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Manual for Studying of Morphology and Anatomy of Angiospermic Plants

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RESEARCH ARTICLE

ABSTRACT

The most important aspect of plant taxonomy is the description of the plant in terms of morphology and anatomy. Taxonomy is a branch of science that deals with identification, nomenclature, and classification. Taxonomy and description of plant groups are the most significant aspects of Plant Science. Anatomical and morphological characters have traditionally been used to identify plants. The majority of medicinal plants can be identified using only the vegetative and reproductive organs. For the purposes of identification and nomenclature, the major and minor sections of the plant should be described and observed. Morphology is also known as phytomorphology. It is the study of the exterior structure or physical structures and arrangement of plant material in both natural and laboratory settings. Morphological character gives the key information related family or distinguishing character like inflorescence, flower, fruit, root, stem, leaf root etc. Anatomy of entire plant parts such as roots, stems, and leaves is learned. We're learning about the plant's internal structure, including cellular organisation and tissue arrangement. The main types of tissue include simple tissue, complex tissue, meristematic tissue, and epidermal tissue. We learn the basic architecture of plants when studying morphology and anatomy. A detailed knowledge of morphology and anatomy is needed to recognize plant groups. Plant morphology and anatomy are fundamental sciences that can be extended to a variety of fields such as physiology, biochemistry, biotechnology, pharmacognosy, geography, taxonomy, and genetics.

KEYWORDS

Morphology, Anatomy, Angiospermic Plants

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1.INTRODUCTION

In Plant Science most of the important aspect is taxonomy and identification of plant groups. Plant identification is classically based on anatomical and morphological characters. Most of medicinal plants can be identify with the help of only vegetative organ as well as reproductive organ [Alves et al., 2007]. Plant systematics has always been based on the study of plant structure, morphology, and anatomy. Even taxonomy research reveals plant characterization using various technologies [Endress et al. 2000]. The aerial part of the plant is called a shoot, whereas the underground part is called a root. Each system is made up of different parts stem, leaf, flower, and fruit are organs that make up the shoot system, while the roots and their parts make up the root system. The root system, for example, performs functions such as water and mineral absorption, as well as soil attachment. In plants, the stem serves as a supporting organ, while the leaf serves as a photosynthesis organ, and the flower serves as the reproductive organ. Their uniqueness is responsible for all of its functions. In terms of morphology and anatomy, its uniqueness can be studied [Carrillo López et al., 2019]. Morphology is derived from the Greek words morphe, which means forms and structure, and logus, which means to research. Morphology is a branch of botany that deals with the study of plant structure and forms Plant Morphology is the study of plant groups as a function of plant parts, primarily the vegetative parts such as the root, stem, and leaf. The reproductive character or organisation of plant parts will be studied with the aid of plant parts such as flowers, fruits, and seeds [Sattler et al. 1997]. Anatomy is a branch of biology that deals with the plant's gross internal structure, such as the root and stem, and prior characterization is useful for identifying plant classes such as monocot and dicotyledon plants. Plant anatomy refers to the complex structure of a plant, including its leaf, stem, roots, flowers, and fruits. Higher plants have roots that provide them with water, nutrients, and anchorage; stems that provide support; and leaves that perform photosynthesis for growth and development. Various types of tissue, such as epidermal tissue, which has a defensive function, vascular tissue, such as xylem and phloem, which has a conductive function, and meristematic tissue, which has a developing nature, can be detected when observing the anatomical character. Flowers, which are simply assemblies of leaves specialised for reproduction, may have tissues that are defensive, supportive, vascular, or meristematic in nature, and organs can be changed to perform various functions [Lopez, et al,. 2017]. Most biological divisions, such as physiology, biochemistry, genetics, molecular biology taxonomy, and others, are dependent on overall morphology and anatomy.

