CHAPTER XIII

BRANCHING.

The lateral development of similar parts is branching. There are two types of branching :—

(1) *Lateral*, (2) *Dichotomous.*

(1) Lateral branching—the main axis elongates and from the sides, branches arise by the development of axillary buds. Lateral branching is of two types :—

(*a*) *Racemose*, (*b*) *Cymose.*

(*a*) *Racemose* branching when the main axis has an unlimited growth and branches arise in acropetal succession *i.e.* the youngest branch is near the apex and the older ones near the base of the plant.

(*b*) *Cymose* branching does not show the unlimited growth of the apex, but the apical bud is arrested in its growth.

The buds below the apex take up the growth and are similarly followed by other buds, so the daughter branches are more prominent and strong than the parent axis. This type of branching is called *Cymose.*

(1) In the case of cymose branching, one branch develops followed by such other branches, it is called *Uniparous cyme* or *Monochasium.* If the branch system devolops on one side, it is called **Helicoid** but if alternate branches develop it is called **Scorpioid.**

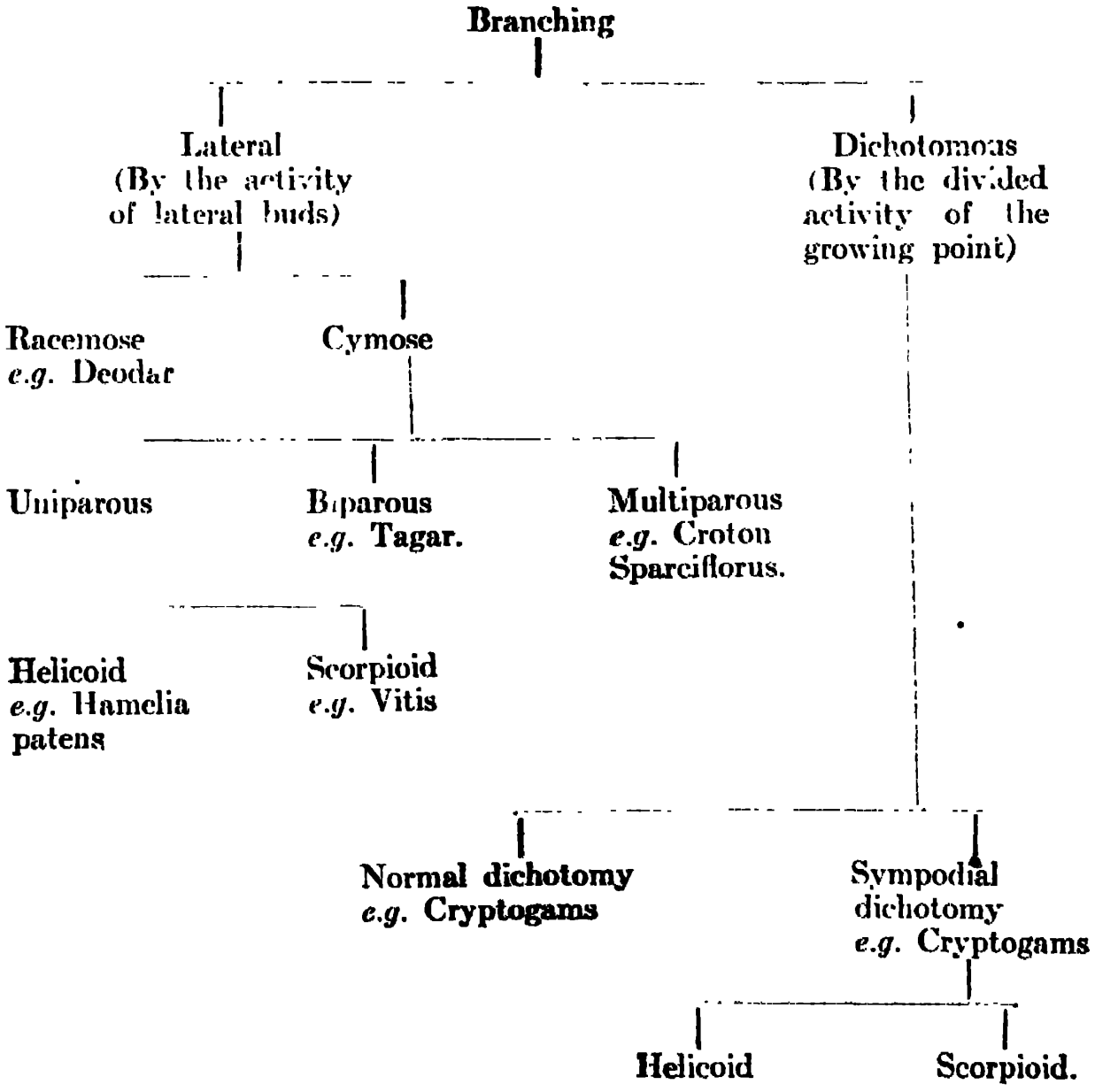
(2) If two such branches develop it is called **Biparous cyme.**

(3) If more than two branches develop it is called **Multiparous cyme.**

Dichotomous Branching—

When the main axis divides equally into two branches and are followed by similar branches, it is known as **Dichotomous** branching. It occurs in the Cryptogams.

If branches develop on one side, it is **Helicoid** and when alternate development of branches is observed it is called **Scorpioid.**



CHAPTER XIV

LEAF.

Leaf is the *lateral dissimilar appendage* of the stem or branch. It is the laboratory of the plant where the simple food-materials collected from the soil and air are converted into organic food not only for the use of the plant but also for the welfare of the living animals which have to depend upon plants directly or indirectly for their nutrition. They arise in acropetal succession on the stem. The ordinary leaves are known as foliage leaves and are usually green in colour. They sometimes take other forms and colours.

Kinds of Leaves—

(1) **Ordinary foliage leaves,** these leaves, are flat and green.

(2) **Cotyledons,** these are the primary leaves of the baby plant.

(3) **Scale-leaves,** these are found on the underground stems.

(4) **Bract leaves,** these are associated with flowers, often they are green but sometimes highly coloured *e.g.* Euphorbia pulcherrima (Lalpata)—Poinsettia.

(5) **Floral leaves,** these are the enveloping leaves of flowers, often highly coloured to attract insects *e.g.* sepals and petals.

Functions of ordinary leaves—

(1) *Manufacture of organic food* from simple materials *e.g.* **Assimilation.**

(2) *Large amount of water vapour escapes* from the leaves *e.g.* **Transpiration.**

(3) Leaves take in oxygen and give out CO_2 (carbon dioxide) *e.g.* **Respiration.**

(4) Sometimes leaves protect delicate structures *e.g.* **Protection.**

Parts of a Leaf—

The leaf consists of three distinct portions. The flat and broad portion is called the **Lamina or Blade or Epipodium.** The stalk-like portion below the blade is called the **petiole or leafstalk or Mesopodium.**

The lowest part near its attachment to the stem is called the **leaf-base or Hypopodium.**

Stipules—

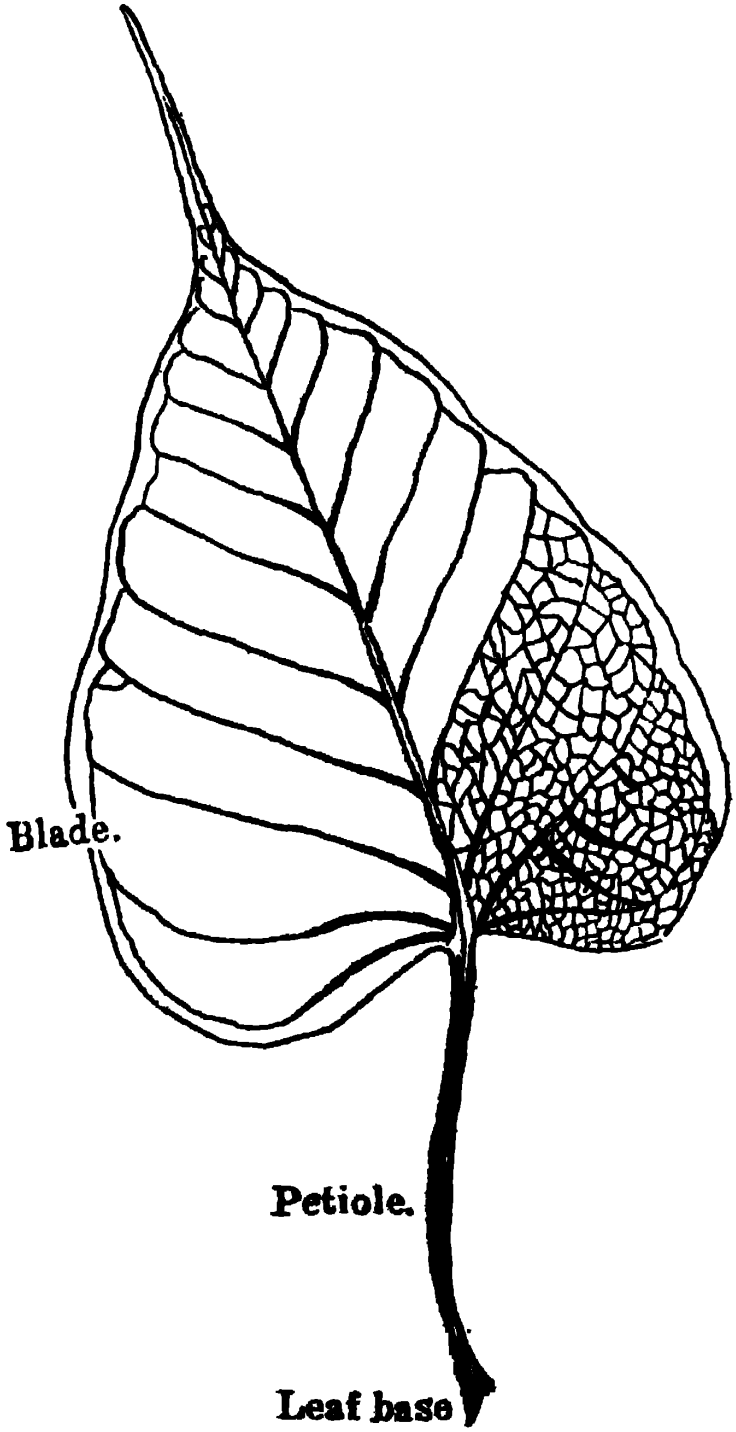
The base of the leaf sometimes shows a pair of structures which are called **Stipules.** If the leaf bears the stipules, it is called **stipulate,** while those leaves without stipules are known as **exstipulate.**

The stipules may be :—

(1) *Free lateral* when they arise from the sides of the leaf-base *e.g. Jaba.*

(2) *Foliaceous,* when the stipules are very prominent and leaflike *e.g.* Pea.

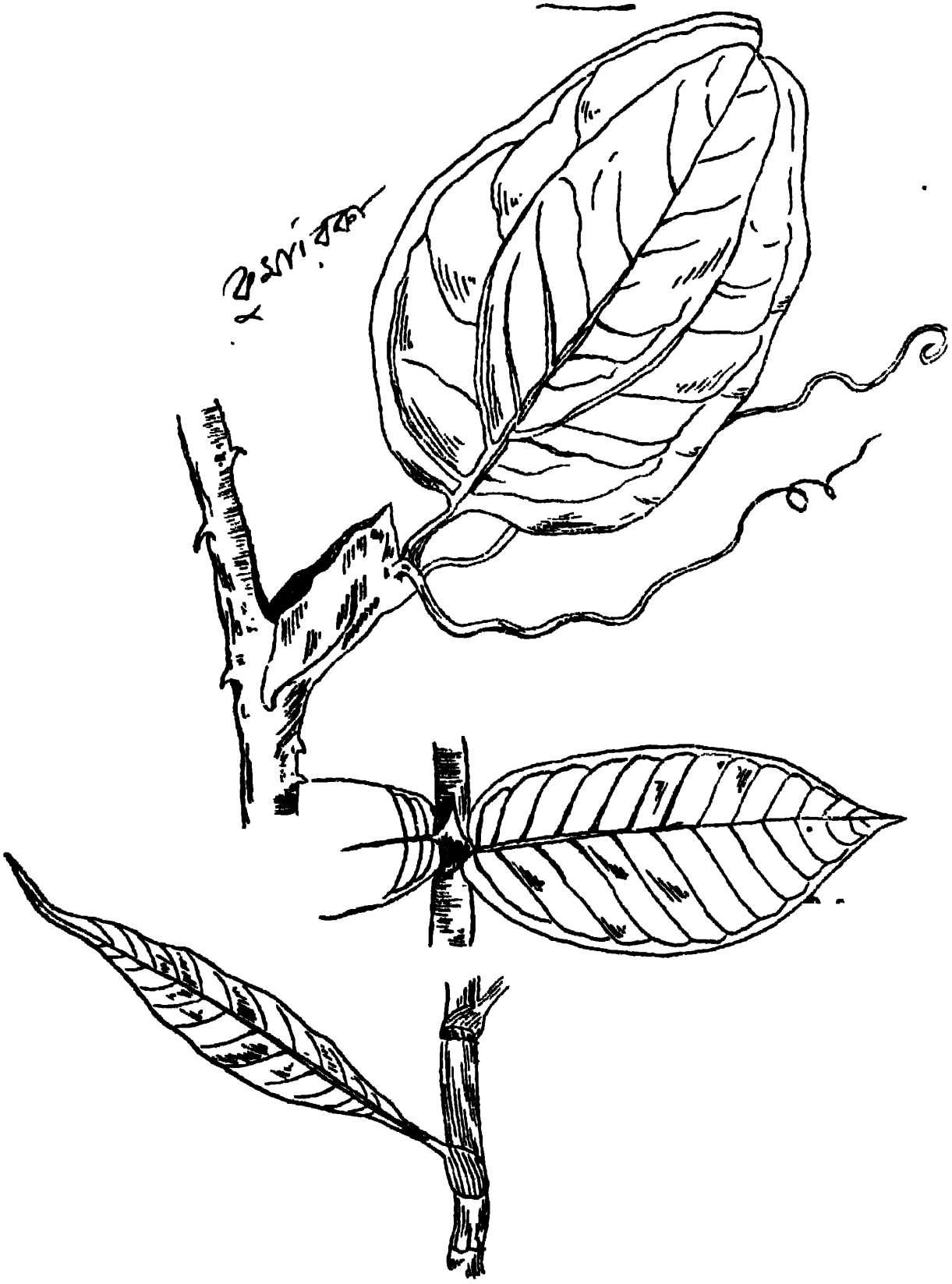
(3) *Spiny,* when the stipules are converted into spines *e.g.* **Mimosa, Babla.**



(4) **Interpetiolar,** when the stipules join up *e.g.* Rangan.

(5) **Adnate,** when the stipules enclose the base of the leaf *e.g.* **Rose.**

Tendrillarstipule.

