, the fluid escapes through the gullet. Along with this, water-soluble wastes are thrown out of the body. Ammonia, the nitrogenous waste product, resulting from catabolism, passes out through the general body surface by diffusion. Excretory substances may also be emptied by the contractile vacuole into the reservoir. It has been suggested that a dense zone of cytoplasm around the contractile apparatus is both osmoregulatory and excretory in function. It secretes water as well as excretory products into the lumen of the vacuole.
6. **Response to Stimuli**: *Euglena*. has a light-detecting eyespot that allows it to sense and move towards light, enabling it to perform photosynthesis efficiently. Euglena reacts to a variety of stimuli in the same manner as protozoa do (moving towards favourable stimuli and away from unfavourable stimuli).
7. **Locomotion:** Euglena viridis performs 2 different kinds of movements which are flagellar and euglenoid movements.

    a. Flagellar movement. Euglena swims freely in water with the help of a single, long locomotory flagellum by whipping, twisting, and turning it around like that of a propeller. The three different types of movement of

the Euglenoid body caused by the locomotory Flagellum are **forward movement, rotational movement,** and **revolutionary movement.**

b. Euglenoid movement. This type of movement is usually possible due to the presence of a Pellicle on the surface of the body. The pellicle is flexible and contractible which enables Euglena to perform peristaltic movements.

Economic Importance of *E. viridis*

Euglena sp. have potential economic significance due to their ability to perform photosynthesis and produce a carbohydrate compound called paramylon. Paramylon has some health benefits, including lowering blood cholesterol levels.

Activity 4.10: Exploring the value of E. viridis

1. Fill clean and wide-mouth large bottles with boiled tap or pond water and add boiled wheat grains to each bottle. Keep the bottles in a sunny place for a week. Add the wheat grain monthly to maintain the culture. Observe the sample water under the light microscope.
2. Boil manure solution (horse or cow manure) in a pond or distilled water in a jar. Allow these manure solutions to cool for 2 days and put some weeds from the pond containing Euglena in the jar. Keep the jar near a well-lightened window for a few days. Observe a sample under the light microscope.
3. Record and discuss your findings with your classmates and teacher.

THE LIFE PROCESSES AND ECONOMIC IMPORTANCE OF *SPIROGYRA PORTICALIS*.

Spirogyra porticalis

Spirogyras, commonly known as blanket weeds, water silk, or mermaid's tresses, are filamentous, free-floating algae that are commonly found to live in freshwater habitats such as ponds, pools, tanks, lakes, and stagnant waters. They are also known as pond scum or pond silk because of their filamentous and slimy nature that can float freely in masses over the water surfaces and are capable of movement. Under a light microscope, Spirogyra is seen as long threadlike, green colonies

called filaments that are joined end to end, without any differentiation into base and apex.

