VEGETATIVE PROPAGATION

- Vegetative propagation consists of using vegetative structures – stem, root and leaf.
- Stem, leaves and roots - contain buds or develop buds and roots - grow into new individuals.
- Useful in raising several commercial crops.
- Fruit crops, vegetable crops, plantation crops, cash crops and ornamentals.

OBJECTIVES OF VEGETATIVE PROPAGATION

- In many crops propagated by seeds off springs do not resemble parent plant which produced the seed.
- Certain valuable plants that produce no seeds can be effectively propagated by vegetative means.
- Some plants produce seeds which do not germinate easily.
- Some plants propagated vegetatively are more resistant to diseases and can be used as propagules.
- Propagation method is very economical.
- Valuable varieties can be easily propagated.

- **Helps to avoid or overcome the long juvenile periods of shrubs and trees.**
- **For the maintenance of clones.**
- **Promotes combination of desirable clones.**
- **Controls unwanted vegetative growth.**
- **Use of only limited plant parts.**
- **Practiced during any time of the year.**
- **In limited time and limited space numerous plants can be produced.**
- **Success rate is very high.**

PLANT PROPAGATION

1. NATURAL

Modified structures	Specialized structures
Runners	Bulbs
Stolons	Corms
Offsets	Tubers
Suckers	Rhizomes
Crowns	Tuberous roots

2. ARTIFICIAL

Cutting
Budding
Grafting
Layering

3. MICROPROPAGATION

ORGANS USED IN PROPAGATION

- **Asexual propagation involves reproduction from vegetative parts of plants**
- **Possible because vegetative organs of many plants have the ability for regeneration.**
- **Stem cuttings have the ability to form adventitious roots.**
- **Root cuttings can regenerate a new shoot system.**

- **Leaves can regenerate new roots & shoots.**
- **A stem and root can be grafted together to form a continuous vascular connection.**
- **Some plants produce certain specialised vegetative structures like – bulbs, corms, tubers, rhizomes, tuberous roots, pseudo bulbs, etc.**
- **These organs are primarily modified plant parts specialized for food storage**

NATURAL VEGETATIVE PROPAGATION

- **Propagation by specialized vegetative structures - bulbs, corms, tubers, rhizomes, tuberous roots and pseudo bulbs.**
- **Primarily modified plant parts specialized for food storage.**
- **In these herbaceous perennials, shoots die off in the end of a growing season and the plant lives underground dormant as fleshy organs which bear buds to produce new shoots in the next season.**

- **Second function of these specialised organs is that of vegetative reproduction.**
- **Propagation procedure which utilises the production of naturally detachable structures like bulbs, corms, etc., is called separation.**
- **When plant is cut into sections as is done in rhizome, stem, root tubers, etc., - it is called division.**

<u>BULBS</u> : Produced by monocot plants for storage & reproduction.

- **Specialized organ consisting of basal, short, fleshy stem axis bearing at its apex a growing point enclosed by thick fleshy scales.**
- **Outer scales are fleshy, containing reserve food materials & inner ones are leaf like, protecting growing point.**
- **Growing points in axils of scales produce miniature bulbs called bulblets.**
- **Bulblets formed above ground are called bulbils.**
- **Beginning of growth period - adventitous roots develop - bottom of basal plate. Eg: Lillies, Amaryllis, Allium (onion), Garlic, etc.**

<u>CORMS</u>: Swollen base of a stem axis enclosed by dry scale leaves.

- **Solid stem structure with nodes and internodes.**
- **Bulk of corm is storage tissue composed of parenchyma.**
- **Apex of corm - terminal shoot bud - develop into leaves and flowering shoot.**
- **Axillary buds - produced at each of the nodes.**
- **Adventitous roots - produced from base of corm. Eg: Colocasia, Gladiolus, etc.**

<u>TUBERS</u>: Storage or propagative organ produced in one growing season, remains dormant & starts new growth producing new shoots.

- **Modified stem - develops below ground by swelling of underground stem.**
- **Tuber has all parts of a typical stem – nodes represented by eye on the surface, consisting of one to several small buds, protected by a leaf scar.**
- **Division of tubers are done with a sharp knife before planting.**
- **When adventitious roots are initiated, buds grow out to produce new plants. Eg: Potato.**

- **<u>RHIZOMES</u>: Specialised stem structure in which main axis - grows horrizontally just below ground surface.**
- **Appears segmented and is composed of nodes and internodes.**
- **Leaf-like sheath is attached at each node enclosing the stem –**

  expands to form foliage leaves.
- **When leaves and sheath disintegrate, a scar is left at node and gives segmented appearance to rhizome. Eg: Turmeric, Ginger, etc.**

<u>TUBEROUS ROOTS</u>: Thick tuberous roots produced by certain perennials.

- **Have internal and external features of a typical root.**
- **Differ from stem tuber in that they lack nodes and inter nodes.**
- **Buds are formed only at the crown and new roots at the opposite end. Eg: Sweet potato, Dahlia, etc.**

Some plants exhibt modifications of vegetative structure or method of growth - lead to their natural vegetative increase – runners, stolons, offsets, suckers and crowns.

<u>RUNNERS</u>: Specialised stem - develops from axil of leaf at the crown of a plant,

grows horrizontally along the ground and forms a new plant at one of the nodes.

