

Arizona Grown Specialty Crop Lesson Plan

**Don't Wait,
Just
Propagate!**



LEVEL: Grades 10-12

SUBJECTS: Science, Environmental Science

AZ ACADEMIC STANDARDS: SCHS-S4C1, SCHS-S4C2, SCHS-S4C4, SCHS-S4C5

MATERIALS

Seeds of selected trees/shrubs, cacti, succulents, and wild flowers.

Stems of selected trees/shrubs, and cactus pads. Seeds/stems may be planted into individual pots or directly into the soil depending on availability. Sulphur powder, root-tone powder, sand, soil, topsoil, pruning shears, and pH meters may be purchased at a local nursery. Stock plants may come from each school campus for stem use.

VOCABULARY

seed, stem, leaf, propagate, germinate, bud scale, areole, spine, root-tone, population, sexual and asexual reproduction, species, cross/self pollination, seed coat, damping off, osmosis, imbibition, fungus, cotyledon, pH value, alkaline/basic, acidity, meristematic tissue, DNA, heredity, leaf scar

RELATED LESSONS

If it Smells Good, is Edible and Attracts Wildlife, Then it's a Practical Garden!
Where do They Go?
Let's Make Stew
How do Plants Make Food?
Survival of the Fittest

Getting to the Root of the Matter
This Can't be a Plant
Soggy Seeds
Plant Seedling
Plants, Plants and More Plants

SUPPORTING INFORMATION

There are many methods to propagate plants, and in this lesson the student will use seeds and/or stems to increase the population of selected trees/shrubs, cactus, and wild flowers. There are plants that can be used in low-water use landscaping (xeriscaping). Alternative plants may be used to accommodate different growing zones.

SEEDS:

In flowering plants, seeds are the result of sexual reproduction where pollen (anther of stamen) combines with eggs (ovule of pistil) of the same or different flower within that species (self or cross pollination). Cone-bearing plants share the same strategy, but have no flowers. The end result is a matured ovule that contains all the genetic information to make a new individual of that plant. In addition, diversity is achieved through this process of combining the sperm (pollen) from the male and the ovule (unfertilized egg) from the female. Each seed has within it a living embryo and a food source (cotyledon) covered by a seed coat. The teacher should spend

BRIEF DESCRIPTION

Students will grow selected landscape plants by propagating with seeds and stems. Through observation, the student will observe which method is most successful. This activity can be started at anytime of the year in the classroom, greenhouse or directly in soil.

OBJECTIVES

To grow plants from seeds.
To observe different methods for germinating seeds.
To grow new plants from stems.
To determine/observe which method works best for propagating plants for use in the landscape.
To observe how to rapidly increase the population of a plant species through plant propagation.

ESTIMATED TEACHING TIME

Two class sessions for set-up; two class sessions for seed lecture and stem lecture. Daily observations follow.

SUPPORTING INFORMATION (cont'd)

one class period on plant anatomy with emphasis on how seeds develop from flowers/cones. Seeds with thin outer coats can be easily planted directly into the ground or into pots. To make germination occur faster, try soaking the seeds overnight in water, not to exceed 24 hours. Seeds with thick coats may be scraped with sandpaper until you see the white cotyledon before soaking. Boiling water may also be poured onto unscraped seeds and then allow them to stand for 24 hours before planting. Soaking the seeds allows water to enter via osmosis, where the seed is imbibing, thus causing it to swell almost twice its size. Cactus seeds can be started in a pot of well-drained moist soil (mostly sand) where the seeds are sprinkled on top and covered with a plastic bag with a rubber band (set in a sunny place). Wild flower seeds are best started during the fall months to become established in the ground. All of the seeds used should not dry out after germination, because it is the critical time for the young plant no matter what time of year it is planted. Temperature of about 80 degrees F will allow germination to occur quicker. A heat tape can be used if additional temperature is needed. Seeds can be planted (sown) directly into the ground in rows to a depth twice the diameter of the seed. The spacing between each seed will vary as to the type, however, one can always thin out (pull or transplant) excess plants. Plants that are growing too close to one another or if their roots are entangled constitute excess plants. If planting in containers, plant seeds to a depth of twice the diameter, using four to five seeds spaced out evenly. A larger

container will allow more room for seeds to be planted. The advantage of planting directly into the ground may eliminate transplanting later. Don't let the seeds dry out in either area.

