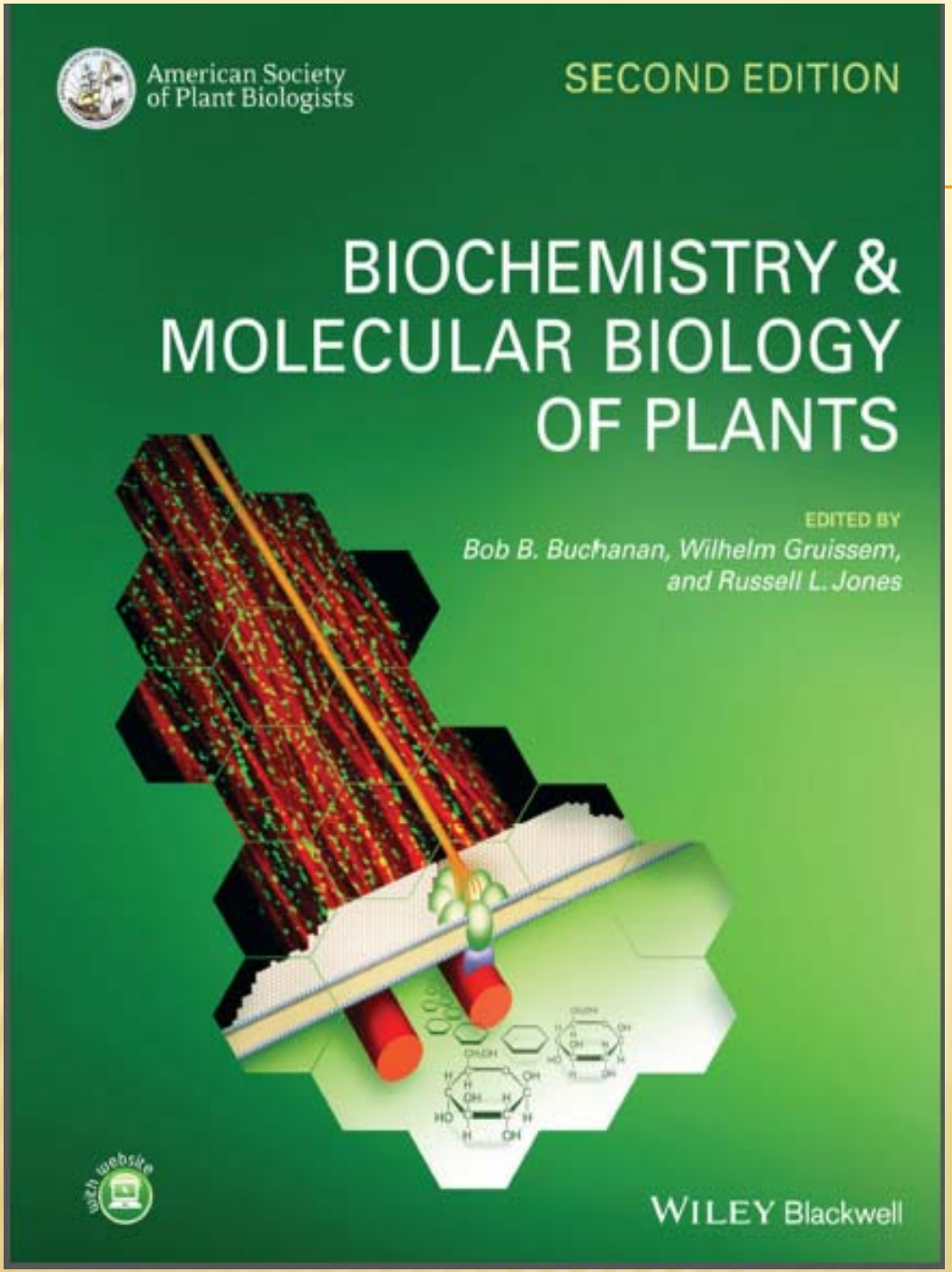
IN THE NAME OF GOD

Plant Physiology

M. Gholami


American Society of Plant Biologists
SECOND EDITION
BIOCHEMISTRY & MOLECULAR BIOLOGY OF PLANTS
EDITED BY
Bob B. Buchanan, Wilhelm Gruissem, and Russell L. Jones
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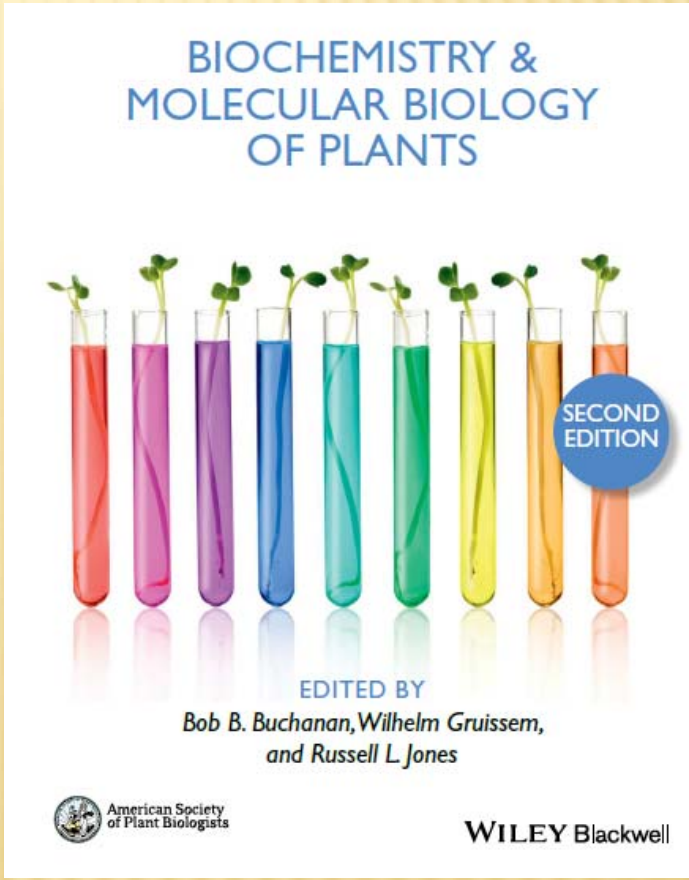
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AIMS :

1. To study chemical and physical processes associated with life as they occur in plants.

- At the small scale like molecular interactions in photosynthesis, internal diffusion of water, minerals and nutrients.

