



National Institute of Food and Agriculture
U.S. DEPARTMENT OF AGRICULTURE



A TRAINING GUIDE TO TRAINERS

A large graphic featuring a vibrant green leaf with a stem and a small green square at the end of the stem, all enclosed within a white circular frame. The leaf is positioned behind the main title text.

MICRONESIA GROWS TECHNOLOGY

A Program to Facilitate
Distance Learning for
Agriculture and Extension
Students at the College of
Micronesia-FSM

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GLOSSARY

ANTIBIOSIS

AN ANTAGONISTIC ASSOCIATION BETWEEN TWO ORGANISMS(ESPECIALLY MICROORGANISMS) IN WHICH ONE IS ADVERSELY AFFECTED

BAGGING

THE PROCESS OF PLANTING OR PLACING SOIL IN A POT OR ANY PLANT CONTAINER

BASAL APPLICATION

THE PROCESS OF APPLYING FERTILIZER INTO THE SOIL BEFORE SOWING SEEDS OR PLANTING A SEEDLING

BUDDING

A TYPE OF GRAFTING TECHNIQUE THAT USES A BUD WHEN PROPAGATING A PLANT

CROP

A CULTIVATED PLANT THAT IS GROWN AS FOOD, ESPECIALLY A GRAIN, FRUIT, OR VEGETABLE

CULTIVATION

THE PREPARATION AND USE OF LAND FOR GROWING CROPS WHICH INVOLVES DIFFERENT TILLAGE OPERATION

CUTTINGS

A PLANT PROPAGATION TECHNIQUE THAT CUTS ANY PLANT PARTS THEN RE-PLANT IT INTO A NEW POT OR ANY PLANTING CONTAINER

FURROW

A LONG NARROW TRENCH MADE IN THE GROUND BY A PLOW OR ANY AGRICULTURAL EQUIPMENT FOR PLANTING SEEDS OR FOR IRRIGATION

GROWING MEDIA

MIXTURES OF NATURAL COMPONENTS FROM EARTH THAT PROVIDE WATER, AIR, NUTRIENTS, AND ETC. TO SUPPORT THE PLANTS

HARDENING-OFF

THE PROCESS OF EXPOSING THE PLANTS TO HARSH ENVIRONMENTAL CONDITIONS LIKE SUNLIGHT, WIND, AND UNEVEN TEMPERATURE BEFORE TRENPLANTING

MULCH

REFERS TO MATERIALS LIKE DECAYING LEAVES, BARK, COMPOST, OR SPECIAL PLASTIC WHICH ARE SPREAD AROUND OR OVER THE PLANT TO ENRICH OR INSULATE THE SOIL

PLANT NURSERY

A PLACE WHERE SEEDLINGS OR PLANTS ARE PLANTED AND TAKEN CARE OF UNTIL THEY GROW AND PRODUCES CROPS

GENERAL INSTRUCTION

01

INFORMATION AND INSTRUCTIONS TO THE TRAINER

This manual should be used purely as a facilitator's guide. The sessions under each module are presented with an outcome(s) to facilitate the assessment of participants' understanding and depth of knowledge at the end of each session. Following the outcomes are the topics to be covered and facilitating methodology. However, the facilitator should feel free to adapt the methodology suggested to the needs of participants. To enhance a participatory learning process, some methods of presentation and the steps to follow are therefore outlined. The manual also provides some background information on each session. The information is also meant to aid the facilitator in the preparation for the session. Like all participatory methods, the involvement of the participants in all stages of the learning process is vital. However, all users of this manual must study and research into the content of each module before the presentation. Start each sub-topic and group activity by explaining the objective and learning outcomes expected of them, and ensure they are met.

The session should be interactive, participatory, lively and interesting. Let the participants express themselves in local language, if deemed necessary, for them to understand the concepts. Encourage them to ask questions especially on concepts that they do not understand. Switch to either English or vernacular language when you find some farmers or all of them do not understand you in one of the languages.

Start the session with greetings, welcoming remarks, and introduce yourself. Ensure you have the necessary stationery, equipment, and materials for the trainees: projector, flip charts or whiteboard, whiteboard markers, marking pens, posters, and handouts. Be time conscious as you facilitate the session.

This manual is organized around aspects of Agricultural Crop Production particularly selecting planting materials, and preparing growing media.

02

USERS OF THE MANUAL

The manual is intended to be used by facilitators in conducting training workshops across the College of Micronesia-FSM through the aid of C.R.E extension agents and agriculture major students.

03

PRESENTATION METHODOLOGY

The methods of presentation outlined in the manual are suggested as a guide to the facilitator. The facilitator is expected to use his or her judgement in selecting the appropriate method or combination of methods in presenting each session.

04

ASSESSMENT

At the end of each session, the facilitator is expected to assess/evaluate the participants' understanding and level of knowledge by using a simple question and answer session as appropriate. In some of the sessions, assessment questions are suggested as activities whilst in some, the facilitator is given a free hand in determining the kind of questions to be asked. However, all assessments must relate to the session.