Attention to soil preparation will help to produce healthy plants. Whether one plants in containers or directly into the ground, keep these points in mind: Plants like soil that is porous and well drained, yet retains moisture. There are many combinations of soil mixes that you can make up. They should contain organic material such as peat moss, or compost, and mineral material such as local soil, sand, perlite, and vermiculite. Experimenting with the proportions will allow the soil to hold water without being soggy in addition to not having to water constantly. Local nurseries have packaged soil blends ready to use in the ground or in containers. The advantage of buying bags of soil at a store is that the soil is sterilized and does not contain fungus/bacteria which would kill off new seedlings (damping off). Customized soil blends can be baked in the oven to kill microorganisms. Optimum pH can range from 6-8 where 7 is neutral, 6=acid, 8=basic. The pH test can be done with a meter. When the pH range falls outside of the optimum range, certain nutrients (N, Ca, Mg, Fe, Mn, Cu, Zn) become tied up in the soil, and are not available to the plant.

STEMS:

Stems have many functions for plants; they store food, make food, conduct water and minerals (xylem tubes), transport food (phloem tubes), and give the leaves a place of attachment to collect sunlight. Located along the stem are bud scale scars (which shows growth between each year), lateral

buds which may produce stems, leaves, and flowers (meristematic tissue), and leaf scars/node (shows where last year's leaf was attached). The lateral (axillary) bud is located just above the leaf scar. The terminal bud is where the visible growth is taking place. The teacher should spend one class period observing and discussing stems. Any botany or biology book will show a diagram of the stem (see diagram).

Stem tip cuttings should include a terminal bud plus two-six nodes, where the stem cut is made below the node. A six inch section of stem may be used.

The description for stem propagation refers to herbaceous (soft green flexible stems of perennial plants) and hardwood (woody stems from shrubs and trees) cuttings. When collecting stems to propagate, be sure to use stems that are not too green (showing this year's growth), but have some woody texture and can break easily when bent (usually last year's growth). Collect several of the same species to try, and choose several other species because some shrubs/trees can be temperamental when attempting to grow. Use a six inch section of stem which has several nodes, lateral buds, or leaves. Remove all of the leaves and lateral buds to prevent water loss through transpiration during this propagation procedure. When removing the leaves and side stems, it may be difficult to determine which end of the cutting goes into the soil/sand. Holding the cutting upright, the leaf/bud scars show a smile shape which is the correct position. Students may have some leaves remaining to show direction. Rooting hormone powder can be applied to the lower lateral bud regions to

enhance roots to grow. One or two nodes should be under the media. Complete this task by dipping the lower two inches of the cutting into the root tone. Knock off any excess powder before inserting the stem into the moist soil/sand container. Rooting powder is not necessary for cuttings to be successful. Look for new bud growth on the tip (terminal bud) of the cuttings within a few weeks. Keep humidity high by placing a plastic bag around the pot covering the cuttings.

The medium for successful cuttings should have excellent water percolation and fast drainage to prevent mold and bacterial infections to cuttings. Pure sand is the best and has no organic matter (prevents mold/bacterial problems), but needs to be watered frequently. Some combination of sand/perlite/vermiculate with peat moss may be used to hold moisture in. The media must be kept moist, or the roots will dry out. Cover with a plastic bag to keep the moisture level high. Growth should be seen in about 20 days.

GETTING STARTED

(Quantities of materials):

For a class of 30 use 25 seeds and 10 stems/group (four students). Total = 200 seeds/class, 80 stems/class. Amounts may vary depending on availability.

PROCEDURES

Procedure for Cacti

Propagation

Cuttings from cactus are accomplished by removing the pads off at each section. The cut ends can be powdered with sulphur and then left for a few days on its side on any open tray while it develops a skin. This can protect the cactus from disease/infections. Sulphur is not necessary for this

propagation to be successful. Place the cutting halfway in decomposed granite or sand which is dry; do not water! In a month, new growth may be seen. The roots emanate from the areole where the spine originates. This propagation occurs naturally in the desert as the pad or broken cactus lies on the ground. The roots are stimulated from the areole facing the ground. The student could cut up a cactus pad into sections with areoles and make many new plants, by planting these pieces as previously described. Without much preparation, cactus pads can be placed directly into the media (decomposed granite) halfway covering many of the areoles.

