INTRODUCTION TO PROPAGATION

HANDOUT (PRESENTATION OUTLINE)

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(Note that this is just an outline of the presentation and is of limited use. Be sure to refer to the appropriate reference at end for more details)

INTRODUCTION
- Can only be an overview
- Many facets could be a semester-long course in themselves

1. **SEXUAL VS. ASEXUAL or VEGETATIVE**
2. **Sexua**l – seeds and spores.
3. Asexual propagation uses other parts of the plant
4. Several things will determine which method you use.
   Some species can only be propagated by seed eg. OAKS, PINES, MANY PALMS, CALIF. BUCKEYE
5. Some of our desert LEGUMES eg. BLUE PALO VERDE, MESQUITE, and some ACACIAS
6. MONOCARPIC AGAVE SPP. (bloom & die w/ no "pups" or offsets), MONOCARPIC YUCCAS.
7. ANNUALS, eg/ ZINNIAS, AFRICAN DAISY, SWEET PEA, COCKSCOMB, CELOSIA
8. Annuals include many vegetables eg/ CABBAGE, CARROTS, PEAS, SQUASH
9. Some plants may not produce seed. In Baja California where there are numerous plants, ROSA MINUTIFOLIA produces plenty of seed, but
10. The single California individual plant was self sterile, producing no seed.
11. BAMBOO –
    a. some species do not produce seed
    b. others have a 20 to 60 year bloom cycle & seed is difficult to come by
12. Some plants may produce seed with poor viability [eg. SOME NATIVE GRASSES eg. PURPLE THREE-AWN, *Aristida purpurea*]
13. Some plants do not come true from seed
    - Red fruited TOYON, normal color
14. Yellow fruited TOYON
    a. Naturally occurring occasionally but seed planted mostly produces red fruited plants
    b. Must use vegetative or asexual propagation to guarantee yellow fruit
15. Like most horticultural selections of perennial plants:
    - PEARS & APPLES, BEARDED IRIS, DAYLILIES, ROSES
    - Must be propagated vegetatively to maintain characters
16. Make use of the variation in seed grown plants to select new varieties.
    - Only way to make **hybrids** is by seed or sexual propagation (not using gene manipulation)
17. Selections are made from the seedlings, then the new selection is propagated vegetatively or asexually (to maintain selected characteristics)
18. **SEEDS**
19. **STORAGE** -- for most, cool and dry – less than 40 degrees F & less than 8% moisture (with a desiccant)
20. **VIABILITY**
21. 1 to 2 weeks for WILLOWS (*Salix*), COTTONWOOD (*Populus*), spores of SCOURING RUSH (*Equisetum*)
22. a few months for OAKS, *CALIFORNIA BUCKEYE* (*Aesculus*), Bunya-bunya (*Araucaria bidwillii*) & other fleshy seeds like NAKED LADIES (*Amaryllis belladonna*)
23. NAKED LADY seed actually germinate without being planted
24. Seeds with long viability – 100% germination on PALO VERDE seeds stored 25 years in uncooled office
25. LUPINES rumored to germinate after 10,000 years but that's been largely disproved
26. CANNA (*Canna compacta*)
    a. seeds have been germinated after 600 years.
    b. Seeds came from a 600 year old rattle
27. **GERMINATING SEEDS**

a. Many seeds, annuals especially, may be planted untreated, in place, or in containers to plant out later, eg. ZINNIAS, AFRICAN DAISY (*Dimorphotheca sinuata*), CALIFORNIA POPPY (*Eschscholzia californica*), Four o'clocks (*Mirabilis jalapa*)