PROJECT BRIEF

The Federated States of Micronesia are situated in the Pacific Island region and have a mix of traditional cultures impacted greatly by successive Spanish, German, Japanese, United Nations and United States colonizations and territorial agreements. The food systems here are in transition. Large pelagic and near shore aquatic resources are spread across thousands of kilometers and the potential for misuse is extreme. Local land-based agricultural practices are a mix of traditional and imported crop farming and husbandry. Both ocean- and land-based systems are subject to increasingly challenging results from climate change. In this context, one of the most important tools that local communities have is their knowledge. Showing how traditional knowledge integrates with modern, scientific agricultural research and practices is one of the benefits of a robust CRE program.

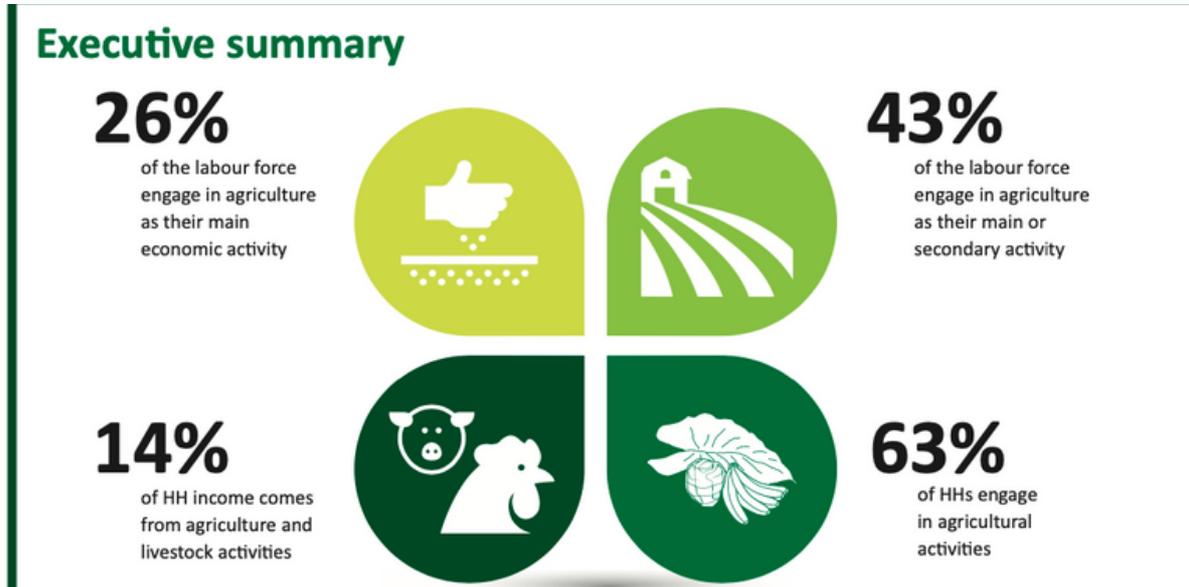
The College of Micronesia-FSM is a learner-centered institution of higher education that is committed to the success of the Federated States of Micronesia by providing academic and career & technical educational programs characterized by continuous improvement and best practices. The college is accredited by the Accrediting Commission for Community and Junior Colleges (ACCJC) of the Western Association of Schools and Colleges (WASC). Prior to the coronavirus pandemic, the college was not accredited to offer distance education programs to its students.

Distance education plays a major part in this process of integration now with the pandemic, as academic offerings of the college are exclusively online where feasible. As a result of the Micronesia Grows Technology program, well-trained agricultural workers will adopt best practices in the region, and will succeed in bringing integrated knowledge to local, state, and regional actors. Acting in concert with the college, which serves all four states of the Federated States of Micronesia (FSM), this progress will reach national communities and impact international practices as well-spoken contributions come from these former agricultural research and extension students. Affording them with personal laptop computers will make this possible in a way that faces forward and opens up access to the whole world of internet offerings in agricultural practices. Familiarity with computing helps make this happen.

The Cooperative Research and Extension (CRE) program provides training, knowledge and skill development in agriculture and aquaculture, nutrition, resource management, and youth and families through our research, extension, and resident instruction programs. The rental program providing laptops to agriculture students will add momentum to the overall goals of the college, and in particular will aid the CRE in its mission to provide unrestrained support in aiding the development of the Federated States of Micronesia.

In a Nutshell

FSM AGRICULTURE



Agriculture is extremely important for the livelihoods of households (HH) across the Federated States of Micronesia (FSM). 63% of HHs report conducting some form of agriculture and forestry. 43% of the labour force conduct agriculture as a primary or secondary activity, and agriculture contributes 14% to overall HH income.

However, most of these agricultural activities are for subsistence. Nearly 40% of HHs produce goods purely for their own consumption (subsistence). Only 24% of FSM HHs have sold any part of their agriculture production. Very few agriculturally active HHs hire labour or use inputs such as fertiliser and irrigation.

Agricultural production varies considerably across states. The most important food crops (in terms of total value sold, gifted and consumed) were: taro in Yap, breadfruit in Chuuk, yam in Pohnpei and banana in Kosrae.

Other crops also provide significant income in some states. Sakau (kava) had the highest value of production in total, and provides the highest income from sales, with more than USD2.5 million in sales in Pohnpei. Betel nut was a major income earner in Yap, and was sold, gifted and consumed across all states.

