PRM 201 INTRODUCTION TO FORAGE SCIENCE

COURSE LECTURERS:

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COURSE SYNOPSIS

- **IMPORTANCE OF PASTURE IN ANIMAL AND CROP PRODUCTION SYSTEMS, LEGUMES, GRASSES, BROWSE PLANTS**
- **CLASSIFICATION OF PASTURE GRASSES AND LEGUMES.**
- **ESSENTIAL SOIL NUTRIENTS FOR PASTURE PRODUCTION**
- **TERMINOLOGIES IN PASTURE PRODUCTION.**
- **PROSPECTS IN PASTURE PRODUCTION – TURF MAKING, CONSERVATION, ENGINEERING, BREEDING, PUBLIC AND PRIVATE SECTORS, ETC**

CLASSIFICATION OF PASTURE GRASSES AND LEGUMES.

- GRASSES BELONGS TO FAMILY GRAMINEAE (POACEAE)
- MADE UP OF TWO MAIN PARTS: SHOOT OR TILLERS (AERIAL PARTS) & ROOTS (SUBTERRANEAN PARTS). AT FLOWERING THE REPRODUCTIVE PARTS ARE INCLUDED.
- MONOCOTYLEDONOUS
- THEY ARE HERBACEOUS (NON-WOODY), divergent in size, shape and growth habit, can be annual or perennial in life form.

A. VEGETATIVE ORGANS
1. AERIAL PARTS

- **SHOOTS** CONSISTS OF STEM (CULM, HAULM) AND THE LEAVES.
- **STEMS** ARE CYLINDRICAL OR ROUNDED AND JOINTED I.E MADE UP OF **NODES** SEPARATED BY **INTERNODES**.
- INTERNODES CAN BE HOLLOW (e.g. *Brachiaria mutica)* FILLED WITH WHITE PITH (e.g. *Zea mays, Sorghum vulgare and Hyparrhenia spp.*) or SOLID e.g. *Axonopus scoparius).*
- Stems can be glabrous or pubescent.

Shoots develop from buds found at the nodes and produce side branches.
The basal portion of tufted grasses is called CROWN.
Stolons are creeping stems that grow above the surface of the ground and develop roots and shoots at the nodes. E.g. *Pennisetum clandestinum*, *Cynodon nlemfuensis* and *Digitaria pentzii*.

LEAVES CONSISTS OF THE SHEATH, LIGULE AND THE LEAF BLADE.
LEAF BLADES ARE BORNE ON SHEATHS
LEAVES ARE SITUATED ON STEM IN OPPOSITE ROWS ALTERNATIVELY.

SHEATH: edges are free, have chlorophyll.
Leaf blade can be setaceous (wiry and bristle) or filiform (thread-like)
Leaves could be smooth or rough
Midrib is usually prominent with faint lateral veins

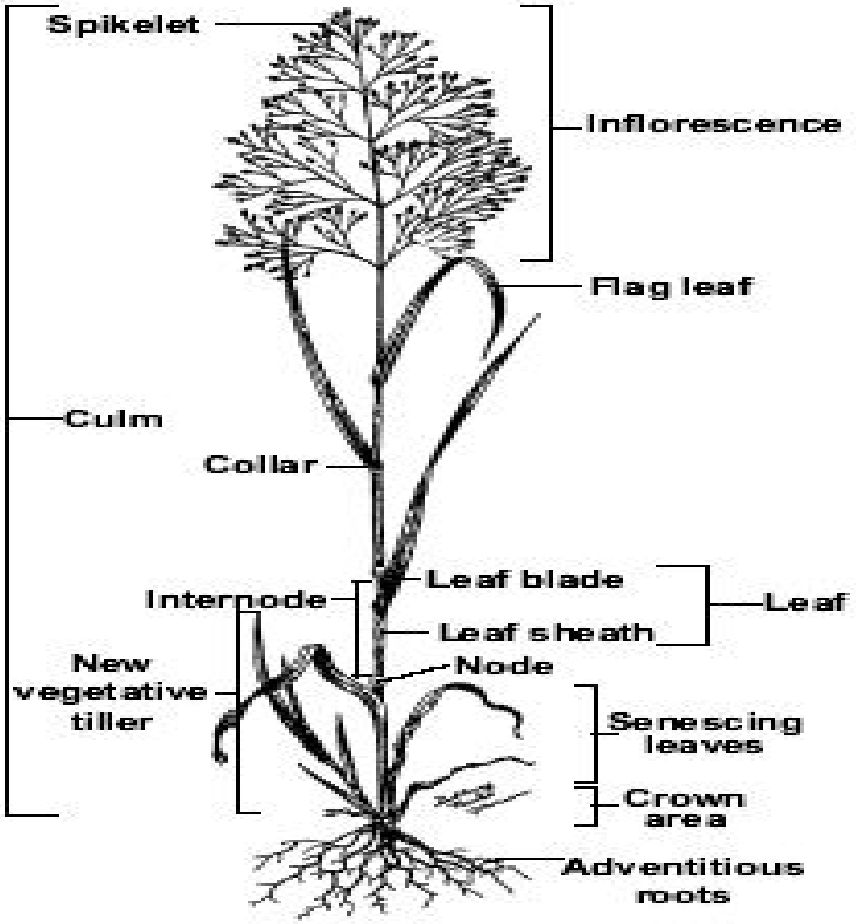
LIGULE is an appendage found at the junction of the leaf blade and the sheath, usually closely ad pressed to the culm. It may be a membrane, a fringe of hairs or a hardened ring & varies in size, shape & texture, can be used for identification.

AURICLES are earlike outgrowths at the leaf base of some spp. They can be prominent and encircle the stem, minute & inconspicuous or absent, no chlorophyll, no function, but use in taxonomic identification.