- **Rooted daughter plants are separated and transplanted. Eg: Strawberry.**

STOLONS: Horrizontally growing stems - produce adventitous roots when in contact with soil. Eg: Cynadon.

OFFSETS: Lateral shoots or branches, shortened and thick with rosette like appearance which develop from main stem.
Removed by cutting them close to main stem. Eg: Date palm, Pineapple, etc.

SUCKERS: Shoot which arises on a plant from below ground, from an adventitious bud on a root.
Dug out and cut from the parent plant for separation. Eg: Murraya (curry leaf), Raspberry, etc.

ARTIFICIAL VEGETATIVE PROPAGATION

- **Involves reproduction from vegetative parts of plants and it is possible because most of the vegetative parts have the capacity for regeneration.**
- **Involves mitotic cell division and hence plants propagated vegetatively reproduce by means of DNA replication of all genetic information of parent plant.**
- **Progenies produced by this technique - true to type or uniform to their parent.**
- **Method is important for raising a plantations of uniform species.**
- **Important methods of veg. prop. include – cutting (leaf, stem, root), budding, grafting and layering.**

CUTTING (CUTTAGE)

- **Portion of stem, root or leaf is cut from the parent plant – placed under favorable environmental conditions and induced to produce roots and shoots – producing a new independent plant- identical to the parent plant.**

ADVANTAGES OF CUTTING

- **Most important means of propagating ornamental shrubs, evergreens, fruits, and vegetable crops.**
- **Widely used commercially in green house propagation.**
- **Many new plants can be started in a limited space from a few stock plants.**
- **Inexpensive, rapid and simple.**
- **No problem of compatibility with root stocks or of poor graft union.**
- **Greater uniformity due to absence of variation.**
- **Parent plant reproduced exactly with no genetic change**.

SELECTION OF MATERIAL

- Select stock plants free of diseases and of moderately vigorous growth of known identity.
- Avoid stock plants injured by frost or drought, defoliated by insects, stunted in growth due to excessive fruiting or mineral deficiency & of vigorous growth.
- Establish stocks that are uniform, true to type, pathogen free & growing in proper nutritive conditions (not starving).

STEM CUTTINGS

- Stem used for propagation.
- Cuttings made from stem (healthy and disease free)
- Stem segment may have terminal buds or lateral buds.
- Develop adventitious roots & then independent plants.
- Type of wood, stage of growth, time of making cuttings are important for satisfactory growth.

HARD WOOD CUTTING

- **Least expensive and easiest method.**
- **For mature dormant hard wood- that do not perish easily**
- **Can be shifted safely to over long distances.**
- **Cuttings prepared during dormant season from wood of previous seasons growth.**
- **eg: Fig, Olive, Plum, Peach, Rose, Mulbery, Grape, Pomegranate, Gooseberry, etc.**
- **Materials should be taken from healthy, moderately vigorous, stock plants growing in full sunlight.**

- **Cuttings should not have long internodes.**
- **Cuttings should not be taken from interior regions of the plant.**
- **Tips of a shoot or stem low in stored food should be discarded.**
- **Central and basal parts make best cuttings.**
- **Diameter range from 0.6- 5 cm depending on species.**
- **Wood of moderate vigor and moderate size most desirable.**

Three types of cuttings are made –

- **Mallet- With a short section of stem**
- **Heel- With only a small segment of wood**
- **Straight- Not including older woods**
- **Polarity should be maintained.**
- **Always make slanting cut to the portion which has to form roots.**

SEMI HARD WOOD CUTTING

- **Many ornamentals and fruit trees are propagated.**
- **Cuttings of 7.5-15 cm in length with leaves retained only in upper end.**
- **Larger leaves should be reduced in size.**
- **Shoot terminals can also be cut.**
- **Basal cut to be made just below a node.**

- **Cuttings should be made in cool hours of morning.**
- **When stems are turgid they are kept wrapped till planted.**
- **To be kept out of sunlight.**
- **Should be rooted under conditions that check water loss.**
- **Growth regulator treatments are beneficial.**

  eg: *Rosa, Bougainvillea, Hibiscus*, etc.

SOFT WOOD CUTTINGS

- **Cuttings selected from soft, succulent new grown branches.**
- **Rooting easier and quicker than other types.**
- **Cuttings with leaf attched.**
- **Handle crefully without drying.**
- **Rooted under conditions which avoid excessive loss of water.**
- **All flowers and flower buds should be removed.**
- **Cuttings – made during early part of day.**

eg: *Allamanda, Vinca, Verbena*, etc.

HERBACEOUS CUTTINGS

- **Cuttings made from herbaceous succulents like *Geranium, Coleus, Carnations*, etc.**
- **Cuttings of 7.5- 12.5 cm long with leaves retained in the upper end.**
- **Cuttings should be rooted under shade - they root easily.**
- **Cuttings should be protected from sunlight.**
- **They root well at high humidity.**
- **Root promoters not required.**
- **Those that exude out sticky sap should be allowed to dry before planting- to prevent entrance of microbes.**

ANATOMICAL CHANGES IN STEM CUTTINGS DURING ROOT FORMATION

- **Dedifferentiation of specific mature cells – becoming meristematic – near the vascular bundles.**
- **These meristamatic cells produce out new root initials.**
- **Root initials develop into root primordia.**
- **Growth and emergence of root primordia outside.**
- **Formation of vascular connections between the root primordia and conducting tissues of cutting.**

