Introduction to Botany. Lecture 26

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Outline

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Previous final question: the answer

Provide a list of plant organs.

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Provide a list of plant organs.

- Leaf, stem, root, FU

Stem and shoot
Anatomy of primary stem

Protoderm to epidermis

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

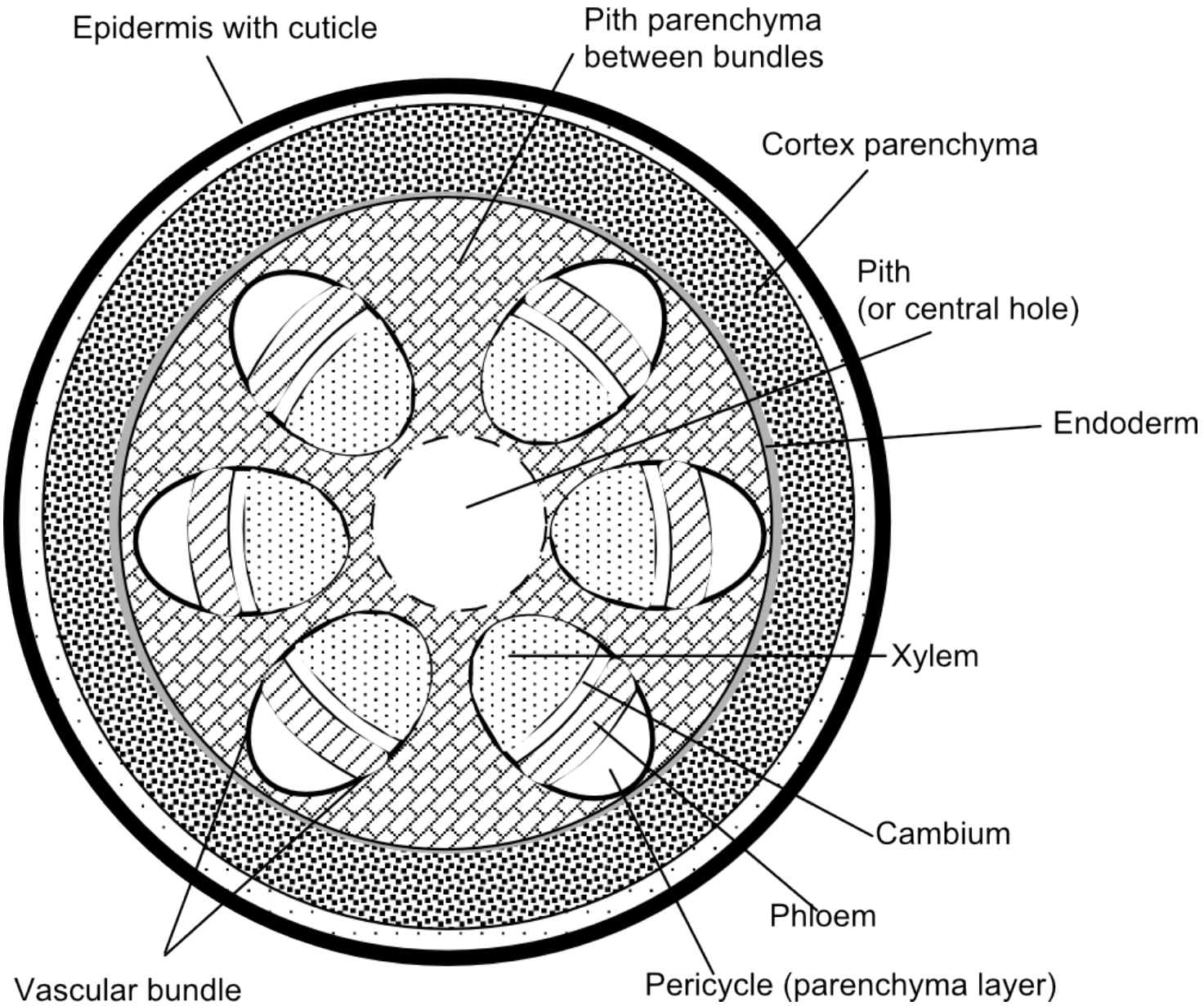
Ground meristem to cortex and pith

- 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

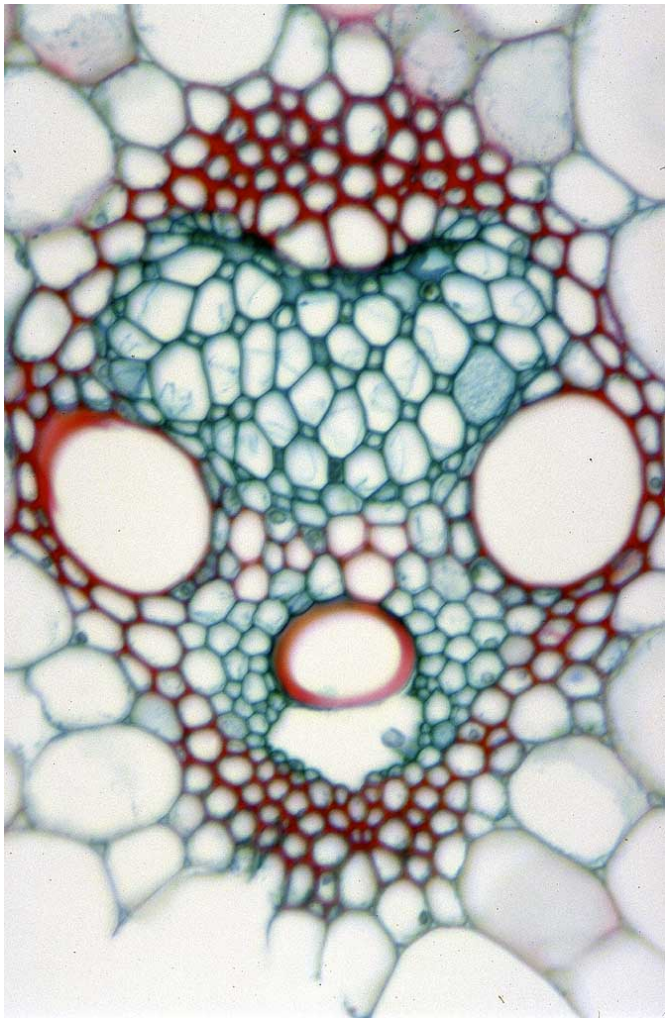
Procambium to xylem and phloem

- Outer layers of procambium form **primary phloem**
- Inner layers become **primary xylem**
- Middle layer could be completely spent **or** will make cambium for the secondary thickening
- Sometimes outermost layers of procambium form **pericycle** (parenchyma cells)
- In some cases, inner layers of cortex could form **endoderm**

Primary structure of stem

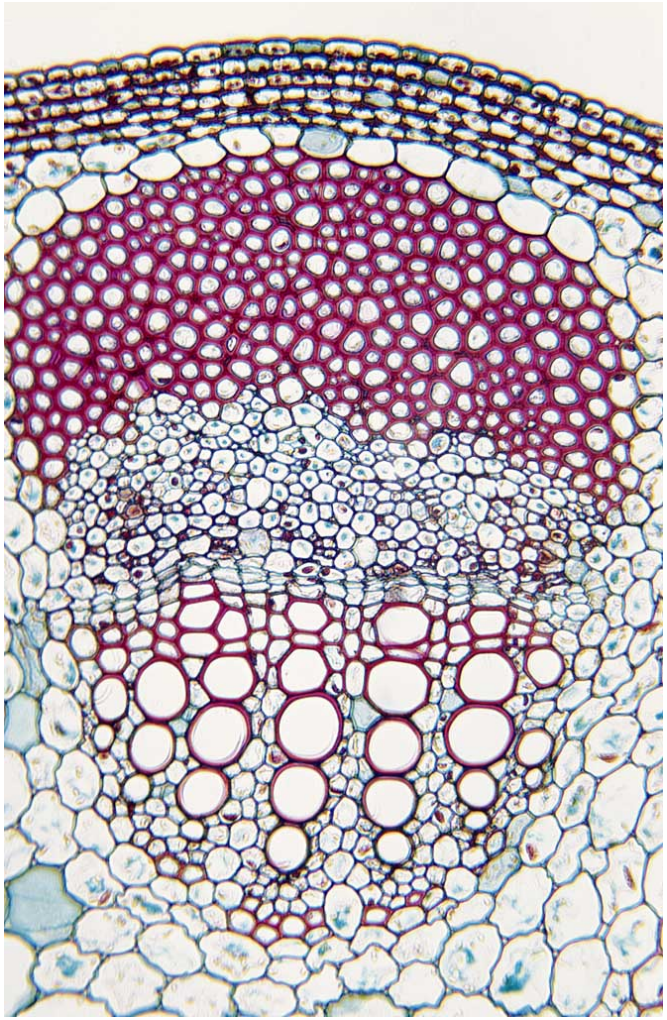


Vascular bundle (monocot)