Procedure for Seed

Propagation

From your teacher, collect five or more seeds from five different shrubs, trees, wild flowers, and prepare them as suggested in the supporting information section. As they are soaking in water, label the jars to keep order. After 24 hours, plant the seeds directly into the ground or pots with labels. Remember to plant the seeds for the appropriate depths and spacing. Do not let the soil dry out during this time.

Cactus seeds can be sprinkled directly on top of the moist soil in a pot, and covered and sealed with a plastic bag. Set in a sunny place.

Procedure for Stem

Propagation

From the stems collected, keep stems moist by storing in a plastic bag with some moisture until ready to use. Stems can then be kept in the refrigerator to prevent molds from growing on your specimens. It is best to use the cut stems as soon as possible. From the stems available, cut six sections, removing lateral buds and leaves. Dip the bottom end in rooting hormone powder, and

place in the prepared cutting medium. Choose five or more stems from five different shrubs/trees, and prepare them as previously described in the supporting information section. Keep the medium moist; check daily.

EVALUATION OPTIONS

Were you successful in growing plants from seeds, stems (green and woody), and cactus pads? (answers vary)

Which method worked the best for the seed germination? (answers vary)
How many total plants would you end up with by the end of the year if you continued to propagate each week?

Consider that some plants die in the process. (answers vary)

Which seeds grew fastest?

Why? (answers vary)

Did any of the stem/cactus pad cuttings die? Why or why not? (answers vary)

Why does the propagating medium need to be constantly moist for the stem cuttings, but dry for the cactus pad cuttings? (To prevent drying out of the newly formed roots. Cacti in wet soil would rot due to no roots having developed to take up the moisture).

Once growing why would you want to transplant plants from small pots to large pots? Why would you want to transplant growing stems from the cutting medium to a pot or directly into the ground?

(Roots of plants would need more room to grow. Nutrients are not found in cutting media, so plants will do better in a nutrient rich soil.)

Why is water so critical in the beginning for seeds to germinate? (Water imbibes the seed and prepares it from its dormant state to germinate.)

Does it matter in which direction the seeds are planted in the ground or pot? (No. Roots will grow towards

the ground (gravity), and stems grow up towards the sun.)
Why is it better to start seeds directly into the ground rather than to transplant them later? (There may be a chance of injuring the root/stem of the young seedling in the transplant process.)
Why are the stems used to propagate plants, rather than the flowers? Could roots propagate new plants? Could leaves propagate new plants? Why are green flexible stems (new growth) from hardwood trees not successful in propagating? (Stems have the genetic information to reproduce the vegetative parts of the plant; flowers do not have this ability. Roots can also be used to propagate the plant. Some leaves can only remain leaves and will not produce roots, and stems due to the lack of genetic information in the leaf. Green stems are not mature and do not have the necessary genetic information to propagate another plant.)
List some examples of how plants have evolved to propagate themselves in nature? (Cactus pads that fall off due to wind or an animal bumping into plant grow where they land. Drooping branches of a tree/shrub that touches the ground and begins to grow another plant.)
Which propagation method brings diversity to the next generation? Why? Any advantages to this strategy? (Sexual reproduction resulting from a transfer of pollen (sperm) to the egg (ovule) results in fertilization. The end product of this union develops into a seed which has the unique qualities of both the male and female parents from the previous generation. Diversity is achieved, and perhaps producing a stronger genetic strain that will survive environmental as well as biological challenges.)

Which propagation method reproduces exact copies of the parent plant? Why? (Vegetative propagation results from using the same part of the parent plant to create more copies of itself. Since only one parent is involved, this is asexual reproduction, thus more copies are produced and are exactly alike genetically.)
Are there any disadvantages to vegetative propagation? (Yes. If a disease, fungus, virus, bacterial infection or insect problem can affect one plant, it will affect all plants due to each plant having the same genetic combination. Since there is no diversity as in sexual reproduction the plants do not have a better chance for survival because as one plant is affected, all are affected.)
Did you lose any plants in the transplanting process? If yes, list some reasons. (answers vary)
Did you lose any plants in the propagation process? If yes, list some reasons. (answers vary)
How does propagating plants help a greenhouse grower in his/her business? (This method increases the number of plants to sell ultimately increasing revenue for the business.)
How can these propagation exercises help an area that has suffered a forest fire? (By propagating trees from the same area into bare or disturbed areas, wildlife may ultimately benefit from future food, nesting and shelter. An immediate result could be in the lack of soil erosion from rain due to the new plantings.)

