

Introduction to Botany. Lecture 10

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Outline

- 1 Questions and answers
- 2 Anatomy of stem
 - From SAM to primary structure
 - Vascular bundles
 - Anatomy of mature stem

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- 2 Anatomy of stem
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Previous final question: the answer

What are contractile roots?

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What are contractile roots?

- Shrinking roots

Stem: definition and functions

- Axial vegetative organ of shoot with functions of support and transportation
- Other functions:
 - ① Photosynthesis
 - ② Storage
- Features:
 - ① Radial structure
 - ② No root hairs
 - ③ Continuous growth

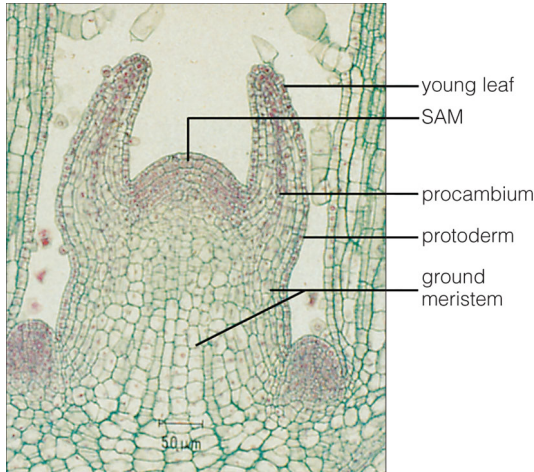
Protoderm to epidermis

- Stem apex meristem (SAM) produces **protoderm**
- Protoderm cells differentiate into epidermal cells

Ground meristem to cortex and pith

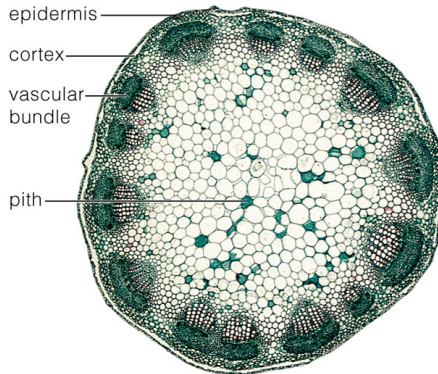
- SAM produces also **ground meristem**
- Ground meristem differentiates into **cortex** and **pith**
- Procambium raises between cortex and pith, it forms vascular bundles or vascular cylinder

Three primary meristems: procambium, protoderm and ground meristem



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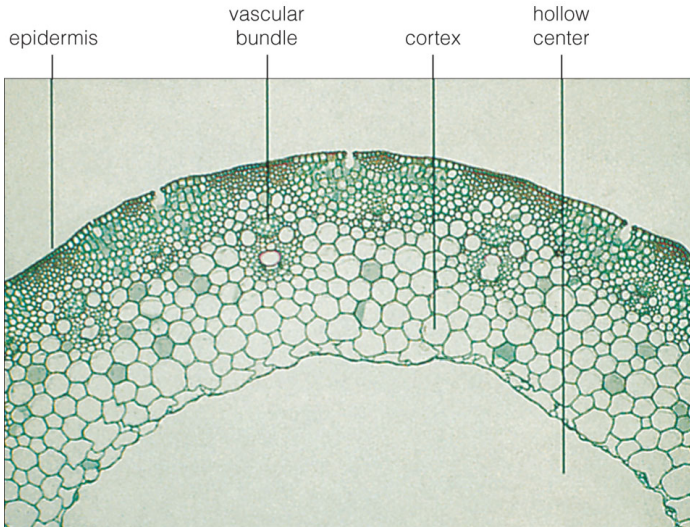
Young stem with primary tissues



b

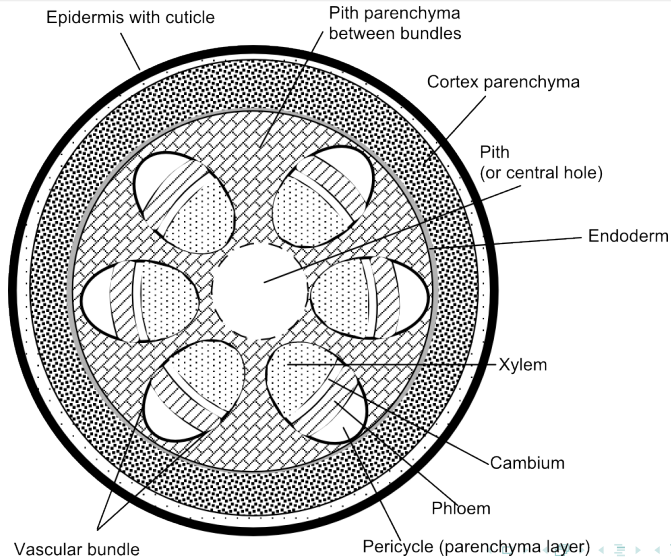
transverse section of a stem,
with enlargement of a vascular
bundle shown to the right