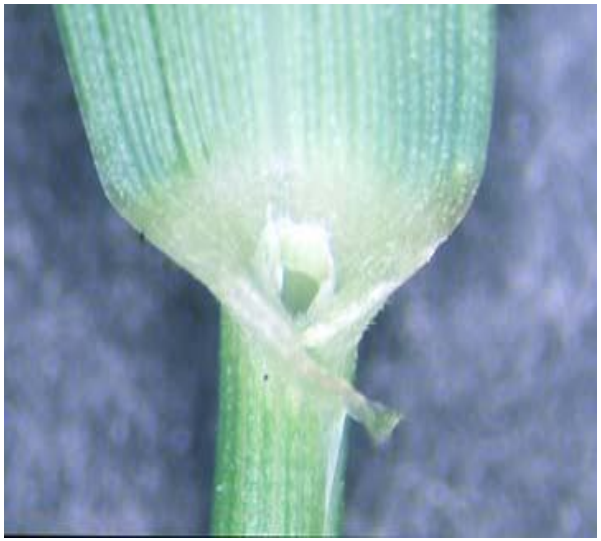
COLLAR: marks the junction of the outer surface (upper region) of the sheath and leaf blade, usually discoloured, leaves breaks at the collar.

PROPHYLLUM: is a two-keeled organ (a reduced leaf) covering the bud in the axil of the sheath.

Grass plant


Spikelet
Inflorescence
Flag leaf
Culm
Collar
Leaf blade
Leaf
Internode
Leaf sheath
New vegetative tiller
Node
Senescing leaves
Crown area
Adventitious roots