ROOT CUTTINGS

- **Root pieces from young stock plants.**
- **Roots should be well supplied with stored foods before new growth starts.**
- **Polarity should be maintained when planting.**
- **Straight cuts at proximal end and slanting cuts at distal end.**
- **Cuttings of 2.5- 5.5 cm long.**
- **Can also be kept horizontally over the soil, covered with thin layer of soil.**
- **Can be stored in shady places.**
- **Once plants are formed, transplant them.**

Eg: ***Aralia, Murraya, Artocarpus, Pelargonium, Papaver*****, etc.**

LEAF CUTTINGS

- **Leaf blade, leaf blade +petiole and leaf buds are used.**
- **Adventitious roots develop from base of petiole or leaf – producing new plant.**
- **Original leaf does not become a part of the new plants. eg: Sansivieria**
- **Tapering leaves of 7.5 c.m long – are selected – the cuttings inserted 3/4th their length in sand.**
- **New plants develop from cut end and leaf segment degenerates.**

  eg: *Begonia* – the larger leaf veins are cut on the under surface and then laid flat on the surface of sand - new plants originate from each point where vein is cut and old leaf blade disintegrates.

- **eg: *Saintpaulia* (African violet) – leaf blade + petiole immersed in sand or water and new plants originate from base of petiole.**

  eg: Bryophyllum – new plants easily produced from margins of leaves.

LEAF BUD CUTTINGS

- **Leaf blade + petiole and a short piece of stem with axillary bud.**

  eg: Lemon, *Rubus, Anthurium, Rhododendron,* etc.
- **Useful when propagating materials are scarce.**
- **Each node with leaf can be used as cuttings.**
- **Sand and peat moss in 1:1 is ideal.**
- **High humidity is essential.**

BUDDING (BUDDAGE)

- Utilizes only one bud and a small section of bark with or without wood.
- Method depends on bark's slipping ability (easy separation of bark from wood).
- Should be done at the beginning of new growth in spring.
- Do not select weak, less vigorous, diseased branches.
- Budding results in stronger union than grafting.
- It makes more economical use of propagating wood than grafting.

- **Each bud is potentially capable of producing a new plant.**
- **Important when propagating wood is scarce.**
- **Technique more simple than grafting.**
- **Budding practiced in young plants or small branches of large plants.**
- **Budding widely used in producing nursery stock of ornamentals, fruits, etc.**
- **Should be done when plant is in active growth.**
- **Well developed buds of desired variety should be selected.**
- **Different types of budding include – T,I,H, chip, patch, etc.**

T – BUDDING

- **Most common method used by nursery men.**
- **Root stocks of 2-3 cm thickness with fairly thin bark.**
- **Actively growing – bark easily separated from wood.**
- **‘T’ shaped cut made on bark of stock at a height of 10-15 cm.**
- **Started with vertical cut first & horizontal cross cut on top.**
- **Bud - form of shield - shield budding.**
- **Bud inserted into raised flaps of bark & exposed.**
- **Wrapped with polythene tape.**
- **Protect from entry of water & drying.**

INVERTED T- BUDDING

- Method is the same as ‘T’ budding .
- Cut on the root stock is in the form of inverted ‘T’.
- Here the bud is inserted into the lower part of the incision and pushed upward.
- Since it is inverted cut - water will not enter the into the cut.

PATCH BUDDING

- Rectangular patch of bark removed completely from stock & replaced with a patch of bark of same size containing a bud of the plant to be propagated.
- Bud is placed in the cut wrapped properly with polythene tape.

I – BUDDING

- Two transverse cuts - made on stock & joined at center by vertical cut.
- Bud patch cut from desired variety in the form of a rectangle or square.
- Two flaps of the bark on stock are raised for the insertion of bud patch.
- After bud is inserted, it is wrapped with polythene tape.

CHIP BUDDING

- Chip of bark removed from region between nodes & replaced with another chip of same size & shape from the bud stick.
- Cut edges should be sealed by proper wrapping.

H- BUDDING

- Method similar to ‘I’ budding - here two vertical cuts are made parallel to each other & joined by a horizontal cut in middle.
- Rectangular patch bud from selected variety is inserted by splitting apart the flaps & cut region is wrapped.

ADVANTAGES OF BUDDING

- To propagate clones that are not successful by cutting, layering or grafting or sexual methods.
- To obtain special forms of plant growth.
- Only very small piece of scion bud is required.

LAYERING (LAYERAGE)

- **Method of propagation where the adventitious roots are made to form on a stem while it is still in contact or attached to mother plant.**
- **Rooted- layered stem is detached to become a new plant growing on it's own roots.**
- **It is natural means of reproduction in plants like strawberries, chlorophytum, gooseberry, etc.**
- **Can be induced artificially in many kinds of plants.**

FACTORS AFFECTING LAYERING

- **Nutrition : Stem is attached to plant during rooting – so gets continous supply of water and minerals through intact xylem.**
- **Stem treatment: Cutting, twisting, etc. on the under surface of stem – so that more hormones & nutrients concentrate near the point of treatment and rooting occurs their.**
- **Light extrusion: Light should be eliminated from part of stem where roots are to develop – blanching or etiolation.**
- **Use of root promoting substances: Like IBA, NAA, IAA etc – applying such powder on the girdled part of the stem – in contact with soil.**
- **Other conditions : Rooting depends on supplying continuous moisture, good aeration and moderate temperature.**

ADVANTAGES OF LAYERING

- **Method of propagation – naturally in some plants – Strawberry , *Adiantum, Hydrocotyl,* etc.**
- **To propagate plants where cuttings do not root easily**
- **Less cost and labor required in layering.**
- **Used to produce large sized plants in a short time.**
- **Only minimum propagating facilities are required.**

DISADVANTAGES OF LAYERING

- Layering is limited to certain types of plants which produce low lying branches.
- Number of new plants which can be produced by layering from a mother stock plant is low as compared to cuttings.
- Requires daily watering to maintain a very good growth.