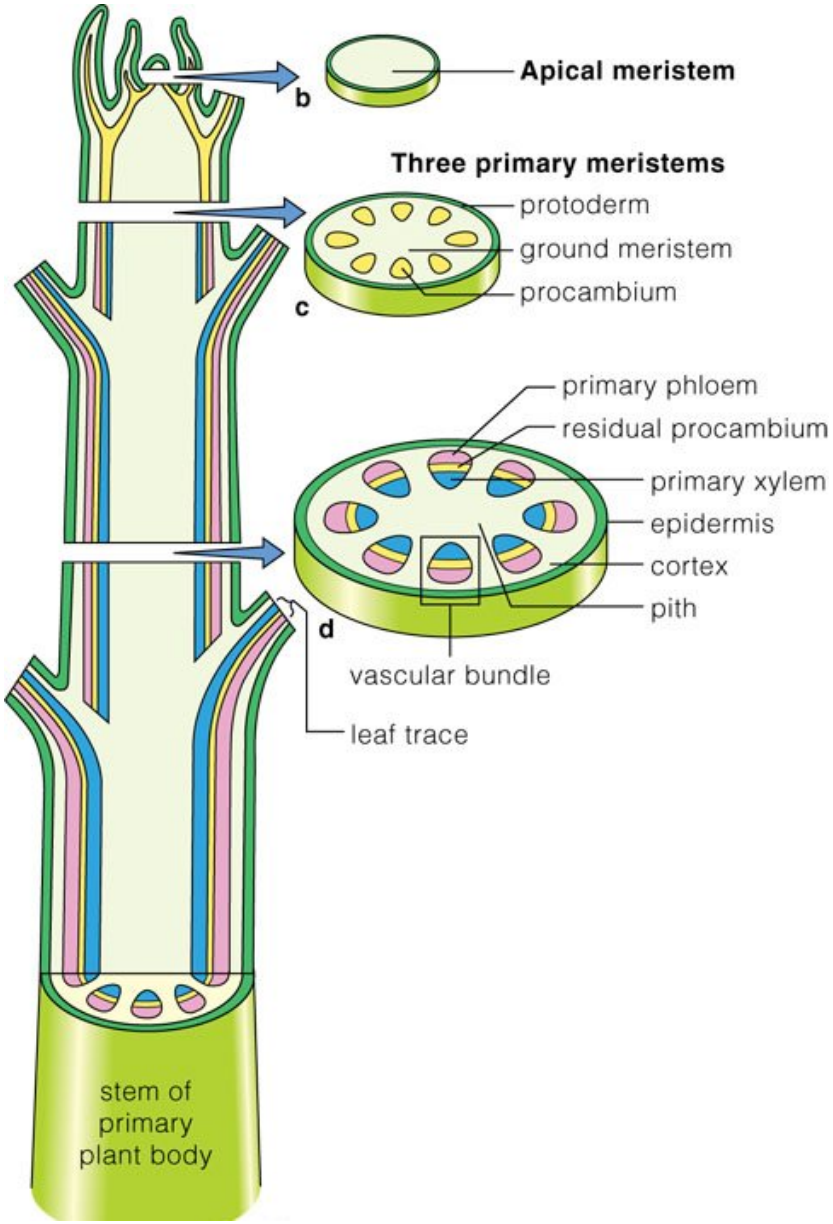
Corn (*Zea mays*) mature stem cross-section showing single vascular bundle, Brightfield (LM $\times$400)

Vascular bundle (asterid)