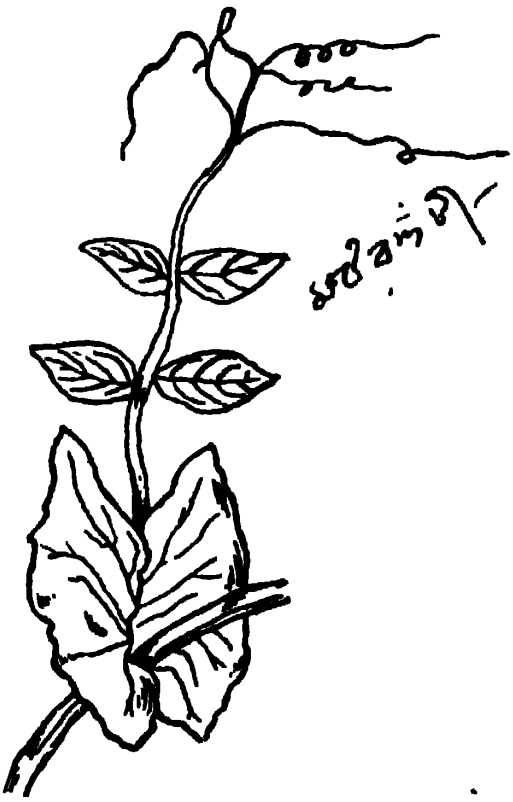


Ochreate Stipule.

(6) **Tendrillar** *e.g.* Smilax (Kumarika).

(7) **Scaly,** when they are converted into scales *e.g.* Banyan.

Spiny Stipule.



Foliaceous Stipule.

(8) **Ochreate** *e.g.* Panimarich (Poligonum).

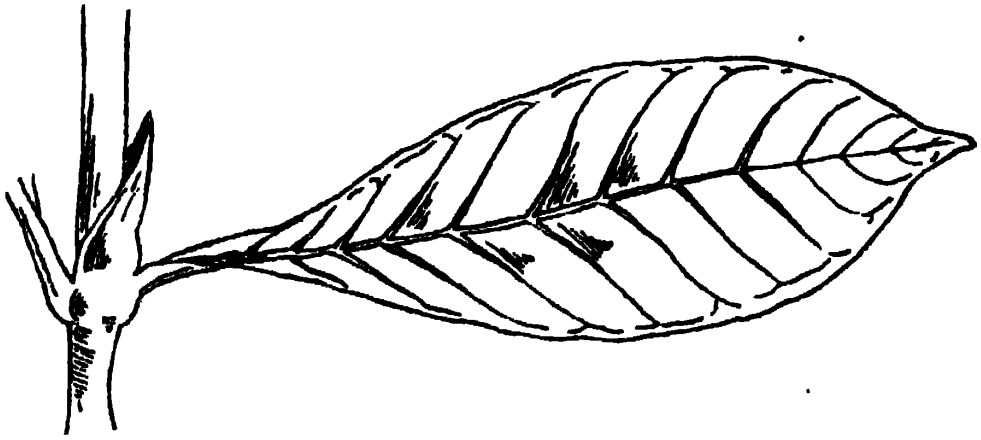
(9) **Intrapetiolar** *e.g.* Gandharaj.

Petiole of Leaf—

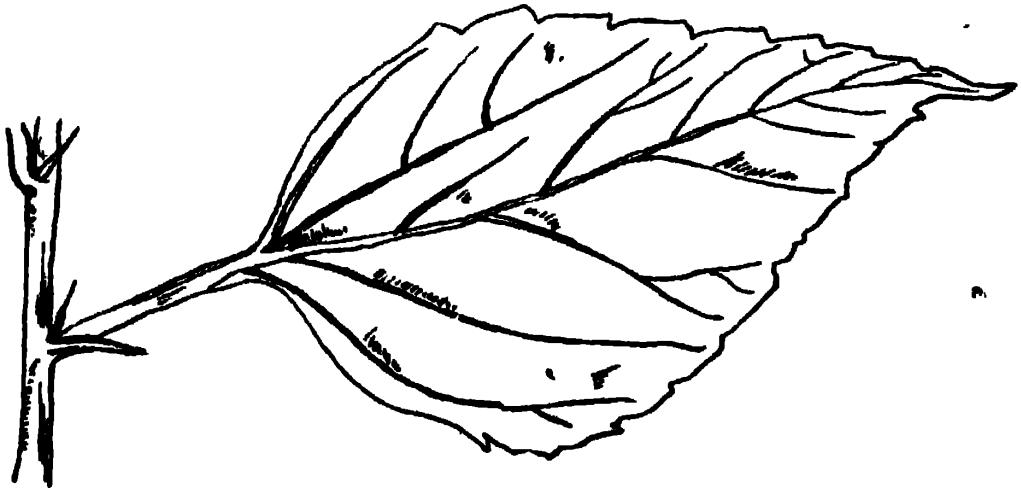
The petiole is usually round but may be long or short. Leaves with petiole are called **Petiolate** and those without it are called **Sessile.** Often the leafblade without attaining its permanent form, falls away and the work of the blade is performed by the petiole which becomes flat *e.g.* Australian Acacia. Such a petiole is known as ***Phyllode.*** The blade generally is flat and the terminal

end is called the apex of the leaf. There is a prominent vein in the leaf running almost in the middle which is

Adnate Stipule.



Intrapetiolar Stipule.

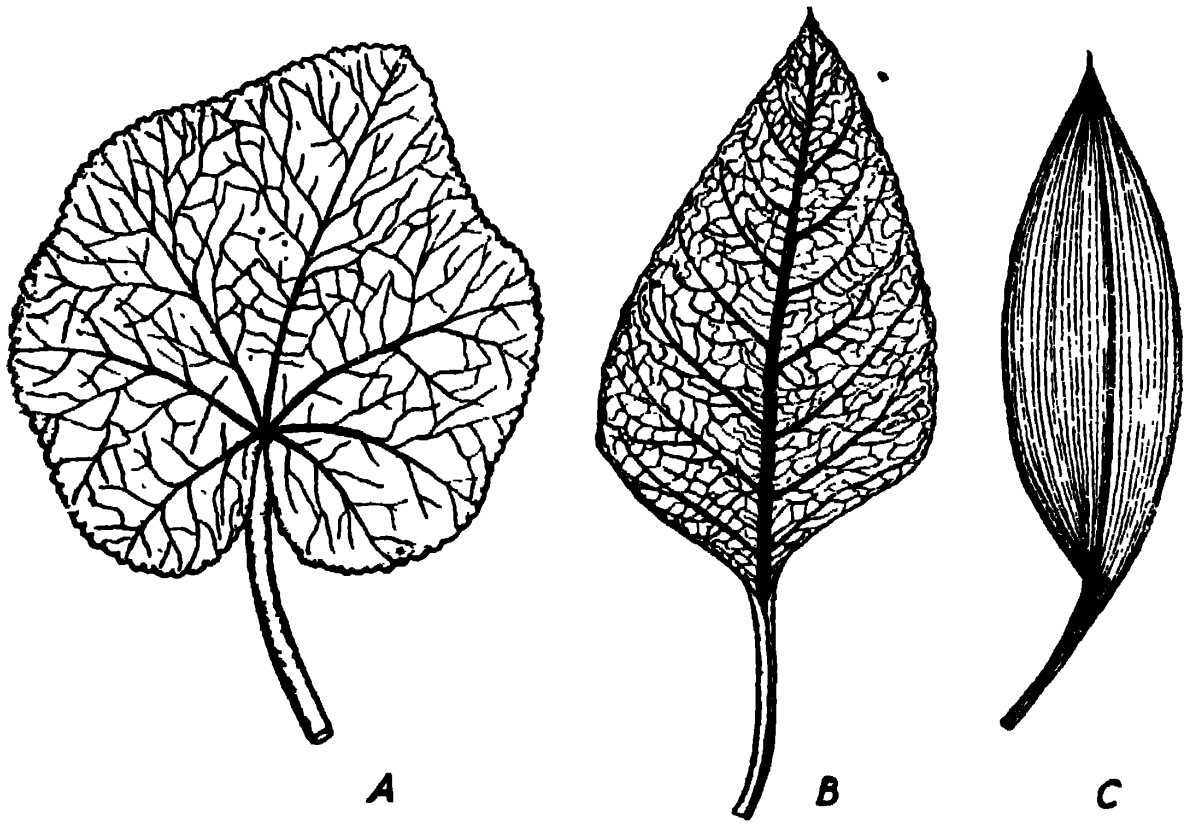


Free lateral Stipule.

called the midrib. There are other veins which form a network in the leaf coming out of the midrib.

Venation—

There are slender impressions on the leaf running all about it which are visible on looking at the leaf against light, these are due to the presence of *veins*. The arrangement of veins in a leaf is called venation.



–Palmate B—Pinnate. C—Parallel.

There are two principal types of veins, (A) **Reticulate** and (B) **Parallel.** (A) Reticulate, when the veins branch and gradually spread and form a netlike structure. *Reticulate* venations are of two types (1) **Pinnate** and (2) **Palmate.** (1) **Pinnate,** or **unicostate type** there is a prominent vein like a feather or central core of a feather and branches are given off from the sides like the pinnae of feather *e.g.* Mango. (2) **Palmate,** or **multicostate type** several strong veins

arise in the blade of the leaf and a central midrib is absent *e.g.* Papaw, Gourd.

B. Parallel, when the veins arise in the leaf parallel to one another. This type is characteristic of monocotyledons *e.g.* Grass.

Parallel may be pinnate or unicostate as Plantain, canna or Palmate or multicostate as Water-hyacinth, Bamboo.

Function of Veins—

The veins carry the food solution to different parts of the leaf and also help the leaf in keeping up its form *i.e.* they give mechanical strength to the leaf.

Segmentation of leaf—

If the margin of a leaf shows incisions running to less than half the depth of the lamina, it is called **pinnatifid** *e.g.* Chandramallika. If more than half the depth of the leaf is incised, the leaf is called **pinnatipartite** *e.g.* Paniphal. If the incisions run up to the midrib, it is **pinnatisect** *e.g.* Genda.

Texture of leaf.

A leaf may be :—

(1) *Succulent* when the leaf is fleshy and juicy *e.g.* Aloe (Ghrita-kumari). (2) *Leathery* or coriaceous, when it is strong and tides over the winter season succesfully as in Pine. (3) *Herbaceous,* when the leaves fall off periodically and last but a single season *e.g.* Amra.

The leaf is studied from different points of view *e.g.* Apex, Margin and shape.

The *apex might* be of one of the following forms :—

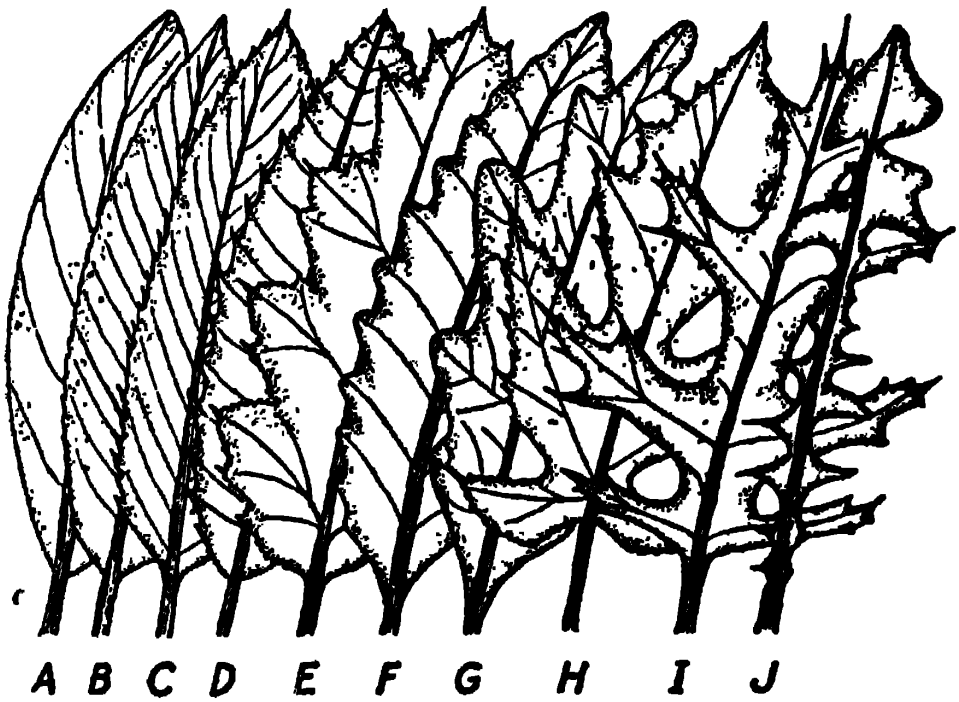
(1) *Acute,* when the apex ends in an acute angle *e.g.* Jaba.

(2) *Acuminate,* when it ends in a fine point *e.g.* Aswatha.

(3) *Obtuse,* when the apex ends in an obtuse angle *e.g.* Deshibadam (Terminalia).

(4) *Emarginate,* when there is a depression at the apex *e.g.* Oxalis (Amrul).

(5) *Tendrillar,* when the apex ends in a tendril *e.g.* Ulatchandal.