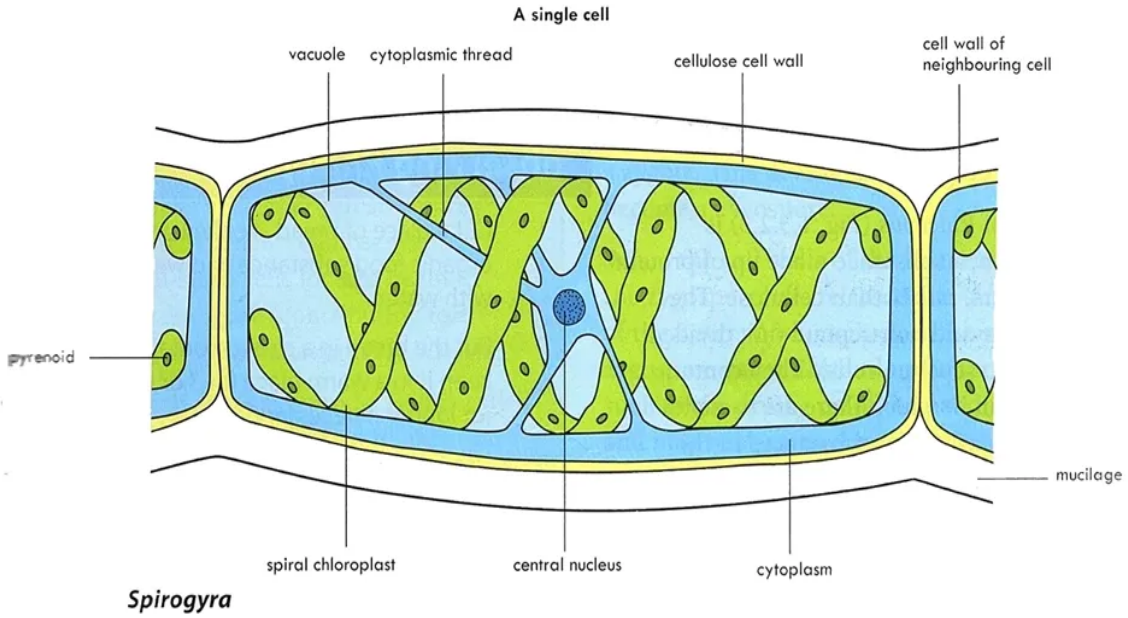


Figure 4.8: Structure of *Spirogyra porticalis*.

Fun fact:

The name 'Spirogyra' is derived from the Greek words, 'speria', meaning coil, and 'gyras', meaning twisted.

Life Processes of *Spirogyra porticalis*

1. **Nutrition**: *Spirogyra porticalis* is a photosynthetic organism. It contains chloroplasts that enable it to synthesize its food using sunlight, carbon dioxide and water.
2. Although they thrive to grow in nutrient-rich environments, Spirogyra produces their own food using the green pigment chlorophyll and sunlight through photosynthesis, thus performing an autotrophic mode of nutrition.
3. **Respiration**: *Spirogyra porticalis* undergoes respiration to obtain energy from the breakdown of stored sugars. Similar to plants, during daytime Spirogyra takes in carbon dioxide dissolved in water to release a relatively large volume of oxygen using specialized cells called stomata. The released oxygen remains trapped as tiny bubbles between the tangling strands of their filamentous body that helps them to float in water and become visible as a slimy green mat. At night and on overcast days, the process reverses,

as Spirogyra consumes oxygen and produces carbon dioxide as a metabolic waste product of cellular respiration.

4. **Reproduction**: *Spirogyra porticalis* reproduces both asexually through fragmentation (breaking into pieces that grow into new individuals) and sexually through the conjugation process.

   a. **Asexual Reproduction.** It occurs mainly through a process called fragmentation. Under favourable conditions of growth, the walls of adjacent cells dissolve, thereby causing breakage of the filament. After fragmentation, the vegetative filament develops into a new filament where each fragment undergoes multiple division and elongation to form a new filament. When a Spirogyra filament attains considerable length, it breaks into smaller pieces that can grow into a mature organism. Fragmentation is also found to occur due to a mechanical injury or a change in their aquatic medium's salinity and temperature.

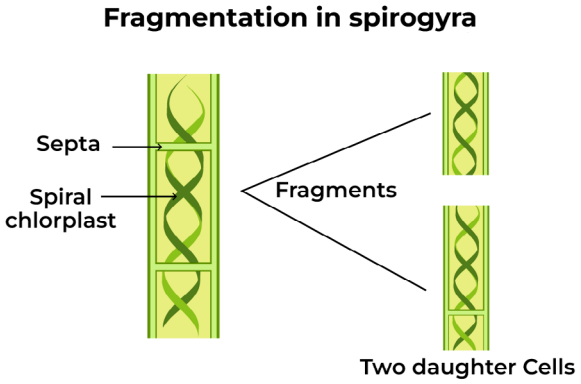


Figure 4.9: Asexual reproduction in Spirogyra

During unfavourable growth conditions, the cytoplasmic content of the cell shrinks and loses water, developing a hard covering around the cell, and resulting in the formation of spores. Depending upon the thickness of the cell wall and their ability to move, spores in Spirogyra can be of three types – aplanospores (thin-walled and non-motile), akinetes (thick-walled and non-motile) and azygospores (thin-walled and motile). While akinetes and aplanospores develop into a new filament under favourable conditions after the decay of the parent filament, azygospores fail to fuse during sexual reproduction and develop into a new filament asexually. Asexual reproduction is thus a form of adaptation in Spirogyra.