Older stem with hollow in the center



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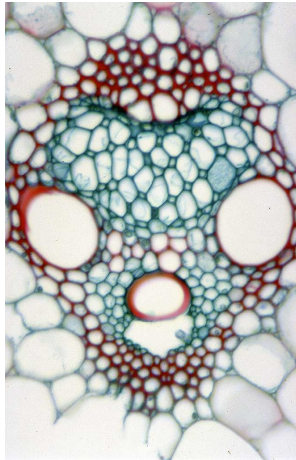
Primary structure of stem



Procambium to xylem and phloem

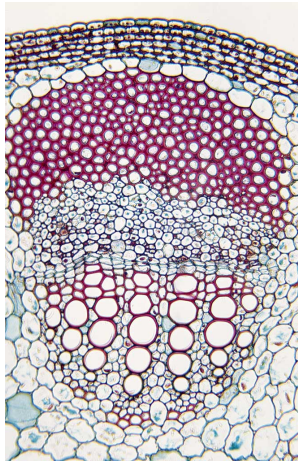
- Outer layers of procambium form **primary phloem**
- Inner layers become **primary xylem**
- Sometimes outermost layers of procambium form **pericycle** (parenchyma cells)
- In some cases, inner layers of cortex could form **endoderm**

Vascular bundle 1



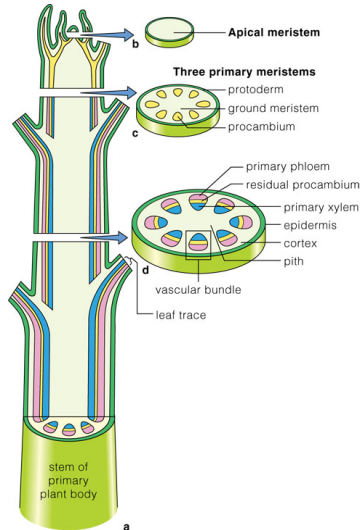
Corn (*Zea mays*) mature stem cross-section showing single vascular bundle, Brightfield (LM $\times 400$)

Vascular bundle 2



Wild Sunflower (*Helianthus* sp.) with nearly mature vascular bundle (LM $\times 35$)

Origin of vascular bundles

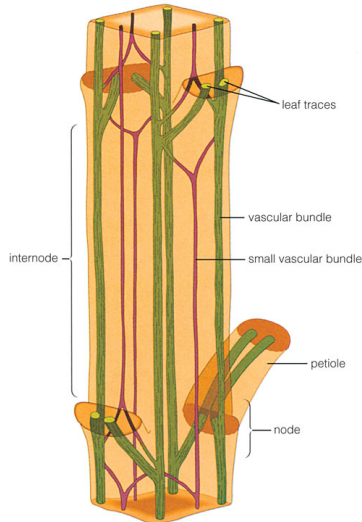


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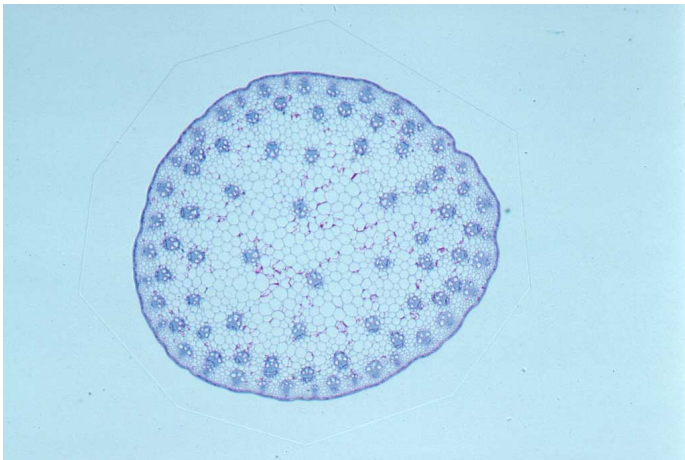
Vascular bundles

- Vascular bundles connect leaves and stems
- In many plants, they form **ring** on the cross-section of stem (“dicot” stem)
- Monocot stems usually have **dispersed** vascular bundles

Vascular bundles and leaf traces



Monocot stem

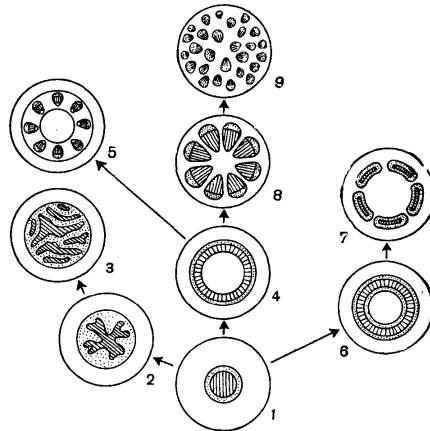


Corn (*Zea mays*) stem (LM $\times 4$)