2. MORPHOLOGY

2.1 Root

From seed germination (radicle protrusion) and emergence to subsequent seedling growth and development, seedling root systems play an important physical and physiological role. Shoot anchorage, water absorption, nutrient uptake, and hormone development are all important root functions [Leskovar et al. 1995] Carrots, beets, radish, turnips, jicama, and sweet potatoes are examples of edible horticultural origin. In sprouting embryos, the root is the first organ to appear. The seed coat is broken, and the root begins to expand inward, creating tube-like structures. Buds, leaves, and stomata are all missing from the base. There are two types of roots based on their shape: taproot and fibrous. Fibrous roots, on the other hand, are shorter, smaller, and hairy, and grow more shallowly than taproots. Taproots have a broad central root with shorter lateral or branching roots, while fibrous roots have a smaller central root with shorter lateral or branching roots.

2.2 Stem

The stem emerges from the embryo plumule as a primary axis that grows in the opposite direction of the radicle [root system], and it can be subterranean, eventually becoming the plant's aerial portion. Buds, nodes, internodes, and leaves are all found on the stem. Some plants, such as cactus branches, have stems that are devoid of leaves. Floral buds are those that grow into flowers, while vegetative buds are those that develop into branches. [Leskovar et al. 1995] Apical buds are those that are found at the apex of the stem; axillary buds are those that are found on the sides or above the stem. The stems of plants may be categorised as aerial, marine, or subterranean, depending on the climate in which they live. The subclasses erected, creeping, and climber stems are included among the aerial forms. Subterranean stems are those that develop underground and are known as rhizomes, tubers, or bulbs. Aquatic stems are those that grow in rivers or lakes, while subterranean stems are those that grow underground and are classified as rhizomes, tubers, or bulbs [Alves et al., 2007].

2.3 Leaf

The leaf is the only vegetative component that distinguishes each plant group. The first leaves emerge from the plumule at seed germination, and the following leaves emerge from the terminal and axillary buds of stems and branches. [Leskovar et al, 1995] At the end of the petiole, leaves become lateral laminar-shaped structures attached to the stem or its branches, and may bear two lateral small leaf-like structures called stipules. Leaves bear an axillary bud, which may later grow into a branch. The lamina, or green expanded part of the leaf, is the green expanded part of the leaf. A prominent middle vein, known as the midrib, and lateral veins connected to the midrib are common.

2.4. Inflorescence

In plant morphology, inflorescence is a critical parameter. The arrangement of flowers on the floral axis is referred to as inflorescence. [Alves et al. 2007]. They are classified into three groups based on the arrangement of flowers, their attachment, and flower design. cymose inflorescence, racemose inflorescence, and special types of inflorescence; the arrangement flower can be acropetal or basipetal; spathe peduncle, pedicle, and form of flower are also factors to consider. Inflorescence is important in terms of taxonomy, as inflorescence may be used to identify a genus, for example, Asteraceae (capitulum), and Umbeliferae (Umbe). Lamiaceae and Euphorbiaceae (Cyathium) (Verticilaster) [Leskovar et al. 1995]

2.5 Flower

Flower is a shoot system made up of four compartments (calyx, corolla, androecium, and gynoecium). It develops from the leaves' determinate axis and contains sepals, petals, stamens, and carpels, which are adapted for sexual reproduction. There are two important whorls and two non-essential whorls among these four parts. Sepals and petals are considered accessory parts because they are not necessary for reproduction, while stamens and carpels are considered essential parts because they are involved in reproduction. The sepals are individual members of the flower's calyx, while the petals are individual members of the corolla; the perianth is made up of both whorls. The stamens (consisting of filament and anther) are the male parts (androecium), while the carpels are the female parts (gynoecium) (consisting of stigma, style, and ovary). Instead of calyx and corolla, the perianth has tepals, which are independent members of the perianth (lily). [Leskovar et al, 1995] We must study characteristics of flowers such as complete incomplete, bracteate ebracteate, actinomorphic, zygomorphic, fine, imperfect, sexuality, calyx colour, sepal structure, and petal structure while studying flowers. The structure of androecium and gynoecium is extremely important .for the taxonomic way identification of plant group [Alves et al. 2007].