b. Sexual Reproduction. It occurs during favourable conditions of growth through a process known as conjugation. It is of two types Scalariform conjugation and Lateral conjugation

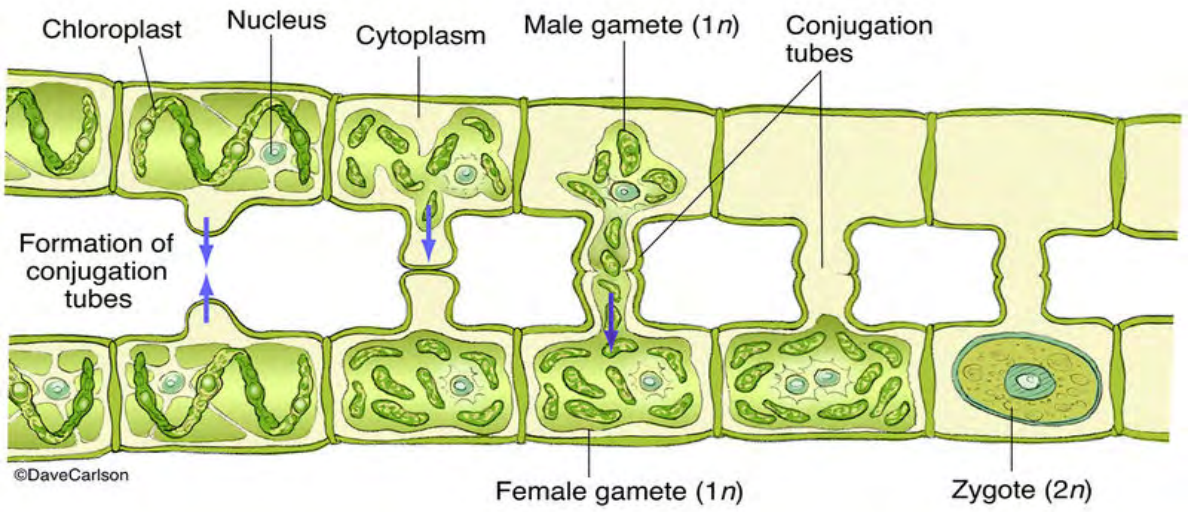


Figure 4.10: Conjugation in Spirogyra

5. **Excretion**: Waste products are eliminated through the cell membrane.
6. **Response to Stimuli**: *Spirogyra porticalis* exhibits a slow, passive movement in response to environmental changes. Spirogyra forms long filaments that are capable of bending and curving, enabling movement. They are capable of orientation towards light. They strangulate to become heavy and sink to move away from light when light intensity is too high. They loosen up to become less heavy and float to the surface for light during the day.

Economic Importance of *Spirogyra porticalis*

Spirogyra porticalis plays a vital role in aquatic ecosystems as it contributes to oxygen production through photosynthesis. Additionally, *Spirogyra* serves as a food source for certain aquatic organisms, supporting the aquatic food chain. In research and education, *Spirogyra porticalis* is a commonly studied organism for understanding plant cell structure.

Activity 4.11: Significance of Spirogyra porticalis in the Ecosystem

1. Visit a nearby stream pond or slow-moving river to observe *Spirogyra* in its natural habitat
   - **a.** Give the special adaptations of Spirogyra for its life processes.
   - **b.** Describe how *Spirogyra* undergoes movement and nutrition.

c. Discuss the economic importance of *Spirogyra* in its habitat.

d. Record your observations and compare them with your friends

Activity 4.12: Observe and sketch

1. Observe *Spirogyra* under the light microscope from temporary slides prepared from freshly fetched water from a ditch or pond

a. Make a diagram of your observation in your sketchbook.

b. Describe your observations and findings and record them.