Steles

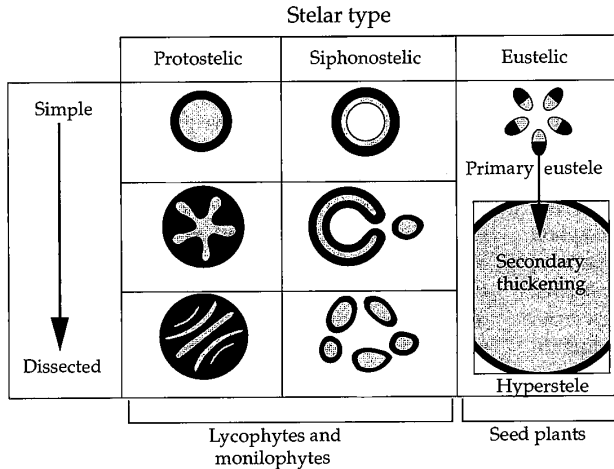
- **Stele** is an overall configuration of primary vascular system of plant stem
- The most important kinds of steles are: **protostele**, **siphonostele**, **eustele** and **ataktostele***

Diversity of steles



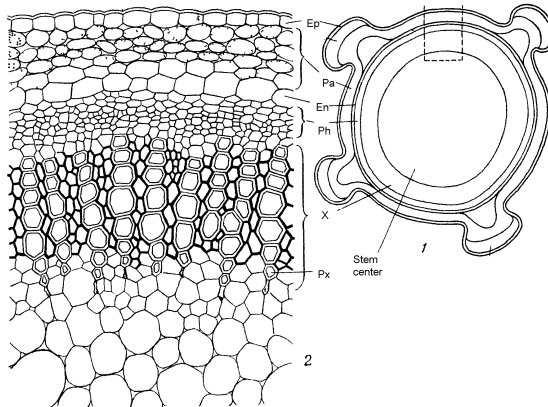
(1) is protostele, (7) siphonostele (occurs in ferns), (8) eustele (“dicot” stem), (9) ataktostele (monocot stem)

Hyperstele



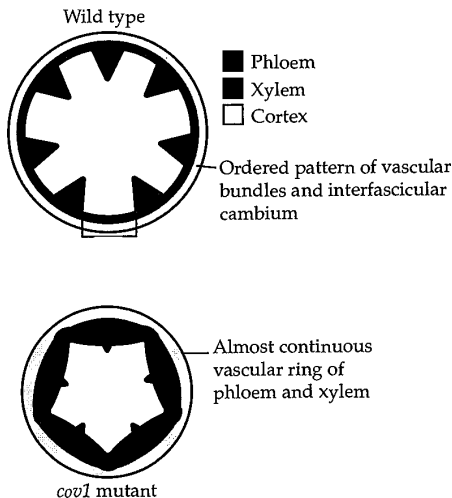
Mature stem with secondary structure often called “hyperstele” (Cronk, 2009)

Vascular cylinder: alternative to ring of bundles



Sometimes, vascular bundles are so dense that they form almost a cylinder. We may call this vascular cylinder “solenostele” (#4 on the scheme of steles)

Gene alternates cylinder and bundles

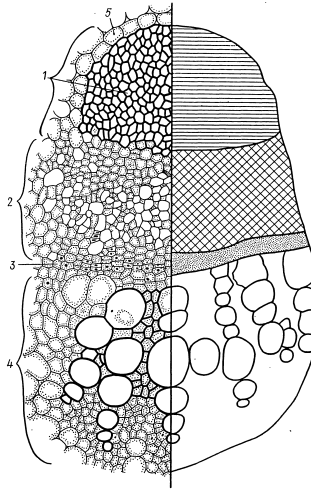


The COV mutant of Arabidopsis (after Parker et al., 2003)

Vascular cambium

- In many plants, residuals of procambium transform into fascicular cambium
- Parenchyma cells between vascular bundles produce inter-fascicular cambium

Where is fascicular cambium?



Summary

- SAM produces **protoderm** and **ground meristem**, ground meristem differentiates into **cortex** and **pith**
- Procambium forms **vascular bundles** or vascular cylinder
- Outer layers of procambium transform into primary phloem, inner layers — into primary xylem
- Monocot stem usually has dispersed vascular bundles (**ataktostele**)

Final question (1 point)

Final question (1 point)

What is ataktostele?

For Further Reading



J. E. Bidlack, Sh. H. Jansky.
Stern's introductory plant biology. 12th edition.
McGraw-Hill, 2011.
Chapter 6.



Th. L. Rost, M. G. Barbour, C. R. Stocking, T. M. Murphy.
Plant Biology. 2nd edition.
Thomson Brooks/Cole, 2006.
Chapter 5.