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ABSTRACT

This competency-based curriculum unit on nursery propagation is one of five developed for classroom use in teaching the landscape/nursery area of horticulture. The four sections are each divided into teaching content (in a question-and-answer format) and student skills that outline steps and factors for consideration. Topics covered include planting the seed, transplanting the seed, propagation by cuttings, and grafting. A list of references precedes a section containing visual aids, student skill checklist, and student activities, such as field trips, handouts, discussion activities, worksheets, crossword puzzles, hands-on experiences, tests, and quizzes. Answer keys are provided. (YLB)

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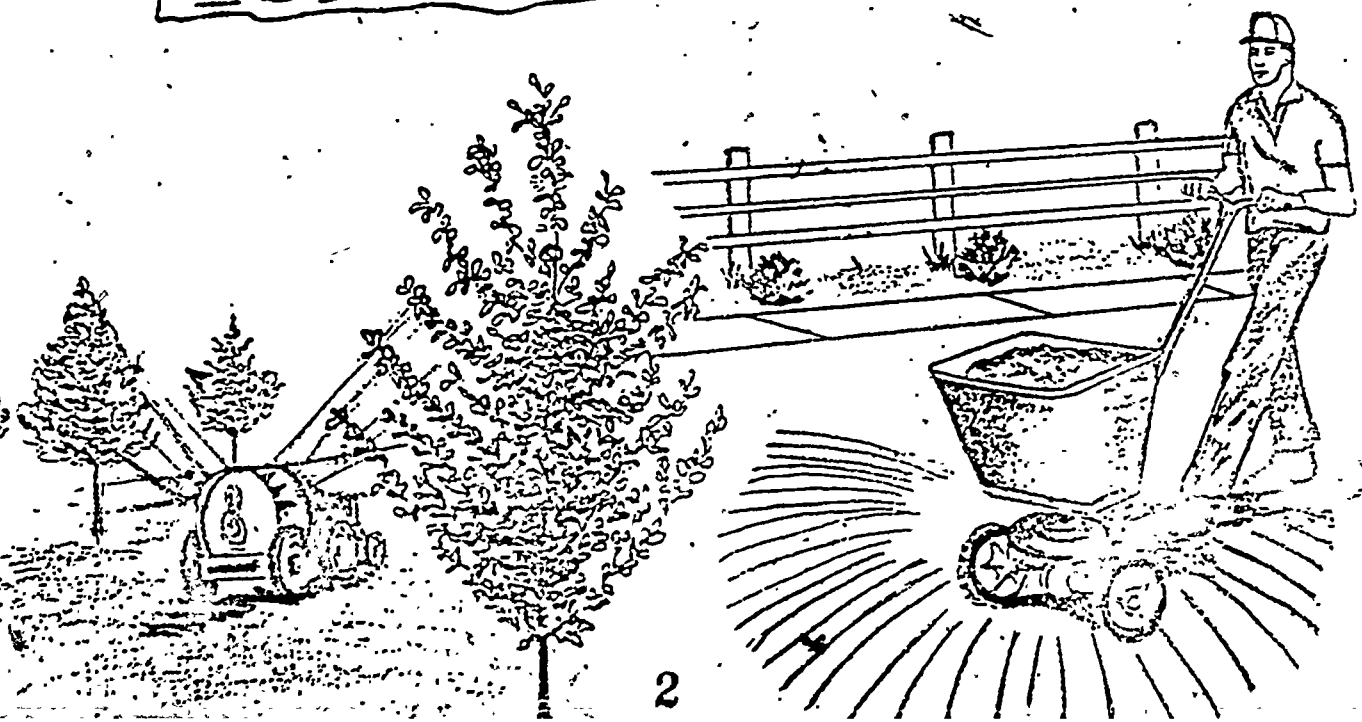
Nursery Propagation

Competency Based Teaching Materials in Horticulture



CE 031 417

Listed below are competency based curriculum units developed for classroom use in teaching horticulture. All units are indexed and include teaching content, references, student activities, a skill check list, and visual aids.

LANDSCAPE/NURSERY Tree Identification Developing a Landscape Plan Implementing the Landscape Plan Maintaining the Landscape Nursery Propagation	GREENHOUSE PRODUCTION & MANAGEMENT Controlling the Greenhouse Environment Greenhouse Soils Foliage Plants Propagation Sales Cut Flower Production Bedding Plants
TURF AND LAWN SERVICES Identification of Turf Grasses Soils and Fertilizers Planting Turf Grasses Insects and Diseases	VEGETABLE PRODUCTION Identification of Cool Season Vegetables Identification of Warm Season Vegetables Vegetable Production Insects, Diseases, and Weeds
FRUIT PRODUCTION (In progress)	

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NURSERY PROPAGATION

CONTENTS

Nursery Propagation

PLANTING THE SEED

Teaching content: 19 questions; 12 student skills

Question 1 How do chemical pollutants hinder seed germination?

- Molecules compete for enzyme bonding surfaces
- Pollutant molecules clog cell membranes reducing diffusion
- Pollutant molecules interfere with mitotic cell division

Question 2 What are the common chemical pollutants from unclean containers?

- Fungus from previous plantings
- Soap residue

Question 3 How can chemical pollution from unclean containers be avoided?

- Clean containers thoroughly using brush and soap solution
- Rinse containers several times with clean water

Student Skill 1

CLEAN CONTAINERS

Steps	Factors for Consideration
1. Gather and prepare materials	1. Bucket or sink, soap solution, water, brush
2. Wash containers	2. Use brush vigorously
3. Rinse	3. Use clean water to thoroughly remove any soap residue
4. Drain-dry	4. Towels may add residues not wanted on containers

Question 4 What are the three types of seed treatments used to control diseases?

- Disinfestation
- Disinfection
- Seed protection

Question 5 What is the major use of each type of seed treatment.

- Disinfestants eliminate organisms present on the surface of the seed
- Disinfectants eliminate organisms within the seed itself
- Protectants are materials that are applied to the seed which protect it from fungicides

Question 6 What materials are used to control diseases for each type of treatment?

- Disinfestation materials include calcium hypochlorite, Merthiolate, bromide water, and mercuric chloride and calcium hypochlorite
- Disinfection materials include hot water, formaldehyde and aerated steam, LF-10,
- Protectant materials include certain zinc and copper fungicides, copper oxide (red or yellow). Other fungicides in use include chloronil, thiram, ferbam, benomyl, captan, and zinc trichlorophenate.

Question 7 What are the types of seed treatment used to stimulate seed germination?

- Mechanical scarification
- Soaking seeds in water
- Acid scarification
- Moist-chilling (stratification)
- Combinations of two or more pregermination treatments
- Timing the planting
- Dry storage
- Chemical stimulants (gibberellins)
- Cytokinins
- Ethylene
- Potassium nitrate
- Thiourea
- Sodium hypochlorite
- Exposure to light

Question 8 What are the requirements a seed germination should meet?

- Favorable pH level
- Adequate supply of nutrients--limited amounts
- Firm soil
- Porous
- Uniform in texture
- Sterile
- Free of weeds, insects, and disease organisms

Question 9 What types of germination media are available?

- Soil
- Sand
- Peat moss
- Sphagnum moss
- Perlite
- Vermiculite
- Jiffy Mix
- Pro-Mix
- Mixtures

Question 10 What are the specific uses of each as a medium?

- Soil--can be mixed with other materials as growth medium; not used by itself; must be sterilized before use
- Sand--is most useful as a propagation medium for cuttings.
- Peat moss--used for growing and propagating plants; used as a covering for germinating seeds, as an integral part of seed and potting composts, as a propagation medium; can be used alone or with sand
- Sphagnum moss--may be used as a germinating medium or as a growing medium for plants
- Perlite--as a rooting medium for cuttings; particle size from 2-8 mm is ideal
- Vermiculite--used as seeding medium; horticultural grade is preferred
- Jiffy mix--used as germinating and growing medium
- Pro-mix--several types available; sterilized material for germination and growth of seedlings
- Mixtures--light mixtures of the nature of loam or sandy loam are preferred for germinating seeds and as a growing medium for potted plants. Synthetic mixtures containing one part soil, one part sand and one part peat, by volume, are used. Mixtures of peat and sand are widely employed for propagation by means of cuttings.

Question 11 What kind of containers are available for planting?

- Flats
- Trays
- Peat pots
- Pans
- Market packs
- Other

Question 12 How much potting material should be used?

- After packing, at least 10 times the thickness of the seed
- Depends on height of the potting container
- Packed to within 1/2 to 1/4" from top rim

Question 13 How firm should potting material be packed?

- Firm enough that material does not shrink downward after watering

Question 14 How full should containers be filled?

- About 1/2 to 1/4" from top rim

Question 15 Why is the level of the fill important?

- 1/4" at top allows for water to settle without washing away any media and possible seeds
- More than 1/2" from top rim may cause a shadow (less light) on seedling when it surfaces!

Student Skill 2

FILL CONTAINERS

Steps	Factors for Consideration
1. Gather materials	1. Clean containers, potting media
2. Fill containers	
3. Pack potting material in containers to within 1/2 to 1/4" from top rim	3. Firm to touch, but not as hard as you can. Potting material should not shrink-down when water is added
4. Water from bottom in tray of shallow water	4. Until moist on top
5. Let stand 2-6 hours	5. Allows excess water to drain
	6. Can be watered after sowing seed

Question 16 When should seed be sown?

- Use booklets, catalogs, circulars for information, past year's records; Calendar, dates for each seed type, hardiness of plant
- Figure backwards starting with date of sale, then back to planting date using: days from planting to transplanting; days from transplanting time to date for planting in ground or sale to customer. For outdoor plants: know tolerance to weather of plants. Average frost free date for area.

Question 17 How are seeds designed for survival?

- Seed coat reduces chance of dehydrating contents
- Small hole (near hilum) allows for oxygen to enter
- Food supply inside for growing embryo
- Seed-leaves (cotyledons) inside for immediate photosynthesis when seedling surfaces.

Question 18 What are factors affecting germination?

- Water
- Water availability
- Oxygen-exchange of gases between embryo and atmosphere
- Temperatures between 36°F and 92°F

Question 1.9 How are water and oxygen used for germination?

- Water softens seed coat for expanding due to growth
- Water is required for diffusion of chemical molecules across a living membrane
- Oxygen is required for conversion of stored food to energy used in mitotic cell division.

Student Skill 3

SOW SEEDS

Steps	Factors for Consideration
1. Make drills (or rows) in flats	
2. Spacing of seeds--different seeds for different uses:	
a. Close together-almost touching	a. Size of seed varies
b. Farther apart	b. Seed size affects spacing
c. For transplanting later	c. Sow closely together if transplanting to be done later
d. For planting directly into soil (peat pot)	d. Certain seeds do not transplant well--plant these in individual pots, or peat pots
e. For specimen planting	e. Plant seeds in rows for better air circulation to reduce disease, mold, mildew.
f. In rows rather than small clumps	f. Clumps of seeds do poorly due to competition for nutrients, light, moisture, air--roots will be short and crowded, stems spindly, leaves small
g. Outdoors in final location	g. Some seeds grow adequately when planted outside
	h. Space correctly when planted
	i. The greater spread of top growth requires increased spacing
	j. Spacing of seeds affected by germination percentage--age of seed and conditions of storage. Low germination--sow thicker
	k. Check germination rate
3. Disperse seeds between fingers, or use a battery-powered vibrating tool.	
4. Depth to plant:	
a. 2-3 times diameter of seed	4a. Light-sensitive seeds for germinating--must be on top of soil. Follow seed company directions

Student Skill 4

COVER SEEDS

Steps	Factors for Consideration
1. In the drill, cover to twice the diameter of seed	
2. Use shredded sphagnum moss. Moss is high acid pH and helps prevent "damping off"	2. Must be sterile
3. May use fine perlite, fine sand, or regular media	
4. Very fine seeds--do not cover	4. With dark-germinating seeds follow package directions.

Student Skill 5

WATER THE SEED FLAT

Steps	Factors for Consideration
1. Use tub of H_2O for inserting flats at shallow depth for subirrigation	
2. May be top-watered	2. Capillary action brings water from bottom to top--the smaller the tube (or soil mix), the higher it goes. Top watering may bury seeds too deeply or disturb seeds. Extremely dry and/or fine media must be premixed with water by hand as it won't soak up H_2O

Student Skill 6

LABELING SEED FLATS

Steps	Factors for Consideration
1. Use plastic plant label or pieces of plastic cartons	
2. Write using pencil or permanent felt marker	
3. Write information on label	3. Identify seed, variety, date
4. Insert label edgewise along side of media in flat	4. Won't get broken off, lost, pushed over, if covered

Student Skill 7

ADJUST CONDITIONS FOR GERMINATION

Steps	Factors for Consideration
1. Bottom heat for flat of 18°-21°C (65-70°F)	
2. Flats or pots covered with glass or plastic plate, or sheet of plastic film, tucked in and/or around	2. Retains moisture for germination--no additional watering needed. Newspaper works, but can't see seedlings thru it.
3. Full sun or fluorescent lights (one cool-white bulb and one regular white bulb) should be used for food production after seed has germinated.	3. Distance 15-20 cm (6-8 in.)

Student Skill 8

CHECK SEEDLING GROWTH

Steps	Factors for Consideration
1. Remove cover when seedlings reach desired height	
2. Water as needed--uniformly, room-temperature water	
3. Fertilize with water-soluble nutrients regularly	
4. Provide proper drainage of flat	
5. Lower temperature as plant adapts to conditions	
6. Place in full sunlight	6. Desire sturdy stem, large leaves, short internodes
7. Reduce water before transplanting	7. Induces better root growth. Easier to transplant as media crumbles off somewhat. More root hairs and primary roots stay on seedling.

Student Skill 9

ADAPT LIGHT-SENSITIVE GERMINATING SEEDS

Steps	Factors for Consideration
1. Omit covering with germinating media	1. Light stimulus is needed to germinate seeds
2. Follow directions on seed container	2. After germinated, add a small amount of media to cover roots as needed

Student Skill 10

LOCATE OPEN SEED BED AREA OUTSIDE FOR TREES AND SHRUBS*

Steps	Factors for Consideration
1. Use semi-shade	1. 3-4 hours sun per day
2. Use a canopy of burlap or muslin on a wooden frame.	2. Helps in light and wind screening
3. Plant in fall outside	3. Alternate freezing and thawing helps break dormancy

*This method not frequently used; more often seeds are placed in coolers to break dormancy.

Student Skill 11

PLANT SEEDS OUTSIDE IN PROTECTED AREA

Steps	Factors for Consideration
1. In cold frame	
2. Mulch with hay or straw in winter	

Student Skill 12

PLANT IN OPEN GARDEN OR FIELD

Steps	Factors for Consideration
1. Remove mulch early	1. Soil warms faster in early spring
2. Add organic matter and side-dress fertilizer	
3. Spacing determined by needs of mature plant	
4. Sow seeds	
5. Water seeds	
6. Mulch soil over seeds	
7. Thin seedlings later	7. Refer to Tree and Shrub books for planting.

TRANSPLANTING THE SEED

Teaching content: 32 questions; 8 student skills

Question 1 At what stage should a seedling be transplanted?

- When it has three true leaves (seed leaves that develop into food-producing structures).

