

# Introduction to Botany. Lecture 10

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# Outline

## 1 Questions and answers

## 2 Roots

- Anatomy and development of roots
- Secondary structure of root
- Origins of root tissues
- Diversity of roots

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## 2 Roots

- Anatomy and development of roots
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## Previous final question: the answer

What are adventitious roots?

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What are adventitious roots?

- Roots which grow from stem



# Roots

## Anatomy and development of roots

# Periphery of root

- **Rhizoderm** (root epidermis): fast-degrading cells
- **Cortex**, which includes also:
  - **Endoderm**: 1-cell layer with specialized cell walls, located on the border with vascular cylinder
  - And (sometimes) **exoderm**: similar to endoderm but located just under rhizoderm
- In some plants (i.e., orchids), part of cortex modified into **velamen**



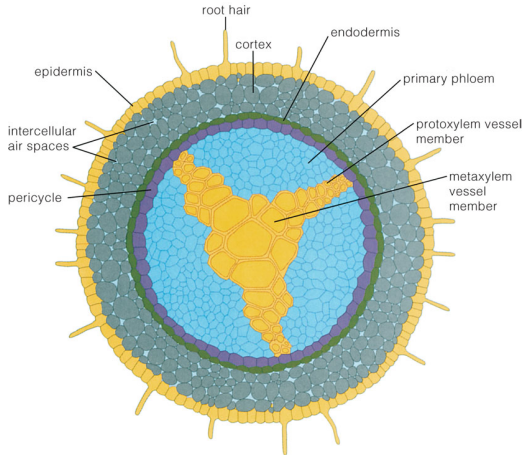
# Root center: vascular cylinder

- Pericycle
- Vascular tissues located in the center
- No central hollow, central parenchyma presents in monocot roots





# Anatomy of root



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# Pericycle

- Long-lived parenchyma cells served as half-meristem
- Initiates development of lateral roots
- Contributes to vascular cambium
- Contributes to cork cambium



# Development of lateral roots

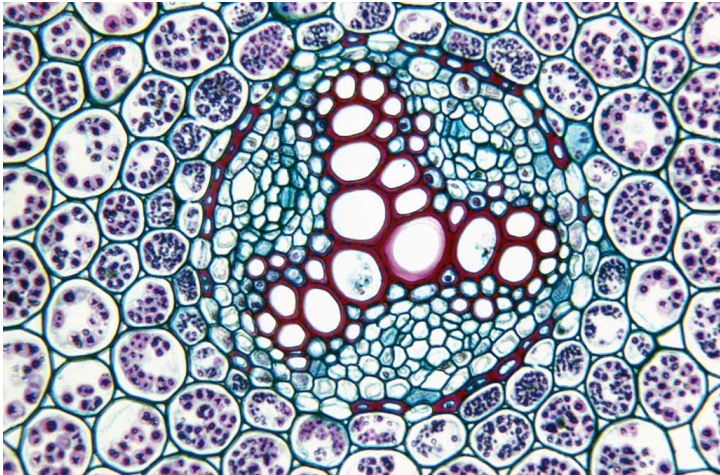


# Vascular bundle

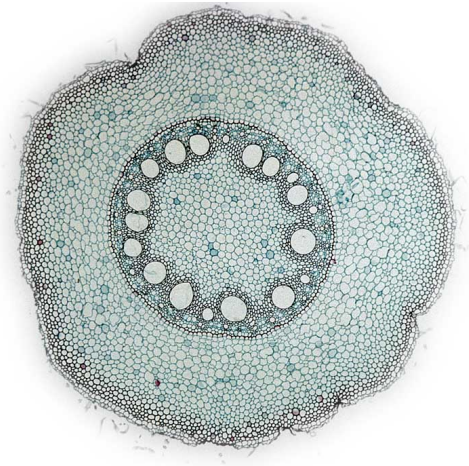
- Only one!
- Has radial (star-like) symmetry
- Xylem arranged in rays, multiple in monocots, 2-4 in other plants