TYPES OF LAYERAGE

SIMPLE LAYERING

- Bending a branch to ground and covering it partially with rooting medium, but leaving the terminal (tip) region exposed.
- Tip of branch is sharply bent to an upright position about 10-15 cm back from tip.
- Sharp bending is necessary to induce rooting.
- Rooted segment of the branch is then separated and transplanted. Eg: Rose

TIP LAYERING

- **Rooting occurs near tip of current season's shoot which is bent to the ground and covered with rooting medium.**
- **Tip will not continue its growth in length but instead produces an abundant root system and a healthy young vertical shoot. Eg: Jasminum**

AIR LAYERING

- **Roots form on aerial parts where stem has been girdled.**
- **Injured portion is covered with suitable rooting media like moss, saw dust or paddy straw and protected using a polythene tape.**
- **When roots are formed - layers can be detached from parent plant and transplanted. Eg: Mango**.

MOUNT LAYERING

- Also called stool layering which involves cutting a plant to the ground level during the dormant season.
- Soil is heaped around the base of the newly developing shoots to encourage root formation.
- Plants with stiff branches that do not bend easily and that are capable of producing an abundance of shoots are used for this method. Eg: Psidium.

TRENCH LAYERING

- **Consists of growing a plant or a branch in a horizontal position in the base of a trench.**
- **Soil is filled around the new shoots as they develop so that the shoot bases are etiolated.**
- **Roots will develop from base of these shoots which are later separated and transplanted. Eg: Apple.**

GRAFTING (GRAFTAGE)

- **Grafting - art of connecting two pieces of living plant tissues - they unite, grow & develop as one plant.**
- **The two pieces are – stock and scion.**

<u>STOCK</u>

- **Also called root stock or under stock – it is the lower portion of the graft develops root system of the grafted plant.**
- **It may be a seedling, rooted cutting or a layered plant.**

SCION

- These are short pieces of detached shoot containing several dormant buds.
- It is the upper portion of graft from which new stem and branches grow out.
- It should be of a desired cultivar free from diseases.

ADVANTAGES OF GRAFTING

- **Useful when cutting, layers, division and other asexual methods not satisfactory.**
- **Used for obtaining special forms of plant growth.**
- **For repairing damaged parts of trees.**
- **Will enable the top working (changing cultivars) of established plants.**
- **To speed up reproductive maturity of seedlings.**

FORMATION OF GRAFT

- **Fresh cut scion capable of meristematic activity is brought to initiate contact with freshly cut stock tissue.**
- **This brings the cambial region of both in close proximity.**
- **Temp. & humidity should be favourable to promote growth in newly exposed & surrounding cells.**
- **Outer cell layers of cambial region of scion & stock produce parenchyma cells that soon intermingle & interlock – to form callus tissue.**

- **New cambial cells are formed from the callus in line with cambium layers of intact scion and stock.**
- **New cambial cells produce new vascular tissues – xylem towards inside and phloem outside – this is the requisite of a successful graft union.**
- **Healing of graft union is like healing of wound.**
- **No intermingling of cell contents in region of graft union.**

- **Cells produced by stock and scion maintain their own identity.**
- **Only if stock and scion are compatible graft union is formed permanently successful.**
- **Proper polarity is essential if graft union is to be permanently successful**

Grafting can be done

- **With in a clone – eg: Peach.**
- **Between clones of a species- eg: Fir.**
- **Between species – eg: *Pinus, Citrus,* Plum.**
- **Between genera – eg: Tobacco X Tomato**
  Datura X Tomato
  Brinjal X Potato
- **Between family -**
  eg: *Helianthus annus* X *Meliotus alba*
  (Compositae) X (Leguminosae)

Incompatibilty in grafting : Results in various disorders like -

- **Yellowing of leaves.**
- **Falling off of leaves.**
- **Premature death of trees.**
- **Overgrowth above or below graft union.**
- **Breaking off of components at graft union.**

TYPES OF GRAFTING

WHIP GRAFTING

- **Scion shoot is given a slanting cut and a similar cut is made on the root stock.**
- **Cut surfaces are placed together and tied.**

Eg. Apple, Pear, Peach, etc.

WHIP AND TONGUE GRAFTING

- **Similar to whip grafting except for the making a tongue shaped cut in the scion to hold the stock and scion more tightly.**
- **Stock and scion are joined by inter locking the tongue of the scion and whip of the stock.**

  Eg: Croton, Bougainvillea, etc.