Question 2 What competitive factors increase the need for transplanting seedlings?

- Nutrients of the soil--minerals, water
- Space above ground--to spread leaves
- Carbon dioxide--for photosynthesis
- Sunlight--for photosynthesis

Question 3 What parts of the seedling are fragile?

- Stem
- Roots
- Root hairs
- Leaves

Question 4 Why are seedlings so fragile?

- New (cellular) growth does not include hardened resins for support

Question 5 What is the purpose of root hairs?

- Increase surface area, thereby increasing rate of absorbing materials (mineral ions) from the soil.

Question 6 How are root hairs designed to accomplish their purpose?

- Very thin, very numerous

Student Skill 1

REMOVE SEEDLINGS FROM SOIL MEDIA

Steps	Factors for Consideration
1. Moisten seedling bed	1. Reduces chance of breaking root hairs
2. Remove (dig up) seedling with fingers or small shovel without pulling loose from surrounding soil	2. Special care should be taken to not injure (by stretching) root hairs. Dirt ball removed with seedling should be about same size (diameter) as that of leafy top.

Question 7 What determines the pot type to use when transplanting?

- Small single pot or peat pots for single speciman use and sale
- Market pack of six for small volume sales
- Market pack of 12 for larger group sale and supply
- Consecutive transplanting to next size larger pot for certain species
- Transplanting shock to the specific plant--keep to a minimum

Question 8 What type soil media should be used?

- Adequate soil nutrients
- Well aerated
- Absorbs moisture, holds moisture
- Sterile, weed free, and insect free
- Future use affects soil media for weight of soil
  *Hanging pots should be lighter weight mix
- Determine by plant needs for moisture, drainage, aeration, etc.

Question 9 What type pots should be used for growing plants?

Alternatives	Factors for Consideration
1. Clay pots	- Porous, loses moisture readily, heavy, easily broken. Round shape is not economical of space. After continued use, toxic salt accumulations build up. Can be steam cleaned and reused. Very popular.
2. Plastic pots	- Can be round or square, reusable, lightweight, use little storage space since they "nest", and are nonporous. Pathogenic organisms can be eliminated by hot water dip (158°F, 70°C) for 3 minutes without damage to plastic. Cannot be steam sterilized.
3. Fiber pots	- Can be small pots, 2-4" in size, round or square pressed into shape from peat plus wood fiber, with fertilizer added. Are dry and keep indefinitely. Are biodegradable and are set in soil with plant inside. Will fall apart when moved. Unless they are kept moist, roots will fail to penetrate walls of pot and will grow into an undesirable spiral pattern.

Question 10 What are the various types of germinating, propagating and growing media available?

- Peat
- Sphagnum moss
- Sand
- Vermiculite
- Volcanic rock (perlite)
- Mixtures

Question 11 What are the specific uses of each as a medium?

- Peat. Peat is used for growing and propagating plants. Peat moss is used as a covering for germinating seeds, as an integral part of seed and potting composts, and as a propagation medium, used alone or with sand.
- Sphagnum moss. May be used as a germinating medium or as a growing medium for plants.
- Sand. Most useful as a propagation medium for cuttings.
- Vermiculite. As a seeding medium; the horticultural grade is used
- Volcanic Rock (Perlite). As a rooting medium for cuttings, perlite ranging in particle size from 2-8 mm is ideal
- Mixtures. Light mixtures of the nature of loam or sandy loam are preferred for germinating seeds and as a growing medium for potted plants. Synthetic mixtures containing one part soil, one part sand and one part peat, by volume, are used. Mixtures of peat and sand are most widely employed for propagation by means of cuttings.

Question 12 Why do you grasp the seedling by the leaves, not the stem?

- Leaves are only a part of the plant
- Stem may be pinched too tightly and choke off plant; it dies
- A stem will not regrow again easily, but a leaf will

Question 13 What damage could be caused by too loose a repack?

- Seedlings need support against falling over; leaves touching soil will decay (rot)

Question 14 What damage could be caused by too hard a repack?

- Fragile root hairs could be broken and therefore reduce absorption power of seedling

Question 15 What part of the seedling is (totally) responsible for the absorption of water?

- Root hairs

Question 16 Why is water absolutely necessary for plant growth?

- Dry materials cannot be absorbed through a living cell membrane
- Water dissolves the minerals in soil and brings them to the root hairs

Question 17 What damage can occur with too much water pressure when watering newly planted (transplanted) seedling?

- Bending seedling and sticking leaves to media; leaves will rot when stuck to soil
- Root hairs may be torn (due to stretching)

Student Skill 2

PRE-WATER MEDIA FOR TRANSPLANTING

Steps	Factors for Consideration
1. Mix Pro-mix with water	1a. 12-20 times its weight of water 1b. Work water in with hands or use small tumbler (or cement mixer)
2. Fill trays with water about 1" or 1/2 as deep as height of containers	2a. Watering from bottom helps to settle soil
3. Place containers in water in tray	
4. Allow containers to stand until top of potting material looks wet	
5. Remove excess water from tray and allow to drip (pots)	5. Then plant soon to prevent evaporation

Student Skill 3

TRANSPLANT SEEDLINGS

Steps	Factors for Consideration
1. Prick out seedling	1a. Use plant label or fork 1b. Take out only a very few so roots won't dry before planting
2. Pick up seedling	2. Grasp leaf with fingers, NOT the stem
3. Make hole in media for seedling	3a. Use pointed dibble--either a single, or a many-dibble set up for the whole flat 3b. Deeper hole than roots 3c. Wider hole so roots will be spread out
4. Insert plant	4a. Extend roots 4b. Plant about same depth as before
5. Firm soil around seedling	5a. Use fingers and knuckles of both hands 5b. Plant should remain erect
6. Water soil gently	6a. Soil level in pot one inch below surface edge of pot 6b. No water if media was pre-watered 6c. All the way thru media, if not pre-watered.
7. Insert label (plant)	7. Indicate variety, name, and date.
8. Put container into tray	8. Same variety of plants together

Question 18 What are possibilities for watering the media?

- Some fine, dry media (like Pro-Mix) must be mixed with 12-20 times its weight with water before putting into pot (as per directions on package)
- Soil sub-irrigated before planting seed
- Soil top-watered before planting seed
- Soil sub-irrigated after planting seed
- Soil top-watered after planting seed

Question 19 What are problems in sub-irrigating pots?

- Takes a little longer as water moves up thru media by capillary action
- Reduces leeching of potting material and its nutrients

Question 20 What are advantages in sub-irrigating pots?

- Does not disturb seeds or seedling
- Does not bury seeds or wash seeds out of media

Question 21 What are problems in top-watering of pots?

- Media will settle more unless firmed down
- Wash away potting media covering seeds, and around plant
- Wash away potting media surrounding seed, and around plant
- Wash away seed or plant

Student Skill 4

MOISTEN TRANSPLANTS

Steps	Factors for Consideration
1. Moisten surrounding soil until repacked media remains moist, but water is not standing.	1. Fine spray reduces chances of washout of repack

Question 22 What soil treatment is done to prevent "damping off", a fungus disease?

- Cover soil with sterile media--sand, perlite, vermiculite
- Use milled sphagnum moss (or ground) which is low pH (acid). This helps prevent damping off.
- Spray seedlings with a chemical solution, such as "Captan".

Question 23 What light intensity should the seedlings receive?

- Medium light intensity for one or two days--to adjust roots to new pot of soil
- Increase to bright(er) light after 2 or 3 days
- Gradually move into sunlight, if possible
- Stronger light of 1500 to 2000 ft.-c (foot-candles) and up, will produce healthier plants with larger leaves, shorter internodes, and better growth with earlier blooms, etc.

Question 24 What humidity levels should be maintained?

- High humidity for several days
- Greenhouse effect for plants--cover with a plastic (baggie, if singles), or film or tent to keep humidity 60 to 70%
- After transplanting shock is over, you can remove the hoods or tents

Question 25 What water requirements should be carried out?

- Water regularly and as needed
- Brighter light or sunshine produces more growth, photosynthesis, and evaporation giving a greater need for water--twice daily on some days
- Warmer days produces more growth requiring more water

Question 26 What are the nutritive requirements for the seedling?

- Some mixes already have a complete fertilizer added--good for a couple of weeks
- A dilute solution of a complete fertilizer may be added daily with each watering

Question 27 When should you transplant seedling the next time?

- Depends on plant--some are to be kept pot-bound, some varieties need space. (Read the growing conditions for that plant)
- When roots begin showing thru the peat pot, repot
- When roots begin showing thru drain holes, repot
- When top growth gets adequate or large, repot

Question 28 What do you transplant the young plant into?

- Use the next size larger pot. If 2 1/4, go to 3". If 3" go to 4".
- Some plants which transplant poorly should be put into the second size larger pot
- If in a peat pot, put into permanent location, and tear off top edge of peat pot, or burn peat pot completely to prevent "wicking" of moisture by capillary action upwards, producing faster drying of soil, pot and plant.

Student Skill 5

TRANSPLANT A SECOND TIME

Steps	Factors for Consideration
1. Select pot	1a. Next size larger 1b. More permanent style pot
2. Cover drain hole	2a. Use sphagnum moss, pottery pieces, pebbles, piece of nylon stocking, or paper towel piece
3. Add small amount of media to bottom of pot	3a. Old plant ball should be about the same height in soil in new pot 3b. Estimate depth with plant in older, smaller pot
4. Soil around plant in pot should be somewhat dry before transplanting	4a. Do not water plant the morning of transplanting 4b. Knocks out of pot easier 4c. Soil will not "puddle" so easily
5. Spread fingers of left hand around plant stem and over top of soil	5a. To hold plant stem in with roots 5b. To catch dirt ball with roots
6. Invert pot over left hand, and gently tap pot edge on edge of table	6a. Tap once or twice on table 6b. Certain pot--you may need to hit bottom of inverted pot with palm of right hand
7. Remove pot from root ball as it loosens	7a. Plant, soil, and roots should all come out together in a ball 7b. Keep roots all in tact
8. If roots are pot bound, gently loosen them from soil at edges or unwind them	8a. Try to save all roots 8b. Roots will grow out into new soil better if loosened
9. Place root ball into new pot	9a. Center the plant 9b. Plant erect
10. Fill in edges around root ball with soil	10a. Firm down with fingers 10b. Firm media all around the pot 10c. Leave one inch top space to water
11. Water completely	11a. Either from top or bottom 11b. Add water until water runs out bottom
12. Replace plant label	

Question 29 Why is drainage needed in a flower pot?

- To reduce mold in roots due to lack of aeration
- To keep water (in soil and pot) "sweet and clean."
- To eliminate offensive odor

Question 30 What do you use to cover drainage hole?

- Piece of broken pot
- Sphaghum moss
- Pebbles
- Piece of nylon stocking--will not rot
- Paper towel, cloth--for temporary use

Question 31 What do you do if there is no drainage hole?

- Make a hole--use drill, chisel, hot wire, hot poker
- Put a 1" layer of charcoal (washed) in bottom of pot. Then add layer of coarse sand; then layer soil media. Charcoal helps keep water "sweet"
- Put a rigid glass tube into pot before filling with soil (all way to bottom). With a "dip stick", put it in tube to bottom, pull out and check level of water in bottom where roots are. Replace measuring stick in tube in pot.

Question 32 Why should a plant be "hardened off"?

- To acclimate the plant to outside conditions
- Sunshine is stronger outside than inside greenhouse by about 10-15% or inside your home by 25-75%
- Transpiration and evaporation is much greater to plant due to more wind or air movement outside
- A greater fluctuation of temperatures outside
- More wind to possibly blow over the plants
- Plants are not as sturdy inside

Student Skill 6

"HARDEN OFF" THE PLANT

Steps	Factors for Consideration
1. Allow plant to adapt to outside environment	1. Slowly over several days to week's time
2. Reduce watering frequency	2a. Produces stronger roots 2b. Induces plant stress 2c. Readies plant for adverse growing conditions
3. Place outside in protected area	3. Begin with a few hours/day; use morning hours
4. Increase time span and temperature conditions outside	4a. Gradually increase time and sun brightness outside 4b. Increase temperature extremes
5. Use a cold frame	5. Remove cover and/or check temperature hourly
6. Cover if extreme cold for next few days	6. Use milk cartons, hood, other covers when out in open row

Student Skill 7

SELECT AND MAINTAIN HEALTHY STOCK PLANTS

Steps	Factors for Consideration
1. Observe stock plants for habit of growth, flower characteristics, amount of flower production and disease symptoms	
2. Select uniform, true to type, pathogen-free stock plants that can be maintained under proper nutritive conditions	

Student Skill 8

DETERMINE PHYSIOLOGICAL CONDITION OF PLANTS

Steps	Factors for Consideration
1. Select those shoots with greenish stems	1. Greenish stems are more likely to contain ample carbohydrates, and have a high nitrogen content. They will produce fewer roots but stronger shoots
2. Determine carbohydrate content by examining stem firmness	2. Stems that are soft and flexible and unsuitable
3. Make iodine test to determine a desirably high starch content. Place freshly cut ends of a bundle of cuttings into a 0.2% solution of potassium iodide	3. Cuttings having highest starch content will stain darkest color

PROPAGATION BY CUTTINGS

Teaching content: 21 questions; 10 student skills

Question 1 What is the function of growth regulators?

- To increase the percentages of cuttings which form roots
- To hasten root initiation
- To increase the number and quality of roots produced per cutting
- To increase uniformity of rooting

Question 2 Which hormones are used for general purposes of rooting?

- Naphthaleneacetic acid (NAA)
- Indolebutyric acid (IBA)

Question 3 What are the disadvantages of using root-promoting substances?

- Application of synthetic auxins to stem cuttings at high concentrations can inhibit bud development. It may reach to the point at which no shoot growth will take place although root formation has been adequate
- Applications of rooting substances to root cuttings may inhibit the development of shoots from root pieces

Question 4 What are alternative mediums for cutting propagation?

Alternatives	Factors for Consideration
1. Soil	- Ordinarily used for planting deciduous hardwood cuttings and root cuttings. A well-aerated sandy loam is preferable to heavy clay soil. - Cuttings of certain easily rooted plants such as chrysanthemums and geraniums, are sometimes started directly in small containers or plant bands, using a mixture of 2 parts coarse sand to 1 part soil. - Soil should be heat-treated or fumigated before using.
2. Sand	- Is widely used as a rooting medium for cuttings. It is inexpensive and readily available. - Sand is not as retentive of moisture as most other rooting media, necessitating more frequent watering. - Should be fine enough to retain some moisture around cuttings yet coarse enough to allow water to drain freely through it.

- Used alone, very fine particle sand or very coarse sand does not give good results with cuttings of most woody ornaments.
- Best to use sand only once for rooting cuttings unless it can be sterilized.
- For evergreens, such as yews, junipers, and aborvitaes, sand is probably the most satisfactory rooting medium to use.
- With some species, cuttings rooted in sand produce a long, unbranched, brittle root system in contrast to more desirable fibrous and branched systems developed in other media.