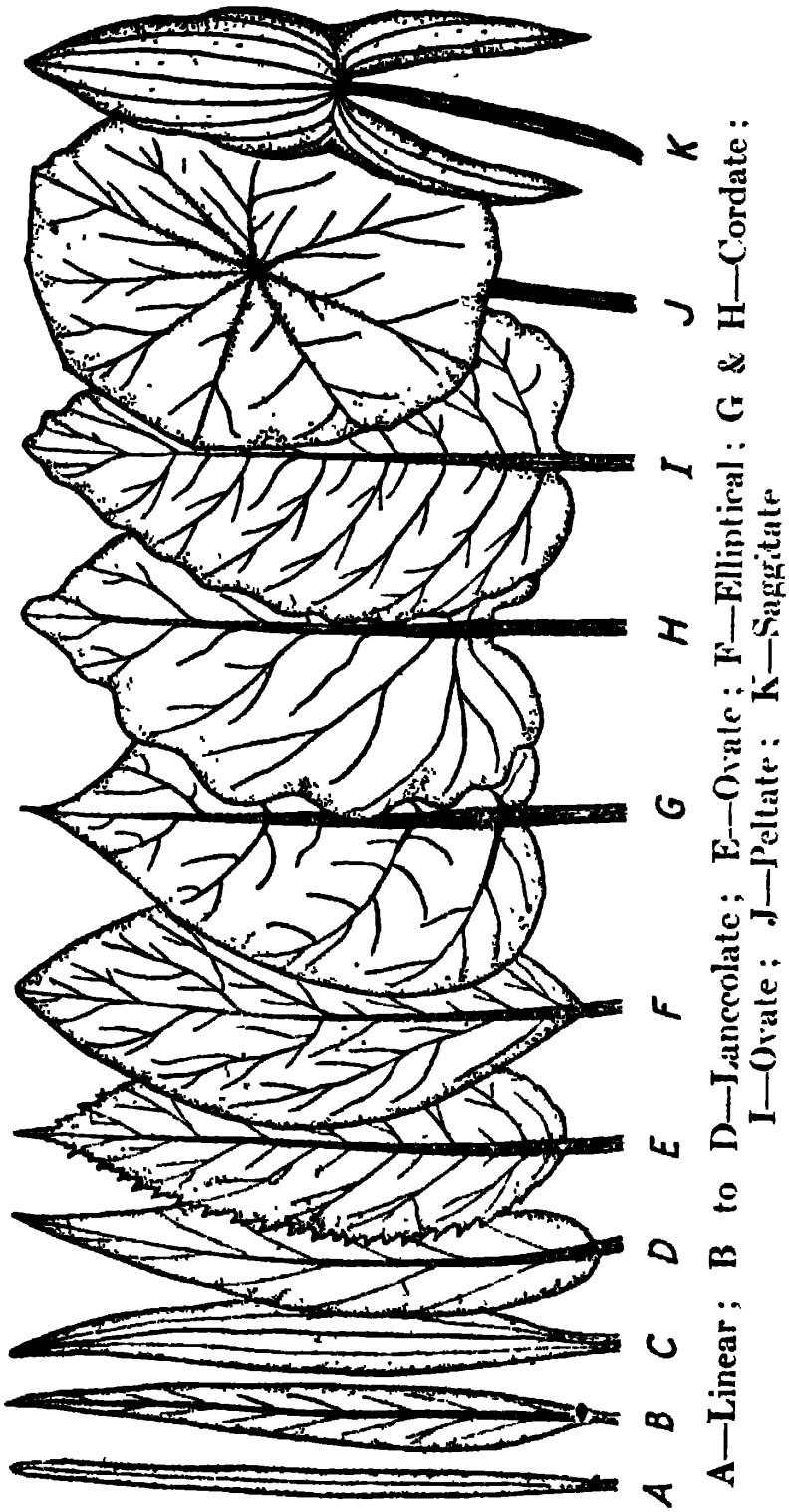


A—Entire ; B to D—Serrate ; E—Dentate ; F—Crenate ; G to J—Pinnatifid to-sect.

The *margin* may be :—

(1) *Entire,* when it has no incision *e.g.* Banyan (Bot).

(2) *Serrate,* when the incisions with their regularity give the margin a sawlike appearance *e.g.* Rose.



A—Linear; B to D—Lanceolate; E—Ovate; F—Elliptical; G & H—Cordate; I—Ovate; J—Peltate; K—Saggitate

(3) *Dentate,* when the margin projects and have toothlike incisions *e.g.* Waterlily.

(4) *Wavy,* when the margin assumes a wave-like appearance *e.g.* Deodar.

The *shape* of the leaves differs from one another and may be one of the following types :—

(1) **Linear,** when the leaf is long and more or less narrow *e.g.* Grass.

(2) **Acicular,** when the leaf is needle shaped *e.g.* Pine.

(3) **Oblong,** when the leaf is more or less rounded *e.g.* Tamarind.

(4) **Lanceolate,** when the leaf is lance—shaped *e.g.* Deodar.

(5) **Cordate,** when the leaf is heart—shaped *e.g.* Piper betle.

(6) **Reniform,** when the leaf is kidney—shaped *e.g.* Hydrocotyl (Thulkuri).

(7) **Orbicular,** when the leaf is more or less circular *e.g.* Lotus (Padma).

(8) **Auriculate,** when the base shows projections *e.g.* Calòtropis (Akanda).

(9) **Ovate** in Banyan, China rose.

(10) **Elliptical** in Nayantara.

(11) **Peltate.**

Simple and **Compound** leaves.

When the blade of the leaf is entire, it is said to be **simple** leaf. When the blade is divided into two or more parts, all articulated to a common axis, the leaf is said to be **compound** leaf. The separate parts of a compound

leaf are called *leaflets*. The leaflets are similar in shape and form to the simple leaves but the axils of the leaflets never bear any bud. Buds are borne at the axil of the compound leaf.

Varieties of Compound Leaves--

They may be (1) **Pinnately** compound. (2) **Palmately** compound. Pinnately compound, when there is a central **rachis** and the leaflets or pinnae are generally borne in an opposite manner *e.g.* Rose. The pinnately compound leaves may be either provided with even number of leaflets *i.e.* the compound leaf has not a terminating leaflet. This is known as Paripinnate type *e.g.* Tamarind. Sometimes the compound leaf instead of bearing even number of leaflets bears odd number of leaflets *i.e.* there is a terminal leaflet *e.g.* Rose. This is known as *Imparipinate* type.

The pinnately compound leaves might be :—

(a) *Once pinnate.*

(*b*) *Twice pinnate* or bipinnate.

(c) *Thrice pinnate* or tripinnate.

(a) Once *pinnate*, when the pinnae are directly borne on the axis *e.g.* Rose.

(b) *Bipinnate*, when the pinnae undergo division of the second order *e.g.* Babla.

(c) *Tripinnate*, when the pinnae further divides into third order *e.g.* Sajina.

2. Palmately compound, when there is no rachis but the leaflets arise from a common point. According to

the number of leaflets a compound leaf of the Palmate type is :—

(1) *Unifoliate,*

(2) *Binnate,*

(3) *Ternate* etc. according as the leaflets number one, two or three etc.

Difference between Simple and Compound Leaves—

1. The blade is *entire* in a simple leaf while the blade undergoes division in a compound leaf.

2. The axil of a simple leaf bears a *bud* while the axil of the leaflets does not bear any bud but the rachis bears a bud.

3. The simple leaf bears *stipules* while the leaflets do not bear the *stipules* but the rachis might bear them.

Distinction between a Branch and a Compound Leaf—

(1) The branch bears buds at the terminal point but the compound leaf does not bear any terminal bud.

(2) The leaves of branches bear buds in the axils but the leaflets of the compound leaves do not bear any bud in the axil.

Prefoliation—

Prefoliation signifies the arrangement of leaves in the bud. It includes the arrangement of individual leaves i.e. how each leaf is arranged by itself and is known as **Ptyxis,** while the arrangement of the leaves with one another in the bud is known as **vernation.**

Ptyxis may be :—

(1) *Plane,* when the leaf is not folded *e.g.* Bakash (Adhatoda),

(2) *Reclinate* or *inflexed,* when the upper part of the leaf is bent down on the lower part,

(3) *Conduplicate,* when the leaf is folded lengthwise along the midrib *e.g.* Magnolia (Champa), Rose,

(4) *Plicate,* when the blade is folded back and forth along the main veins like a closed fan *e.g.* Fan-palm,

(5) *Circinate,* when the leaf is rolled from the tip downward to the base as in ferns,

(6) *Convolute,* when the leaf is rolled lengthwise from side to side, scroll-like *e.g. Plantain-leaf,*

(7) *Involute,* when both edges of the leaf are inrolled lengthwise on the upper surface towards the midrib *e.g.* Lotus, Waterlily,

(8) *Revolute,* when both edges are inrolled on the lower surface *e.g.* Karavi.

Vernation—

This is (1) *Imbricate,* when the leaves in a bud overlap others.

(2) *Valvate,* when the leaves touch only by margins.

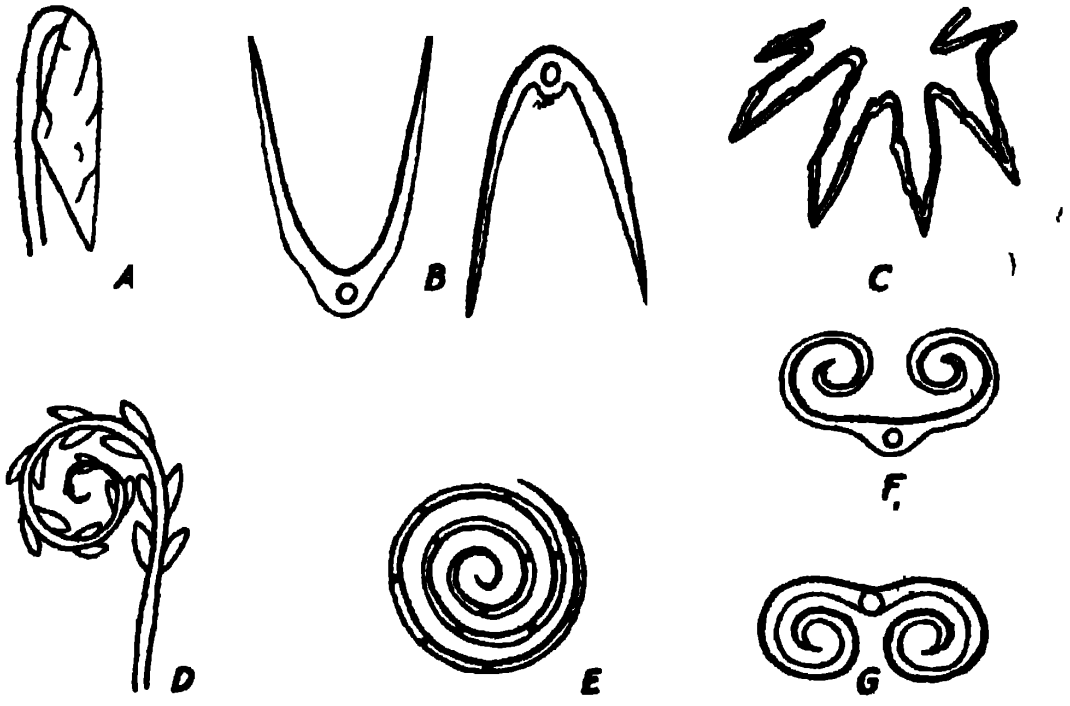
(3) *Twisted,* when one margin is inwards and the other outwards overlapping another inner margin of the leaf.

Phyllotaxis—

Phyllotaxis is the mode of arrangement of leaves on the stem or branches. Phyllotaxis may be

(1) *Opposite,* (2) *Alternate,* (3) *Whorled.*

Leaves are arranged on the stem in various ways in order to expose their surfaces to suitable amount of solar rays and air. If the leaves are congested in a small space, the chances are that the leaves will not be able to get proper nourishment and unhealthy conditions will bring disaster to them.



A=Reclinate; B=Conduplicate; C=Plicate; D=Circinate; F=Involute; E=Convolute; G=Revolute.

(1) *Opposite,* when one leaf finds another opposite to it in a node *e.g.* Tulsi (Ocimum).

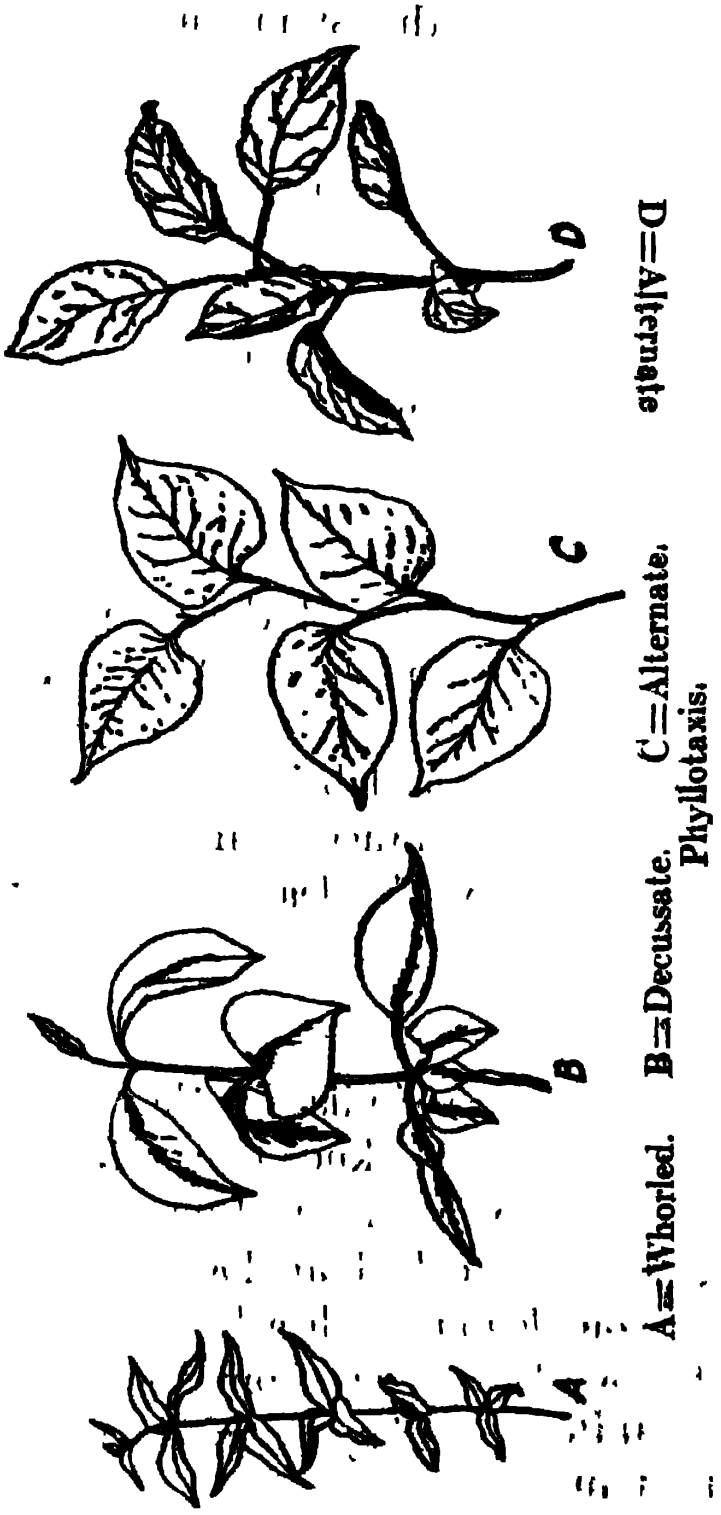
(2) *Alternate,* when one leaf is found in a node *e.g.* Mango, Tobacco, Mustard.

(3) *Whorled,* when more than two leaves arise from a node *e.g.* Karabi, Devil tree (Chhatim).

The alternate arrangement is known as spiral arrangement and several laws govern it,

(1) Leaves are found on different sides of stem,

(2) An imaginary line can be drawn connecting the bases of the leaves which is known as the *genetic spiral.*



(3) If vertical lines be drawn on the stem, the leaves will lie on those lines, the lines are called *orthostichies.*

(4) The distance between any two consecutive leaves along the Genetic spiral, is measured in the fraction of the circumferance of the stem and is called the *lateral divergence,* while the angle subtended by the lateral divergence, is known as Angular divergence. It is measured in degrees. When the number of orthostichies is two, the arrangement is known as Distichous. The divergence is $\frac{1}{2}$ and the angular divergence is $\frac{1}{2}$ of 360° =180° *e.g.* Grasses. When the number of orthostichies is three, the arrangement is called Tristichous, when five Pentastichous and so on.

Leaf-mosaic—

Plants sometimes spread their leaves in the form of a continuous surface and utilise the sunlight to the best advantage. This arrangement is followed to prevent overlapping of leaves and bring the light to the reach of every leaf. The appearance is an adaptation of the plant for mutual welfare of the leaves. *e.g.* Oxalis, Krisnakali etc.

