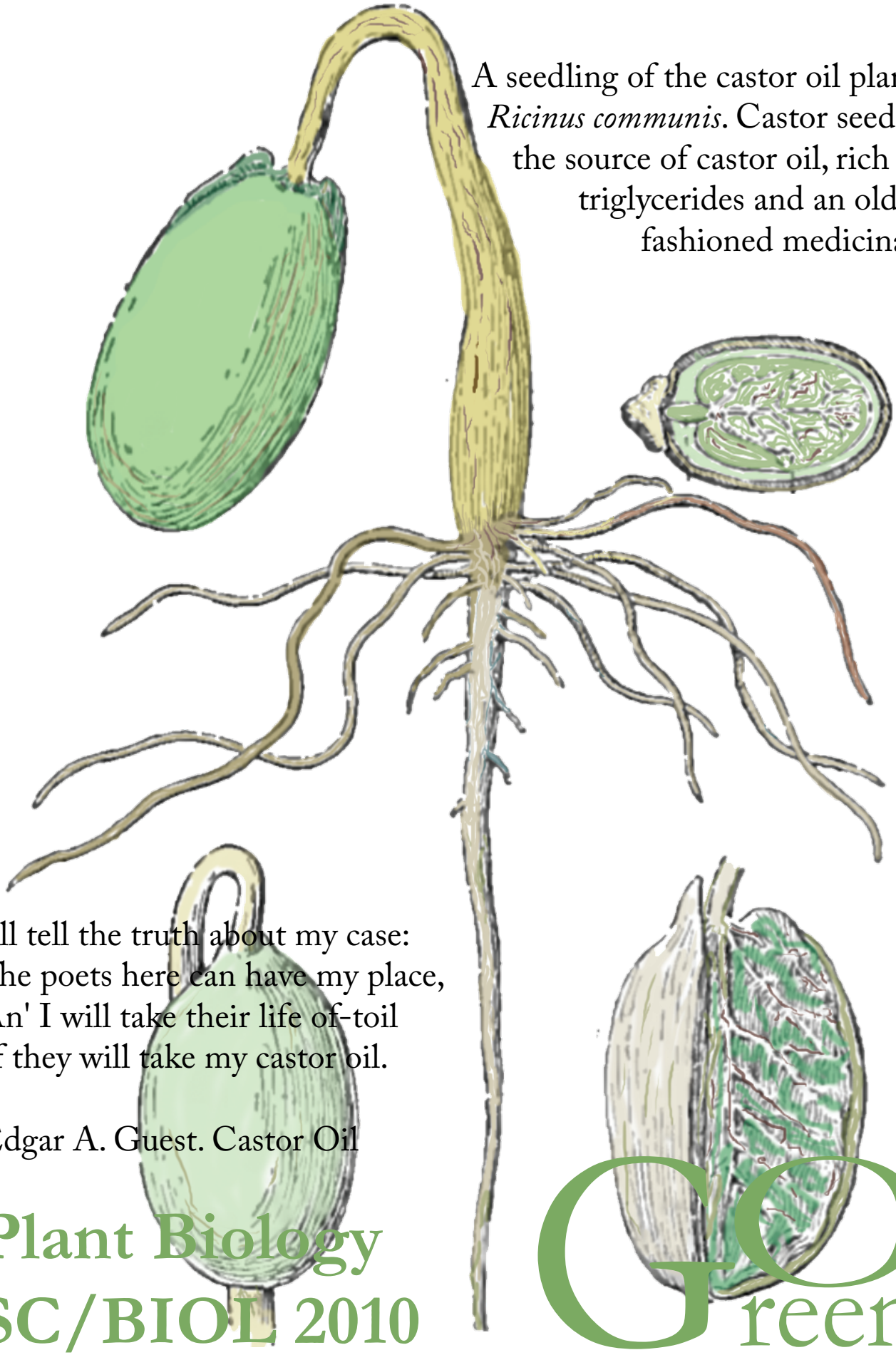


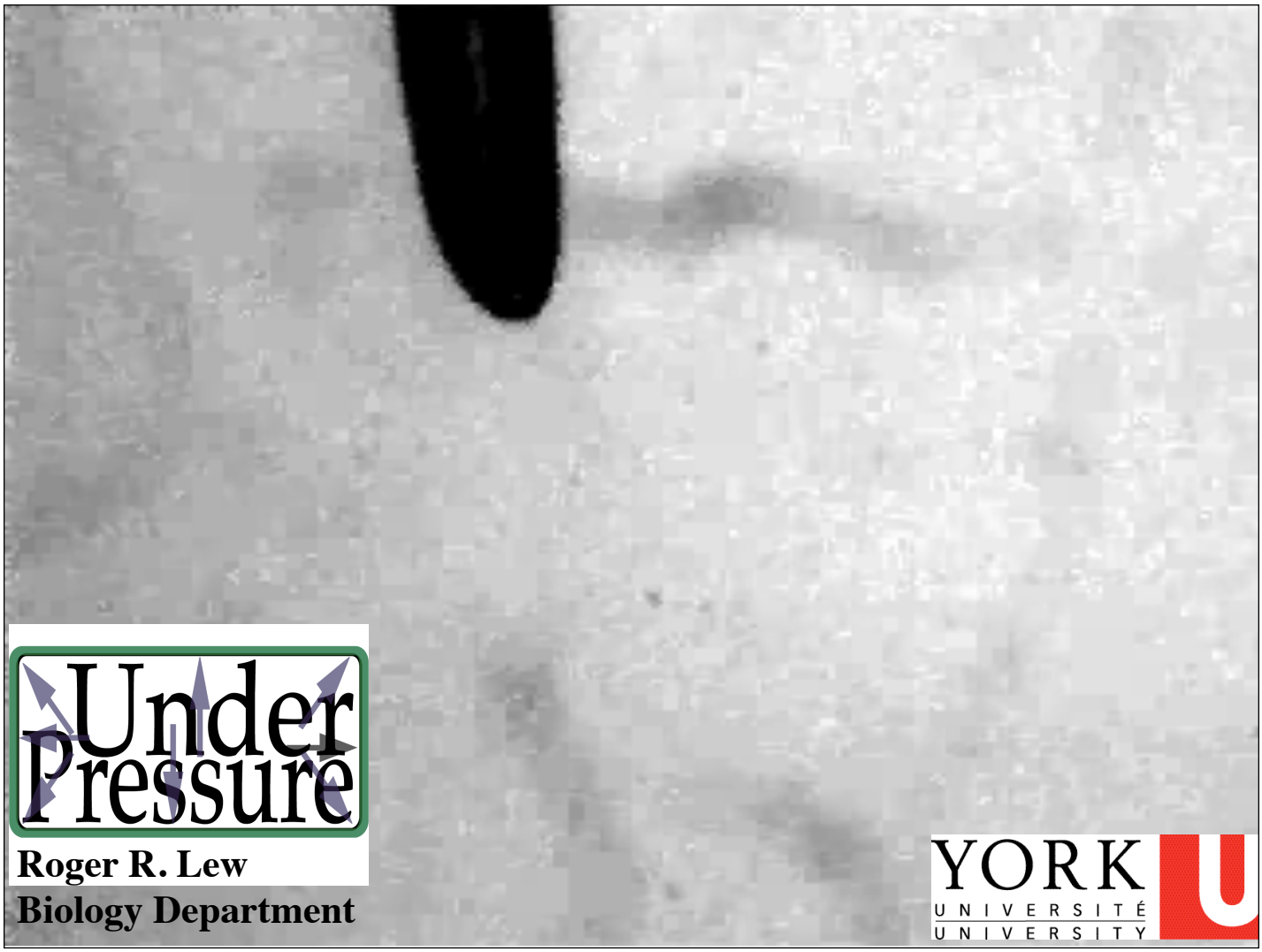
A seedling of the castor oil plant, *Ricinus communis*. Castor seed is the source of castor oil, rich in triglycerides and an old-fashioned medicinal.

I'll tell the truth about my case:
The poets here can have my place,
An' I will take their life of-toil
If they will take my castor oil.