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

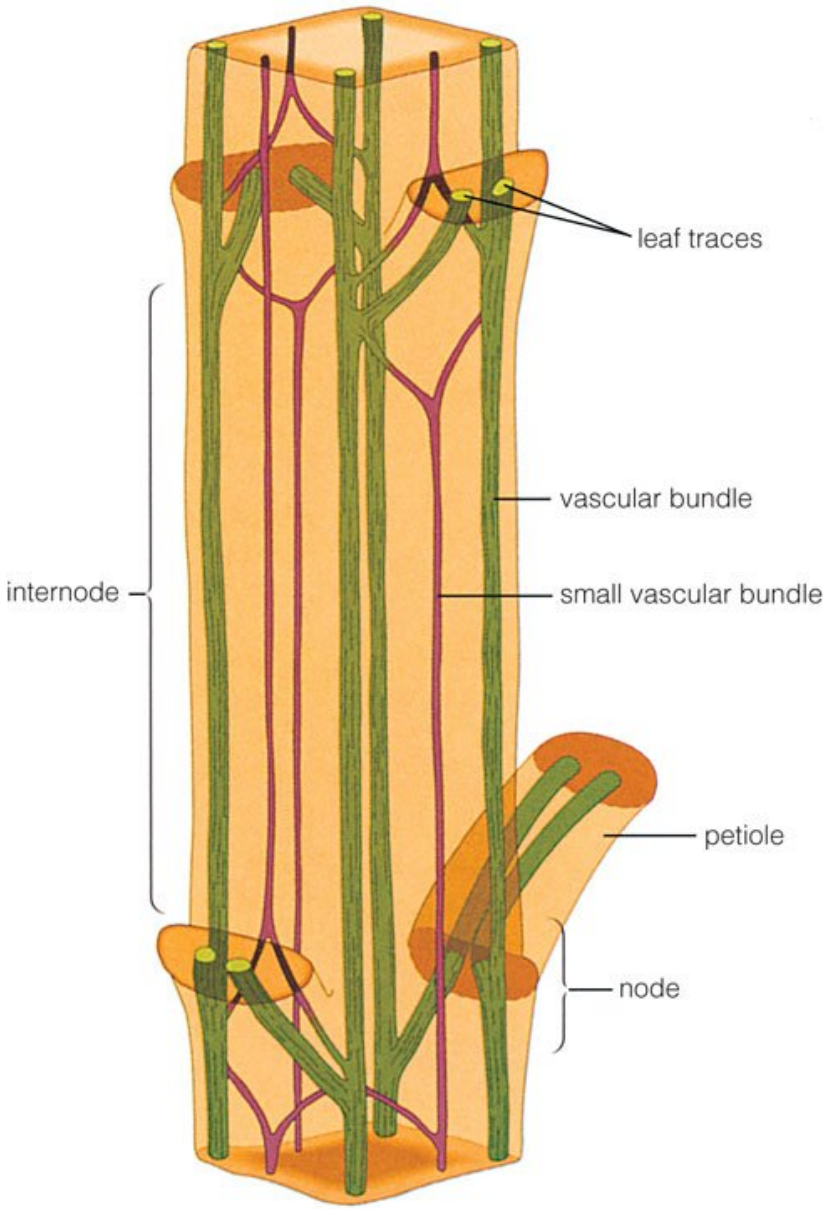
Origin of vascular bundles



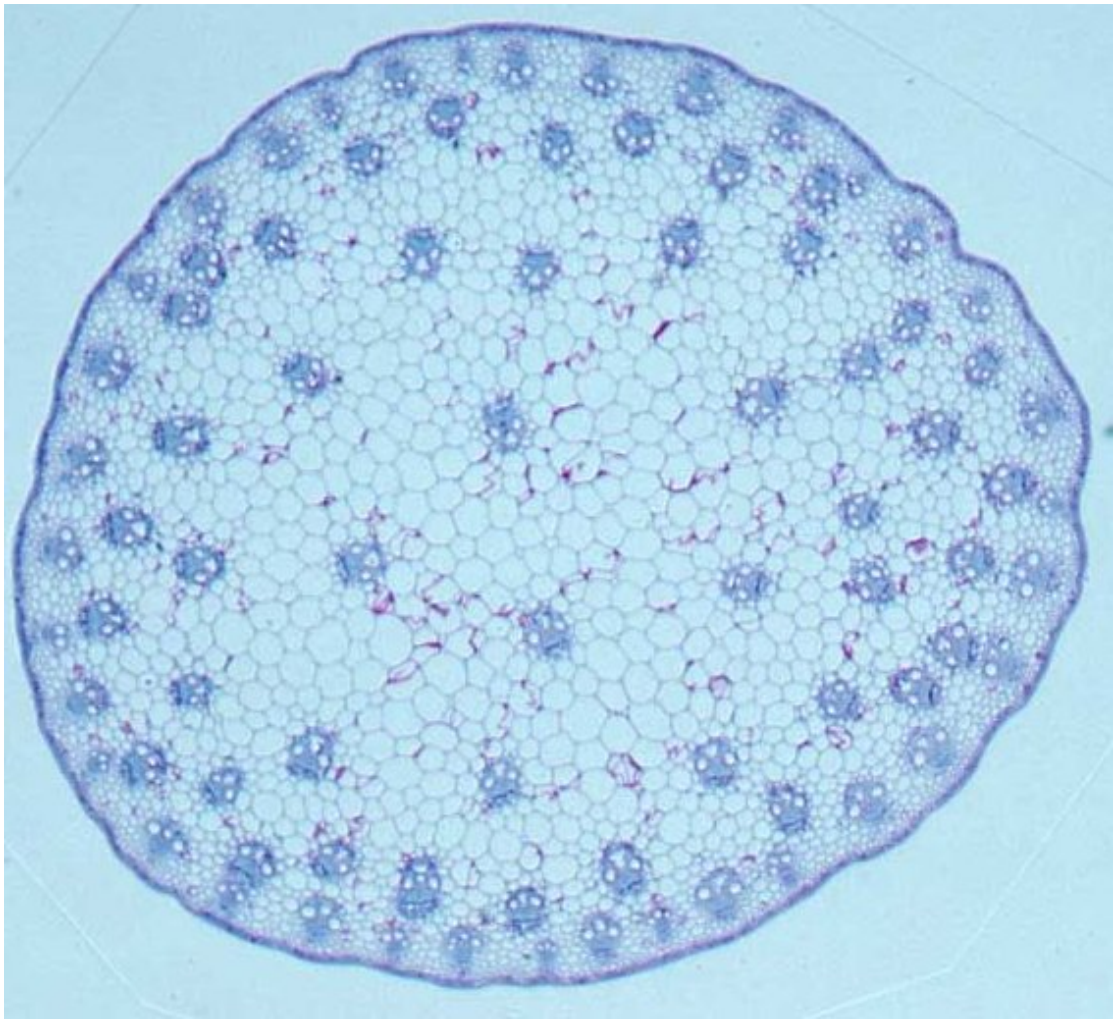
Vascular bundles

- 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

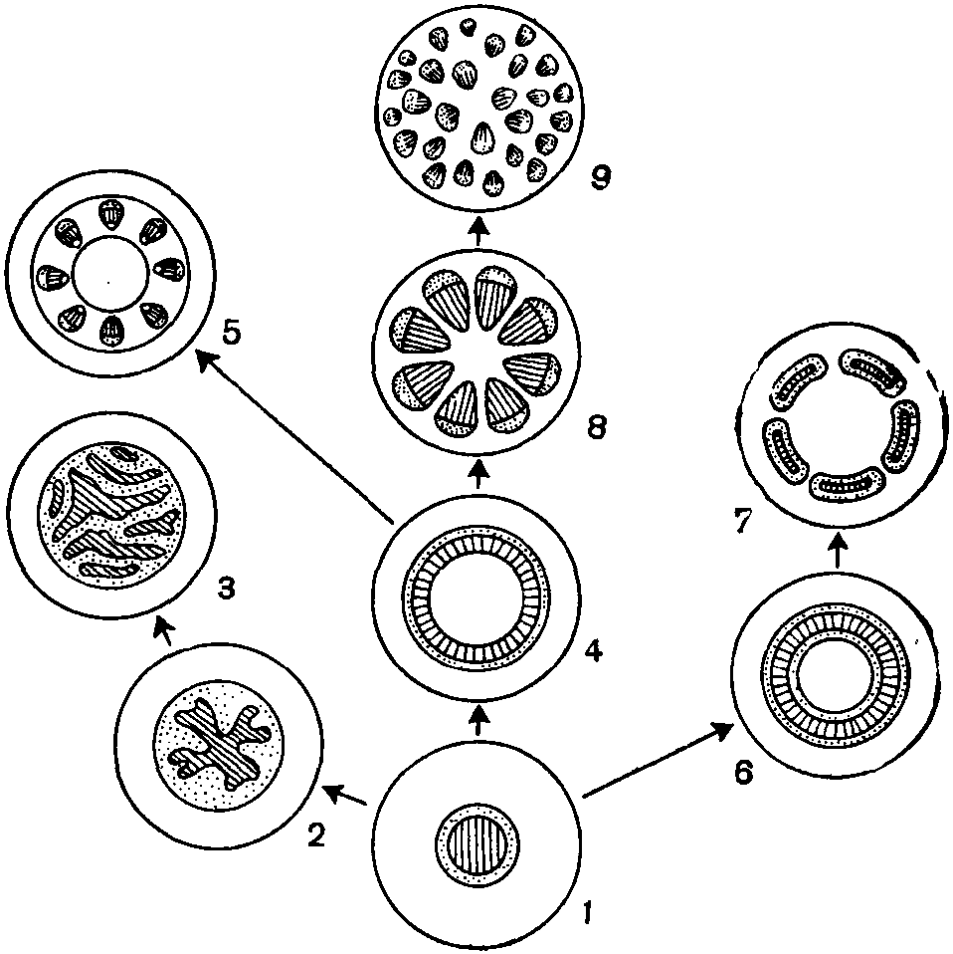


