Process of adventitious root formation

PLSC 368: Lecture 9 PRINCIPLES OF PROPAGATION BY CUTTINGS I. GENERAL INTRODUCION - Kinds of Cuttings a. Stem cuttings b. Cuttings of leaf buds (single-eye cuttings) c. Root cuttings d. Leaf cuttings - Totiopotency -The ability of a single cell to reconstruct entire plant parts and functions -Each cell has all the genetic information required for plant regeneration - Dedifferentiation -The ability of previously developed, differentiated cells to return to a meristem II. ADVENTITIOUS ROOT FORMATION A. What is Adventitious Root? Roots derived from any parts of plants other than by normal development of seedling roots Two types: From preformed roots (antenna roots) Responses to wounds (at incision stem base) Rooting After wounding 1. A necrotic plate is formed at the wound site -corky material (suberin) seals the wound -gummy material plugs xylem protection against dehydration and pathogens 2. Living cells behind the plate divide - form a wound periderm (a layer of parenchymcelles) 3. Initiation of adventitious roots -cells in the region of vascular cambium and phloem divide and become root primodium Four Stages of de novo (re-) Adventitious Root Formation 1. Dedifferentiation -of specifec differentiated cells 2. The formation of root initials - dedifferentiated cells near vascular bundles becomes meristematic 3. Root primordia is formed -from root initiating cells 4. Root emergence -vascular tissues are formed and linked to inserts B. Rooting in Herbaceous Plants-Adventious roots originate just outside and between vascular bundles The tissue from which the roots are derived varies i.e. phloem parenchym (mung bean, pumpkin) epidermis (crass) pericyle (coleus) C. Rooting in Woody Perennials -Adventitious roots are derived from living parenchymceller in young secondary phloem Also from vascular rays , cambium, phloem, lenticels ro pith Site of Adventitious Roots - Just outside the vascular tissue of most woody plants - Phloem ray parenchyma - Callus - Pericycle D. Root formation from Preformed Root Initials (burrknots, rotates) -Burrknots in cherries -Root primordia i Ficus pumila, Golden pothos, salix III. CALLUS - Callus forms at the incision end under environmental conditions favorable for rooting - Kalling and adventitious rooting independently in most species - In severe to root species, adventitious roots can be formed from callus i.e. Pinus radiata, Sedum, Honor helix rooting of friable callus can be harmful (i.e. tissue culture rooting) IV. LEAF CUTTINGS A. Leaf Cuttings with primary Meristems -Foliar 'embyos' (young plants) are resentful of leaf margins or bases -Leaf cuttings made of leaves containing latent primary meristems -Plants: Bryophyllum (Kalanchoe) Tomiea (piggyback plant)* Comptosorus (walking fern) B. Leaf Cuttings with secondary Meristems -New plants formed on secondary meristems Secondary meristems occur from mature cells after ulcers -Both the roots and shoots are (the root of the first before the shots) i.e. the African Violet -Endogenous roots from cells between vascular bundles -Exogenous shoots from subepidermis or subepidermal cortex tissues -Plants: Sainpauliaionantha (African Violet) Sansevieria (snake plant) Begonia Carassula argentea (Jade plant) Lilium longiflorum (Easterlily) -from scale leaf Peperomia, Se, Ficus, etc. V. ROOT CUTS - Buds develop from pericycle (between enddodermis and phloem) near the vascular cambium - Adventitious rootformation often more difficult than the formation of adventitious buds Adventitious roots form at the base of adventitious shoots on root cutting - Advent Rätts Rich shoots arise more easily from the roots of young plant than from the roots of mature plants - Plants propagated by rhizomes and stolons (both modified stems) are not root cuttings - Plants regenerated from root cuttings can exhibit a new phenotype in cases of periclinal chimera i.e. Thornless boysenberry and Thornless trailing black berries both produce plants that are prickly when propagated by root cuttings VI. POLARITY - Shot shape at the distal end (nearest tip of the bulkhead) Roots form at the proximal end (nearest crown - Reversal of the placement of cuttings with respect to gravity does not change polarity - Small pieces of stem tissues still exhibit polarity effect - Auxin movement and distribution involved in polarity - Polarity research in NASA spacecraft? VII. PLANT GROWTH SUBSTANCES INVOLVED IN ADVENTITIOUS SHOOT AND ROTINITIATION Phytohormones- a group of organic compounds, other than nutrients, produced by plants in low concentrations, regulatephysiological processes in growth and development Plant growth Regulators- phytohormones or synthetic compounds that modify the plant

physiological process A. Auxins -Natural: Indoleacetic Acid (IAA) -Synthetic: Indolebutyric Acid (IBA) Naftaleneaceticacid (NAA) -Improves root initiation , activates cambial cells , apical dominance -Synergistic to cytokinin, GA Activities -Concentration Specific B. Cytokines (promotes cell division) -Natural: Zeatin -Synthetic: Kinetin, Benzyl adenine (BAP) -Improves shooting initiation and development -Synergistic to auxins Low auxin and high cytokinin---------->aventitious buds High auxin and low cytokinin---------->adventitious roots C. Gibberellins (GA) -Promotes cell feeding, division -May inhibit both adventitious bud and root formation -Concentration dependency D. Abscisic Acid (ABA) -Regulates stomatal activity , hibernation -Antagonistic to GA -Effect on root promotion not well understood E. Eten (C2H4) -Involved in fruit maturation, abscission, dormancy -Promotes rooting in intact parts of plants -Production enhanced by auxin applied VIII. Effects of buds and leaves A. Presence of buds on inserts stimulates rooting -buds essectial for rooting (auxin source) -removal of buds or a ring of bark under a bud results in no rooting -buds of non-resting stage stimulatory for rooting -after buds are rooting reduced (apple, plum) B. Presence of leaves stimulating to rooting -Carbohydrates are translocated to root initiation site -Auxin source -Cuttings containing leaf root better C. Rooting Cofactors -Synergistic to auxins -A group of compounds (polyphenol oxidase, IAA oxidase, etc.) needed for activation of rotinitination -Translocated from leaf to root ing site D. Endogenous Root Inhibitors -Present more in hard-rooted plants -Synthesized in roots and moved upward in shoots -Reduce root mass and quality Found in pears , Vitis (grape), Eucalyptus Leaching inhibitors from cut ends recover rooting IX. PLANT CLASSIFICATION IN TERMS OF ROOTING ABILITY - Three classes: 1) Rapid rooting - plants contain all the necessary substances required for rooting (cofactors, auxin, etc.) - roots immediately under favorable environment 2) Auxin requires - plants contain all internal cofactors but lack auxin - root well when auxin is valid 3) Cofactor-deficient - one or more cofactors are missing - auxin application fails to stimulate rooting X. FACTORS THAT AFFECT SUCCESS OF CUTTING A. Environmental conditions -moisture -brightness -light intensity and duration -O2 B. Physiological Status -layer plant health and etiolation -carbohydrates -mineral nutrition -gördling C. Type of Wood Selected 1. Rooting difference between lateral and terminal shots 2. Proximal versus distal selection 3. Flowering vs vegetative woods 4. 'Heel' vs. 'nonheel' cuttings i.e. quince, cuttings with 'heel' better D. Seasonal Timing -for diciduous woody plants plants