Edgar A. Guest. Castor Oil

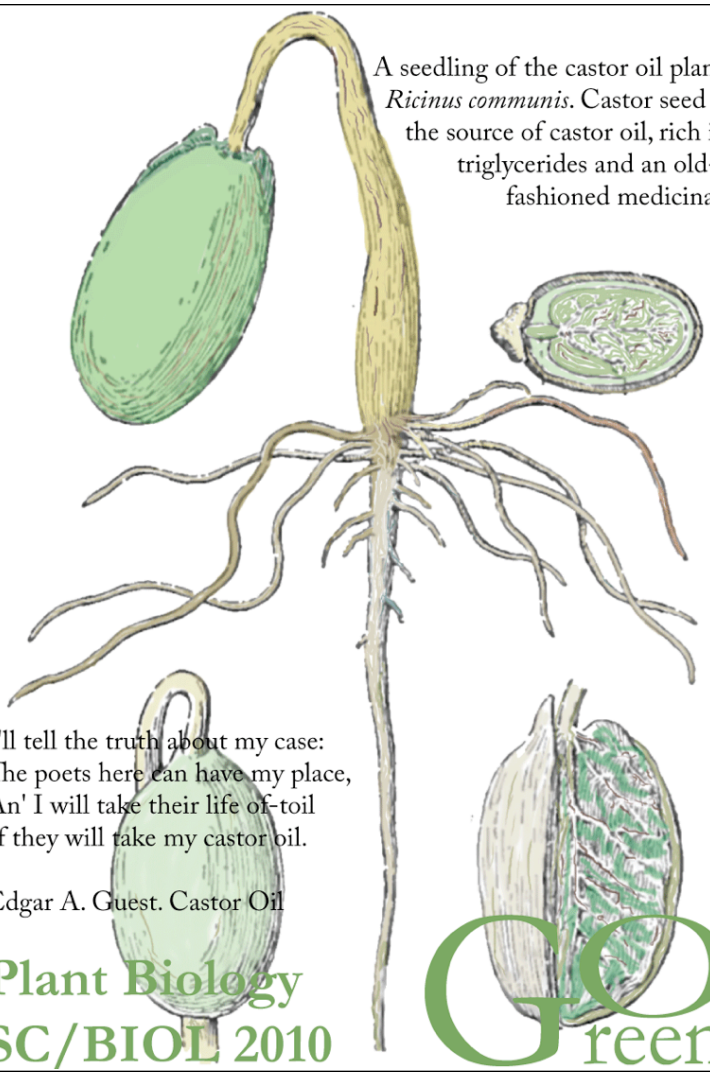
Plant Biology
SC/BIOL 2010

GO Green



Roger R. Lew
Biology Department

YORK
UNIVERSITÉ
UNIVERSITY



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GO Green

DISCOVER THE GREEN IN YOUR WORLD AND GET TO ITS ROOTS (SCIENCE RENDEZVOUS)

Announcements

Below is information about preparations for the Science Rendezvous (*Discover the Green in Your World and Get to its Roots*) event (Greenhouse: 09 May 2009)

Root Growth

The objective is to reveal the remarkable contribution of root growth to the overall growth of a plant.

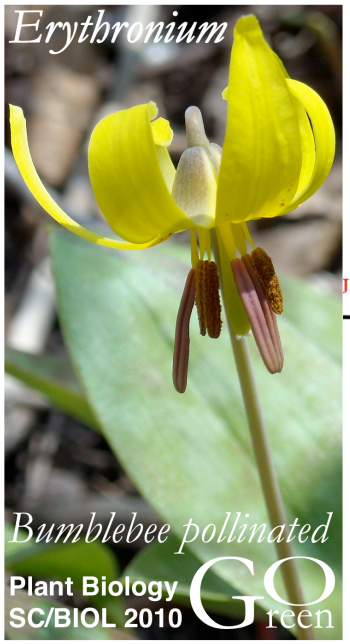
The method was to fill large bore glass tubes (3.5 cm or 4.75 cm inner diameter, 1.2 meters long) with a standard potting soil mix (without added sand to minimize abrasion of the glass tubes). One end of the tube was covered with a cotton gauze and placed in a pot of soil. The soil was wetted, then sown with tomato or bean seeds, or with a transplant (a Penta (?) sp., kept in the greenhouse; it should be flowering by the time of the event; the tube is covered with aluminum foil to minimize light avoidance by the developing roots).

The glass tubes were mounted in a research lab at 25 degrees Celsius

Once the seeds had germinated (within four days), a fluorescent light was positioned close to the top of the tube. The fluorescence tubes were T8, with a colour temperature of 6500K (that is, a strong blue color to maximize plant growth). The irradiance (50 µmol m^{-2} sec^{-1}) is about 2.5% the intensity of direct sunlight.

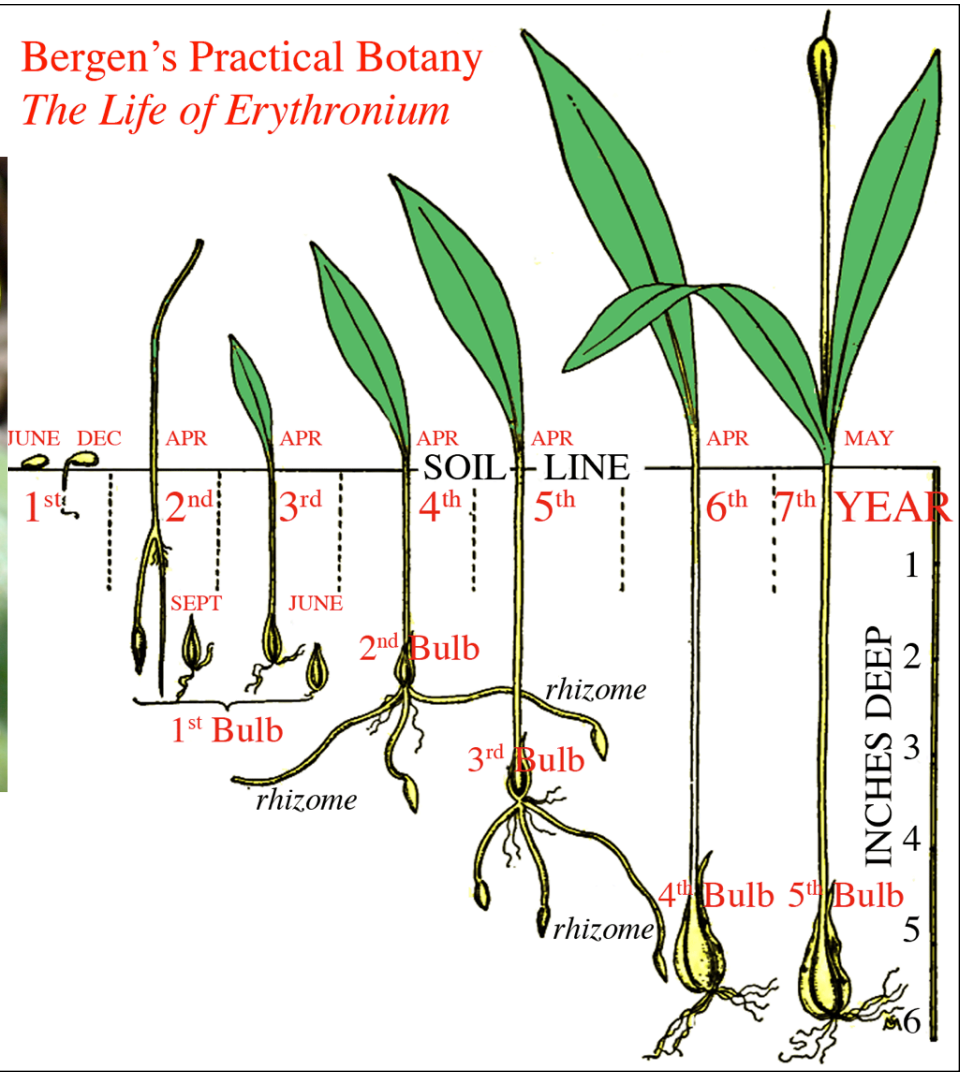
Here is a more detailed description of the technique and possible experiments: [pdf] (30 MB)