Homology and **Analogy—**

Organs which are similar in their origin but perform different functions are known as *Homologous* organs. Organs which perform similar function but are different morphologically are called analogous organs. The tuber of potato is homologous with a branch. Floral leaves and ordinary foliage leaves are homologous structures. The tuber of potato is analogous with radish because their function is similar.

CHAPTER XV

INFLORESCENCE

It is known that flowers arise from buds which are different from buds giving rise to foliage leaves. The buds are called floral buds. They may be terminal or axillary. A floral bud arises usually from the axil of a leaflike structure called **Bract.** The *Bracts* are generally coloured and much smaller in size than the foliage leaves. Bracts mainly perform the function of attraction and protection. Bracts may be :—

(1) *Coloured,* when they are known as petaloid bracts *e.g.* Baganbilas (Bougainvillea).

(2) *Spathe,* when fleshy and encloses the flowers *e.g.* Plantain.

(3) *Glumes,* much smaller in size *e.g.* Grass.

(4) *Epicalyx,* forms a ring round the base of the flower *e.g.* Jaba.

(5) *Involucre,* when a number of bracts often found round a number of flowers collected together *e.g.* Sunflower.

Inflorescence is a branch system bearing a number of flowers. There are two types of inflorescence :—

(A) **Racemose.** (B) **Cymose.**

Racemose inflorescence is characterised by an indefinite growing point. The oldest flowers are found

towards the base. The youngest flowers are near the apex. The flowers are said to open in acropetal succession. Sometimes the axis of this type of inflorescence becomes greatly shortened and assumes a flat disk-like structure, in such cases the flowers open from the circumference towards the centre. There are several types of Racemose inflorescence.

Racemose inflorescence.

Cymose inflorescence bears a terminal flower *i.e.*, the ultimate growing point is defined by a flower. Here the order of opening of flowers is reversed. The youngest flower is found near the base of the inflorescence and the eldest flower at the apex. In cymose inflorescence, if the

disc becomes flat and the axis of the inflorescence shortend, the flowers open from the centre to the circumference.

Definitions —

When there is a stalk supporting a single flower, the flower is said to be *solitary* and the stalk, is called the **Peduncle.** The stalk of the individual flowers of an inflorescence is called **Pedicel** and the main axis a **Rachis.** If the flower has a pedicel, it is called Pedicillate, if not, *sessile.*

The following types of racemose inflorescence are met with :—

(1) *Raceme,* when the flowers are stalked *e.g.,* Radish, Mustard.

(2) *Spike,* when the flowers are sessile *e.g.,* Rajanigandha.

(3) *Spadix,* when the rachis is fleshy and the inflorescence is covered by a bract often showy called spathe *e.g.,* Mankachu, Plantain.

(4) *Corymb,* when the flowers by different unequal lengths of the stalks come to the same level *e.g.,* Rangan.

(5) *Catkin,* is a spike-like type of inflorescence but the *flowers* are unisexual *e.g.* Berch (Bhuryapatra), Pituli.

(6) *Umbel,* when the rachis is shortened and flowers with equal pedicels spring up from it *e.g.* Onion.

(7) *Capitulum* or Head, when the rachis becomes flat and forms a receptacle and the flowers develop centripetally *i.e.,* the oldest flowers open from the circumference towards the centre *e.g.,* Sunflower.

(8) *Panicle*, when the axis or rachis bears branches. These branches bear pedicelled flowers. This "raceme of racemes" is called a panicle *e.g.* Yucca.

raceme

spike

panicle

corymb

simple umbel

compound umbel

capitulum

monochasium

dichasium

Types of *Cymose* inflorescence.

1. The *cyme*, when the terminal flower opens first and several flowers then open under *e.g.* Jasminum (Juin). The cyme is again divided into several forms according to the number of branches developing below the terminal flower :—

(*a*) If there are two branches, it is called *Dichasium* or Biparous cyme *e.g.*, Teak (Sagoon), Juin or Jasmine.

(*b*) If more than two branches develop it is called *Polychasium e.g.*, Euphorbiaceae.

(*c*) If only one branch develops, it is called *Monochasium*. Monochasium may confine their branching to one side when it is called Helicoid *e.g.* Begonia. If the branching be in alternate form it is known as Sorpioid type *e.g.*, (Heliotropium) Hatisur.

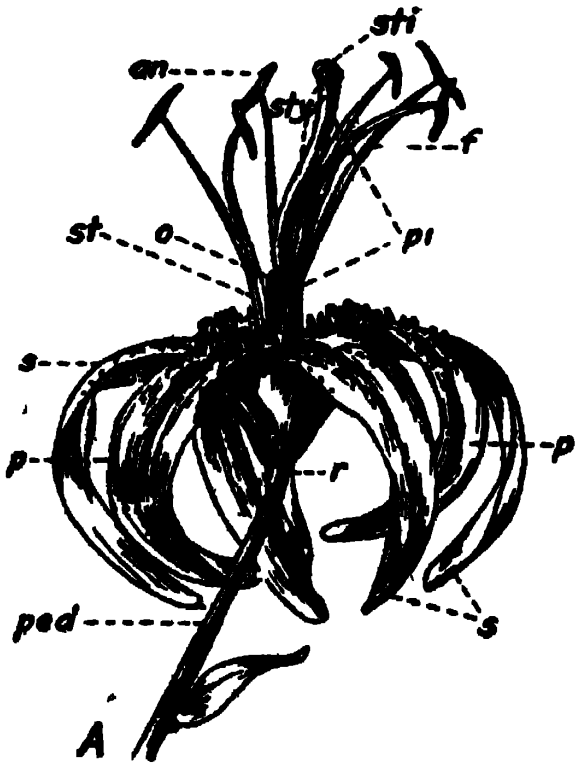
2. Cymose umbel is cymose in form but assumes the form of an umbel *e.g.*, Calotropis (Akanda).

3. *Verticillaster* is a cymose type developing in the axils of opposite leaves *e.g.*, Ocimum sanctum (Tulsi).

Flower—

A flower is a modified shoot specially adapted for reproduction. Priestley and Scott define *flower as a short shoot axis bearing structures associated with reproduction.* The condensed region of the shoot axis in the flower is described as the receptacle. Functional flowers must contain either stamens or carpels or both, but the term flower is used to cover also certain abnormal forms produced under conditions of cultivation, in which

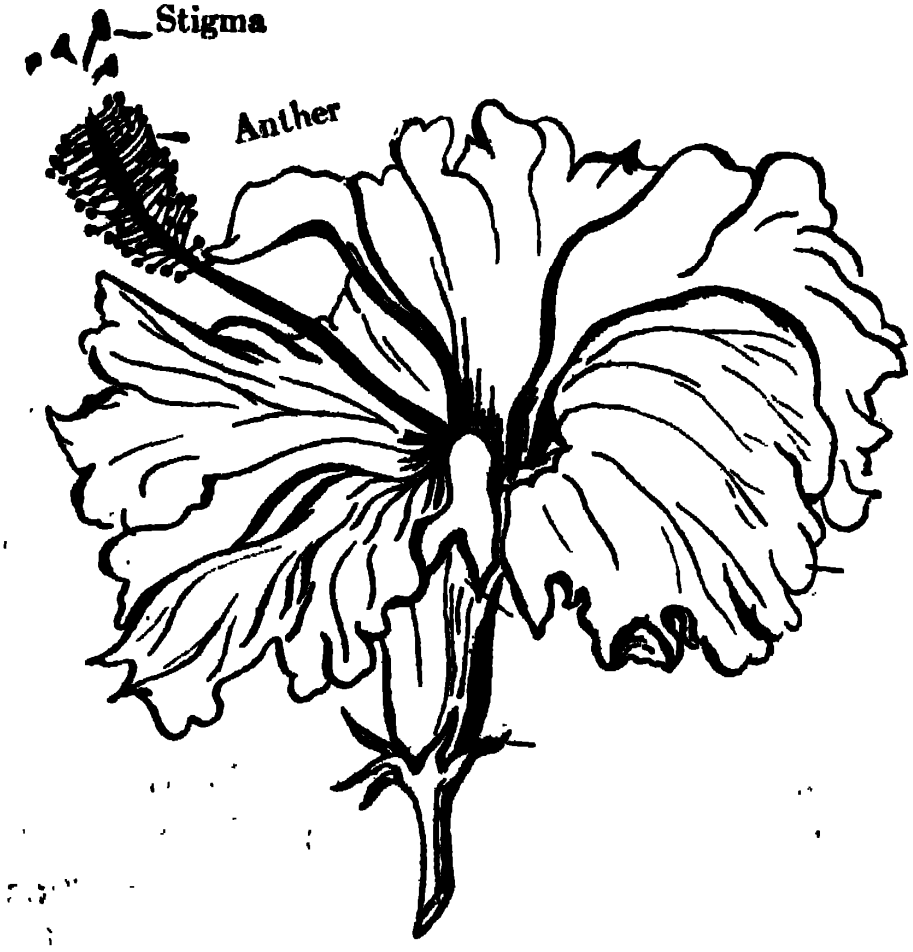
only the inessential parts such as sepals and petals are present and which therefore take no part in reproduction. A flower consists of four whorls *e.g.* **Calyx, Corolla, Andraecium** *and* **Gynoecium.** The individual parts of the first whorl namely the **Calyx,** are the **sepals.** The parts of the second whorl are the **Petals.** The members



Ped=peduncle, R=receptacle, S=sepal, P=patal, an=anther, O=Ovary, Pi=pistil, F=filament. Sti=Stigma, Sty=Style, St=Stamen.

of the third whorl are the **stamens** and the members of fourth or last whorl are the **Carpels.** The pea flower shows all the four whorls. The axis of the flower on which the floral leaves develop is called the **Thalamus.** Sometimes the end of the peduncle or pedicel in enlarged to which other flower parts are attached and is termed the **Receptacle.** The function of the sepals is regarded as *assimilatory* and a subsidiary function is *protec-*

tion to more delicate parts of the flower. The sepals are usually green. The petals serve mainly *to attract agents of pollination* which help the flower in attaining the aim for which it is produced by the plant. The Androecium produces stamens, the **anthers** of which bear **pollengrains** which are suitably placed on the terminal part of the carpel *e.g.*, the stigma when both



China rose

stamens and carpels are mature and produces the seed. The stamens and carpels are the most important parts of a flower. The calyx and corolla may or may not be present in a flower but the presence of the Androecium or Gynoecium either in the same or different flower is essential for the reproduction of the plant, otherwise they

run the risk of being annihilated from the surface of the earth. The calyx and the corolla no doubt serve some purpose but that purpose is not the *essential* one. For this the calyx and corolla are regarded as *Helping* or *Non-essential* whorls, whereas the Androecium and the Gynoecium on account of their immediate and unavoidable necessity to the plant are regarded as *essential whorls* of a flower.

The stamen has a slender stalk called a **filament** and a terminal part called *Anther* which bears the *pollensacs* containing pollengrains. The filament at its terminal part bears a structure called **connective** joining the antherlobes. The carpel consists of a swollen basal part called **ovary** bearing a slender part known as the **style** and the terminal part called the **stigma.** The ovary gets a stimulus on the ovum being fertilised by male gamete produced by pollen-grain and the globular bodies within an ovary known as ovules ultimately form the seeds.

Thus it is found that a flower is a collection of **sporophylls,** either **microsporophylls** or stamens or **megasporophylls** or carpels or both, which are specialised and localised leaves for spore production (microspore or pollen-grain; megaspore or embryosac) and these may or may not he surrounded by accessory sets of floral leaves such as perianth or calyx and corolla. The sporophylls are inserted on a condensed axis called the thalamus and are arranged either in spirals or in whorls. (After Prof. S. N. Banerjee of Calcutta University). In 1676, **Nehemial Grew** first suggested that the stamens and carpels are the male and female organs,

respectively of plants. In 1694, **Camerarius** really discovered sex in plants. 150 years after this, the Swedish botanist, **Carl Linnaeus,** accepted the work of Camerarius and made them the basis of classifying the spermatophyta.

The **flower is regarded as a modified shoot** on account of the following reasons :—

(1) It shows the colour and structure of ordinary foliage leaves in the sepals and petals *e.g.* Water-lily.

(2) The phyllotaxy resembles the ordinary phyllotaxy of leaves. Most flowers show whorled phyllotaxy but spiral arrangement is found in Water-lily, Cactus etc.

Flower of Gynandropsis showing node and internode

(3) Flower buds arise in the axils of bracts.

(4) Nodes and inter-nodes although much suppressed sometimes are distinctly visible *e.g.*, Gynandropsis pentaphylla (Hurhure), Passion-flower (Jhumkolata).

(5) Sometimes the flowering axis after producing the

reproductive organs is continued into a leafy shoot *e.g.*, Pear, Rose.

(6) In some cases as American Aloe, some of the flowers of the inflorescence are modified into leaf-buds called bulbils for vegetative propagation.

Definitions—

When the sepals and petals are not distinguishable from one another, the whorls are known as Perianth. The Monocots usually have a perianth *e.g.*, Tube rose (Rajanigandha). The perianth might have one or more whorls, *e.g.*, Champa (Michelia).

When the four whorls are present in a flower, the flower is said to be **complete.** When one or more of the whorls are absent, the flower is said to be **Incomplete.** When either the Calyx or Corolla is present in a flower, the term **Monochlamydeous** is used *e.g.*, Compositæ.

When both calyx and corolla are present, the flower is said to be **Dichlamydeous** *e.g.*, Rose.

When there is absence of both calyx and corolla, the flower is said to be **Achlamydeous** *e.g.*, Piper betle (Pan).

When both stamens and carpels are present in a flower, it is said to be **Hermaphrodite, bisexual** or **monoclinous.** If either the stamens or carpels are present the flower is said to be **unisexual** or **diclinous.**

Sometimes the flower bears only stamens or carpels, the former is called **Staminate** flower and the latter is known as **Pistillate** flower. The plant is **monoecious** when both staminate and pistillate flowers are borne by

the same plant. The plant is **dioecious** if either kind of flowers is borne by a plant *i.e.*, either male or female. If both unisexual and hermaphrodite flowers occur on the same plant, it is said to be **Polygamous** *e.g.*, Mango.

When the sepals and petals are equal in size in their respective whorls, the flower is **regular.** If the size differs among members of the calyx and corolla in their respective whorls, the flower is **irregular.**

If there is a single plane which divides the flower into two equal halves but not more, the flower is said to be **Zygomorphic.**

If there is an indefinite number of planes which can divide the flower into equal halves, the flower is regarded as **Actinomorphic.** When the flower cannot be divided in any plane without losing symmetry, the flower is said to be **Asymmetrical.**

When the sepals, petals, stamens and carpels agree in their number or any multiple thereof, the flower is said to be **Isomerous.** If the number be two or any multiple thereof, the flower is **dimerous,** if three **trimerous,** if four **tetramerous,** if five **pentamerous** and so on.

