

Introduction to Botany. Lecture 27

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November 4, 2016



Outline

- 1 Questions and answers
 - Quiz
- 2 Stem and shoot
 - Phyllotaxis
- 3 Root
 - Root morphology
 - Anatomy and development of roots
 - Origins of root tissues



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Questions and answers

Quiz

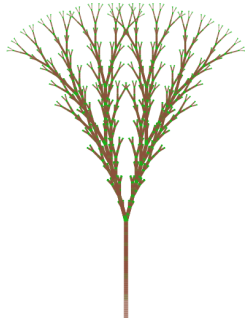


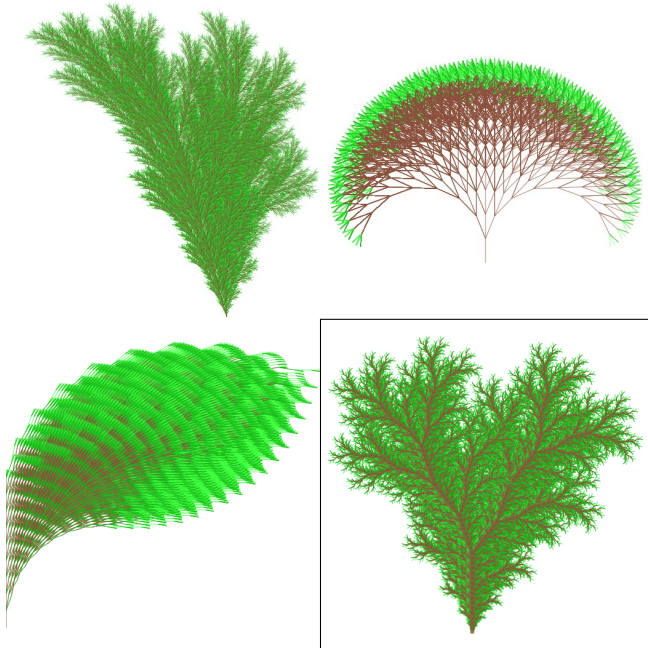
Final question (2 points)

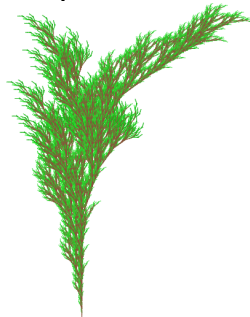
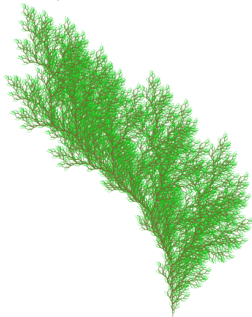
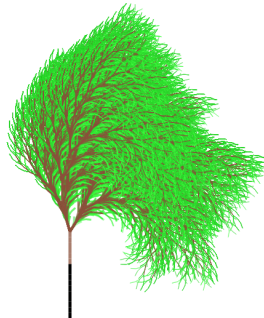
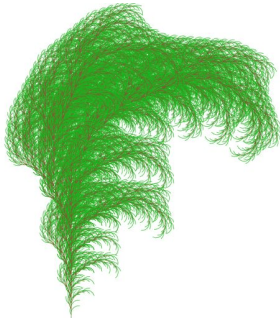
What is ataktostele?

- When vascular bundles do not make regular structure(s).









Stem and shoot Phyllotaxis



Spiral phyllotaxis: Fibonacci rule

- Multiple types of leaf spiral leaf arrangement mostly follow **Fibonacci rule**
- Formulas of leaf arrangements is very similar to Fibonacci fractions: $\frac{1}{2}$, $\frac{1}{3}$, $\frac{2}{5}$, $\frac{3}{8}$, $\frac{5}{13}$, *et cetera*
- Numerator is number of spiral circulations, denominator is number of leaves in a series (counted from zero)
- Denominator gives the number of **orthostychy** (this is plural)