Here are some beautiful images of the seedlings (courtesy Milissa Elliott)(click on photo for a higher resolution tif)(day 6)

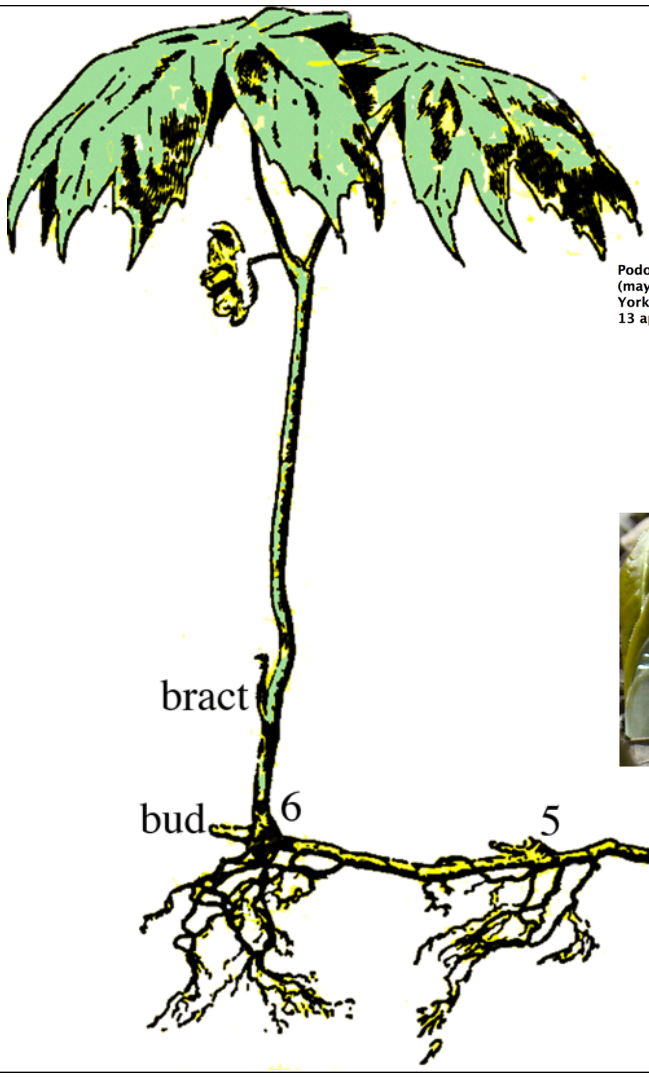


Bergen's Practical Botany

The Life of Erythronium

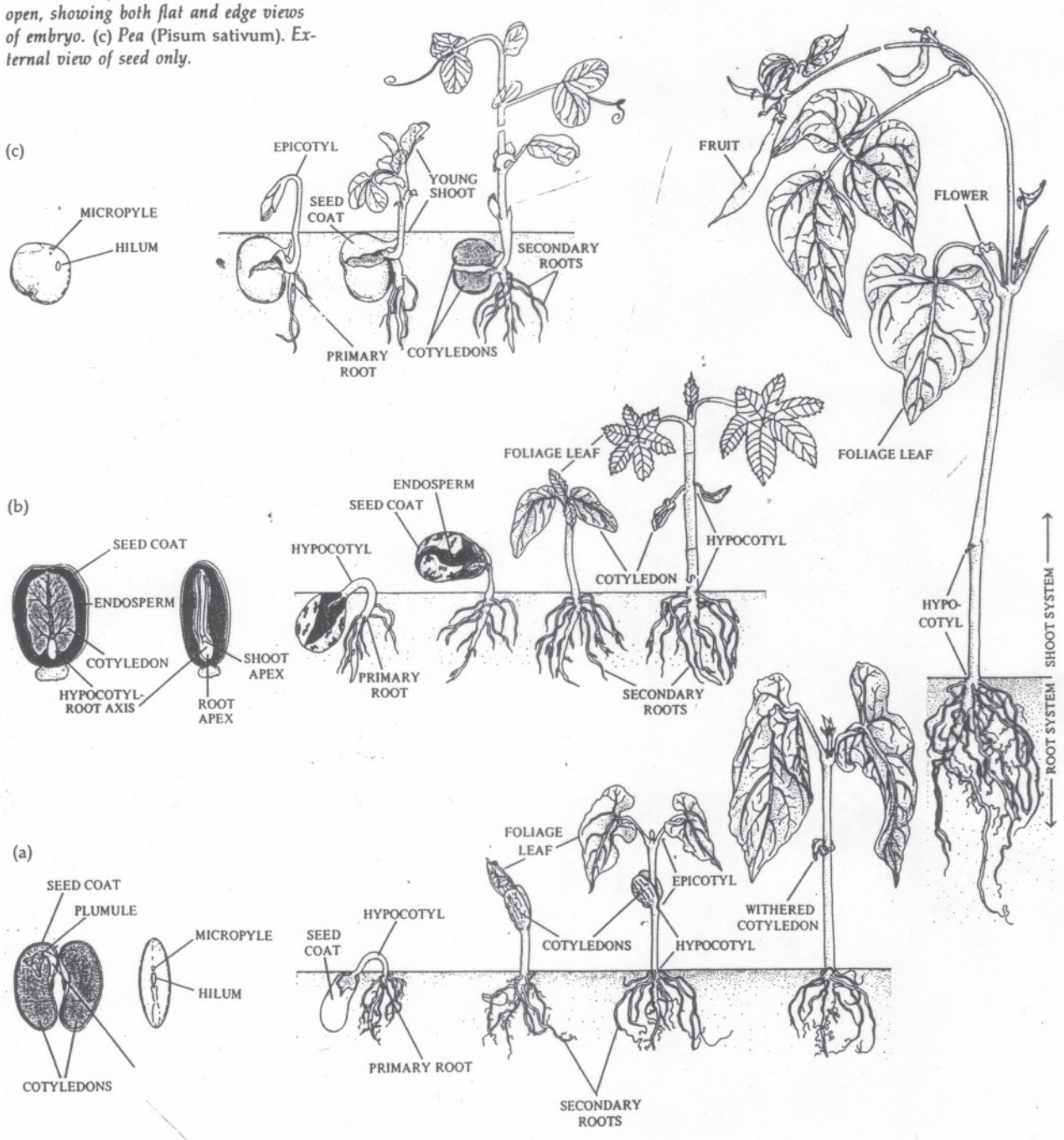


Bergen's Practical Botany
The Life of Podophyllum

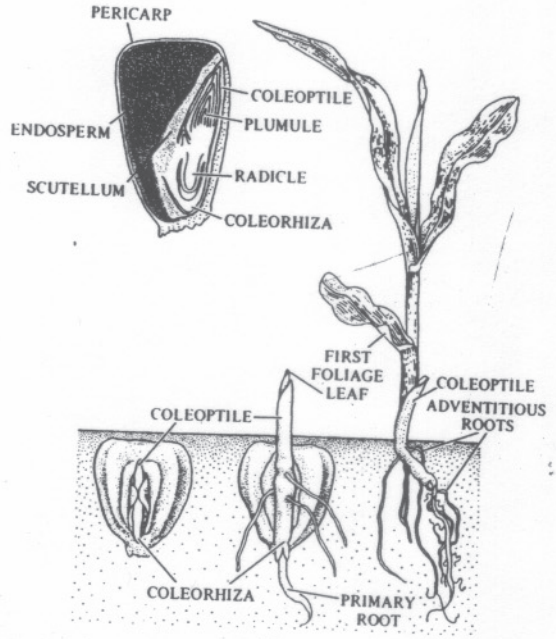


Podophyllum
(mayapple)
YorkU woodlot
13 april 2010

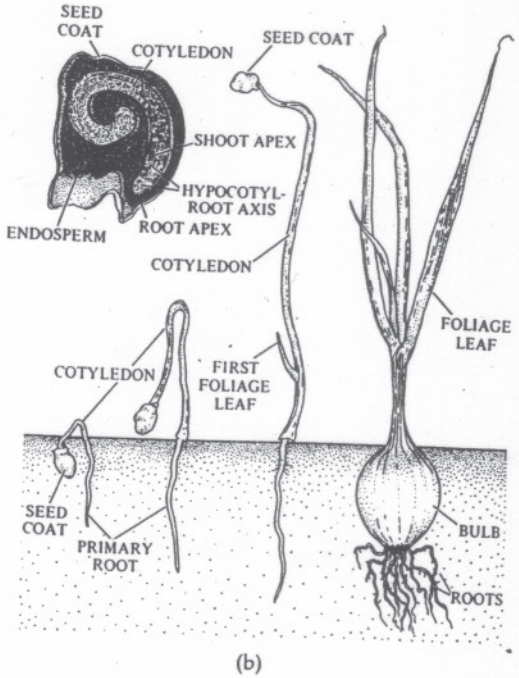
18–2