3. Peat moss

- Peat moss is often added to sand in varying proportions, mainly to increase water-holding capacity of mixture. Sand and peat moss combination makes a good rooting mixture for cuttings of many species. Mixtures used vary from 2 parts sand and 1 of peat moss to 1 part sand and 3 of peat moss.
- Including peat moss in a rooting medium considerably increases the mixture's water-holding capacity and the danger of overwatering
- High proportions of peat moss in mixture if kept wet, as in a mist bed, will sometimes cause deterioration of roots soon after they are formed.

4. Shredded sphagnum moss

- Sometimes used as a rooting medium when mixed with an equal part of sand.

5. Vermiculite

- Often used as rooting medium. Cuttings of some plants root better in larger particle sizes, whereas others do better in smaller sizes.
- Mixture of equal parts of vermiculite and perlite (or a medium-grade sand) usually give better results than either material used alone.

6. Perlite

- Used as a rooting medium for leafy cuttings, especially under mist, owing to its good drainage properties. May be used alone but is best used in combination, in varying proportions with peat moss or vermiculite.

7. Water
- Water can be used to root cuttings of easily propagated species. Disadvantage is lack of aeration. Artificially aerating water with aid of oxygen can produce excellent rooting of cuttings of some species. In aerated water, best roots are produced near basal end of cuttings, whereas in nonaerated water, best roots are produced near surface of water where oxygen content is higher.

8. Moisture-saturated air
- Can be used as a rooting medium by placing cuttings in closed frames in which relative humidity is maintained by mist nozzles close to 100%. This method has resulted in satisfactory root formation with some plants and is especially successful with root cuttings.
- Does not lend itself to large-scale use.

Question 5 Where should cutting be severed from mother plant?

- Best about 3-6" from terminal tip(s)
- Trim off all but top 3 leaves to decrease rate of transpiration (water loss)

Question 6 What damage could occur from a ragged cut?

- Decaying cellular debris on edges would prevent healthy cell growth close to the nutrients

Question 7 What are some examples of plants that can be propagated easily using the "stick" method?

- Roses
- Geraniums
- Garden Chrysanthemums
- House plants in general (e.g., African violets)

Question 8 How deep should the cut stem (removed shorter part) be "stuck" into the soil?

- About 1/3 of its length (1-2").

Question 9 How is the cut stem "stuck" into the soil without causing damage to the cells at the cut edge?

- Poke a hole into soil with a pencil or finger--slide stem into hole and gently repack

Question 10 How firm should the media (soil) be repacked around the "stuck" stem?

- Firm to the touch, but not as hard as you can push
- Enough to support cutting from falling over, but not to crush underground portion of stem

Student Skill 1.

PLANT CUTTINGS (STICKING)

Steps	Factors for Consideration
1. Make a hole in sticking-bed 1-2" (as needed) with pencil or finger	
2. Slide prepared stem into hole	
3. Repack media around "stuck" stem	3. Firm to touch, but not as hard as you can

Question 11 Why are leaf slips generally grown inside vs. outside in the yard?

Alternatives	Factors for Consideration
1. Inside	- Environmental conditions are controlled (i.e., water, temperature, air circulation, humidity) - Leaf slips do not take up much room and can be grouped together in a tray
2. Outside	- Slips subject to harsh environmental conditions (beating action of rain and sun) - Slips easily destroyed by being stepped on, etc.

Question 12 Where is best probable place to cut leaf for maximum root development?

- About 1/5 to 1/4 distance from peticle attachment to leaf

Question 13 What damage could occur from a ragged cut on the leaf?

- Cellular growth requires healthy cells, close to nutrients--without decaying cellular debris on edges.

Question 14 What are some examples of plants that can be propagated easily using the "slip" method?

- Begonias
- Mother-of-thousands
- Royal velvet
- La Jolla plant

Student Skill 2

CUT FROM MOTHER PLANT

Steps	Factors for Consideration
1. Obtain a sharp knife	1. Unlike cutting of stems, a scissors can be used since leaves are thin. However, scissors must be sharp.
2. Cut off bottom (where petiole attaches to leaf) 1/5 or 1/4 of leaf	2. In general, area cut probably will be widest part of leaf on plants being used.

Question 15 How deep should this cut leaf (top part) be "slipped" into growth media?

- 1/4-1/2"

Question 16 Which part of cut leaf is "slipped" into the growth media?

- Cut edge goes in media (leaf standing vertical)

Question 17 When should the growth media be watered--before or after planting?

- Loosened growth media is DRY; moisten only after planted
- If outside yard is media, wet thoroughly BEFORE planting

Question 18 How firm should growth media be repacked around "slipped" leaf?

- Firm to touch, but not as hard as you can push
- Enough to support leaf vertically, but not to crush underground portion of leaf's cut edge

Student Skill 3

PLANT SLIPS (CUTTINGS)

Steps	Factors for Consideration
1. Slide cut edge of leaf 1/4-1/2" into growth media	1. Leaf to stand vertically
2. Repack media around planted edge of leaf	2. Firm to touch, but not as hard as you can

Question 19 Why is water absolutely necessary for plant growth?

- Dry materials cannot be absorbed through a living cell membrane
- Moist soil (growth media) is "softer" for new root growth to push through

Question 20 How much water should be added?

- Enough that growth media looks moist (and remains moist) but water should not be standing on surface

Student Skill 4

MAKE LEAF CUTTING

Steps	Factors for Consideration
1. Propagate begonia by stamping out leaf disks (2cm diameter) with cork borer	1. This method may be useful in propagating other species with large flat leaves
2. Obtain 40 to 50 disks from a single leaf	
3. Treat disks with indolebutyric acid and kinetin to stimulate root and shoot development	
4. Place disks on moistened filter paper in covered petri dishes during regeneration period	

Student Skill 5

MOISTEN PLANTING

Steps	Factors for Consideration
1. Moisten soil (growth media) surrounding "slipped" leaf until growth media appears moist looking	1. Use a fine spray if possible to reduce chances of washout or repack or knocking leaf over

Student Skill 6

MAKE HERBACEOUS CUTTINGS

Steps	Factors for Consideration
1. Make cuttings 3-5" long with leaves retained at terminal end or without leaves	1. Cuttings that exude a sticky sap such as geranium, pine, or cactus should be allowed to dry for a few hours
2. Use root-promoting substances to gain uniformity in rooting and development of heavier root systems	
3. Supply high humidity and bottom heat	
4. Root in a medium of peat, sand, vermiculite or a 1:1:1 mixture	

Student Skill 7

MAKE HARDWOOD CUTTINGS (DECIDUOUS SPECIES)

Steps	Factors for Consideration
1. Take cuttings from stems of moderate vigor and with a diameter range from 1/4-2" and a length from 6-8". Take from dormant leafless one-year old shoots	
2. Include at least two nodes in cutting; make basal cut just below a node and top cut 1/2-1" above a node	
3. Make a "mallet" cutting by including a short section of stem of older wood	
4. Make a "heel" cutting by including a very small piece of older wood	
5. Make a "straight" cutting by not including any of older wood	
6. Distinguish between top and base of cuttings by making one of cuts with a slant rather than cutting at right angles	
7. Dip basal ends of cuttings in a solution of indolebutyric acid or another root-promoting substance	
8. Use a dibble to insert cuttings and to firm soil	8. Some plants must be calloused before planting.
9. Plant cuttings 3-4" apart and deeply enough so just one bud shows above ground	
10. Plant in a loose sandy loam	

Student Skill 8

MAKE HARDWOOD CUTTINGS (NARROW-LEAVED EVERGREEN SPECIES)

Steps	Factors for Consideration
1. Take 4-8" long cuttings from young seedling stock. Select 1-year shoots	1. Take cuttings between late fall and late winter. Handle with rapidity.
2. Cut mature terminal shoots of previous season's growth	
3. Treat with indolebutyric acid or another root-promoting substance	
4. Root cuttings in a greenhouse under high light intensity and high humidity	
5. Supply a bottom heat temperature of 75°-80°F (24°-26.5°C)	
6. Dip cuttings into fungicide solution	
7. Place cuttings in a flat filled with sand or use a 1:1 mixture of perlite and peat moss	
8. Restick slow to root cuttings in rooting compound	

Student Skill 9

MAKE SOFTWOOD (GREENWOOD) CUTTINGS

Steps	Factors for Consideration
1. Take cuttings from soft, succulent new spring growth	
2. Take cuttings in early part of day and keep cool and moist	
3. Select stems that have some degree of flexibility but are mature enough to break when sharply bent	
4. Select stems from lateral or side branches with average growth	
5. Make cuttings 3-5" long with 2 or more nodes. Make basal cut just below a node	
6. Remove leaves on lower portion of cutting and retain those on upper part	
7. Remove all flowers or buds	
8. Dip in a root-promoting preparation	
9. Plant in a media of 1:2:1 made from sand, loam soil and peat	
10. Place in high humidity	
11. Supply bottom heat of 65°-70°F	

Student Skill 10

MAKE SEMI-HARDWOOD CUTTINGS

(Usually made from woody, broad-leaved evergreen species, but leafy summer cuttings taken from partially matured wood of deciduous plants could be considered as semi-hardwood)

Steps	Factors for Consideration
1. Take cuttings during summer from new shoots just after a flush of growth has taken place and wood is partially matured	
2. Make cuttings 3-6" long with leaves retained at upper end	
3. Use shoot terminals or basal parts of stem	
4. Make basal cut just below a node	
5. Take cuttings in cool early morning when stems are turgid and keep wrapped in a clean moist burlap bag or put in a large polyethylene bag	
6. Dip into a liquid rooting "hormone" (auxin) preparation for 5 seconds	
7. Place in a rooting media of 1:1 mixture of perlite and peat moss or perlite and vermiculite	
8. Cut rows in rooting media with a heavy knife against a board	
9. Supply bottom heat of 75°-80°F	
10. Place leafy cutting under intermittent mist sprays.	

GRAFTING

Teaching content: 29 questions; 15 student skills

Question 1 What is the advantage of grafting one plant type to another?

- Start a desired plant on one with established root system
- Desired plant may have root system typically susceptible to disease

Question 2 Why use dicot plants rather than monocot plants for root stock?

- Functional xylem and phloem near outer edge on dicot plants; scattered at random throughout monocot stems
- Most monocot plants are annuals (die after one year)

Question 3 What are the qualities of healthy root stock at time of budding?

- Seedling root stock must be in an active growth, indicated by soft, rapidly growing branch tips

Question 4 What is a final test to determine if seedling is receptive to bud?

- Bark should slip loose easily when cut and wood underneath appear moist and smooth, with no tearing or stringing of tissue

Student Skill 1

SELECT ROOT STOCKS FOR BUDDING

Steps	Factors for Consideration
1. Select root stock plant that has desired characteristics of vigor, growth habit, and disease resistance	1. Root stock plant must be easily propagated
2. Select root stock plant that has had 1 year's growth in nursery row before budding is to be done	2a This root stock plant may be a rooted cutting, rooted layer, or more commonly, a seedling
	2b Seedlings of slow-growing species may require two seasons growth to produce a root stock plant large enough to be budded

Question 5 Why use dicot plants rather than monocot plants for stem stock?

- Functional xylem and phloem near outer edge on dicot plants; scattered at random throughout monocot stems
- Most monocot plants are annuals (die after one year)

Question 6 Why is it best to choose root and stem stock that are same diameter at location to be grafted?

- Functional xylem and phloem are near outer edge on dicot plants; they must match-up if materials are to flow through them

Question 7 Can two different diameters be grafted together?

- Yes, but be sure one edge of each is lined up together to increase the possible number of xylem and phloem tubes lining up for continuation of flow
- Chances of successful grafting (plant survival) decreases with decreased number of xylem and phloem lined up

Question 8 What is the primary function of each: xylem, phloem, and cambium?

- Xylem basically carries water and dissolved minerals upward from root hairs to leaves for photosynthesis
- Phloem basically carries food (glucose) produced via photosynthesis in leaves downward to stem (trunk) and roots for energy or storage (starch)
- Cambium basically is only tissue capable of making new cells (xylem and phloem) via mitosis, therefore necessary for diameter growth of plant

Question 9 What type root stock is compatible with which types of budwood or scion?

Alternatives	Factors for Consideration
1. Grafting between species within a genus	- In some cases grafting can be done successfully with plants of different species and genus. - Grafting between most species is done within a common genus: *Citrus* is successful and widely used. - Cultivars of the almond, the apricot, European plum, and Japanese plum--different species--are grafted commercially to the peach, a completely different species, as a root stock. On the other hand, almond and apricot, both in same genus, cannot be intergrafted successfully - Compatibility between species may depend upon particular clone or seedling being used, either for root stock or scion - In some cases a given interspecies graft is successful, but reciprocal combination is not

2. Grafting between genera within a family
   - When plants to be grafted together are in different genera but in same family, chance of union being successful is remote
   - There are few cases of success: Trifoliage orange is used commercially as dwarfing stock for various species in genus, Citrus. The quince has been used as a dwarfing root stock for certain pears.

3. Grafting between families
   - Successful grafting between plants of different botanical families is usually considered impossible but there are a few reported instances in which it has been done with short-lived herbaceous plants

Question 10 When is dormant budwood collected?

- The budwood may be collected in the late fall after the trees have lost their leaves.

Student Skill 2

COLLECT DORMANT BUDWOOD

Steps	Factors for Consideration
1. Collect relatively straight medium-vigor budwood of current season's growth	1. Select from healthy, true-to name stock plants.
2. Place cut ends of canes in a small amount of moist sphagnum moss	
3. Place entire bundle in a polyethylene bag or wrap it in polyethylene-kraft paper	3. This can also be placed in a moist sphagnum moss and sealed in a polyethylene bag.
4. Store package at temperature of 75°-80°F for 3-8 days	4a Degree of dormancy or rest governs length of time required for seasoning. 4b During this period, cambium layer will become active, and bark can be readily separated from woody central cylinder. 4c Careful attention must be given to condition of plant material since it is being seasoned under relatively high humidity and temperature. Buds may begin to grow if held too long. These buds may be lost before they are used.

Student Skill 3

COLLECT BUDWOOD FOR SUMMER BUDDING

Steps	Factors for Consideration
1. Collect budwood of current season's growth: new shoots which have developed since growth started in spring.	
2. Keep root stock actively and continuously growing.	
3. Defoliate budsticks immediately after collection in field.	
4. Place budsticks in moist medium such as sphagnum moss or moist newspaper, over-wrapped with a waterproof paper such as polyethylene kraft paper, or place in a polyethylene bag, and hold in a refrigerated storage until used.	

Student Skill 4

SELECT STEM STOCK (FOR GRAFTING)

Steps	Factors for Consideration
1. Choose desired stem type plant which most closely resembles the same diameter of the root stock to be used.	1. Exactness at this point is not absolute since both stem and root will be trimmed before grafted

Question 11 "Where should the stem and root stock be cut for joining?

- Roots are actually <u>not</u> cut; stock is cut on stem just above roots
- Stem stock is cut to same diameter as cut root stock
- Cut both stem and root stock stem on a diagonal; BE SURE angle of cuts is same

Question 12 What detriment could result from ragged cuts?

