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ENSB

N° d'ordre:

Preparatory Cycle - First Year

Collection of practical work in Plant biology

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Target Audience

This course material is intended for first-year engineering students at the National Higher School of Biotechnology of Constantine (ENSB).

General Objectives of the Practical Sessions

The general objectives of these practical sessions are to :

- Develop students' skills in microscopic observation and histological preparation of plant tissues.
- Understand the anatomical, morphological, and histological organization of different plant organs (root, stem, leaf, flower, fruit).
- Identify the main taxonomic groups of lower plants (algae, fungi, lichens, bryophytes) and higher plants (angiosperms).
- Analyze the structural and functional adaptations of plants related to their growth, reproduction, and environment.
- Acquire practical experience in using laboratory equipment and in preparing biological samples for microscopic analysis.
- Interpret microscopic and macroscopic observations through accurate scientific drawings and comparative analysis.
- Reinforce theoretical knowledge of plant biology through hands-on experimental work and direct observation.

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Glossary

- **Meristem:** A region of plant tissue with actively dividing cells that allows for growth.
- **Parenchyma:** A fundamental plant tissue involved in photosynthesis, storage, and tissue repair.
- **Sclerenchyma**: Strengthening tissue composed of dead cells with thickened, lignified walls.
- **Xylem:** Tissue responsible for water and mineral transport from roots to leaves.
- **Phloem:** Tissue responsible for transporting organic nutrients, especially sugars.
- **Conidiophore:** A specialized fungal hypha that produces asexual spores (conidia).
- **Sporangiophore:** A specialized fungal hypha bearing a sporangium.
- **Sporangium:** A structure where spores are produced in fungi and some plants.
- **Photobiont:** The photosynthetic partner (algae or cyanobacteria) in a lichen.
- **Mycobiont:** The fungal partner in a lichen symbiosis.
- **Apothecia:** Cup-shaped fruiting bodies of certain lichens and fungi producing ascospores.
- **Thallus:** The body of algae, fungi, and lichens lacking true stems, roots, or leaves.
- **Scalariform Conjugation:** A form of sexual reproduction seen in filamentous algae like Spirogyra.
- **Bryophyte:** A group of non-vascular land plants including mosses, liverworts, and hornworts.
- **Zygospore:** A thick-walled resting spore resulting from the fusion of two gametes in fungi or algae.
- **Actinomorphic:** Having radial symmetry, typical of many flowers.
- **Zygomorphic:** Having bilateral symmetry, typical of certain flowers like orchids.
- **Hypogynous Flower:** A flower with a superior ovary situated above the attachment of other floral parts.
- **Epigynous Flower:** A flower with an inferior ovary embedded below the attachment point of other floral parts.

Fundamental Aspects of Plant Biology
Practical Sessions

<u>Fundamental Aspects of Plant Biology Practical Sessions</u>

Plant Biology is the scientific study of plants living organisms that play a vital role in sustaining life on Earth. Plants produce oxygen, store energy through photosynthesis, and form the base of all food chains. They are also a major source of food, medicine, raw materials, and ecological stability. In this course, practical sessions help students connect theoretical knowledge with real observations. By examining roots, stems, leaves, flowers, algae, mosses, fungi, and lichens, students learn how plants are organized, how they grow, reproduce, and interact with their environment. Laboratory work encourages curiosity, observation skills, and scientific drawing essential tools for any biologist.

- **Plant Anatomy: Roots, Stems, and Leaves**

Plant anatomy studies the internal structure of plant organs. Understanding how cells and tissues are arranged helps explain how plants transport water, nutrients, and food, and how they grow and adapt to their environment.

All plant organs are made of several tissue types that work together:

- **Protective Tissues** : The epidermis covers and protects young organs, preventing water loss and damage. In older stems, the periderm replaces the epidermis and forms cork.

- **Fundamental Tissues :** Parenchyma cells perform photosynthesis and store nutrients. Collenchyma and sclerenchyma provide mechanical support and strength.

- **Conducting Tissues :** The xylem transports water and minerals; the phloem carries sugars and organic molecules.

Growth occurs through meristems regions of actively dividing cells. Primary meristems allow elongation, while secondary meristems (vascular cambium and cork cambium) produce wood and bark.

Microscopic observation of monocot and dicot roots and stems allows identification of tissue organization and comparison of vascular systems.

- **Thallophytes: Green Algae (Spirogyra and Ulothrix)**

Thallophytes are simple, non-vascular plants without true roots, stems, or leaves. Algae are early photosynthetic organisms essential for oxygen production and aquatic ecosystems.

Spirogyra is a filamentous green alga with spiral chloroplasts. It reproduces by fragmentation (asexual) and conjugation (sexual). The zygospore formed after fertilization survives harsh conditions.

Ulothrix is another filamentous green alga attached to rocks in cold water. It reproduces vegetatively or sexually through isogamy (fusion of similar gametes). Studying these algae illustrates early plant evolution from aquatic to terrestrial life.

- **Bryophytes: The First Land Plants**

Bryophytes (mosses, liverworts, hornworts) are non-vascular plants that depend on water for reproduction. They have a simple structure without true roots, stems, or leaves.

Their life cycle alternates between a dominant gametophyte (haploid) and a dependent sporophyte (diploid*). Funaria hygrometrica* and *Polytrichum formosum* are model species for observation. Bryophytes are ecological pioneers that retain moisture and initiate soil formation.

- **Angiosperms: Flower Morphology, Inflorescences, and Fruits**

The flower is the reproductive organ of angiosperms. It typically contains four whorls: calyx, corolla, androecium, and gynoecium. Flowers can be actinomorphic or zygomorphic, with superior or inferior ovaries.

Examples include Sinapis arvensis (Brassicaceae), Hedysarum coronarium (Fabaceae), and Leucanthemum vulgare (Asteraceae). Inflorescences such as racemes, spikes, umbels, and capitula represent different flower arrangements.

After fertilization, the ovary develops into a fruit dry or fleshy, simple, aggregate, or multiple. Observing these variations teaches plant classification and reproductive strategies.

- **Fungi and Lichens**

Fungi are heterotrophic, non-photosynthetic organisms with filamentous bodies (hyphae forming a mycelium). They may be saprophytic, parasitic, or symbiotic.

Examples:

- *Rhizopus nigricans*: black bread mold, reproducing by sporangiospores.

- *Penicillium sp.:* mold producing conidia; source of antibiotics.

- *Aspergillus sp:* filamentous fungus with vesicular conidiophores.

Lichens are symbiotic associations between a fungus and an alga or cyanobacterium. Types include crustose, foliose, and fruticose forms. Xanthoria parietina and Physcia sp. are common examples. Lichens reproduce by soredia, isidia, or fragmentation and serve as bioindicators of air quality.

Plant Biology Practical Sessions

General introduction

Plant biology, as a fundamental branch of life sciences, explores the structure, physiology, reproduction, and evolution of plants organisms that play a crucial role in maintaining life on Earth. Plants are not only the primary producers in all ecosystems, converting solar energy into chemical energy through photosynthesis, but they also serve as a source of oxygen, food, shelter, medicine, and raw materials. Understanding plant biology therefore provides an essential foundation for applied disciplines such as agronomy, biotechnology, environmental sciences, and pharmacology.

This practical manual is designed to help students gain hands-on experience in plant biology through laboratory sessions focused on anatomy, morphology, and reproduction. By observing and analyzing plant tissues, organs, and life cycles, students will develop a deeper understanding of the structural and functional organization of plants, as well as their evolutionary adaptations to different environments. The experiments presented here are structured to gradually introduce learners to the diversity and complexity of the plant kingdom, from simple thallophytic organisms to higher angiosperms.

The first set of practical sessions deals with plant anatomy, emphasizing the study of meristems, primary and secondary tissues, and the differentiation between monocotyledonous and dicotyledonous structures. Through microscopic observation, students learn how to identify and distinguish between the various tissue types : epidermal, parenchymatous, collenchymatous, sclerenchymatous, and vascular that compose the basic framework of plant organs such as roots, stems, and leaves.

The second part focuses on cryptogamic plants, including algae and bryophytes, which represent the early evolutionary stages of the plant lineage. These organisms are particularly valuable for understanding the transition from aquatic to terrestrial life. Observations of Spirogyra, Ulothrix, and moss species like Funaria hygrometrica and Polytrichum formosum provide insight into vegetative and sexual reproductive strategies that paved the way for the development of vascular plants.

The following sessions are devoted to angiosperms, the most advanced and diverse group of plants. The study of floral morphology, inflorescences, and fruits allows students to grasp the diversity of reproductive structures and their evolutionary significance. By dissecting flowers of families such as Brassicaceae, Fabaceae, and Asteraceae, learners can interpret floral diagrams, formulas, and the relationship between form and function in reproductive biology.

Finally, the manual introduces fungi and lichens, two groups traditionally studied within botany due to their ecological and symbiotic relationships with plants. These sessions highlight the structural organization, modes of reproduction, and ecological importance of fungi as decomposers and symbionts, as well as the dual nature of lichens as composite organisms resulting from a mutualistic association between fungi and algae.

Overall, this practical manual aims to bridge theoretical knowledge with empirical observation, fostering both scientific curiosity and methodological rigor. Each laboratory activity encourages observation, drawing, classification, and interpretation key skills in the biological sciences. By the end of the course, students should be able to recognize major plant structures, describe their function, and appreciate the evolutionary continuum that connects simple thallophytes to complex flowering plants. Beyond factual knowledge, this learning experience aspires to cultivate a sense of respect for the plant world and its indispensable role in sustaining ecosystems and human life.

Lab Session 01 and 02 : Plant Anatomy

Practical Session: Histology, Anatomy, and Morphology of the Stem, Root, and Leaf in Monocotyledons and Dicotyledons (Including Histological Section Preparation Techniques)

1. Overview

In this session, you will study the anatomy of plants with a focus on the root and stem. The exercise begins with a review of plant tissues and moves on to the formation of secondary structures. Detailed instructions are provided for preparing both monocotyledonous and dicotyledonous plant sections for microscopic observation.

Most plants have organs with specialized functions that are composed of distinct tissues. A tissue is a group of cells sharing a common origin and performing similar functions.

Tissues arise from meristems, which are young, undifferentiated embryonic cells that actively divide in a directed manner. These meristems may remain functional only briefly in annual plants or for many years in perennials.

2. Types of Meristems

- **Primary Meristems**

Located at the apex of stems (cauline meristems), roots (radicular meristems), and the base of leaves, these meristems produce the primary tissues that form the plant's initial structure. They are responsible for the vertical (lengthwise) growth of the plant.

- **Secondary Meristems**

After the primary meristems have developed, the secondary meristems—namely the phellogen and the vascular cambium—take over. They generate the secondary tissues responsible for lateral (width-wise) growth.

Four Major Tissue Types :

2.1. Protective or Covering Tissues

a. Epidermis

This is a continuous layer of cells that covers the aerial parts of the plant. The epidermis protects the plant against desiccation and external damage while regulating gas exchange with the atmosphere.

b. Periderm

In plants where the epidermis dies off, a new protective layer forms. The periderm is generated by the phellogen (one of the secondary meristems), which produces dead cells filled with suberin (a waterproof substance) on the outside to form cork (suber) and a living tissue called phelloderm on the inside. The outer cells, destined to die, along with the suberin-rich cork, comprise the bark of woody plants.

2.2. Fundamental Tissues

These include both filler tissues and supporting (mechanical) tissues:

- **Parenchyma:** These are living cells that perform functions such as photosynthesis and reserve storage. They often enclose spaces known as lacunae or intercellular spaces, which vary in size.

2.3. Supporting Tissues:

- **Collenchyma**

Found mostly in aerial organs, collenchyma is composed of living cells with cell walls thickened by additional cellulose deposition. It provides flexible support.

- **Sclerenchyma**

This tissue provides structural support for organs that have ceased to elongate. It consists of dead cells whose walls are thickened with lignin, which imparts rigidity and hardness. In plants with substantial secondary growth (like trees), the structural support is mainly provided by conductive tissues (xylem and phloem) rather than collenchyma or sclerenchyma.

2.4. Conducting Tissues

In angiosperms, the movement of fluids is handled by a system comprised of two primary conducting tissues:

- **Xylem**

Responsible for transporting raw sap (a liquid solution of water and mineral salts) from the roots (where water is absorbed) upward to the leaves, where photosynthesis occurs.

- **Phloem**

Also known as the liber, phloem transports the processed sap—a solution rich in organic substances, particularly sugars—from the leaves to other parts of the plant. In diagrams, these tissues are represented using standardized symbols.

3. Formation of Secondary Structure

Secondary structures support lateral growth and are primarily responsible for the formation of wood and cork, especially in dicotyledons and conifers.