# Radial structure of root vascular bundle in buttercup (*Ranunculus* sp.)



# Root of monocot (*Zea mays*)



# Roots

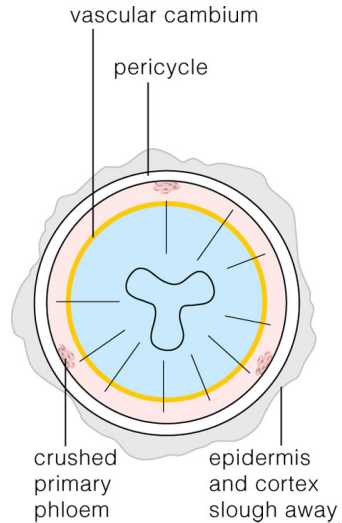
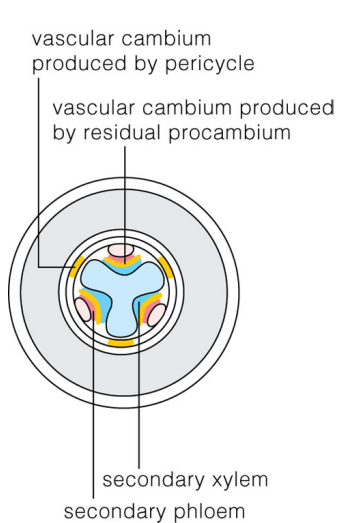
## Secondary structure of root

# Secondary thickening

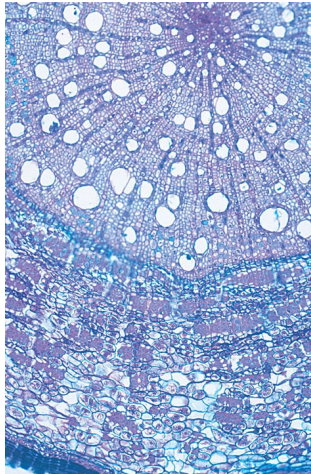
- Vascular cambium is produced by both pericycle and residual procambium (located between xylem and phloem)
- Cork cambium appears in cortex



# Root thickening



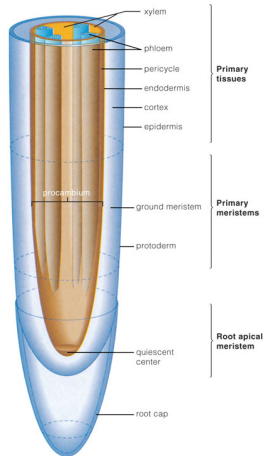
# Secondary root (*Quercus* sp.)