- Ragged cuts result in cellular debris and unhealthy cells at edges; cellular growth (and healing) requires healthy cells in close contact to nutrients or other living cells that can pass nutrients to it
- Cellular debris at cut edges can allow leakage of nutrients being passed from one section to the other
- Cellular debris at cut edges can allow air leaks and therefore drying of cellular tissue--remember, dry material can NOT be absorbed through cell membranes

Student Skill 5

TRIM GRAFTED AREAS

Steps	Factors for Consideration
1. Obtain a sharp knife	1. Do not use a scissors
2. Make angular cut completely through stem and root stock stem so angles and diameters are same	2. Diameter sameness not absolutely necessary, but certainly desired

Question 13 Is total line-up of the xylem, phloem, and cambium absolutely necessary?

- No, but the better they line up, the better the chances of having a successful graft and plant survival

Student Skill 6

HOLD ROOT STOCK TO STEM STOCK

Steps	Factors for Consideration
1. Hold cut edges of root stock and stem stock together with your fingers	1. Be sure both cut edges are lined up without air spaces

Question 14 What is the purpose of the wrap material?

- To secure stem stock to root stock
- To prevent entrance of disease causing organisms (pathogens)
- To decrease chances of drying out at cut edges

Question 15 What characteristics should the wrap material have?

- Water resistent: remember, DRY materials cannot go across living cell membranes
- Flexible: material should be able to be stretched by plant to compensate for additional diameter due to growth

Question 16 Why should care be taken not to damage cut edges?

- Growth and successful living (cellular) require healthy cells
- Damaged cells (debris) at cut edges can block passage of nutrients and spread decay (from bacteria on stock)
- All edges have been exposed to the environment
- Cut edges have been artificially secured together

Student Skill 7

WRAP ROOT STOCK TO STEM STOCK

Steps	Factors for Consideration
1. While holding lined up stock, wrap two together with wrap material (rubberband)	1. Firmness of wrap to stock is necessary to secure one to other so neither can move, BUT be careful not to wrap so tightly that stem and root cells are crushed

Question 17 What is transpiration?

- Water that is absorbed by the root hairs, travels through the stem to the leaves for photosynthesis, but is not used in photosynthesis, is evaporated from surfaces of leaves (i.e., morning dew).

Question 18 Is transpiration of value to the plant?

- Yes, transpiration helps pull absorbed water through plant

Question 19 Why should top third of grafted branch be cut off?

- To reduce water loss due to transpiration, especially if root stock used is not established and needs to be planted.

Student Skill 8

TRIM TOP THIRD

Steps	Factors for Consideration
1. Obtain sharp pruning tool--looks like a pair of pliers 2. Cut off top third of stem stock (branch) in an arc	1. Do NOT use scissors or knife 2. You may find this action emotionally hard to do after such care and work, but doing it will greatly enhance the chances of the plant's survival

Question 20 How are rocks detrimental to root growth?

- Waste of time and energy for plant to grow among (detour) rocks and debris in soil
- Shifting of rocks (i.e., weathering) can cut and/or injure tender roots

Student Skill 9

CLEAR NEW PLANTING BED OF DEBRIS

Steps	Factors for Consideration
1. Rake and pick out debris	1. Debris is rocks and any man-made materials 2. Debris within 6" from surface should also be removed

Question 21 If root stock selected is to be planted, how big a hole should be dug?

- Roots of root stock should be able to be spread out; not crushed together
- Hole should be deep enough that grafted area is BELOW surface of ground when grafted root stock is placed in hole

Student Skill 10

DIG HOLE (IF ROOT STOCK IS TO BE PLANTED)

Steps	Factors for Consideration
1. Obtain shovel 2. Dig hole	2. Pile dirt close to top edge so handy for repacking after planting.

Question 22 Why are some air spaces in soil important?

- Air spaces due to loosening media before planting allows complete penetration of water into the media.
- Dry minerals cannot be absorbed into a cell (plant) unless material is in solution

Student Skill 11

LOOSEN MEDIA IN HOLE

Steps	Factors for Consideration
1. Using shovel, rake, or scarlet claw, loosen dirt on all surfaces of the hole	1. Loosen surfaces by digging in 1-2"

Question 23 What is purpose of wetting the pre-planted soil?

- Allows for complete moistening of soil
- Watering after planting to thoroughly moisten soil enchances leeching of valuable minerals from repacked soil

Student Skill 12

FILL HOLE 2/3 WITH WATER

Steps	Factors for Consideration
1. Obtain water source: bucket or attached garden hose 2. Gently fill hole 2/3 full with water	2. If water drains out (percolates) fast, refill until water remains in hole

Question 24 How firm should removed ground (dirt) be repacked around planted grafted plant?

- The dirt should be replaced in hole (containing roots of plant, stem to and including wrapped area, and water)
- The water in the hole will allow the dirt to mesh together easily (removing air bubbles) without crushing root hairs
- Firm to touch, but not as hard as you can push--plant should be secure standing

Question 25 Why is it advisable to secure planting via staking?

- Mud surrounding root stock tends to allow movement of new planting
- Established root systems secure plant against wind
- Staking secures plant until root system can establish itself in hole and secure plant

Student Skill 13

PLANT GRAFT

Steps	Factors for Consideration
1. Lower (gently) grafted root stock into water in hole until wrapped area is 1-2" below surface of hole	1. Hold plant at this desired level while repacking soil back into hole
2. Replace soil into hole (without splashing) evenly around	
3. Pack soil into hole, firm to touch, but not as hard as you can push	3. Be sure wrapped area is covered (buried)

Question 26 How can too much water pressure in post-planting watering cause damage?

- Soil surrounding plant can be washed out of hole and therefore expose wrapped area

Question 27 What is mineral leeching?

- Since water is pulled downward by gravity, any minerals of soil that water dissolved will also be washed downward--possibly away from root hairs

Student Skill 14

MOISTEN TRANSPLANT

Steps	Factors for Consideration
1. Obtain watering source: sprinkling can or hose	
2. Gently water planted grafted plant and surrounding repacked soil	2. Use a fine spray if possible to reduce chances of washout of repacked soil, therefore exposing wrapped area

Question 28 How long should grafted plant remain wrapped?

- At least three months

Question 29 How can leaving the wrap on indefinitely harm the plant?

- Until the "breaking point" of the wrap material is reached, the wrap material tends to be a detriment to the growing stem's diameter by not allowing it to expand
- The flexibility (ability to stretch) of the material decreases the more the material is stretched

Student Skill 15

REMOVE WRAPPING

Steps	Factors for Consideration
1. After at least 3 months, gently remove soil surrounding wrapped area with your fingers 2. Gently (slowly) cut away wrapping material 3. Rapack removed dirt 4. Staking should probably remain functioning at least until next year	1. Do not use any tool as it probably will "skin" the newly healed area 2. Wrapping material (e.g., rubberband) need not be removed as long as it is cut loose and is no longer a binding force

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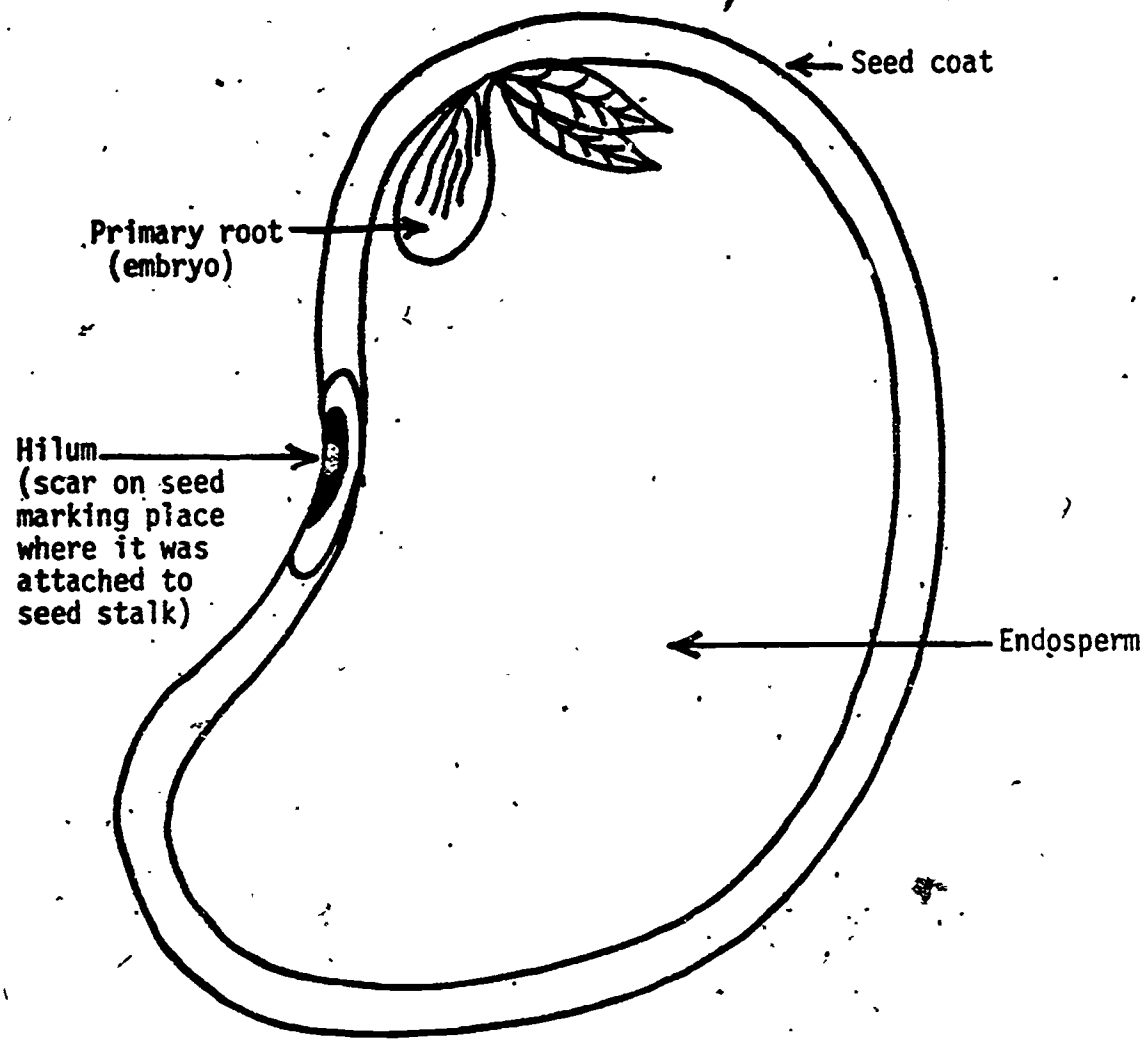
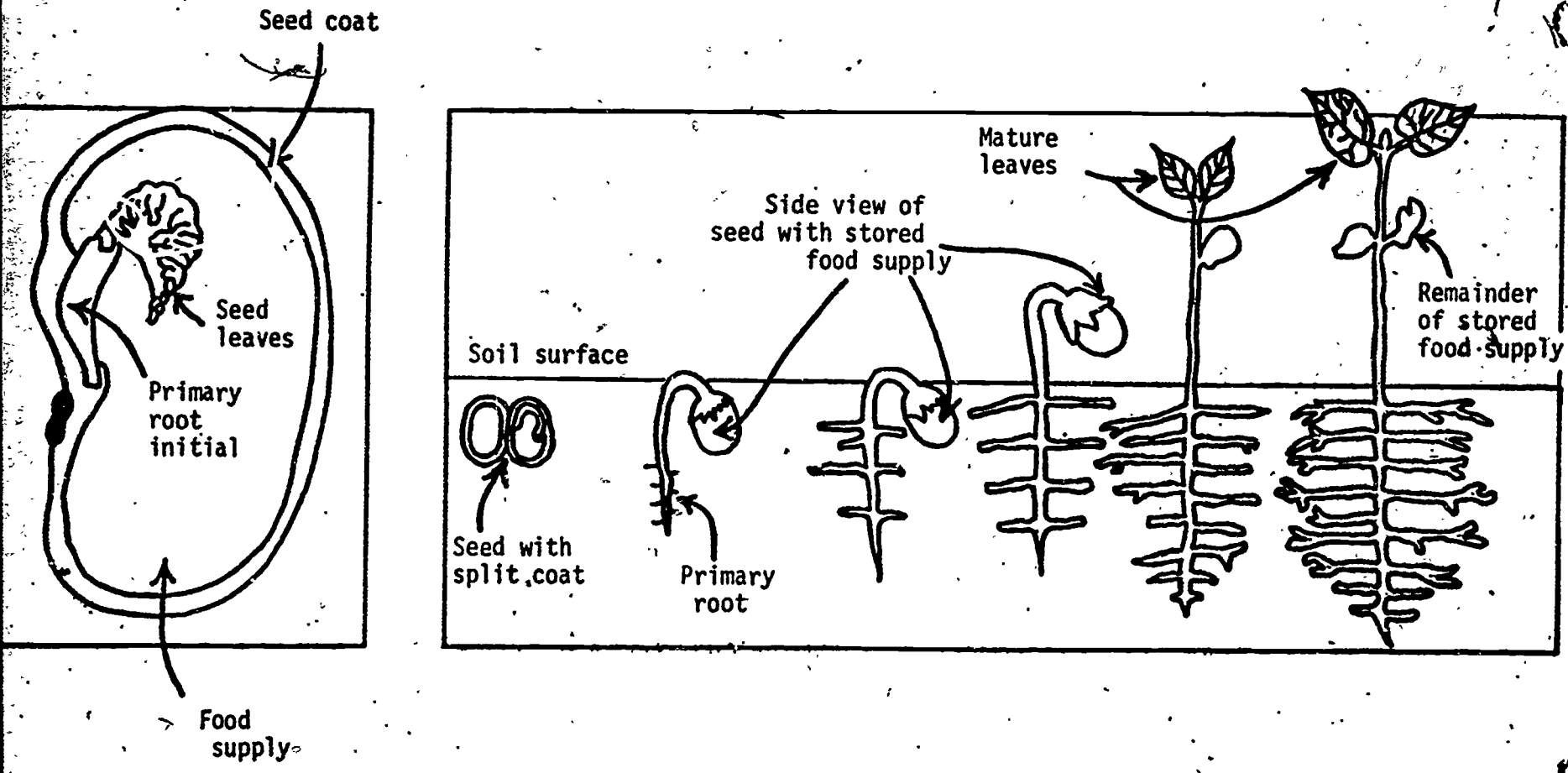
STUDENT ACTIVITIES

