What's New in the Biology of Plant Propagation

Fred Davies

Dept. of Horticultural Sciences
Texas A&M University
College Station, Texas

So, What About this cutting thing???

Adventitious Roots

Wound-Induced, *De Novo* Adventitious roots (from a new meristem)

Preformed Adventitious Roots (from existing, meristem)

***De Novo* Adventitious Roots** – Roots that arise “anew” (from scratch) from stem or leaf cells that experience a stimulus, such as wounding, to differentiate into roots.

Dedifferentiation – The early stage of adventitious root or bud formation when previously developed, differentiated cells are triggered to form new meristematic regions

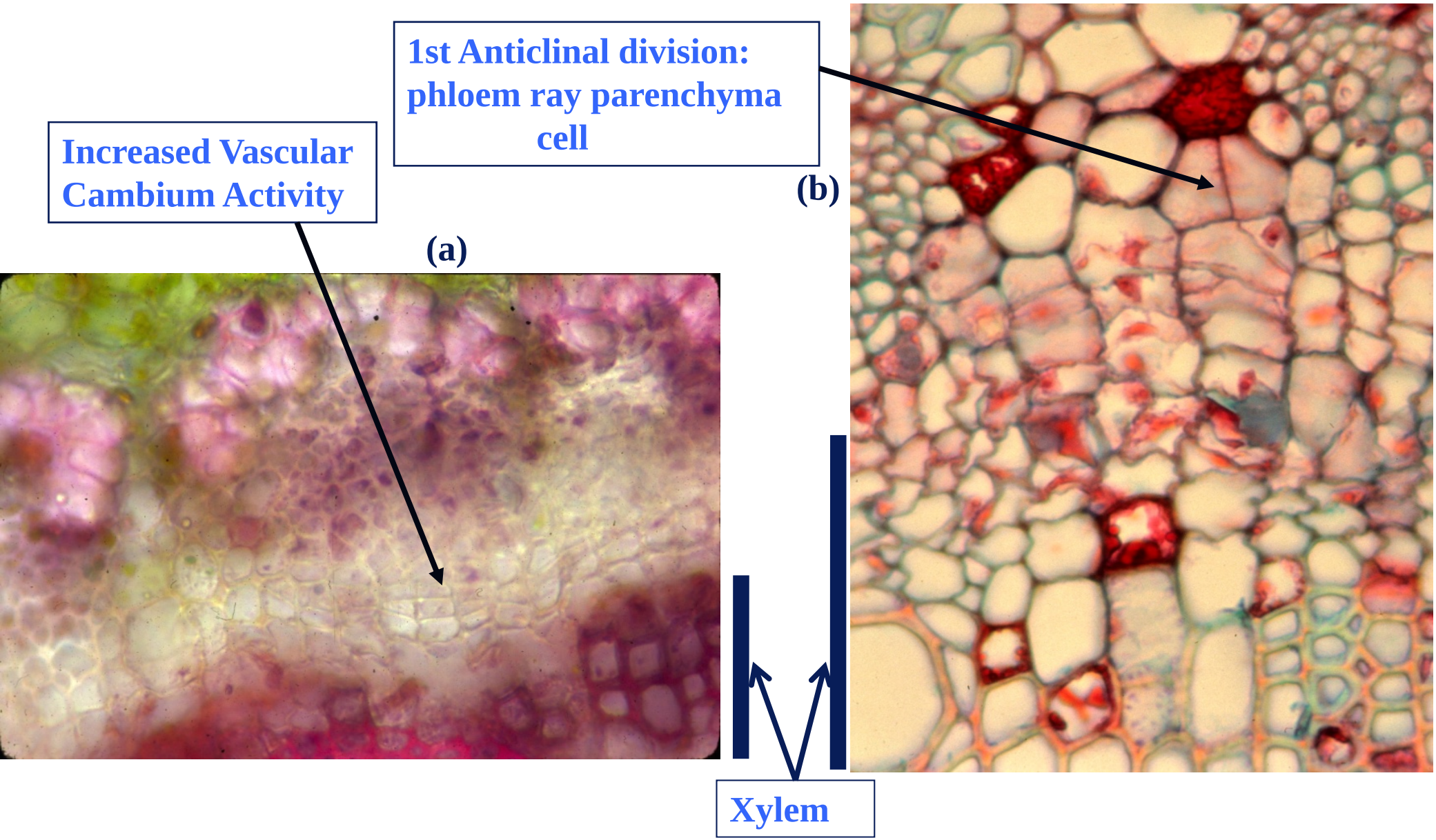
Stages of De novo Adventitious Root Formation (ARF)

- Stage I: Dedifferentiation;
- Stage II: Formation of Root Initials;

++++++++++++++++++++++++++++++++

Stage III: Development of an organized root primordia;

Stage IV: Emergence of Root Primordia



Early events of rooting: (a) increased vascular cambium activity and (b) first anticlinal division of phloem ray parenchyma cell during (early) stage II

Phloem Ray Parenchyma Cells

⇨ All cells are initially parenchyma cells.

⇨ Totipotency.