SPLICE GRAFTING

- **Simplest method usually applied to herbaceous plants.**
- **Both the stock and scion must be of the same diameter.**
- **Cut off the root stock making a diagonal cut ¾ - 1 inch long.**
- **Make the same type of cut at the base of the scion.**
- **Fit the scion to the stock and wrap this junction with a polythene tape.**

Eg: *Chrysanthemum.*

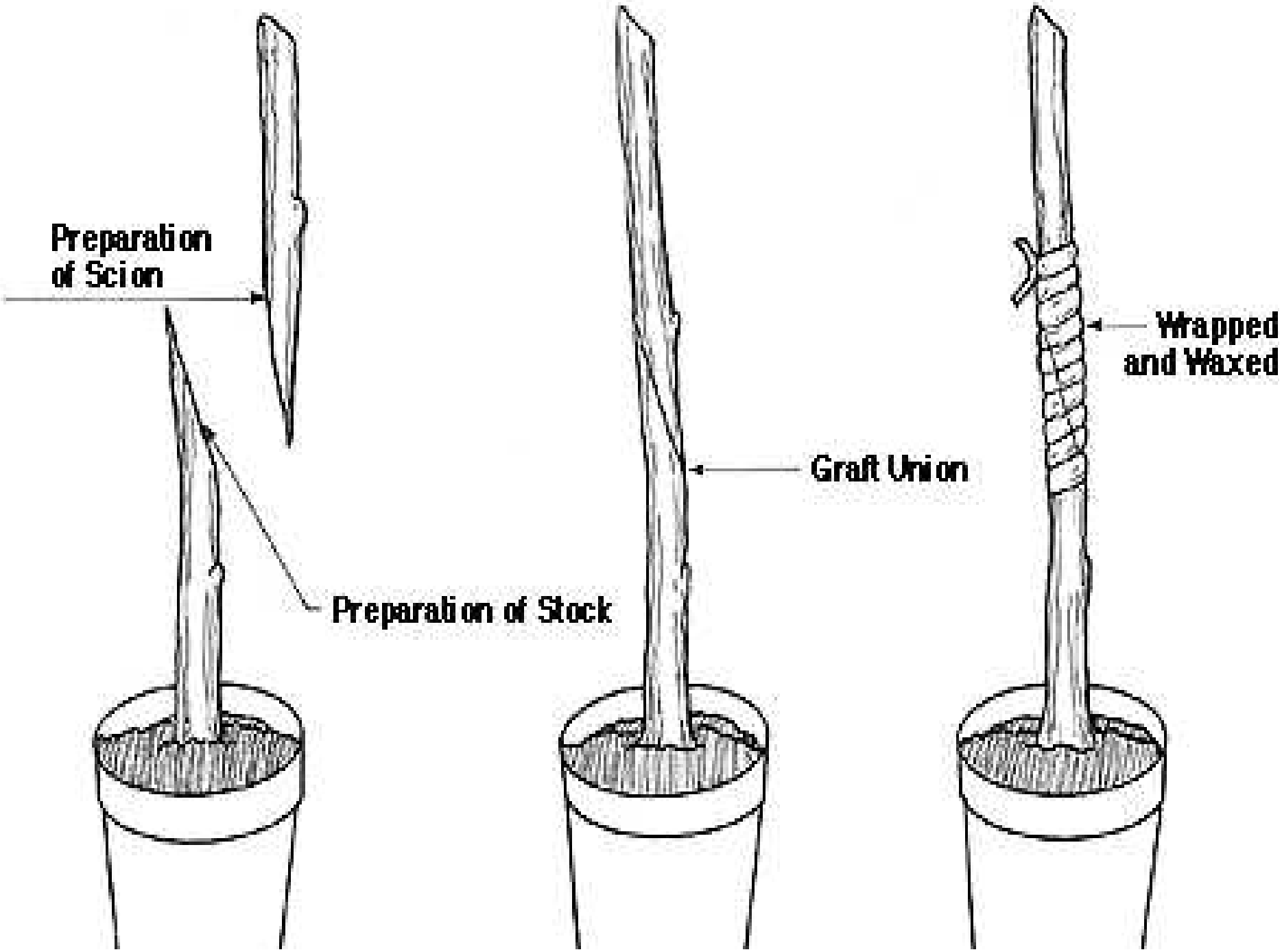
SIDE GRFATING

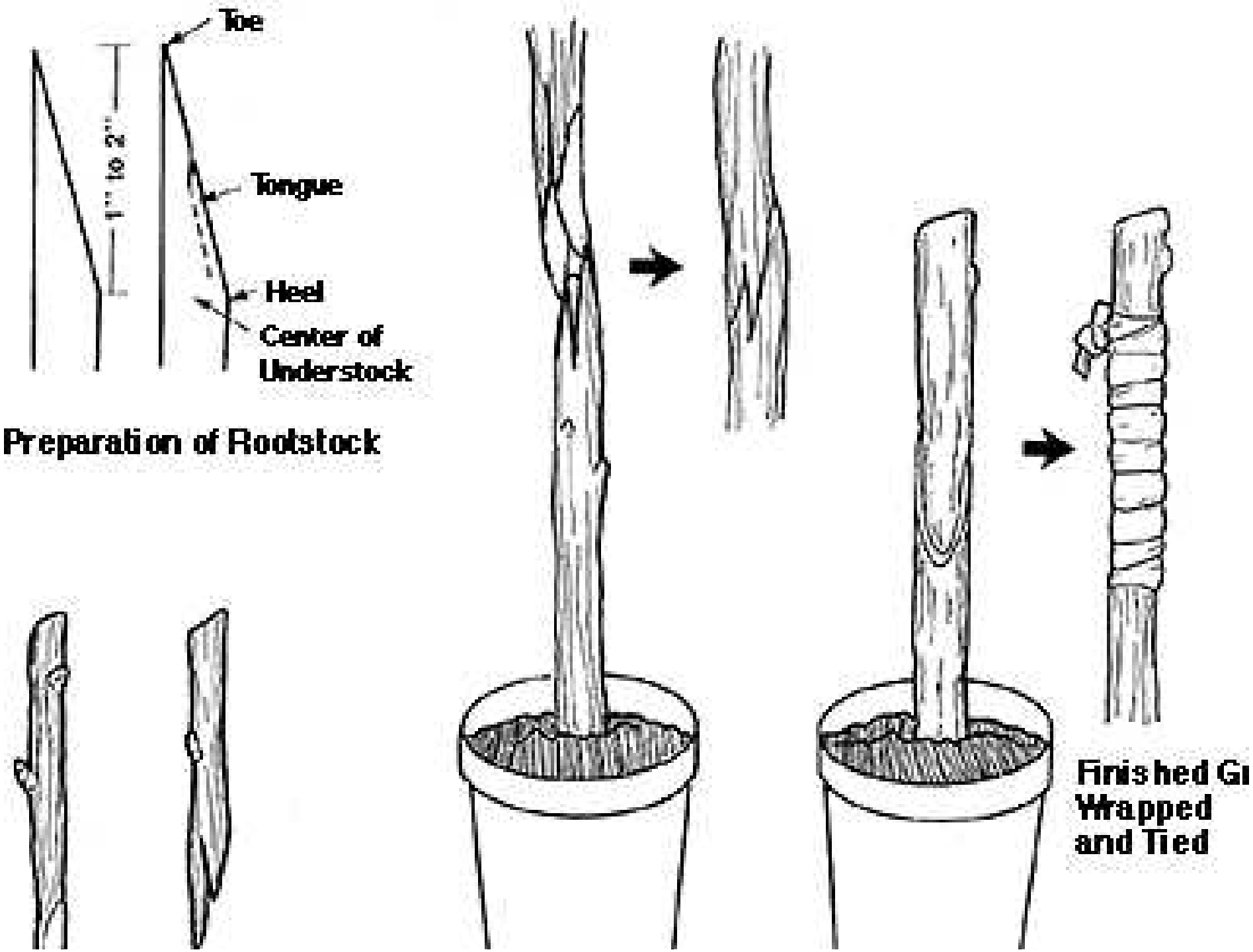
- **Scion is inserted into the side of the stock which is generally larger in diameter than the scion. Eg. *Citrus*, Pear.**