When there is no agreement in their number, the flower is known as **Anisomerous.**

Usually the flowers are identified from the number of sepals, petals etc. **Trimerous** nature is seen among Monocotyledons while **pentamerous** form prevails among Dicotyledons. This rule has many exceptions; therefore it should not be much relied upon.

When the flower shows the members to be arranged in the form of whorls, the flower is called **Cyclic** or

whorled, if the members are arranged **spirally** it is known as **Acyclic.** The side facing the stem is known as **Posterior** and the side away from the stem is known as the **Anterior** side of the flower.

Hypogynous. Perigynous and **Epigynous flowers—**

When the ovary is placed at the top of the thalamus and the sepals, petals and stamens arise below it, the flower is **Hypogynous** and the ovary is superior *e.g.*, Lotus, Brinjal, Mustard, Magnolia.

If the sepals, petals and stamens arise round the neck of the ovary, the flower is **Perigynous.** The ovary is here superior *e.g.*, Rose, Pea.

When the sepals, petals and stamens arise from the top of the ovary, the flower is **Epigynous.** The ovary is inferior *e.g.* Sunflower, Guava, Cucumber, Gourd.

Calyx—

The outermost whorl of a flower is known as Calyx. The individual parts of the calyx are known as Sepals. The sepals might be free from one another, when they are known as **Polysepalous.** If the sepals are united to form a tube, they are known as **Gamosepalous.** The number of sepals is made out by counting the number of teeth.

The sepals sometimes fall off as soon as the immediate function is performed, it is then known as **Deciduous.** Sometimes the calyx remains even after the fruit has developed from the flower, it is then known as **Persistent** as in Brinjal, Dillenia (Chalta).

The calyx of the Gamosepalous type may be :—

(1) *Tubular*, when it is tube-like *e.g.*, Datura.

(2) Bell-shaped, when it looks like a bell *e.g.*, China rose (Jaba).

(3) *Hair-like* called Pappus *e.g.*, Sunflower.

Corolla—

The corolla is generally highly coloured *e.g.*, red, yellow, etc., and the individual members are known as **Petals.** Each petal consists of a narrow base known as **Claw,** and a broad upper part known as the **Limb.** The petals when united are known as **Gamopetalous,** while the petals when free are known as **Polypetalous.**

The **polypetalous** corolla may be :—

(1) **Rosaceous,** when the petals have small or no claw *eg.*, Rose, Tea.

(2) **Cruciform,** when four petals are arranged in the form of a cross *e.g.*, Radish, Mustard.

(3) **Papilionaceous,** when the petals are irregular, five in number, and one of which is larger than others. The largest petal is posterior and is called the **Vexillum** or **standard.** The two petals situated at the sides are known as **Alae** or **Wings.** The two petals situated anteriorly form a boat-shaped structure called **Keel** or **Carina** *e.g.*, Pea, Papilionaceae, Bean, Clitoria (Aparajita).

Gamopetalous corolla may be :—

(1) **Tubular,** when the petals form a tube. *e.g.*, florets of Sunflower.

(2) **Campanulate** or Bell-shaped *e.g.*, Swarnòlata, Gooseberry (Tepari).

(3) **Rotate,** if the tube is short but the limbs are spreading *e.g.* Brinjal, Periwinkle (Nayantara), Night jasmine (Shephalika).

(4) **Labiate** or **Bilabiate,** when the petals are irregular and generally form a two-lipped structure *e.g.*, Ocimum (Tulsi), Leonurus (Drone).

Flower with papilionaceous corolla.

(5) **Infundibuliform** or funnel-shaped when the corolla is shaped like a funnel *i.e.*, gradually spreading outwards from a narrow base as in Datura (Thornapple), Water bindweed (Kalmi-sak).

(6) **Personate** or masked where the corolla is two-lipped but the lips almost touch at the throat of the corolla as in Lindenbergia (Basanti).

(7) **Ligulate** or strap-shaped when the corolla is flattened and strap-like as in the ray florets of Sunflower.

Corona—

Sometimes the throat of the corolla shows an outgrowth of scales, lobes or hairs, which are called **Corona** as in Passion-flower, Oleander (Karabi).

CHAPTER XVI

AESTIVATION.

The arrangement of petals and sepals in a flowerbud is called **Aestivation** as compared with Vernation which is an arrangement of foliage leaves in a bud. They may be :—

(1) **Valvate**—when the sepals or petals lie very close but do not overlap as in Custard apple (Ata), Lemon, Artabotrys (Kantali-champa).

(2) **Imbricate**—when the margins overlap each other *e.g.*, Poppy, Cassia (Kalkasunde).

(3) **Vexillary**—when the vexillum encloses other petals in a papilionaceous corolla *e.g.*, Pea, Bean.

(4) **Twisted**—as in China rose, Cotton.

Andraecium—

The collective name of the stamens is **Andraecium.** The stamens contain within them the **pollen-grains** or **microspores** which ultimately bring about certain drastic changes leading to the production of seed. Each **stamen** has three distinct parts *e.g.*, a fine slender stalk called **Filament,** a knoblike head called **Anther** bearing two lobes. Each lobe contains two **pollensacs** carrying a number of **pollengrains.** The two lobes of the anther are connected by a structure called the **connective.**

The attachment of the filament to anther may be in the following forms :—

(1) **Dorsifixed,** when the filament is attached to the connective at the back of anther *e.g.*, Passion-flower.

(2) **Basifixed.** when the filament is attached at the base of anther *e.g.*, Mustard, Waterlily.

(3) **Versatile,** when the anther freely moves to and fro at the end of the filament *e.g.*, Grass, Spider Lily (Crinum).

(4) **Adnate,** when the filament runs from the base to the apex of the anther *e.g.*, Michelia (Champa).

Definition —

The union of similar parts is known as **cohesion** *e.g.*, stamen with stamen. The union of dissimilar parts is known as ***adhesion*** *e.g.*, petal with stamen.

The stamens are usually free but sometimes they cohere with one another. The stamens may form one bundle when they are called **Monadelphous** *e.g.*, China-rose. If they form two bundles, they are known as **Diadelphous** *e.g.*, Pea. If they form more than two bundles they are called **Polyadelphous** *e.g.*, Orange, Castor oil.

When the cohesion is confined to the anthers, the filaments remaining free, the condition is known as **Syngenesious** *e.g.*, Sunflower.

If there are four free stamens in a flower of which two are long and two are short, they are known as **Didynamous** *e.g.*, Ocimum (Tulsi), Labiatæ.

When the number of stamens is six of which four are long and two are short, they are known as **Tetradynamous** *e.g.*, Mustard, Cruciferæ.

If the stamens adhere to the corolla tube as if they arise from the petals, they are known as **epipetalous** *e.g.*, Datura. If the stamens unite with the pistil, it is **gynandrous** *e.g.*, Calotropis (Akanda).

When the anthers are ripe, the pollengrains come out by bursting the anther in various ways :—

(1) By valves *e.g.*, Tejpat, Cinnamon.

(2) By pores *e.g.*, Brinjal, Potato.

(3) Longitudinally *e.g.*, Shoeflower, Datura.

Gynoecium or **pistil** —

The gynoecium or pistil is the collective name of the last whorl of a flower. The pistil may be composed of a single carpel or a number of carpels. The pistil has got three parts, a more or less swollen basal part called the **Ovary,** a tube-like middle part called the **Style** and a sticky upper part called **Stigma.** The female cell is situated inside a globular body called **Ovule** attached to the ovary. There may be a single ovule inside an ovary or a number of ovules. The pollen-grain comes to lie on the stigma and then it passes by means of a tube to the ovule. Inside the ovule, we get the female cell called **Oosphere** or **Ovum.**

When the ovary is composed of a single carpellary leaf *i.e.*, when the margins of a carpellary leaf unite to form the ovary, it is known as **Monocarpellary.** The margins unite to form the **ventral suture** and the corres-

ponding midrib forms the **dorsal suture.** The chamber is called the **Loculus** or **cell.**

If there is a single carpel and the ovary is formed by the margins uniting to form a chamber, it is called **Apocarpous** (single) gynoecium. If the carpels remain separate in a multicarpellary ovary, it is known as **Apocarpous** (Multiple) gynoecium *e.g.*, Rose, Lotus.

When the carpels instead of remaining separate unite to form a single structure, it is known as **Syncarpous** as China rose.

The syncarpous ovary may be composed of two, three, four etc., and are accordingly termed **bicarpellary, tricarpellary** etc. If the carpels unite by their margins, then the central chamber is single but the margins might project inside the chamber to divide it into two, three etc. **loculi.**

Placentation —

The ovules remain attached inside the ovary by a **special tissue** which is known as **Placenta.** The arrangement of the placenta is known as **Placentation.**

It may be :—

(1) **Parietal,** when the ovary is syncarpous (two or more carpels) and the ovules arise from the united carpellary margins *e.g.*, Gourd, Mustard, Poppy, Papaw.

(2) **Marginal,** when the ovules arise from the margins of a monocarpellary ovary *e.g.*, Pea, Bean.

(3) **Axile,** when the margins inside a syncarpous ovary approach the central axis dividing the ovary into

several chambers and then the ovules appear to develop from the central axis. Such placentation is called Axile *e.g.*, Lemon, Orange, China rose (Jaba), Potato.

(4) **Free-central,** when the partitions in a syncarpous ovary disappear and the ovules arise from the central column *e.g.*, Pink flower.

(5) **Basal,** when there is a single erect basal ovule arising from the terminal point of the thalamus *e.g.*, Sunflower.

(6) **Superficial,** when the placentæ develop all round the inner surface of ovary *e.g.*, Water-lily.

Forms of ovules —

The study of the forms of ovules may be preceded by a brief description of the structure. The stalk of the ovule is known as the **funicle. Hilum** is the point of attachment of the stalk of the ovule. The tissue which is found inside the ovule is known as **Nucellus** and the covering of the ovule is in the form of two **integuments.** There is an opening at the apex of the ovule which is called the **micropyle.** At the base of the nucellus and the integuments, the structure which is not clearly distinguishable is known as the **chalaza.** There is a large structure embedded in the nucellus towards the micropylar end called the **Embryo-sac.** The embryo-sac gradually develops by division of the nucleus—8 nuclei which collect cytoplasm and form 7 naked cells. Towards micropyle, three cells are found called the **egg-apparatus;** one of which is the female gemete called the **ovum** or **oosphere** (egg-cell) and the other two are the **synergidae** or helping cells. Three cells lie opposite the

micropyle called the **antipodal** cells. In the middle of the embryo-sac, the remaining two nuclei fuse to form the **Secondary nucleus.**

Ovules may be :—

(1) **Atropous** or **Orthotropous,** when the micropyle, funicle and the chalaza, all lie in the same straight line *e.g.*, Pine, Betel (Pan).

(2) **Anatropous,** the funicle runs parallel with the inverted ovule *i.e.*, the chalaza and the micropyle lie in the same straight line and the ovule is situated by the side of the funicle *e.g.*, Bean.

(3) **Campylotropous,** if the ovule curves and the micropyle and the chalaza are not placed in the same line *e.g.*, Krisnakali, Mustard.

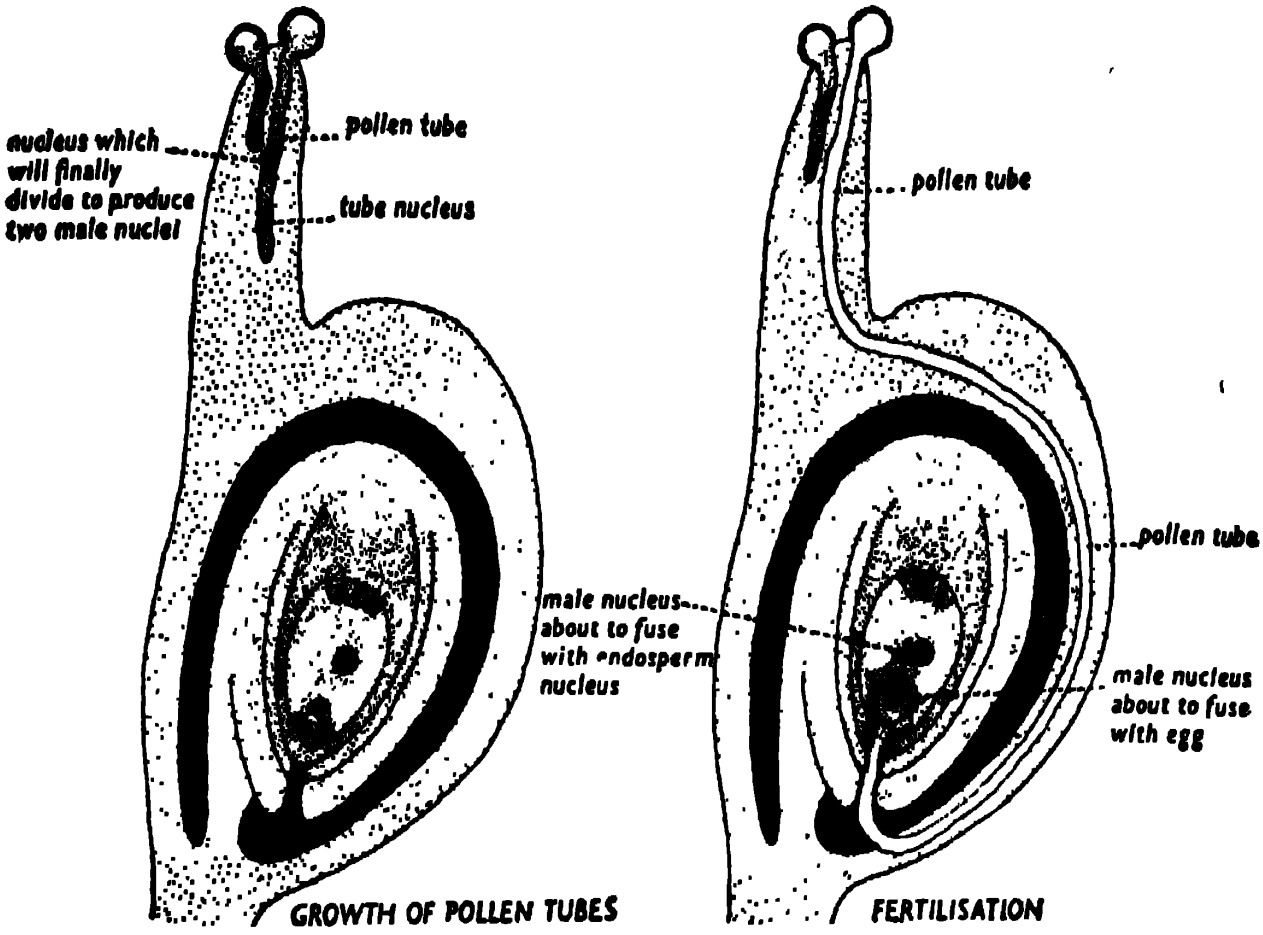
(4) **Amphitropous,** when the ovule is at right angles to the funicle and the chalaza and the micropyle lie in the same line *e g.*, Poppy.

