LIFE CYCLE OF ANGIOSPERHS (CAPSELLA)

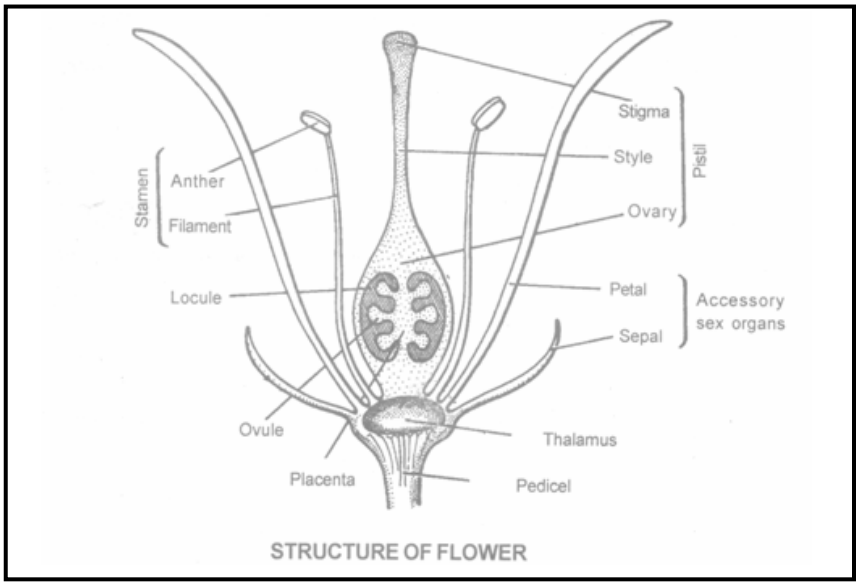
CLASSIFICATION

Class - Dicotyledonae
Subclass – Polypetalae
Series – Thalami florae
Order – Parietales
Family – Cruciferae or Brassicaceae
Genus – **Capsella**
Species – **bursa pastoris** [Common name**" Shepherd's purse"**]

SPECIAL POINTS TO BE REMEMBER

- **Angiosperm** originated in **Mesozoic era.**
- Angiosperm originated either in the beginning of **Cretaceous** period or in ending of **Jurassic period** of **Mesozoic era.** It means they are originated between **Cretaceous** and **Jurassic** period on the earth.
- **Angiosperm** dominated over the earth in Coenozoic era. So this era is known as "Golden Period of Angiosperm".
- First of all N. Grew realized the fact, Stamens are **male sex** organ of flower **(Anatomy of plants)**
- **Sexuality** in plant first of all reported by Jacob Camerarius.
- He reported **Anthers are male sex organ** and **Ovary** with **style and stidma** are **female sex organ,** and for the formation of seed, interaction is essential in between both the sex organs.
- **Significance of pollination** and **role of insects in pollination** was recognized by **Josheph Kolreuter.**
- **C.F. Wolf- Father of plant Embryology.**
- **Prof. P. Maheshwari- Father of Indian plant Embryology.** he wrote a book – **'An Introduction to Embryology of Angiosperm'.**

I. GENERAL INTRODUCTION



STRUCTURE OF FLOWER

Most of the important Angiospermic characters are found in **Capsella** so that for the study of Angiosperms, it is considerd as a "**Typical Angiosperm".**

- It is an **annual** plant and grows as **weed** during the winter season in the field.
- The main plant of the **Capsella** is a sporophyte. Which is **diploid** and it is differentiated into **root, stem and leaves.**
- Capsella is a **heterosporous** plant it means there are two different types of spores are formed in the life cycle which is classified into two categories in which **male spores** are called **Microspores** and **female spores** are called **Megaspores**.
- The process of reproduction takes place in this plant through a special structure, called **flower.**
- **Calyx, Corolla, Androecium** and **Gynoecium** are present in the **typical** or complete flower.
- The **calyx** and **corolla** are termed **accessory whorls** of the flower. Because structures do not participate in the process of reproduction, only helps.
- The **androecium** and **gynoecium** are known as **essential whorls,** because they are directly related with the reproduction.

II. FLOWER IS A MODIFIED SHOOT

According by **Goethe, Flower is modified shoot which shows favourable adaptation for reproduction through a special method.** Flower has a small or long stalk like – structure called pedicel. Free end of the pedicel is flattened or dome shaped is called thalamus. The thalamus is a type of **modified stem,** on which nodes and internodes are present.