NURSURY PROPAGATION

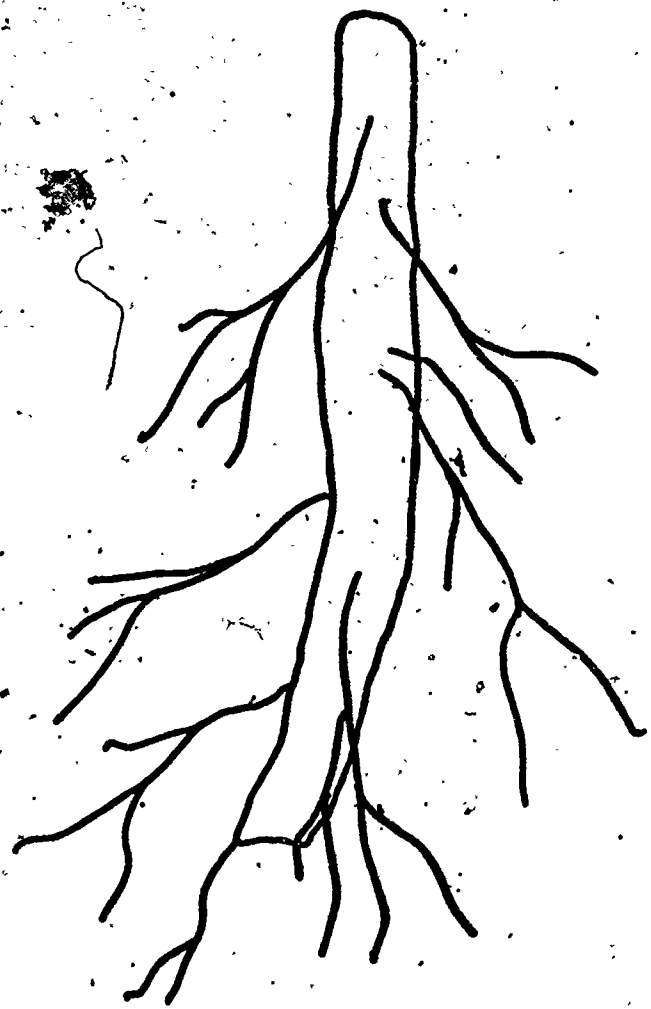
PARTS OF A SEED

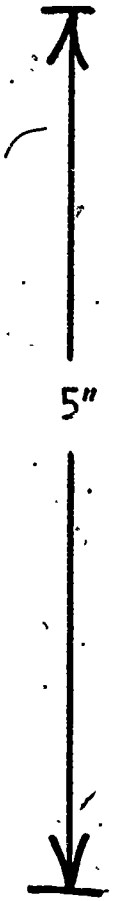


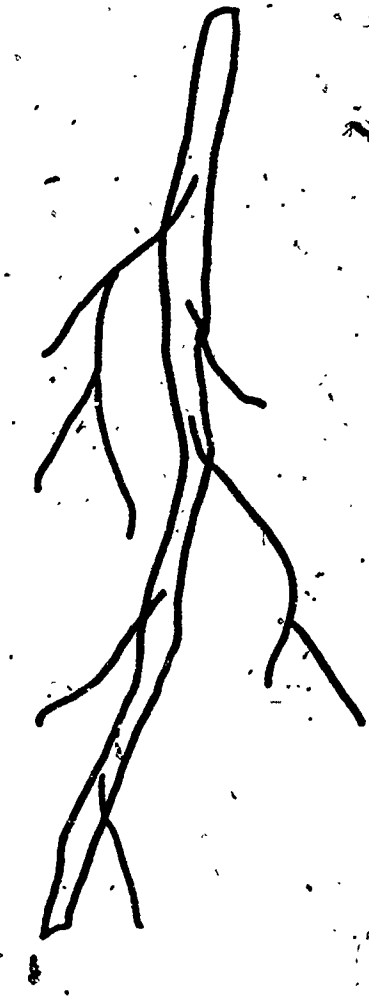
SEED DEVELOPMENT



ROOT CUTTINGS







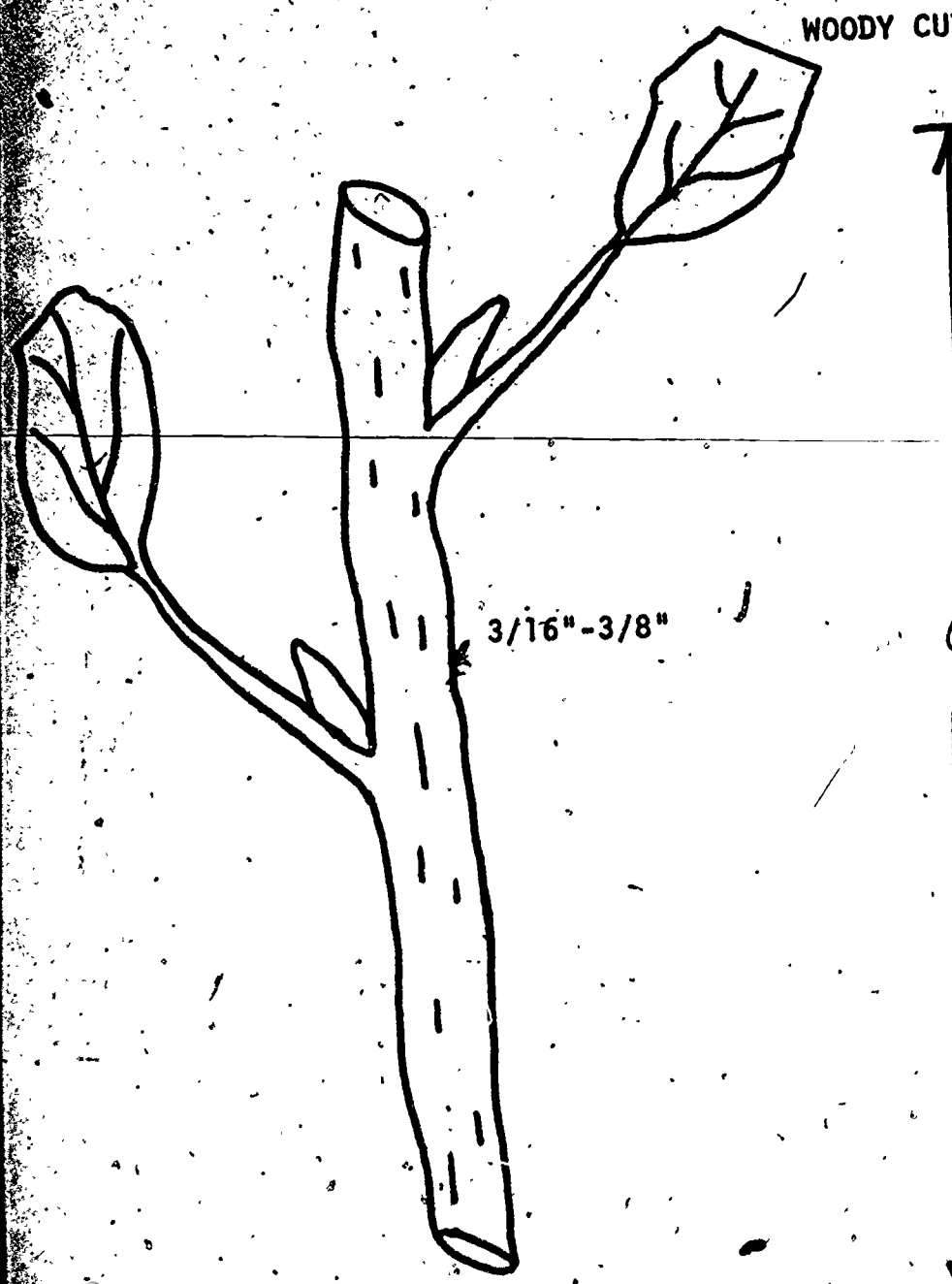
GOOD

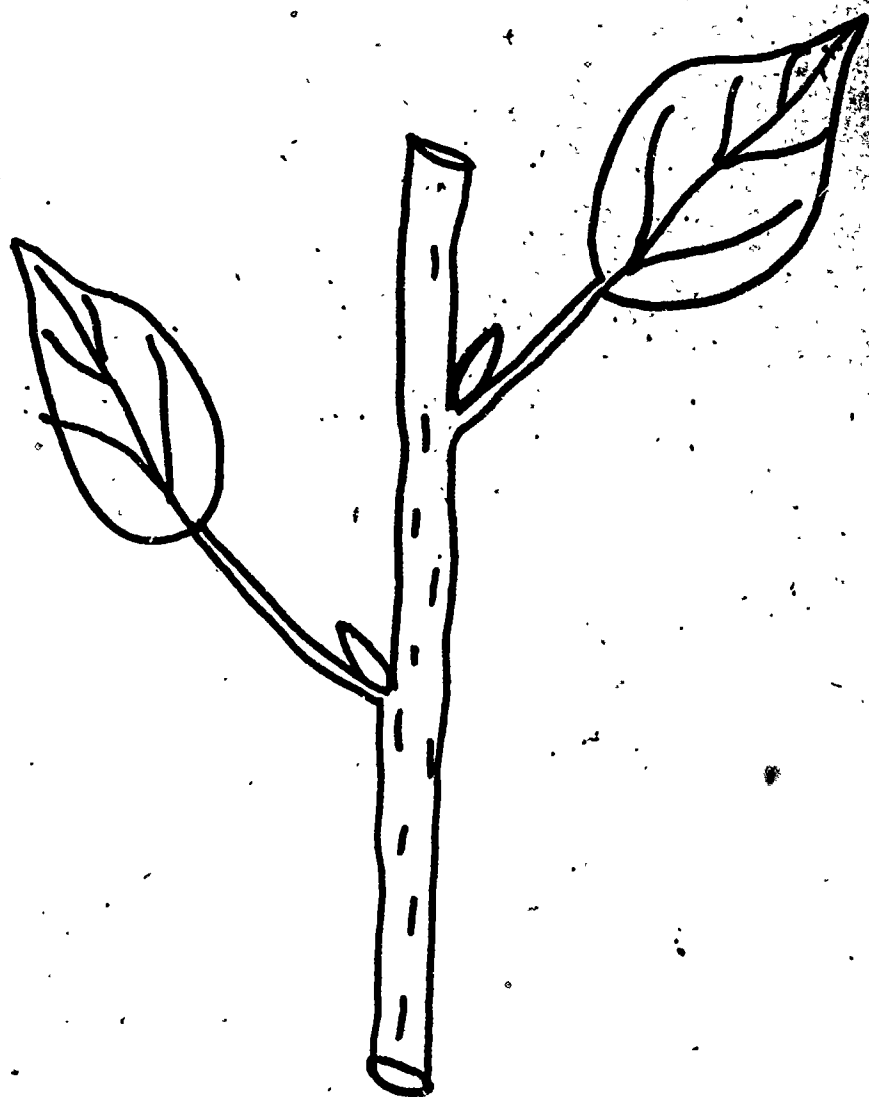
1. DIAMETER - 3/8"
2. SEVERAL SMALL ROOTS

BAD

1. DIAMETER - TOO SMALL
2. TOO FEW SMALL ROOTS

WOODY CUTTINGS





GOOD

1. GOOD DIAMETER

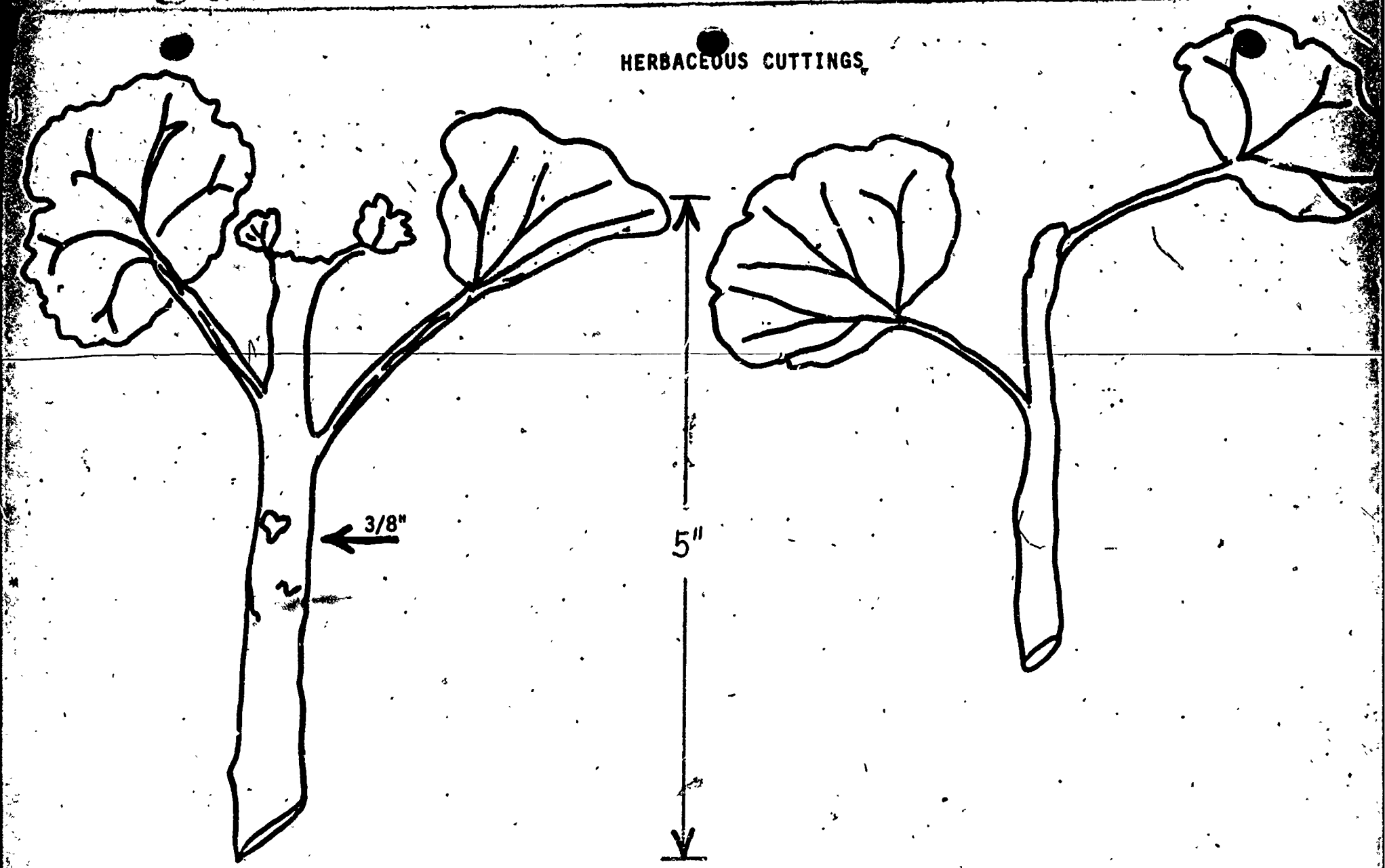
BAD

1. DIAMETER TOO SMALL
2. NEW GROWTH

1. GOOD DIAMETER
2. 1 YR. OLD - MORE STORED FOOD

2. NEW GROWTH

HERBACEOUS CUTTINGS

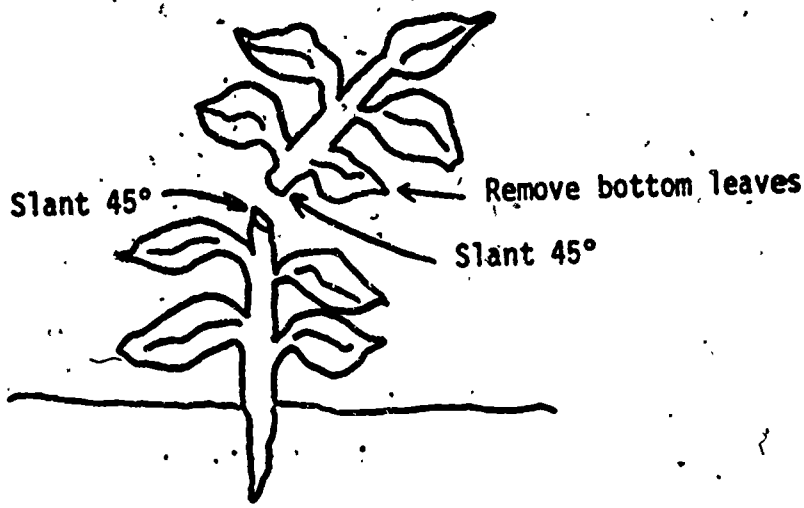


GOOD

1. THICK STEM
2. YOUNG TERMINAL LEAVES

BAD

1. STEM TOO NARROW
2. TERMINAL GROWTH WEAK



Simple Hardwood Stem Cutting

Table 2. Formulas for the Five Basic U.C. Soil Mixes

Soil mix	Ingredients by percent volume: Fine[1] sand	Peat moss	Ingredients to be added per cubic yard: Potassium[2] nitrate	Potassium sulfate	Single superphosphate	Dolomitic lime	Calcium carbonate lime	Gypsum
A	100%	0%	8 oz.	4 oz.	2½ lbs.	1½ lbs.	-----	2½ lbs.
B	75%	25%	6 oz.	4 oz.	2½ lbs.	4½ lbs.	1¼ lbs.	1¼ lbs.
C	50%	50%	4 oz.	4oz.	2½ lbs.	7½ lbs.	2½ lbs.	-----
D	25%	75%	4 oz.	4 oz.	2 lbs.	5 lbs.	4 lbs.	-----
E	0%	100%	6oz.	-----	1 lbs.	2½ lbs.	5 lbs.	-----

Adapted from The U.C. System for Producing Healthy Container-Grown Plants by K. F. Baker [ed.] 1957. California Agricultural Experiment Station, Manual 23.