- At large scale like processes of development, seasonality, dormancy etc.

What is Plant Physiology?

- Literal Definition:
  - In Greek: *physis* = nature and *logos* = word

    "Discourse on the nature of plants"
- Definition:

"Science of how plants develop, grow, and respond to their environment at the cellular & biochemical level"

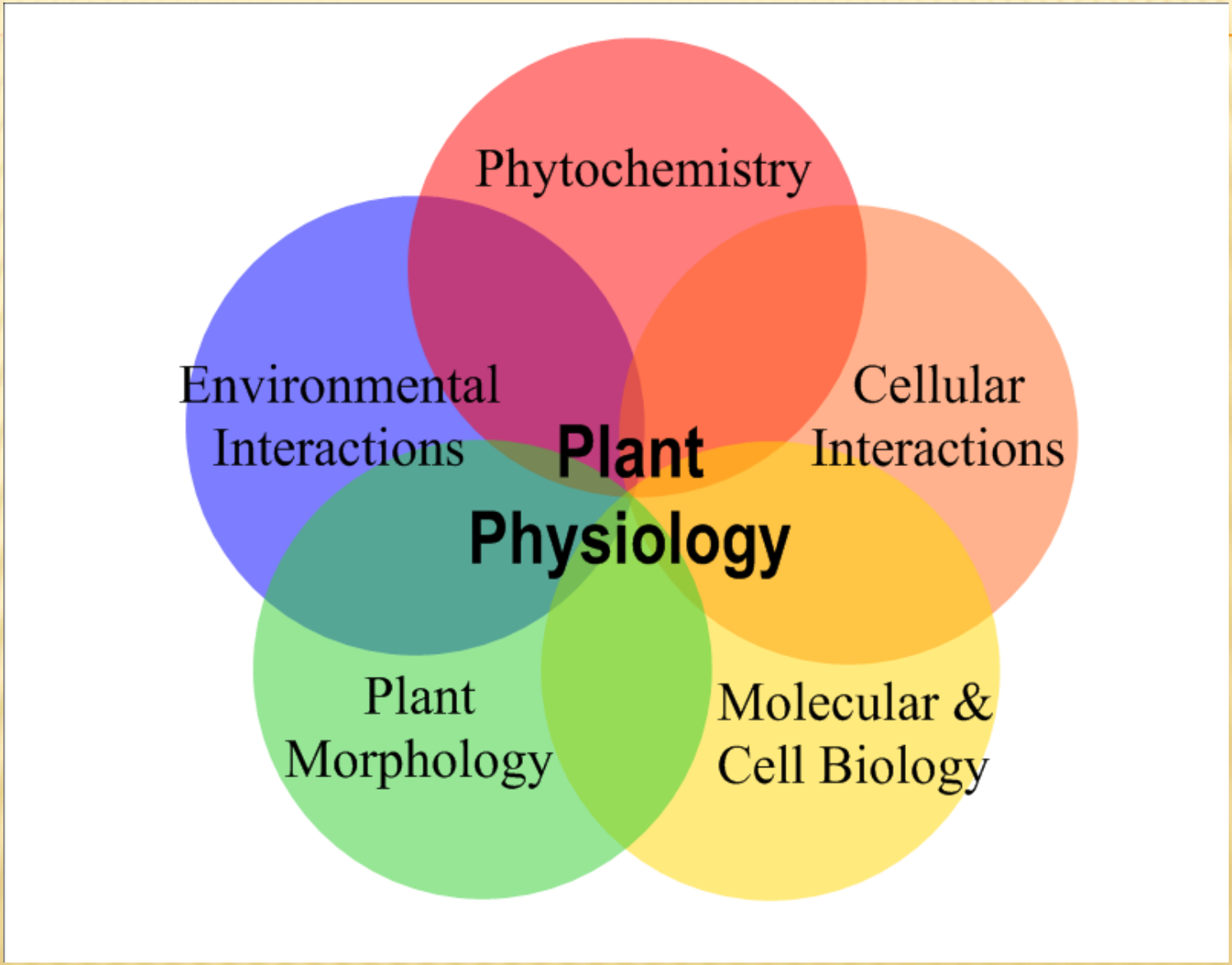
- Plant physiology is a **lab science**.
- Plant physiology is an **experimental science**.
- Plant physiology relies heavily on **chemistry and physics**

HISTORY OF PLANT PHYSIOLOGY

- **Sir <u>Francis Bacon</u> published one of the first plant physiology experiments in 1627 in the book, *Sylva Sylvarum.*** (Bacon grew several terrestrial plants, including a rose, in water and concluded that soil was only needed to keep the plant upright)

- **<u>Jan Baptist van Helmont</u> published what is considered the first quantitative experiment in plant physiology in 1648.** (concluded that plants get all their weight from water, not soil)