- Nodes are present very close to each other and internodes are small highly reduced in the thalamus.
- The whorls present in the flower are **the modifications of leaves** and arranged in four circles on the thalamus.
- The **four nodes** are present on the thalamus, in which first modified leaves are attached on the **first lower** node are called **calyx.**
- The **corolla** born on the **second node. Androecium** are present on **the third node** and **gynoecium** on the **fourth node** in uppermost position
- In some of the plants the length of internode increases which is present in between**Calyx** and **Corolla** is called **Anthophore e.g. Silene plant, Dianthus.**
- The length of internode between the corolla and androecium increases. it is called **androphore** e.g. **Passiflora.**
- If the internode between **androecium and gynoecium** increases then it is called **gynophore**. e.g. **Capparis.**
- Both androphore and gynophore are present in the same flower is called **gynandrophore** or **androgynophore.** e.g. **Gynandropsis pentaphylla** and **Cleome gynandra.**
- **Calyx** is also **modified vegetative leaves.** Such as in **Mussaenda** flower, one sepals of calyx modified into leaf like bright and attractive yellow colour structure called **"Advertising flag".** it helps in pollination.
- In some flowers; thalamus grows inside the ovary is called **carpophore** e.g. **Coriandrum** and **Foenicuium.**
- In **Nymphaea** Petals like stamens are present.
- On the basis of **above examples,** we can prove **"Flower is modified shoot".**

MONOCARPIC PLANTS:

- The plants in which flowering and fruiting takes place only **once** in the **whole life cycle** are called **monocarpic e.g. Annual & Biennial plants.**

POLYCARPIC PLANTS:

- The plants in which **flowering** and **fruiting** takes place **many times** in the entire life cycle are known as **polycarpic e.g. Perennial plant.**

EXCEPTION:

Bamboo, Palms, Banana, Centuary plant (Agave americana) are perennial plants but they are the example of monocarpic plants.

III. REPRODUCTION – IN FLOWERING PLANTS –[EMBRYOLOGY]

"Reproduction is one of the important processes by which every living organism make a copy of itself, it is the means of multiplication and perpetuation of species because the older individual of each species undergo senescence and die"

All the reproductive methods of plants are broadly categorized into two types-

1. **Asexual Reproduction** 2. **Sexual Reproduction**

1.EXUAL REPRODUCTION

In asexual reproduction, the new individual are produced by any means **other than the fusion of sex** gametes. It means a **"reproduction in which new individual are formed without meiotic division and fusion of gametes** is called **asexual reproduction.**" in this way asexual reproduction is also known as apomixes.

[Greek-Apo = without; mixis = mixing] **Apomixis** term suggested by **Winkler.**

The Apomixis is characterised by quick multination and reproduction of genetically similar plants from the single parent. Such a population produced from single individual is called **"clone"** and each member of the clone is called **ramet.**

In flowering plants, there are two main types of **Apomixis.**

(i) **Agamospermy**

(ii) **Vegetative Propagation**

(I) AGAMOSPERMY:

In this type of method **embryo** is formed without fertilization and meiotic division is called **agamospermy.** It means plants belonging in this category propagated through **seeds** but the embryo formation does not involve meiosis and syngamy.

There are **three different type of agamospermy-**

[A] DIPLOSPORY:

In this method **archesporium** differentiates and to form a **megaspore mother cell** but this megaspore mother cell directly gives rise to an embryosac without meiosis. This embryo sac is diploid and a diploid embryo is formed without fertilization from diploid **egg** of this embryosac.

Diplospory is also known as **diploid parthenogenesis.**

Example: Parthenium, Taraxacum

Parthenogenesis: In this process haploid egg cell of female gametophyte is responsible to form a haploid embryo without fertilization.

Apogamy: In this process any haploid cell of female gametophyte except egg cell is responsible to form a haploid embryo without fertilization.

Parthenogenesis and Apogamy both are not included in agamospermy

Note: If both gametophyte and sporophyte are diploid in Parthenogenesis and apogamy then it is called diploid Parthenogenesis and diploid apogamy.

[B] ADVENTIVE EMBRYONY:

in this method, an embryo is formed from any **diploid cells**[Nucellus or integuments] of the ovule except embryosac. This diploid cell behave like a zygote. Adventive embryony derived.