1 Fine sand is defined in the above publication.

2 Potassium nitrate may be replaced with potassium sulfate if no initial nitrogen is desired. For example in Mix A, 12 ounces of potassium sulfate could be used in lieu of the suggested 8 ounces of potassium nitrate and 4 ounces of potassium sulfate.

Table 3. Cornell Peat-lite Mixes

Peat-lite mix	Sphagnum peat	Vermiculite	Perlite	Ground limestone	Superphosphate 0-20-0	Potassium Nitrate	Fritted trace elements	Wetting agent
A	11 bu.	11 bu.	-----	5-10 lbs.[4]	1-2 lbs.	1 lb.[1]	2 oz.	3 oz.
B	11 bu.	-----	11 bu.	5-10 lbs.[4]	2 lbs.	1.5 lbs.	2 oz.	3 oz.
Foliage Plant Mix[2]	11 bu.	5½ bu.	5½ bu.	8 lbs.	2 lbs.	1 lb.	2 oz.	3 oz.
Epiphytic Mix[3]	7 1/3 bu.	*	7 1/3 bu.	7 lbs.	4 lbs.	1 lb.	2 oz.	3 oz

Adapted from Cornell Peat-Lite Mixes for Commercial Plant Growing by J. W. Boodley and R. Sheldrake, 1972. New York College of Agriculture, Cornell University, Information Bulletin 43.

* Douglas, red, or white fir bark, ground and screened to 1/8 - 1/4 inch, is used instead of vermiculite.

1 Calcium nitrate may be used instead of potassium nitrate.

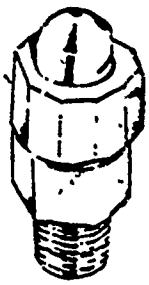
2 To this mix also add .75 ounces of iron sulfate and 2.5 pounds of 10-10-10 fertilizer.

3 To this mix, also add .5 ounces of iron sulfate and 2.5 pounds of 10-10-10 fertilizer.

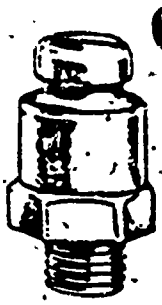
4 Less limestone is added for seedlings and bedding plants; more for general use.

D. J. Tyznik, Soils for Plant Growth, VAS 5024, Vocational Agriculture Service, Urbana, IL: University of Illinois.

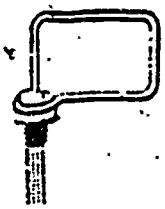
OVERHEAD IRRIGATION EQUIPMENT



MIST NOZZLE



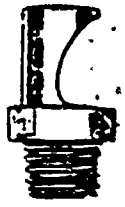
SUPERIOR NOZZLE



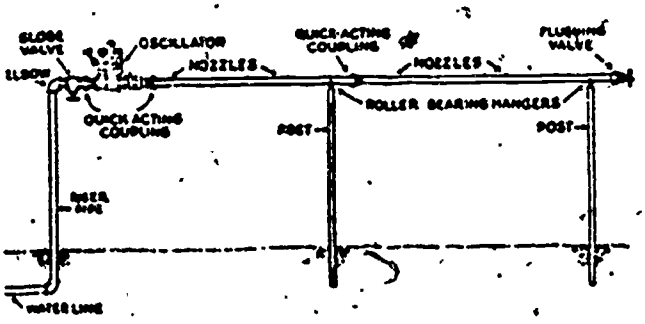
MIST PROPOGATION NOZZLE

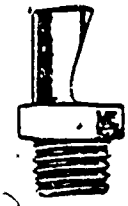
SS SHORT THROW NOZZLE

FOG-MIST NOZZLE



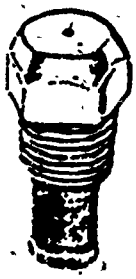
SS 50° GREENHOUSE NOZZLE



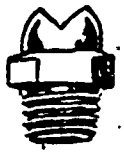


SS 70° GREENHOUSE NOZZLE

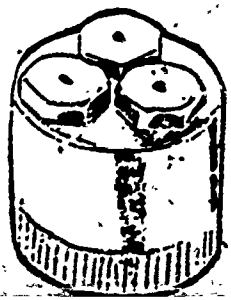
SS 80° GREENHOUSE NOZZLE



HUMIDIFICATION NOZZLE



CATFISH NOZZLE



FOGG-IT NOZZLES

SILVER STREAM OUTDOOR NOZZLE

KEY TO PLANT-NUTRIENT DEFICIENCY SYMPTOMS

Element Deficient

A. Parasitic and virus diseases disseminated by bacteria, fungi or virus entities (excluded from present discussion).

A. Non parasitic troubles; never infectious; caused by element deficiencies.

1. Older or lower leaves of plant mostly affected; effects localized or generalized.

a. Effects mostly generalized over whole plant; more or less drying or firing of lower leaves; plant light or dark green.

1) Plant light green; lower leaves yellow, drying to light brown color; stalks short and slender if element is deficient in later stages of growth ..... Nitrogen

2) Plant dark green, often developing red and purple colors; lower leaves sometimes yellow, drying to greenish brown or black color; stalks short and slender if element is deficient in later stages of growth ..... Phosphorus

b. Effects mostly localized; mottling or chlorosis with or without spots of dead tissue on lower leaves; little or no drying up of lower leaves.

1) Lower leaves mottled or chlorotic, with or without dead spots; leaf margins sometimes tucked or cupped upward or downward.

a) Mottled or chlorotic leaves typically, may redden, as with cotton; sometimes with dead spots; tips and margins turned or cupped upward; stalks slender ..... Magnesium

b) Mottled or chlorotic leaves with large or small spots of dead tissue.

i) Spots of dead tissue small, usually at tips and between veins, more marked at margins of leaves; stalks slender ..... Potassium

ii) Spots generalized; rapidly enlarging, generally involving areas between veins and eventually involving secondary and even primary veins; leaves thick; stalks with shortened internodes . Zinc

2. Newer or bud leaves affected; symptoms localized.

a. Terminal bud dies, following appearance of distortions at tips or bases of young leaves.

1) Young leaves of terminal bud at first typically hooked, finally dying back at tips and margins, so that later growth is characterized by a cut-out appearance at these points; stalk finally dies at terminal bud ..... Calcium

1) Young leaves of terminal bud becoming light green at bases; with final break down here; in later growth, leaves become twisted; stalk finally dies back at terminal bud ..... Boron

b. Terminal bud commonly remains alive; wilting or chlorosis of younger or bud leaves with or without spots of dead tissue; veins light or dark green.

1) Young leaves permanently wilted (wither-tip effect) without spotting or marked chlorosis; twig or stalk just below tip and seedhead often unable to stand erect in later stages when shortage is acute ..... Copper

2) Young leaves not wilted; chlorosis present with or without spots of dead tissue scattered over the leaf.

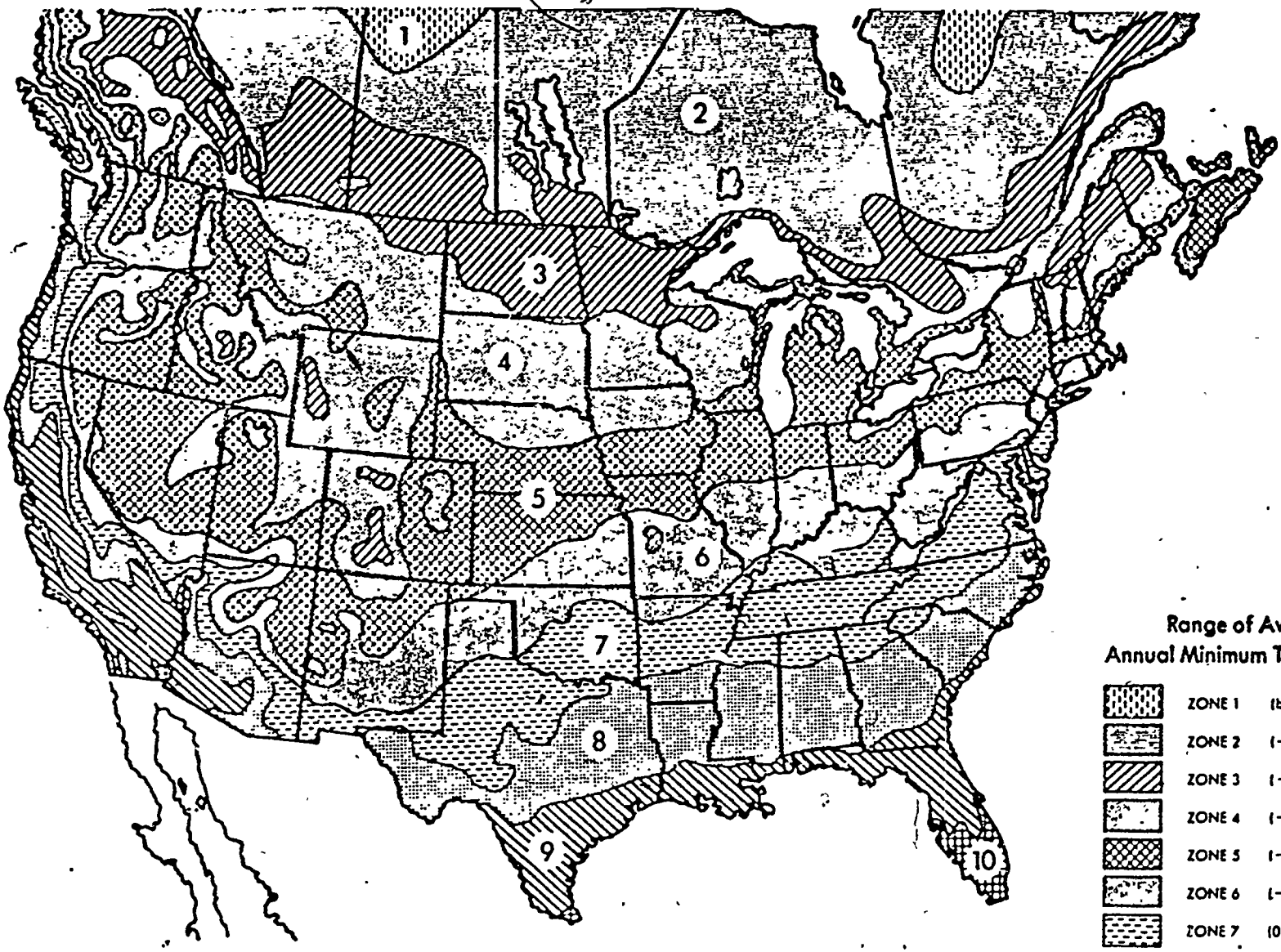
a) Spots of dead tissue scattered over the leaf; smallest veins tend to remain green, producing a checkered or reticulated effect ..... Manganese

b) Dead spots not commonly present; chlorosis may or may not involve veins, making them light or dark green in color.

i) Young leaves with veins and tissue between veins light green in color ..... Sulphur

ii) Young leaves chlorotic, principal veins typically green; stalks short and slender .... Iron

J. E. McMurtrey, Jr., Diagnostic Techniques for Soils and Crops. The American Potash Institute, 1948.



Zones of Plant Hardiness

W. R. Nelson, Landscaping Your Home (Rev. ed.), Urbana, IL: Cooperative Extension Service, Circular 1111, 1975.

NURSERY PROPAGATION

Evaluation Check-Off Form for Sowing Seeds
(Maximum score = 100 points)

_____1. Are the holes in the flat covered with moist sphagnum moss?

_____2. Is the flat filled with a 1:1:1 mixture of loamy soil, sand and peat or vermiculite or a commercial medium such as Jiffy Mix?

_____3. Has the medium been tamped to provide a uniformly firm seed bed to a level of about 1/2 below the top of the flat?

_____4. Are the rows straight?

_____5. Have the directions on the seed packet been followed to determine the distance apart and the depth the seeds should be sown?

_____6. Have the seeds been covered with shredded sphagnum moss, fine perlite or fine sand?

_____7. Was the flat properly watered?

_____8. Is the seed flat covered with a pane of glass or polyethylene?

_____9. Is the seed flat placed in a semi-shaded area of the greenhouse?

_____10. Is the seed flat placed on a propagating mat or heat coil or hot water pipes for a bottom heat of 65° to 70°F?

NURSERY PROPAGATION

Evaluation Check-Off Form for Grafting

____1. Are both root stock and stem stock dicots?

____2. Are the stem on the root stock and stem to be grafted the same diameter (thickness)?

____3. Are the stem on the root stock and the stem to be grafted both cut at the same angle?

____4. Is the wrapping material wound so both stem and root stock are held together firmly, but not stretched out totally?

____5. Are both ends tied securely after winding in the prescribed method?

____6. Was the hole filled with water before the grafted roots were planted?

____7. Is the entire wrapped area planted below the ground line?

____8. Is the grafted plant(s) staked for additional support?

____9. Has the top third of the above ground line plant been trimmed off?

____10. Was the ground around the planted grafted plant watered in the prescribed method after planting?

WORK SHEET

You are given a sample each of peat, sphagnum moss, sand, vermiculite and perlite. Determine which medium would be best used for germinating, propagating and growing.

1. Determine the medium best used for germinating seeds.

   Answer: Sphagnum moss or a 1:1:1 mixture of loamy soil, sand or peat, and vermiculite.

2. Determine the medium best used for propagating most cuttings?

   Answer: Peat, sand, vermiculite, perlite or a mixture of peat and sand.

You are given young, healthy stock plants to make root cuttings.

3. Determine the correct polarity when cutting.

   Answer: Cut the proximal end with a straight cut and the distal end with a slanting cut.