Seeds and stages in germination of some common dicotyledons. (a) *The garden bean* (Phaseolus vulgaris). *Seed shown open and from external edge view.* (b) *Castor bean* (Ricinus communis). *Seed open, showing both flat and edge views of embryo.* (c) *Pea* (Pisum sativum). *External view of seed only.*



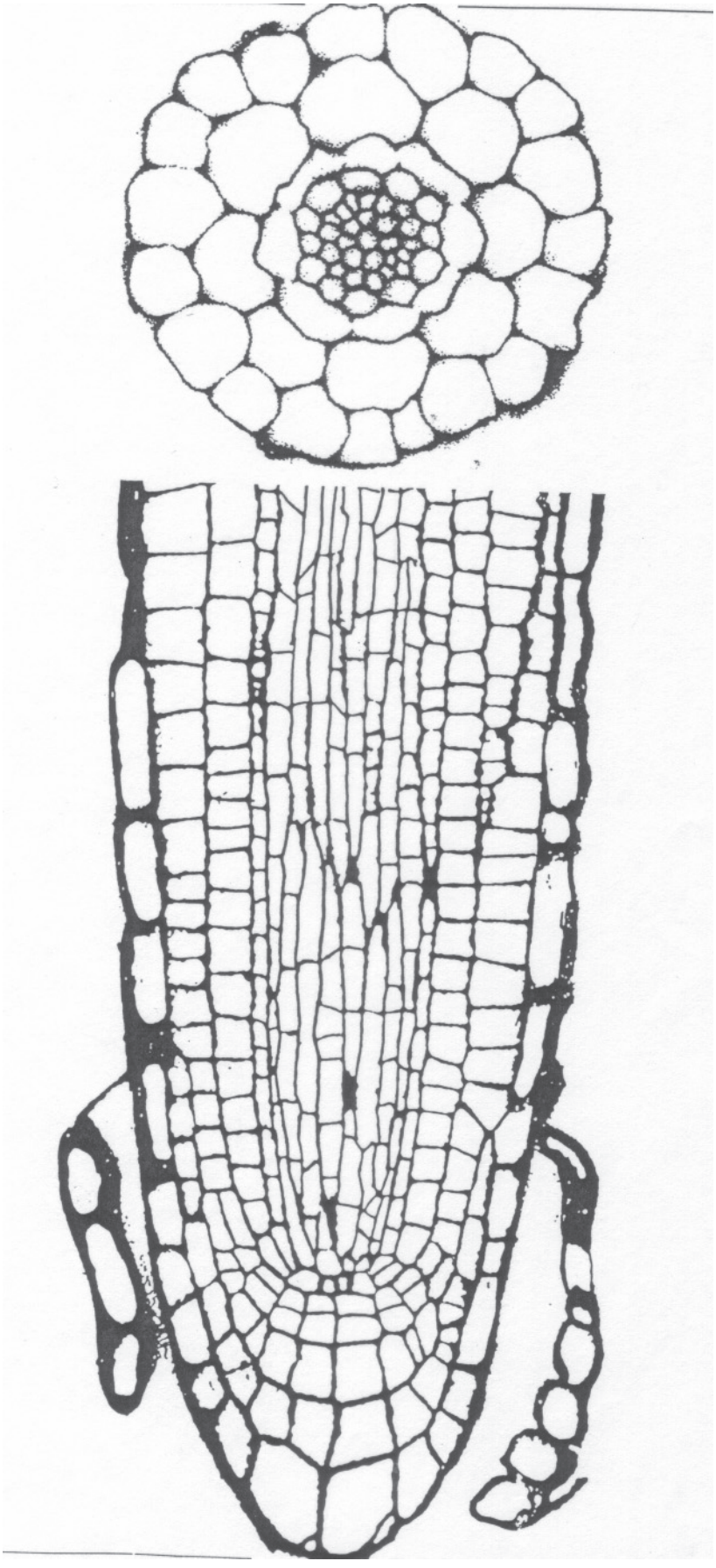
18–3
Seeds and stages in germination of some common monocotyledons (a) *corn* (Zea mays) *and* (b) *onion* (Allium cepa). *Both seeds shown in longitudinal section.*

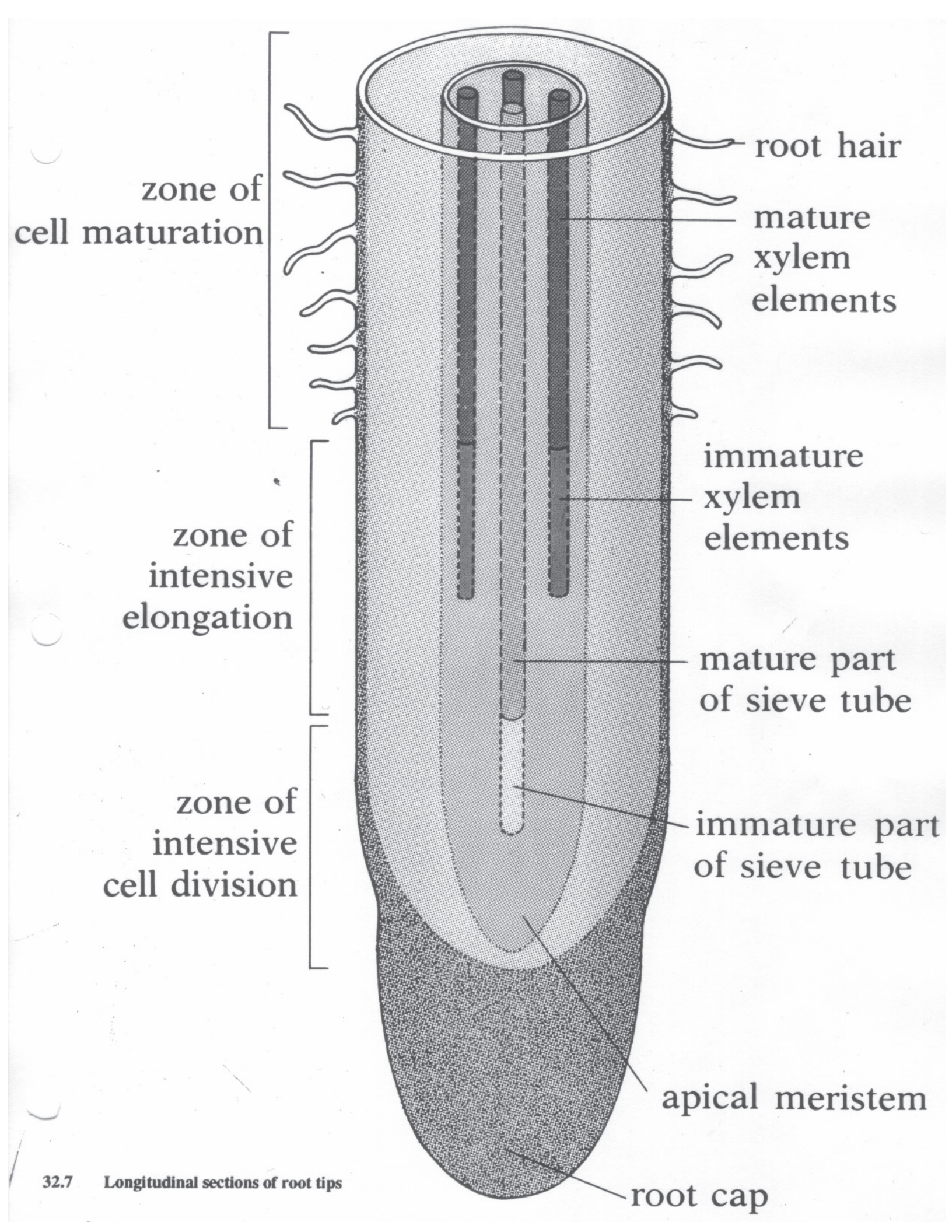


(a)