From Nucellus – **Citrus, Mangifera, Opuntia, Mamillaria**

From Integuments – **Spirant us austral is.**

[C] APOSPORY:

It is discovered by **Rosenberg** in **Heiarcium** plant. In this method embryosac or females gametophyte is

directly formed from any diploid cell of the sporophyte except megaspore mother cell without meiosis is known as apospory. In this gametophyte always remains **diploid, e.g. Heiracium, Rannuculus and Rubus.**

POLYEMBRYON

Many embryos are formed inside the single seed is called **polyembryony.** First of all, it is observed by **Leeuwenhoek** in **Citrus (Orange) seeds.** Polyembryony is commonly found in **Gymnosperms** but it is also found in some of Angiospermic plants such as **Orange, Lemon and Nicotiana etc.**
If polyembryony develops **naturally** then it is called **spontaneous polyembryony [self].** While it develops **artificially is called induced polyembryony.**
When many embryos are formed from separate – separate embryosacs [more then one] inside the ovule is called false or pseudo **polyembryony.**
When many embryos are formed inside the single the embryo sac of the seed is called "true poly embryony". It is either develops from:-

(i) **Clevage of Zygote** or **budding** – e.g. **Cymbidium, Exocarpus, Nymphaea, Nicotiana, Orchids** etc.,

(ii) **By the fertilization of synergids –** e.g. , **Anemone, Aristolochia, Sagittaria** etc.

(iii) **Fertilization of antipodal cells –** e.g. **, Paspalum, Ulmus** etc.

Note: In **Lilium** all three types of polyembryony are present.
[Adventive embryony is also example of polyembryony in which additional number of embryos are formed from **nucellus** or **integuments]**

ANDROGENIC HAPLOID PLANTS

This concept was given by Haberlandt and practically proved by Steward. It is based on tot potency.
Anther of the plant grown on culture medium by **Guch** and **Maheshwari.** As a result of this culture, haploid and diploid two different type of plants are formed. **Diploid** plants developed from the **wall of the anther** and **haploid** plants developerd from the **pollen grains.** Such type of **haploid plants** obtained from the tissue culture are known as **androgenic plants.**
Fast vegetative multiplication through the **tissue culture** from any part [cell or tissue] of the plant in the field of **Agro forestry** and **Horticultur**e is called "micro propagation".

(i) **P. Maheshwari** established – **Research centre of Angiosperm Embryology at Delhi University.**

(ii) Book published by **Maheshwari- An Introduction to the Embryology of A ngiosperms.**

(II) VEGETATIVE REPRODUCTION / PROPAGATION

Plants belonging to this category propagate by a part of their body other than a seed. The structural unit that is employed in place of seed for the propagation of new plants is called **propagule**. In **Angiosperms** any parts of the plants – **roots, stems** and **leaves** used for vegetative propagation.
Generally method of vegetative propagation have been further divided into **two types-**

[A] NATURAL VEGETATIVE PROPAGATION

(a) By roots: - Modified tuberous root of **Sweet potato (Ipomoea batatas), Asparagus, Tapioca, Yam, Dahlia** and **Tinospora** can be propagated vegetatively when planted in soil. In some plants adventitious buds develop on the ordinary roots like – **Dalbergia sisso,** Populus, Guava, Murraya, Albizzia lebbek etc. Which grow to form new plants.
The **buds**a present on the **roots** grow into leafy shoot above the ground is called **Slips.**

(b) Under ground Stem :- In some plants under ground modified stem such as – **Rhizomes – Typha ; Canna, Ginger, Turmeric, Lotus, Musa** etc
Corm – Gladiolus, Colocasia, Crocus, Amorphophallus, Alocasia etc.

Bulbs – Onion, Garlic and **Lilies**
Tubers – Potato, Helianthus tuberosus etc. which grow to form a new plants.
Sucker – Mint and **Chrysanthemum ;**

(c) Creepers :
In creeping stem of the plants adventitious root are developed from the nodes the nodes and to form a aerial shoots such as
(i) **Runners – Cynodon, Oxalis** and **Cantella**
(ii) **Stolon = Fragaria** (Strawberry) & **Vallianeria**
(iii) **Offset – Pistia, Eichhornia (water hyacinth)** etc
Aerial stem – Opuntia

(d) Leaves :
Some plants produce adventitious buds on their leaves e.g. , **Bryophyllum, Begonia, Streptocarpus, Saintpaulia.** These buds remains dormant, when the leaves attached with plants but after separation, when it comes in contact with moist develop new plantlets [buds] which from new plants.