28. But some seeds have adaptations to survive various climate/conditions & may be difficult to germinate
    a. may require one or more treatments to germinate, or for more uniform germination
29. **Cold moist stratification**
    a. < 40 degrees 1 to 3 months
30. eg. *ROSA*, STONE FRUITS, TRUE MYRTLE (*Myrtus communis*), TOYON (Heteromeles arbutifolia)
31. **Fire/heat** – some plants from **Chaparral, Matorral** in Spain, **Fynbos** in South Africa & Australian **Bush** - fire-adapted communities around the world
32. Burning straw, excelsior or pine needles over the seed bed will often overcome the seed dormancy
33. Eg. MATILIJA POPPY (*Romneya coulteri*), TREE POPPY *(Dendromecon*), CHAMISE (*Adenostoma fasciculatum*)
34. **Smoke** / **charate made from chamise** (same reasons as above) may improve germination
35. Eg. GOLDEN YARROW (Eriophyllum) from California Chaparral, ROCKROSE (*Cistus*) in the Mediterranean Matorral, GREVILLEA (Grevillea) in the Australian Bush, PROTEA (Protea) in the South African Fynbos
36. **Liquid Smoke** can be used instead of chamise charate
37. LARGE-FLOWERED PHACELIA (*Phacelia grandiflora*) from California Chaparral germinates abundantly after fires.
38. Germination comparison: 0% germination for no liquid smoke, good germination for 10 & 15% liquid smoke, uneven germination for 20% liquid smoke.
39. KNOB CONE PINE (*Pinus attenuata*) from California - cone opens after fire to disperse seeds
40. HAKEA (*Hakea*) from Australia - seed pods open after fire to disperse seeds
41. Some seeds have a hard seed coat that prevents the seed from imbibing water & germinating
    Scarification - to break through a hard outer seed coat
    a. In nature, freezing, microbial action or passing through a digestive tract of animals would do the job
    b. Using a file - works for a few, large seeds
42. CANNA (*Canna*) seeds after filing
43. BLUE PALO VERDE (*Cercidium floridum*)
    a. Clipped with pruner or razor blade
    b. **Cut away from the micropyle** - where it was originally attached to the pod
44. **Hot water soak** - ~ 6 times the seeds' volume of 180 to 200° F water left to cool for 12 to 24 hours
45. Examples of seeds responding to one of these methods of scarification: FLOWERING MAPLE (*Abutilon*), MORNING GLORY (*Ipomoea acuminata*), LUPINE (*Lupinus*), PELARGONIUM (*Pelargonium*)
46. SUNDEW (*Drosera gigantea*)
    a. Some plants have small seed with hard seed coats
47. **Sandpaper** (100 grit) being used to scarify tiny sundew seeds
48. ANCHOR PLANT (*Colletia cruciata*) *Ceanothus* relative
    a. Tried for years to germinate
    b. Finally rubbed the hard seed with a brick and had nearly 100% germination
49. **Acid scarification** eg. MANZANITA (*Arctostaphylos*)
    a. Sulfuric acid (H_2SO_4) for a few minutes to a few hours)
    b. For small seed that would be difficult to use other coarser methods
    c. For larger amounts of seed that would be time consuming to use other methods
    d. Why do you think seeds might be adapted to respond to an acid treatment?
       .....passing through animal digestive tract
50. Seed responding to acid scarification: MANZANITA (*Arctostaphylos*), CEANOTHUS OR CALIF. LILAC (*Ceanothus*), BLUE PALO VERDE (*Cercidium floridum*), RED SHANKS (*Adenostoma sparsifolium*)

51. **Light**
    a. Some seeds need light to germinate
    b. Don't cover seeds BEGONIA,
52. Seeds needing light to germinate: BEGONIA, COLUMBINE, PETUNIA, FLOWERING TOBACCO (*Nicotiana*)
53. **Dark**
    a. Some seeds need dark to germinate
    b. Cover the seeds completely
54. Seeds needing dark to germinate: CILANTRO, CALENDULA, LARKSPUR, SWEET PEA
55. **Double dormancy** - LEMON LILY (Lilium parryi)
    a. Needs 3 to 6 months warm temperatures then 2 to 3 months cold,moist
56. Other seeds requiring similar treatment: some VIBURNUMS, some JUNIPERS, LILACS (*Syringa*), TREE PEONY (*Paeonia suffruticosa*)
57. Seeds requiring a **wet-dry-wet regime** to germinate: RUBY ROMULEA (*Romulea subulosa*) a bulb from South Africa, LESSER BUSH SWEET PEA (*Podalyria sericea*) - a leguminous shrub from South Africa
58. CAPER (Capparis spinosa)
    a. Have tried unsuccessfully for years to germinate the seed
59. Yet they germinate at the base of the plant by the dozens
60. **Gibberellic Acid**
    a. Presoaking seeds in gibberellic acid will aid germination of many seeds that would otherwise require prolonged treatments like cold, ageing, light, etc.
61. Media that we use for propagating
62. Sponge Rok or Perlite
    a. Mined, then heated & exploded like popcorn
    b. Volcanic glass, don't breath dust
    c. Aeration, prevents compaction, lightens soil mixes
63. Vermiculite
    a. Mica, heated & exploded like popcorn
    b. Don't breath dust
    c. Water-holding, some aeration
    d. Accordion like shape allows it to collapse from weight of soil & loses aerating capacity
64. Pumice
    a. Mined
    b. Similar in properties to perlite
    c. Aeration, lightens soil mixes
    d. Usually not sterile
65. Coir
    a. Coconut husk
    b. Renewable peat moss substitute
    c. Grades from powder to chunks
    d. Neutral rather than acid
66. UC Mix #2 or other sterile potting soil or seed starting mix
    a. 75% sand + 25% peat or ground bark + nutrients/additives
67. Planted seed
68. Cover seed with vermiculite or the seed starting soil
69. General rule of thumb: cover the seed 1 ½ to 2 times the width of the seed
70. DO NOT COVER seeds that require light
71. Water from the bottom so you don't disturb the seeds
72. Label with name, date, any treatment details
73. Drain & bag the seeds. Like a miniature greenhouse
74. After seeds have germinated the bag can be opened over a couple of days to harden off the seedlings
75. Large seeds of plants that don't like disturbance - we plant in individual pots
    eg. PURPLE ORCHID TREE (Bauhinia variegata)