- **Vascular Bundle (Libero-Woody Bundle) :** The vascular bundle (or "libero-woody bundle") comprises both the primary phloem and primary xylem separated by the vascular cambium.
- **Between the Bundles :** Cambial cells divide to form radial files of parenchyma cells that extend both toward the center and the outer parts of the stem.
- **Within the Bundles:** The cambium produces: Secondary Xylem (Wood) : Cells arranged radially toward the center of the stem.
- **Secondary Phloem (Liber) :** Cells arranged radially toward the periphery of the stem. Note that the activity of the cambium is polarized, resulting in much less phloem compared to xylem.
- **Bark Formation :** The suber-phelloderm system at the outer region of the stem leads to the formation of cork (suber).

4. Practical Work

4.1. Section Preparation

- **Cutting the Samples:**

Prepare a single, finely made transverse section from either the root or the stem of a plant (choose either monocot or dicot). The cut should be as thin as possible to ensure clear microscopic observation.

- **Staining the Sections:**

Place the sections into separate microscope slide preparations following the timing below:

Bleach (Water): 15–20 minutes

Water: 1 minute

Acetic Acid: 5–10 minutes

Green Carmin: 3 minutes

- **Slide Mounting:**

Mount the sections between a slide and a coverslip using a drop of water. Carefully place the coverslip over the preparation.

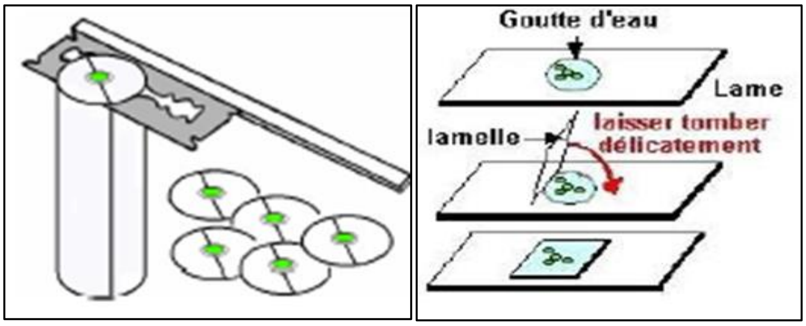


Figure 1 : Section Preparation

4.2. Microscopic Observation :

You must observe the following four preparations:

- Root cross-section from a monocotyledon
- Stem cross-section from a monocotyledon
- Root cross-section from a dicotyledon
- Stem cross-section from a dicotyledon

4.3. Histological Drawing:

Create one histological drawing. Do not reproduce the entire section; if there is symmetry in the sample (for example, bilateral symmetry), draw only a representative half. Clearly delimit all recognized tissues and use the conventional symbols outlined in the provided table.

- **Conventional Figures for Plant Tissues**

The table below provides the conventional symbols used to represent each type of tissue in plant anatomy diagrams :

Table 1 : The conventional symbols used to represent each type of tissue in plant anatomy diagrams

Tissue	Presentation	Tissue	Presentation
Epidermis	ou	**Phloem**	phloème I^{re} phloème II
Cortical parenchyme	(leave blank)	**Xylem**	bois xylème I
Vasculair parenchyme		**Suber**	suber II suber I
Collenchyma	ou	**Cambium or endoderm**	
Sclérenchyma	ou		

Note : The table also distinguishes between monocotyledonous and dicotyledonous samples for roots and stems.

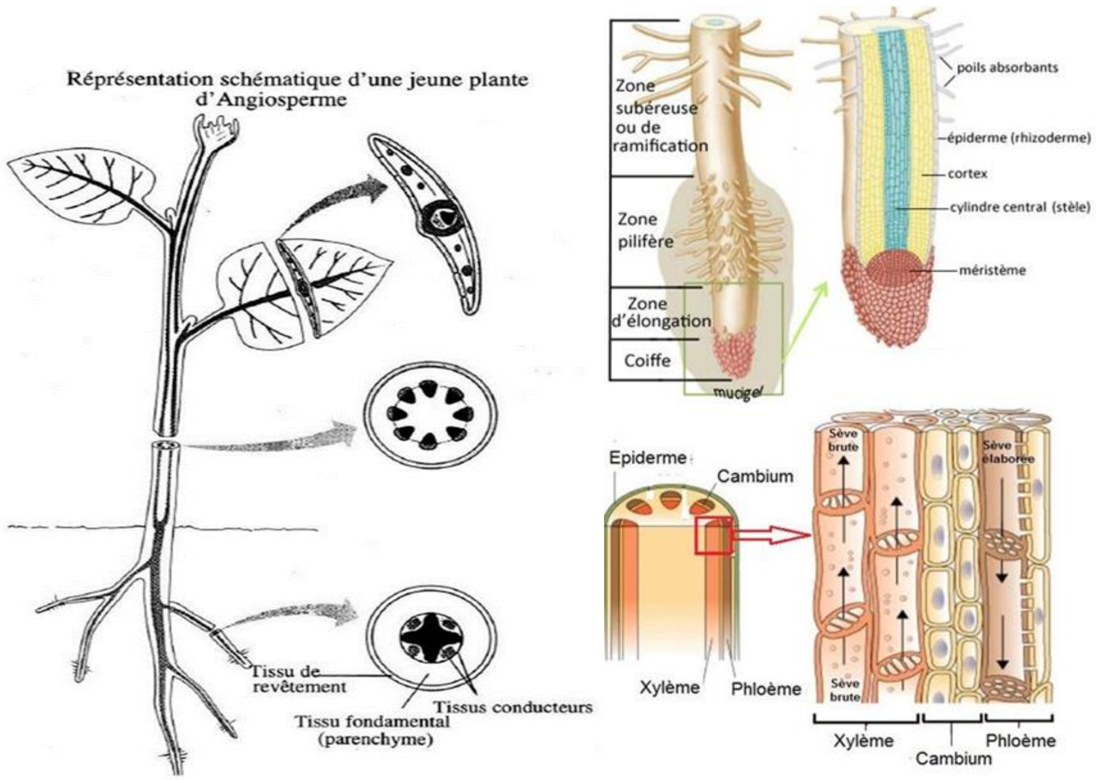
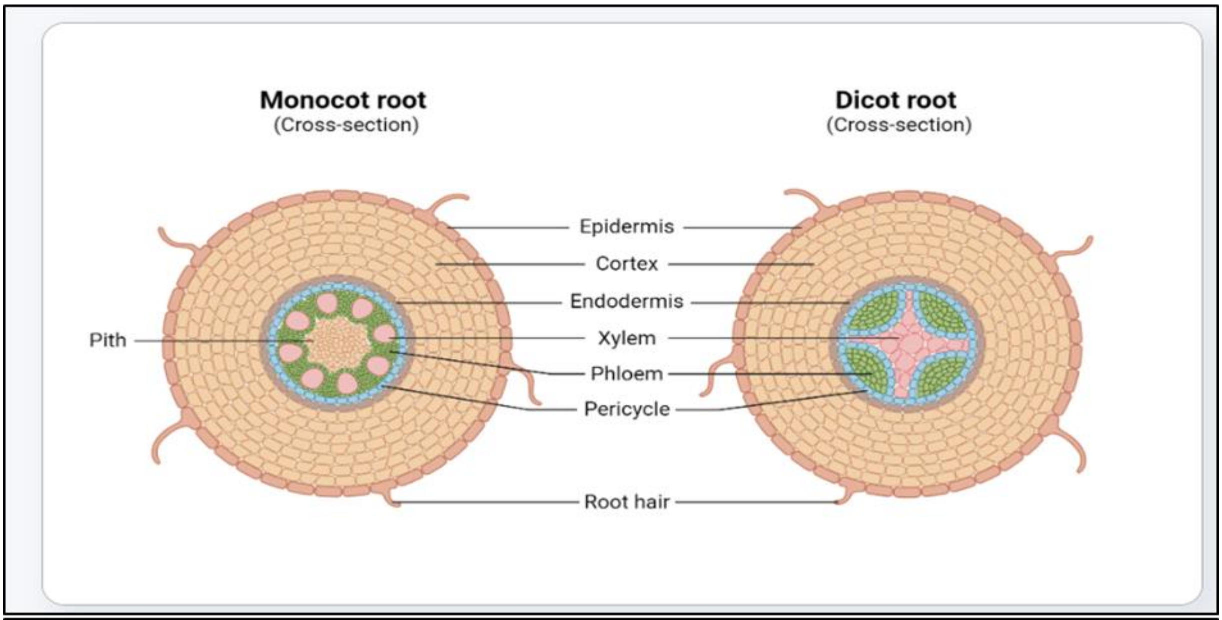
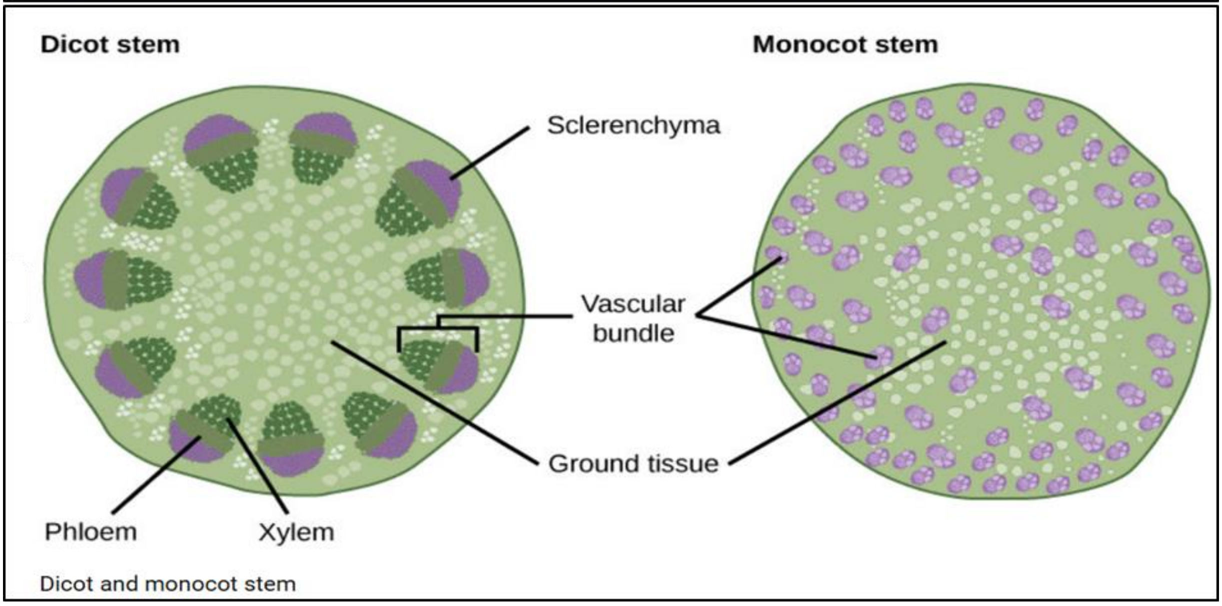


Figure 2 a: Structure of a Root





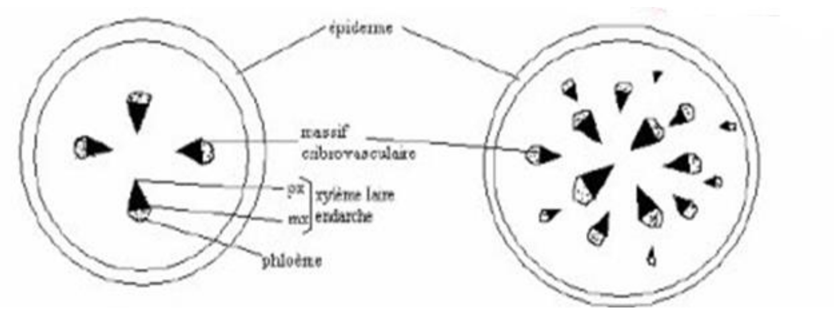


Figure 2 b: Structure of a Typical Dicotyledon and Monocotyledon Stem

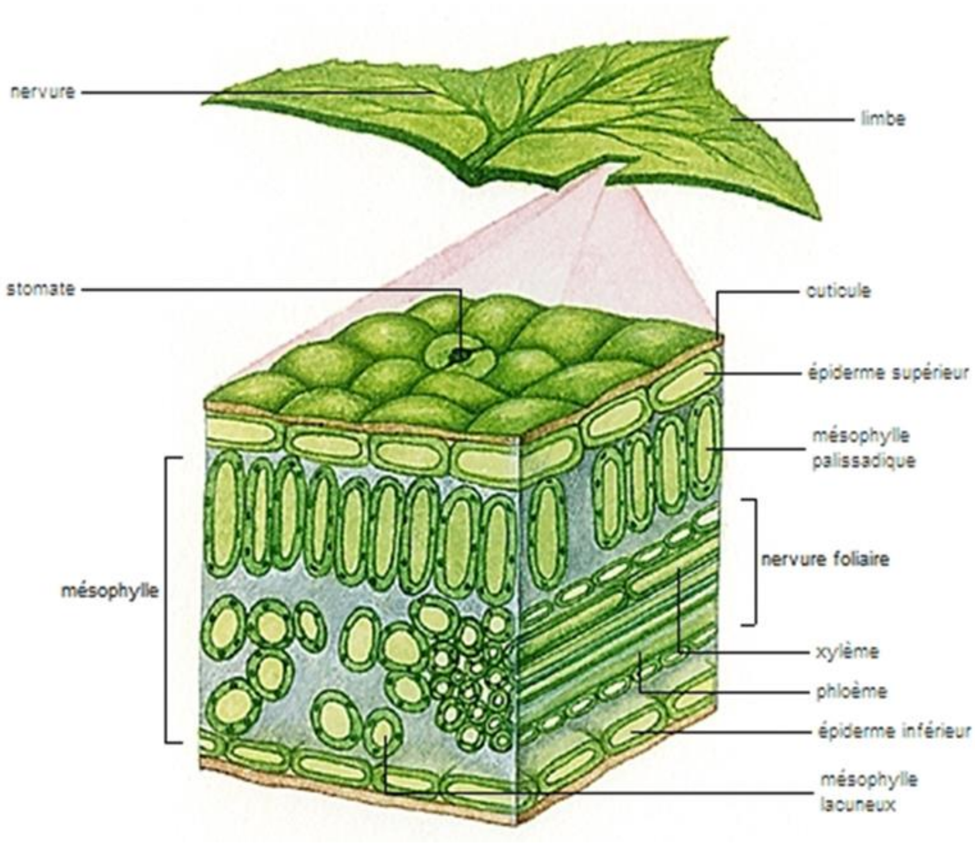


Figure 3: Structure of a Typical leaf

Important Note:

During the lab session, only the technical datasheets are allowed as reference material. No additional documents may be consulted.