☞ In **Kalanchoe,** plant whole portion of **leaf blade** regenerate a **new plant.** in soma of the plants, **fleshy axillary buds** develop from **axis of leaves** are called **Bulbils**
Example – **Dioscorea, Oxalis, Dentaria, Globba, Agave, Liolium.**

☞ There are special type of fleshy buds develop in Aquatic plant are called **Turions.**
e.g. **Potamogeton, Utricularia.**

[B] ARTIFICIAL PROPAGATION:

Gardeners and **Horticulturist** have employed the various method of vegetative propagation for economic production. All the method are man made so that their practices constitute **artificial means of vegetative propagation.** These are as follows-

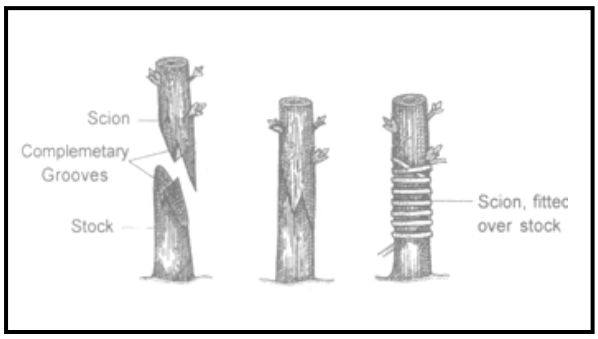
[i] Cutting :- A cutting is separated portion of root, stem or leaf which is used for propagation, Factors are taken into consideration for successful propagation such as (i) age of the parent plant, (ii) length and diameter of the cutting, (iii) season and (iv) type of plants. Some time the stem cuttings are treated with rooting hormone [IBA, IAA or NAA] for proper development of adventitious roots e.g. , **Sugar cane, Rose, Croton, Tapioca,Chiinarose (Stem cutting) Lemon, Tamarind (Root Cutting) etc.**
[Favourable time for cutting – Rainy season]

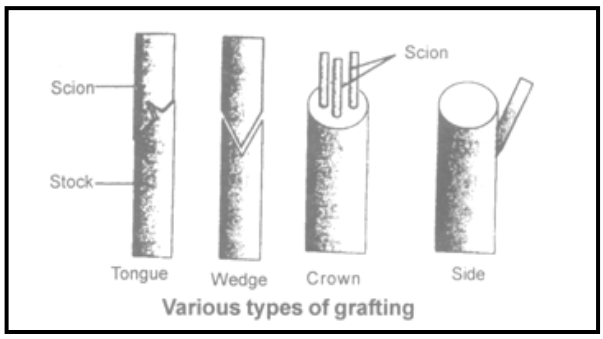
[ii] Grafting :-It is the most common method of vegetative propagation described by ancient gardeners long before the science of horticulture become established. In this method, parts of two plants are joined in such a way that they grow as one plants. Grafting is done between two closely related **dicotyledonous** plants having **vascular cambium.** The **rooted supported portion** of one plant called **Stock** is joined with a **twig of another plant** called **Scion.** Generally, the **root stock** belong to **wild variety** which is resistant to disease & pest. The **scion** is derived from the plant possessing **better characters.** In grafting, the stock and scion cuts are marked in such a oblique manner so that they fix with each other. This joint covered with clay or a laye3r of wax. Within a few days, tissues of stock and scion combined together and to form a new plant . e.g. , **Grafted Mango, Roses, orange, Seedless Grapes and Guava, Apple, Pear.**

Types of Grafting –

(a) **Tongue/ Whip grafting** (b) **Wedge grafting**
(c) **Crown grafting** (d) **Side grafting** (e) **Approach grafting**

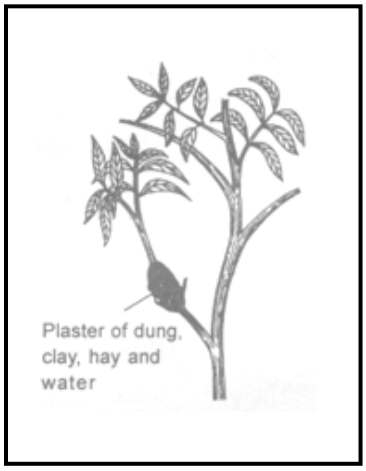
☞ **Bud grafting** – This method is similar to grafting except that scion in this case consist of a bud along with some portion of bark having intact cambium.
Generally bud grafting is done during the **rainy season** e.g. , **Roses, Peach.**





Various types of grafting

[iii] **Layering :-** This method is used in those plants which are having **flexible long branches .** In this method, roots are artificially induced on the stem branches before they are detached from the parent plants for propagation. There are **two** common types of layering.