Livestock is also important for subsistence. 51% of HHs reported raising livestock but only 20% of these HHs sold their production. Pigs are the most important livestock, with 80% of livestock HHs reporting having pigs.

PRE-TEST

- 01** THE REPRODUCTION OF PLANTS THROUGH SEXUAL AND ASEXUAL MEANS.
- a. Seed Testing
 - b. Plant Propagation
 - c. Cutting
 - d. Grafted Materials

- 02** A PROCESS OF CUTTING OR DETACHING PLANT PARTS FROM THE MAIN PLANT AND REPLANTING THEM OR COMBINING THEM WITH OTHER PLANTS FOR REPRODUCTION, PRESERVATION AND PRODUCTION OF A HYBRID TYPE OF PLANT.
- a. Plant Propagation
 - b. Asexual Plant Propagation
 - c. Sexual Propagation
 - d. Propagation Techniques

- 03** THE FOLLOWING ARE EXAMPLES OF SOIL STERILIZATION EXCEPT
- a. Applying Powder into the Soil
 - b. Pouring Boiling Water
 - c. Burning of Straw in the Soil Surface
 - d. Sun Drying

- 04** A STATE WHEREIN SEEDS HAD STOPPED FROM GERMINATING.
- a. Seed Testing
 - b. Seed Sowing
 - c. Seed Dormancy
 - d. Seed Germination

- 05** BED OF SOIL PREPARED FOR PLANTING SEED.
- a. Seed Bed
 - b. Seed Box
 - c. Seed Tray
 - d. Garden Soil

- 06** THE FOLLOWING ARE THE LIST OF GOOD CHARACTERISTICS OF GROWING MEDIA, EXCEPT
- a. High Cation Exchange Capacity
 - b. Able to Form into a New Element
 - c. Low Salinity
 - d. Sufficiently firm and dense

MODULE 5

PERFORMING NURSERY OPERATIONS



OBJECTIVES

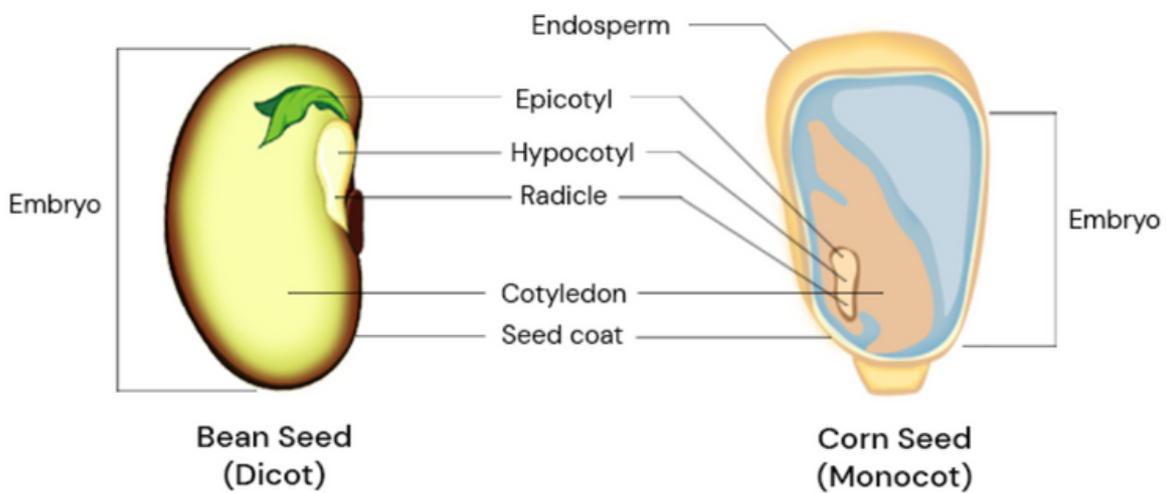
- **DETERMINE THE KINDS AND VARIETIES OF PLANTING MATERIALS;**
- **DEMONSTRATE PROCEDURES FOR BREAKING SEED DORMANCY;**
- **PREPARE THE GROWING MEDIA ACCORDING TO PLANT REQUIREMENT; AND**
- **PREPARE THE SEEDBED FOR SEED GERMINATION.**



TOPIC 1: KINDS & VARIETIES OF PLANTING MATERIALS

Plant propagation is the process of increasing the number of plants of a particular species or cultivar. There are two primary forms of plant propagation: sexual and asexual. In nature, propagation of plants most often involves sexual reproduction, or the production of viable seeds.

PARTS OF SEEDS



SEED COAT

usually tough and is partly impenetrable to water.



EMBRYO OR MINIATURE PLANT OF THE SEED

a young plant that contains cotyledon, radicle, and hypocotyls



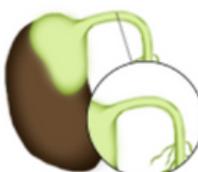
COTYLEDON

protects the young plant and provides it with nutrients during the early stages of its development.



RADICLE

develops into the first roots of the seedling.



HYPOCOTYLS

the stem that connects the cotyledon and the radicle.



ENDOSPERM

stores food and nutrients(starch, oil, proteins, etc.) for the young plant.