Lab session 3 : Thallophytes (Algae)

Filamentous Green Algae

1. *Spirogyra sp.*

Spirogyra is a genus of filamentous green algae in the family Zygnemataceae. Algae of this genus (around 300 species) and of this family live exclusively in fresh or brackish water and have a flocculent appearance with a slimy texture. They can grow several decimeters long and are formed of unbranched filaments that are 50 to 100 µm wide. They colonize aquatic environments either freely (unattached) or more rarely fixed via their rhizoids to sediments, rocks, or walls. The massive presence of this species is considered a bioindicator of organic and/or mineral pollution.

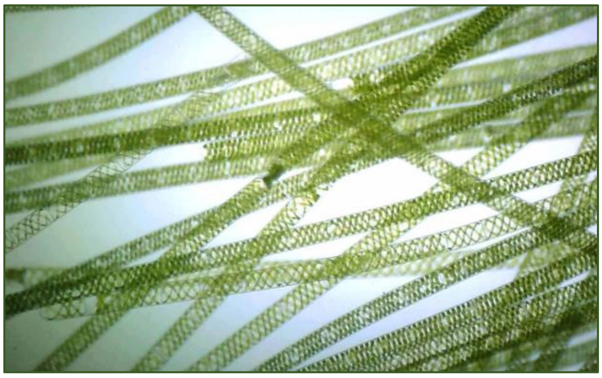


Figure 4: Microscopic View of Spirogyra

Spirogyra contain only one or two ribbon-shaped chloroplasts arranged in a spiral (hence the name **Spirogyra**). The cylindrical cells, arranged in rows, are enclosed by a transparent cellulose cell wall, providing some rigidity. Adhering to this wall on the inner side is a thin cytoplasmic membrane. Near this membrane, in the cytoplasm, lies the chloroplast. Their chlorophyll, when exposed to light, enables photosynthesis; Spirogyra accumulate starch stored around pyrenoids.

The thallus of Spirogyra continues to grow through cell division during the summer. At the end of the season, when climatic conditions become less favorable, sexual reproduction appears: two distinct filaments come closer together. Some filaments, in a set of parallel filaments, act as the female and others as the male. The walls of the facing haploid cells deform, extend tubular projections toward one another, and eventually fuse to form a conjugation tube or copulation canal between the two cells. One of the cells leaves its envelope and crawls through this canal to fuse with the opposite cell, which contracts to make room.

Each of these haploid cells is a gamete: the moving cell is the male gamete, and the stationary one is the female gamete. Their union is called scalariform conjugation. It is a type of fertilization where gametophytes do not exist, and it occurs with minimally differentiated gametes – a process known as *cystogamy*.

The result of this fertilization is the formation of diploid zygotes (zygospores) in the female filaments. These zygotes develop a resistant cyst, fall to the bottom of the water, and remain as resting eggs until spring. In spring, meiosis occurs, producing four unequal nuclei: three degenerate, and one forms a new haploid cell, which develops into a new filamentous alga. Some species appear to disappear around mid-June, while others may extend the life of their colonies into autumn.

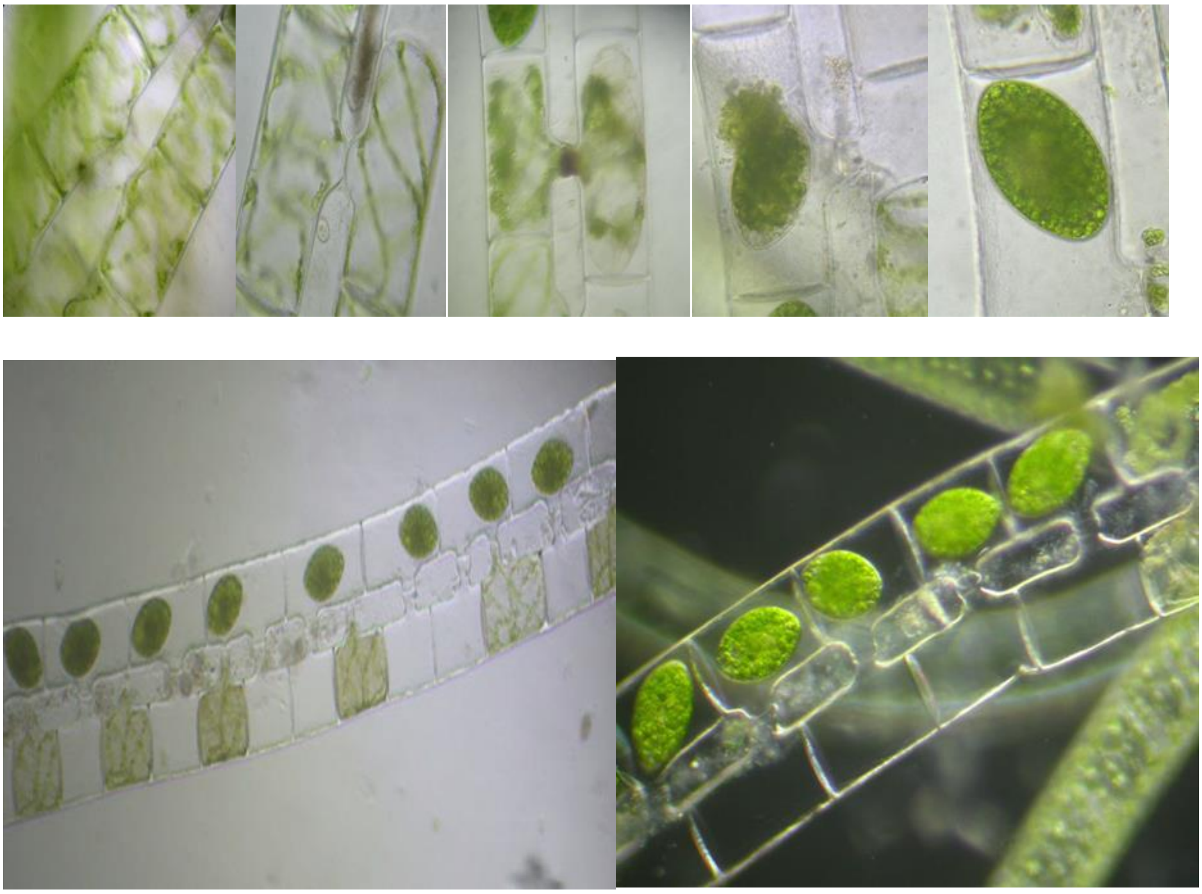


Figure 5: Diagram of Scalariform Conjugation in Spirogyra

2. Ulothrix sp.

Ulothrix is a genus of filamentous green algae (family Ulotrichaceae) found in marine and freshwater environments. Each cell contains a distinct nucleus, a central vacuole, and a large, thin chloroplast with at least one pyrenoid. The cell specialized for attachment is called the *holdfast*, and the filaments are typically unbranched.

The *Ulothrix* thallus is filamentous, long, unbranched, and multicellular, with cells arranged in a single row (i.e., uniseriate). The filaments are bright green and remain attached at one end to a substrate such as stones, rocks, or other solid objects.

- **Basal cell:** The lowest cell of the filament, usually elongated and gradually tapering at the bottom; it widens at the basal end to form a disc-shaped structure. This cell is hyaline or brownish and functions in substrate attachment and is called a rhizoid cell.

- **Apical cell:** The highest cell of the filament, dome-shaped, and green in color.

- **Middle cells:** All cells between the basal and apical cells are identical. These cells are wider than they are long and generally rectangular (or quadrangular).

All cells, except the basal holdfast, can divide. Their cell wall has an outer pectin layer and an inner cellulose layer. Inside the cell wall is the plasma membrane, which encloses the protoplast. The protoplast consists of cytoplasm, chloroplast, and nucleus.