Pollination and Fertilization -

The transfer of the mature pollen-grains from the anther to the surface of the stigma is known as **pollination.**

Pollination is effected by various ways. Pollination is essential for a flower because the production of seed is dependent on this transfer. The pollen-grain when transferred to the stigma sends out a tube which carries within it, the **male cell** to fuse with the **female cell** lying within the ovule.

When the pollen-grain of the same flower is pollinating the stigma, the process is known as **self-pollination.** If the pollen of one flower pollinates the stigma of another flower of the same species, the process is



known as **Cross-pollination.** As the pollination is directly concerned with the production of seed, certain essential changes proceed in the interval. The male cell unites with the female cell and this process of union is known as **fertilization.**

Self-pollination and Cross-pollination —

There are advantages and disadvantages in both the processes. In self-pollination, the characters of the identical flower are perpetuated *i.e.*, the same conditions

are available for the plant. The advantage is that the chance is very great for pollination. In cross-pollination the characters of different individuals are available so that the future plants are much more healthy and strong. The disadvantages are that a considerable portion of the material of the plant is spent to make room for adopting contrivances namely colouration of the flower etc. and the chances of pollination become remote. If for any reason, the pollinating agents fail to discharge the pollen on the stigma.

Pollen-grains cannot move by themselves so that in cross-pollination, they have to be carried by different agents namely water, wind, insects, birds etc.

Flowers that are pollinated by insects, are known as **entomophilous** flowers *e.g.*, Shoeflower (Jaba), Lotus.

Flowers which receive the pollen through water are known as **hydrophilous** *e.g.*, Vallisneria.

Flowers which are pollinated through wind are known as **Anemophilous,** *e.g.*, Grass. Flowers that are pollinated by birds are known as **Ornitho-philous** *e.g.*, Silk-cotton tree (Simul).

The next step after the deposit of pollen is fertilization. The union of male cell or gamete with female cell or gamete results in fertilization. The **fertilization** gives a stimulus which is shown by activity of the surrounding parts namely the changes undergone by the ovary. In the higher plants such as Angiosperms, the pollen-grain germinates on the stigma and sends out a tube-like structure carrying within it the male gamete and finally passes through the style to the micropyle of the ovule.

The ovule contains within it the female gamete or oosphere besides other cells which serve as guiding structures. The male gamete unites with the oosphere to form the oospore. The oospore gradually develops into an embryo.

The ovules after fertilization become the seeds enclosed in the case called the fruit. The other structures namely the sepals, petals and stamens generally wither away. Occasionally however, some parts might grow with the fruit.

CHAPTER XVII

FRUIT.

The **Fruit** is derived from the ovary as a result of fertilization of ovule.

The fruit may be formed from the ovary only or other parts of the flower may take part in its formation. There are two kinds of fruits, those that are derived from the ovary only are known as **True fruits** *e.g.*, Mango. Those that are derived from the ovary together with some other parts are known as **False fruits** *e.g.*, Pine-apple, Rose, Dillenia (Chalta).

Sometimes fruits are fleshy. The wall of the fruit is known as **Pericarp.** The pericarp shows different layers and in mango, the pericarp is differentiated into three parts. The uppermost skin-like part is known as **epicarp.** The middle fleshy part is called the **mesocarp.** It is fibrous in cocoanut and forms fleshy edible portion in mango. The hard stone within is known as **endocarp.**

Fruits are classified into three classes :—

(1) **Simple,** (2) **Aggregate** and (3) **Collective** or **Multiple.**

Simple fruit is generally derived from a single ovary with one carpel or from syncarpons multicarpellary ovary.

(2) Aggregate fruit is derived from a single ovary with apocarpous pistil.

(3) Collective fruit is formed from a group of flowers and other parts might grow with the fruit.

Simple fruits —

Simple fruits are divided into two groups :—

(1) *Dry fruits,* in which the pericarp is dry and membranous.

(2) *Succulent fruits,* in which the pericarp is fleshy.

Dry fruits may be :—

(*a*) **Indehiscent,** where the pericarp does not rupture to disperse the seeds.

(*i*) **Achene,** one-seeded and the fruit arises from a superior ovary and the pericarp is membranous *e. g.,* Clematis (Chagalbati), Sunflower.

(*ii*) **Caryopsis,** one-seeded and the fruit arises from a superior ovary but the pericarp and testa are closely attached *e.g.,* Paddy (Dhan), Wheat, Barley, etc.

(*iii*) **Samara,** one or two-seeded; pericarp bearing a wing-like outgrowth *e.g.,* Shorea (Sal), Hiptage (Madhabi-lata).

(*iv*) **Schizocarp,** carpels two or more; united *e.g.,* Carrot.

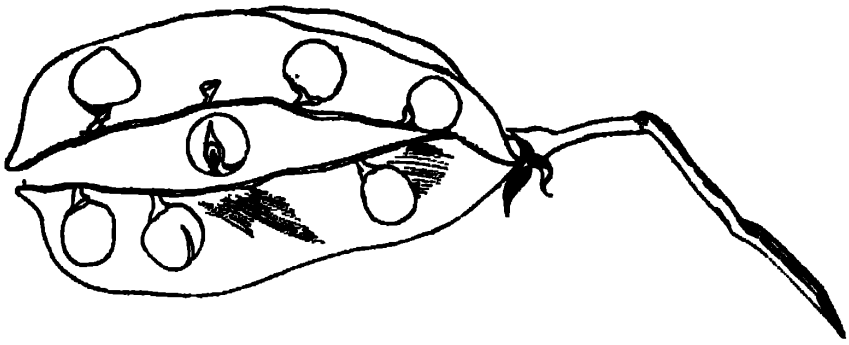
(*v*) **Nut,** a hard, one-seeded fruit, generally from a compound ovary *e.g.,* Oak.

(*b*) **Dehiscent,** when the pericarp bursts down to distribute the seeds.

(*i*) **Follicle,** the fruit consists of a single carpel and the dehiscence takes place along the ventral suture *e.g.,*

Nerium (Karabi), Michelia champaca (Champa), Periwinkle (Nayantara).

(*ii*) **Legume or pod,** the fruit is monocarpellary but dehisces from both ventral and dorsal sutures *e.g.*, Pea, Bean.



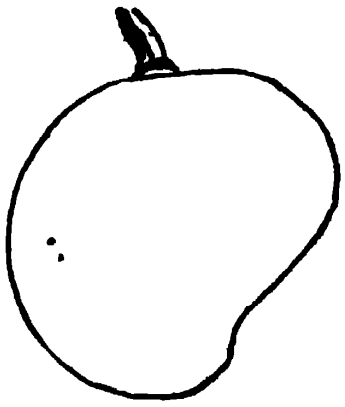
Legume—Pea.

(*iii*) **Capsule,** the fruit is derived from a syncarpous ovary *e.g.*, Cotton, Datura.

(*iv*) **Siliqua,** dry, long, fruit derived from superior bicarpellary ovary. It dehisces from below upwards *e.g.*, Mustard.

Fleshy or Succulent fruits —

Succulent fruits are generally with a pulpy mass and



Drupe—Mango.

differentiated into three more or less distinct layers. They do not dehisce.

(*i*) **Drupe,** the fruit shows a fleshy pericarp having a thin outer epicarp, a succulent mesocarp and a hard endocarp. It is one-seeded and derived from a single carpel *e.g.*, Mango.

(*ii*) **Berry,** the ovary—wall is fleshy and encloses one or more carpels and seeds *e.g.*, Grape, Tomato, Date, Plantain, Brinjal.

Berry—Brinjal

(*a*) **Pepo,** the fruit is a berry with hard rind *e g*, Cucumber, Gourd, Water-melon (Tarmuj).

(*b*) **Hesperidium,** a type of berry with a leathery rind *e.g.*, Orange, Lemon.

(*iii*) **Pome,** it is derived from several carpels; receptacle is fleshy; outer portion of pericarp is fleshy and the inner portion is papery *e.g.*, Pear, Apple.

Aggregate fruits—

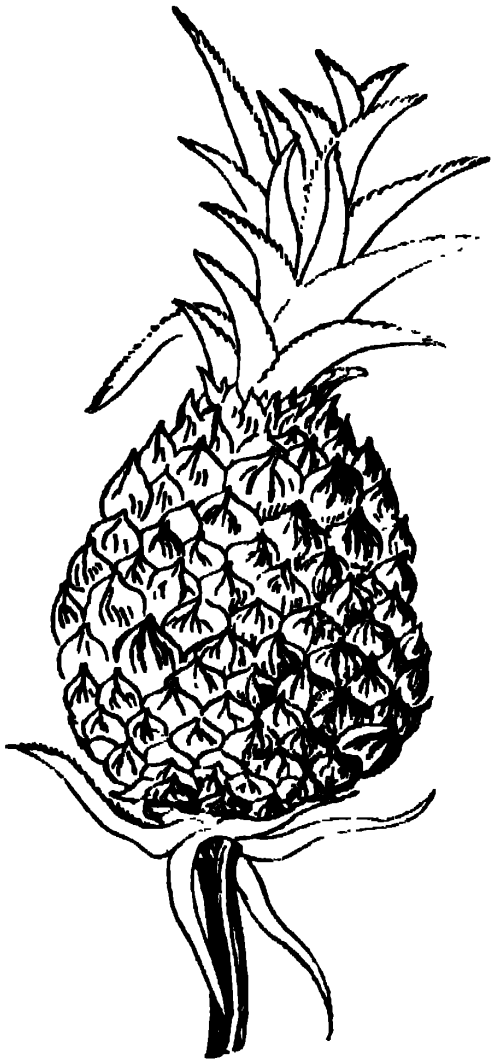
The aggregate fruits are derived from apocarpous pistils. The fruits are so to say collection of simple fruits. The term etaerio is used for them. Thus there may be etaerio of achenes, drupes, follicles; rose, lotus etc.

Collective fruits or Multiple fruits—

Sometimes the whole inflorescence may be converted into a single fruit. It is also called an **Infructescence.**

(*i*) **Sorosis,** the whole inflorescence with the fleshy axis is converted into a single fruit *e.g.*, Jack-fruit (Kantal), Pineapple.

(*ii*) **Syconus,** when the jug-shaped thalamus bearing a number of flowers, is converted into a fruit *e.g.*, Fig, Banyan.



Pineapple—Sorosis

(*iii*) **Cone,** when the scales also take part in the formation of the fruit and looks like a cone *e.g.*, Pine.

Dispersal of fruits and seeds —

The fruits and seeds require that distribution should take place in as far lands as possible. There are various

ways whereby such distribution is helped. Plants distribute their seeds in order to prevent congestion of too many plants in a limited area. The means adopted by plants are :—

(1) *Wind*, (2) *Animals*, (3) *Water* and (4) *Human agency*.

Wind,—the plants which distribute their fruits and seeds through wind either develop wing-like outgrowths or bear pappus or develop hairs. Fruits of Hiptage (Madhabilata) develop wings, the sepals of Shorea (Sal) act as wings in fruits ; seeds of horse-radish (Sajina) have wings.

Animals,—sometimes seeds adhere to animals either through some hook-like structures or they may eat the fruits without digesting the seeds which in the meantime are carried to a distance and when the seeds leave the alimentary canal, are more fit to germinate *e.g.*, Plum, Banyan and Date-palm are distributed in the above manner.

Water,—current of water carries the seeds to long distances and ultimately deposits the seeds to grow on the shore *e.g.*, Cocoanut.

Human agency,—human beings take fancy over certain fruits and carry them to long distances and thus help in the distribution of seeds.

CHAPTER XVIII

HISTOLOGY OR ANATOMY OF PLANTS.

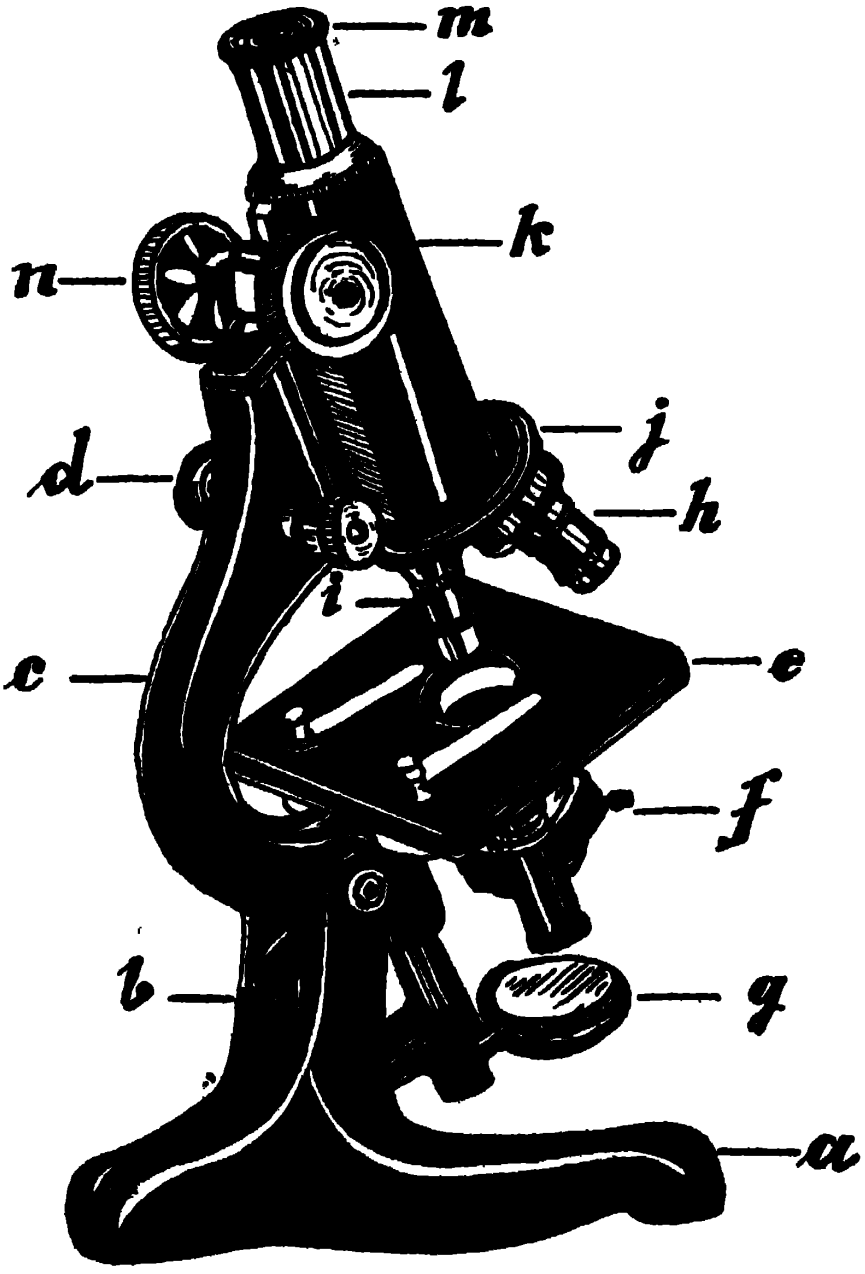
The Vegetable Cell —

The study of plants with the help of a special instrument called **microscope** revealing the minute structure is called **histology.** There are very minute units which group to form the body of a plant. Ordinarily, a thin slice from any part of a plant when placed under the microscope shows that there are brick-like structures which are known as **cells.** Plants may be composed of a single **cell** or a number of cells. Plants like the rose are composed of millions of cells. A single cell might perform all the duties performed by different organs of a highly developed plant like the pea or maize. Protococcus and Pleurococcus are examples of unicellular plants.