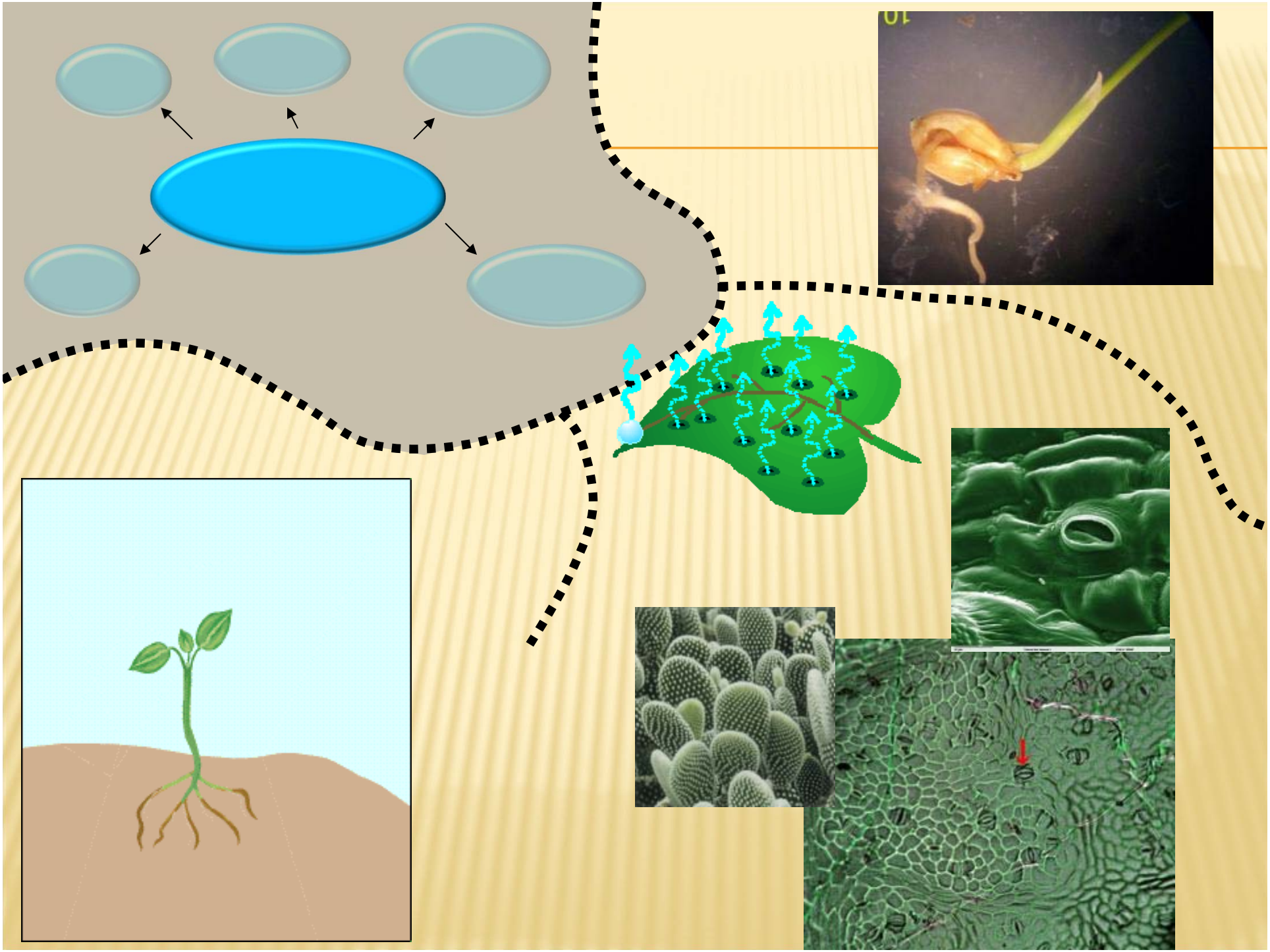
- **In 1699, <u>John Woodward</u> published experiments on growth of <u>spearmint</u> in different sources of water.** (He found that plants grew much better in water with soil added than in distilled water).


Phytochemistry
Environmental Interactions
Cellular Interactions
Plant Physiology
Plant Morphology
Molecular & Cell Biology

What does phsiology include ?

* Combining what is known about:
  - Structure and anatomy as it relates to plant function
  - Sources of energy for growth & development
  - Water & nutrient uptake and movement
  - Responses to the environment (light, temp., water)
  - Plant responses to stresses (abiotic & biotic)

* What types of science are involved?
  - Plant biology
  - Plant anatomy
  - Ecology and Environmental Biology
  - Cell biology
  - Inorganic & organic chemistry
  - Biochemistry
  - Molecular biology



Why Study Plants

1. **Plants provide the Oxygen we breath**
   - 4.5 billion years before
     - Ancient Atmosphere:
     - $H_2O + N_2 + NH_3 + CO_2 + CO + CH_4 + H_2 + H_2S$
       - an anaerobic (no oxygen gas) atmosphere
       - Toxic to life
     - $CO_2 + H_2O$ + light +chlorophyll----> $CH_2O + O_2$
     - potential to change the atmosphere in important ways

2. Plants provide the Ozone UV screen

- oxygen gas in the atmosphere is routinely converted to ozone by natural processes:
  - O_2 ---> O_3
- Ozone
  - absorbs ultraviolet light coming from the sun
  - provided a protective shield allowing life to exist with much less mutation
  - provided stability for life

3. **Plants provide a diversity of food**

- **Plants are the source of energy and protein for animals**
  - **Plants are responsible for feeding all the animals on the planet** (food web)
  - **Eating plants rather than animals (vegetarian) makes feeding the world more efficient**
  - **To make one kilogram of beef it takes 10 kilograms of grain! It is more efficient to eat the grain ourselves!**

4. Plants provide fibers

- Not all carbohydrates are digestible
  - The indigestible carbohydrates include cellulose referred as "fibers"
  - it is nevertheless very useful to us
- Cellulose in plants is deposited into xylem.
- In some plants these fibers are long and slender and can be spun together to make thread.
- This thread can be woven into fabrics including linen (flax fiber) and cotton (fruit fibers)

5. Plants provide wood and paper

- large concentrations of xylem made the tissue as wood.
- This forms the trunks of trees and can be cut into lumber for building houses and ships.
- Be burned as fuel for heating homes and cooking food.
- The fibers sized together into sheets of paper.