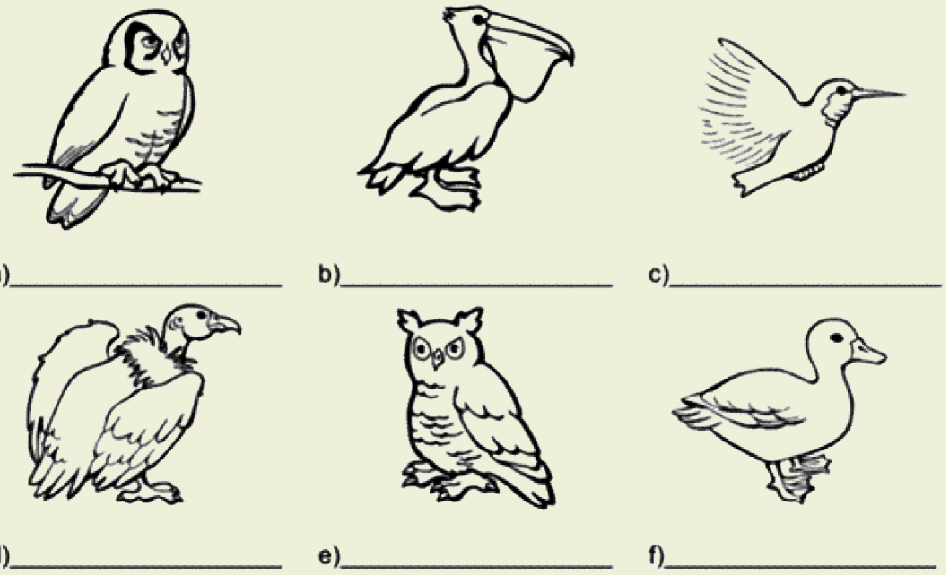
c. Analyse your microscope observations of *Spirogyra* and discuss results with your friends.

REVIEW QUESTION

Review Questions 4.1

1. Explain the purpose of biological keys and how they are used.
2. Describe briefly the two main types of biological keys.
3. Why are biological keys important for scientists and naturalists?
4. What are the advantages of using a dichotomous key?
5. Imagine you are using a dichotomous key to identify a plant. You encounter a step with two choices: “leaves simple” and “leaves compound”. What does this mean and how would you decide which choice applies to your plant?
6. What are some potential limitations of using a biological key?
7. Construct a biological key to identify some unknown plants found in your community using the following features: leave blade size, simple or compound leaf, leaf arrangement on stalk.

8. Construct a dichotomous key to identify the birds in each picture. Write each bird's name below its picture:



9. Use the numbered key to identify the following organisms.

Hint:

Identify and write down paired observable physical characteristics.

a. Choose one picture at a time.

b. Follow the key until you classify the organism.

c. Identify the organism by writing the appropriate name below it.

d. Discuss your answers with members of other groups

Review Questions 4.2

1. Discuss the background of classification, linking it to simple living organisms, and the factors that are considered in classifying them.
2. Discuss the various forms of classification among living things.
3. Examine the differences between natural and artificial classification of simple living things. *Hint: Describe at least three basic differences between natural and artificial forms of classification.*
4. Analyse the steps to be taken to classify a newly discovered simple living organism, hence discuss why it is necessary to classify living things.

   ***Hint**: Discuss the major steps that taxonomists follow to classify and name newly discovered species.*
5. Identify the key factors required in creating a system for the identification and classification of simple living things.
6. Explain why you think it is important that a biology learner should have a good basis in classifying living things.
7. Discuss the strengths and limitations of natural and artificial classification. *Hint: Discussion on the advantages and disadvantages of natural and artificial classifications, using factors such as the bases of classification, criteria of classification and flexibility.*
8. Collect samples (10-20 specimens) from your school community and group them under their various taxa as far as possible, assigning reasons as to why a particular organism is placed in a specific group.