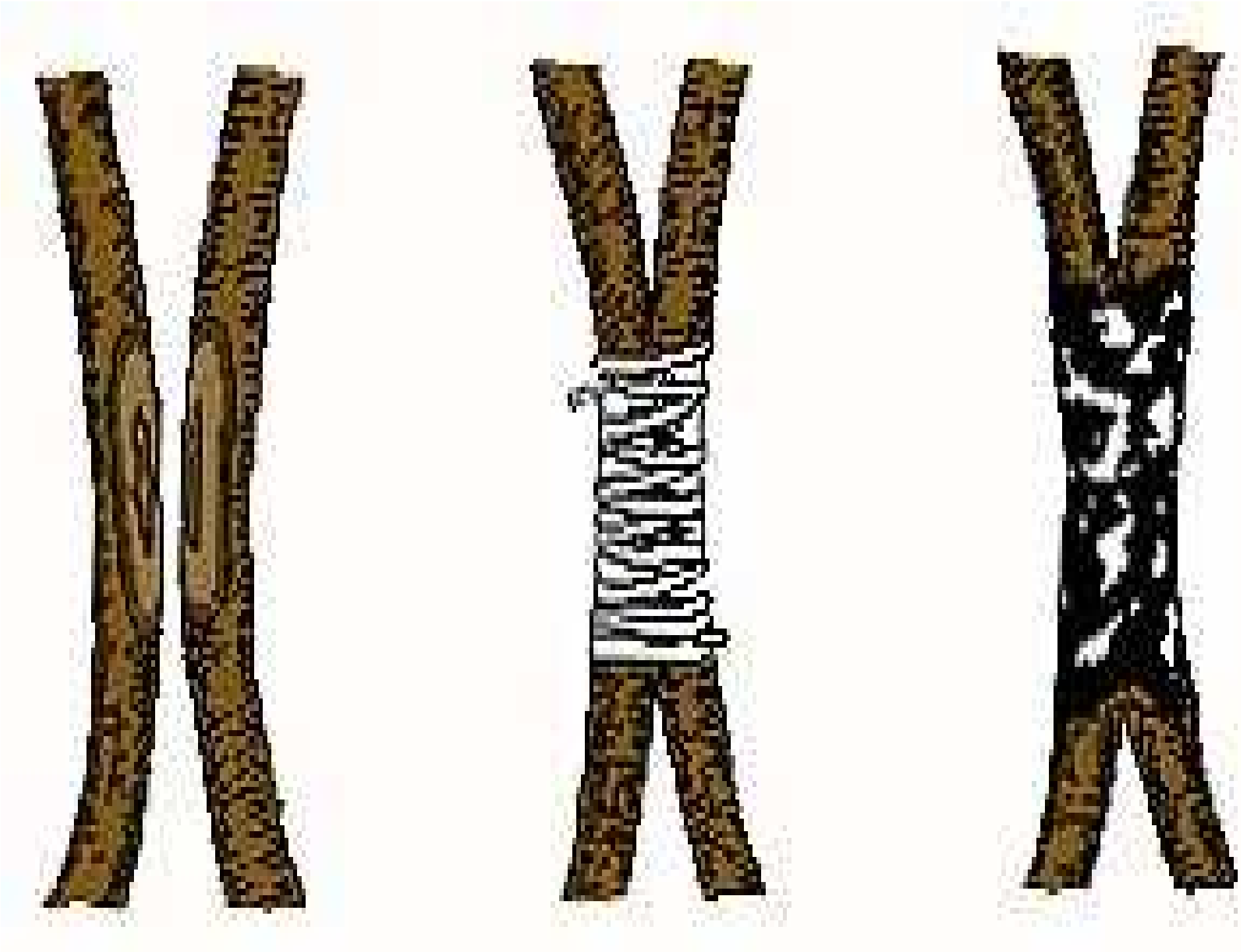
APPROACH GRAFTING

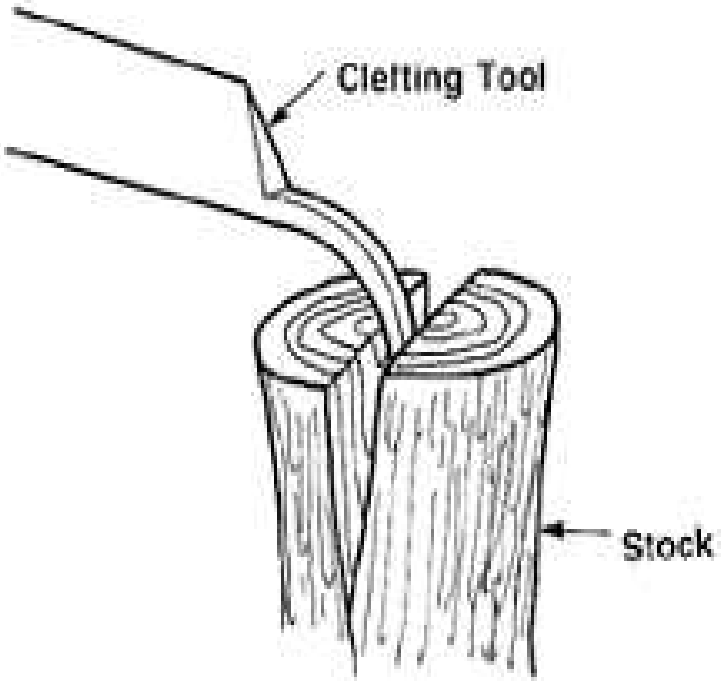
- **Two independent self sustaining plants are grafted together.**
- **After a union has occurred, top of the stock plant is removed above the graft.**
- **Base of scion plant is removed below the graft union.**

  Eg: Croton, *Bougainvillea.*

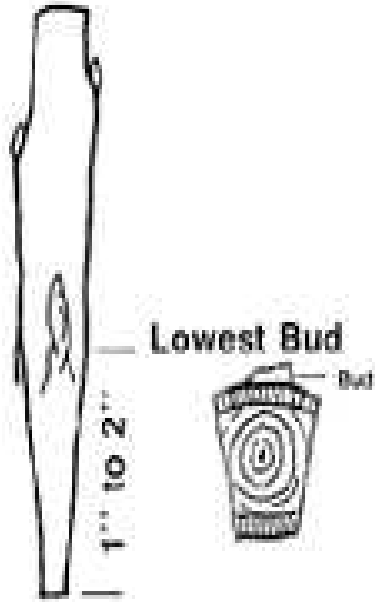

Preparation
of Scion
Preparation of Stock
Graft Union
Wrapped
and Waxed


Toe
1" to 2"
Tongue
Heel
Center of
Understock
Preparation of Rootstock
Finished Gr
Wrapped
and Tied