Vegetable Cell —

The **cell** of a plant generally shows a definite limiting membrane called **cell-wall** enclosing within it a bit of living matter called **protoplasm.** The protoplasm is a general name which includes all structures found within the cell-wall. There is a highly specialised body called the **nucleus.** The nucleus is generally placed at the centre of a cell. The mass of protoplasm outside the nucleus is known as **cytoplasm.** There are some round bodies in the cytoplasm called **plastids.** According to recent researches, food is stored up inside the cells from the very beginning which may be in the liquid form in special small cavities called **vacuoles.** The vacuoles are

filled with cell sap. The older theory was that vacuoles are formed in old cells as a result of active growth. Some special bodies called mitochondria are found in the



a=foot,
b=pillar,
c=limb.
d=fine adjustment screw,
e=stage,
f=condenser,
g=mirror,
h=objective,
i=objective,
j=nosepiece,
k=body-tube,
l=draw-tube,
m=eye-piece,
n=rough adjustment.

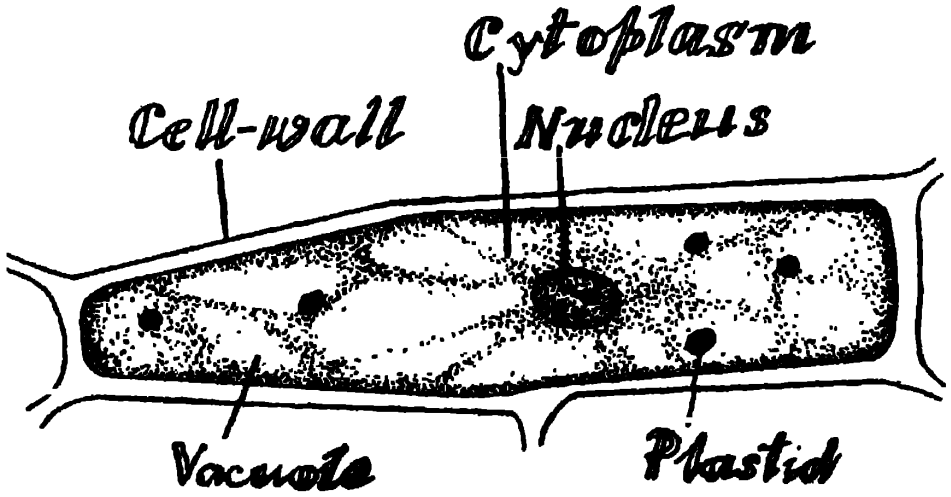
Compound Microscope.

cytoplasm in the form of rods. Special stains reveal a net-like structure of yet another minute body in the cell

called the Golgi-body. The presence of golgi-body has recently been disputed.

Therefofe a **typical plant—cell** has a definite cell-wall, nucleus, cytoplasm, plastids, mitochondria, golgi-body and vacuoles.

Vegetable cell



The cells are regarded as the structural and functional units of the plant-body.

The living cell-contents—

Protoplasm (protos=first; plasma=anything formed. See Chapter II, page 7).

A unit or independent mass of protoplasm as found in a cell, is known as the **Protoplast** and is differentiated into (*a*) **cytoplasm,** (*b*) **nucleus** and (*c*) **plastids.**

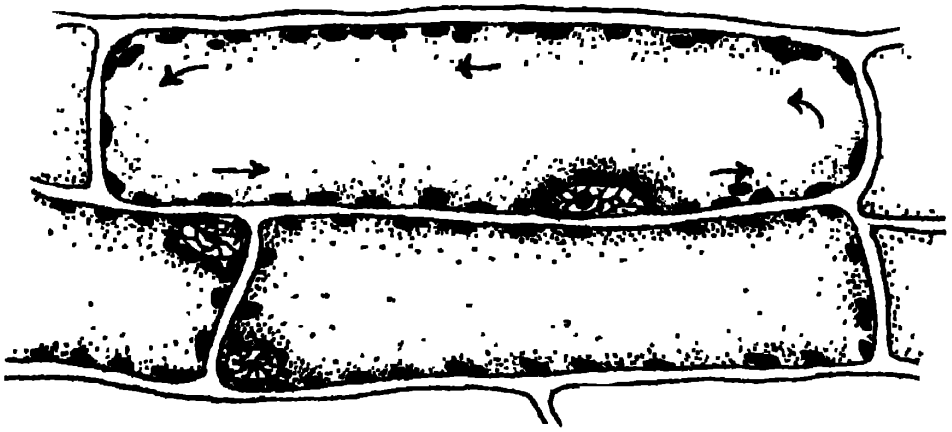
The term protoplasm was used by a human physiologist named Purkinje in 1840 for the granular substance of the animal ovum. In 1844, Von Mohl designated the living substance of the plant-cell as protoplasm. Between 1844 and 1855, the identity of plant protoplasm and animal protoplasm was established.

Plastids—

These are spherical bodies found in the cytoplasm of vegetable cells. They are living structures and are

always formed by division from the pre-existing ones. Plastids are absent in fungi. There are three types of plastids *e.g.*, (1) **Chloroplastid** or **Chloroplast** or green plastid, (2) **Chromoplastid** or **Chromoplast** and (3) **Leucoplastid** or **Leucoplast.**

(1) **Chloroplastid**—These are found in green parts of plants. The green colour called **Chlorophyll** is stored in the plastid and hence the name. It is essential for the purpose of photo-synthesis. Chlorophyll is associated with two other pigments called **Xanthophyll** (yellow) and **Carotin** (orange-red). The movement of cytoplasm is evident from the plastids of Vallisneria leaf. Really the plastids do not move but the medium *e.g.*, cytoplasm is moving.



Rotation

(2) **Chromoplastids** or **chromoplasts**—These bodies are generally found in the coloured parts of plants specially the petals of flowers. They contain various colours *e.g.*, yellow, red etc.

(3) **Leucoplastids** are colourless (white) plastids and are generally found in parts not exposed to light *e.g.*, underground stems and roots. They convert sugar into starch. The plastids are formed from other plastids (division) which were already in the cells.

CHAPTER XIX

NUCLEUS.

The **nucleus** is the highly differentiated structure in a cell. It is more or less round. The nucleus has a wall called nuclear membrane. The central part of the nucleus shows one or more round bodies called **nucleoli.** Its structure is net-like and is called **nuclear reticulum** consisting of threads called linin. The whole structure found within the nucleus is called **nucleoplasm.** In the nucleoplasm, there are empty cavities filled with **nuclear sap** and are called nuclear sap cavities.

Generally, a cell has a single nucleus which is known as uninucleate condition but there are cells which have more than one nucleus which are called multi—nucleate cells. If a nucleus divides and forms several nuclei without developing partition—walls *i.e.*, if a single cell has many nuclei it is called a **coenocyte.** In some reproductive cells, multi—nucleate condition is found.

The composition of nucleus is similar to protoplasm *i.e.*, almost all the elements are found common to both and an additional amount of phosphorus is found in the nucleus.

Function of nucleus—

Nucleus is the most important structure in a cell. It directs all the activities of the cell. Nucleus has got some structures within it, called **chromosomes** which are visible when the cell divides and which are endowed with the property of carrying **hereditory characters.**

Test for nucleus—

· Iodine solution stains nucleus deep brown.

The cell-wall—

Every vegetable cell has a wall composed of a substance called cellulose although there are some cells which are naked *i.e.*, without wall in the reproductive stage of plants. The cell wall is regarded as a non-living structure as opposed to nucleus and cytoplasm which are living structures of a cell. The cell—wall is a secretion of the protoplasm. It is permeable to water. Cell wall has a very important work to do, it preserves the shape of the cell. The cell wall thickens in various ways :—

(*a*) **Apposition**—new particles of cellulose are deposited on the old wall in succession.

(b) **Intussusception**—sometimes particles are deposited inside the old membrane.

(*c*) **Superposition**—when there are layers of cellulose deposit.

Composition of cell-wall—

Cell-wall is composed of a substance called cellulose which belongs to the group of carbohydrates, a near relative of starch. The formula is $(C_6H_{10}O_5)n$. Cellulose is the substance generally forming the wall of all higher plants but there is another substance called **chitin** which forms the cell-wall of plants belonging to the group of Fungi.

Tests for cellulose.

(*a*) Treat a piece of cotton wool which contains cellulose with iodine and sulphuric acid, it swells up and turns blue.

(*b*) Chlor-zinc—iodine gives it a violet colour.

The thickening of the cell-walls takes place not uniformly but generally thin portions are left out for the entry of water and other dissolved substances. The cells become rigid as a result of such thickening and assist the plant to withstand all sorts of pressures *i.e.*, they become mechanical tissues of the plant. The cells lose their protoplasmic contents and are dead.

The cells thus assume various forms and are said to be :—

(*a*) **Annular**—when the thickenings are in the form of rings.

(*b*) **Spiral**—when it assumes the form of a spiral.

(*c*) **Reticulate**—when the thickenings by joining with one other, assume the form of a net.

(*d*) **Scalariform**—when the thickenings assume the forms of a ladder.

(*e*) **Pitted**—when cavities are left by thickenings spread over almost the whole surface.

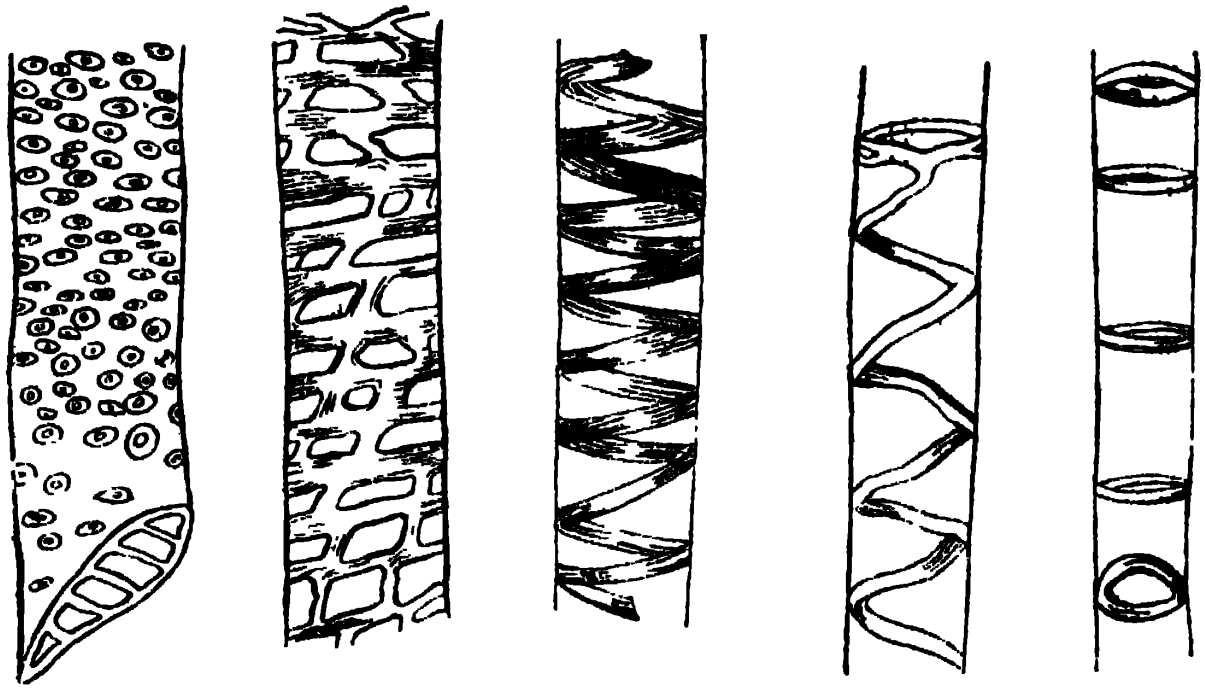
The pits often assume the form of two concentric circles when seen from the surface. A circular area of the wall remains unthickened. Such thickenings are known as **Bordered** pits.

Cell walls are modified from cellulose to serve other purposes which the exigency of situation devolves upon them.

The ordinary modifications are :—

(*a*) **Lignin,** (*b*) **Cutin,** (*c*) **Suberin,** (*d*) **Mucilage,**

Lignin—the cells whose walls have lignin are called lignified. This is hard and elastic. It is the characteristic of wood cells and other strengthening cells of the



Pitted Reticular Spiral Spiral Annular

plant. It is able to absorb water but cannot retain within it, the absorbed water.

Test—It turns brown to yellow with chlor-zinc-iodine.

Cutin—It is found on the outer surface of the epidermis of plants. The cells having cutin are called cuticularised cells. It is slightly permeable to water. It protects the plant from various external factors.

Test—Turns brown with chlor-zinc-iodine.

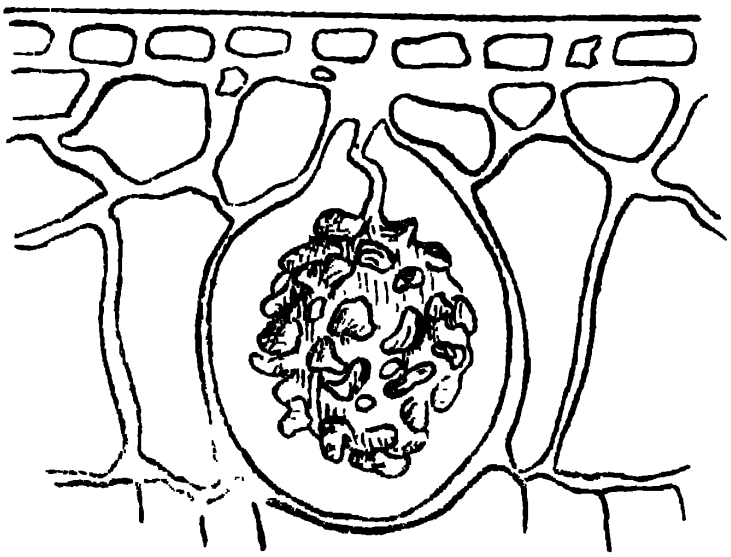
Suberin—it is like cutin but is generally found in the internal structure of plants specially the cork cells. It is not permeable to water.

Mucilage—The cell wall often shows mucilage on it. This is an adaptation to fix the seed to the soil because in seeds of Linseed and Isapgul, the seeds when moistened absorb considerable guantity of water and collect a soapy coating over them.

Test—Turns blue with iodine and sulphuric acid.