Review Questions 4.3

1. Describe the 8 taxa/ranks in modern classification with examples of common organisms.
2. Explain how you will classify a named species of simple organism into its taxa.
3. Describe the eight taxa identified in hierarchical classification.
4. Design a flowchart of the hierarchies in classification and select one common example to identify each of the eight taxa it belongs.

Review Questions 4.4

1. Explain binomial nomenclature in taxonomy and give some common examples. *Hint: Explain the term binomial nomenclature and give the binomial names of at least three common living things.*
2. Explain why some nomenclatures are two termed names but others may be three. *Hint: Explain the concept of sub-species, resulting in some species bearing trinomial names due to their sub-species names.*
3. Discuss the factors that affect binomial names assigned to living things.
4. As a taxonomist, why would you prefer to use the binomial names of living things in your study, and not their common names? *Hint: Discuss the advantages and implications of binomial names over common names i.e. ensure uniformity in naming and identifying living things amongst biologists the world over.*

Review Questions 4.5

1. List at least three life processes of *Amoeba*, briefly describing each.
2. Describe any two of the following processes in *Amoeba*: nutrition, movement, excretion, and reproduction organs.
3. Outline the economic importance of *Amoeba* in a named ecosystem.

Review Questions 4.6

1. List three life processes of *Euglena*, and briefly explain each.
2. Describe at least one of the following processes in *Euglena*: nutrition, movement, excretion, reproduction
3. Describe the economic importance of *Euglena* in a named natural habitat
4 Discuss whether *Euglena* or *Amoeba* is the more advanced protoctist, indicating the parameters used for the comparison.

Review Questions 4.7

1. List at least three life processes of *Spirogyra*, and briefly explain each.
2. Describe at least one of the following processes in *Spirogyra*: nutrition, movement, excretion, or reproduction
3. Examine the economic importance of *Spirogyra* in a named natural habitat.
4. Discuss whether *Spirogyra* or *Euglena* is the more advanced protoctist.

   Indicate the parameters used in your analysis.

ANSWERS TO REVIEW QUESTIONS

Review Questions 4.1

1. They are essential tools for identifying unknown organisms. They make use of the physical features of the organism by answering a yes or no question on the presence or absence of a specific feature.
2. Dichotomous keys involve forming a couplet of contrasting questions and answering a yes or no depending on the presence or absence of a feature. This eventually narrows down to the specific organism. Numbered keys usually consist of a series of statements or questions each followed by a choice of two or more options e.g. 1a, 1b, 1c etc. Each option leads to another question or statement, which eventually leads to the identification of the organism.
3. Biological keys help scientists and naturalists generally understand the diversity and classification of living things.
4.
    - It breaks down identification into a series of simple yes/no choices, making it a simple tool to use.
    - It leads directly to the correct identification, making it an efficient tool that saves time and effort.
    - It's an accurate tool for identification if the specific steps are followed.
    - It's a versatile tool for identifying a wide variety of organisms, ranging from macro to micro-organisms.
5. Leaves simple: mean single undivided leaf blades attached to a stem.

    Leaves compound: means leaves made up of multiple leaflets attached to a central stalk.

    How to decide on the choice that applies to your plant:

    - Observe your plant
    - Count the leaves/leaflets

6.

- Oversimplification of complex characteristics
- Incomplete information (omission of some characteristics)
- Ambiguity (keys may use ambiguous terms)
- Limited scope of application of keys
- Difficulty with hybrid or variant species

7.