CHARACTERISTICS OF GOOD QUALITY SEEDS

1 

VARIETAL PURITY
free from mixed varieties

2 

GERMINATION AND VIGOR
seeds that germinate 90% will establish more seedlings than those that germinate only at 70%

3 

MECHANICAL PURITY
pure seeds free from mechanical injury

4 

UNIFORMITY OF SIZE
seeds of uniform size are also more likely to be similar in seedling vigor

5 

FREE FROM SEED-BORNE DISEASES
disease-free plants are expected to give better field performance than

6 

FREE FROM MIXTURE
it must be free from any mixture with other seeds and foreign matter

TYPES OF VEGETATIVE PROPAGATION



SUCKERS



TISSUE-CULTURE
PLANTLETS



CUTTINGS



RHIZOME



CORM



GRAFTED
MATERIAL



TUBER



RUNNERS/STOLON

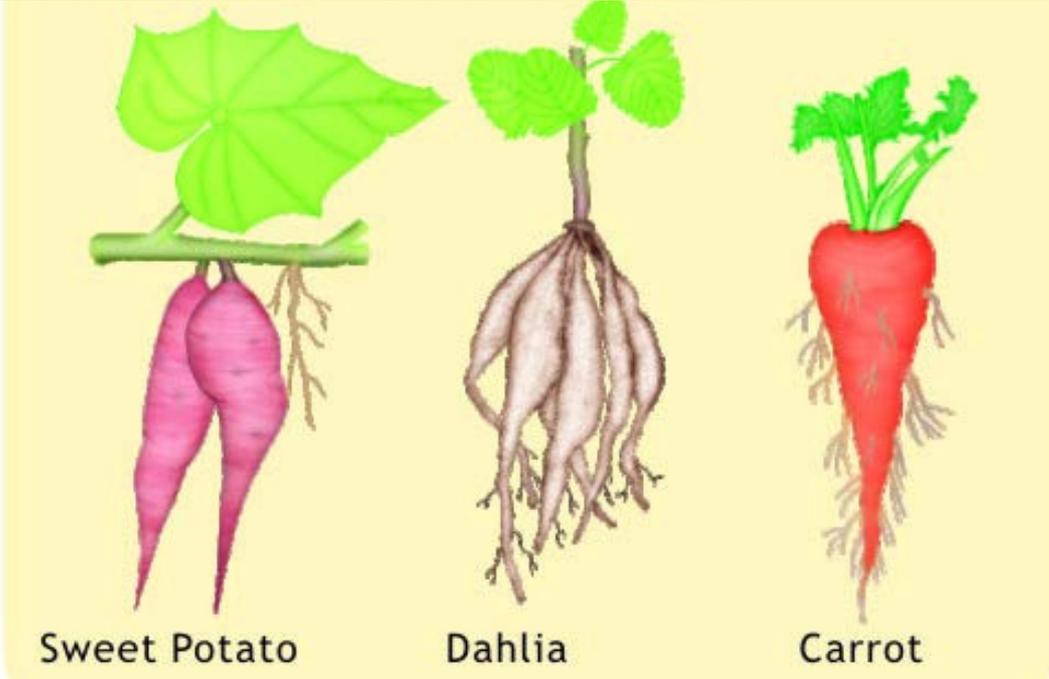


BULB

TYPES OF VEGETATIVE PROPAGATION

By Roots

The swollen tap roots of carrot, turnip and radish have buds at the base of old stems just above the tap root which serve as organ of vegetative propagation. Adventitious roots of Asparagus, Dahlia, sweet potato, yam etc. serve to propagate plant vegetatively.



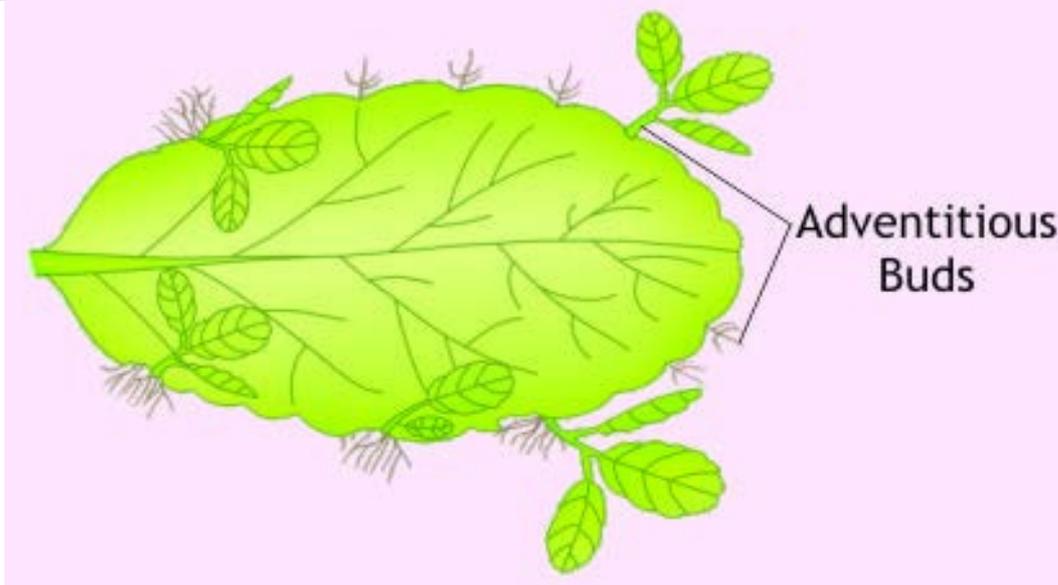
Sweet Potato

Dahlia

Carrot

By Leaves

The fleshy succulent leaves of Bryophyllum bear adventitious buds in their notches located in the margins. When the leaves fall on moist soil, these buds develop into small plants completing the process of vegetative propagation.