(a) **Mound/ Ground Layering –** This method is only utilized in **herbaceous** plants. In this method , the lower branch of stem isbent down and partially defoliated and injury is made on defoliated part. It is covered by thin layer of moist in such a way that the growing tip of the branch remains above the soil surface . After a few days the pegged portion develops adventitious roots. Then rooted branch cut and separated from parent and grown into a new plant e.g. **jasmine , strawberry , Raspberry etc.**

(b) **Air Layering or Gootee –** This method is commonly employed in case of **shrubs** and **trees** which do not possess branches near the ground. In this method a **ring of bark** is removed [girdled] from the **aerial branch.** This girdled portion is covered with **moist grafting clay** [2parts clay + 1 part cow dung + some pieces of hay + cotton + water] and wrapped with a polythene sheet. This wrapped portion of the branch is called **gootee.** Inside the gootee roots developed within a period of a or two month (s) e.g. , **Litchi, Pomegranate, Orange, Lemon** and **Bougainvillea , Guava** etc.

According to P. Maheshwari:

Recurrent apomixis → Agamospermy, Vegetative Propagation

Non recurrent apomixis → Parthenogenesis, Apogamy

(a) Merits of Vegetative Propagation:

(i) It is good for the multiplication of seedless plants e.g. **Banana, Sugarcane, pineapple** and **seedless Orange** and **Grape.**

(ii) It is the fastest method of reproduction e.g. , **Potato crop** requires more then One year with the help of seeds, however, it takes only 3 to 4 months with the helpof tubers. Simiar4ly, Lily takes 4 to 7 years through seed, however , 1 to 2 years by bulbs.

(iii) By grafting, desirable quality of fruit / flower/ seed can be obtained.

(iv) **Disease free plants** can be cultured by **microgagation** and **micrografting.**

(v) Plants with long seed dormancy or poor seed viability or poor seed can be propagated vegetatively e.g. , **Cynodon dactylon** (Lawn, Doob or Bermude grass).

(vi) **Good quality** and **better yield varieties** can be **preserved** for a long duration in **offsite collection, herbarium, botanical gardens** etc.

(vii) It gives **100%** genetical similarity to their parents i.e. , **clone.**

(b) Demerits of Vegetative Propagation:

(i) Diseased parents always give diseased clone.

(ii) Clone undergoes degeneration due to the absence of sexual reproduction.

(iii) Vegetative organs can not be preserved for long duration like **culms** of **Sugarcane.**

(iv) Vegetative Propagatory organs or structures cannot be safely and easily stored as comparison to seed. They are easily decomposed and attached by various **pathogens like Bacteria, Virus, Fungi.**

(v) Do not cause any variation in plantlets, thus decrease in the adaptation power.

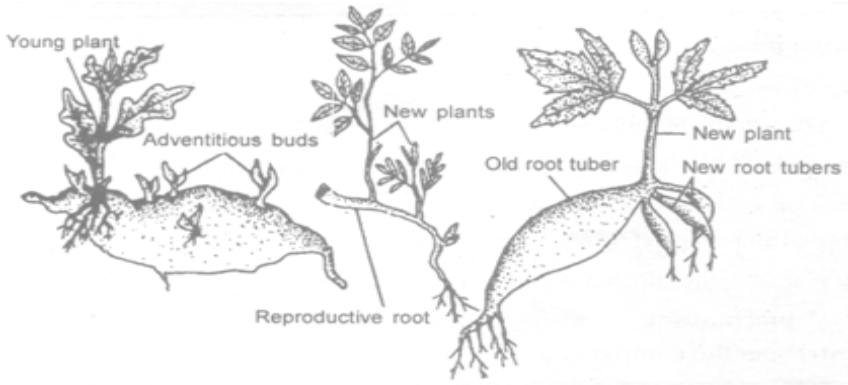
(vi) There is absence of **dispersal mechanism.** Vegetative Propagation in a particular area causes **overcrowding.** It results in **interspecific competition.**

SIGNIFICANCE VEGETATIVE PROPAGATION

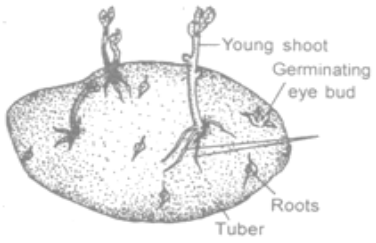
1. It is the only method of reproduction in those plants which have lost their capacity to produce seeds – e.g. **Banana Seed less grapes, Orange** etc.
2. The plants which produce **small quantities of seeds, poor viability** of seed Or **prolonged seed dormancy,** reproduce only by this method because it is more rapid, easier and less expensive.
3. Production of these plants more as compared to seeded plants.
4. The greatest advantage of this method is that a **biotype of plant** [Original plant] can be retained and multiplied indefinitely without any change or variation.