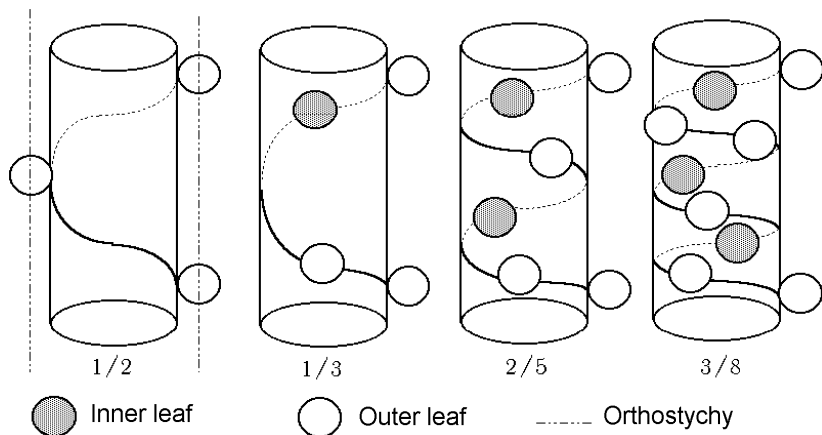


Spiral phyllotaxis: how to make a formula

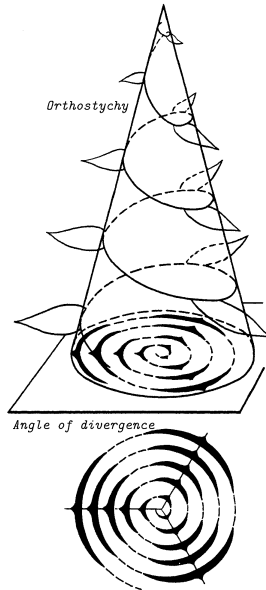
- Take a branch, find any leaf (it will be leaf #0)
- Find the second one which is located in the same position (exactly above or exactly below leaf #0)
- Count how many leaves are in this series (start from 0), this will be a denominator
- Imagine (or use a real thread) a spiral which go from leaf #0 to the last leaf of series, count how many times this spiral circulate the stem—this is a numerator



Spiral phyllotaxis: orthostychy



Spiral phyllotaxis: angles of divergence for $1/3$

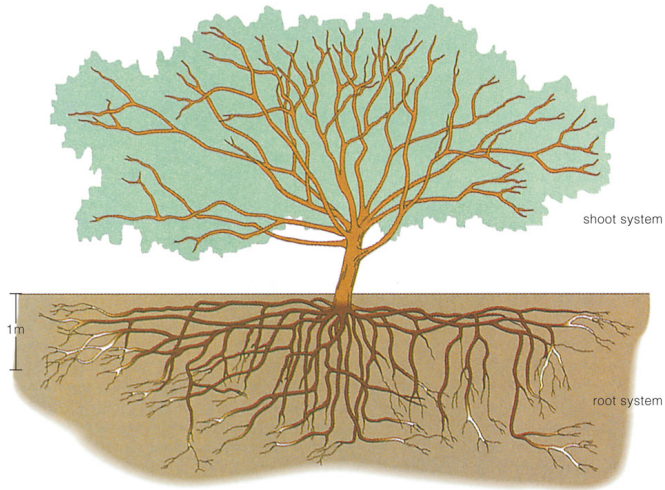


Root

Root morphology



Root system and shoot system



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Definition and functions

- Axial vegetative organ with a function of soil nutrition
- Other functions:
 - ① Anchor
 - ② Synthesis
 - ③ Storage
 - ④ Communication
- Features:
 - ① No leaves
 - ② Geotropic growth
 - ③ Locates in soil or water



Types of roots

- Primary root: originates from root of seedling
- Secondary (lateral) roots: originate from primary roots
- Adventitious roots: originate from stems