6. Plants provided fossil fuels

- Not all of the plant carbohydrate was eaten with 3-billion years of plants living and dying before animals started eating up everything produced
- But much of the plant material remained piling up in the ancient landscape.
- The piles were covered over and buried deeply by sediments.
- The buried vegetation initially decomposed to form natural gas (CH_4) in part

7. Plants provide medicines

- Plants are a source of medicines directly
  - Quinine from plant bark prevents malaria
  - Caffeine from plants is an important daily stimulant for many humans
- Fossil fuel is also converted into a wide range of synthetic compounds including alcohol and a wide range of medicines
  - Alcohol was produced from starch early in civilization

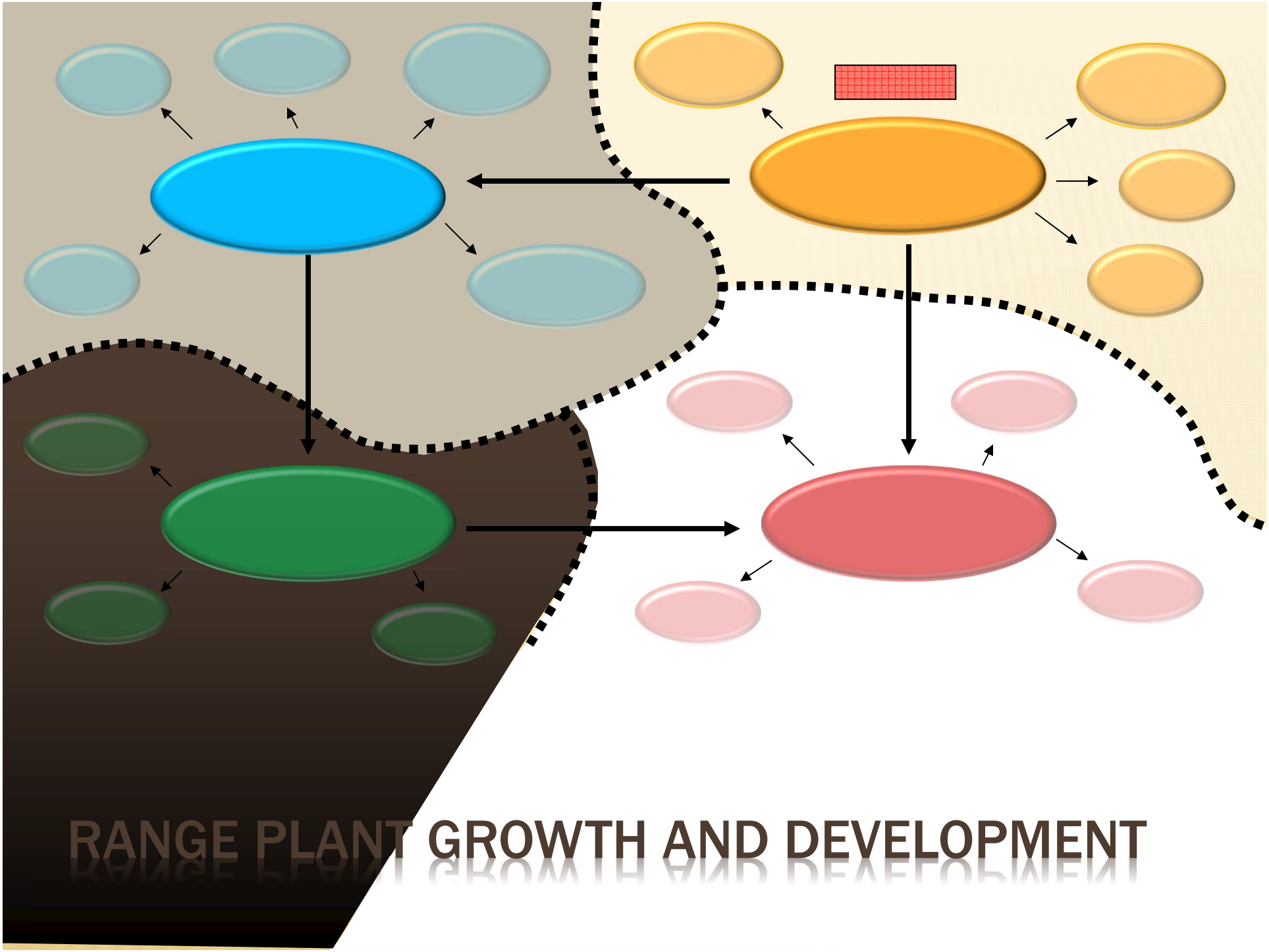
8. Plants provide latex

- Rubber trees in the tropics bleed a kind of sap when wounded that we can harvest as latex
- This natural rubber can be used for making gloves for surgery and dish washing, or washers and water-tight seals
- The latex can be combined with sulfur and formed into vulcanized rubber that makes really tough tires

9. **Plants provide essential oils**
   - Used to make our homes and bodies smell better and our food to taste better

10. **Plants provide decoration**
   - used in landscaping towns, businesses, and homes

11. **Plants provide jobs**
   - Plants have been a constant source of business and employment throughout human history



RANGE PLANT GROWTH AND DEVELOPMENT

WHAT IS PLANT ANATOMY?