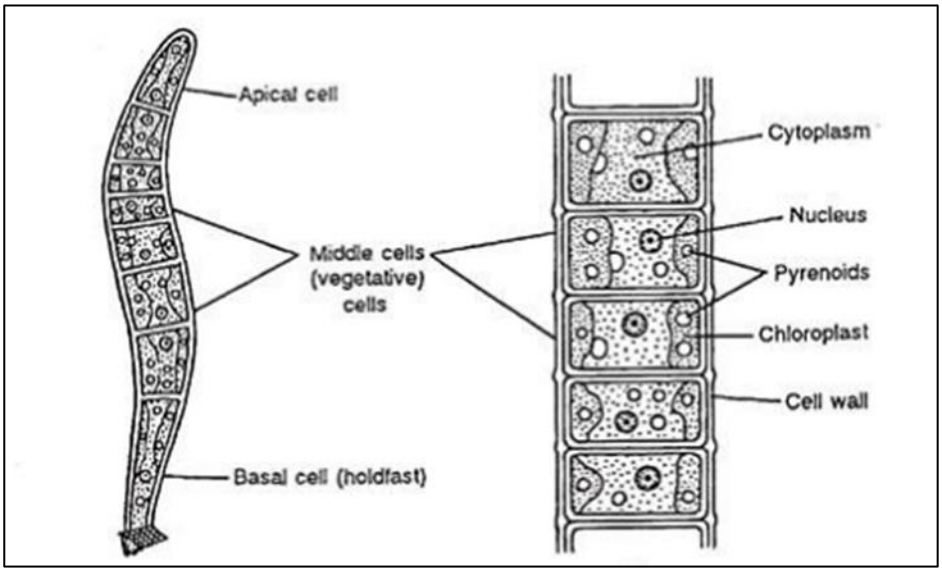


Figure 6: Vegetative Structure of *Ulothrix*

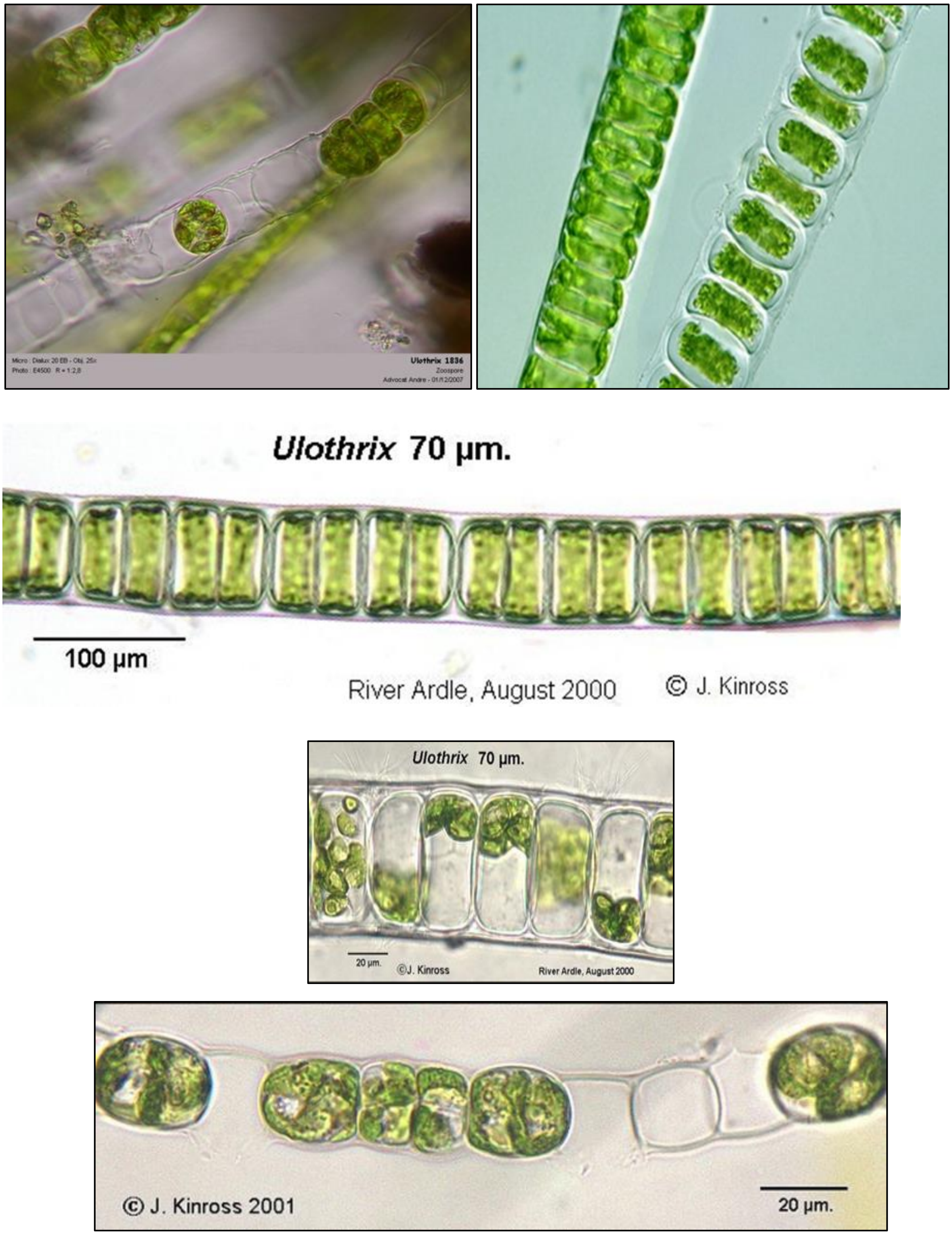


Figure 7: Vegetative Morphology of *Ulothrix* as Observed under the Microscope

3. Vegetative Reproduction

It occurs by fragmentation of the thallus, creating two individuals that grow into filaments identical to the parent filament.

4. Sexual Reproduction

Toward the end of the growing season, Ulothrix reproduces sexually. The sexual reproduction is *isogamous*, meaning the union of similar gametes.

Fusion occurs between gametes developed in different filaments, making the species heterothallic or dioecious (e.g., *U. rorida* is monoecious). Morphologically, the gametes resemble microzoospores. They are produced in gametangia similar to zoosporangia.

Depending on the species, the number of gametes produced can be 8, 16, 32, or 64. Like microzoospores, they are uninucleate and biflagellate but smaller in size. Although morphologically similar, the gametes are physiologically different and are referred to as + and − strains.

Once released, gametes swim for a while. Gametes of opposite types (+ and −) fuse and form a spindle-shaped, quadriflagellate zygote. Initially, the zygote swims, but later it settles on a substrate, loses its flagella, and becomes round.

The zygote rests for about 5 to 9 months. After resting, the zygote nucleus (2n) undergoes meiosis to form 4 haploid nuclei of different strains (2+ and 2−). Mitosis may follow meiosis, producing 8 to 16 haploid nuclei.

The nuclei, along with some cytoplasm, form spores called *meiospores*. These are haploid and quadriflagellate. Upon germination, they develop into haploid Ulothrix filaments of type + or −.

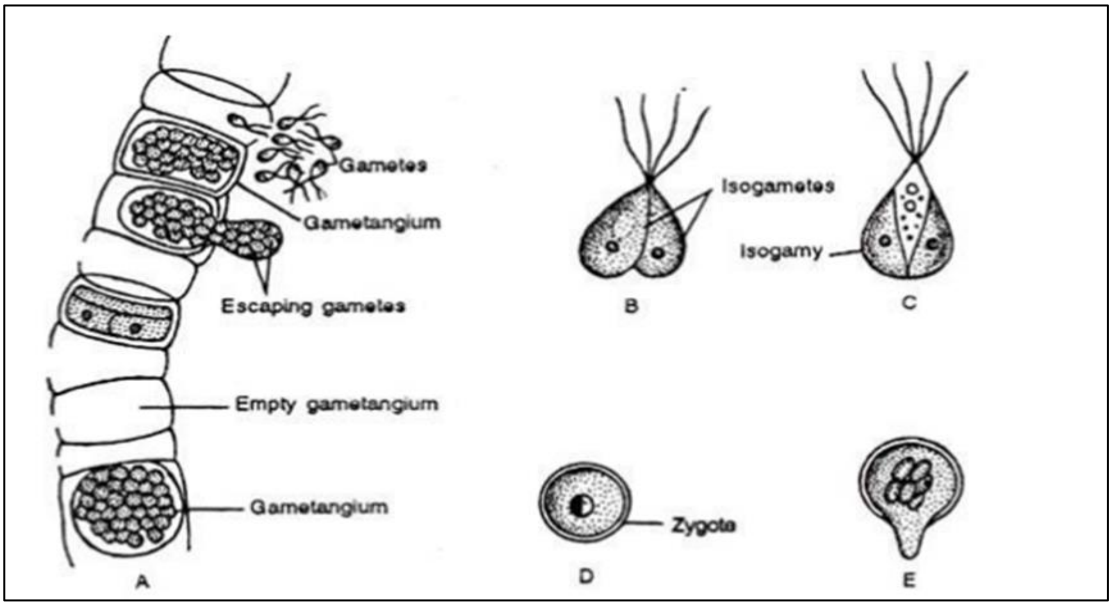


Figure 8 : Life Cycle of *Ulothrix*

5. Practical Work

- Take a drop of water from a lake that contains algae (in vivo sampling).

- Place the drop on a slide and cover it with a cover slip.

- Observe under a microscope at low, medium, and high magnification (live observation).

- Identify a filamentous alga, draw it, and label the parts.

Lab Session 04 : Cryptogams (Bryophytes)

1. Bryophytes

Bryophytes are believed to have evolved from early land plants that favored the haploid generation over the diploid one. These small, chlorophyllous plants, typically only a few centimeters tall, thrive in moist, shaded environments. Water is essential to their reproductive cycle, as their male gametes are motile. However, bryophytes can withstand extended dry periods by significantly dehydrating and entering a dormant state. They resume normal activity when water becomes available again. Because of this resilience, bryophytes—like lichens—are considered pioneer organisms, capable of colonizing bare, mineral-rich surfaces such as rooftops and walls.

Their vegetative structure is a cormus, a simple stem with leaf-like structures, lacking true vascular tissue or roots. Bryophytes are thought to have originated approximately 350 million years ago.

This group includes around 23,000 known species, divided into three main classes:

- 13,500 species of mosses (e.g., Polytrichum and Sphagnum)
- 9,000 species of liverworts
- 350 species of hornworts

Fertilization in bryophytes requires water (oogamy). The resulting embryo remains attached to and nourished by the haploid gametophyte, and the diploid sporophyte never becomes independent. Thus, the dominant life stage is the haploid gametophyte. The spores are protected by a sporopollenin-rich wall that helps them survive during dispersal.

This life cycle is classified as a haplodiplontic cycle with a dominant haploid phase.

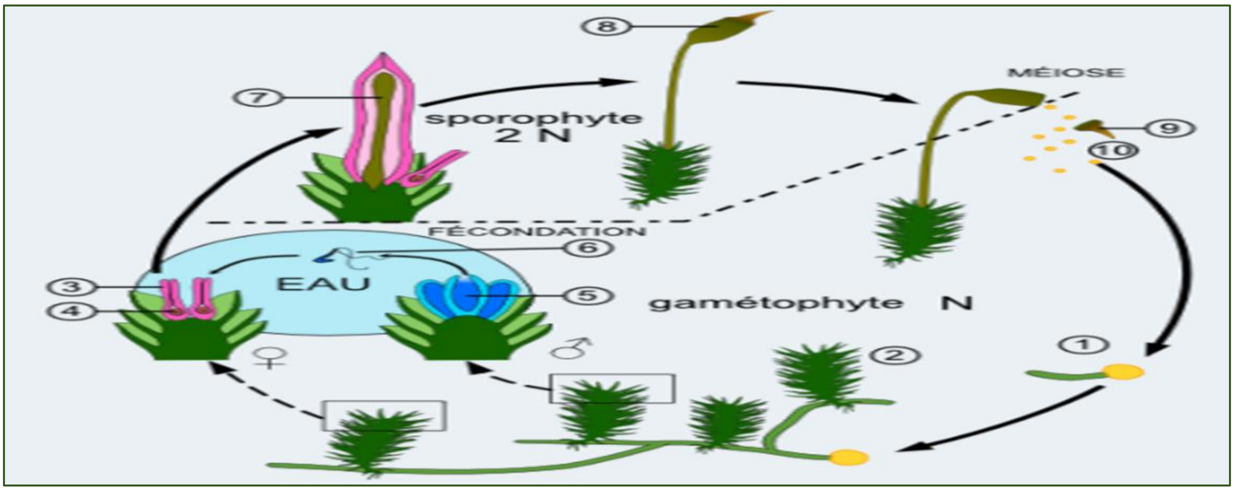


Figure 9 : Reproduction cycle of a Moss

1: a spore germinates by producing a green filament (protonema), **2**: male or female moss shoots (N) develop on the protonema; these are the gametophytes, **3**: the female shoots produce archegonia, each containing one oosphere or female gamete ♀ (**4**), **5**: the male shoots produce antheridia containing antherozoids or male gametes ♂, **6**: an antherozoid swims in a drop of water to fertilize an oosphere, **7**: fertilization gives rise to a sporophyte (2N), **8**: in the capsule, meiosis produces spores (N), 10: the spores are released when the operculum (**9)** falls off.

2. Funaria hygrometrica

Funaria hygrometrica is one of the most common moss species found in temperate regions. A member of the Funariaceae family, it responds quickly to changes in humidity and rainfall.

Figure 10 : ***Funaria hygrometrica***

Developmental Cycle: Alternation of Morphologically Distinct Generations

The reproductive cycle begins with a haploid spore, which undergoes successive mitotic divisions to form a multicellular filamentous protonema growing on the soil. This structure, which resembles the thallus of certain green algae, is short-lived. Bud-like outgrowths from the protonema develop into the mature moss plant.

1. The leafy, autotrophic stem produces reproductive organs—antheridia and archegonia. This leafy stem represents the gametophyte generation. Male gametes (spermatozoids or antherozoids) produced by antheridia swim to fertilize the ovule housed within the archegonia, leading to the formation of a diploid zygote.

2. The zygote develops into the sporophyte generation—a structure known as the sporogonium, which consists of a nutrient-absorbing foot and a reproductive capsule. The capsule produces haploid meiospores via meiosis. These spores are then released to complete the cycle. The sporophyte remains attached to and dependent on the gametophyte.