Corn (*Zea mays*) stem (LM $\times 4$)

Steles

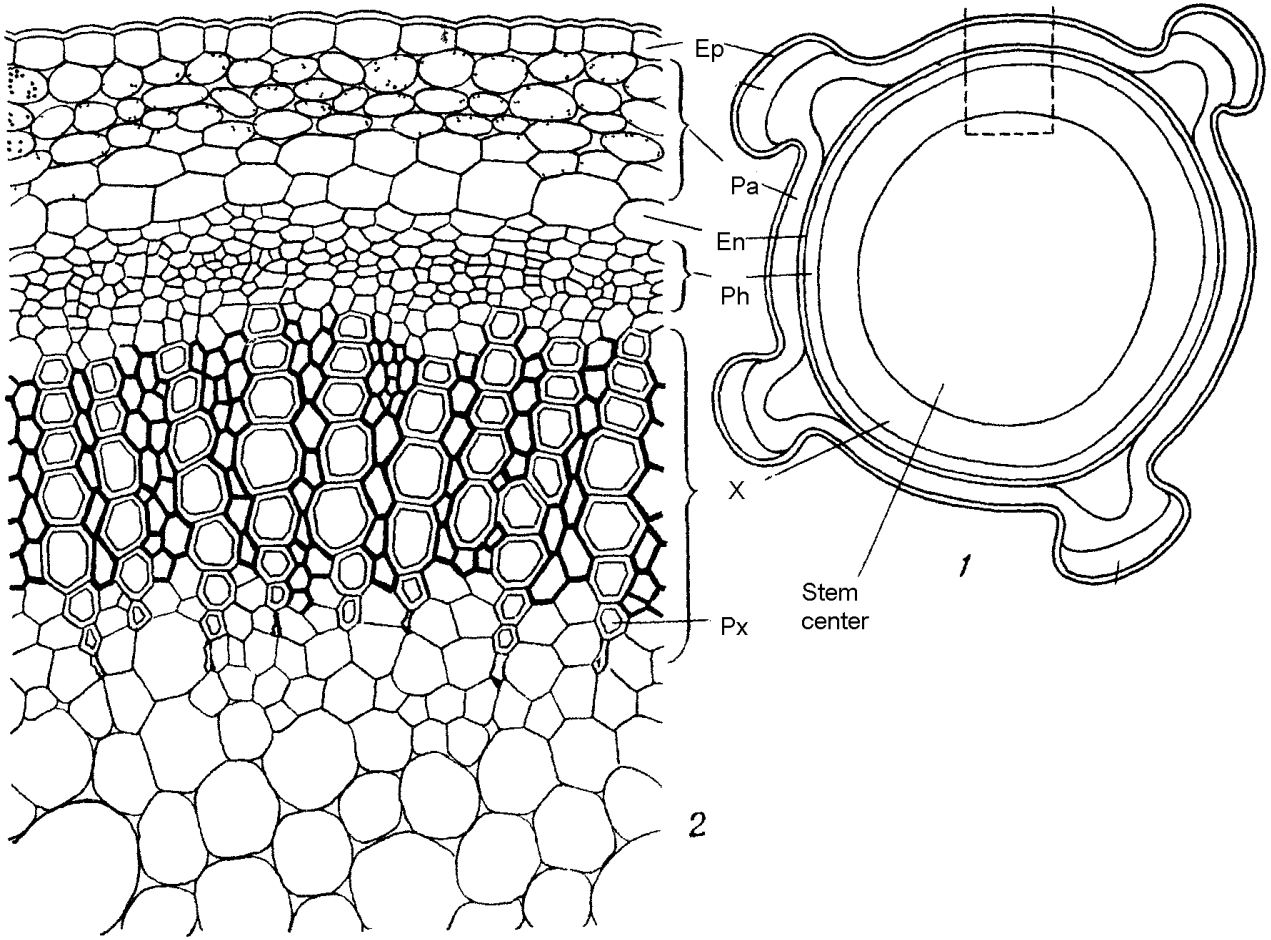
- **Stele** is an overall configuration of primary vascular system of plant stem
- The most important kinds of steles are: **protostele**, **solenostele**, **eustele** and **ataktostele***