Auricles



Present

Blunt

Absent

Ligule

Absent

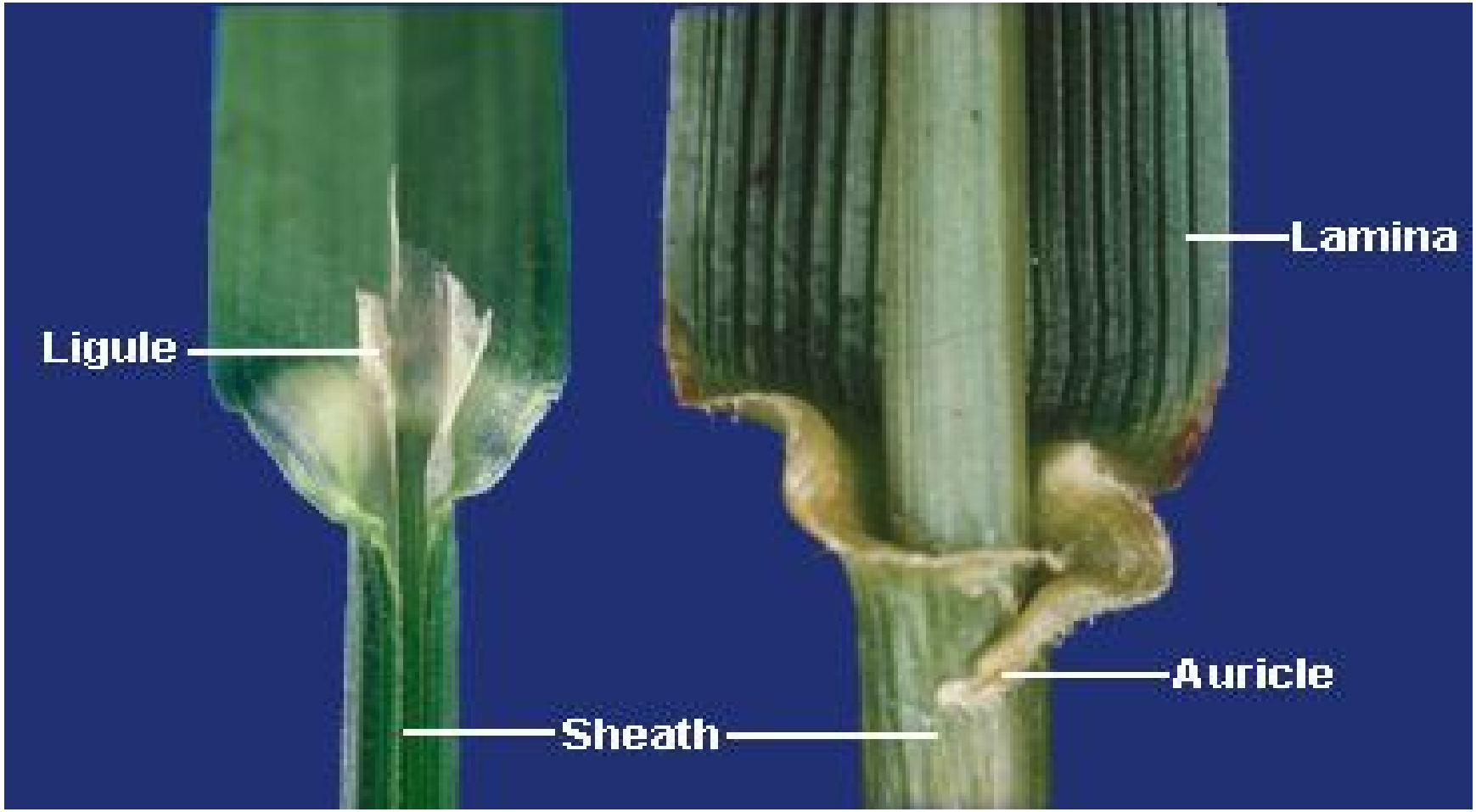
Membranous

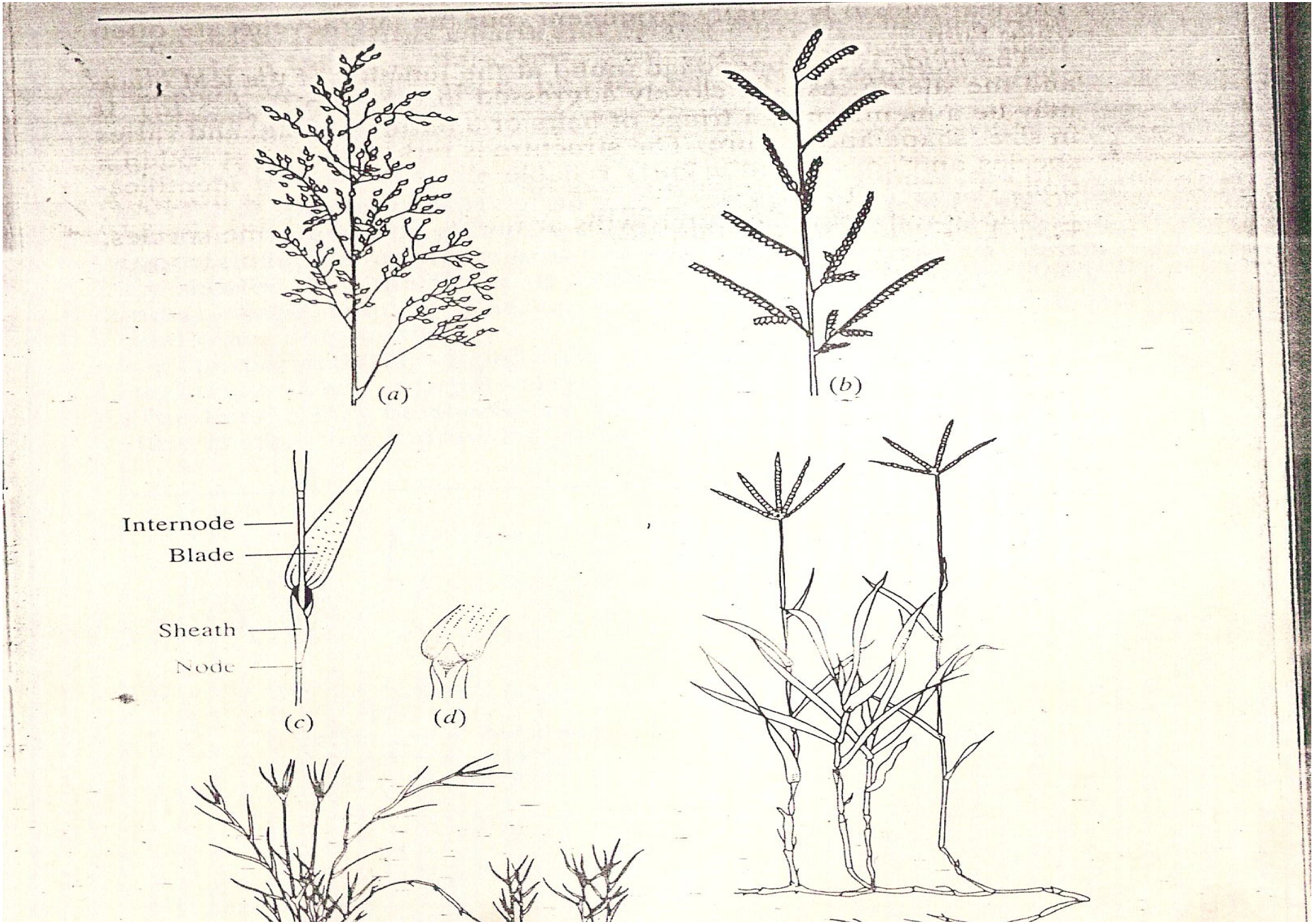
Sheath

- Fused or overlapping

Fused

Overlapping


Lamina
Ligule
Auricle
Sheath


(a)
(b)
Internode
Blade
Sheath
Node
(c)
(d)

2. SUBTERRANEAN PARTS

- **Roots appear 1st from the germinating seed known as the PRIMARY ROOTS.**

- **Can branch and provide seedlings with water & mineral nutrients in the 1st stage of growth.**

- **Replace with secondary roots which can be very numerous, helps retain soil particles to prevent erosion.**

- **SECONDARY OR ADVENTITIOUS ROOTS are those that developed from the nodes of tillers or creeping stems.**

B. REPRODUCTIVE ORGANS

The Floral Organs are MODIFIED SHOOTS, consisting of STAMENS and PISTILS.

INFLORESCENCE: The flowers or inflorescences may be terminal, or axillary. The basic unit of the inflorescence is the SPIKELET, which consists of flowers usually occurring in groups or clusters.

SPIKELET: A typical spikelet consists of an axis (rachilla), two glumes and one to many florets. The perfectly developed floret has a lemma and a palea (lower and upper bracts, respectively) which enclose the flower. The structure of the lemma is such that it provides protection for the seeds and perhaps means of dispersal. The palea is shorter than the lemma and thinner.

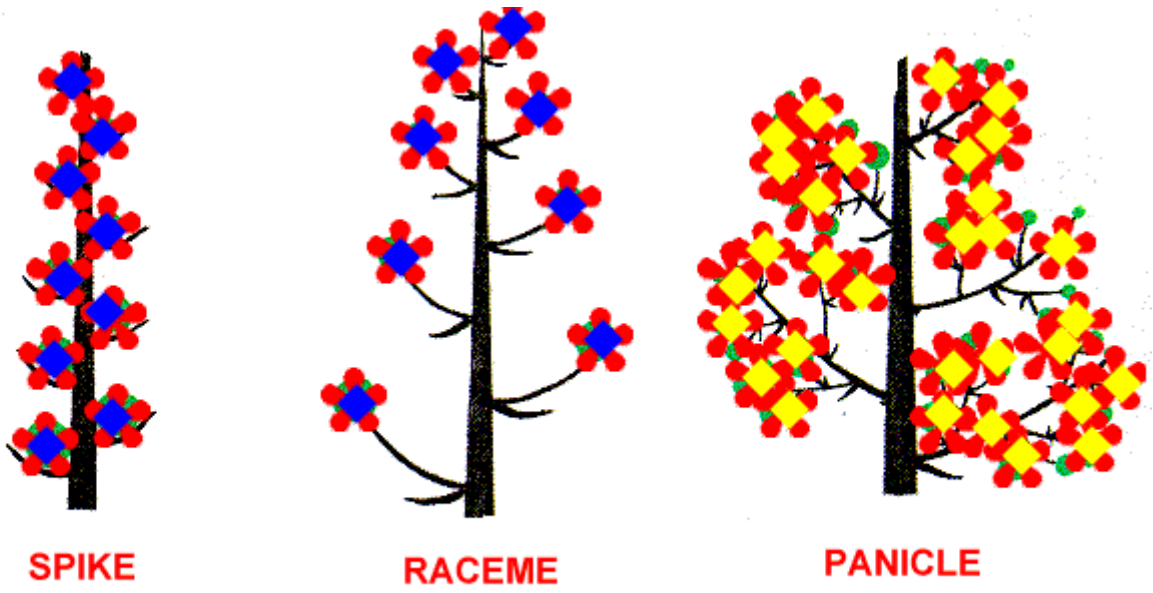
Inflorescence types are classified as:

1.SPIKE: the spikelets are sessile (without stalks) or nearly so, on an UNBRANCHED axis (rachis) eg. Lolium, Triticum, Secale, Hordeum, Agropyron or be ONE-SIDED eg. Ctenium elegans or DIGITATE (finger like) as in Chloris and Cynodon Spp. or RACEMOSE on a central axis as in Dactyloctenium and Leptochloa spp.