EXTENSIONS AND VARIATIONS

-Measure plant growth daily, and use data to graph out.
-Visit a local nursery to observe how they propagate plants.

-Use different soil blends to propagate plants.
-Arrange with a plant nursery to start plants for them to sell.
-Select seeds from different climate zones.

RESOURCES

United States Forest Service
Tonto National Forest
2324 E. McDowell Rd
Phoenix AZ (602)225-5200
U of A Maricopa
Co. Cooperative Extension,
4341 E. Broadway, Phoenix
AZ 85040 (602)470-8086x317
<http://cals.arizona.edu/agliteracy>
Desert Botanical Garden
1201 N. Galvin Parkway
Phoenix AZ 85008
(480) 941-1225 www.dbg.org
The Boyce Thompson
Southwestern Arboretum
Highway 60E, Superior AZ
<http://cals.arizona.edu/BTA>
ASU Arboretum
Main Campus, Tempe AZ
(480) 965-8467
Wild Seed
PO Box 27751, Tempe AZ
(480) 276-3536
AZ Game and Fish Dept
2221 W Greenway Rd,
Phoenix AZ 85023
(602) 942-3000
www.gf.state.az.us
Native Seeds/SEARCH
526 N. 4th Ave, Tucson AZ
85705 (520) 622-5561
info@nativeseeds.org
www.nativeseeds.org

MAGAZINES

National Gardening
PO Box 51106
Boulder, CO 80323

Organic Gardening
PO Box 7583
Red Oak, IA 51591

Horticulture
PO Box 51455
Boulder, CO 80323

CREDITS

Sunset Western Garden
Book or
Sunset Western Landscape
Book
Sunset Books Inc.
Menlo Park CA 94025

Xeriscape Training Manual
Ron Dinchak
Mesa Community College
1833 W. Southern Ave
Mesa AZ 85202
(480) 461-7000

EDUCATORS' NOTES

CURRICULUM DESIGN
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Vocabulary Definitions

Seed - The fertilized ripened ovule of a flowering plant containing an embryo and capable of germination to produce a new plant.

Stem - The plant organ that provides structural support for upright growth, contains tissues for transporting food, water, and other materials.

Leaf - The lateral outgrowth from a stem that constitutes a unit of the foliage of a plant and functions primarily in food manufacture by photosynthesis.

Propagation - A type of asexual reproduction in which numbers of individual plants are increased.

Bud Scale - One of the leaves resembling scales that form the sheath of a plant bud.

Lateral Bud - A growth area on the stem that may produce stems, leaves, and flowers.

Leaf Scar - Part of the stem where the last year's leaf was attached.

Terminal Bud - The tip of the stem where visible growth is taking place.

Areole - The cushion-like growing point of a cactus where the spine emerges.

Spine - A stiff, pointed plant process along the stem which is a modified leaf.

Root-Tone - Rooting hormone powder which enhances root development from plant cuttings.

Population - All the individuals of a species that live in a particular area at the same time and can interact with each other.

Sexual Reproduction - Pattern of reproduction which involves two parents each with different gametes (sperm and egg) which fuse to form a new offspring with different characteristics (diversity).

Asexual Reproduction - Pattern of reproduction which involves one parent to produce an identical offspring without the fusion of gametes.

Species - A group of organisms that can interbreed and produce fertile offspring in nature.

Cross-Pollination - The pollination of a flower by pollen from a completely different plant from the same species.

Self-Pollination - The pollination of a flower by pollen from the same flower or another flower on the same plant.

Seed Coat - The protective layer on a seed.

Damping Off - A diseased condition of seedlings or cuttings caused by fungi and marked by wilting and rotting.

Osmosis - Diffusion of water through a semi-permeable membrane where the concentration of water moves from areas of greater concentration to areas of lesser concentration. **Imbibition** - The act of taking on water. When seeds are placed in water for a 24 hour period, they expand in size.

Fungus - A major group of organisms that cannot make their own food and consumer dead organisms or are parasitic on living things and include molds, rusts, smuts, mildews and mushrooms.

Cotyledon - The first leaf developed by the embryo of a seed plant after germinating.

pH Value - A scale showing the hydrogen ion concentration of soil or water. The scale runs from 0 - 14 where 7 is neutral because the number of hydrogen ions equals the number of hydroxide ions.