2.6 Fruit

Fruit is the product of fertilisation. The fruit is a mature ovary or mature ovaries of one or more flowers that have grown after flowering plants have been fertilised. All floral organs spontaneously detach after fertilisation, with the exception of the ovary, which survives, grows, and undergoes transformations to become a fruit. Describing fruit based on seed formation, inner pulpy material, and seed dispersion. All floral organs spontaneously detach after fertilisation, with the exception of the ovary, which survives, grows, and undergoes transformations to become a fruit. Describing fruits based on their characteristics formation of seeds inner pulpy substance mechanism for seed dispersal. The pericarp and seed are the two main sections of the fruit. The pericarp tissue, which grows from the ovary wall, is also the edible component of the fruit. Epicarp (outer layer), Mesocarp (middle layer), and Endocarp (inner layer) are the three components of the pericarp. The epicarp, also known as the exocarp, is the fruit's normally tough outer skin. The fleshy middle layer of the pericarp is the mesocarp, which is located between the epicarp and the endocarp. It is typically the edible portion of the fruit, eaten along with the epicarp when the latter is soft, as in peach, plum, and guava. The endocarp is the pericarp's innermost layer, which covers the seeds directly. As in drupes, this may be very hard and inedible.

2.7 Seed

The most common edible horticultural seeds are nuts with a stony endocarp that must be broken to release the inner edible material, while the rest of the pericarp is inedible. Once fertilised, the ovule grows into seeds with a seed coat and an embryo as their basic structure. The outer testa and the inner tegmen make up the seed coat, while the radicle and plumule make up the embryo. The ovary's ovules mature into seeds, while the ovule wall matures into the seed coat [Carrillo López et al., 2019].

2.8 Steps Describing plant [Carrillo López et al., 2019]

- Collection of Plant Material in different growth stages
- Field Characterization
- If its aquatic it wash and preserve in the specific preservative
- If it is woody remove the soil particle
- Make suitable herbarium of that plant material
- Firstly observe their character with help od authenticates flora manual and available literature and make identification
- Microscopic character with magnification lens and high resoluaton microspe are used for that