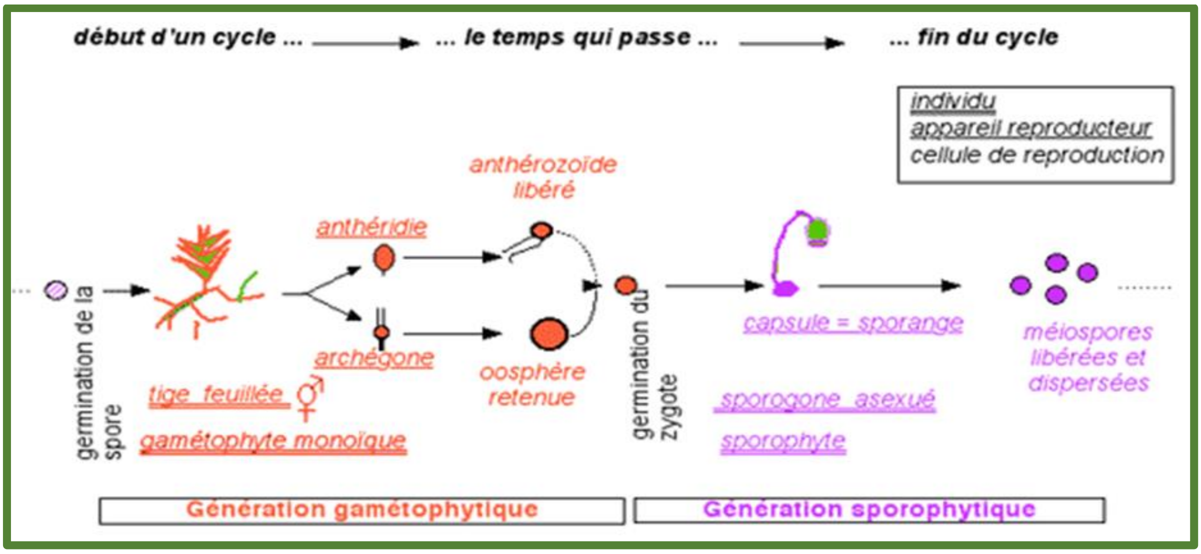


Figure 11: Life Cycle of Bryophytes

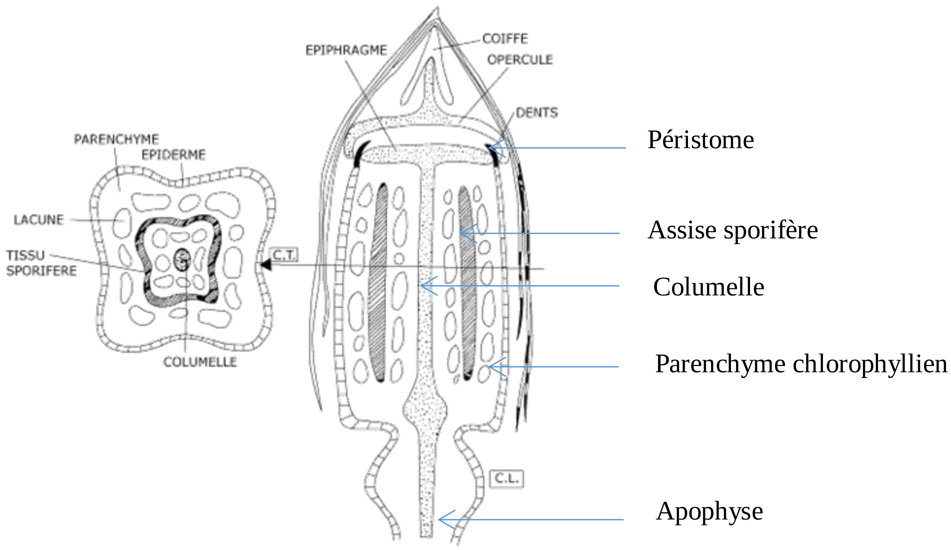
3. Polytrichum formosum

This moss typically forms loosely packed, upright cushions, ranging from 3 to 15 cm in height. Its dark green to bluish leaves are narrow, lance-shaped, and deeply toothed. The seta (stalk) measures 4 to 8 cm, and the capsule is entirely covered by a fibrous calyptra. The antheridia are enclosed by yellowish perigonial leaves. *Polytrichum formosum*, a member of the Polytrichaceae family, commonly grows in dry, shaded forests with slightly acidic soils.

Figure 12 : *Polytrichum formosum*

A transverse section of a young *Polytrichum formosum* sporangium reveals (from outside to inside):

- An outer layer forming an epidermis with rudimentary stomata
- A loose, photosynthetic parenchyma interrupted by longitudinal air spaces
- A dense tissue layer forming the spore sac
- A central, water-filled column known as the columella



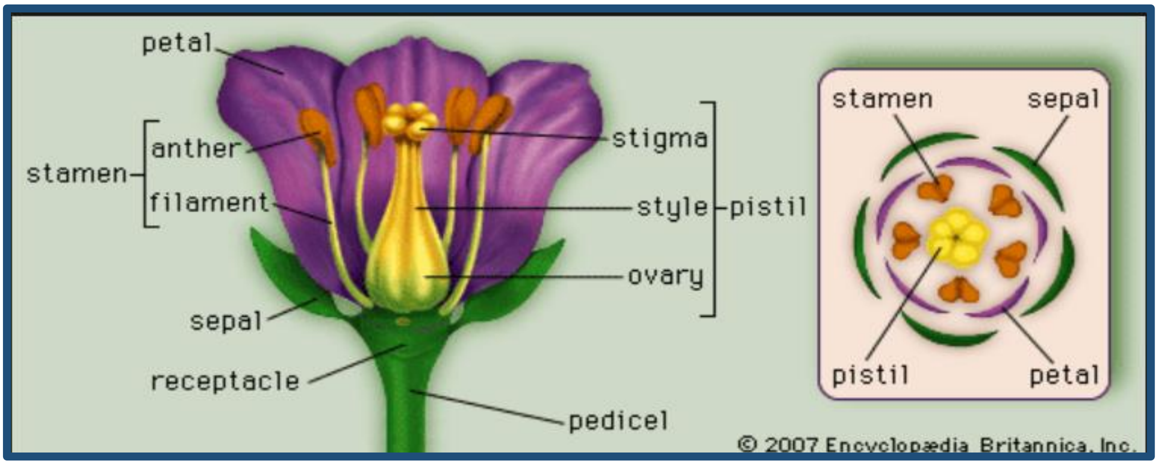
Figue 1 3 : Longitudinal Section of a Sporogonium

4. Practical Work

- Observe living samples of various moss species.
- Write a brief, three-line description of your observation.
- Observe and draw a longitudinal section of a *Polytrichum formosum* sporogonium.

Lab Session 05 : Floral Morphology of Angiosperms

1. Key C oncepts of Floral Morphology



Figue 14 : Floral sturcture and diagram of *Sinapis arvensis*

2. The Perianth

When petals and sepals are arranged in whorls or spirals around the flower stalk (pedicel) with radial symmetry, the flower is described as actinomorphic (regular). If they are arranged along a bilateral axis, the flower is zygomorphic. If no symmetry is observed (a rare case), the flower is termed irregular.

Flowers are called dialypetalous when their petals are completely free from one another (e.g., Crucifers, Rosaceae), and gamopetalous when petals are partially or completely fused. The same applies to sepals: they may be gamosepalous (fused) or diallysepalous (free). When a sepal cannot be distinguished from a petal, it is called a tepal.

3. Ovary Position

3.1. Superior Ovary:

In this type of flower, the gynoecium is carried on a convex receptacle and located above the point where other floral parts are attached. This floral structure is described as hypogynous.

3.2. Inferior Ovary:

Here, the receptacle forms a cup-like structure in which the ovary sits below the insertion point of the other floral organs.

(For illustration: Flower diagram - Wikimedia Commons)

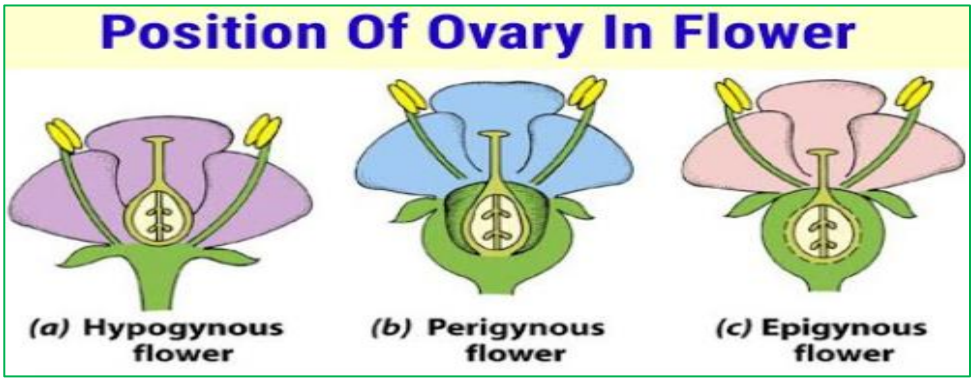


Figure 15 : position of ovary flower

4. Sinapis arvensis

Figure 16 : *Sinapis arvensis*

Sinapis arvensis commonly known as **wild mustard**, is a herbaceous perennial plant from the Brassicaceae family (also known as crucifers). It is often considered a weed, frequently found in fields and gardens.

4. Practical Work

Required materials : specimen (*Sinapis arvensis*), dissecting microscope, fine forceps, razor blade.

- Prepare a transverse section of the flower
- Draw and label the cross-section
- Determine if the flower is zygomorphic or actinomorphic
- Describe the characteristics of its floral parts
- Identify whether the ovary is superior or inferior

Lab session 6 : Floral Morphology of Angiosperms

Morphological Study of Flowers from Monocotyledons (Liliaceae and Poaceae) and Dicotyledons (Fabaceae and Asteraceae Families)

1. **Northern Sulla*: Hedysarum coronarium* (Family Fabaceae)**

It is cosmopolitan and comprises 11,300 species distributed across 440 genera grouped into 31 tribes. Most species are herbaceous; their flower is irregular and composed of five petals: a standard, two wings, and two petals partially fused into a keel. The Papilionoideae are used for the production of edible seeds such as peas (*Pisum sativum L*.) and beans (*Phaseolus vulgaris L*.); and also for livestock feed, as forage crops such as alfalfa (*Medicago sativa* L.) and sulla (*Hedysarum coronarium* L.). Hedysarum coronarium is a forage legume endemic to the Mediterranean basin.

Figure 17 : Northern Sulla *(Hedysarum coronarium)*

Legumes or Fabaceae are classified among angiosperms, eudicotyledons with pods. This is the third largest family of angiosperms in number of species after the Orchidaceae and Asteraceae, with 727 genera and nearly 20,000 species. The species range from dwarf Arctic and alpine herbs to massive tropical forest trees. Plants in the Fabaceae family are legumes with zygomorphic, papilionaceous-type flowers composed of 5 fused sepals, 5 petals (generally 3 free and 2 fused), and 10 stamens, usually 9 of which are fused by their filaments. Based on floral shape, the family is divided into three subfamilies : Papilionoideae, Mimosoideae, and Caesalpinoideae. They form by far the most important group of plants involved in nitrogen fixation through symbiotic bacteria. The Papilionoideae subfamily (named due to the corolla shape resembling a butterfly) contains more than two-thirds of the species and includes almost all economically important legumes.

2. Common Daisy: *Leucanthemum vulga*re (Family Asteraceae)

The family Asteraceae or Compositae consists of numerous dicotyledonous plants: it includes nearly 13,000 species across 1,500 genera. They are mostly herbaceous plants, though the family also includes trees and shrubs. Asteraceae are characterized by tiny flowers grouped into an inflorescence called a capitulum, where flowers are tightly packed without pedicels. These flowers are located at the tip of a branch or stem and surrounded by a structure made of floral bracts forming a cup- or collar-like structure called an involucre. Thus, contrary to common language, what is referred to as a "sunflower" or "thistle" flower is actually a capitulum made up of many small flowers.

Asteraceae flowers are very particular: the stamens are fused by their anthers facing inward. Below the stigmas are "pollen brushes." The rapid growth of the style enables the pollen to be brushed and collected. Once the stigma passes through the anther tube, the stigmas spread out and expose their sticky surface to the pollen.

Figure 18 : Asteraceae flowers

The common daisy is a tufted flowering plant, with an erect, ridged stem, basal petiolate leaves, and toothed, sheathing cauline leaves. The inflorescences are large capitula with white ligules (sterile ligulate flowers) surrounding the yellow center, itself composed of many fertile tubular flowers. This plant is used in herbal medicine: dried flowers are used for infusions. The daisy has antispasmodic, calming, and digestive properties.

3. General Overview of flower structure

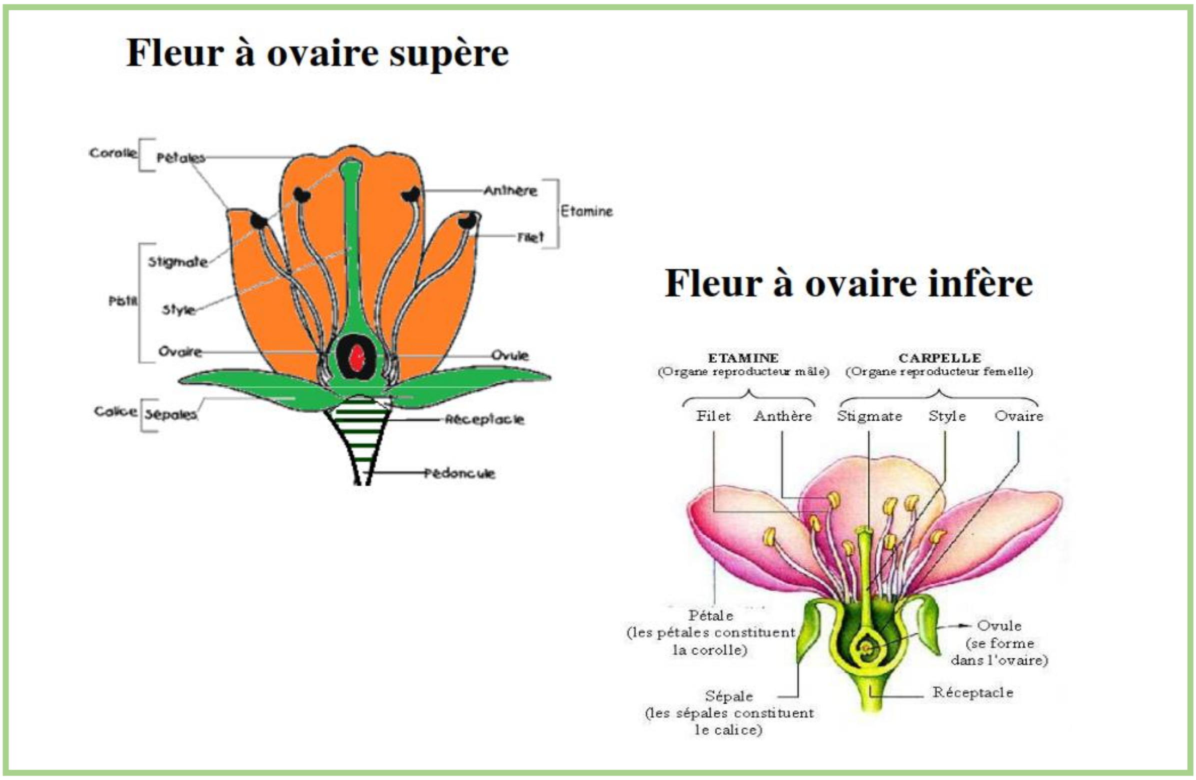


Figure 19 : Overview of flower structure

4. Practical Work

- Make a longitudinal section of a capitulum of Leucanthemum vulgare and observe it under a stereomicroscope.
- Draw and label the section.
- Observe the general morphology of a flower of Hedysarum coronarium.
- Establish its floral diagram and floral formula.
- Establish a floral formula.