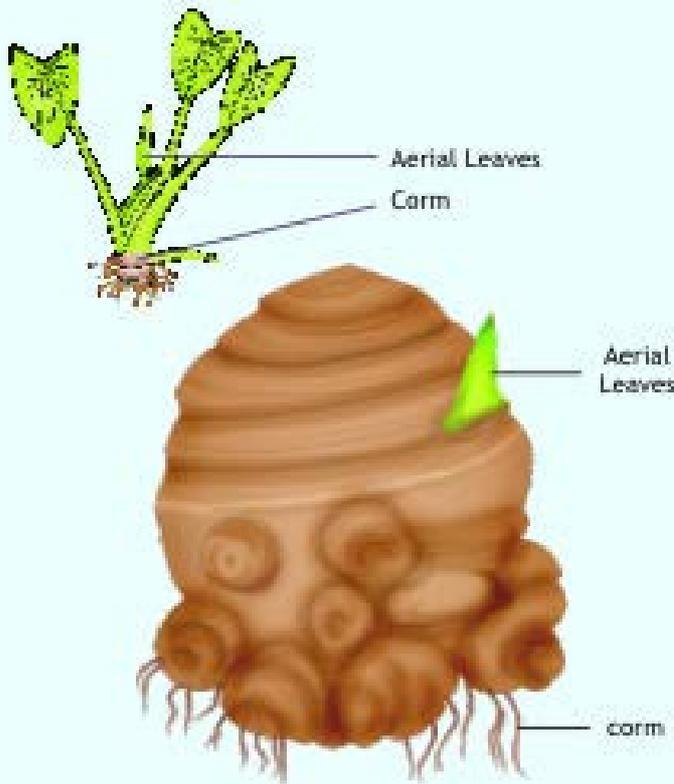


Adventitious Buds

TYPES OF VEGETATIVE PROPAGATION

By Underground Stems

In certain plants the underground stems become modified for storage of food during the active phase of the growth.
Examples- Rhizome (Ginger), tuber (Potato), bulb (Onion) and corm (colocasia)



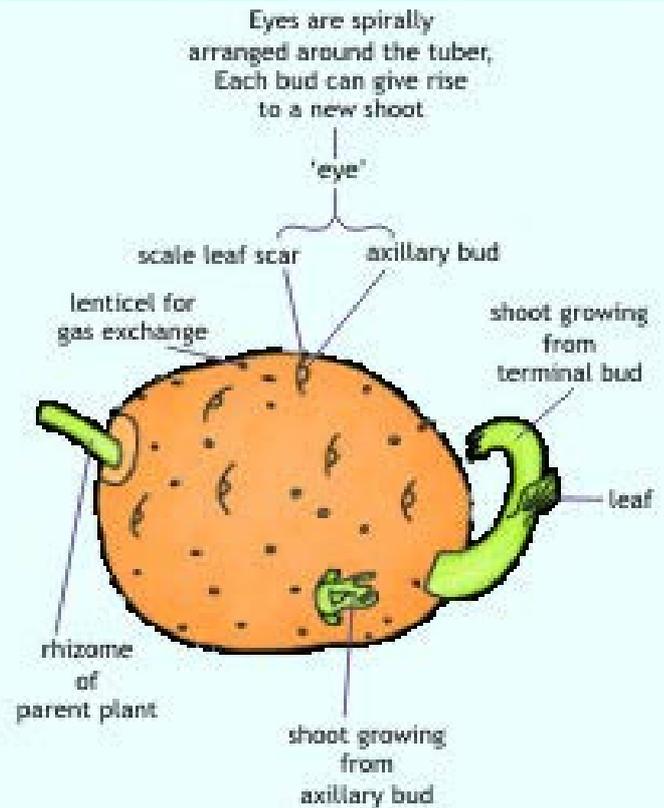
Corm

Corm: Colocasia

Corms look like bulbs and are often confused with them. There are no modified leaves on a corm as in the onion. Corms are squashed, compressed stems. They can't be pulled apart into individual leaf scales.

Corms are flattened underground stems swollen with food and produce cormlets at their bases.

Cormlets can be separated carefully from the parent corm and grown to produce new plants.