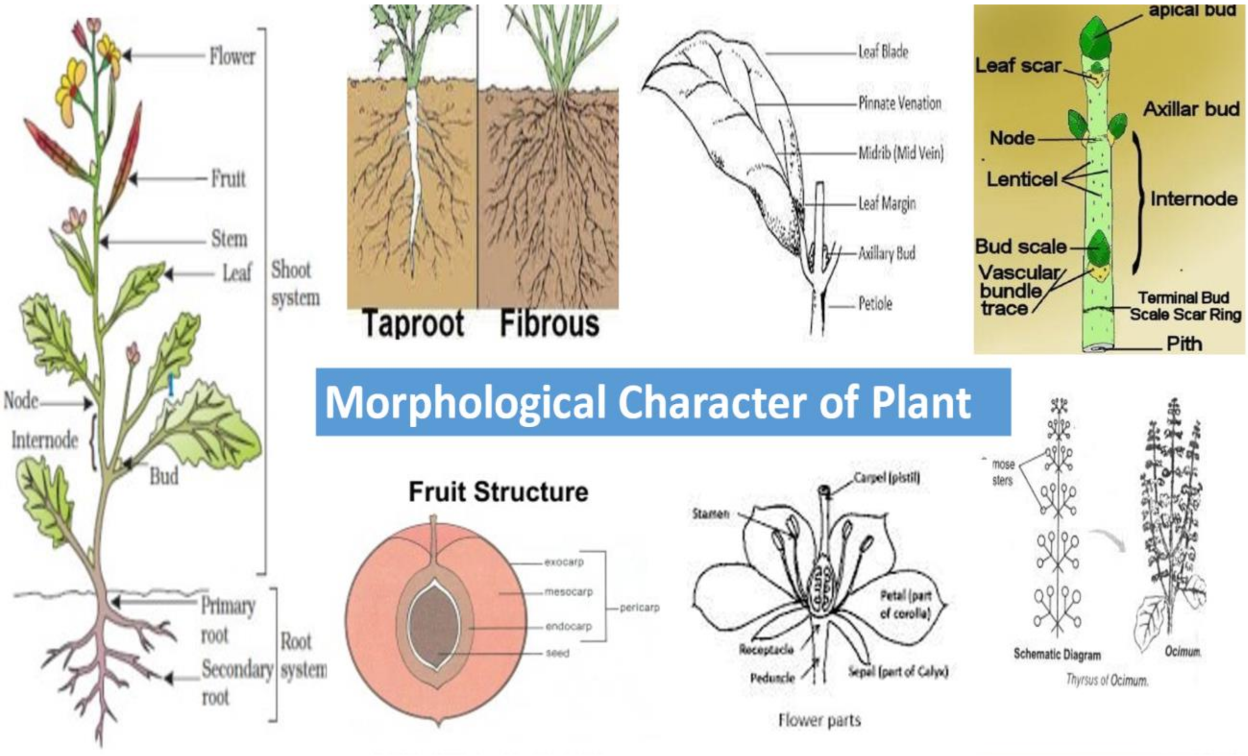

Figure 1: Morphological character of plant parts.

3. ANATOMY

When we are learning about anatomy, we must observe various anatomical tissues. When we take a segment, we must observe the number of cells and tissue that are most plentiful, as well as the different types of tissue. Tissue is a set of cells that are both identical and dissimilar. Simple tissue is a type of tissue in which a group of one type or similar cells is grouped together, whereas Complex tissue is a group of two different types of cells grouped together [Carrillo López et al., 2019].

3.1 Simple Tissue

3.1.1 Parenchyma

The parenchyma is a thin-walled, isodiametric tissue of the cortex that is present between the epidermis and the vascular tissues, as well as the pith, the area to the inside of the vascular tissues, of stems and roots [Carrillo López et al., 2019]. The fleshy portion of fruits, roots, tubers, and leaves is made up of parenchyma cells, which are the most normal and abundant plant tissue. If they are turgid, parenchyma cells may serve as storage sites for starches, proteins, oils, and other nutrients, as well as providing support to the plant.

3.1.2 Collenchyma

Collenchyma is a simple tissue derived from parenchymal cells that have been transformed by the addition of primary cell wall material, which is accumulated primarily in the corners of the cells. Elongated living cells with irregular primary thick walls and hemicellulose, cellulose, and pectic materials make up collenchyma tissue. Collenchyma is found in ridges underneath the epidermis and in the midribs of leaves, where it develops with the plant and supports elongating stems Collenchyma tissue is relatively inexpensive for the plant to produce because its cell walls lack hydrophobic materials, but it, like parenchyma, only helps protect the plant if it is turgid. It gives young plants' petiole, leaf veins, and stem support, structure, mechanical power, and flexibility, allowing for fast bending without breaking. Collenchyma tissue is responsible for the celery strands' stretchinessm [Carrillo López et al., 2019]

3.1.3 Sclerenchyma

Sclerenchyma cells are dead cells with thickened lignified walls that keep them solid and waterproof. Sclereids and fibres make up sclerenchyma. Fibers are long, elongated cells found in stems, roots, and the vascular bundles of leaves. Sclereids can be found in a variety of plant tissues, including the periderm, cortex, pith, xylem, phloem, leaves, and fruits, and come in a variety of shapes (spherical, oval, or cylindrical). This type of cell is responsible for the hardness of nuts' shells, the coats of several seeds, and the stone of drupes (cherries and plums). Sclereids, which are found scattered in the parenchymatous tissue of pears and quinces, may give them a grainy texture. Sclereids are approximately isodiametric, and clumps of these stone cells (brachysclereids) give the Bartlett pear (Pyrus communis) its grittier appearance. Many plants, especially legumes, have two layers of sclereids in their testas (seed coats), and sclereids make up the thick dense layer that forms the coconut's shell (endocarp). Water lily leaves (Nymphaea sp.) have tough but pliable astrosclereids that allow them to withstand the tearing forces of waves and currents The tracheid and vessel elements of the xylem, the tracheary elements of plants, are the conducting forms of sclerenchyma [Sattler et al,. 1997]