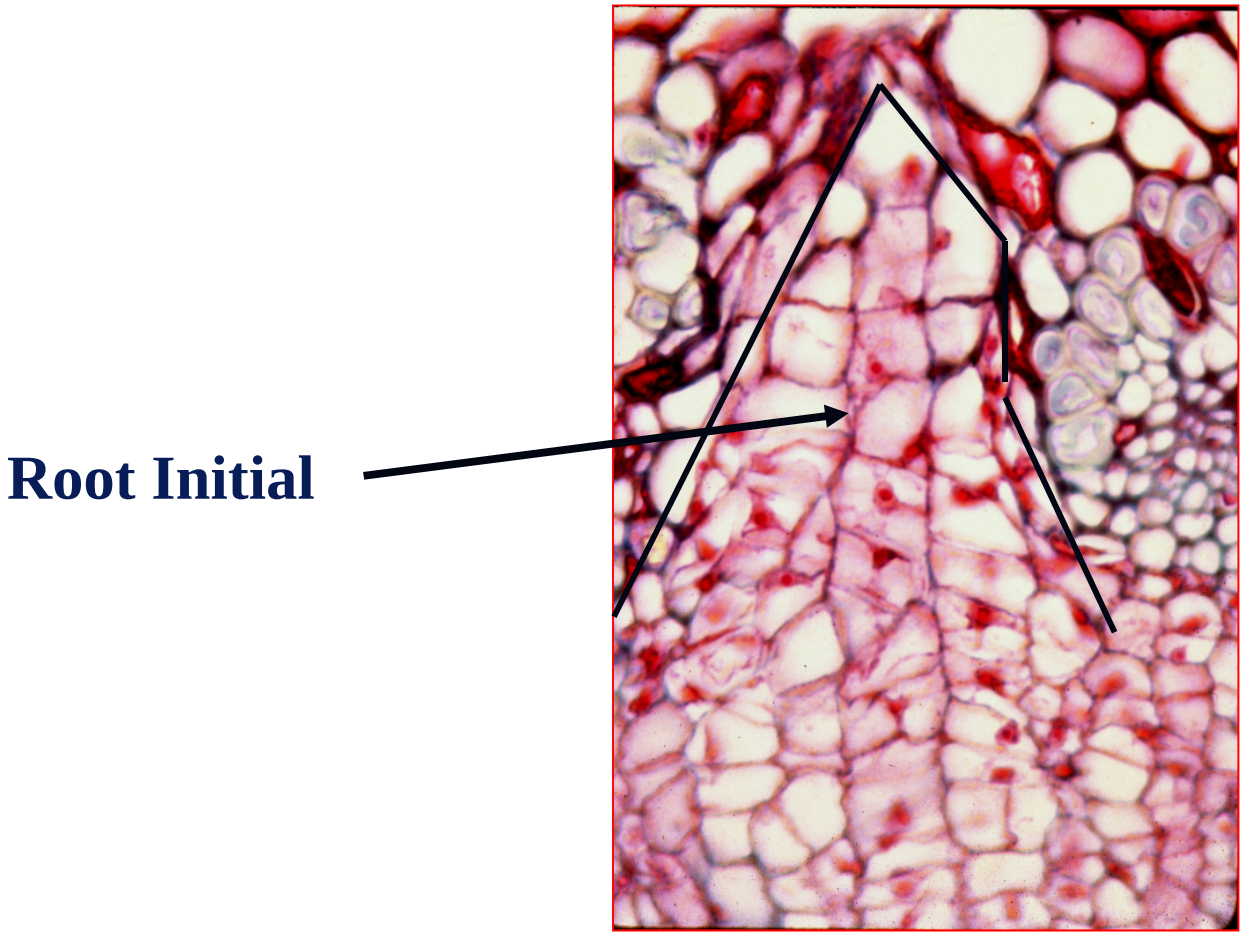
⇨ Parenchyma cells can develope into other types of cells, i.e. initially revert to meristematic cells in *de novo r*ooting

⇨ Phloem - “Loading zone” — rich in carbohydrates, other metabolites.

⇨ Auxin is translocated through phloem parenchyma cells.

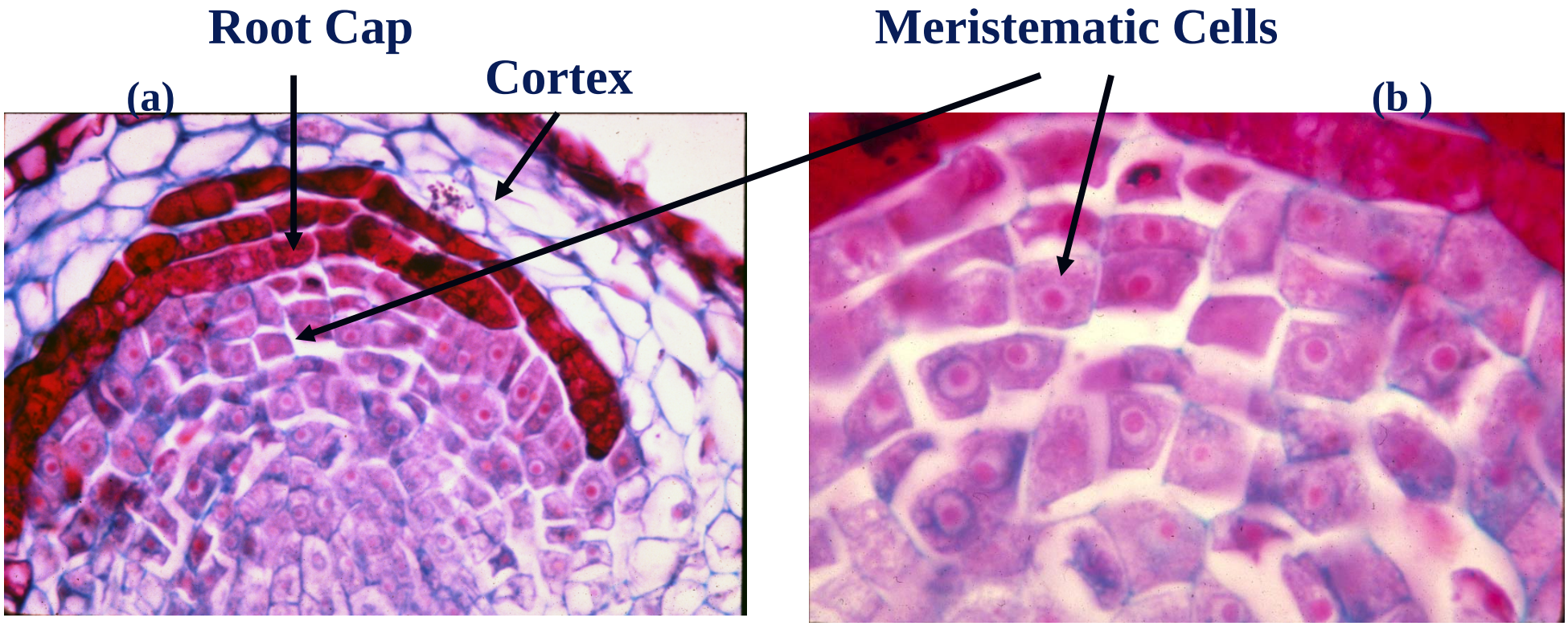
Stage II of Adventitious Root Formation – Root Initial Formation.