NB :

The floral formula indicates the number of floral parts in each flower. The letters indicate the type of floral organs: S = sepals P = petals E = stamens C = carpels

The numbers show how many of each organ. For values above 12, use “n”. A “X” before the formula indicates a zygomorphic flower, while a “O” indicates an actinomorphic flower. When C is underlined, it denotes a superior ovary; when C has a line above, it denotes an inferior ovary.

Example - Ranunculaceae:

O : 5S, 5P, nE, nC

(Actinomorphic flower, 5 free sepals, 5 free petals, n free stamens, n free carpels, superior ovary)

When organs are fused, they are placed in parentheses:

Example: Tulip (actinomorphic), with 6 tepals, 6 stamens, and 3 fused carpels with a superior ovary:

O: 6T, 6E, (3C)

If there are 2 or more groups of a floral organ, a “+” is used.

Example - Brassicaceae:

O: 4S, 4P, 4E + 2E, (2C)

(Actinomorphic flower, 4 free sepals, 4 free petals, 4 large + 2 small free stamens, 2 fused carpels, superior ovary)

Lab session 7 : Study of Inflorescences and Fruits

1. Objective

To observe, describe, and classify the different types of inflorescences and fruits in flowering plants.

2. Content Overview

2.1. Inflorescences

Definition: A cluster or group of flowers arranged on a stem.

Types

- *Simple inflorescences:* Raceme, spike, umbel, corymb, capitulum.
- Compound inflorescences: Panicle, compound umbel, compound spike.
- Observation Points: Arrangement of flowers, presence or absence of pedicels, t ype of branching.

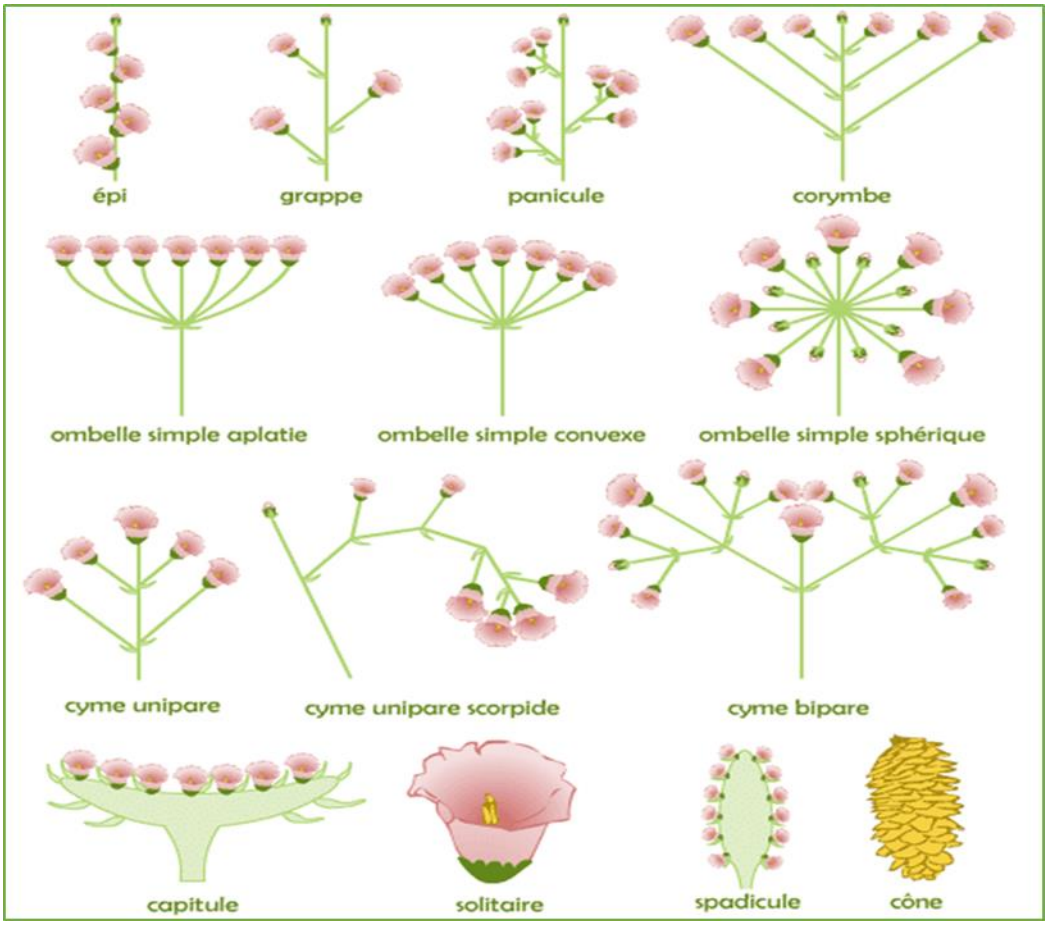


Figure 20 : the different types of inflorescences

2.2. Fruits

- **Definition:** A mature ovary containing seeds, formed after fertilization.
- **Classification:**
  - *Simple fruits:* Dry (dehiscent/indehiscent) and fleshy (berry, drupe).
  - *Aggregate fruits:* Derived from multiple ovaries of one flower.
  - *Multiple (compound) fruits:* Developed from a cluster of flowers (inflorescence).
- **Observation Points:** Origin, texture, number of seeds, dispersal mechanisms.

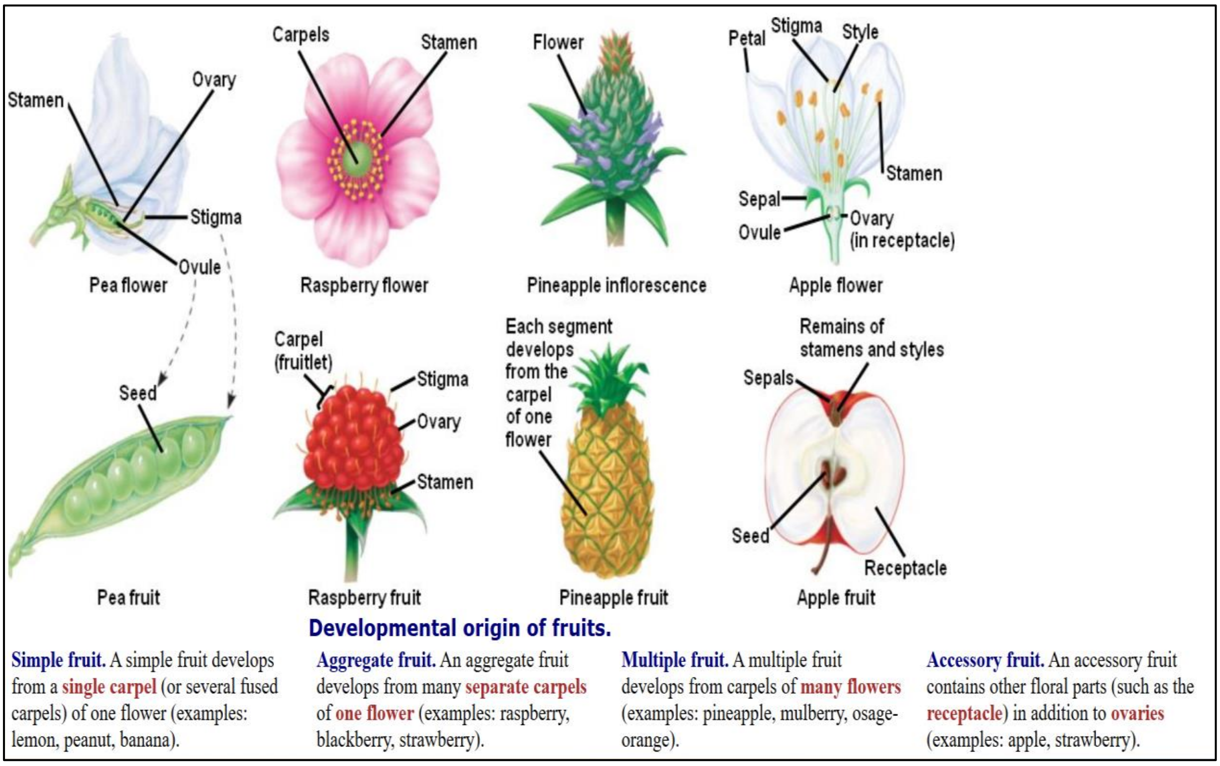


Figure 21 : The different types of fruits

Expected Skills:

- Identifying different types of inflorescences and fruit structures.
- Understanding the relationship between flower arrangement and reproductive strategies.
- Developing classification and comparative analysis skills.

Table 2 : This observation sheet is designed to help identify and classify different types of inflorescences and fruits found in flowering plants during Practical Session 7.

Category	Type	Example(s)	Key Features
Inflorescences	Raceme (Grappe)	Lily of the valley	Flowers on pedicels along a central axis
	Spike (Épi)	Wheat, Corn	Sessile flowers along an unbranched axis
	Capitulum	Sunflower, Daisy	Dense cluster of sessile flowers (florets)
	Umbel	Wild carrot	Pedicels of equal length from one point
	Corymb	Pear tree	Outer pedicels longer, flat-topped cluster
	Panicl!e	Rice, Oat	Branched raceme with pedicellate flowers
Simple Fruits	Dry, dècehiscent	Bean (pod), Poppy (capsule)	Opens at maturity to release seeds
	Dry, indehiscent	Sunflower (achene), Wheat (caryopsis)	Does not open at maturity
	Fleshy – Berry	Tomato, Grape	Entire pericarp fleshy
	Fleshy – Drupe	Cherry, Olive	Fleshy with a hard stone (endocarp)
Aggregate Fruits	Multiple small fruits	Strawberry, Raspberry	Derived from multiple ovaries of one flower
Multiple (Compound)	From an inflorescence	Pineapple, Fig	Formed from several flowers fused together

Lab session 8 : Fungi and Lichens

1. Objective

The objective of this practical session is to study the morphological and functional diversity of fungi and lichens through the observation of representative specimens (*Rhizopus, Penicillium, Aspergillus, Xanthoria, Physcia)*. The aim is to identify their characteristic structures (thallus, hyphae, reproductive organs, fungal-algal symbiosis), compare their nutritional modes (saprophytism, parasitism, symbiosis), and examine their reproductive strategies (sexual and asexual). This practical also seeks to highlight their ecological significance in ecosystems as well as their economic and industrial importance.

2. Fungi

Fungi are thallophytic, heterotrophic, eukaryotic organisms, formerly regarded as primitive or degenerate plants because they lack chlorophyll. They may be saprophytes, parasites (of humans, animals, and plants), or live in symbiosis with plants. They display extremely diverse forms and are found in nearly all habitats where life is possible.

3. Bread Mold - Rhizopus nigricans (Zygomycota)

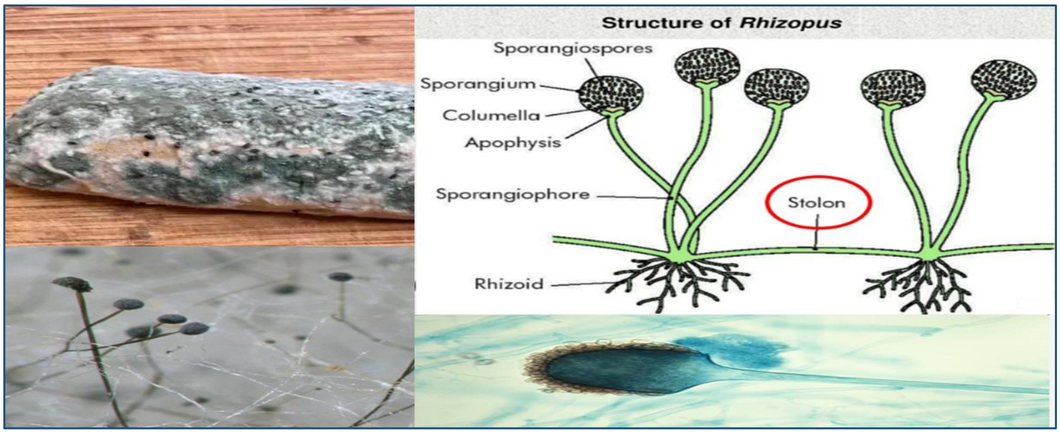


Figure 22 : Microscopic Structures of *Rhizopus nigricans*

Rhizopus nigricans (Zygomycota)

- Kingdom: Fungi
- Phylum: Zygomycota
- Class: Zygomycetes
- Order: Mucorales
- Family: Mucoraceae
- Genus: *Rhizopus*
- Species: *Rhizopus nigricans*

***Rhizopus nigricans*,** the black bread mold, develops on moist bread within a few days. Initially, white filaments form a dense mat that progressively spreads. Some filaments then stand upright, with their tips rounding and darkening from grey to black. These spherical structures contain mature spores, later released to colonize new substrates.