Tuber

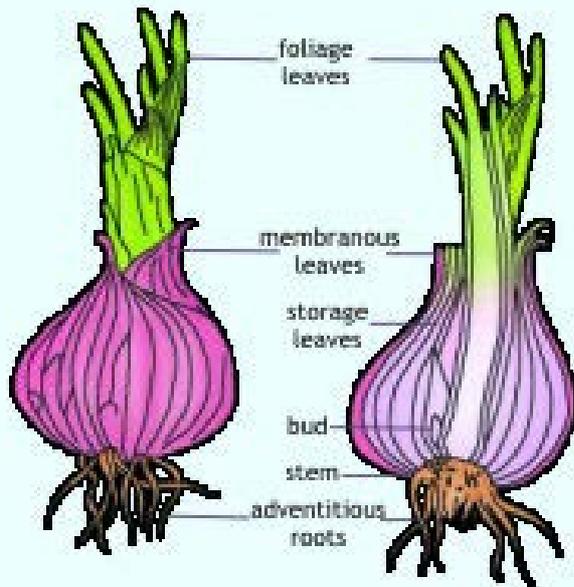
Stem tuber: Potato

A tuber is a swollen underground stem.

A tuber can produce shoots from buds, also known as 'eyes'. It can be divided by being cut into pieces or grown from a small tuber known as a 'seed' tuber. Once divided, each piece of stem tuber has a bud or eye that will grow to produce roots and shoots. The piece of stem tuber will provide the energy for growth until the new shoot is above ground level.

TYPES OF VEGETATIVE PROPAGATION

By Stems



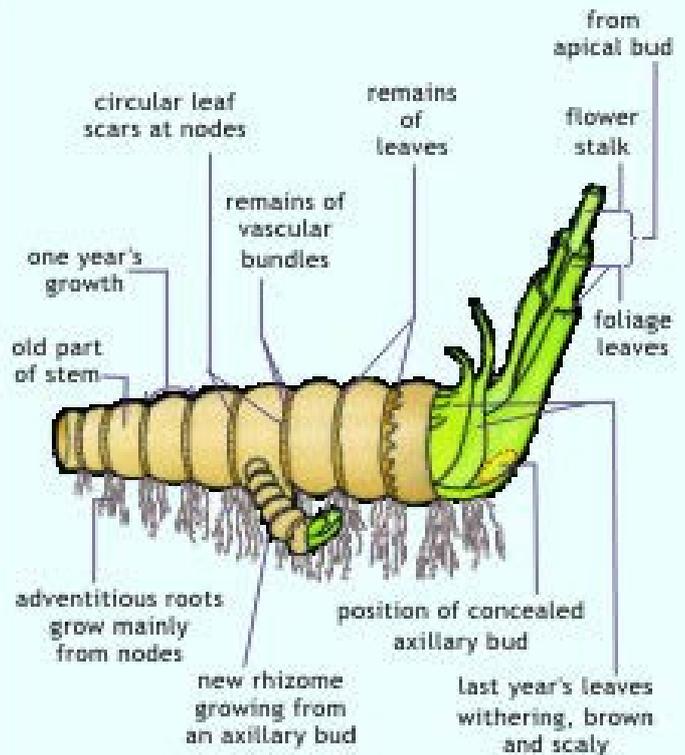
Bulb

Bulb: Onion

A bulb contains an underground stem. Leaves are attached to the stem. These leaves contain much stored food.

At the centre of the bulb is an apical bud. Also attached are lateral buds. The apical bud will produce leaves and a flower while the lateral buds will produce new shoots.

As the plant grows and develops, it will form a new bulb underground.



Rhizome

Rhizomes: Iris, Ginger

Rhizomes are stems that grow under the soil surface can be divided by cutting the parent plant into sections when the plant is dormant.

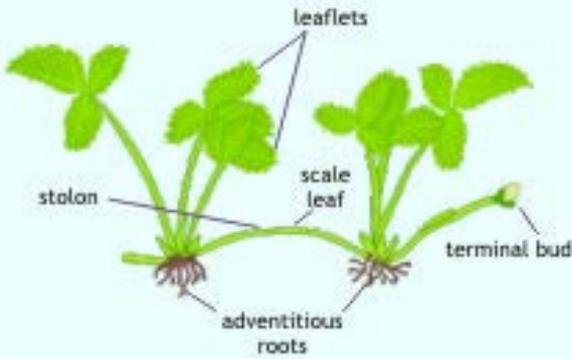
Each section must have a bud at a node.

New shoots and roots will form from the buds.

TYPES OF VEGETATIVE PROPAGATION

By Sub-aerial and Aerial Stems

Subaerial stems may develop as lateral branches from the mother plant. These may break up from the parent plant and then, grow into new plants.
Example- Runners (Oxalis), sucker - (banana, Chrysanthemum), stolon (Jasmine), offset (Eichhornia)



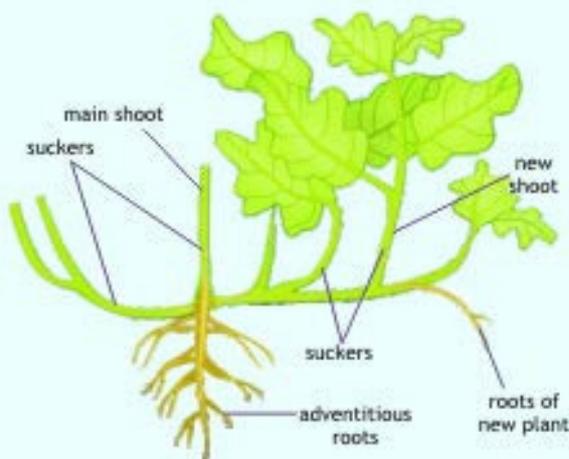
Stolon

The growing end of a shoot arches over and touches the ground.
The terminal bud touches the ground and develops adventitious roots producing a new plant.
Eg. Blackberry and Jasmine