Early root primordia development in *Ficus pumila* with the meristematic zone in the phloem ray becoming more organized



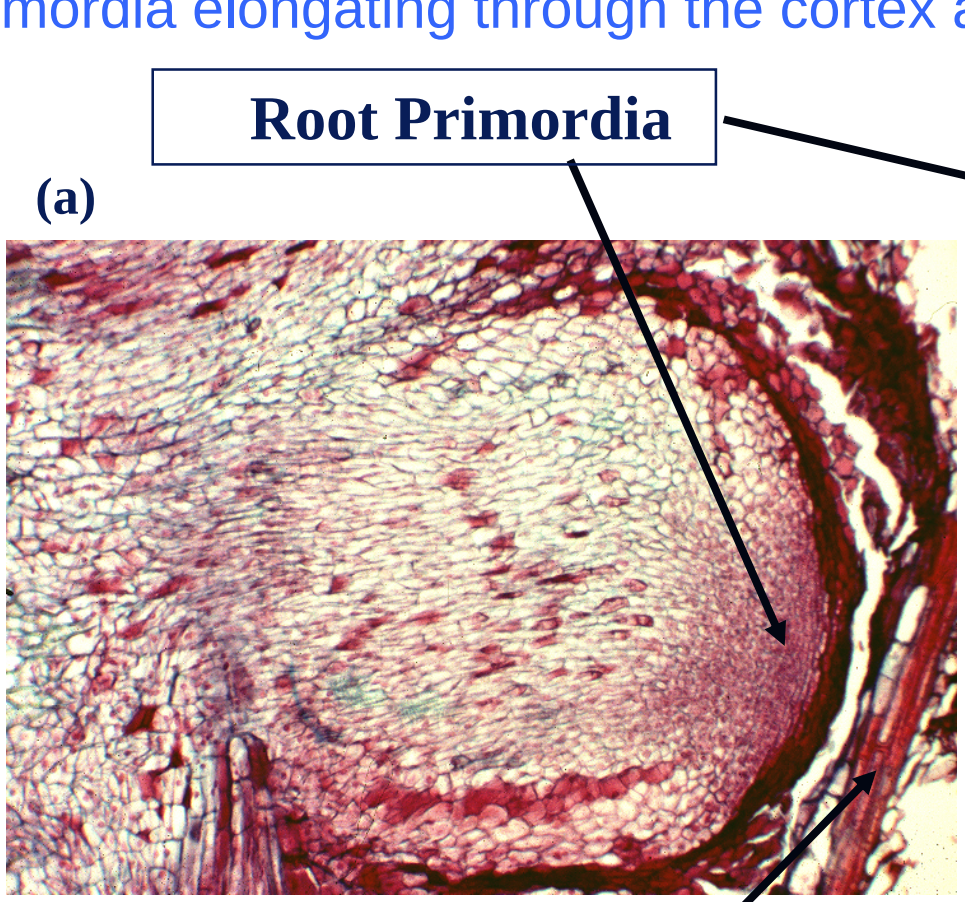
Stage III Adventitious Root Formation – Root Primordia Formation

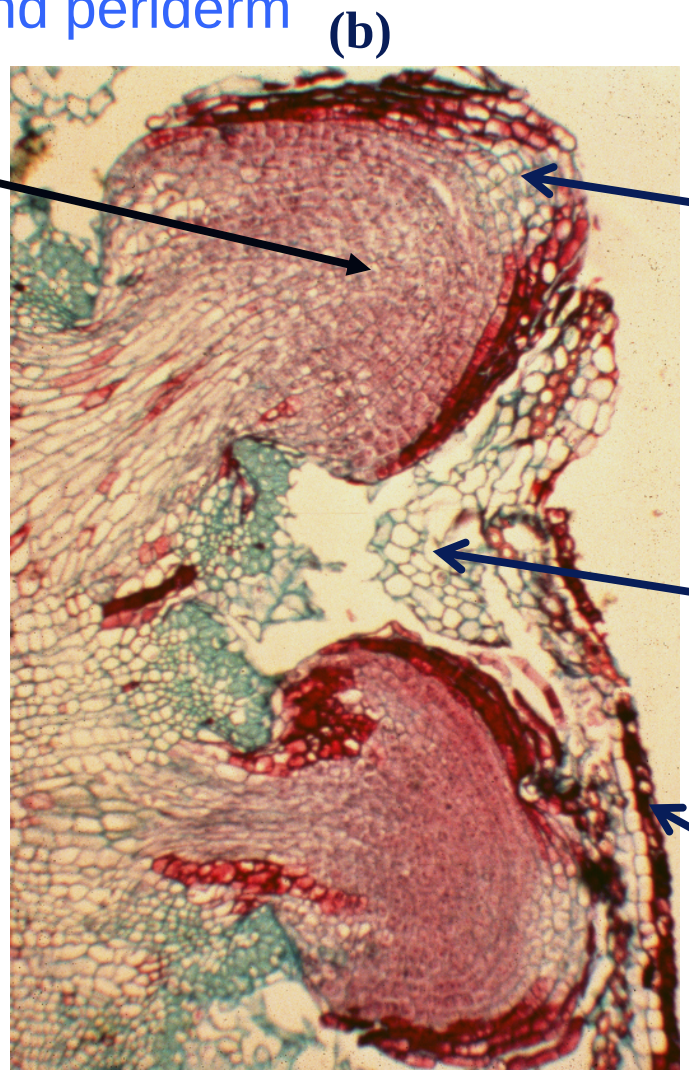
Fully organized meristem (a) The root cap of the adventitious root has become organized, and (b) meristematic cells are characterized with isodymetric cell walls, deeply staining cytoplasm and large nuclei in a *Ficus pumila* cutting.