Mineral matters—Sometimes mineral deposits of silica and calcium are found on the cells of epidermal tissue which serve to strengthen the tissue and secondly when developed on spiny organs are meant for protection.

Cystolith—These are developed on the walls of certain epidermal cells of the leaves of India-rubber and



Cystolith

Banyan trees. These are projections of the cell wall and not a cell content. It looks like a bunch of grapes hanging from a stalk. It is composed of inorganic crystals of calcium carbonate.

Test—Add a drop of acetic acid to the section; the cystoliths become transparent and dissolve; bubbles of gas being given off. When the carbonate is dissolved, a mass of cellulose is left, showing concentric stratification and radial striation.

CHAPTER XX

DIFFERENT KINDS OF CELLS.

Cells assume different forms due to difference ip growth. When the cells grow at their ends, they are called prosenchymatous cells *i.e.*, more or less long cells.

If the growth is more or less equal in length and breadth *i.e.*, Isodiametric, it is called parenchymatous cell. A parenchymatous cell may be :—(*a*) Round. (*b*) Oblong, (*c*) Polygonal, (*d*) Star-shaped, (*e*) Brick-shaped (*f*) Cylindrical.

Cell Contents—

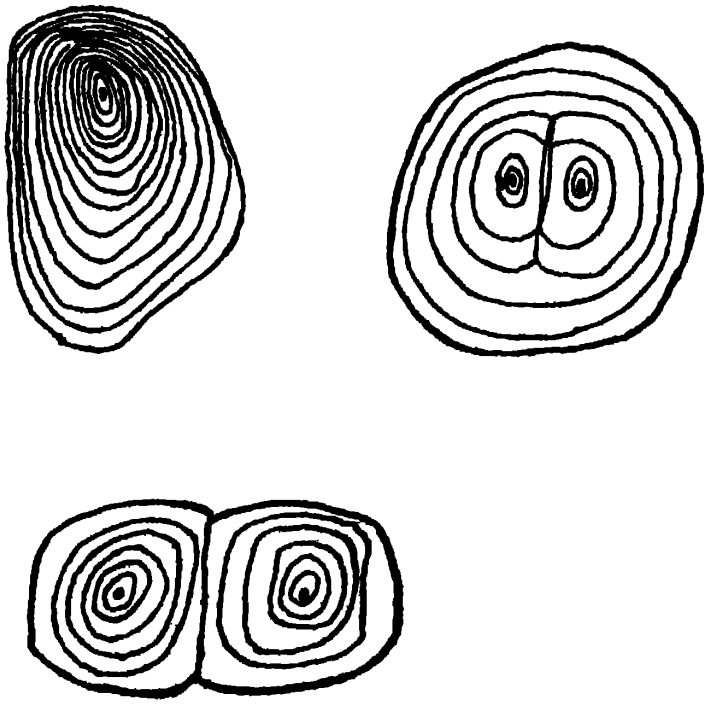
The contents of a cell may be living contents or non-living. The prótoplasm consisting of cytoplasm, nucleus and plastids are the living contents whereas the non-living contents are the various reserve products or secretory or excretory poducts. The reserve .products are meant for the future use of the plants, the secretory products help in some way the life-processes of the plant and the excretory products are the useless products found as the result of metabolic processes.

The reserve products may be starch, sugar, glycogen, cellulose, innulin, proteids, fats and oils.

Starch—is plentifully found in the plant more often in the form of reserve starch. The starch of potato is largely used by human beings. It is a carbohydrate having the formula $C_6H_{10}O_5$. Starch is manufactured

by chloroplasts and leucoplasts. Starch grains manufactured by the former are smaller than those by the latter.

Starch grains have a centre called Hilum and stratificatons are found around it which represent the mode of deposit of fresh material. When the strtifications are in the form of concentric lines round the hilum, the grain is concentric but when pushed at one end, it is excentric; example of the former is pea, and the latter is potato. When the grains are separate, they are called simple, when two or more are found attached, they are called compound but if a few common lines surround the grains, they are called half-compound.



Starch grains

Starch is insoluble in water and cannot be used by the plant unless converted into the soluble form. There is an active agent which converts starch into sugar and

places the food at the disposal of the plant through the intermediation of a starch-splitting enzyme.

Test—Iodine solution turns starch blue.

Sugar—

Sugars are soluble in water and belong to the group of carbohydrates. Forms of cane sugar occur in the stems of sugarcane and in the roots of Beet. Grape sugar occurs in grape and in the fleshy leaves of Onion bulb.

Test—Fehling's solution gives a brick red precipitate with sugar.

Glycogen is starch-like carbohydrate found in Fungi.

Test—Reddish brown with iodine.

Cellulose—is a carbohydrate having the formula $(C_6H_{10}O_5)n$ found plentifully in the seeds of Date, Cocoanut.

Inulin—It is a carbohydrate found in the cell sap as a liquid. Occurs in Sunflower.

Test—with absolute alcohol crystals are formed.

Proteids or Aleurone grains—

These are nitrogenous reserve food materials. The proteid grains are found in the seeds of Pea and Castor oil. In pea, the grains are small whereas in the castor oil seed, they are crystallised and form crystalloids. Crystalloids are proteids and associated with them are globular mineral matters called globoids.

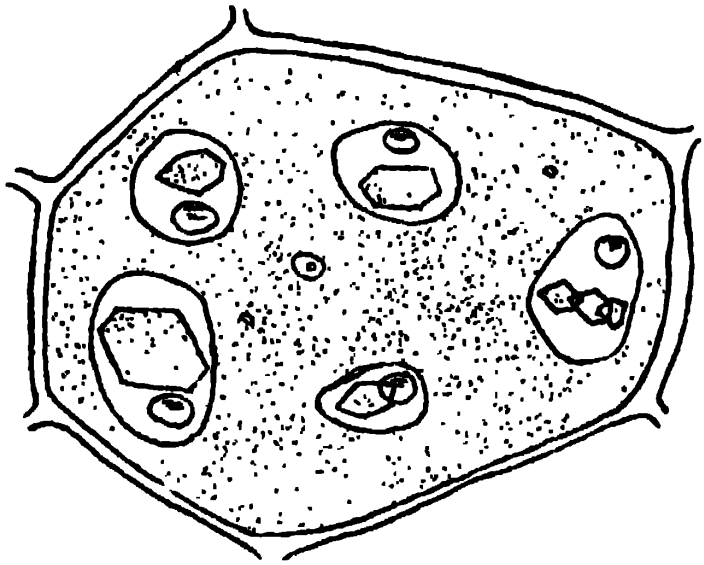
Test—It turns yellow with nitric acid and potash.

Fats and oils—These occur in the form of drops in the seeds of castor-oil, cotton, mustard etc., and in the fruits of olive.

Test—They turn black with 1% Osmic acid.

Secretions—

Various secretions are found in the plant-body. The flowers secrete honey and through glands give out

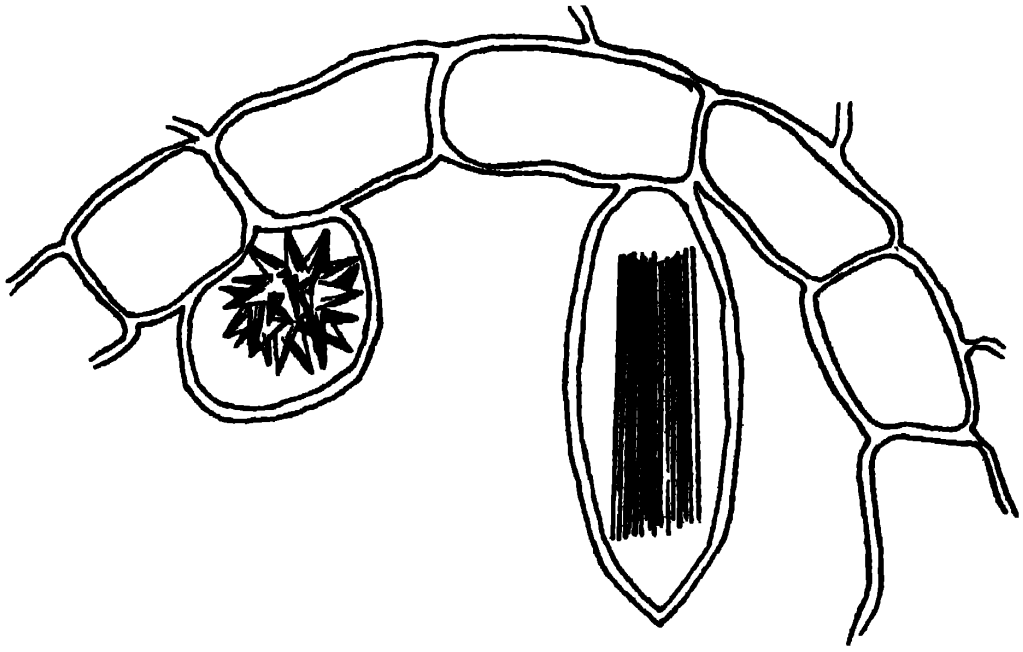


Crystalloid and Globoid

odour to attract pollinating agents. The various colours of plants are also secretory products.

Excretions—These are bye-products of metabolism and occur either in isolated ducts or passages mostly towards the periphery so that with the secondary growth when bark is formed they are eliminated. Sometimes they give protection to plants when they give annoyance to intruding grazing animals in the form of bad smell. Excretion differs from secretion in that the former does not help the plant directly. Examples of excretory substances are resin found in resin glands, tannins or

tannic acid in tamarind, tea, acacia etc., and alkaloids such as morphine in poppy, thein in tea, cocaine in the leaves of Erythroxylon, caffein in coffee and quinine in the bark of cinchona.



Raphides

Latex is found as a milky substance in the stems of Akanda, in Mansa and Banyan etc.

Sometimes mineral matters are found which are inorganic salts of calcium oxalate in the form of **raphides.** When the raphides are needle-shaped, they are called acicular *e.g.*, Kachu (Colocasia), Ol etc. If star-shaped, they are called sphæ-raphides *e.g.*, stem of beet.

Cell Formation—

Plants and animals are generally multicellular. but the cells are formed as a resut of division. Generally

the plant has to begin its life as a unicellular structure just after the union of male and female gametes. The body of the plant or the animal is gradually formed by repeated cell-divisions. Sometimes new cells are formed not by the ordinary method of division but by modification of the structure already present. The commonest method which occurs in the body cells of plants and animals to form new cells is somewhat complicated and is known as **Karyokinesis** or **Mitosis** or **Indirect method** of division. (The term Karyokinesis is now seldom used).

The different methods of cell division are :—

(1) **Direct method** or **Amitosis** or fission or fragmentation. The nucleus elongates after a projection has appeared, and afterwards cytoplasm surrounds each nucleus, a constriction separates the two independent cells *e.g.*, Bacteria, degenerating cells.

(2) **Karyokinesis,** it takes place in the body cells of plants and is divided into four stages. The resting nucleus gradually forms a number of chromosomes. The nucleolus and the nuclear membrane disappear.

In the second stage which is called **Metaphase,** the nuclear spindle is fully formed and the chromosomes which are Vor U-shaped arrange themselves in the equator with their apices directed opposite to one another. The **chromosomes,** in the metaphase longitudinally split. In the third stage, the chromosomes turn their apices towards the poles and travel on the threads of the spindle. This travelling phase of the chromosomes is **Anapase.** The last phase is called the **Telophase.** Here the chromosomes aggregate at the poles and reconstruction of

the nucleus begins, so that from the original cell, two new cells are formed.

In *karyokinesis*, there is longitudinal splitting of the chromosomes, so that each daughter nucleus receives the same amount of nuclear material. The chromosomes are very important structures as they are regarded as the bearers of hereditory characters.

In summary, the fundamental feature of nuclear division (indirect) is an equal division of the chromatin of the nucleus, half of which is passed to each of the two daughter nuclei. Briefly what happens in mitosis is, first the aggregation of the chromatin into recognisable chromosomes, the rod-shaped bodies characteristic of the dividing nucleus. Next, the nuclear membrane disappears and a spindle shaped structure which in most stained preparations seems to be composed of fibrils, appears in the cell. Following the formation of the spindle, the chromosomes arrange themselves at the equator of the spindle, splitting lengthwise just before they assume this position. The fibres of the spindle appear to be attached to the chromosomes. This arrangement of spindle fibres and chromosomes suggests that the two halves of each chromosome are pulled apart (according to others, the halves of chromosomes separate owing to repulsive forces). Finally, these separated halves pass to the opposite poles of the spindle and form the chromatin mass of the new daughter nuclei. A cell-wall forms at the equqator of the spindle, thereby separating the two new nuclei, each of which receives approximately one-half of the cytoplasm.

The condition of the nucleus when not dividing is called the **resting stage** or **interphase** *i.e.*, the phase between divisions. In the order of their sequence the phases are the **prophase, the metaphase,** the **anaphase** and the **telophase.** The **prophase** is the first phase of the division stage of the nucleus. It extends from the first change in the resting stage during which the chromosomes become recognizable entities to the beginning of the **metaphase,** or changing phase, during which the split chromosomes collect at the equator of the spindle. The **anaphase** or going back phase, is characterised by the passage of the separated halves of the chromosomes to the position of the two new nuclei. In the **telophase** or last phase the chromosomes are consolidated into the new nuclei. The activity of the

dividing stage gradually subsides during the telophase and finally appears to cease altogether. At this period of the telophase, the last phase of the dividing stage ends and the nucleus is said to have resumed its resting stage or, as some authors designate it, the interphase.

(3) *Reduction division* or **Meiosis.**

This type of division is confined to reproductive organs of plants and animals. This means that the original number of chromosomes is reduced to half. As a result of union of male and female cells, two nuclei fuse together, if the number of chromosomes is not reduced, then every union means the doubling of chromosomes and ultimately the number would have been infinite so reduction is absolutely necessary before union of cells takes place.

(4) Free cell formation.

In free cell formation, the nucleus divides by Karyokinesis into two, but the partition separating the cells does not appear, instead the daughter nuclei again divide so that a large number of nuclei are formed in one cell. These nuclei collect some cytoplasm with each so that a number of naked cells are formed.

Ex.—formation of endosperm of seeds.

(5) Budding.

In budding an outgrowth appears which in its turn bears another so that a chain is formed.

Ex.—Yeast.

Formation of new cell without division of a pre-existing cell.

(6) Conjugation.

Two similar gametes unite together to form the zygospore. Nucleus fuses with nucleus and cytoplasm

with cytoplasm. The zygospore secretes a wall round itself.

Ex.—Conjugation is found in Mucor, Spirogyra etc.

(7) **Fertilisation,** means the union of male and female gametes *i.e.*, the gametes are dissimilar. As a result of fertilisation, an oospore is formed. The common name both for *oospore* and *zygospore is zygote.* The oospore secretes a wall round it. Fertilisation occurs in the Moss, Fern etc.

(8) **Parthenogenesis,** when the female gamete without fertilisation behaves like a zygospore. The process is called parthenogenesis.

Ex.—Spirogyra.