DIFFERENCE BETWEEN ASEXUAL AND SEXUAREPRODUCTION

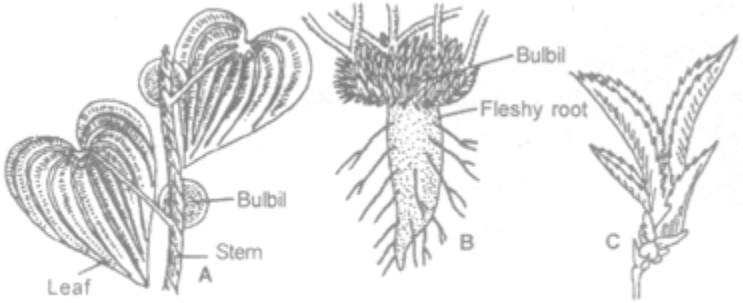
Asexual Reproduction	**Sexual Reproduction**
1. It does not involve the formation and fusion of gametes.	It involves the formation and fusion of two gametes, generally distinguished into male and female.
2. New individual develops from one cell or a part of one parent.	New individual develops from zygote or fusion product of two gametes, which may or may not be produced by two parents.
3. New individual are genetically similar to the parents.	New individual or offsprings are generally different from either of the two parents.
4. It involves only mitotic division.	It involves meiosis at one or the other stage. In higher plants, it occurs at the time of sporogenesis
5. It does not required the formation of sex organs.	Formation of sex organs is a pre-requisite for sexual reproduction.
6. It does not introduce variability. Hence, has no evolutionary importance.	It introduces variability and is, hence of evolutionary importance.



Sweet Potato* and *Dahlia



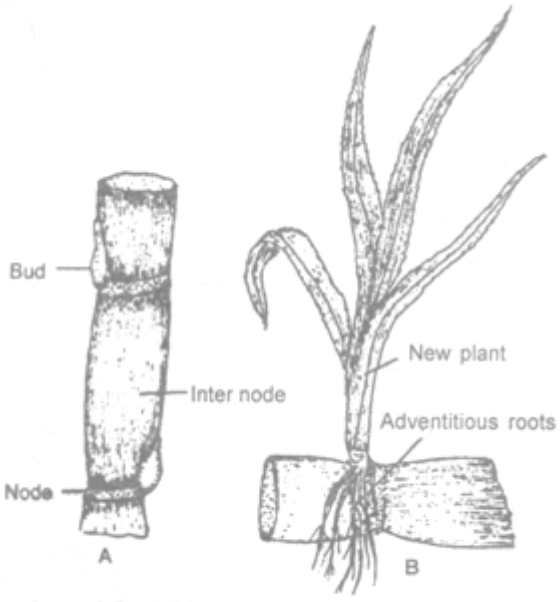
Aerial shoots arising from the buds in the regions of nodes or eyes in *Potato tuber*.



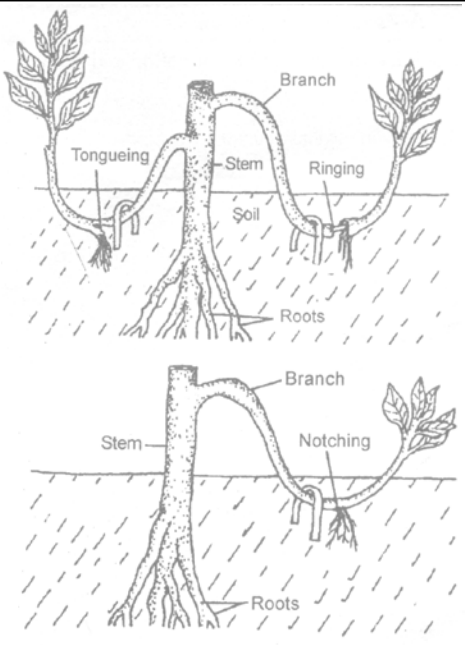
Bulbils : *A. Dioscorea* ; *B. Oxalis* ; *C. Agave* sp.



A leaf of *Bryophyllum* showing formation of new plants from marginal adventitious buds.



A portion of Sugarcane Stem having buds **A bud growing into new plant**



Vegetative propagation by layering