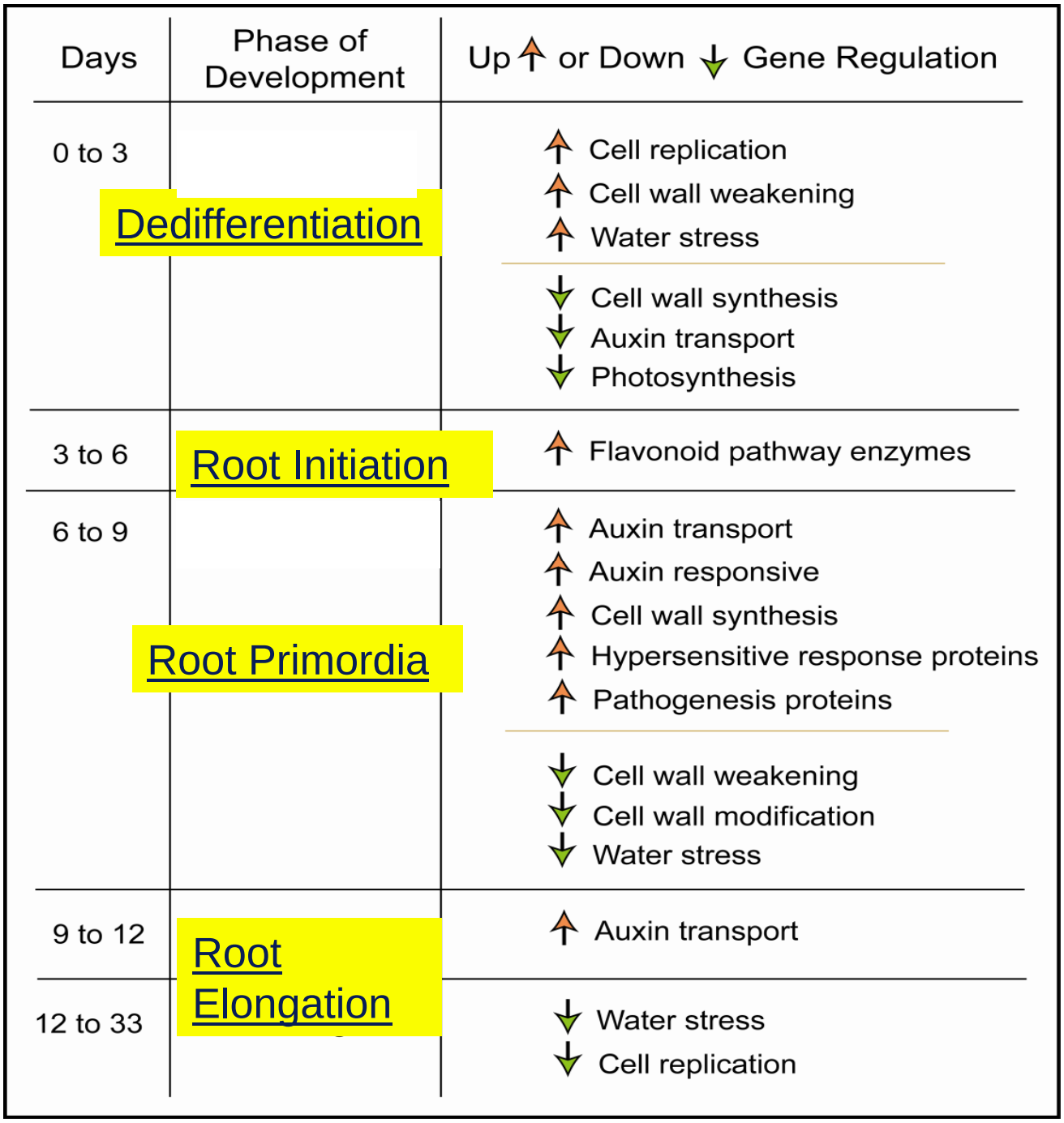


Stage IV of Adventitious Root Formation - Elongation of Root Primordia

(a) Longitudinal section with root primordia elongating through the cortex, pushing out sclereids in the exterior of the cortex. (b) cross-section of two root primordia elongating through the cortex and periderm







Gene expression during the different stages of Rooting

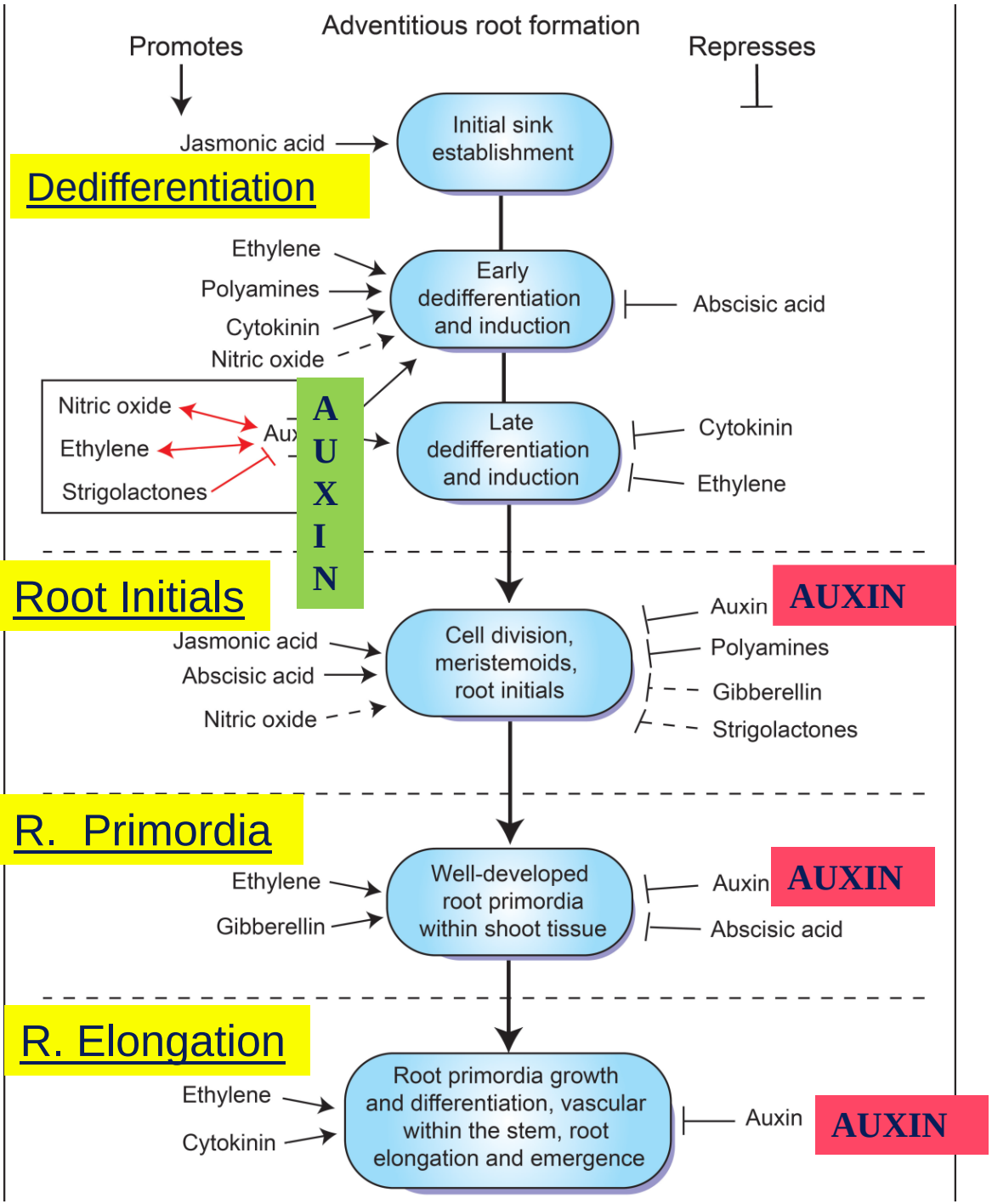
Lodgepole pine (*Pinus contorta)* hypocotyl cuttings.