This fungus is saprophytic, feeding on dead organic matter like sugars and starches.

3.1. Key features

- Spores without flagella.
- Coenocytic hyphae (continuous cytoplasm without septa).
- Rapid asexual reproduction through sporangia.
- Quick expansion through stolons that spread across the surface.

3.2. Observation of Structures

- Sporangium : Comprising the stalk (sporangiophore) and the spore capsule (sporangium).
- Reproductive organ : Sporangium containing sporangiospores.
- Propagation organ : Stolons.
- Attachment organ : Rhizoids.

4. Penicillium sp.

- Kingdom: Fungi
- Phylum: Ascomycota
- Class: Eurotiomycetes
- Order: Eurotiales
- Family: Trichocomaceae
- Genus: *Penicillium*
- Species: *Penicillium sp.*

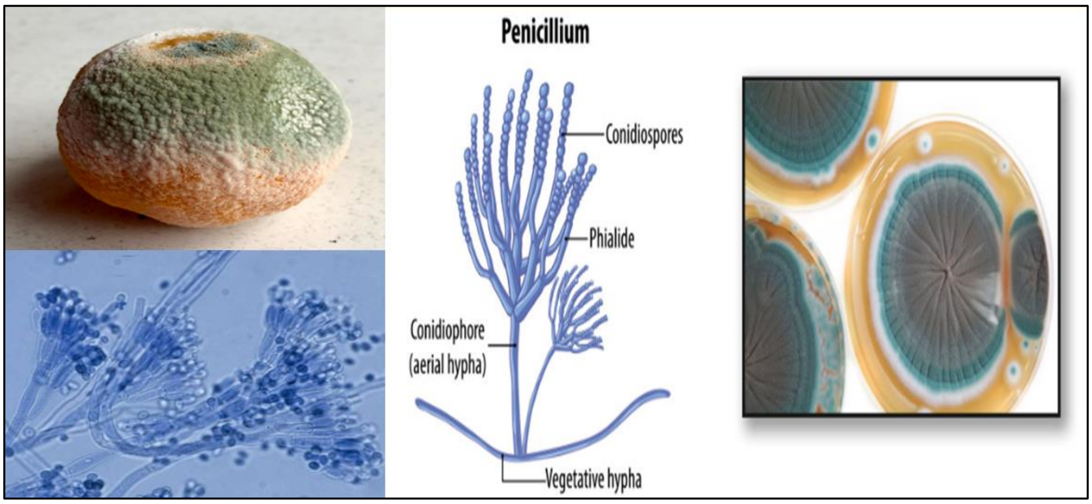


Figure 23: Conidiophores of *Penicillium*

Penicillium species are filamentous fungi, generally known for their asexual (imperfect) forms, though some sexual forms do exist. They are ubiquitous in the environment, often found in soil, decaying organic matter, food products, fruits, and seeds.

Some species are industrially important, used in cheese production and the manufacture of metabolites like antibiotics (penicillins), gluconic acid, and others. However, certain species can produce harmful mycotoxins.

Morphology

- The Latin term "penicillium" means "small brush," referring to its brush-like spore-producing structures.
- Characterized by erect conidiophores ending in phialides and subtended by metulae.
- Hyphae are septate (divided by walls).
- Conidiophore: Specialized filament producing conidia.
- Phialide: Elongated bottle-shaped cells producing spores.

5. Aspergillus sp.

- Kingdom: Fungi
- Phylum: Ascomycota
- Class: Eurotiomycetes
- Order: Eurotiales
- Family: Trichocomaceae
- Genus: *Aspergillus*
- Species: *Aspergillus sp.*

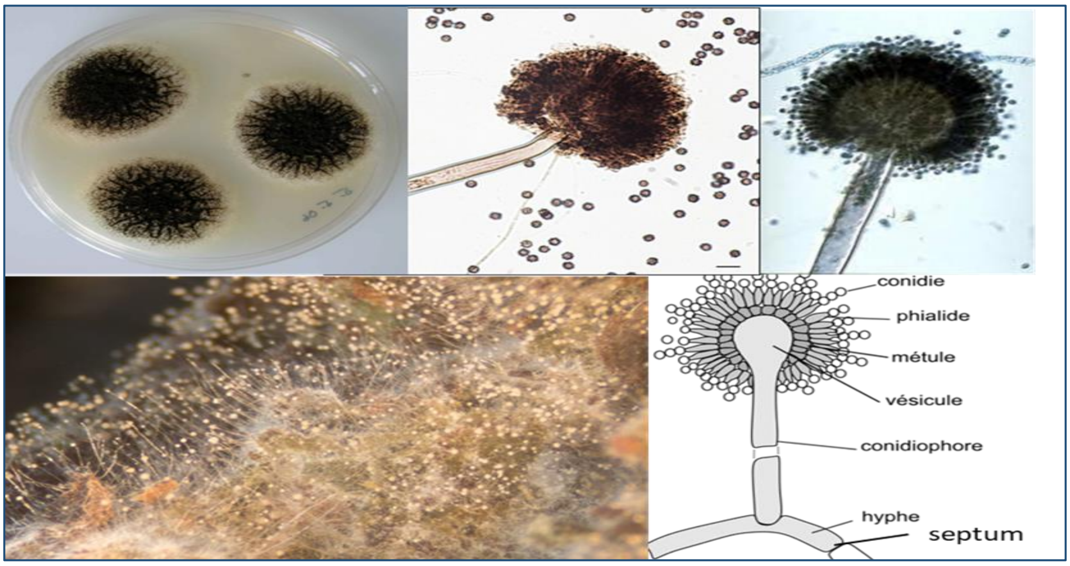


Figure 24: Vesicle Structure of *Aspergillus*

Aspergillus species are filamentous fungi presenting as fluffy colonies. Their hyaline thallus forms a septate mycelium with upright conidiophores ending in vesicles. Unlike Penicillium, their conidiophores are swollen at the tips rather than brush-shaped.

They have a global distribution and thrive on decomposing organic matter, soil, compost, foodstuffs, and grains. Aspergillus spores are widespread in the human environment, with individuals inhaling between 10 to 30 spores daily.

6. Lichens

Lichens are widely distributed organisms found on bare soil, tree trunks, walls, rooftops, road barriers, and even electrical wires. They are remarkably resistant to desiccation and can survive extreme environments from desert heat to Arctic tundras and Antarctic valleys.

Some species, like Xanthoria parietina, can even withstand freezing at -200°C and revive after decades of dormancy.

Lichens are a symbiotic partnership between a fungal partner (mycobiont) and a photosynthetic partner (photobiont green algae or cyanobacteria). The fungus provides protection and moisture retention, while the photobiont produces nutrients through photosynthesis.

Over 20,000 lichen species have been identified, and the scientific name of a lichen corresponds to its fungal component.

6.1. Types of Lichens

- **Gelatinous lichens**: Homogeneous, jelly-like thallus (e.g., Psorotrichia, Collema).
- **Fruticose lichens**: Shrubby or branched thallus (e.g., Usnea, Ramalina).
- **Foliose lichens:** Leaf-like thallus attached at one point (e.g., Xanthoria, Physcia).
- **Crustose lichens**: Crust-like growth tightly adhering to the substrate (e.g., Arthonia).

6.2. Lichen Reproduction

6.2.1. Sexual Reproduction

Only the fungal component reproduces sexually (most often Ascomycota like pezizas and morels; sometimes Basidiomycota).

Three reproductive structures exist :

- **Apothecia:** Small cup-like structures (e.g., *Xanthoria*, *Physcia*).
- **Lirellae:** Slit-shaped elongated apothecia.
- **Perithecia:** Dome-shaped structures with an apical opening.

Spores are released and must find a compatible algal partner to form a new lichen.

6.2.2. Asexual Reproduction

Involves:

- Soredia: Powdery propagules composed of fungal hyphae and algal cells.
- Isidia: Outgrowths from the thallus containing both partners.

These structures are dispersed by wind, water, or small animals.

7. Xanthoria parietina

- Kingdom: Fungi
- Phylum: Ascomycota
- Subphylum: Pezizomycotina
- Class: Lecanoromycetes
- Order: Teloschistales
- Family: Teloschistaceae
- Genus: *Xanthoria*
- Species: *Xanthoria parietina*

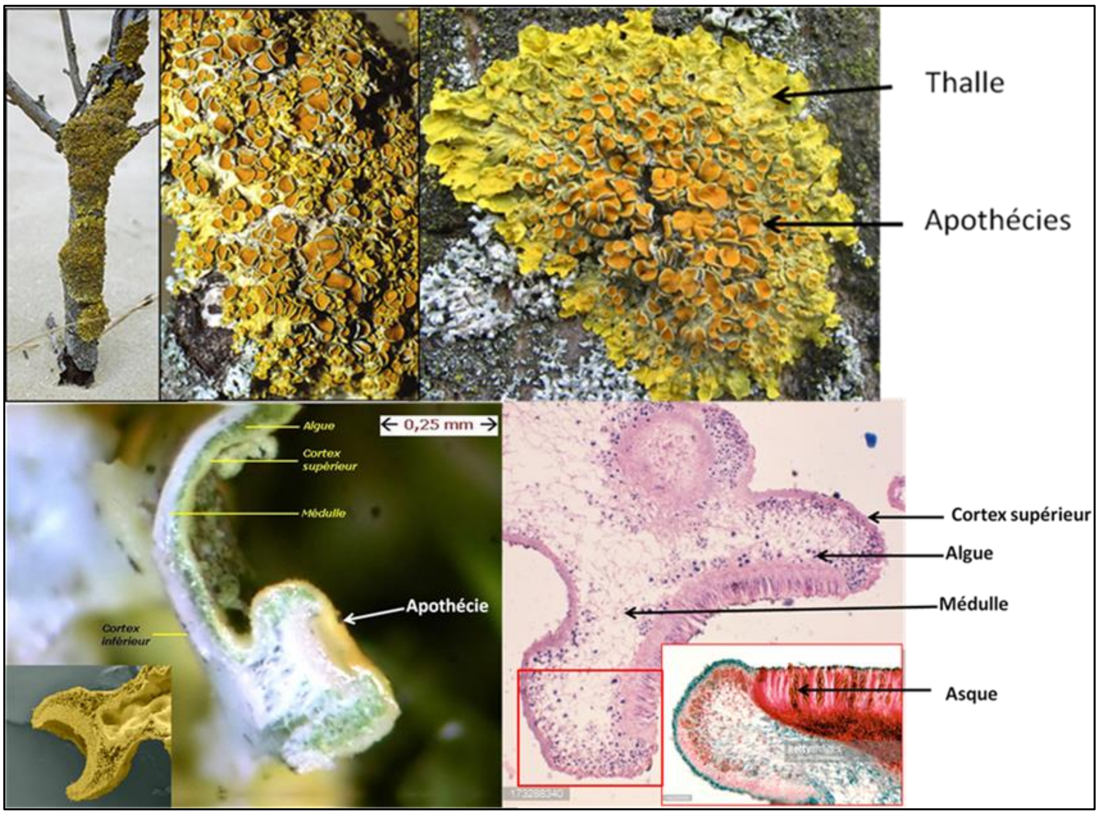


Figure 25: Morphology of *Xanthoria parietina*

Also called "common wall lichen," *Xanthoria parietina* is a widespread, bright yellow-orange foliose lichen, often found growing in rosettes. Thalli typically reach 8 cm, sometimes up to 15 cm.

Its bright coloration, due to a pigment called parietin, is especially vivid in apothecia.

The lower thallus surface is whitish with a few rhizines (false roots). Sexual reproduction occurs through orange apothecia producing ascospores, which require contact with Trebouxia algae to develop.

This species lacks typical asexual propagules (soredia, isidia) and reproduces vegetatively through fragmentation of the central thallus.

7.1. Physcia sp.

- Kingdom: Fungi
- Phylum: Ascomycota
- Subphylum: Pezizomycotina
- Class: Lecanoromycetes
- Order: Lecanorales
- Family: Physciaceae
- Genus: *Physcia*
- Species: *Physcia sp.*

Physcia species are foliose lichens with grey-green dry coloration, growing mainly on tree bark. Their lower surface has very visible rhizines. Apothecia are dark grey and produce ascospores in asci, similar *to Xanthoria.*

Vegetative reproduction also occurs via thallus fragmentation.