Diversity of steles



(1) is protostele, (4) solenostele, (8) eustele (“dicot” stem), (9) ataktostele (monocot stem)

Vascular cylinder: alternative to ring of bundles



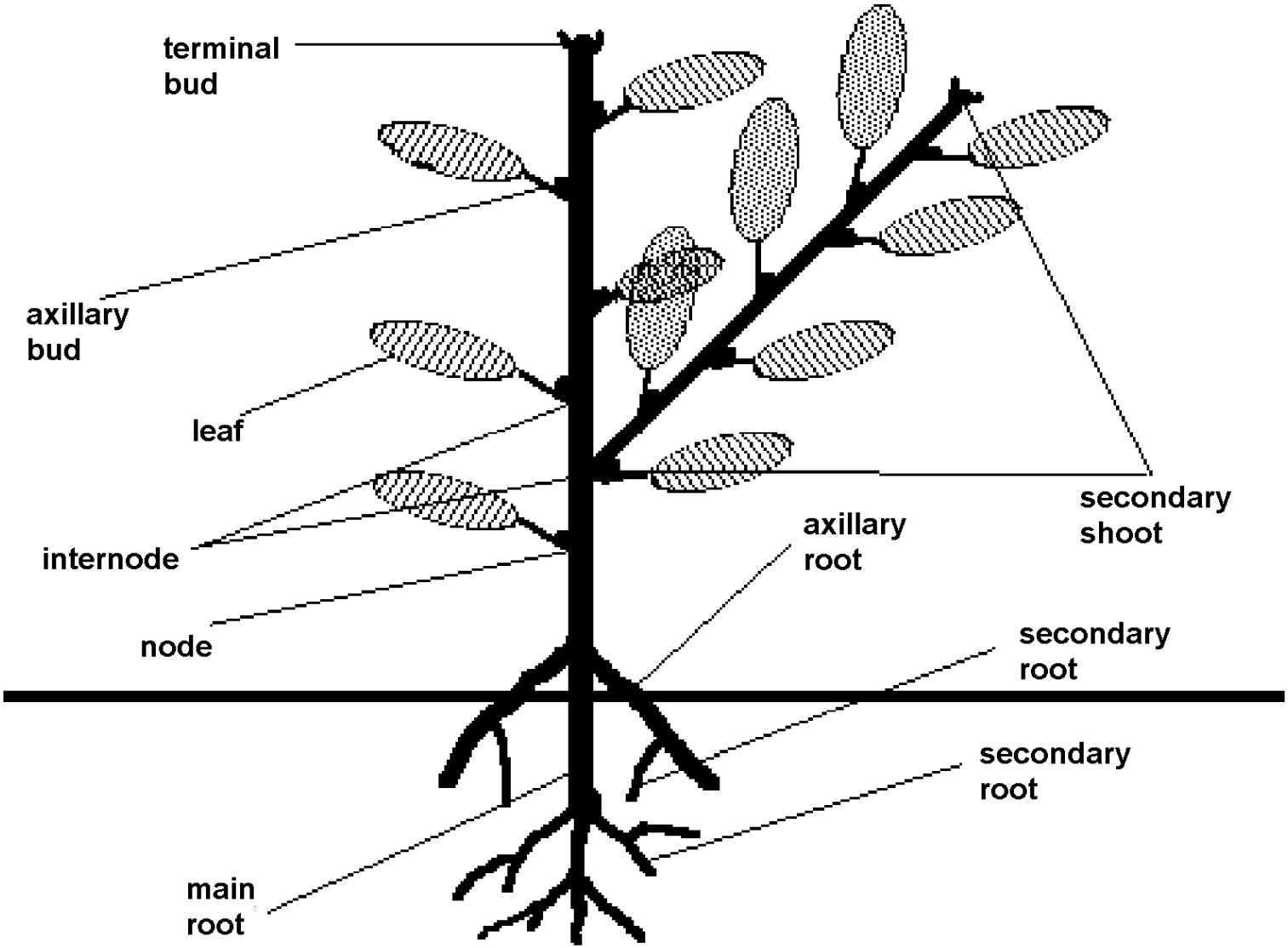
Sometimes, vascular bundles are so dense that they form almost a cylinder. We may call this vascular cylinder “solenostele” (#4 on the scheme of steles)