Gene – segment of DNA – proteins – enzymes – drive chemical reactions

220 genes & encoding proteins were up-regulated (↑increased expression) or down-regulated (↓decreased)

Rooting of petunia

1354 genes induced/ upregulated; 607 proteins produced during rooting



Phytohormone Interactions and Cross Talk during 4 Stages of Rooting

Cross Talk: Signaling among hormones – impacts gene & protein expression.

Auxin is the Master Regulator of Rooting: commercially use: IBA, NAA

Auxin Promote Rooting Stages

Auxin Inhibit Rooting Stages

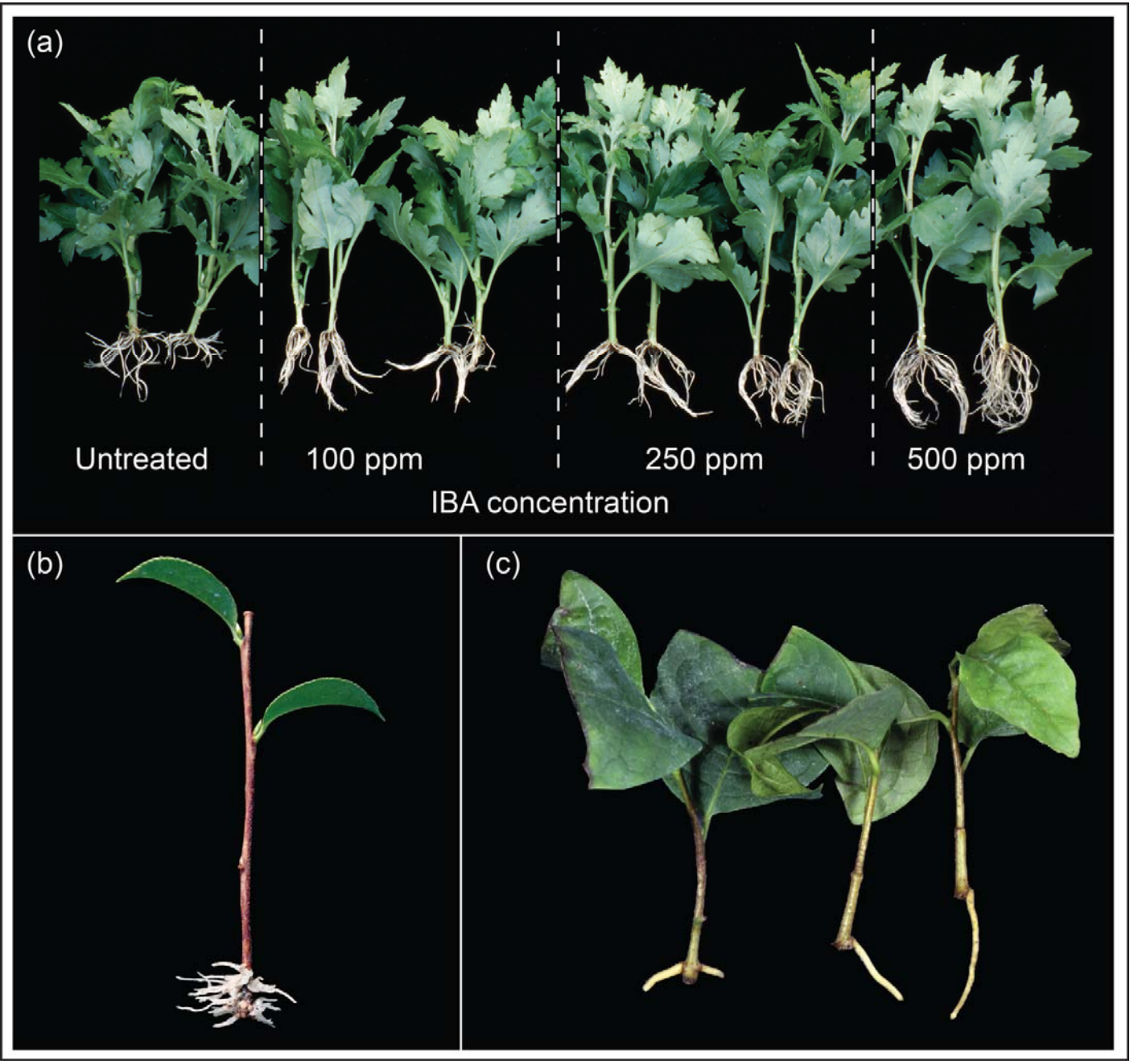
Day 3 9 15

- **Mature, difficult-to-root *Ficus pumila* leaf-bud cuttings.**
- **Spray Application of IBA 3000 ppm**

- **Delaying 15-days after sticking – optimal window for rooting was lost.**
- **Cell receptivity to respond to auxin is lost.**

Chrysanthemum cuttings – Holland – 100 ppm IBA

(Kees Eigenraam, Joel Kroin)