(b)





32.7 Longitudinal sections of root tips

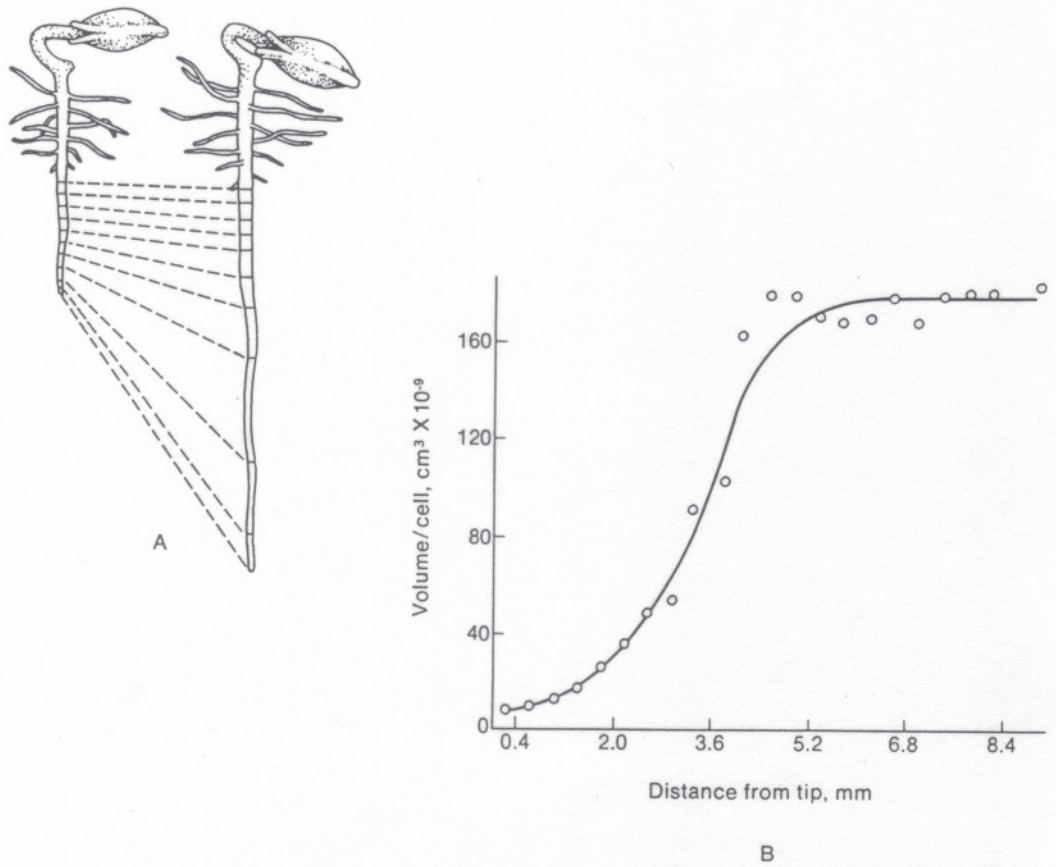


Figure 11-20. **(A)** Amount of growth in various regions of the primary root of a seedling. Ink marks were made at equal intervals on the root of a young seedling, and their spacing after further growth shows the amount of growth in each segment. **(B)** Average volume of pea root cells at increasing distances from the root tip. [B after R. Brown, W. S. Reith, and E. Robinson, *Symp. Soc. Expt. Biol.* **6**:329–347, 1952]

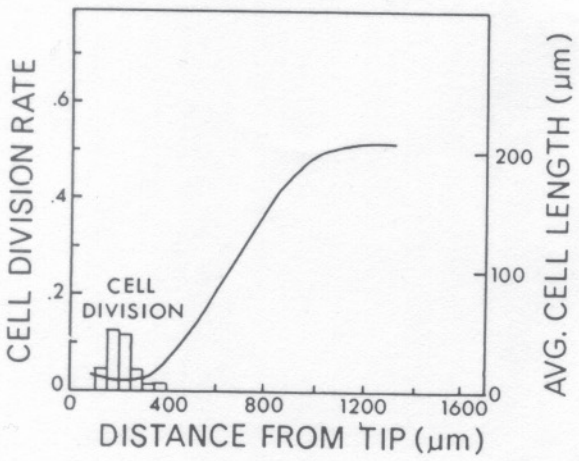


Figure 12.3. *The distribution of cell division and cell elongation of epidermal cells in the root tip of* Phleum pratense *(Timothy grass). (Adapted from Goodwin and Avers, 1956.)*

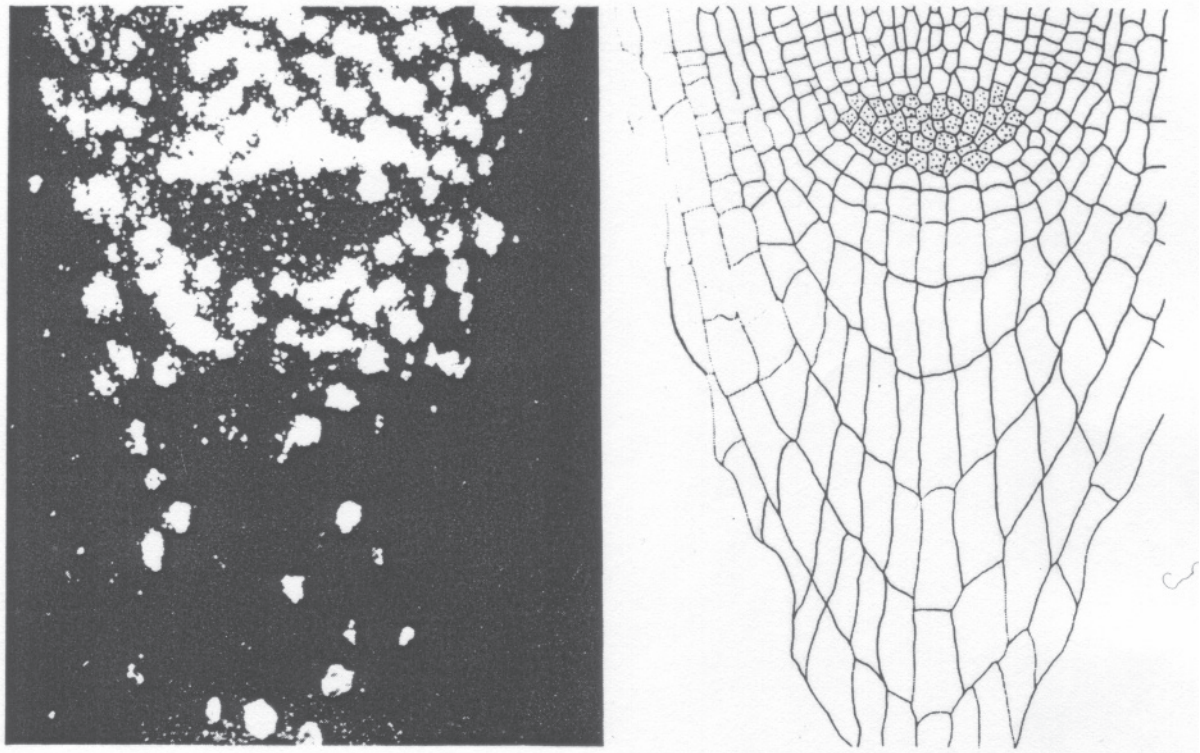


Figure 16-22. Left: Radioautograph of a section through the root apex of *Sinapsis alba* (white mustard) which had been supplied with ^{3}H-thymidine, showing the location of cells (white spots) that had incorporated this tracer extensively in newly synthesized DNA (×320). Note the essential absence of labeling in the quiescent center. **Right:** Drawing of the cell outlines of the same section (×225), showing the quiescent center (stippled cells). [Courtesy of F. A. L. Clowes. Reprinted with the permission of The Macmillan Company from *Plant Structure and Development* by T. P. O'Brien and Margaret E. McCully. Copyright © 1969 by The Macmillan Company]