2. RACEME: spikelets have pedicels along the axis, eg. Digitaria, Paspalum and Brachiaria spp. Racemes are more frequent than spikes.

3. PANICLE: spikelets have short stalks on a branched inflorescence with a central axis and a number of side branches. The panicle may be open and loose (*Panicum maximum*), contracted (*Sporobolus* and *Sorghum* spp.) or spike-like and dense (*Cenchrus ciliaris and Setaria anceps*) or 'false-spike' when the branches of spike-like panicle are concealed by the spikelets (*Pennisetum purpureum*).

Grass Inflorescence



THE FLOWER

The floral organs consists of the gynoecium (female parts), androecium consists of three or one to six, stamens. Each stamen has a slender filament supporting a two celled slender filament supporting a two-celled anther, which consists of the pollen grains. Anther are coloured yellow, purple reddish or may be mottled.

The lodicules base of the flower, outside the stamens.

The flowers of most grasses are perfect (hermaphrodite) i.e the florets have both stamens and pistils except members of the tribe maydese. Zea mays-male & female separated on the same plant.

ture is such that

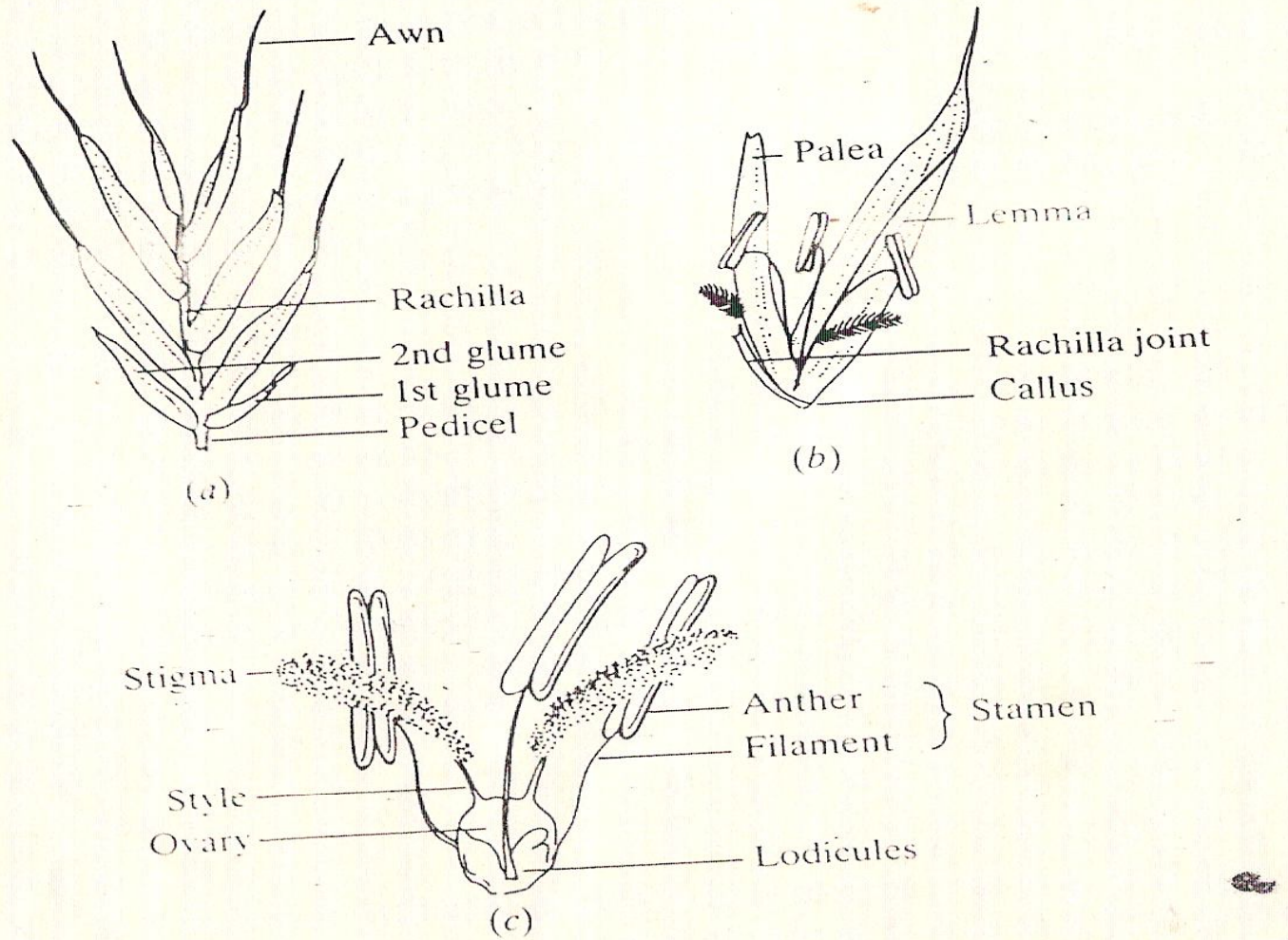


Fig. 3.2 Flowering of the grass plant: (*a*) Spikelet showing arrangement of florets; (*b*) Floret opening at blooming time; (*c*) Typical grass flower showing essential reproductive organs.