1a. Trees with leaves modified as needles – Go to 2

1b. Trees with broad-bladed leaves – go to 3

2a. Two needles in a bundle ... Jack pine

2b. Five needles in bundle … Whistling pine

3a. leaves compound – Go to 4

3b. Leaves simple – Go to 5

4a. Leaf composed of five leaflets … Buckeye

4b. Leaves composed of seven leaflets …Horse chestnut

5a. Leaves opposite … Maple

5b. Leaves alternate – Go to 6

6a. Tree with horns … Hawthorn

6b. Tree with thorns – Go to 7

7a. Leaf blade shaped like a fan – Ginkgo

7b. Leaf blade not shaped like a fan – Go to 8

8a. Leaf blade oval, toothed but not lobed … Elm

8b. Leaf blade lobed – Go to 9

9a. Leaf blade with rounded lobes … White oak

9b. Leaf blade with pointed lobes … Pin oak

8. Does this bird have talons (sharp claws)? If YES, go to 2. If NO, go to 5.

a. Does this bird have ear tufts? If YES, it is a Screech owl. If NO, go to 3.

b. Does this bird have a featherless head? If YES, it is a vulture. If NO, go to 4

c. Does this bird have bar-like markings on its chest? If YES, it is a barred owl. If NO, go to 1.

d. Does this bird have a long-pointed beak? if YES, go to 6. If NO, go to 7

e. Does this bird have a straight beak? If YES, it is a Hummingbird. If NO, go to 7.

f. Does this bird have webbed feet? If YES go to 8. If NO, go to 5.

g. Does this bird have a throat pouch? If YES, it is a Pelican. If NO, go to 9.

h. Does this bird have a short-pounded beak? If YES, it is a Duck. If NO, go to 1.

9.

1) a. Vertebrate (has backbone) ..... Rattlesnake

b. Invertebrate (no backbone) ..... Go to 2

2) a. 6 legs..... Go to 3

b. 8 legs..... Go to 5

3) a. Wings..... Go to 4

b. No wings..... Go to 7

4) a. Coloured wings ..... Go to 8

b. Transparent wings ..... Go to 9

c. Front Wings are hidden with casing ..... beetle

5) a. Very Hairy body ..... Tarantula

b. Light hair covering the body..... Go to 6

6) a. black with large red symbols on body .... black widow spider

b. Often brown body and makes funnel webs..... Hobo spider

7) a. Jumping hind legs ..... grasshopper

b. No jumping ..... Ants

8) a. Antenna are club-shaped with a bulb at the end…… butterfly

b. Antenna are feathery with no club at the end…… moth

9) a. One set of transparent wings … housefly

b. Two sets of transparent wings …… Go to 10

10) a. Hairy, wide body …… Bee

b. Few hairs, longer body …… Wasp

Answers to Review Questions 4.2

1. Factors of classification
   - Morphology
   - Physiology
   - Genetic information
   - Ecological information
   - Evolutionary relationships
2. Forms of Classification
   - Hierarchical Classification
   - Cladistics
   - Phylogenetic Classification
   - Numerical Classification
3. Refer to the main content on page 12 - 16 to guide you in the discussion.
4. Major steps that taxonomists follow to classify and name newly discovered species.
   - Collection and observation
   - Literature review
   - Character analysis
   - Phylogenetic analysis
   - Determination of taxonomic rank
   - Binomial nomenclature
   - Description and publication

5. Factors of Classification
   - Morphology
   - Physiology
   - Genetic information
   - Ecological information
   - Evolutionary relationships
6. Why a biology learner should have a good foundational understanding of taxonomy
   - Understanding relationships
   - Communication
   - Identification
   - Pattern recognition
8. **Classification of Amoeba**

   Domain: *Eukarya* (It has cells with nuclei)

   Kingdom: *Protista* (It is a unicellular eukaryote)

   Phylum: *Amoebozoa* (Organism that moves by internal cytoplasmic flow)

   Class: *Tubulinea* (It is a tubular *Amoeba*)

   Order*: Euamoebida* (It is a type of tubulinea)

   Family: *Amoebidae* (It is a type of *Amoeba*)