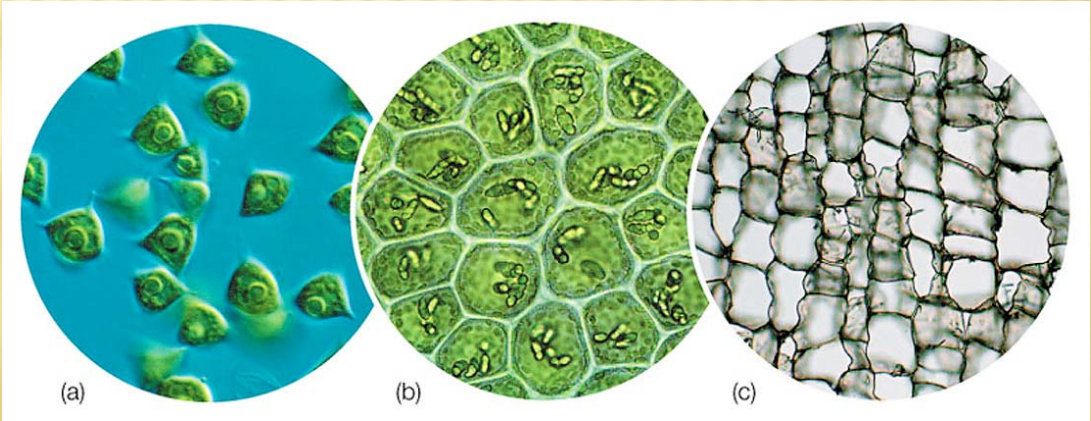
WHAT IS PLANT PHYSIOLOGY?

Always keep in mind that in plant anatomy, morphology & physiology…

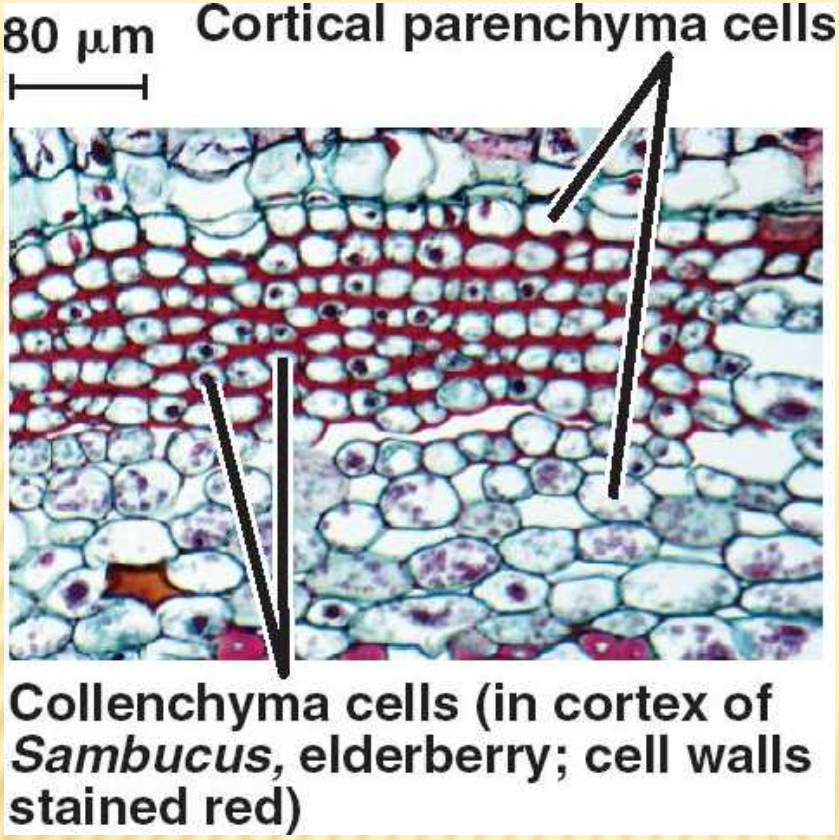
"Structure correlates to function"

PLANT ANATOMY: CELLS

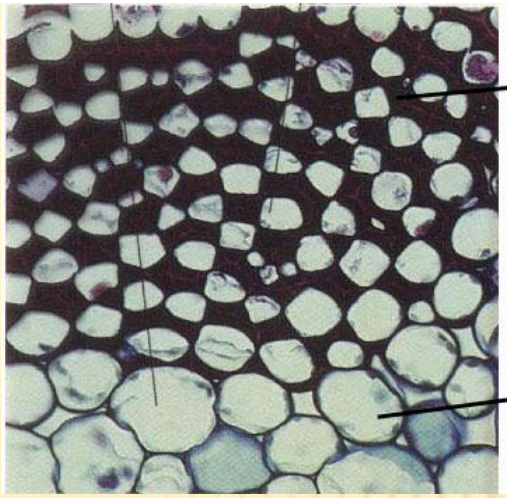
atoms > molecules > cells > **tissues** > **organs** > whole plant > pop.