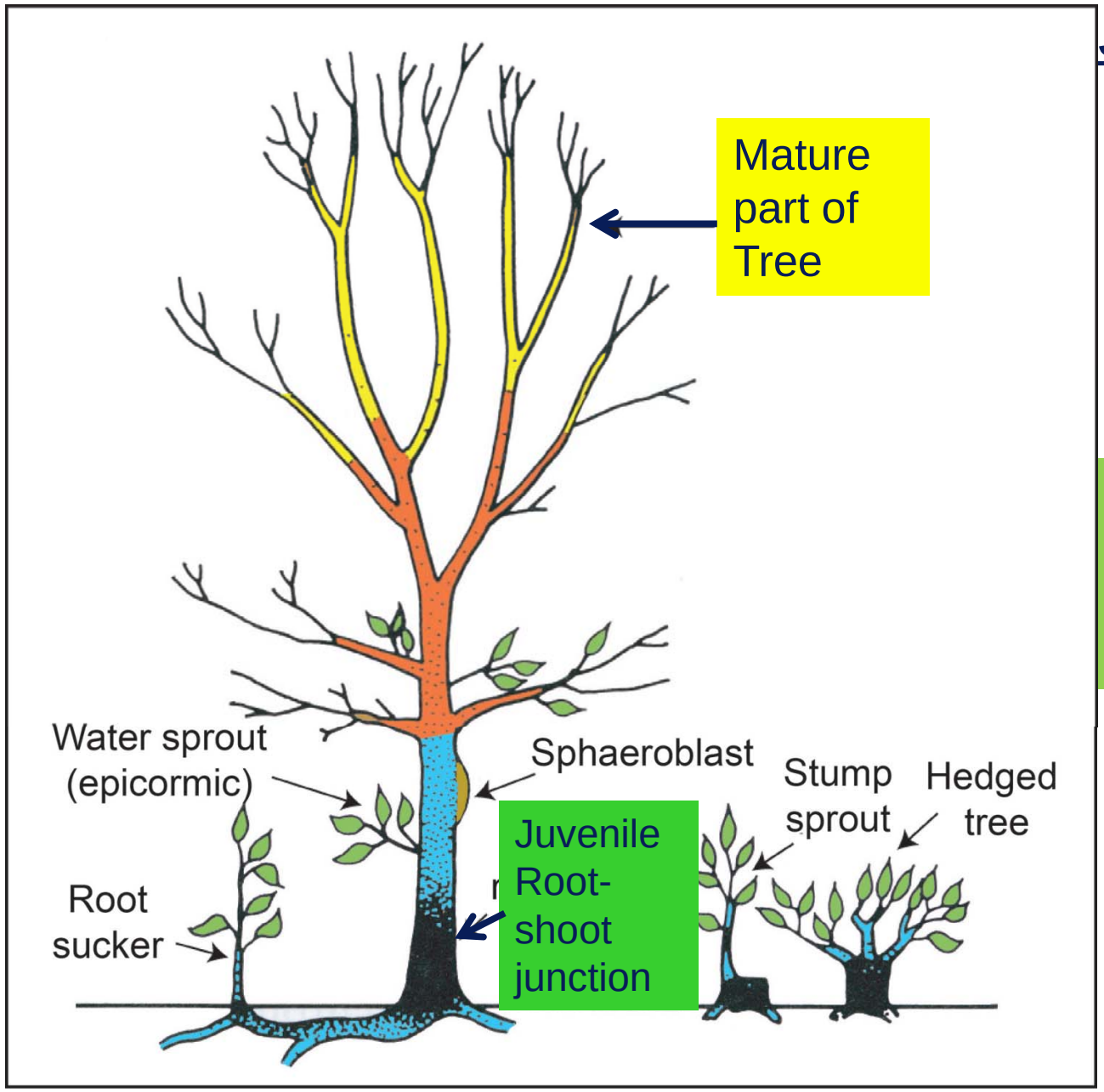


(a) Auxins Enhance Rooting, Not Required.
easy-to-root plants; chrysanthemum.

(b) Auxins Needed to Enhance Rooting
moderately easy-to-root plants; camellia.

(c) Auxin Little Effect on Rooting
difficult-to-root - (recalcitrant) plants; Pawpaw (*Asimina*).

Loss Cell Sensitivity to respond to root morphogens + auxin;



Juvenile-Mature Gradients

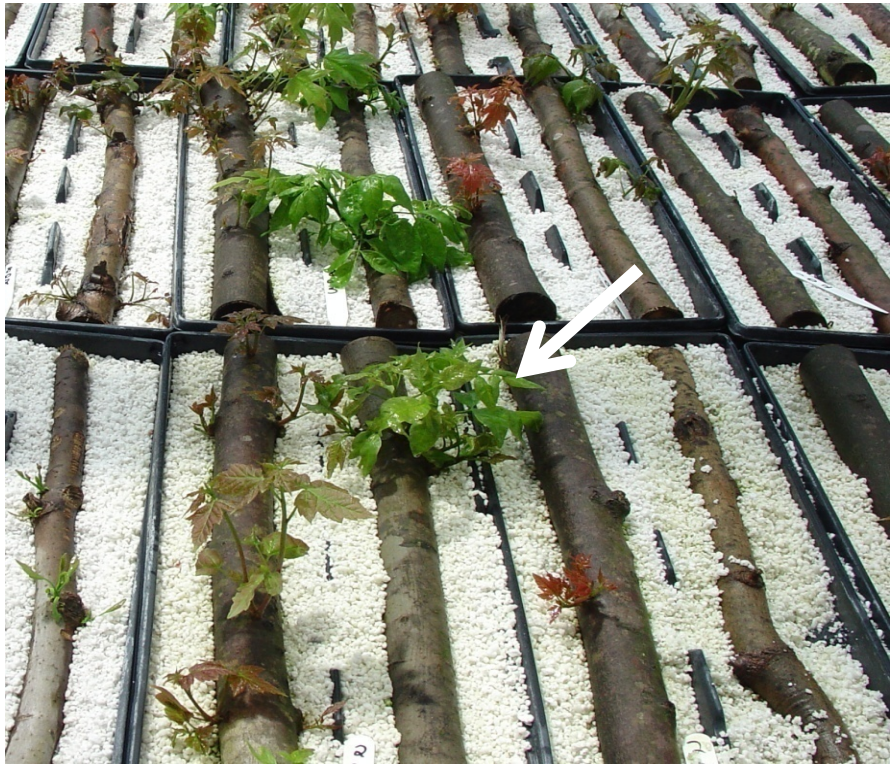
Flowering in '*physiologically mature*' part of tree at the apical part; *poor rooting potential;* Some of the flowering shoots may be *chronologically* only few months old;

Juvenile Root-shoot junction '*physiologically juvenile*'; *high rooting potential* -- even with old tree.