Botany of legumes

Legumes are dicotyledonous, i.e. the embryo consists of two cotyledons or seed- leaves).
The legume family is sometimes divided into three groups or subfamilies: 1.Mimosoideae, woody plants and herbs with regular flowers,

2.caesalpinoideae, plants with irregular flowers;

3.papilionaceae, herbaceous and woody plants with a distinctive papilionate or butterfly shaped flower. Most of the forage and economically important legumes belongs to papilionaceae family. Legumes may be annuals, biennials or perennials.

Vegetative organs

Aerial parts

There are distinct morphological differences among the legumes but general characteristics of some plant are similar and rather uniform. The above ground portion consists of a main stem with axillary branches, usually compound leaves, stipules and inflorescences.

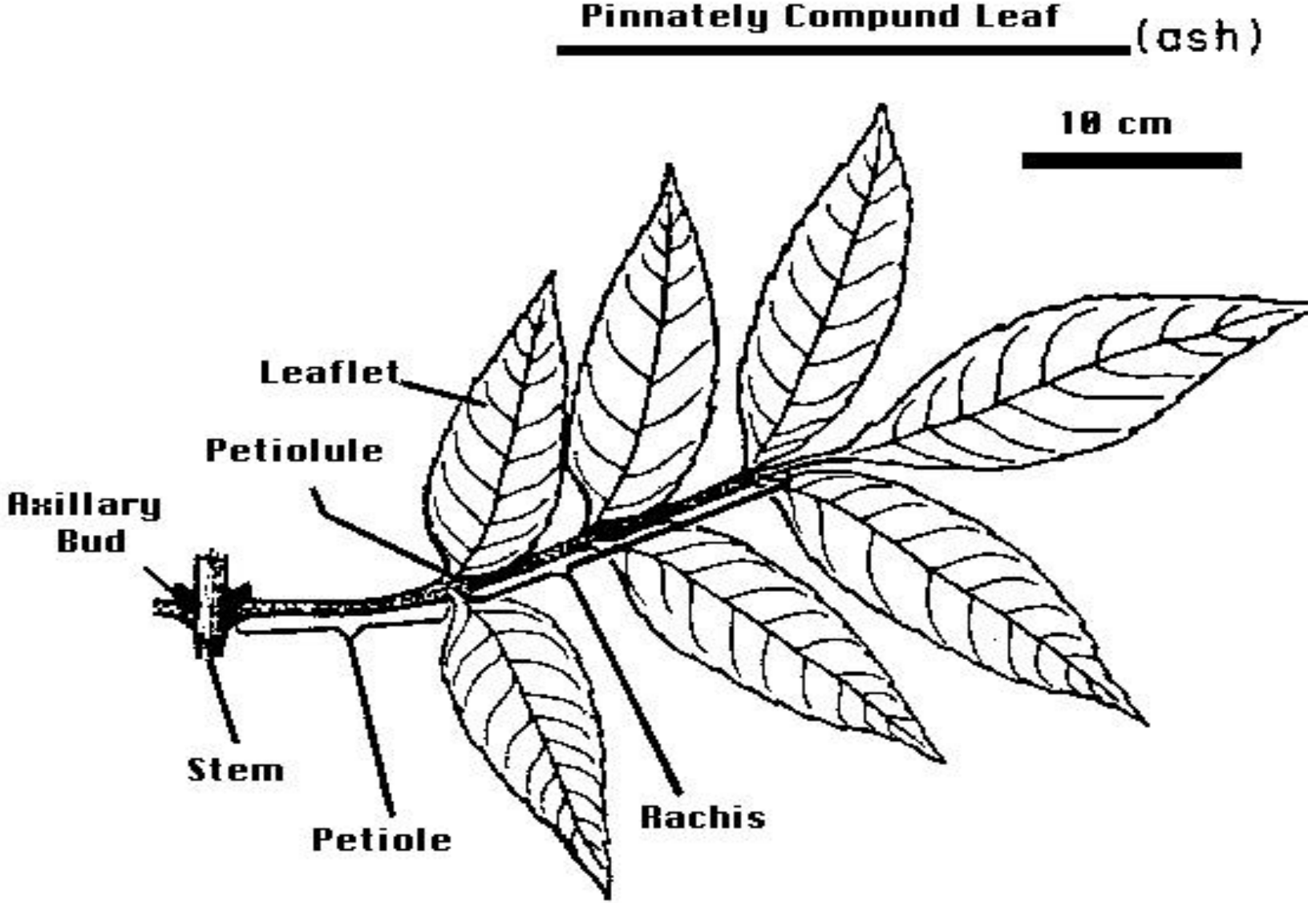
Tillers sometimes arise from the basal portion of the stem (crown) and stems also develop axillary branches. The stems are jointed, with nodes and internodes, and are usually hollow, except at the nodes. They may be covered with hairs or may be glabrous. Herbaceous stems contains chlorophyll.

The leaves contains a common leaf stalk (petiole), with 3 or more leaflets, each with its own stalk (petiolule). The leaves could be 'palmately' compound i.e leaflets directly attached to the end of the petiole e.g. *Centrosema pubescense* or' pinnately'

Compound when the petiole extends into a long slender structure with leaflets e.g *Clitoria ternatea.* Some have leaflets modified to tendrils e,g *Lathyrus spp.* Presence of *pulvinus* is the characteristic feature of legume family.

<u>Stipules</u> are leaf-like outgrowths at base of the main leaf stalk, vary in shape and size and used for identification of species. The leaflets and stipules may be smooth or possess hairs. The veins on the leaves are netted pattern unlike parallel venation of grasses.

Pinnately Compound Leaf	Branch Bearing Simple Leaves
1.It never bears a terminal bud.	It always ends in a terminal bud.
2.It arises from a node.	It develops in the axil of a leaf.
3.Leaflets have no axillary buds.	The leaves borne on a branch have bud in their axil.
4.The rachis of a compound leaf has no nodes and internodes.	The branch bearing simple leaves is always provided with nodes and internodes.
5.Stipules, if present, are seen at the base of the compound leaf, not at base of leaflets.	Stipules, if present, are seen at the base of every leaf.