3.2 Complex tissue

3.2.1 Vascular tissue

Vascular tissue, which includes the xylem, phloem, parenchyma, and cambium cells, is the conduction tissue that transports food, water, hormones, and minerals within the plant. The xylem transports water and minerals in the plant, while the phloem transports photosynthesis products from the leaves to the rest of the plant. The key transport mechanisms of plants, the xylem and phloem, are mostly found in vascular tissue. They are found in vascular bundles in all plant organs, passing through roots, stems, and leaves. Tracheids, vessels, xylem fibres, and xylem parenchyma are the four types of elements that make up xylem. Tracheids are long, lignified dead cells with tapering ends and thick, lignified walls. The vessel is a tubular structure made up of several dead lignified cells called vessel members that are bound by perforations in their common walls. Phloem is made up of long tubular structures that are organised longitudinally and linked to companion cells to shape sieve plates, their end walls are perforated in a sieve-like manner. Companion cells are specialised cells (parenchyma) that are closely associated with sieve tube elements and aid in the maintenance of the sieve tube pressure gradient. The nucleus of companion cells controls the functions of sieve tubes. The xylem is in charge of transporting water and dissolved ions from the roots to the top of the plant. Phloem transports metabolites (primarily sugars, amino acids, and some ions) from sources of development, primarily fully expanded leaves, to sinks, such as growing roots, leaves, and fruits, in solution [Endress et al,. 2000].

3.3. Meristematic tissue

Meristematic tissue is a form of tissue that is still developing. Meristems, which are groups of undifferentiated, genetically sound cells, are responsible for plants' continuous development. Meristems may be fixed, producing organs of specific shapes and sizes, such as leaves and flowers. Indeterminate meristems, on the other hand, have continuous root and stem development, allowing plants to expand in length from their apices or in breadth from cambial activity. Pith and cortex are produced by the ground meristem, while primary phloem and xylem are produced by the procambium. Axillary buds develop branches or flowers when they grow in the axils of leaves. Plants' primary growth pattern is formed by these meristems, which are referred to as primary meristems. The activity of vascular cambium and cork cambium, lateral meristems occurring during secondary growth in eudicotyledons, increases the girth of stems and roots [Endress et al,. 2000].

3.4 Epidermal tissue

The epidermis is the outermost cellular layer of the plant body, consisting of elongated and closely packed cells known as epidermal cells. The parenchymatous epidermal cells are the most common type of epidermal cell [Endress et al. 2000].

3.4.1 Cuticle

Cutin and waxes make up the extracellular composite structure of the plant cuticle. It's a dense waxy extracellular layer that coats the epidermis's outer layer. The cuticular membrane is known for its resistance to water loss by transpiration as well as its resistance to pathogen invasion and chemical penetration [Sattler et al, 1997].

3.4.2 Trichome

Trichomes are single-celled or multicellular appendages that can be found on stems and certain fruits including peaches and kiwifruit. The branched or unbranched multicellular trichomes help to prevent water loss [Sattler et al, 1997].

3.4.3 Stomata

It is a form of tissue designed specifically for the exchange of gases from the atmosphere to the interior and from the interior to the exterior. Stomata are made up of two specialised guard cells that form the stomatal pore, which controls the exchange of carbon dioxide, oxygen, and water vapour between the outside atmosphere and the leaf's substomatal cavities. Guard cells vary from one another [Endress et al. 2000].

3.4.4 Lenticel

It is an essential tissue part of the epidermis that aids in gas exchange. Lenticels, which are made up of parenchymatous cells and are located on the epidermis of various plant organs (stem, petiole, fruits), are pores that are always open, unlike stomata, which control their degree of opening. Lenticels can be seen on the surfaces of fruits like mango, apple, and avocado. Lenticels allow gases to flow freely between the atmosphere and the organs' internal tissue spaces. They allow oxygen to enter while simultaneously releasing carbon dioxide and water vapour [Endress et al. 2000].