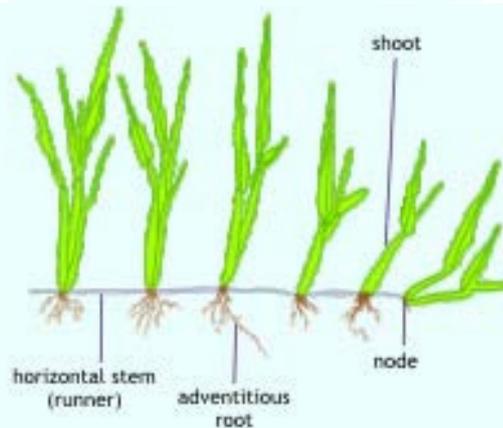
Offset

An offset is a short, thick runner like branch which produces a new plant at its tip. The offsets grow in all directions from the main stem of the parent plant. If any accidental injury results in the separation of these units, each is capable of leading an independent existence. E.g., Pistia, Eichhornia.



Sucker

A lateral branch arising close to the ground level, traveling underground for some distance. It then emerges out of the soil obliquely and give rise to a new plant.
Eg. Chrysanthemum, pineapple, raspberry etc.



Runner

These are horizontal stem growing from the parent plant above the soil. The terminal buds touching the ground develop adventitious roots.
Ex. grass, mint, strawberry etc.

TOPIC 2: CONDUCTING SEED TESTING

Seed testing refers to the method of determining the ability of the seeds to germinate. Seed germination is defined as a process whereby seeds may absorb water, increase water content, swell up and then seed coat ruptures and forms into a new plant. You need to conduct seed testing in order to determine if the seeds meet the quality standards.

METHODS	TYPES	MEANING
SEED TESTING	RAG DOLL	<ol style="list-style-type: none"> 1. Obtain random samples of the seed for testing 2. Remove the empty ones from the sample. You should have the total of 100 filled seeds 3. Write the name of the variety and the date of the test on a paper label 4. Soak a cloth in water and then squeeze the water out. This will help the seed to stick when placed on the cloth 5. Spread the cloth on a flat surface 6. Place the seeds on the cloth. Distribute all 100 seeds evenly in rows of 10. Start about 2cm from the edge of the cloth. 7. Place the bamboo stick along the longer edge of the cloth. Press the border of the damp cloth against the stick and simultaneously roll the stick with the damp cloth while moving toward the opposite border 8. To keep the seed in place, do not roll the stick without moving it toward the opposite border 9. Secure the row by tying both ends with rubber bands or a string 10. Attach the paper label on the stick 11. Moisten the seed by dipping the ragdoll in a pail of water, about 3 dips per day are sufficient to keep the seed moist 12. Store the ragdoll in a shaded place at room temperature of 28 degree Celsius, not in an air-conditioned room to maintain the moisture in the cloth 13. Protect the ragdoll from rats or other pests 14. After 4-5 days, count the number of seeds that have shoots and roots. All shoots must be longer than 1 cm. If there are not, seed viability may have been damaged 15. Record the result. The result is more reliable if the test is based on four ragdolls prepared at the same time .

SEED TESTING	PETRI DISH/ PLATE	<ol style="list-style-type: none"> 1. Prepare the seeds. To easily get the germination rate, you can use 100 pieces of seeds. Do not use broken or damaged seeds. 2. Cut the tissue paper into circles based on the size of the petri dish. 3. Place the cut tissue paper in the petri dish. Do the same to the other petri dish. 4. Moisten the tissue paper. 5. Distribute the seeds evenly in the petri dish. Avoid overcrowding the dish to allow the seeds to germinate quickly. 6. Label the petri dish cover with the seed variety and the date of the test.. Cover the petri dishes. 7. Place the petri dish in a shaded area. Avoid placing the dish in an airconditioned room to maintain the moisture 8. After several days, check the seeds if they have germinated then count the numbers of seeds that have grown shoots and roots. 9. Record the result.
	SEED BOX	<ol style="list-style-type: none"> 1. Prepare the seeds. To easily get the germination rate, you can use 100 pieces of seeds. Do not use broken or damaged seeds. 2. Fill the seed box with soil or any growing media. Spread the soil evenly. Water the soil. 3. Using a stick, make a grid of 100 equally-sized squares on the soil surface. You can use another seed box, if necessary. 4. Sow the seeds and cover them slightly with soil. 5. Water the soil. 6. Label the seed box by writing the seed variety and the date of the procedure. 7. Place the seed box in a shaded area. Always keep the soil moist. 8. After several days, check for signs of germination. 9. If most of the seeds have sprouted. Count the number of germinated seeds. 10. Record the result.