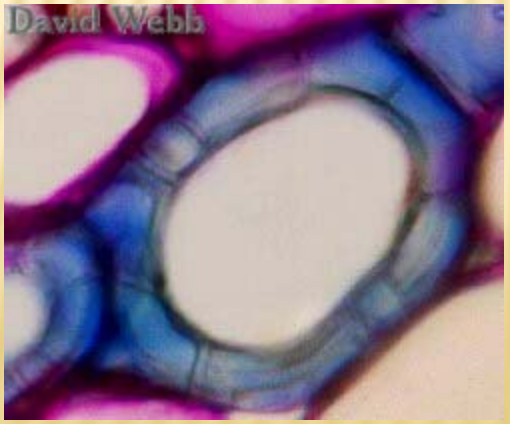
PLANT CELL TYPES

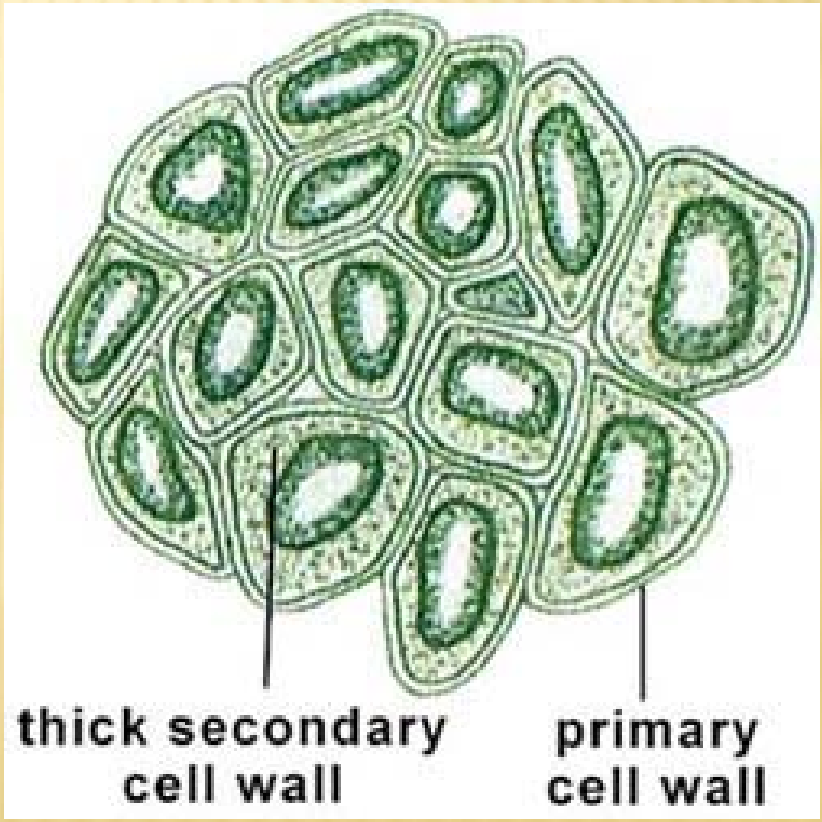


Collenchyma cells (in cortex of *Sambucus,* elderberry; cell walls stained red)



sclerenchyma





PLANT TISSUES TYPES

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1. DERMAL TISSUE

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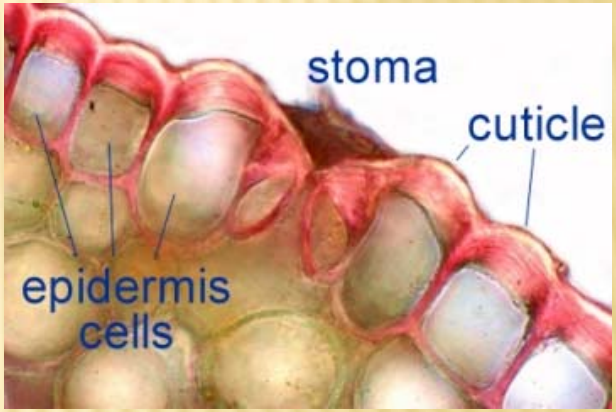
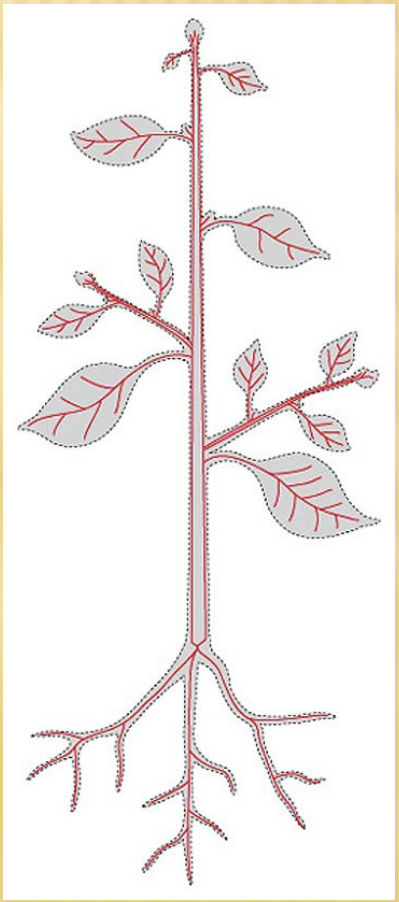