# Roots

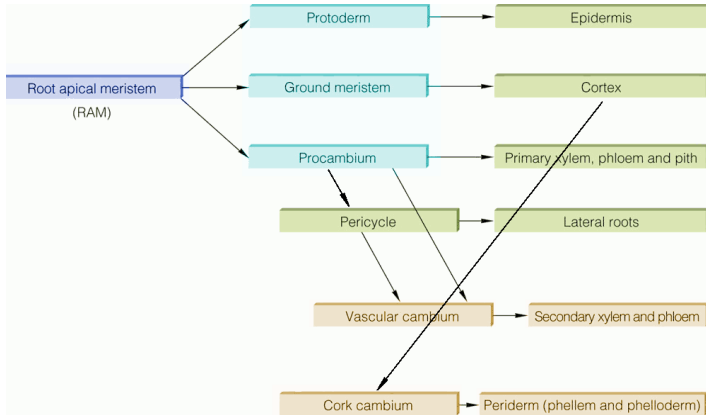
## Origins of root tissues

# Development of tissues



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# Origins of tissues



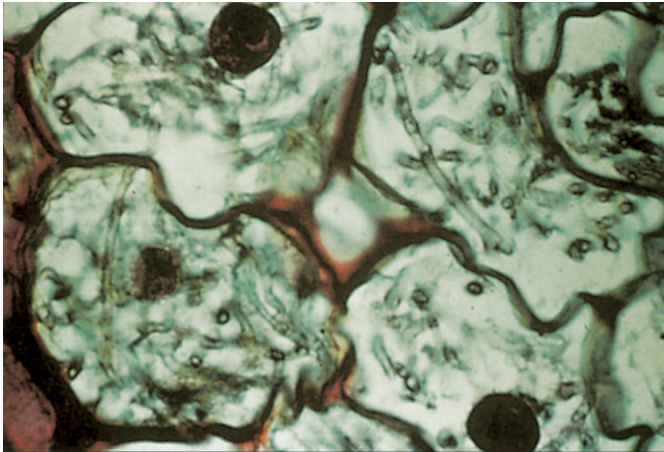
# Roots

## Diversity of roots

# Modifications of roots

- Adventive buds with root origin (many plants)
- Mycorrhizae: endotrophic (grasses, orchids) and ectotrophic (trees)
- Haustoria (parasites like *Cuscuta*—dodder plant)
- Root nodules (legumes, Fabaceae family)
- Contractile roots (*Hyacinthus* spp.—hyacinth, *Taraxacum* spp.—dandelion)
- Storage roots (*Daucus carota*—carrot, *Armoracia officinalis*—horseradish)
- Supportive roots (many tropical plants)
- Defensive, spiny roots (ivy)
- Photosynthetic roots (some orchids)

# Endotrophic mycorrhizae in *Corallorhiza* orchid

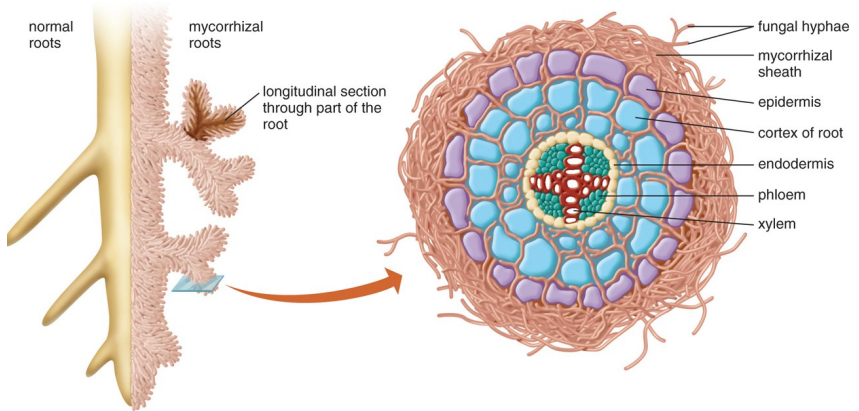


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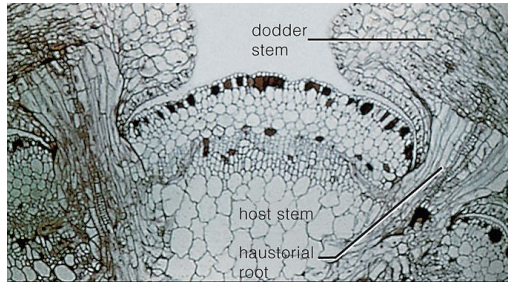




# Ectotrophic mycorrhizae of trees



# Haustoria of *Cuscuta* (dodder)



# Nodulated roots of soybean (*Glycine max*)



# Contractile roots of *Hyacinthus orientalis*



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# Supportive roots of mangrove plants



# Supportive roots of *Pandanus* sp.



# Defensive spiny roots of ivy (*Hedera* sp.)



# Photosynthetic aerial roots of orchids





# Table of modifications

Function	Stem	Leaf	Root
Expansion	...	...	Adventive buds
Storage	...	...	Storage roots
Photosynthesis	...	DEFAULT	Some aerial roots
Defense	...	...	Root spines
Support	DEFAULT	...	Hauatoria, aerial and contractile roots
Interactions	...	...	Mycorrhizae, nodulated roots

## Final question (1 point)

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What is a pericycle?

# Summary

- Root differs from stem having rhizoderm, thick cortex, endoderm, long-lived pericycle and radially arranged primary vascular tissues
- Secondary thickening make root more similar to stem
- Root modifications often provide ways of interaction with other organisms: bacteria, fungi and other plants



## For Further Reading



J. E. Bidlack, Sh. H. Jansky.  
*Stern's introductory plant biology*. 12th edition.  
McGraw-Hill, 2011.  
*Chapter 5.*



Th. L. Rost, M. G. Barbour, C. R. Stocking, T. M. Murphy.  
*Plant Biology*. 2nd edition.  
Thomson Brooks/Cole, 2006.  
*Chapter 7.*