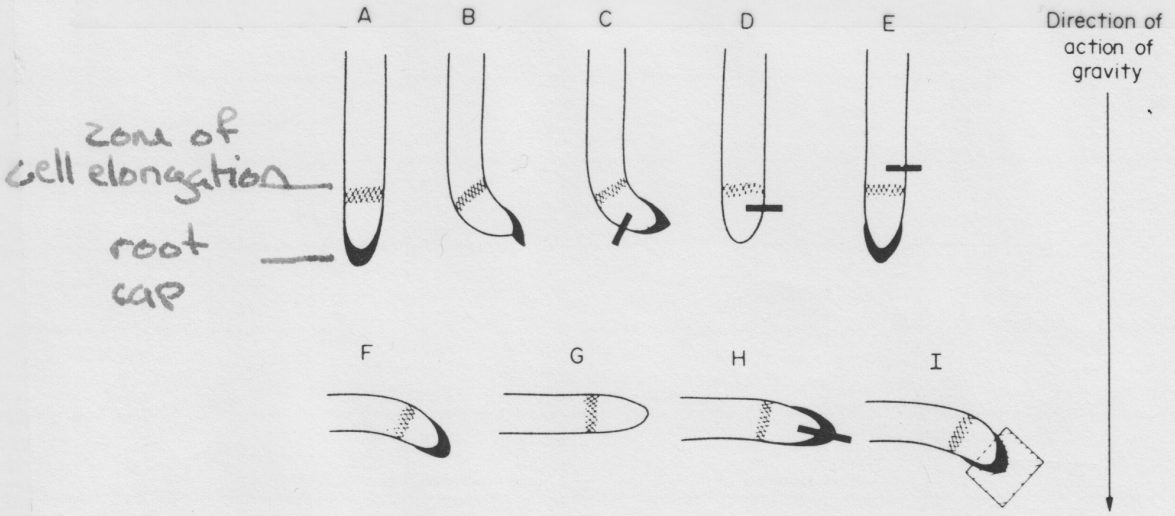
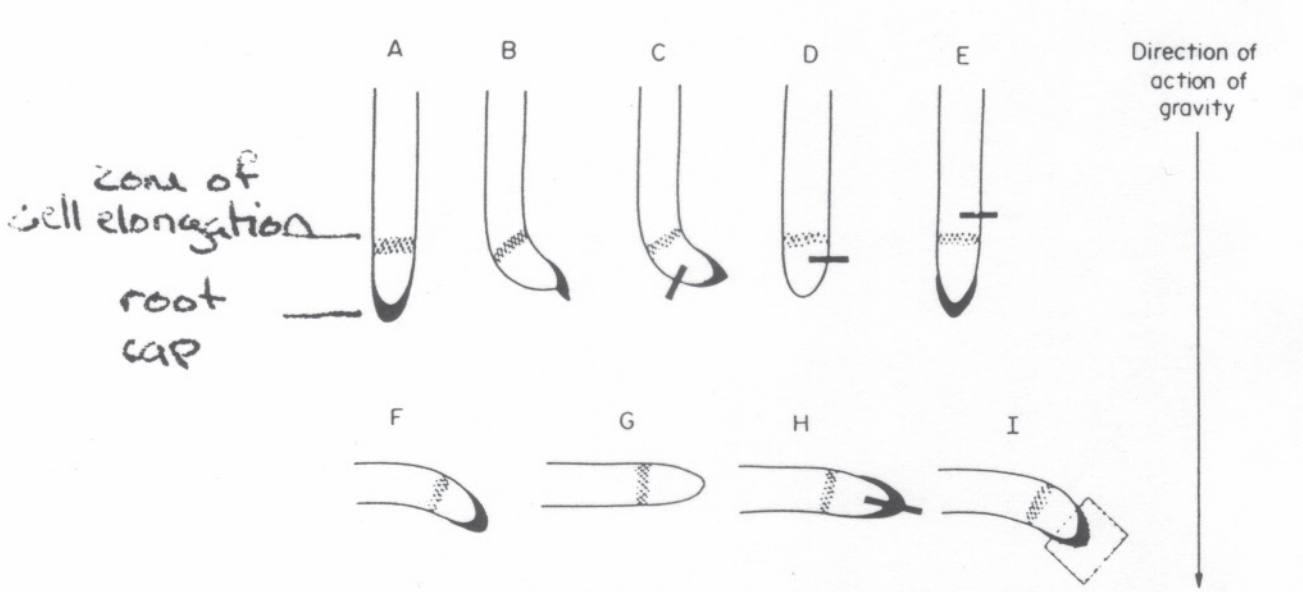
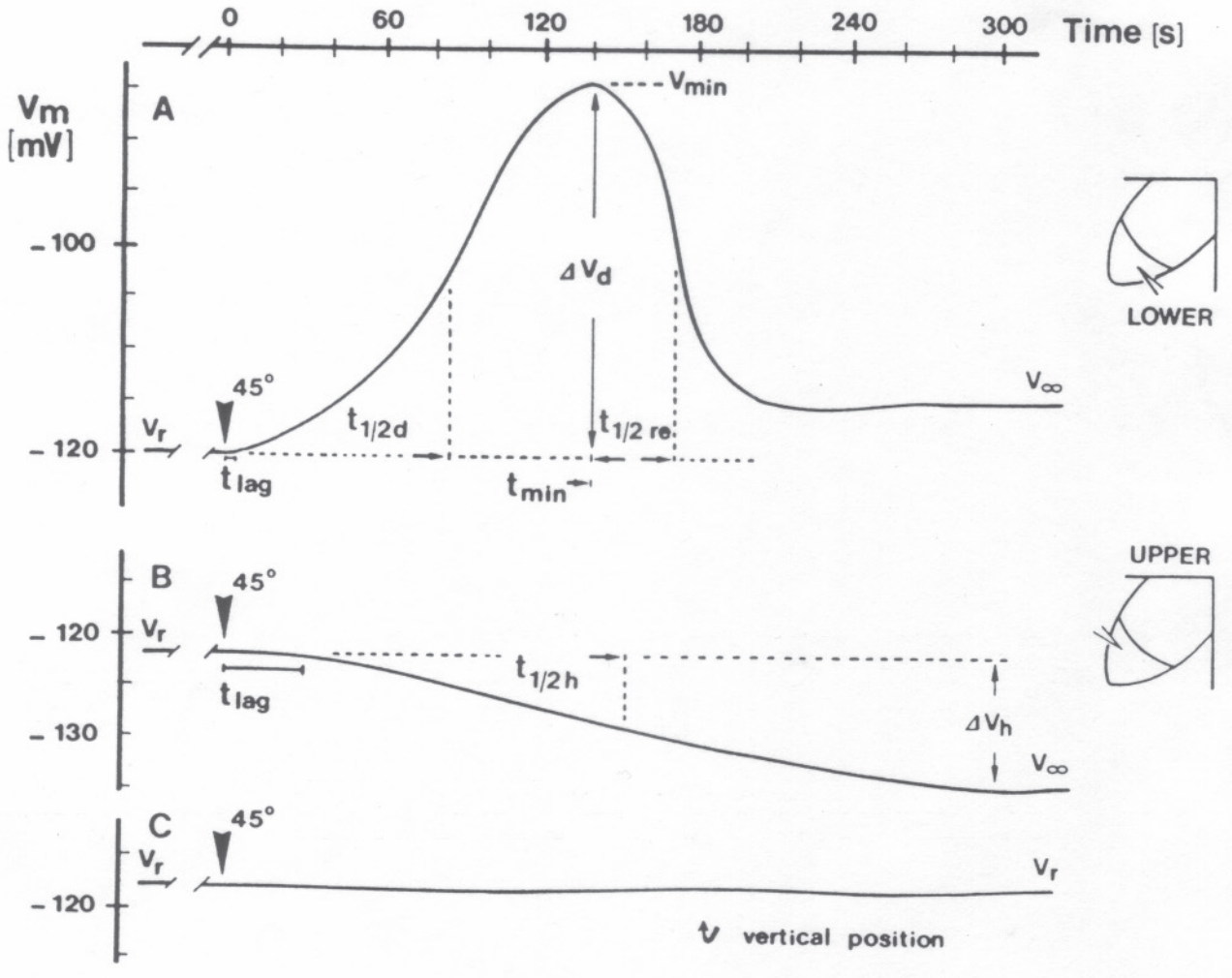