76. Same basic process can be used outdoors in the ground
77. Orchids seeds have special needs - eg. CATTLEYA ORCHID (*Cattleya dowiana*)
78. **Epiphytic orchid seed pod**
    a. Orchid seeds are the smallest of all seeds
    b. There may be as many as 3 million seeds in 1 epiphytic orchid pod
    c. No stored nutrients - must grow in association with **Mycorrhizae fungi**
79. **Mycorrhizae fungi**
    a. A fungus that grows in association with the roots of a plant in a symbiotic relationship
    b. Many plants associate with Mycorrhizae
80. Orchid seed growing on **agar**, a product derived from red algae
81. Ferns grow naturally from spores eg. NIPHIDIUM (*Niphidium crassifolium*)
82. **Sori (singular, sorus)** - patches of spore cases on back of fern leaf
83. **Sporangia or spore cases**
    Each sporangia contains 64 spores
84. **Spores** - single celled reproductive bodies
85. **Spores germinate into prothalli** - 1 to 3 months
86. **Prothallus (singular)** - 3 to 9 months
87. **Prothalli** - 3 to 9 months
    a. Antheridia release sperm
    b. Sperm swim to eggs in archegonia & fertilize it
    c. Resulting embryo grows into the fern as we know it3 to 9 months
88. **ASEXUAL OR VEGETATIVE PROPAGATION**
    a. Uniformity – identical to parent plant – no genetic diversity
    b. Used to maintain a horticulturally desirable trait or qualities eg. flower color, dwarfness, ease of growth, etc.
89. **Methods of asexual propagation**
90. MOTH ORCHID (*Phalaenopsis*) Keiki (baby plants on flower stem)
91. *Hadrodemas warczewicziana* (baby plants on flower stem)
92. MOTHER OF MILLIONS (*Kalanchoe tubiflora*) (plantlets on leaf edges.
93. **Layering**
    a. A low branch is bent down, **girdled** or notched, and covered with soil
    b. One of the most simple
    c. For producing a few plants - not good for mass production
    d. Can be used for many species
94. Plants that naturally layer themselves eg. DESERT ROSE (*Rosa minutifolia*), BLACKBERRY, CATALINA ISLAND PERFUME (*Ribes viburnifolium*), MYOPORUM (*Myoporum parvifolium*)
95. **Air layering (Marcotting)**
    a. Used for difficult to propagate plants
    b. Or where a large plant is wanted, larger than could be propagated by other means
    c. Where just a few are needed - too labor intensive
96. Girdled stem in preparation for air layering
97. Wrapped w/ New Zealand sphagnum moss & wrapped tightly w/ plastic
    a. Green moss is fine
98. Air layer example - BAY LAUREL (*Laurus nobilis*)
99. LITCHI (*Litchi chinensis*)
100. WEEPING CHINESE BANYON (*Ficus benjamina*)
101. Commercial air layering device
102. Air layered plant “harvested” showing how large the resulting plant can be
103. Other plants that are propagated by air layering: DRACAENA (*Dracaena fragrans* ‘Massangeana’), DIEFFENBACHIA, FIDDLE LEAF FIG (*Ficus lyrata*), CROTON (*Codiaeum variegatum*)
104. **Stolons** - BOSTON FERN (*Nephrolepis exaltata* ‘Bostoniensis’)
    a. Stolons - modified, horizontal, above-ground stems