   Genus: *Amoeba* (It belongs to the genus *Amoeba*)

   Species: *proteus* (The specific species name)

   Classification of Chicken

   Domain: *Eukarya*

   Kingdom: *Animalia*

   Phylum: *Chordata*

   Class: *Aves*

   Order: *Gallus*

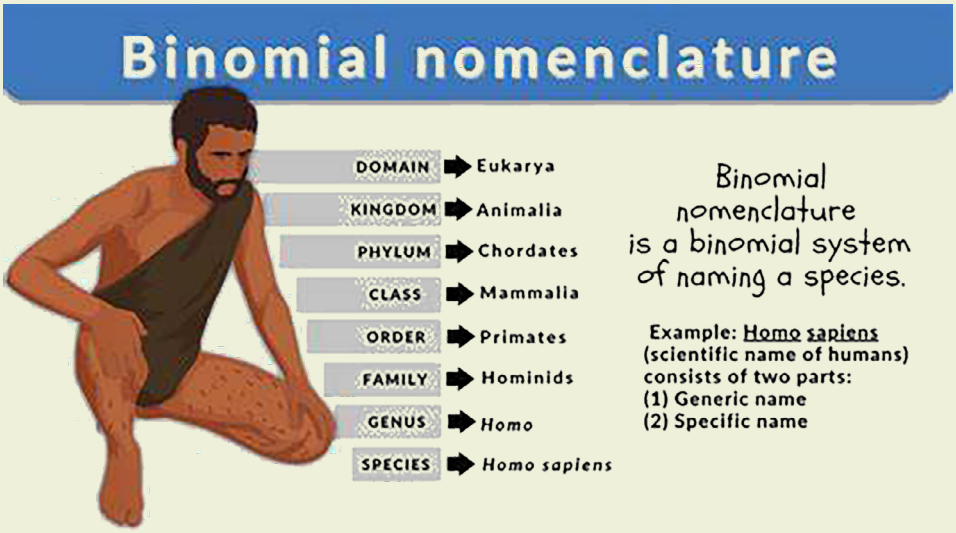
   Family: *Phasianidae*

Genus: *Gallus*

Species: *Gallus*

Answers to Review Questions 4.3

1. Classification of Human Being



Domain: *Eukarya*

Kingdom: *Animalia*

Phylum: *Chordata*

Class: *Mammalia*

Order: *Primates*

Family*: Homin*idae

Genus: *Homo*

Species: *Homo sapiens*

2. Classification of Amoeba

- **Domain**: Eukarya (It has cells with nuclei)
- **Kingdom**: Protista (It is a unicellular eukaryote)
- **Phylum**: Amoebozoa (Organism that moves by internal cytoplasmic flow)
- **Class**: Tubulinea (It is a tubular *Amoeba*)
- **Order**: Euamoebida (It is a type of tubulinea)
- **Family**: Amoebidae (It is a type of *Amoeba*)

- **Genus**: *Amoeba* (It belongs to the genus *Amoeba*)
- **Species**: *proteus* (The specific species

3. Domain, Kingdom, Phylum/Division, Class, Order, Family, Genus, and Species
4. Classification of Mango plant
    - Domain: *Eukarya*
    - Kingdom: *Plantae*
    - Division: *Angiospermophyta*
    - Class: *Dicotyledonae*
    - Order: *Sapindales*
    - Family:*Anacardiaceae*
    - Genus: *Mangifera*
    - Species: *Indica*

Answers to Review Questions 4.4

1. Refer to the content on page 17 to support you in answering this question.
2. Refer to the content on page 17 – 19 to support you in answering this question.
3. Factors affecting Binomial names that should be considered in the discussion include

- Scientific accuracy
    - Consistency and clarity in communication
    - International acceptance
    - Cultural and historical norms and origin of species
    - Taxonomic revision

Answers to Review Questions 4.5

1. Respiration, excretion and reproduction. Respiration, and excretion, in amoeba can be done through diffusion. Amoeba, being a unicellular organism, obtains oxygen and expels waste gas (carbon dioxide) by diffusion. Thus, in amoeba diffusion is used as the method of respiration

as well as excretion. Reproduction is asexual (without the fusion of gamete cells) by binary fission.