Fig. 7.19. Diagrammatic representation of some of the experiments which have indicated that the root cap is the source of growth inhibitor which is involved in the gravitropic response mechanism in roots. The root cap is shown in black, and the elongation zone of the root is shaded. A. Vertical intact root grows downwards. B. Removal of half the root cap results in bending towards the remaining half cap regardless of the direction of gravity. C. Insertion of a glass barrier between half the root cap and the elongation zone has the same effect as removing half the cap. D. A similar barrier in the absence of the cap has no effect. E. A barrier positioned behind the growing zone is without effect. F. Intact horizontal root executing normal downward gravitropic curvature. G. Removal of the root cap abolishes gravitropism (because it appears to be both the region of graviperception and the source of growth regulating substances). H. A horizontal glass barrier through the root cap and apex abolishes, or largely removes, gravitropism in a horizontal root. I. A glass barrier similar to that in H, but orientated vertically, does not prevent the development of a gravitropic curvature. (Adapted from M. B. Wilkins, *Current Adv. Plant Sci.* **6**(3), 317-28, 1975.)


A
B
C
D
E
F
G
H
I
Direction of action of gravity
zone of cell elongation
root cap


0
60
120
180
240
300
Time [s]
Vm [mV]
A
Vmin
ΔVd
45°
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t1/2d
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V∞
LOWER
B
45°
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- 100
- 120
- 130
v vertical position

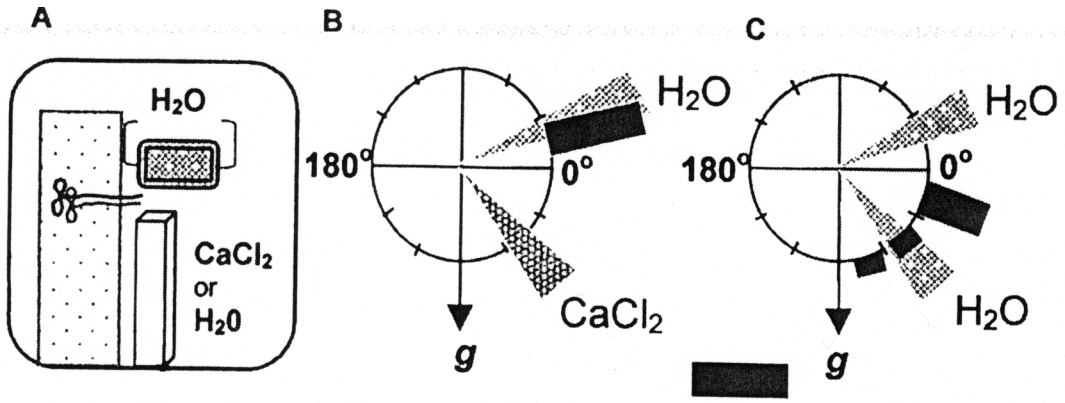

Figure 4. Diagram of the experimental system developed for the induction of positive root hydrotropism in Arabidopsis (A). Hydrotropic and gravitropic responses of wild-type roots grown in a system with an air moisture gradient generated with a saturated $CaCl_2$ solution (B) or water (control; C). The frequency of root growth directions was analyzed by measuring curvature 6 h after the beginning of gravistimulation at 0° (0° angle corresponds to horizontal position of the root tip). Each hydrostimulated and/or gravistimulated root was assigned to one of 12 30° sectors. The length of each bar represents the percentage of seedlings showing direction of root growth within that sector. Bar = 100%. *g*, Gravity vector; H_2O, water source; $CaCl_2$, reduced air moisture source. The gray sectors are indicators of where the $CaCl_2$ and water were placed in the plate. Data are from five independent experiments (n = 24).

A *no hydrotropic response* Root Mutant that Responds Positively to Gravitropism in Arabidopsis[1[w]]