Primary root



Adventitious roots

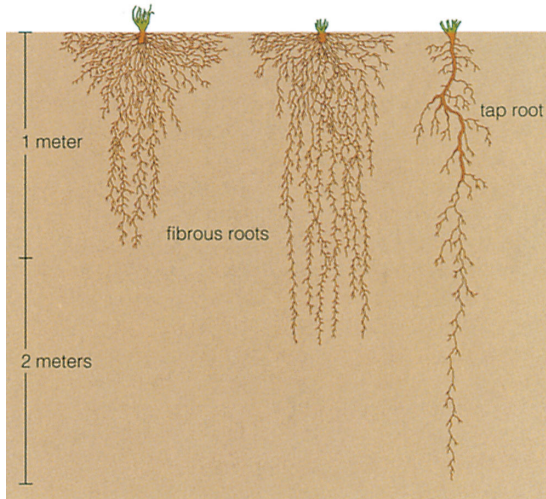


Root systems

- Tap root system: with well developed primary root (most seed plants)
- Fibrous root system: without clearly visible primary root (monocots, ferns)



Fibrous and tap root systems



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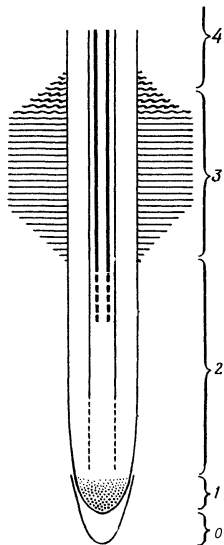


Root

Anatomy and development of roots



Root zones



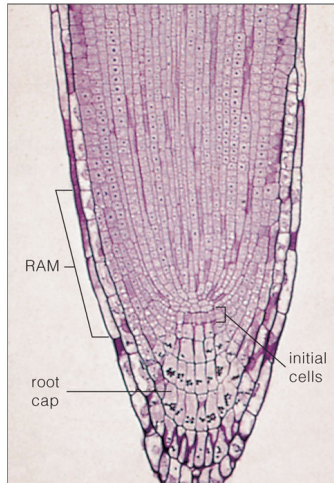
- Root cap
- Root meristem
- Elongation zone
- Absorption zone
- Maturation zone

Structure of root tip

- Initial cells (quiescent center)
- RAM
- Root tip growing both forward (root cap) and backward (other root tissues), initial cells determine the direction of growth
- If root tip touch barrier, it starts to make rotating movements



Root tip



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Periphery of root

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

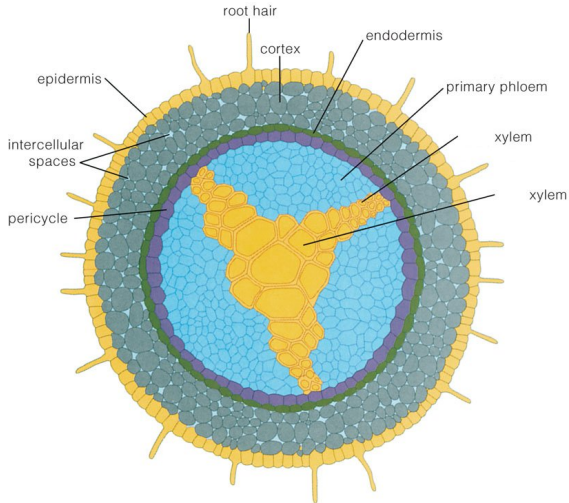


Root center: vascular cylinder

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



Anatomy of root



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Pericycle

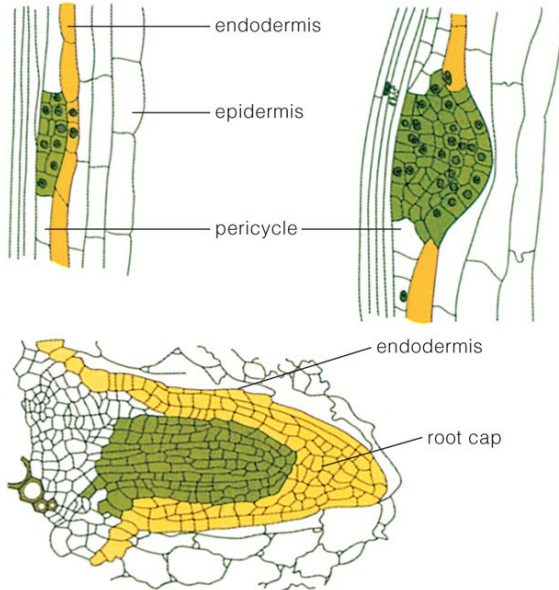
- Long-lived parenchyma cells served as half-meristem
- Initiates development of lateral roots
- Contributes to vascular cambium
- Contributes to cork cambium