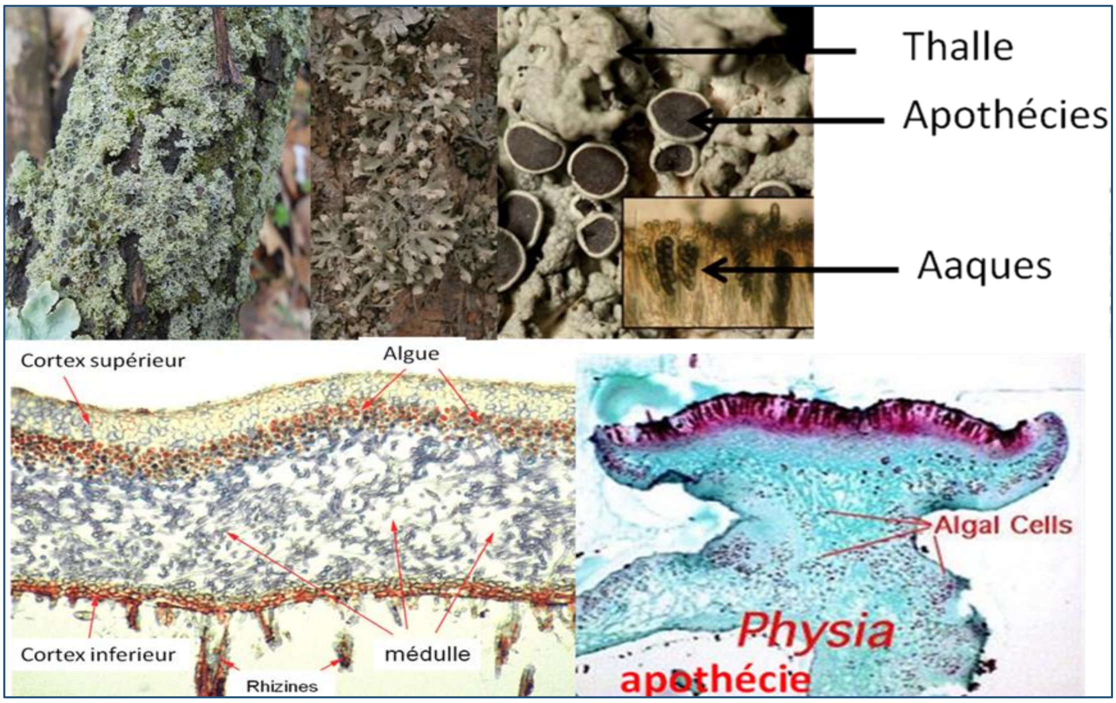


Figure 26: Microscopic Structure of Physcia

7.2. Microscopic structure

- **Cortical layer** : A dense outer layer of intertwined hyphae.
- **Photobiont layer** : Contains green-blue algal cells intertwined with fungal hyphae.
- **Medullary layer** : Looser hyphal tissue.
- **Lower cortex** : Along with filaments, forms rhizines for substrate attachment.

Practical Work

Materials

- Microscope, slides, adhesive tape.
- Different mold cultures on nutrient media.
- Lichens on dead tree branches.
- Phytopathogenic fungi on plant leaves.

Procedure

1. **Sample preparation**: Stick a small tuft of mycelium onto adhesive tape placed on a dry slide.
2. **Observation:** Examine under various microscope objectives and draw the observed structures.
3. **Live observations:**
   - Phytopathogenic fungus on leaves.
   - Two lichen species (*Physcia* and *Xanthoria parietina*) on dead branches.
4. **Microscopic** study:
   - Analyze the thallus structure of *Xanthoria* parietina under the microscope.

Annexe

Annexe 1 : SAFETY INSTRUCTIONS IN THE LABORATORY

In general, handling and carrying out experiments in the laboratory requires the use of products that may be toxic, flammable, or explosive. Performing such work can therefore be a source of accidents or serious poisoning, with immediate or insidious consequences.

Anyone working in a laboratory who does not follow safety rules is exposed to significant risks, with potentially frightening consequences for themselves and their colleagues.

The various scheduled practical sessions do not present any serious danger during handling, except in cases where students fail to follow the teacher's advice and basic safety instructions.

- **Clothing and Behavior in the Laboratory:**

Access to the laboratory is strictly forbidden without a lab coat.

• Lab coats must be made of strong cotton fabric.

• They should be long enough to cover the legs and have long sleeves.

• It is advisable to wear closed shoes that fully cover the feet.

• Long hair must be tied back during lab sessions.

- **The following are strictly prohibited inside the laboratory and during sessions :**

• Eating, drinking, chewing gum, and smoking.

• Wearing inappropriate clothing or shoes (scarves, loose or flammable clothes, etc.).

• Using the phone or listening to music with earphones/headsets.

• Taking unrelated photos during lab sessions.

- **Before leaving the laboratory:**

• Turn off microscope lights, unplug power cords, and carefully return all instruments to their proper places.

• Clean the workbenches, tidy up the chairs, and submit the lab report.

• Wash your hands at the end of each session.

Annexe 2 : Recommendations and Guidelines for Lab Report Writing

- **It is absolutely essential to :**

Avoid arriving late, in order not to disturb or interrupt the lab session;

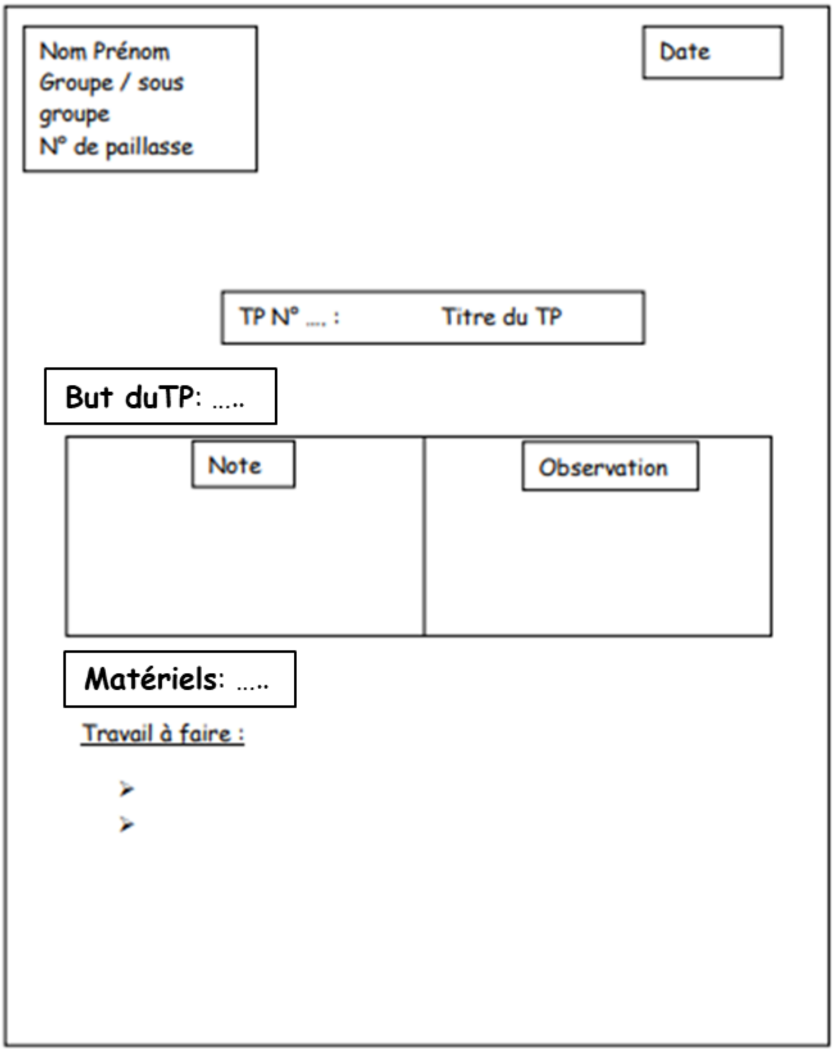
The practical work (TP) may be carried out in pairs or groups of three, depending on the number of students present and the availability of instruments. However, each student must submit an individual report;

At the beginning of each session, students must carefully read the assigned task;

During every lab session, students must bring drawing materials:

- A4 plain white sheets (not graph paper), HB graphite pencil, ruler, eraser, paper clip or stapler;
- Drawings must be made in black pencil only — no colors or pens allowed;
- In general, the drawing should represent the image observed through the observation tool, which is most often the microscope (enlarge the image while preserving its proportions and layout);
- The magnification used must be indicated on each drawing;
- A complete legend must accompany each drawing. It should be clear, well-organized, written on one side only, with parallel arrows;
- The title must be complete and include all keywords (organ, section, scientific name, and common name of the plant);
- The lab report must include a cover page (as the first sheet), followed by the drawing sheets. It should be written in the format shown in the figure below, and double-sided printing is not allowed.

<u>Annexe 3</u> : Example of Lab Report Writing



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Groupe / sous groupe
N° de paillasse

Date

TP N° .... : Titre du TP

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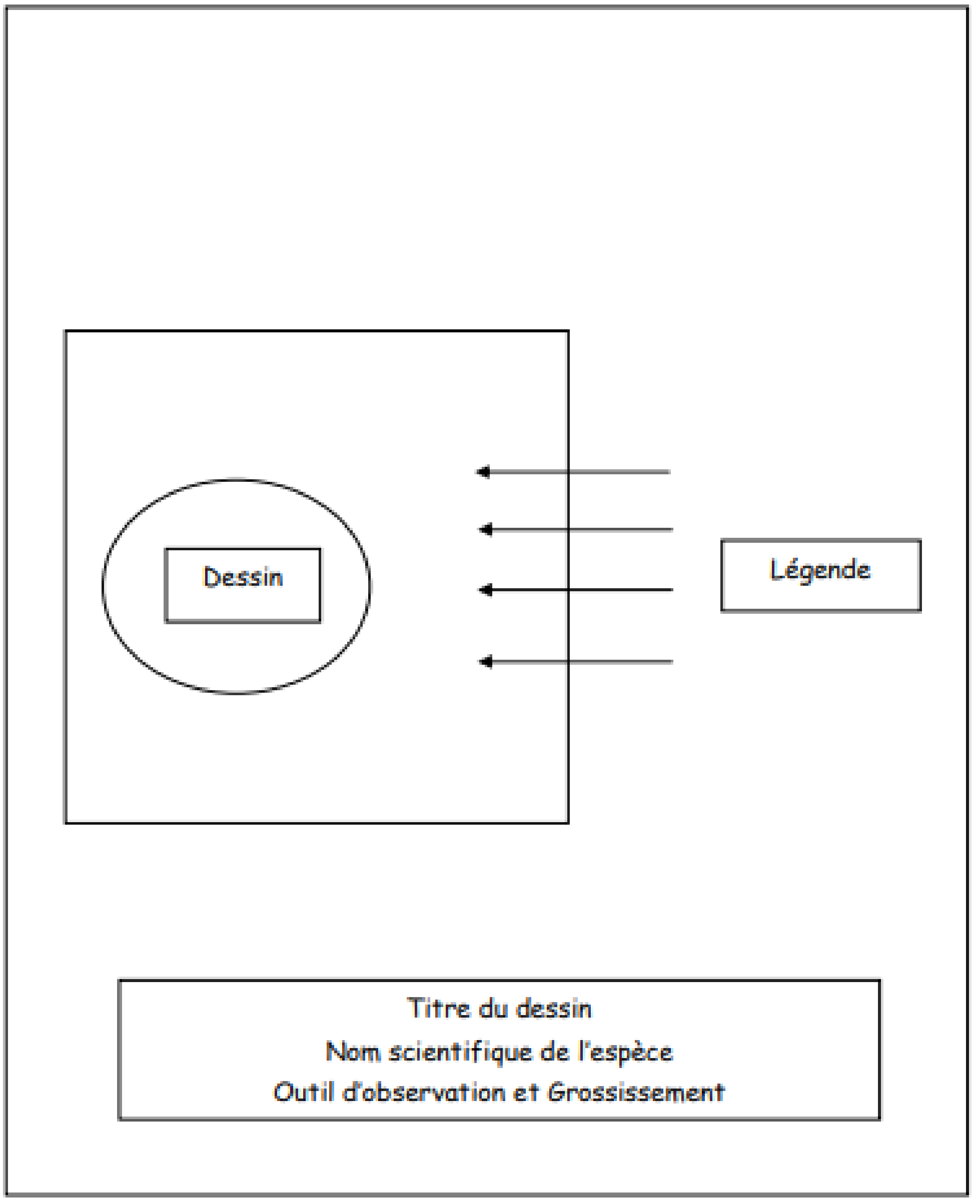
Annexe 4 : Example of Lab Report Writing



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