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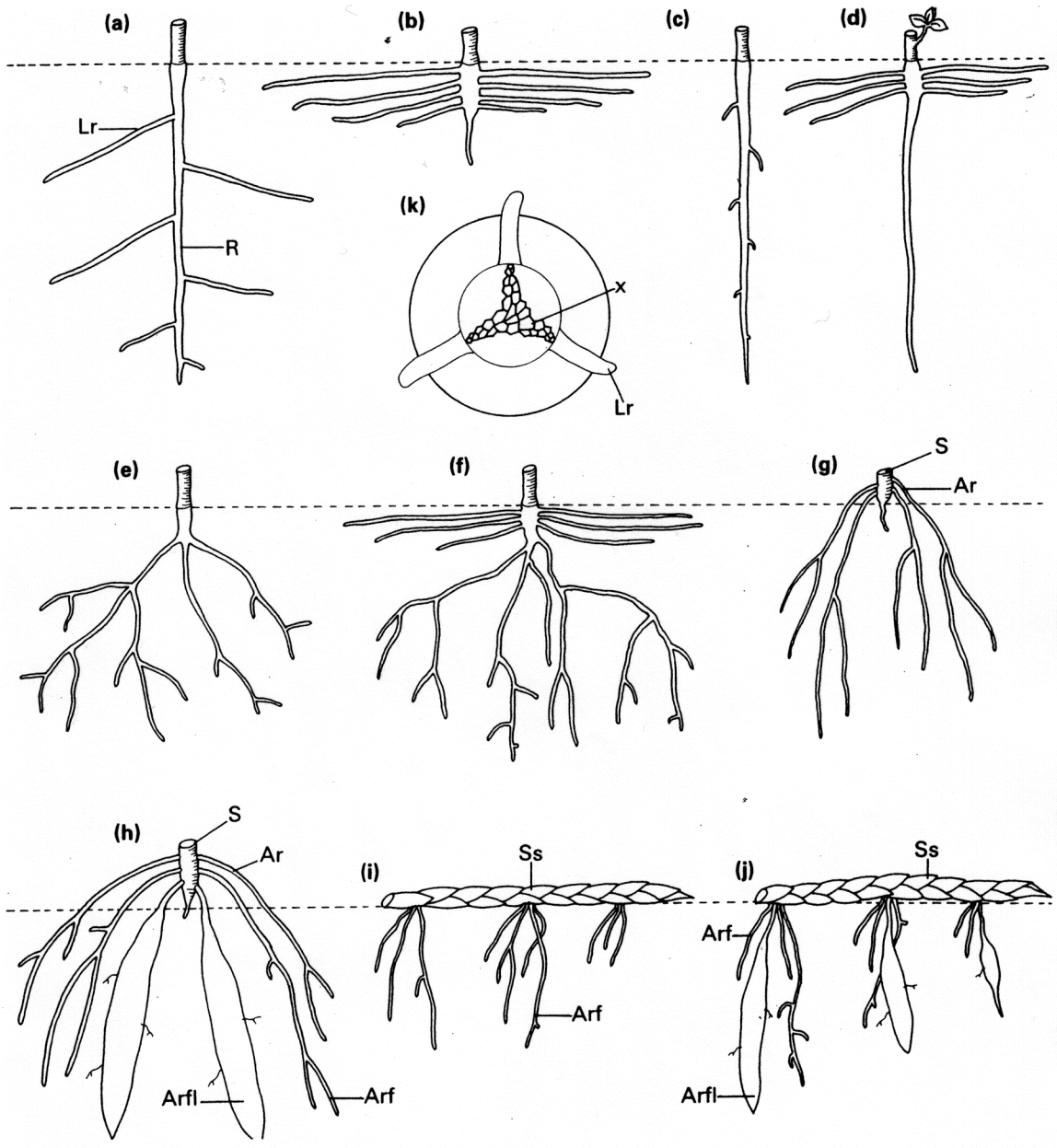
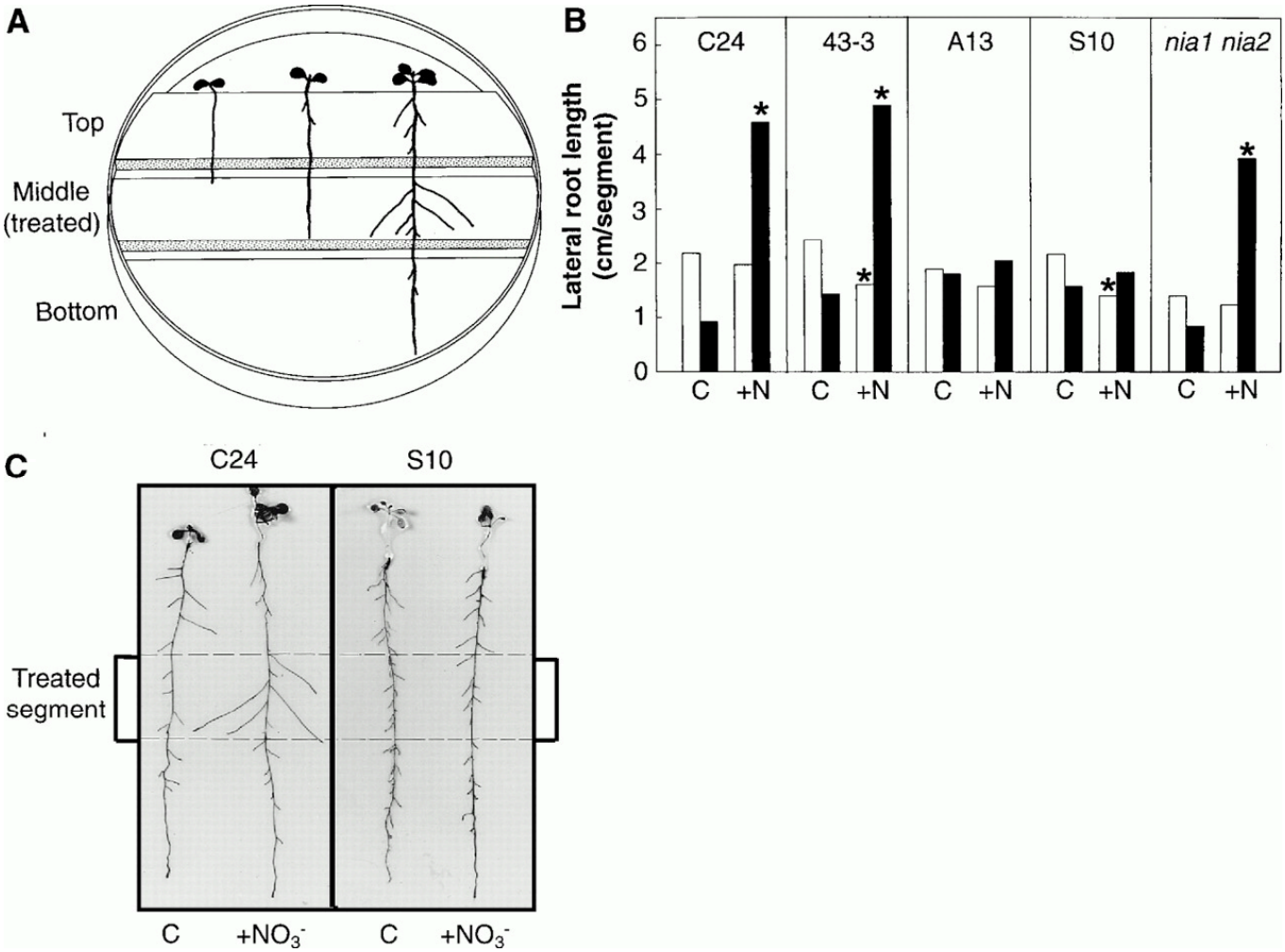
Plant Physiology, February 2003, Vol. 131, pp. 536–546, www.plantphysiol.org

For most plants survival depends upon the capacity of root tips to sense and move towards water and other nutrients in the soil. Because land plants cannot escape environmental stress they use developmental solutions to remodel themselves in order to better adapt to the new conditions. The primary site for perception of underground signals is the root cap (RC). Plant roots have positive hydrotropic response and modify their growth direction in search of water. Using a screening system with a water potential gradient, we isolated a *no hydrotropic response* (*nhr*) semi-dominant mutant of Arabidopsis that continued to grow downwardly into the medium with the lowest water potential contrary to the positive hydrotropic and negative gravitropic response seen in wild type-roots. The lack of hydrotropic response of *nhr1* roots was confirmed in a system with a gradient in air moisture. The root gravitropic response of *nhr1* seedlings was significantly faster in comparison with those of wild type. The frequency of the waving pattern in *nhr1* roots was increased compared to those of wild type. *nhr1* seedlings had abnormal root cap morphogenesis and reduced root growth sensitivity to abscisic acid (ABA) and the polar auxin transport inhibitor N-(1-naphtyl)phtalamic acid (NPA). These results showed that hydrotropism is amenable to genetic analysis and that an ABA signaling pathway participates in sensing water potential gradients through the root cap.



Root morphology: primary root systems

Fig. 97. Adapted from Cannon (1949). a)–f) Variations of primary root systems (lateral roots developing on radicle); g)–j) types of adventitious root systems. Roots developing on vertical (g, h) or horizontal (i, j) stem. k) Section through root having three-rowed xylem arrangement. Ar: adventitious root. Arf: fibrous adventitious root. Arfl: fleshy adventitious root. Lr: lateral root. R: radicle. S: stem. Ss: stem scale leaf. X: xylem tissue.



Insensitivity of lateral root development in *ANR1*-repressed lines to a localized supply of NO_3^-. (**A**) Experimental set-up for applying localized NO_3^- treatments to *Arabidopsis*roots. The agar plates were divided into three segments so that different concentrations of NO_3^- could be maintained in different parts of the plate. At the start of the experiment, seedlings were placed on the plate as shown on the left; lateral root lengths were measured when the seedlings reached the stage shown on the right. (**B**) Effect of a localized NO_3^- treatment on lateral root development in the control lines (C24 and 43-3), two*ANR1*-repressed lines (A13 and S10), and a NR-deficient mutant (*nia1 nia2*). All three agar segments contained 10 μM NH_4NO_3, and the middle segment also contained 1 mM KCl (designated C) or 1 mM KNO_3 (+N). Twelve days after transfer of the seedlings to the segmented plates (or 13 days for *nia1 nia2* because of its slower growth rate) lateral root lengths were measured in the top (open bars) and middle segments (closed bars). (The bottom segment was not included in the analysis because it did not yet contain many laterals). Each bar represents the mean of data from 8 to 12 seedlings; those marked with an asterisk differ significantly ($P < 0.05$ in a *t* test) from the control treatment to the same line. (**C**) Root morphology of seedlings of C24 and S10 that received ($+NO_3^-$) or did not receive (C) a localized NO_3^- treatment. Representative seedlings from the experiment in (B) were stained with toluidine blue and photographed. Science 279: 407-409 [1998] An Arabidopsis MADS Box Gene That Controls Nutrient-Induced Changes in Root Architecture.