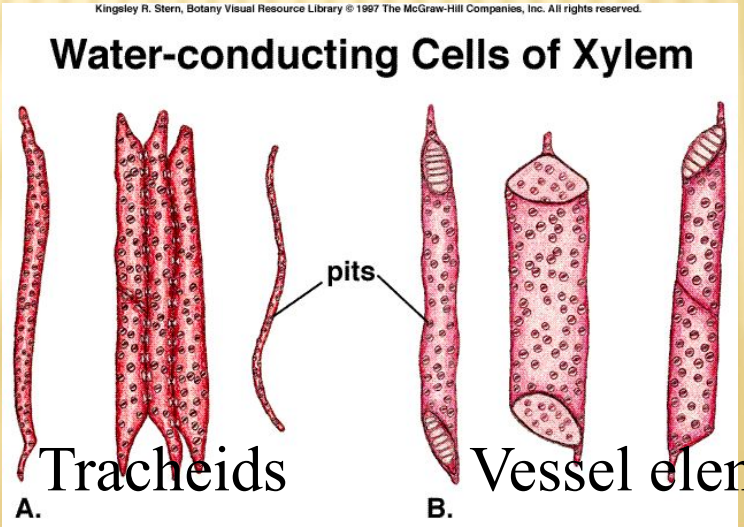
2. VASCULAR TISSUE

- _____ _____ ↑

- **Phloem** – carries dissolved sugars ↘ from leaves to rest of the plant ↓



XYLEM



Tracheids Vessel elements

XYLEM CELLS

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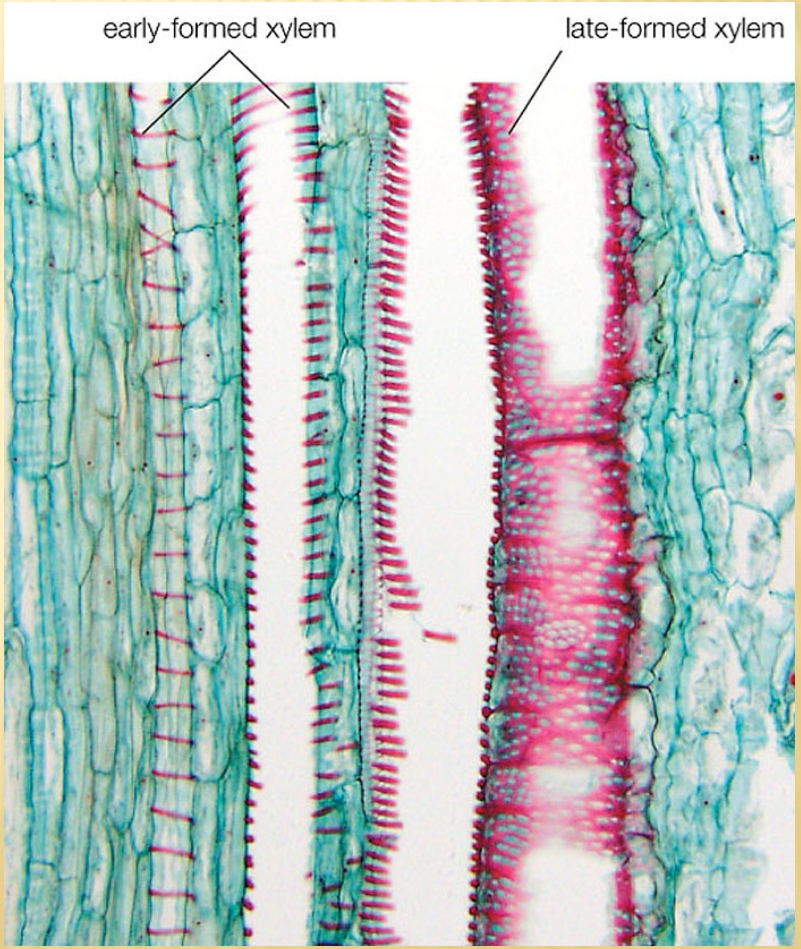
-