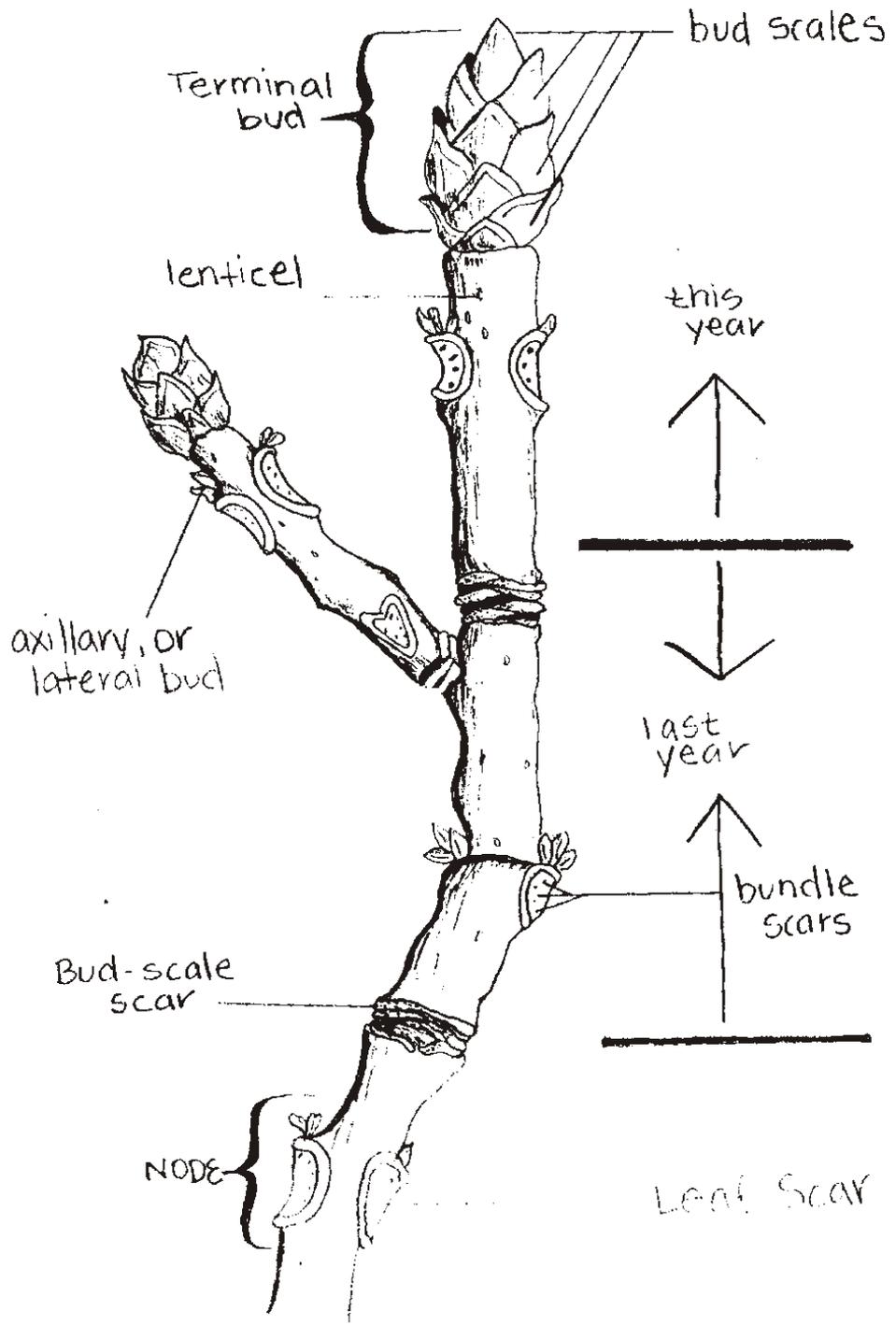
Acidity - When the pH scale runs from 0-7 this shows acidity from excess hydrogen ions present.

Alkaline/Basic - When the pH scale runs from 7-14 this shows alkalinity from excess hydroxide ions present.

Meristematic Tissue - A group of cells specialized for the production of rapidly growing new cells located at the root and stem tips.

DNA - The genetic material responsible for the transfer of traits and characteristics from one generation to the next, and is located in the nucleus of eukaryotic cells.

Heredity - The science of inheritance where traits and characteristics are passed on from the parents to the offspring.



Source: *Plant Anatomy*