2. Refer to content on the life processes of Amoeba
3. Refer to content on the economic importance of amoeba

Answers to Review Questions 4.6

1. Reproduction, Excretion and Response to Stimuli
   - Reproduction is asexual by binary fission. Euglena divides longitudinally to form two daughter cells
   - Excretion of carbon dioxide and nitrogenous waste products (ammonia) occurs through the general body surface by diffusion. Some form of excretion, including removal of excess water however is carried out by the contractile vacuole.
   - Response to Stimuli: *Euglena*. has a light-detecting eyespot that allows it to sense and move towards light, enabling it to perform photosynthesis efficiently.
2. Refer to content on nutrition, movement, excretion and reproduction
3. In a pond ecosystem, Euglena serve primarily as a major primary producer, providing nutrients for some primary consumers.
4. Euglena is comparatively advanced to amoeba per the under-listed parameters
   - Movement: Euglena uses flagellum for fast movement while Amoeba uses pseudopodia for slow movement.
   - Nutrition: Euglena performs photosynthesis and absorbs nutrients; Amoeba consumes particles through phagocytosis.
   - Shape: Euglena has a definite shape; Amoeba lacks a definite shape (amorphous).

   Sensory organs: Euglena has an eyespot to detect light; Amoeba has no complex sensory

Answers to Review Questions 4.7

1. Refer to the main text for answers
2. Refer to the main text for answers

3. *Spirogyra porticalis* plays a vital role in aquatic ecosystems as it contributes to oxygen production through photosynthesis. Additionally, *Spirogyra* serves as a food source for certain aquatic organisms, supporting the aquatic food chain.
4. Both Euglena and Spirogyra are both single-celled organisms with distinct characteristics:
    a. Euglena:
        i. Structure: *Euglena* lacks a cell wall but has a flexible pellicle made of protein which allows it to exhibit exceptional flexibility and contractility.
        ii. Movement: *Euglena* moves using flagellum
        iii. Nutrition: both autotrophic and heterotrophic
        iv. Habitat: may be freshwater or marine
        v. Size: ranges from 80 to 130 micrometres in length
    b. Spirogyra:
        i. Structure: *Spirogyra* is a filamentous green alga with an unbranched chain of cylindrical cells with a cell wall.
        ii. Movement: *Spirogyra* exhibits a slow, passive movement in response to environmental changes with no specialised structure for movement.
        iii. Nutrition: autotrophic
        iv. Habitat: freshwater
        v. Size: *Spirogyra* filament can be long, but individual cells are smaller than *Euglena.*

EXTENDED READING

Click on the links below to watch videos about the various life processes of the organisms discussed above

- What is An Amoeba | Biology | Extraclass.com (youtube.com)
- Euglena under microscope (youtube.com)
- Lifecycle of Spirogyra (youtube.com)
- Spirogyra practical | Dr. Varsha S Khude | botanical Studies (youtube.com)

Excretion in *Amoeba*

It is the process of internal balance between water and dissolves materials irrespective of environmental conditions. The protoplasm of A. proteus is of higher concentration than the freshwater of its environment which causes the water to enter into the body by osmosis through the semi-permeable plasmalemma. To prevent the swelling and ruptures of the animal due to excess water, the contractile vacuole collects the excess water which is less dense than the surrounding cytoplasm and are expelled out of the protoplasm. This contractile vacuole disappears, and a new one starts to form in the endoplasm. When placed in freshwater marine Amoeba develops more contractile vacuole. When the freshwater Amoeba is placed into the saltwater their contractile vacuole decreases and disappears.

The main function of the contractile vacuole is osmoregulation, even though carbon dioxide and nitrogenous wastes are also excreted through it.

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