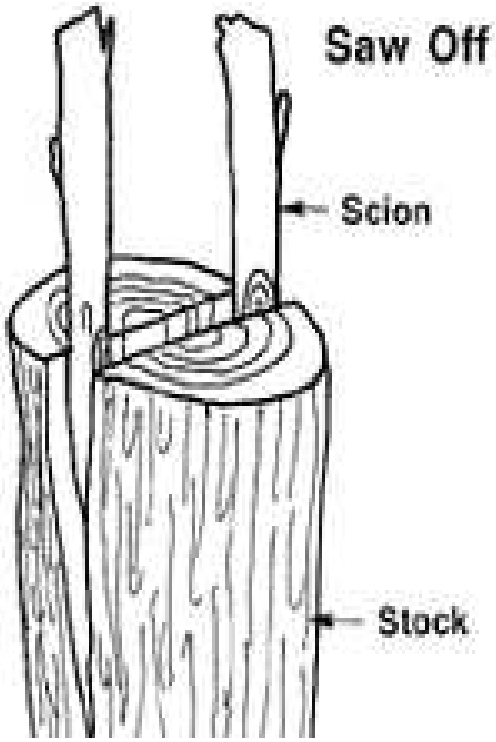


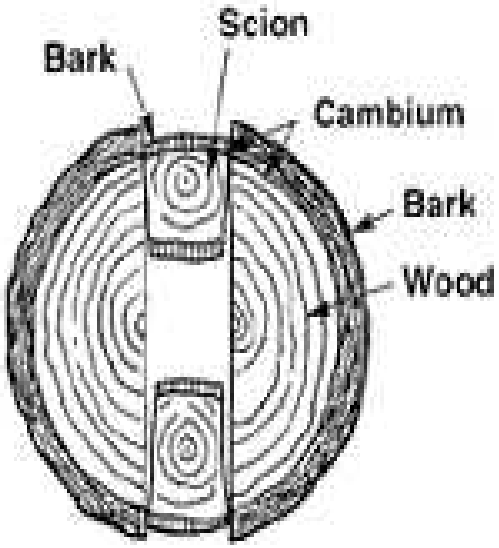


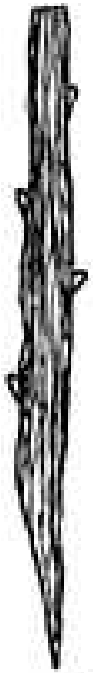
Saw Off Stock and Make Cleft



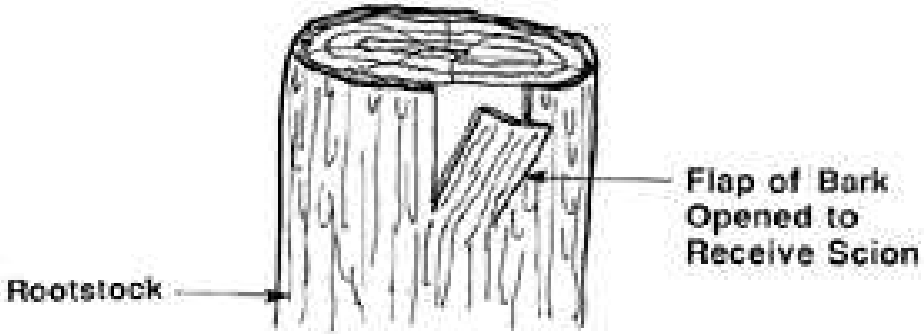
Prepare Scions



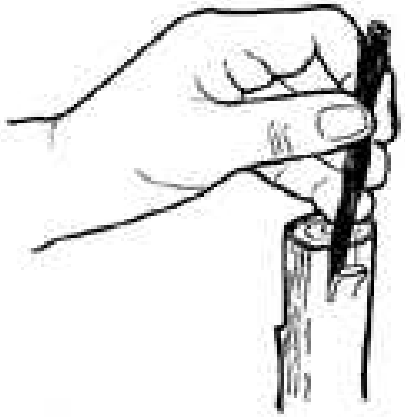




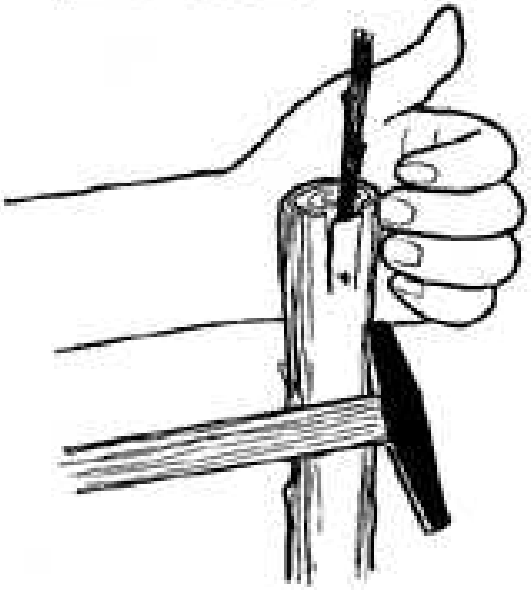
Prepare Scions

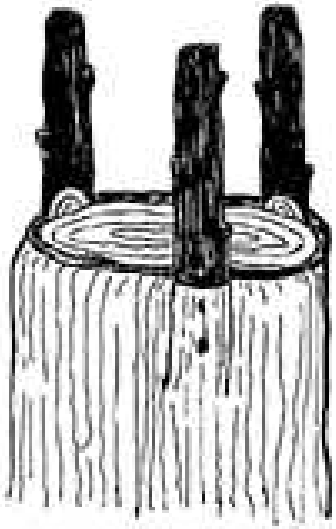


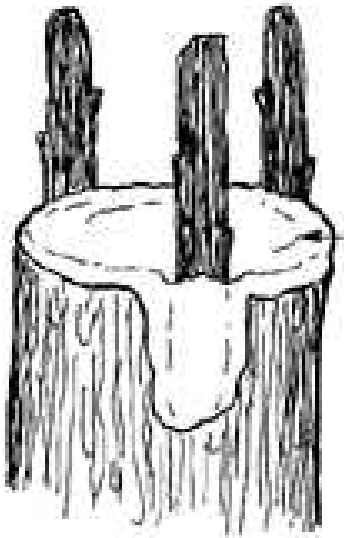
Prepare Rootstock



Insert Scions Beneath
with Cut Surface Toward
Wood of Stock







Wax All
Exposed
Surfaces

Tack Bark Flap Back into Place to Secure Scions