Development of lateral roots



Development of lateral roots (step by step)

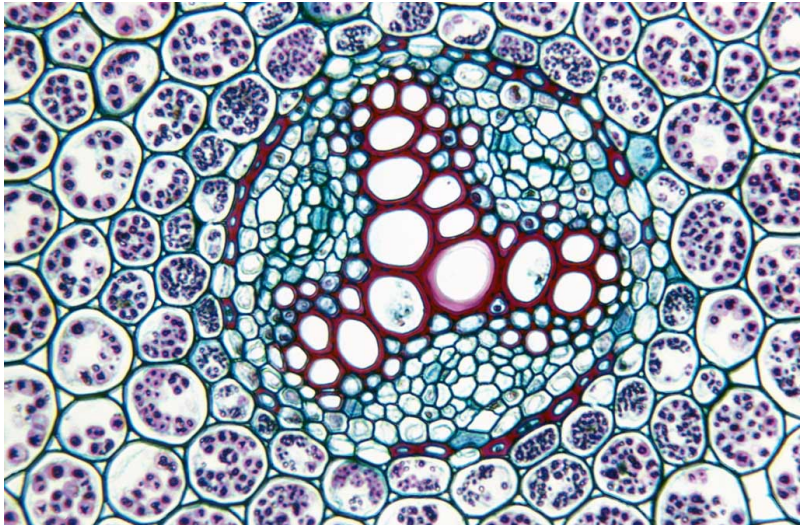


Vascular bundle

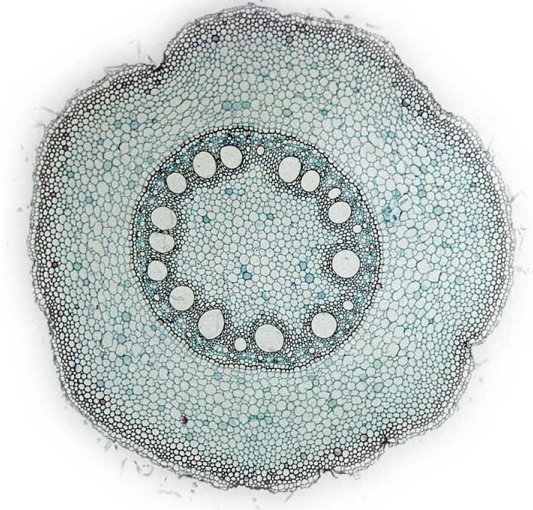
- Only one!
- Has radial (star-like) symmetry
- Xylem arranged in rays, multiple in monocots, 2-4 in other plants



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



Root of monocot (*Zea mays*)

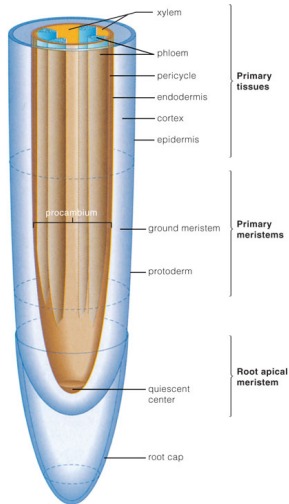


Root

Origins of root tissues



Development of tissues



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In essence, development of tissues in root is analogous to stem.



Summary

- Vascular tissues of root is a modified protostele or solenostele (monocots).



Final question (2 points)



Final question (2 points)

What is exodermis (exoderm)?



For Further Reading



A. Shipunov.

Introduction to Botany [Electronic resource].

2016.

Mode of access:

http://ashipunov.info/shipunov/school/biol_154