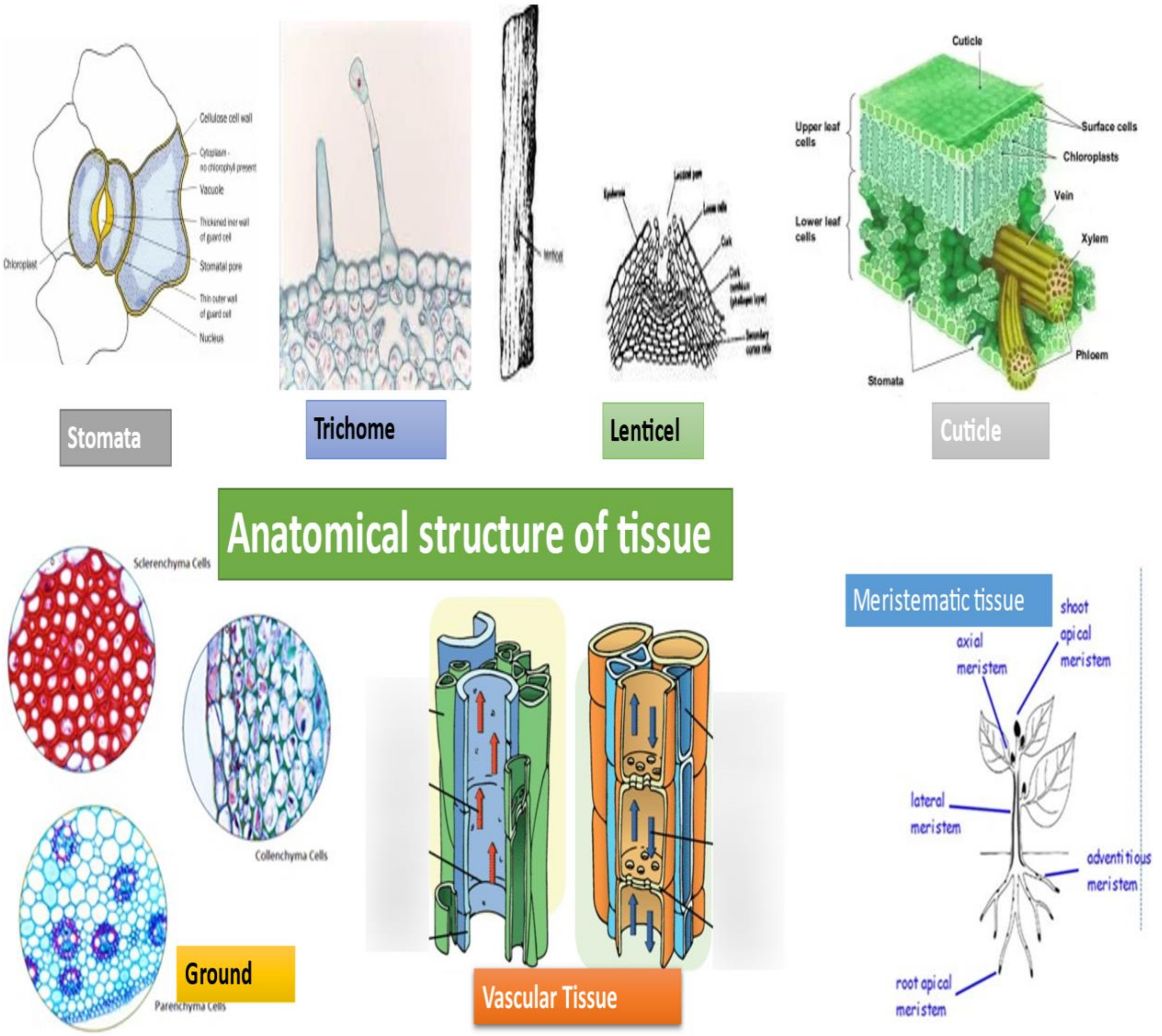

Figure 2: Anatomical structure of plants.

3.5. Techniques use in Anatomical Characterization

SEM: The scanning electron microscopy (SEM) in the late 1960s and early 1970s proved an even greater stimulus to the use of micromorphology in plant systematic studies This was only partly due to the higher resolution and magnification so SEM compared to light microscopy (LM), but largely because the instant three-dimensional view of microscopic structure attracted much greater interest among botanists than two-dimensional (L M) images. In teaching programmes SEM [Sattler et al, 1997]

TEM: Transmission electron microscopy: (TEM) was initially applied to study fundamental aspects such as cell wall organisation in woody plants but soon diversity of ultrastructure also explored or its potentials A. fine example of the discovery and comprehensive study of a new set of vegetative characters TEM is that use for the of sieve-tube plastid ultrastructure [Sattler et al,. 1997]

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