Pinnately Compound Leaf (ash)
10 cm
Leaflet
Petiolule
Axillary Bud
Stem
Petiole
Rachis

Botanically, the term describes an arrangement of discrete structures (such as leaflets, veins, lobes, branches, or appendages) arising at multiple points along a common axis. For example, once-divided leaf blades having leaflets arranged on both sides of a ''[[rachis]]'' are 'pinnately compound' leaves. Plants with pinnate leaves are sometimes colloquially called "feather-leaved".
'paripinnate': pinnately-compound leaves in which leaflets are born in pairs along the rachis without a single terminal leaflet; also called "even-pinnate".

'imparipinnate': pinnately-compound leaves in which there is a lone terminal leaflet rather than a terminal pair of leaflets; also called "odd-pinnate".

'bipinnate': pinnately compound leaves in which the leaflets are themselves pinnately-compound; also called "twice-pinnate".

'tripinnate': pinnately compound leaves in which the leaflets are themselves bipinnate; also called "thrice-pinnate".

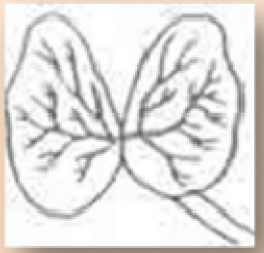
'tetrapinnate': pinnately compound leaves in which the leaflets are themselves tripinnate.

bipinnate

Palmately compound leaves

- Based on the type of leaf blade (lamina) leaves are classified into two types namely simple leaves and compound leaves. All leaflets of a compound leaf are borne on common axis and lack axillary buds in their axils.
- In palmately compound leaf all the leaves are attached at a common point i.e. the tip of petiole. This leaves are into three or more lobes (leaflets) and appears like the fingers from the palm of a hand.

Unifoliate palmately compound leaves

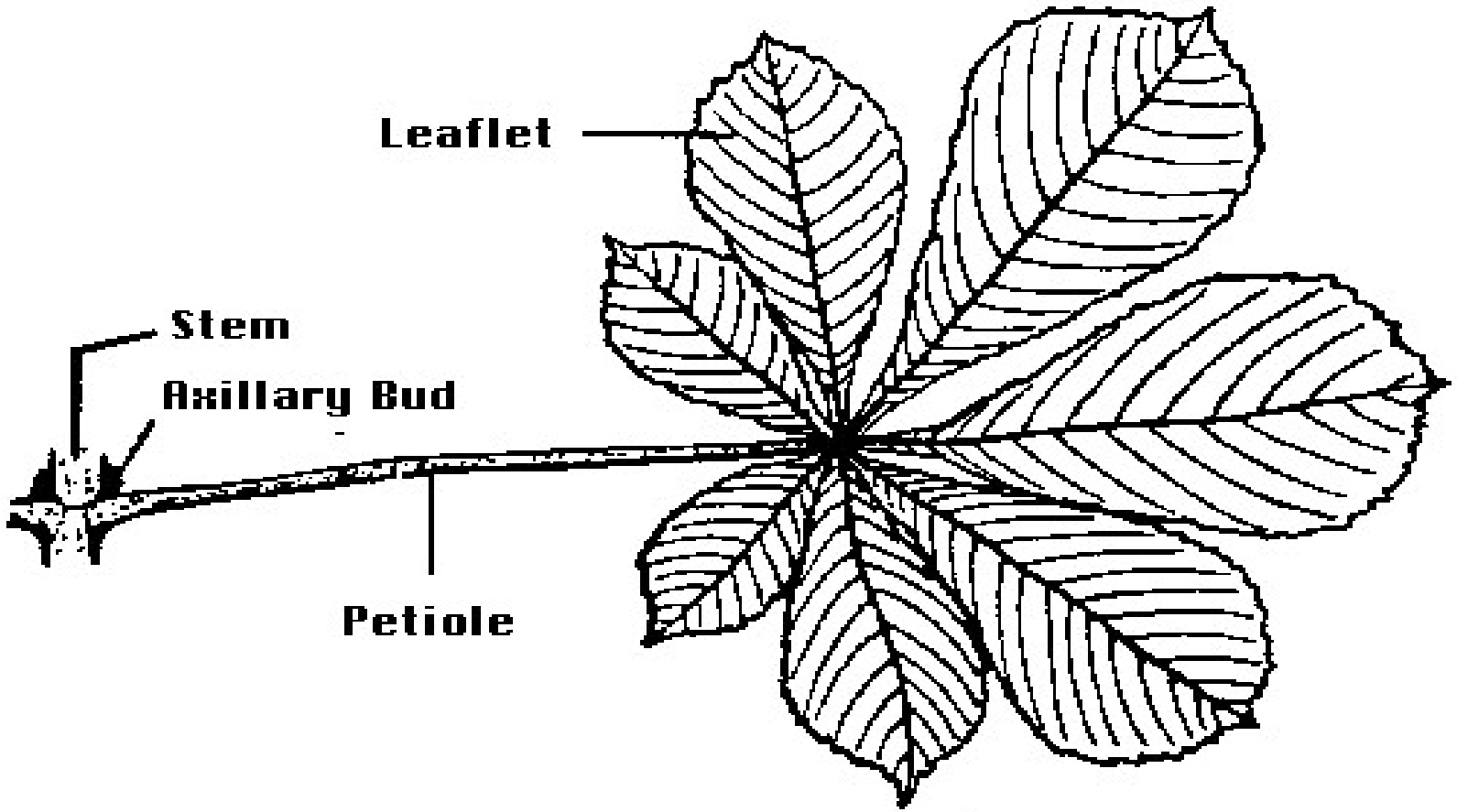


Bifoliate palmately compound leaves

Trifoliate palmate compound leaves

Quadrifoliate palmately compound leaves

Multifoliate palmately compound leaves



Palmately Compoun Leaf (Horsechestnut)

5 cm

Reproductive organs

Inflorescence

The Mimosoideae producer flowers in dense heads or small globular, spike – like inflorescences, and commonly has the floral parts arranged in the sets of four, They are rendered conspicuous by the long, coloured filaments of the numerous stamens. e.g *Leucaena leucocephala* and *Acacia spp.*

The caesalpinoideae flowers appears in clusters or racemes, with overlapping petals .The stamens are usually separated e.g *cassia spp., Ceratonia spp. and Gleditschia.*

The flowers of papilionaceae are arranged in racemes as in *Desmodium spp.* in heads as in T*rifolium spp.* or spike-like racemes as in *Medicago sativa*. There is a central axis, along with the individual flowers develop. Each flower has its own short stalk or peduncle. The inflorescence may be terminal or auxiliary.