4. Ensure uniformity in rooting and the development of heavier root systems.

   Answer: Use root-promoting substances such as the hormone indole-butyric acid.

You have collected dormant bud wood for summer budding.

5. Determine how you would keep it suitable for later use.

   Answer: Place the budsticks in a moist medium such as sphagnum moss or moist newspaper overwrapped with a water-proof paper such as a polyethylene bag or graft paper or place in a polyethylene bag and hold in refrigerated storage until used the following season.

You are given several root stock plants to determine the best selection of material for budding.

6. Determine if the seedling is receptive to the bud.

   Answer: The bark should slip loose easily when cut and the wood underneath should appear moist and smooth, with no tearing or stringing of tissue.

7. Differentiate between flower buds and the leaf buds.

   Answer: Flower buds are plump and the leaf buds are slender and pointed at the tips.

Work sheet (cont.)

You are given various types of seeds.

8. How do you decide which seeds should be covered with a medium?

   Answer: This is determined by the size of the seed. Small seeds such as petunia and begonia are not covered when planted.

You are given such seeds as pansy, portulaca, verbena and dusty miller.

9. What special treatment do they all require to ensure germination?

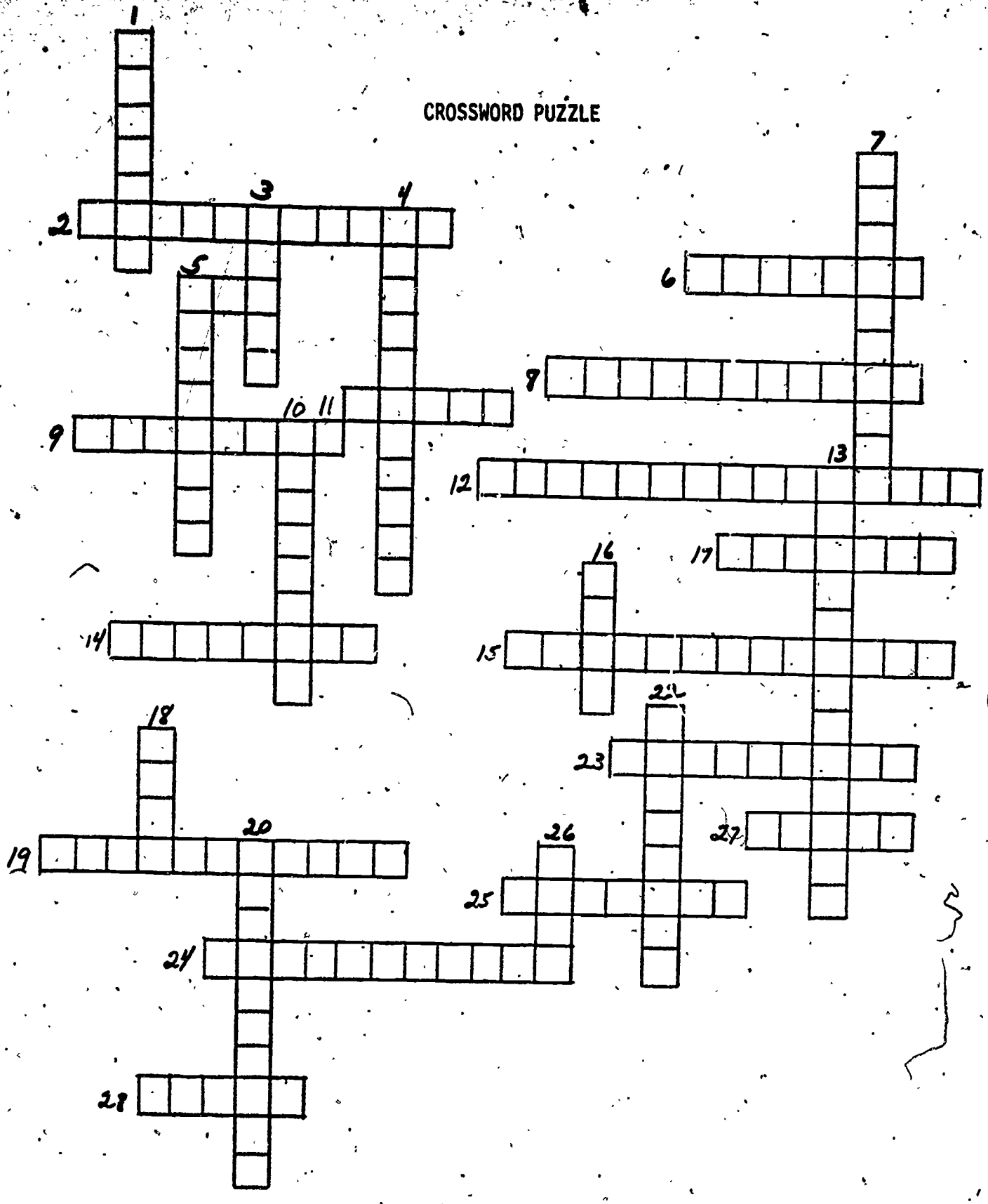
   Answer: They must all be given a 3-day darkness period.

You are given a herbaceous stock plant to choose stem cutting material.

10. Determine those with a high carbohydrate content.

    Answer: Those with a high carbohydrate content will be firm and break easily when bent.

CROSSWORD PUZZLE



CROSSWORD PUZZLE

Across:

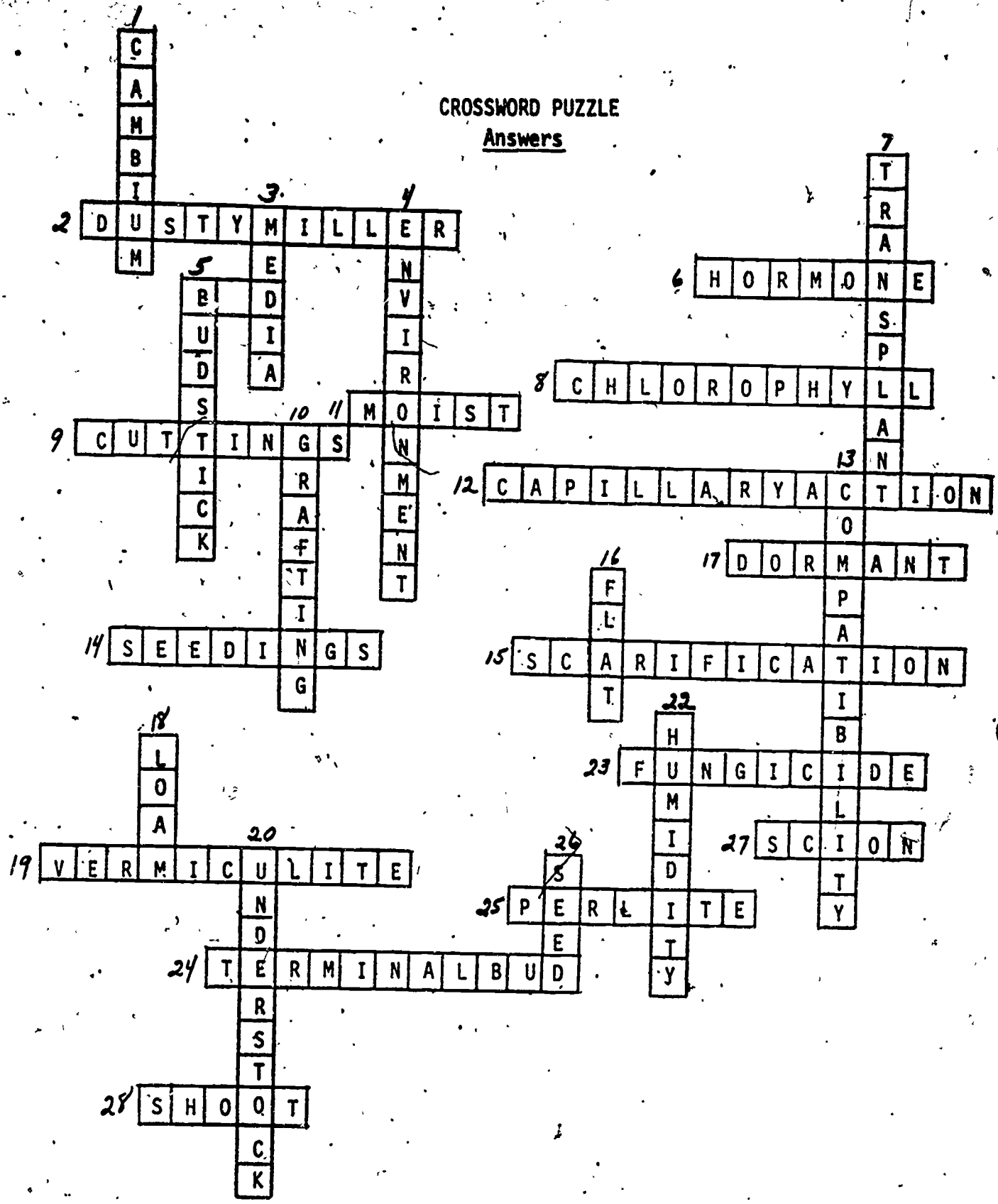
2. A plant that requires a 3-day period of darkness for germination
5. The shoot on a plant containing an unexpanded leaf, branch or flower
6. A growth regulating chemical
8. A green pigment necessary for plant growth
9. A section of stem or root used for propagation of plants
11. A condition that all seeds need to germinate
12. The movement of water upward through narrow spaces in the soil
14. Young plants which have been germinated several days
15. The scratching of a hard seed coat to hasten germination
17. In a resting, or nongrowing state
19. A light mineral with a neutral pH used to increase the moisture holding of planting media
23. A substance which destroys or prevents the growth of fungi
24. Any bud found growing at the tip of a stem
25. A white granular material used to help loosen or open up spaces in rooting media
27. Another word for understock
28. The current season's growth of a plant

Down:

1. Thin, green, actively growing tissue located between the bark and the wood of a plant
3. Material used to start and grow seeds and plants
4. The surroundings
5. Small shoot of the current season's growth used to cut buds for budding
7. To move plants from one growing location to another
10. Uniting two different plants so they grow as one
13. The ability to unite with, and live together
16. A box with a slotted bottom used to start seedlings
18. Soil of equal amounts of sand, silt, clay, and humus
20. The part of a graft that already contains the roots upon which the new plant will depend
22. The amount of moisture in the atmosphere
26. A reproductive structure housing the embryo

CROSSWORD PUZZLE

Answers



NURSERY PROPAGATION
Crossword Clues

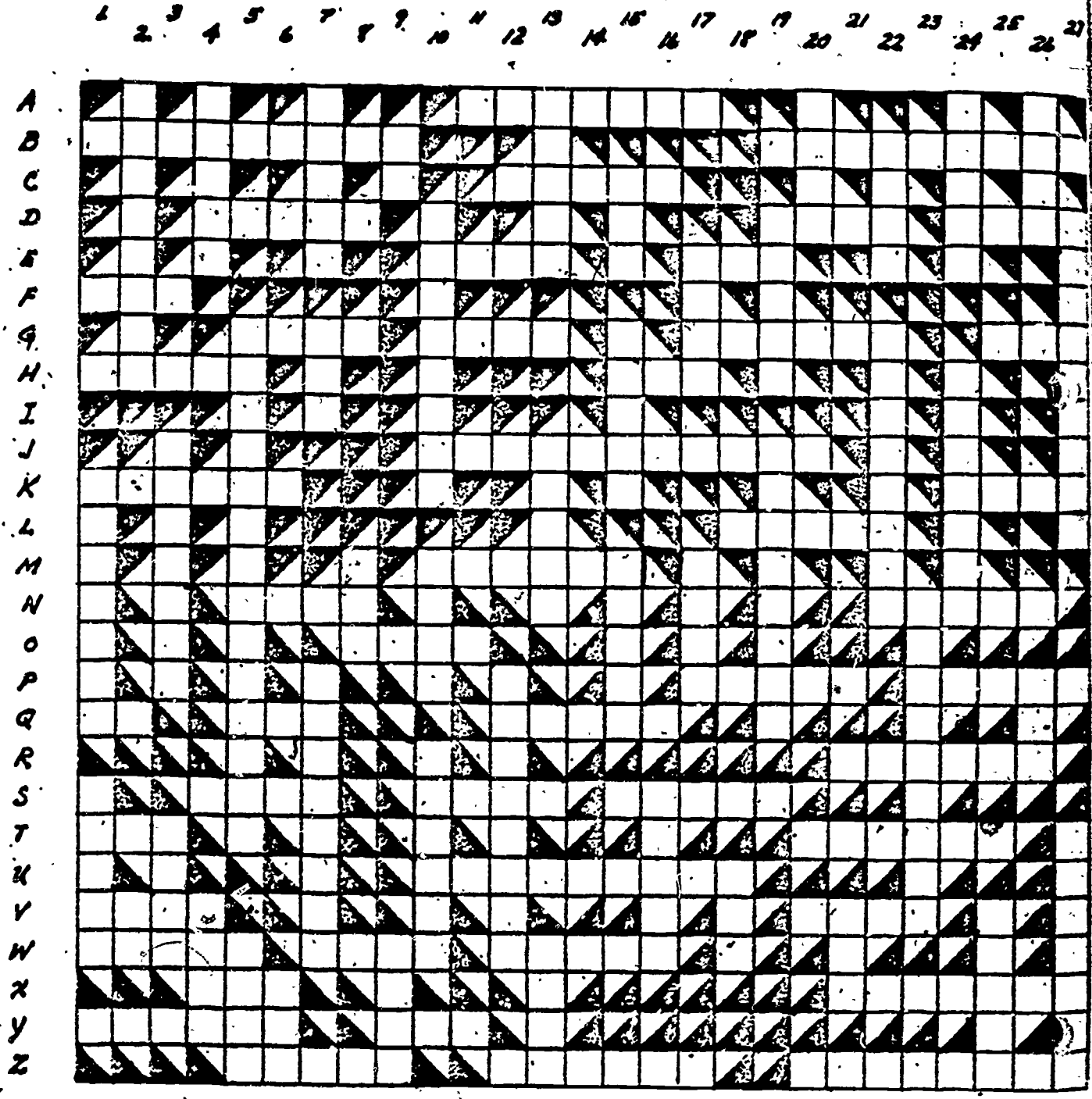
Down

1-K Good plant for slip method
1-S Joining stem to root stock
2-A Eliminate around roots
2-V Exclamation
3-J Don't do to roothairs
3-T Unfertile soil
4-A When to water slip (leaf)
4-D Don't plant seeds too ...
5-G Process of making glucose
6-X Leaves will when touching soil
7-A Necessary for photosynthesis
7-G Leaching: Watering from ...
7-P Part to be removed from stick
8-M To carefully place in hole
9-B Should you use a dull knife?
9-W Good idea to pre- ... seed
10-D Water ... can cause damage
10-P When repacking, gently ...
10-R To be removed before planting
12-P Use only with leaf, not stems
13-A Diffusion requires ... media
13-J Plant graft ... ground line
13-W Remember, plants require ...
15-C Plant ... per hole
15-G Remove top ... of transplant
15-M Water the ...
16-S Cut stems with a sharp ...
17-E Not doing it right is ...
17-M Always make clean ...
18-U Loosen media at least ... inches
19-D Cells without water
19-J Cuts for grafting are ...
20-A Don't graft ... cot plants
21-V How to make clean cuts
22-A Water tubes in plants
22-G Repack ... the plant
23-N Water going down through soil
24-A Competitors for nutrients
26-M Make big clumps of soil ...
27-V To be grafted together
28-A Sprinkle gently, don't ...
28-P Cheapest way to grow plants
29-D Fill hole ... with water first
29-E Movement of water molecules across a membrane