Stem and shoot
Components of shoot

Components of vegetative shoot system

1. Main and secondary shoots
2. Terminal and axillary (lateral) buds
3. Nodes and internodes
4. Leaves

Components of shoot

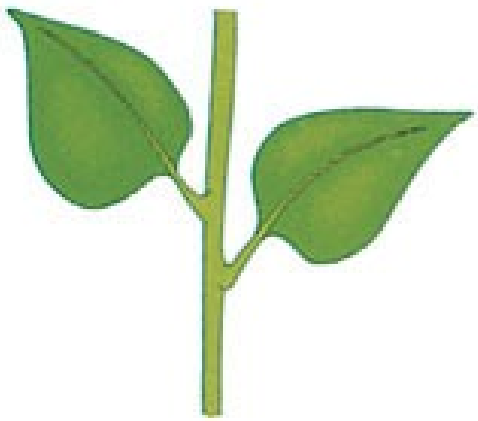


Stem and shoot
Phyllotaxis

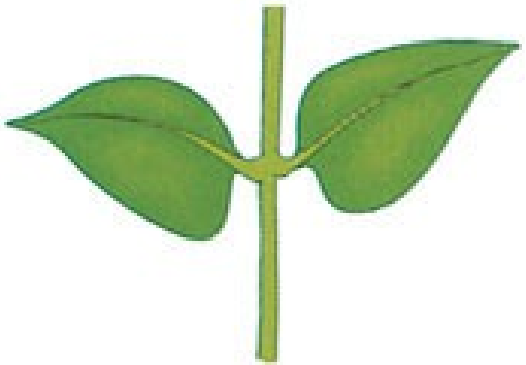
Arrangement of leaves: phyllotaxis

- One leaf per node: **spiral**, or **alternate** arrangement
- Two leaves per node: **opposite** arrangement, they may be:
  - All in same plane
  - Each pair will rotate on 90°
- $>$ 2 leaves per node: **whorled** arrangement (each whorl can also rotates)
- Each type of phyllotaxis has its own *angle of divergence*