The flower

The corolla consists of five petals of three distinct kinds : 'standards' or 'banner' uppermost or outer petal, largest and most showy; two wing petals, with slender stalks called the claw , and an expanded portion; keel, two petals folded together, partially concealed by the wing petals, the expanded portions more or less united at the outer margin into a boat-shaped structure.

The calyx with five teeth forms a tube at the base of the corolla.

The keel encloses the stamens and pistil.The androecium consists of the ten stamens, the filaments of which may be united.
The Staminal tube surrounds a superior ovary, an elongated structure comprising one carpel with one ovule or a single row or several ovules.
A bent style surmounts the ovary and the stylar tip broadens into the stigmatic surface. The nectar resides at the bottom of the corolla tube.

Fruit and Seed

The ripened ovary forms a fruit of variable shape, called legume or pod. Some seeds shatters - dehiscent e.g *Macroptilium atropurpureum* and *Centrosema pubescens* while some are non-dehiscent e.g *Crotolaria* spp.
Pods can the reserve food is stored in the cotyledons.
be glabrous or covered with hairs. Each seeds is enclosed in the testa or seedcoat. Hilum marks place of attachment to the ovary walls. The legume seed has no endosperm.

Subterranean parts

The roots system of most legumes consists principally of an actively growing primary roots and its branches(_secondary). The primary roots may penetrate the soil to a depth of 6-8cm e.g Lucerne. The roots of many leguminous plants become infected by bacteria of the species Rhizobium, Which grows and multiply, forming nodules which differ in size, shape and arrangement on the roots.

Growth habit

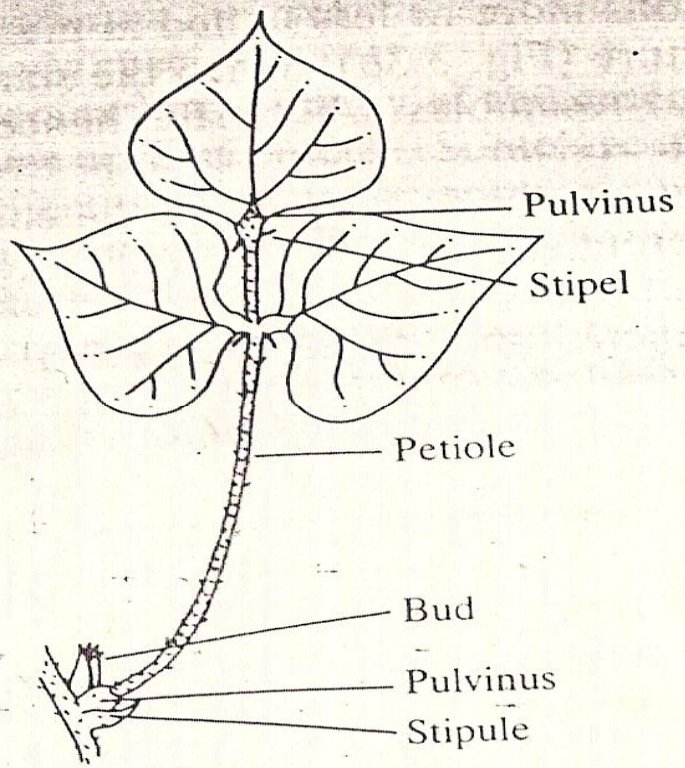
1. **Bush – type – a central stalk with side branches appearing along the main stem and with axillary branches developing *Cajanus cajan*; *Desmodium tortuosum*.**

2. Bunch – type- a single crown from which several stems and new tillers arise, making it difficult to identify a main stems, stems can be erect or decumbents e.g *Stylosanthus guianensis* and *Medicago sativa.*

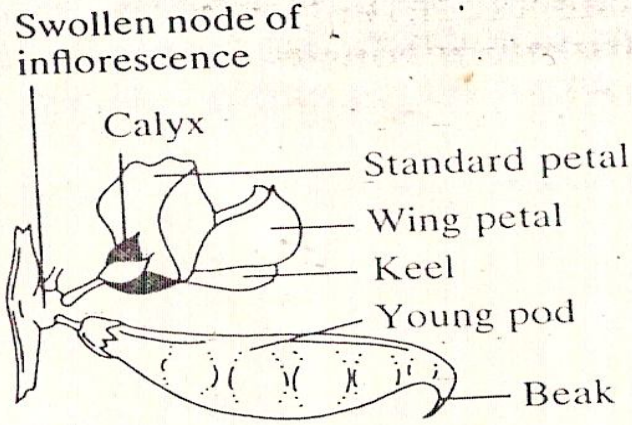
3. Creeping – the stems trail over the ground surface e,g *Calopogonium mucunoides*, *Macroptilium atropurpureum*, some vigna spp.