Across

A-11 Cells for growth
B-1 Movement of molecules
B-19 Seed-leaf
C-12 Plant type for grafting
D-4 Loosen media about ... inches
D-19 Cover stuck or slip with ...
D-24 One type of planting media
E-10 Underground plant part
E-17 No diffusion if cells ...
F-1 Liquid nutrients of plants
G-5 Containers
G-10 Contains plant embryo
G-17 Dome stays on for ...
G-25 Diffusion requires ... media.
H-1 Three times seed size
H-15 Slip to include leaf ...
J-10 Good graft wrapping material
K-1 Best to water from ...
K-24 Plants enhance the ...
L-18 Vital for survival
M-10 Glucose tube from leaf to root
N-5 Good performance is ... work
N-22 Water with a fine ... from top
O-8 Knowing how makes the ... easy
P-17 Be sure your knife is ...
P-23 Be sure to ... container well
Q-1 Sigh of understanding
Q-5 Good work is pleasing to the ...
Q-12 Make all cuts ...
R-21 Repack evenly ... the plant
S-4 Repack should be ...
S-10 Propagation done right is ...
S-15 Doing it right is a ...
T-1 Pulling will ... roothairs
T-20 Be gentle when soil is to be ...
U-10 Most vital for mineral absorption
V-1 Green plants make all ...
V-20 Be sure it doesn't cramp roots
W-1 Plant seeds ... times seed size
W-7 Use ... water pressure with hose
W-12 Be sure to ... grafted plant
X-21 Use ... to remove to transplant
Y-1 Propagation using only leaf
Y-9 If you don't know, ...
Z-5 Propagation using end of stem
Z-12 Remove some with stick method
Z-20 Don't expose plants to ... by not wrapping cut areas

NURSERY PROPAGATION
Crossword



NURSERY PROPAGATION

Answers

DOWN

1-K Begonia
1-S Graft
2-A Airspace
2-V Oh
3-J Stretch
3-T Poor
4-A After
4-D Deep
5-G Photosynthesis
6-X Rot
7-A Light
7-G Top
7-P Terminal
8-M Set
9-B No
9-W Soak
10-D Pressure
10-P Push
10-R Debris
12-P Scissors
13-A Moist
13-J Below
13-W Time
15-C One
15-G Third
15-M Media
16-S Knife
17-E Dumb
17-M Cuts
18-U Six
19-D Dying
19-J Diagonal
20-A Mono
21-V Off
22-A Xylem
22-G Supports
23-N Percolate
24-A Weeds
24-H Smaller
25-V Stems
26-A Pour
26-P Seed
27-D Two-thirds
27-T Osmosis

ACROSS

A-11 Cambium
B-1 Diffusion
B-19 Cotyledon
C-12 Dicot
D-4 Eight
D-19 Dome
D-24 Dirt
E-10 Root
E-17 Dry
F-1 Sap
G-5 Pots
G-10 Seed
G-17 Months
G-25 Wet
H-1 Depth
H-15 Hub
J-10 Rubberbands
K-1 Bottom
K-24 Land
L-18 Water
M-10 Phloem
N-5 Nice
N-22 Spray
O-8 Task
P-17 Sharp
P-23 Rinse
Q-1 Ah
Q-5 Eye
Q-12 Clean
R-21 Around
S-4 Firm
S-10 Easy
S-15 Skill
T-1 Rip
T-20 Repack
U-10 Roothairs
V-1 Food
V-20 Hole
W-1 Three
W-7 Less
W-12 Stake
X-21 Fingers
Y-1 Slip
Y-9 Ask
Z-5 Stuck
Z-12 Leaves
Z-20 Diseases

QUIZ

Plant Propagation by Cuttings

Matching

E 1. This cutting is made just below the petiole, under the bud and continued upward above bud on opposite side.

A 2. This cutting uses one-year-old wood pieces 5" to 7" in length and 3/16" to 3/8" in diameter.

B 3. This cutting is directly through the leaf and is successful with fewer plants such as jade, begonia, and african violet.

D 4. This cutting is made from plants with thick, succulent leaves and stems such as geraniums and coleus.

C 5. This is made from roots 1/4" to 3/8" in diameter and 3" to 6" in length. Phlox and raspberry are most successful with this method.

A. Woody cutting

B. Leaf cutting

C. Root cutting

D. Herbaceous cutting

E. Leaf bud cutting

True or False

F 6. Plants with thick, herbaceous leaves and stems are poor plants to propagate by stem cuttings.

F 7. Terminal buds on woody plants make better rooting structures than cuts from one-year-old wood.

F 8. Leaf bud cuttings are planted more than 3" deep and need little watering.

Fill in the blank

9. Too much moisture and lack of proper aeration will cause herbaceous cuttings to damp off.

10. In woody cuttings, tree cuttings are less successful than shrub cuttings.

NURSERY PROPAGATION

QUIZ

Plant seed

1. How deep should seeds be planted? 3x seed size
2. What is the most important step when cleaning containers? rinsing
3. For potted plants, it is probably best to water from which direction? bottom
4. Watering potted plants by allowing them to absorb water from the bottom of the containers, reduces leeching of minerals.
5. Absorption of minerals from the soil can not occur unless they are in liquid state.
6. Diffusion of chemicals can not occur across the cell membrane unless they are in liquid state.

7/8. Planted seeds need water and oxygen to germinate.

9. Planted seeds do not need light until the plant surfaces.
10. Energy for growth by the embryo in the seed is stored in the cotyledon(s).

Transplant seedlings

1. When thinning seedlings, care should be taken not to damage the roothairs by cutting or stretching.
2. Roothairs are essential to the plant's life because they increase the absorption rate of minerals.
3. Dirt (should/should not) be removed from the roots when transplanting to a new area.
4. About what percentage of a plant is seen above ground? 50%
5. How deep should the dirt-ball be set in the new hole? just below the surface
6. How firm should the media be repacked into the hole around the root-dirt-ball? firm to touch, not as hard as you can
7. Should young seedling be staked after transplanting? no--stem is too fragile
8. If a garden hose is used to water the transplanted plant, use fine spray to reduce damage by too much water pressure.

9/10. Too much water pressure when watering can cause washout of media and therefore reduce support to the plant.

NURSERY PROPAGATION-QUIZ

Stick Method

1. The "stick" method gets its name from sticking the stem into the planting media.
2. Best results of root growth occur when the terminal end of the stem is used, but stuck upright.
3. A sharp knife should be used to make a clean cut of the stem to be stuck.
4. A ragged cut decreases the chances of root growth because of the presence of damaged cells.
5. Most of the leaves are removed to decrease water loss by the process of transpiration.
6. A hole (should/should not) be made before sticking.
7. How deep should the stem be stuck into the media? about 2"
8. How much water should be gently put around the stuck plant? media remains moist, but water not standing
9. To decrease effects of weathering (i.e., water loss, wind, temperature fluctuations) newly stuck plants should be covered with a transparent dome for at least 3 months.
10. Care should be taken so the leaves do not touch the dome.

Slip Method

1. The "slip" method gets its name from being able to slip the cut edge of the leaf into the growth media.
2. Because of the thinness of a leaf, a sharp scissors can be used to make the cut.
3. A ragged cut decreases the chances of root growth because of the presence of damaged cells.
4. Several "slips" can be made from a single leaf if each slip includes part of the leaf's main vein.
5. What is the advantage of making a groove in the media before the slip is inserted? decreases cell damage of cut edge

NURSERY PROPAGATION-QUIZ

Slip Method (cont.)

6. What is the advantage of moistening the media before "slipping" in the leaf edge? decreases friction and therefore cell damage

7. How deep should the cut edge of the leaf be slipped into the media? about 1/4 to 1/2"

8. How much water should gently be put around the slipped leaf? media remains moist, but water not standing

9. To decrease water loss by transpiration and evaporation, newly slipped leaves should be covered with a transparent dome for at least 3 months.

10. Care should be taken so the leaf does not touch the dome.

Grafting

1. When choosing plant stock to be grafted, it is best when the diameter of the stem and root stock are the same.

2/3. When the two areas to be grafted are not the same thickness, the xylem and phloem tubes will probably not all line up.

4. To increase support of the stem stock onto the root stock both should be cut diagonally.

5. The cuts on both the stem and root stock should be at the same angle.

6. The cuts of both the stem and root stock should be made with a sharp knife to increase the chances of a clean cut.

7. Wrapping material should be waterproof and flexible.

8. The hole should be filled with water before planting in order to decrease the chances of blockage by airspaces.

9. The grafted plant should be planted with the wrapped area just below the surface of the soil (ground line).

10. The planted grafted plant should be supported by staking for at least 1 year

NURSERY PROPAGATION

Test

True and False

F 1. All seeds should be covered at the time of sowing.

T 2. All seeds require moisture to germinate.

T 3. Vermiculite makes a good germinating medium.

F 4. Large seeds should never be covered at the time of planting.

T 5. Some seeds such as verbena, dusty miller and pansy require a three-day period of darkness to germinate.

T 6. Some seeds require a period of cooling to ensure germination.

T 7. A polyethylene covering should be wrapped tightly around the seed flat to prevent air from entering.

F 8. All seed flats must be filled and set in a tub of water before planting.

T 9. Seed flats may be allowed to completely dry out.

F 10. Tamping the soil means to fertilize it thoroughly.

Multiple Choice

c 1. A good growing medium in which to plant seeds must

a. drain well
b. hold moisture
c. be sterile
d. all of these

d 2. The best temperature for germinating most seeds is

a. 50° to 60°F
b. 75° to 80°F
c. 80° to 90°F
d. 65° to 70°F

a 3. Pansy and portulaca seeds require three days of darkness before germination will take place. This may be accomplished by

a. covering the flat with newspaper
b. burying the flat or pot in the ground
c. planting the seeds at an unusually great depth

B 4. The growth of seedlings is slowed down by withholding water and lowering the ground temperature. This process, called hardening off, is done to

a. keep the seedlings from growing too quickly
b. prepare the seedlings for transplanting shock
c. hold the seedlings until they can be sold
d. none of the above

C 5. Seedlings are held by the first true leaves instead of the stem when transplanting because

a. there are no cotyledons to grasp
b. the stems are too slippery and seedlings are dropped and lost
c. the stem may be bruised in handling and cause death of the plant
d. this bruises the leaves, which causes better growth

D 6. Type of hardwood cutting is

a. the mallet
b. the heel
c. straight cut
d. all of these

B 7. Chemicals used to eliminate organisms present on the surface of the seed

a. mechanical scarification
b. disinfectants
c. disinfestants
c. neither of these

A 8. Scratching to alter the seed covering to make permeable to water and gases is called

a. mechanical scarification
b. hardening off
c. disinfectants
d. disinfestants

A 9. To aid in the rooting process, the cutting is treated with a

a. hormone
b. fertilizer
c. hardener
d. all of these

D 10. Fungicides are chemicals used to control

a. plant rust diseases
b. fungus diseases
c. plant mildew
d. all of these

Matching

L 1. A good growing media in which to plant seeds must be

G 2. The best temperature for germinating most seeds

H 3. A type of seed that requires darkness for germination to occur

D 4. Makes a good mixture for a well-drained aerated seeding media

M 5. When the growth of seedlings is slowed down by withholding water and lowering the ground temperature

I 6. Used to handle seedlings when transplanting

A 7. Seeds that are not covered by the germinating media when planted

B 8. The label in a flat of seeds should include the name of plant, variety, and the ___

C 9. The holes in a flat should be covered with

E 10. Sown seeds should be covered with sphagnum moss, fine perlite, or

A. Begonia, petunia
B. Date
C. Sphagnum moss
D. 1:1:1 mixture of loamy soil, sand & peat
E. Fine sand
F. Clay
G. 65° to 70°F
H. Verbena
I. True leaves
J. 75° to 80°F
K. Daisy
L. Sterile
M. Hardening off

QUIZ

Maintaining the Landscape

True-False

T 1. A hose connector with threads on the inside is termed "female."

T 2. Washers should be replaced seasonally or when necessary.

F 3. Water breakers are used to cut up hoses.

F 4. In general 1-2" of water should be applied as needed or at least every month.

F 5. Water should always be applied by root injection.

F 6. Soft mulches are permanent and durable.

T 7. Mulches provide a ground pattern for planted beds.

F 8. Mulching helps keep root warm during the winter

F 9. Stones are used as a mulch that can decompose and condition soil.

F 10. The thicker the mulch, the better.

Fill-in-the-Blank

1. Bentgrass responds best to low mowing heights.
2. During periods of stress cut grasses are higher than usual.
3. Flail mowers work well on rough terrain.
4. Mowing on steep slopes should be done perpendicular to the fall line.
5. Reel mowers are used on smooth, even grades.
6. Excurrent branching is typical of conifers.
7. Guy wires can be tightened by previously inserted turnbuckles.
8. The single upright trunk of a conifer is called a leader.
9. Rubbing branches can be corrected by removal of the least desirable branches.
10. Branches close together can be helped to develop by use of wooden separators.

GENERAL DISCUSSION ACTIVITY

Maintaining the Landscape

Mr. Smith calls about some tree problems. He needs help. A red-winged blackbird sat on the top of his "pine" tree (he can't really identify it--but it's an evergreen) and broke off the tip. What would you advise?

Find a strong lateral branch near the break and splint it into a vertical position to form a new leader.

A grove of small trees has not been cared for for many years. Outline what should be done regarding overgrowth and density

Selective pruning; removal of dead and diseased trees; limb removal to allow for growth of remaining trees.

A park district employee completed his daily job. The superviser came round and noticed several things that troubled him and several things that he was pleased with. List them in columns: (GOOD) for favorable items, (BAD) for unfavorable items.

7	1
	2
	3
	4
	5
	6
	8
	9
	10
	11

On the basis of his evaluation, would you praise or reprimand the employee? What could you say to help improve his/her performance? What good things could you emphasize?

Reprimand. Review work procedure. Advise reading, questioning, learning. Would emphasize the good job of wound trimming.

Evaluation:

1. Each spruce had 2 or 3 leaders.
2. Branches were removed and 2" of stub remained on the trunk.
3. Watersprouts and suckers were allowed to grow.
4. Rubbing branches were evident.
5. Guy wires were slack.
6. Mulch was applied a depth of 8".
7. Mower damage was trimmed into a football shaped cut.
8. Bluegrass was sown in the shady grove.
9. Uneven turf was cut by rotary mowers.
10. An uncovered hose end was used to water in new plants.
11. All shrubs were sheared evenly.

Quiz-cont.
Maintaining the Landscape

Match (best answer)

Types of lawns		Mowers
a. golf green	3	1. flail
b. home lawn	2	2. rotary
c. road embankment	4	3. reel
d. airport	2	4. sidebar
e. rocky terrain	1	
f. uneven terrain	1	
g. tennis lawn	3	