105. STRAWBERRY *(Fragaria*)
106. BERMUDAGRASS (*Cynodon dactylon*)
    a. Hybrid bermudagrass lawns planted with chopped up stolons
107. **Division** - used for clumping plants & bulbs eg. SWEET FLAG (*Acorus gramineus*)
108. CYMBIDIUM ORCHID
    a. Minimum of 3 to 5 bulbs per division
    b. Repot every 2 to 3 years
    c. Repot/divide after they bloom but before July 1st
109. Other plants propagated by division: DAYLILY (*Hemerocallis*), BEARDED IRIS, LILYTURF (*Liriope*), PURPLE THREE-AWN (Aristida purpurea) & other perennial grasses
110. **Tissue culture** or **micropropagation**
    a. Specialized equipment & procedures under sterile conditions
    b. Expensive
    c. Unlimited numbers

111. CATTLEYA ORCHID (*Cattleya*)
    a. Orchids were the first plants to be propagated commercially by tissue culture
    b. Equipment & procedures already set up for seed growing
112. BOSTON FERN & relatives
113. MONKSHOOD *(Aconitum novaboricensis*) & other endangered species where there are few individuals
114. COAST REDWOOD (*Sequoia sempervirens*) & other forest trees
    Almost anything can be propagated by tissue culture
115. **Grafting**
    a. Joining two separate plants so they grow as one
    b. Propagate varieties that do not propagate easily by other methods
    c. Or to propagate plants that have weak roots
    d. "New" roots can control the size of the plant or provide disease or nematode resistance
        i. Eg. Avocado grafted on avocado-root-rot-resistant rootstock
116. Plants that are propagated by Grafting/Budding: PEARS & APPLES, CITRUS, AVOCADOS, ROSES - though most miniature roses are on there own roots
117. **Cuttings** - pieces of the plant are encouraged to grow the missing parts, usually roots
    a. stem cuttings
        i. hardwood
        iii. semi-hardwood
        iv. softwood
    b. leaf cuttings
    c. root cuttings
118. **Rooting hormones** - typically contain one or more of the following
    a. Naphthaleneacetic acid
    b. Naphthalenacetamide
    c. Indole-3-butyric acid
    d. Fungicide
119. **Rootone**
120. Rootone label
    a. Naphthalenacetamide in talc + fungicide Thiram
    b. Strength cannot be changed
121. **Dip 'n Grow**
122. Dip 'n Grow label
    a. Indole-3-acetic acid + naphthalenacetic acid in alcohol
    b. Can vary the strength according to how difficult the cutting is to root
    c. No fungicide
123. NEVER DIP CUTTING INTO CONTAINER - CONTAMINATE W/ DISEASE-CAUSING ORGANISMS
124. **Hardwood cuttings**

a. Mature wood
b. Leafless

125. Use straight potting soil
126. Many hardwood cuttings can be planted directly in the ground
127. Plants propagated by winter hardwood cuttings: GRAPE (*Vitis*), WILLOW (*Salix*), WILLOWS (*Salix*), COTTONWOOD (*Populus*), GRAPE, FIGS
128. Plants propagated by summer hardwood cuttings w/ foliage removed: ANGEL'S TRUMPET (*Brugmansia*), CORAL TREE (Erythrina), POINSETTIA, PLUMERIA, OCOTILLO (*Fouquieria*)
    a. Ocotillo fence poles often grow
129. **Semi-hardwood cuttings**
    a. Current season's growth, leaves mature but stem not woody
130. Eg, TOYON (*Heteromeles arbutifolia*), CALIFORNIA LILAC (*Ceanothus*), MANZANITA (*Arctostaphylos*), CAMELLIA
131. **Softwood**
    a. Current growth, soft, green, flexible
    b. Eg. CORAL FOUNTAIN *(Russelia equisetiformis*), SALVIA, COLEUS, MONKEYFLOWER (*Mimulus*), LILAC (*Syringa*)
132. **Intermittent mist bed**
133. Bagged cuttings
134. Tent for cuttings
135. Propagation boxes
136. Rooted community pot
137. Rooted cuttings(1)
138. **Leaf cuttings** - AFRICAN VIOLETS (*Saintpaulia ionantha*)
139. BEGONIA
140. SUNDEW (*Drosera*)
141. SEDUM (*Sedum nussbaumianum*) & some other succulents like *Echeveria*, *Graptopetalum*
142. AFRICAN VIOLET
    a. Whole leaf planted in African violet mix or in water
143. AFRICAN VIOLET
144. BEGONIA
    a. Wedge-shaped pieces of leaf w/ major veins
145. BEGONIA
    a. Whole leaf flat on media, cut major veins
146. SUNDEW
    a. Whole leaves in distilled water or on New Zealand or live *Sphagnum* moss
147. SEDUM
    a. Whole leaves must be carefully pulled sideways so as to take the associated bud with it
148. Works as well for some *Echeveria* & *Graptopetalum* species
149. SNAKE PLANT (Sansevieria trifasciata)
150. SNAKE PLANT (*Sansevieria trifasciata*) - Leaf sections planted vertically
151. VARIEGATED SNAKE PLANT (*Sansevieria trifasciata* 'Laurentii')
    a. Cannot be grown from leaf cuttings
    b. Variegation is a *chimera*, two distinct genetic tissues growing side by side
    c. Plants grown from leaf cuttings will be either white or green
    d. Must be grown by division
152. **Root cuttings** - HORSERADISH
153. Root cuttings - HORSERADISH
154. LIGULARIA or FARFUGIUM
155. Root sections ready to be planted
156. Root sections planted, ready to be covered
157. SAPPHIRE DRAGON TREE (Paulownia kawakamii)
158. Root sections w/ sprouts