4. Scrambling – many of the creeping plants climb onto and grow over upright objects. Some are also twining and encircle upright objects e.g *Centrosema pubescens, Pueraria phaseoloides.*

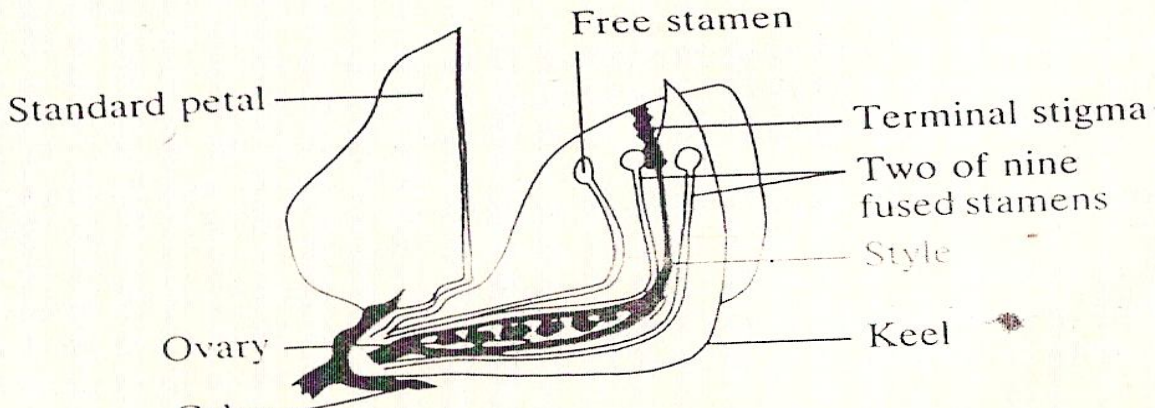
5. Rosette- a vegetative form of some perennials developed after flowering or the onset of cool weather e.g *Medicago sativa* and *Trifolium pratense* at the higher elevations of the tropics.


Pulvinus
Stipel
Petiole
Bud
Pulvinus
Stipule

(*a*)


Swollen node of inflorescence
Calyx
Standard petal
Wing petal
Keel
Young pod
Beak

(*b*)


Free stamen
Standard petal
Terminal stigma
Two of nine fused stamens
Style
Keel
Ovary
Calyx

(*c*)

Classification

Grasses

Graminae (Poaceae) is a large botanical family with about 10,000 spp. grouped into some 650 genera and genera into 50-60 tribes; with sub families of 2 to 12.

3 group are of interest- Festucoid group- temperate grasses; Panicoid group- tropical and subtropical and Chloricoid group- few tropical cultivated and a number of valuable wild grasses the tropical and warmer areas of North American .

Examples of festucoid- Tribes of Triticae (Agropyron spp) Festuceae (Festuca, Dactylis, Lolium, poa) Bromeae (Bromus), Aveneae (Avena,Arrhenetherum) Agrostideae (Agrostis, Alopecurus, Phleum)

Panicoid- Paniceae or mellinidae (*Panicum*, *Brachiaria, Digitaria, Mellinis*, Pennisetum, Cenchrus), Andropogoneae (Andropogon, Hyparrhenia, Sorghum, Lasiurus, Themedia) and Maideae (Zea, Euchlaena, Tripsacum)

Chloridoid- chlorideae (Chloris, Cynodon) and Eragrosteae (Eragrostis, Dactyloctenium, Eleusine)

Legume

Order- Leguminosae (Fabaceae) family is divided into three distinct groups or families- Mimosoideae, Caesalpinoideae, Papilionoideae and subfamilies- Mimosaceae, Caesalpinaceae and Papilionaceae of the botanical order Leguminosae.

Only two spp of mimosoideae are important to us – *Leucaena leucocephala* and *Desmanthus virgatus*, although a number of shrubs and trees are browse plant of Acacia spp.

A number of Caesalpiniodeae are cultivated for fodder and only very few are used as natural browse plants.

Species of Papilionoideae are widely grown as pasture or fodder crops and are of considerable important for natural grazing or browsing.

It is a large subfamily with 200 genera and some 12,000 spp. distributed throughout the world.

Leguminosae in general are of tropical origin with Caesalpinaceae as the most primitive type . 17 tribes of Papilionoideae are recognized .

With important ones as Indigofera, Aeschynomeneae, Sesbanieae, Genisteae, Psoraleae and Trifolieae but majority of legume in cultivation belongs to the tribes – Stylosantheae, Desmodieae and Phaseoleae. The above tribes especially the last three are distributed all over the world, with Desmodieae and Phaseoleae concentrated in Latin American.

ESSENTIAL SOIL NUTRIENTS FOR PASTURE PRODUCTION

- **NITROGEN: Legumes may supply substantial quantities of N to the soil through fixation by symbiotic relationship with rhizobia.**
- **Legumes can absorb nitrogen from that available in the soil.**
- **Nitrogen made available to plants from the soil is derived from applied fertilizer, precipitation and non-symbiotic fixation.**
- **Negative effects of N fertilizer in grass-legume sward**

- Nitrogen is a mobile nutrient.
- PHOSPHORUS: The P requirement of grasses unlike that of N depends more on soil properties than on the grass species.
- P is likely to be limiting factor when grasses are established on land not previously cultivated and fertilized with phosphate.
- P is less mobile in soils than N and K and remains fairly close to the area in which it is placed.

- Molybdenum: It is essential in the formation of nitrate reductase an plays an important role in the symbiotic fixation of nitrogen
- Molybdenum deficiency resembles N starvation and plant symptoms are likely to occur when legumes grow on soils low in available N.
- Potassium: The influence of K on productivity of pasture species or cultivars varies with the requirement of this nutrient for plant growth, ability of plants to extract the nutrient from the soil.

- K Deficiency: a K content of less than 1.0-1.5% in 60 day old grass in an intensive management system will show k deficiency.
- The response of tropical legumes to applied k fertilizers has been variable.
- Sulphur: S deficient soils generally exhibit high allophane or oxides, low in organic matter and often sandy soils may be deficient in S where annual burning occurs.
- Boron: Deficiency not common but was corrected with 25-30kg/ha of borax when noted in lucerne growing on certain soils

- Aluminium: Al toxicity is likely to occur in tropical soils with a pH of 4.5 or less. The effect on plant is largely through root damage with restriction of terminal elongation and branching along with diminished nodulation.
- Manganese toxicity is sometimes compounded with Al toxicity since both ions are progressively released with increasing soil acidity.
- Calcium: Limestone (Caco3) application to pastures in the tropics should be considered as a source of nutrient Ca rather than a soil amendment.

- If lime application is needed for maximum productivity of legumes
- Liming decreased the manganese content of soil and herbage but did not alter P or Mg contents.
- Ca can be transported from lower soil depths to upper layers by roots