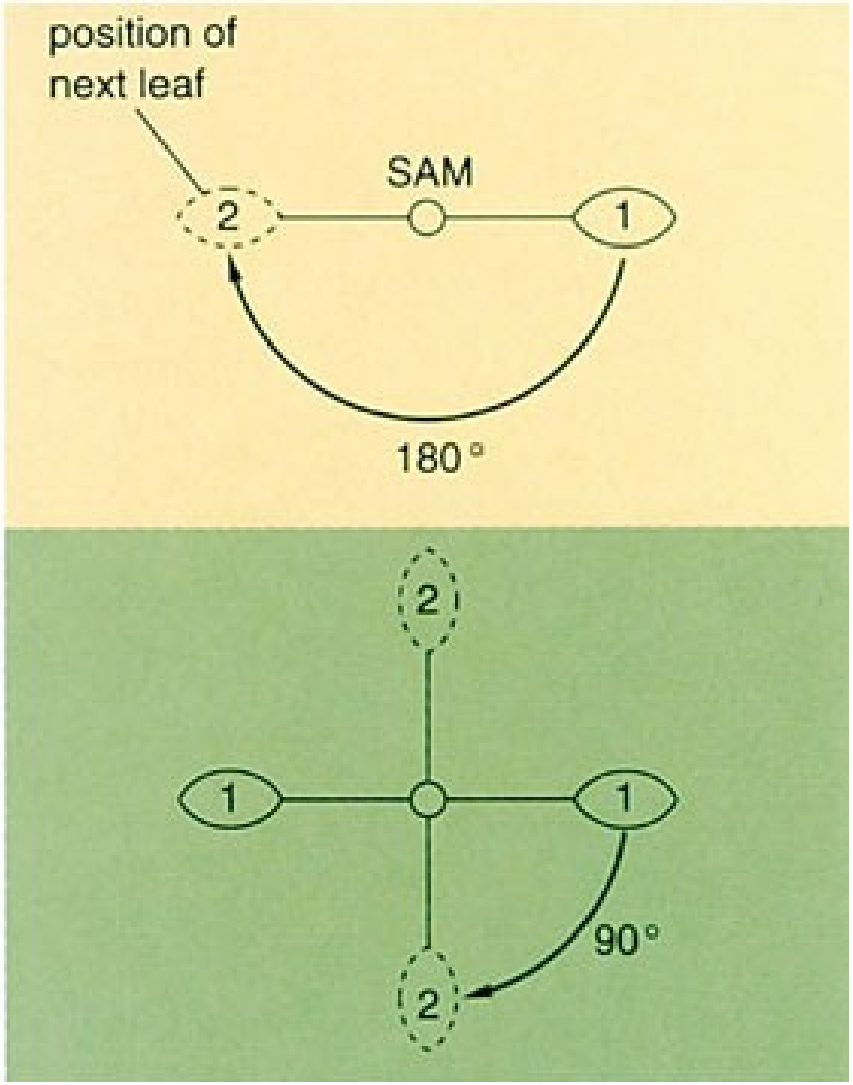
Alternate and opposite phyllotaxes



alternate



opposite



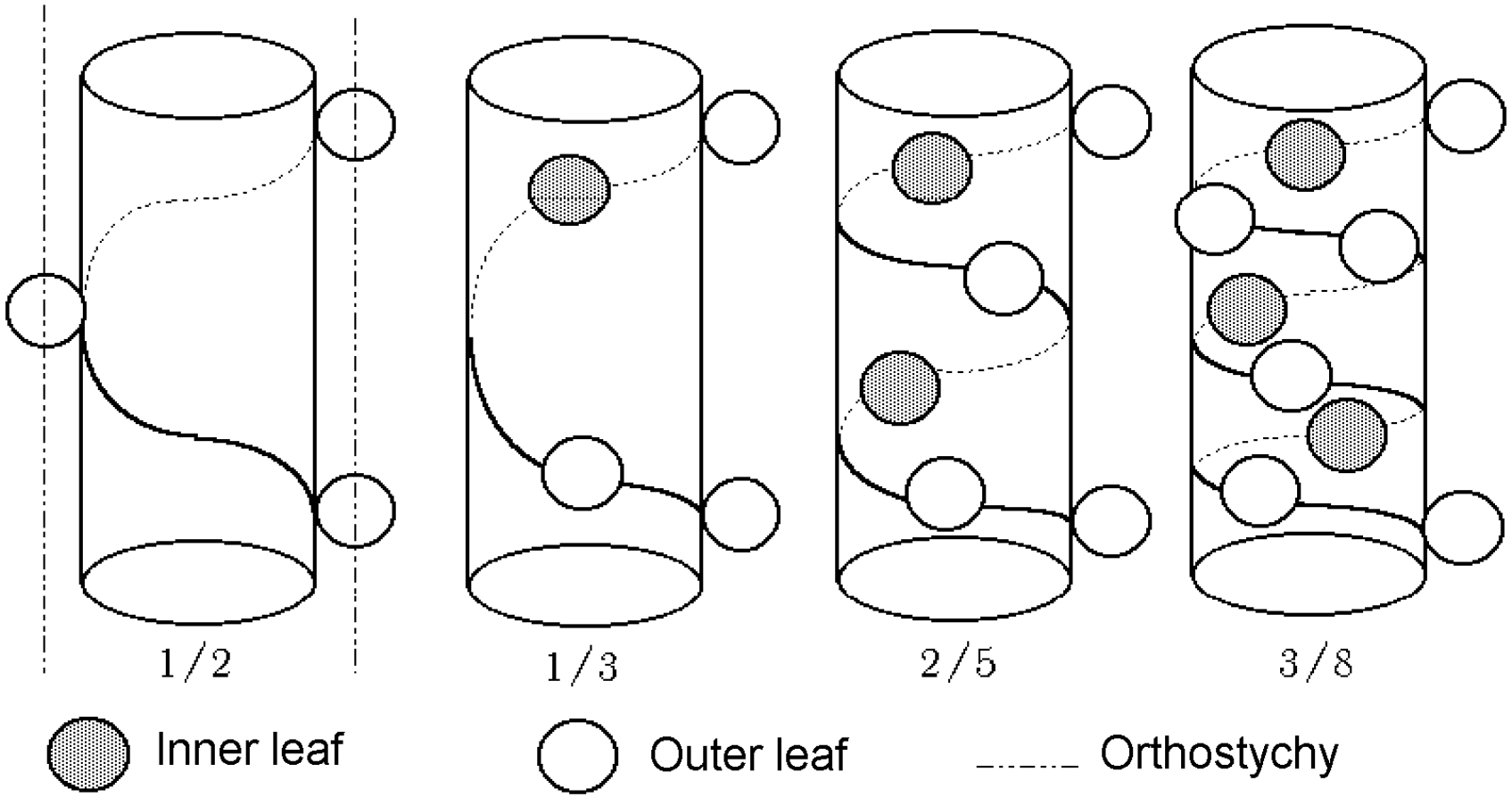
Spiral phyllotaxis: Fibonacci rule

- Multiple types of leaf spiral leaf arrangement mostly follow **Fibonacci rule**
- Formulas of leaf arrangements is very similar to Finobacci 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)

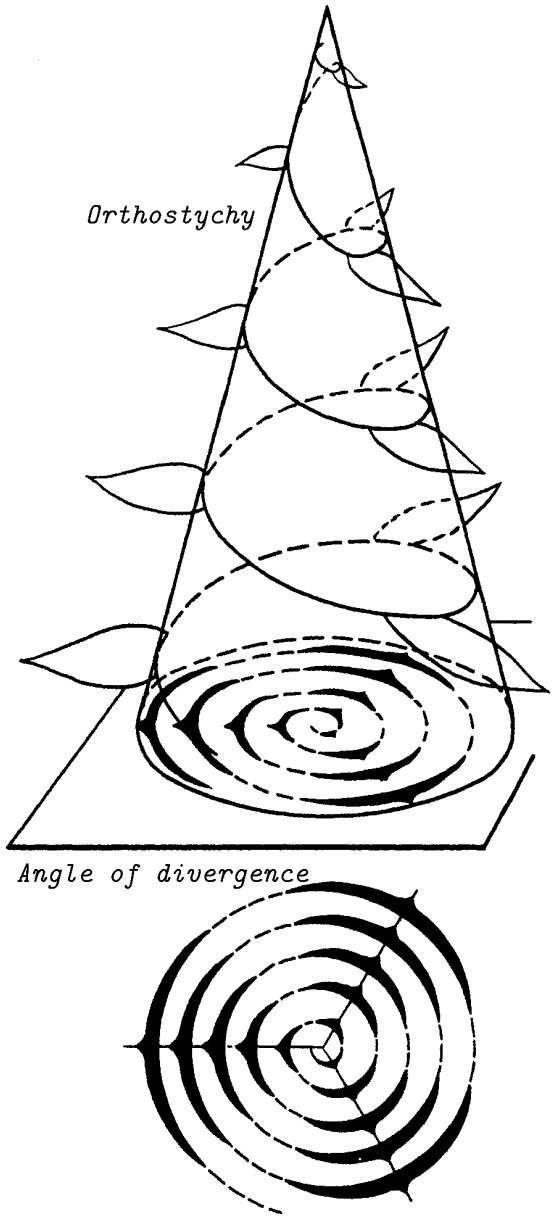
Spiral phyllotaxis: how to make a formula

- 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



Final question (2 points)

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What is ataktostele?

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**)
- Spiral arrangement of leaves follows **Fibonacci** rule

For Further Reading

A. Shipunov.
Introduction to Botany [Electronic resource].
2010—onwards.
Mode of access:
http://ashipunov.info/shipunov/school/biol_154

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