159. MATILIJA POPPY (Romneya coulteri)
    a. Pencil-sized root cuttings planted horizontally
160. Helpful resources
161. Backyard Gardener Seed Germination Database
162. J.L. Hudson, Seedsman Website - How to Germinate Seed
163.
164. *Seed Germination, Theory and Practice* by Norm Deno - available online
165.
166. *Seed Propagation of Native California Plants* by Dara E. Emery
167. *Processing Seeds of California Native Plants for Conservation, Storage, and Restoration* by Michael Wall & John MacDonald
168. *The Grafter's Handbook* by R.J. Garner
169. *Plant Propagation: Principles and Practices*, Sixth Edition (or probably later editions), Hudson Hartmann
170. *California Master Gardener Handbook* by Dennis Pittenger
171. End

SEEDS NEEDING LIGHT TO GERMINATE
http://coastalrain.tripod.com/weegarden/id27.html

* Balloon Flowers
* Basket of Gold
* Begonia
* Bellflower
* Bells of Ireland
* Blanket Flower
* Browallia
* Coleus
* Columbine
* Creeping Zinnia
* Dill
* Flossflower
* Flowering tobacco
* Impatiens
* Leopard's-Bane
* Lettuce
* Maltese-Cross
* Feverfew
* Mexican Sunflower
* Reseda Ordata
* Oriental Poppy
* Ornamental Pepper
* Ornamental Cabbage
* Petunia
* Primrose
* Rock Cress
* Salvia
* Savory
* Shasta Daisy
* Snapdragon
* Stock
* Strawflower
* Sweet Alyssum
* Tickseed
* Transvaal Daisy
* Yarrow

SEEDS NEEDING DARK TO GERMINATE
http://coastalrain.tripod.com/weegarden/id27.html

* Bachelor's Buttons
* Borage
* Butterfly Flower
* Chinese Primrose
* Coriander
* Forget-me-not
* Larkspur
* Nemesia
* Painted Tongue (Salpiglossus)
* Periwinkle

* Phlox
* Poppy
* Pot Marigold (Calendula)
* Sweet Pea
* Treasure Flower (Gazania)
* Verbena

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Backyard Gardener Seed Germination Database: http://www.backyardgardener.com/tm1.html or search

J.L. Hudson, How to Germinate Seed: http://www.jlhudsonseeds.net/germination.htm or search

Deno, Norm. 1993. *Seed Germination, Theory and Practice*, Second Edition. Available online: http://ddr.nal.usda.gov/dspace/bitstream/10113/41278/1/CAT10633450.pdf or search

Seed starting soil sterilization: http://www.colostate.edu/Depts/CoopExt/4DMG/Soil/sterile.htm or search

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Emery, Dara E. 1988. *Seed Propagation of Native California Plants*. Santa Barbara, CA: Santa Barbara Botanic Garden.

Wall, Michael & MacDonald, John. *Processing Seeds of California Native Plants for Conservation, Storage, and Restoration*. Claremont, CA: Rancho Santa Ana Botanic Garden.

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Pittenger, Dennis R. 2002. *California Master Gardener Handbook*. United States of America: Regents of the University of Californica Division of Agriculture and Natural Resources.