METHODS	TYPES	MEANING
SEED DORMANCY	SCARIFICATION	<ul style="list-style-type: none"> Physical seed scarification is a method that uses physical processes to break the seed dormancy. This can be done through nicking or cracking to remove a portion of the seed coat to allow the embryo to easily come out. Chemical seed scarification involves the use of one or more chemicals to break seed coat.
	STRATIFICATION	<p>Seed Stratification. a method wherein seeds are exposed to a new temperature before planting. This mimics nature's approach in waking the seed. This involves placing them in growing media and exposing them in cold temperature. All stratification techniques require moisture. Examples of seeds that can undergo this treatment are apple, lettuce and other seeds with hard coating.</p>

TOPIC 3: TYPES OF GROWING MEDIA

Growing media refers to any organic components or materials that can be taken naturally from the surroundings that can help in providing plants with good pH conditions and enough nutrients to grow. Its characteristics should be porous, firm, uniform in texture, sterile and pest-free so that it will not affect the growth of the planting material. Soil, saw dust, animal manure, and compost are some examples of growing media.

SOIL GROWING MEDIA

2 : 1 : 1



Garden Soil

River Sand

Compost

SOILLESS GROWING MEDIA



CHARACTERISTICS OF GOOD GROWING MEDIA



Sufficiently firm and dense enough to keep cuttings or seeds in place.



Able to maintain moisture (to avoid frequent watering)



Sufficiently porous to allow good drainage and aeration



Free from pest, weeds, and pathogens



Low salinity



High cation exchange capacity (for retention of nutrients and fertilizers)



Uniform and consistent in quality



Economical and readily available

RATIO & PROPORTION OF GOOD GROWING MEDIA



100% compost



100% soilless mix



25% garden soil +
75% compost



25% soilless mix +
25% garden soil +
50% compost



25% garden soil +
75% soilless mix



50% soilless mix +
50% compost

SOIL STERILIZATION/SOLARIZATION



Burning straw on soil
surface



Application of
formaldehyde, fungicides,
nematicides, etc. – soil
drenching, fumigation



Pouring of boiling water on
beds, seed box, seedling trays,
containers or pots



Steaming/cooking



Sun-drying/Soil
solarization

METHOD	ACTIVITY	STEPS
<p>PREPARING GROWING MEDIA</p>	<p>MIXING GROWING MEDIA</p>	<ol style="list-style-type: none"> 1. Wear your gardening gloves. 2. Prepare all the growing media. In the video, there are 1 part of carbonized Rice Hull, 1 part of coco peat, 1 part of compost, 1 part of rice hull, and 3 parts of garden soil. 3. Pour all the different growing media in one place. 4. Mix it thoroughly using a shovel. For mixing a smaller amount of growing media, you can use a hand trowel. 5. Water the mixture sufficiently. Make sure that all parts are watered. 6. Mix it again to ensure that all parts are moisten. Get a small amount of soil and squeeze it to check if it is in the right moisture. Make sure that the mixture is not too dry nor too wet and not too compacted nor too loose. You may use a soil moisture meter to test the moisture. It should range 3 to 5. 7. Then, you can now use your growing media.
	<p>BAGGING/ POTTING OF GROWING MEDIA</p>	<ol style="list-style-type: none"> 1. Open the polybag using your hands. Check for the holes at the bottom part of the bag. If there are none, puncture enough holes. 2. Hold the tip and fill the polybag with growing media. To let the polybag stand firmly, make sure that it is appropriately opened and that there are no crumpled parts. 3. As you fill the bag with growing media, slightly press the sides using your thumb to fill available spaces inside the polybag. 4. Hold the tip and tap the bag several times to avoid spaces inside. 5. Leave at least 2 inches of space from the tip of the polybag. This will help you transport filled bags easily. This will also avoid overflow when watering the plant and allows you to add growing media as the plant grows.

METHOD	ACTIVITY	STEPS
<p>PREPARING GROWING MEDIA</p>	<p>PREPARING SEEDBED USING SEED BOX</p>	<ol style="list-style-type: none"> 1. Make sure that the seed tray or seed box is clean. When using cultured plantlets, sanitize the seed box or seed tray using a solution like nine parts of water and one part bleach. 2. Check if the seed box or seed tray has holes underneath. If they don't have, make holes carefully by puncturing the underside of the seed tray or seed box. If you are using a seed tray or seed box with large openings at the bottom, cover the hole with a newspaper to avoid the growing media from going out. 3. Put the growing media into the seed tray. Fill the tray or the box evenly. 4. Water the growing media. Let the excess water flow out and make sure to leave enough water to retain soil moisture. 5. The seed tray or the seed box is now ready for planting.

POST-TEST

01 THE REPRODUCTION OF PLANTS THROUGH SEXUAL AND ASEXUAL MEANS.

- a. Seed Testing
- b. Plant Propagation
- c. Cutting
- d. Grafted Materials

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- b. Asexual Plant Propagation
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- a. Applying Powder into the Soil
- b. Pouring Boiling Water
- c. Burning of Straw in the Soil Surface
- d. Sun Drying

04 A STATE WHEREIN SEEDS HAD STOPPED FROM GERMINATING.

- a. Seed Testing
- b. Seed Sowing
- c. Seed Dormancy
- d. Seed Germination

05 BED OF SOIL PREPARED FOR PLANTING SEED.

- a. Seed Bed
- b. Seed Box
- c. Seed Tray
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- a. High Cation Exchange Capacity
- b. Able to Form into a New Element
- c. Low Salinity
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