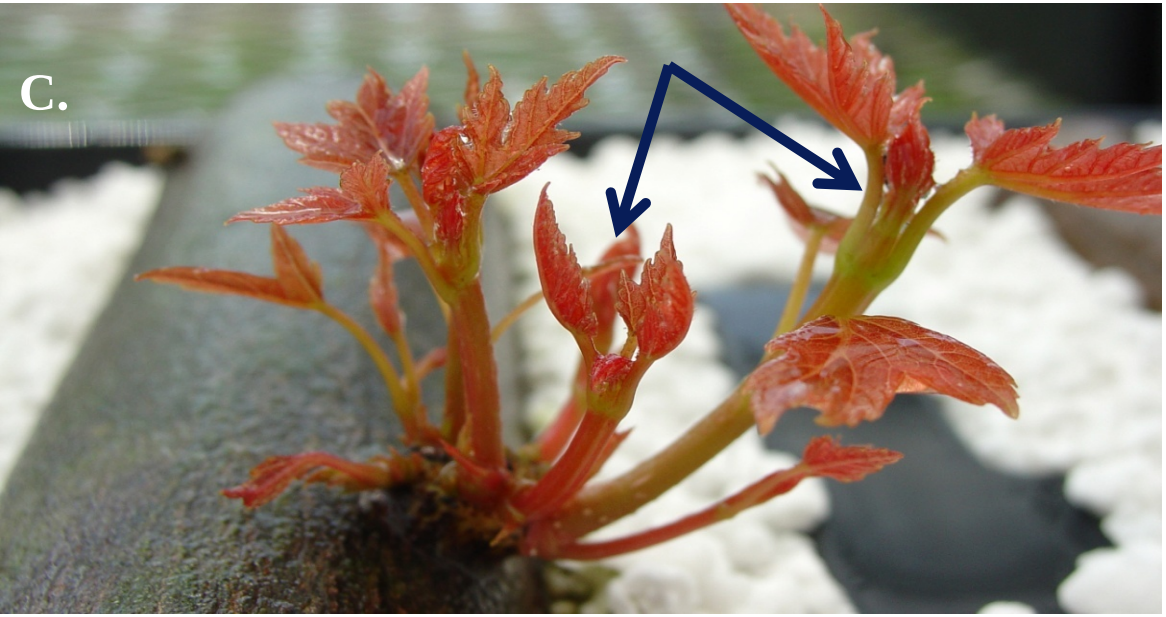
Juvenile structures arising from the "*cone of juvenility*" [dark area] near the base (crown) -root "sucker", watersprout (epicormic shoot), and phaeroblast ; *high rooting potential*

A.

B.

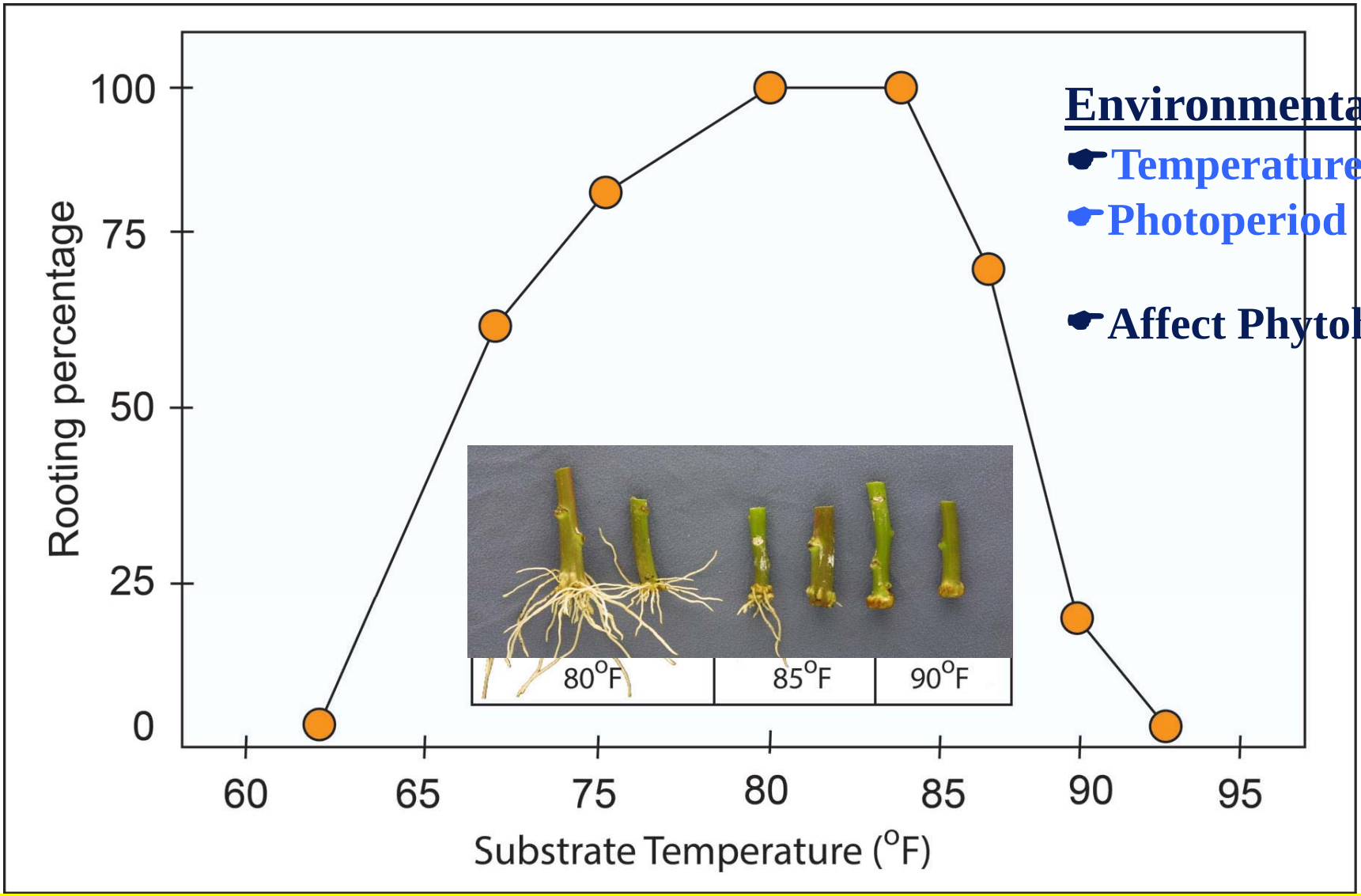


C.



Forcing softwood cuttings from woody stem segments to propagate hardwood species. (a) River birch shoot forcing under intermittent mist, (b) shoot forcing of white ash and silver maple, and (c) epicormic shoots from forced silver maple – will later be harvested as softwood cutting and rooted under mist (*J.E. Preece).*

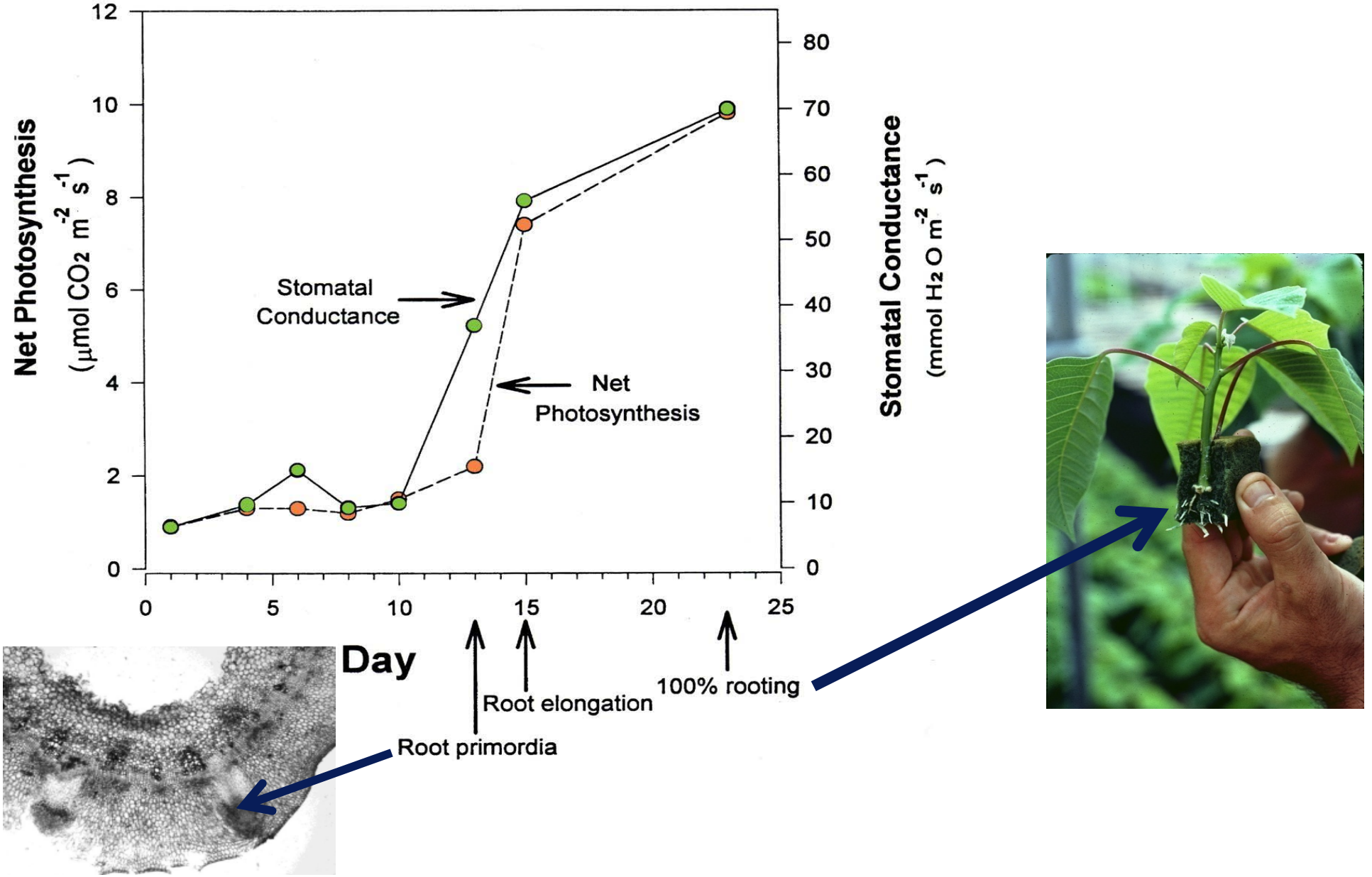
(a) Cuttings generally 5–20 cm (2–8 in.) long. Long cuttings of 50–152 cm (20–60 in.) are used to propagate ornamental and fruit crops. (b) Semihardwood cuttings of rose (*Rosa* 'Pfaenders' rootstock. (c) Nine-month-old rooted liners of elm (*Ulmus* 'Regal'), sycamore maple (*Acer pseudoplatanus*), pear (*Pyrus*), linden (*Tilia cordata*) and English oak (*Quercus robur*) propagated from long cuttings. W. Spethmann.

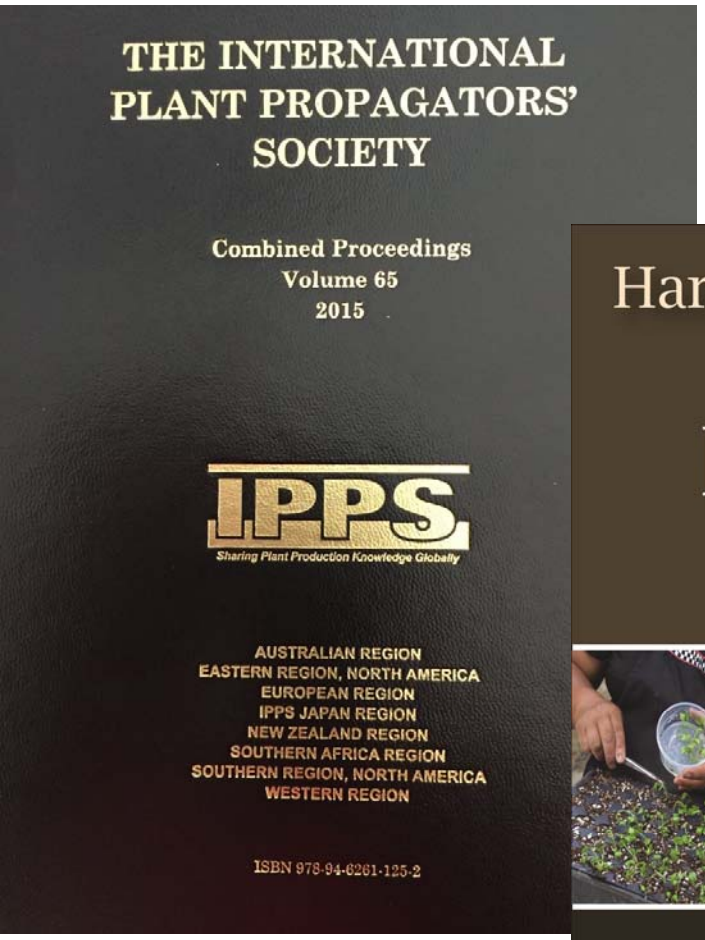


Environmental Cues:

- Temperature,
- Photoperiod
- Affect Phytohormones

Effect of temperature on rooting poinsettia cuttings at 27°C, 29°C, and 32°C (**80°F**, 85°F, and 90°F). A temperature of **27°C** was optimal. Root induction and initiation temperature is higher than that during the later stages of root elongation


Net Photosynthesis
(μmol CO2 m-2 s-1)
Stomatal Conductance
(mmol H2 O m-2 s-1)
Stomatal Conductance
Net Photosynthesis
Day
Root primordia
Root elongation
100% rooting



http://sna.ipps.org/