PHLOEM

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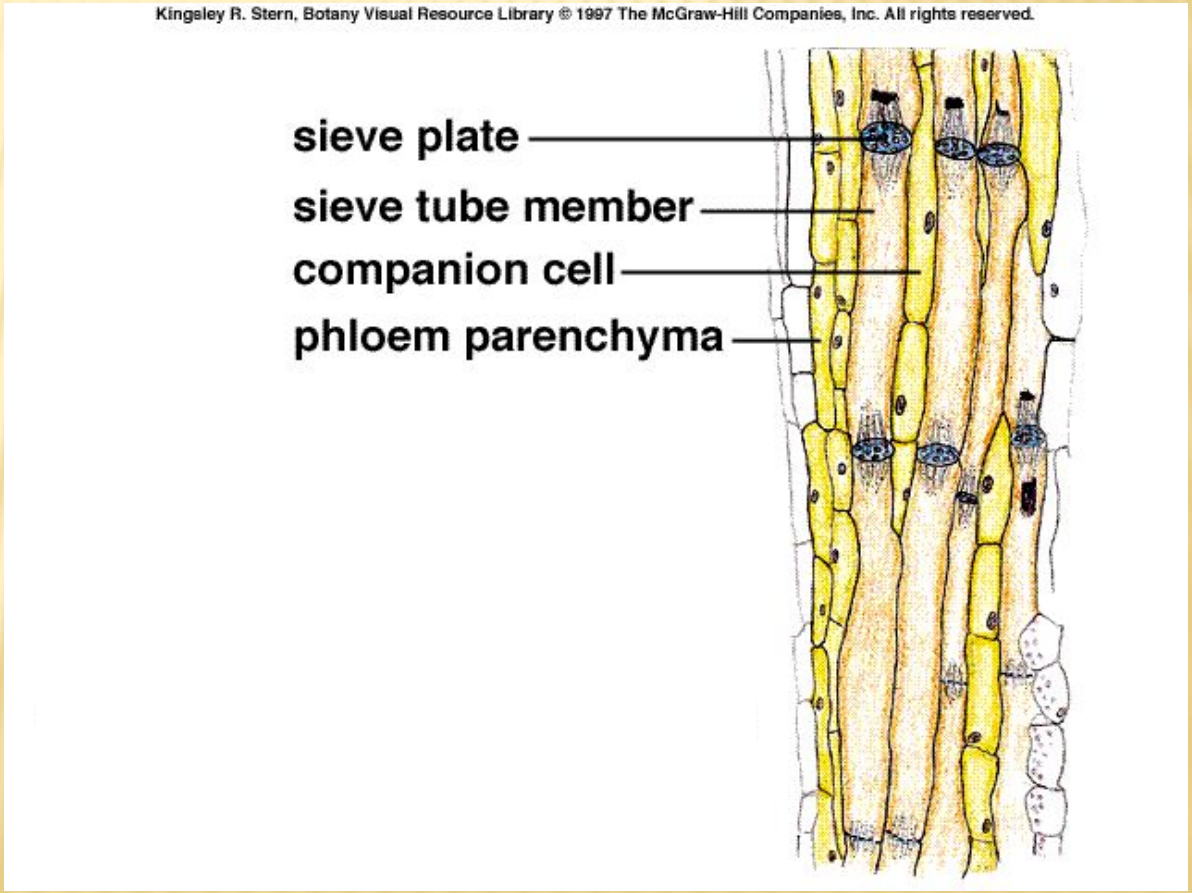
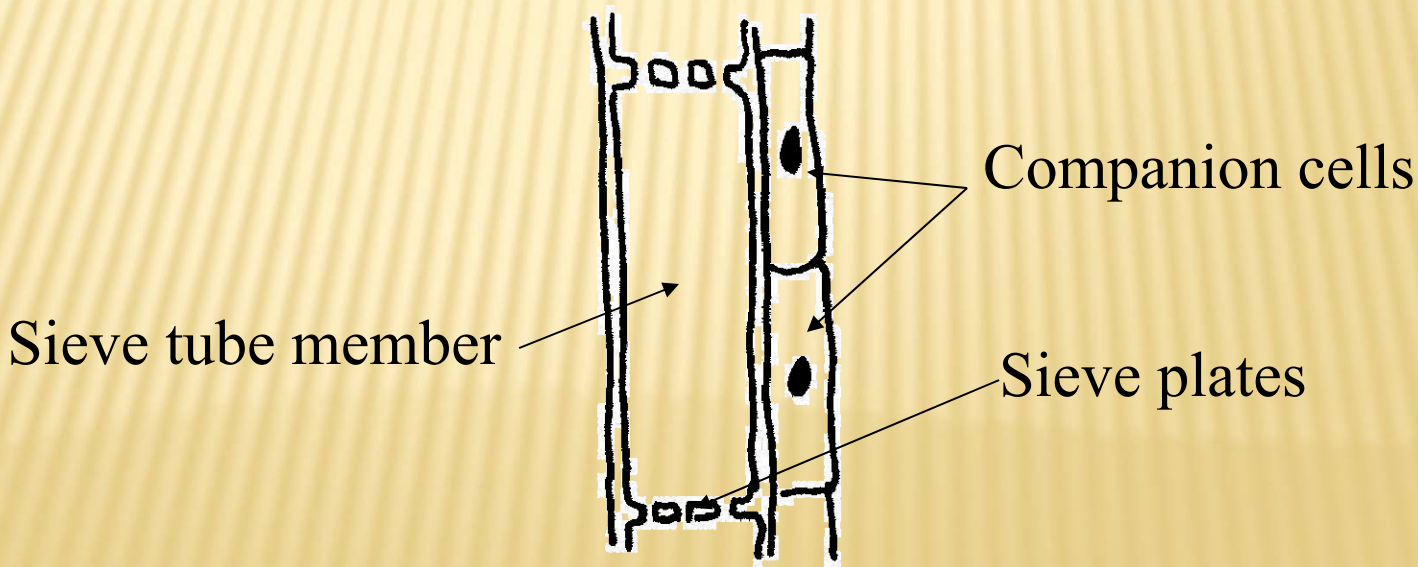
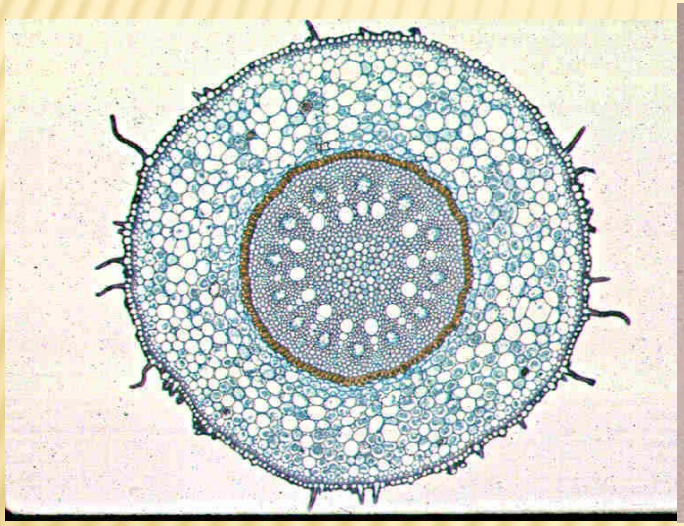


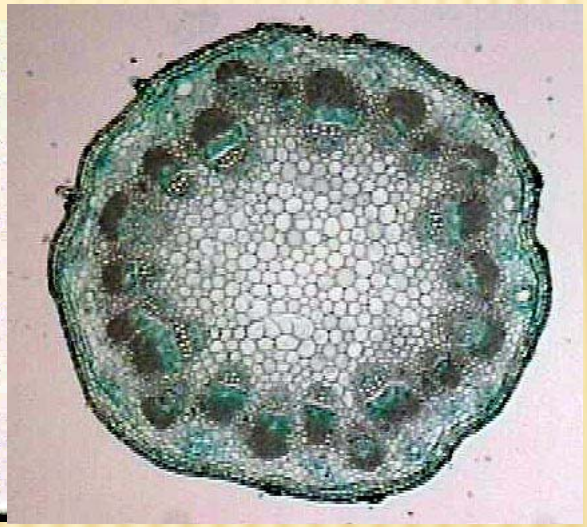
PHLOEM: TRANSPORTS SUGARS



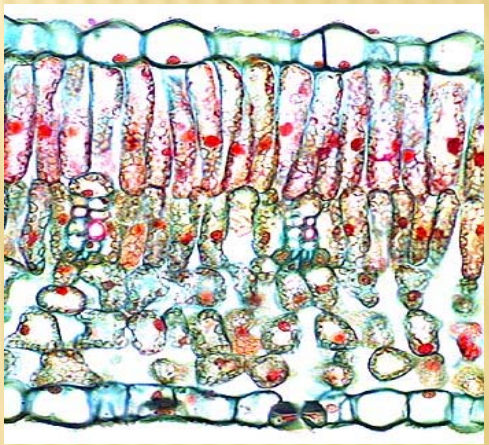
3. GROUND TISSUE



Root



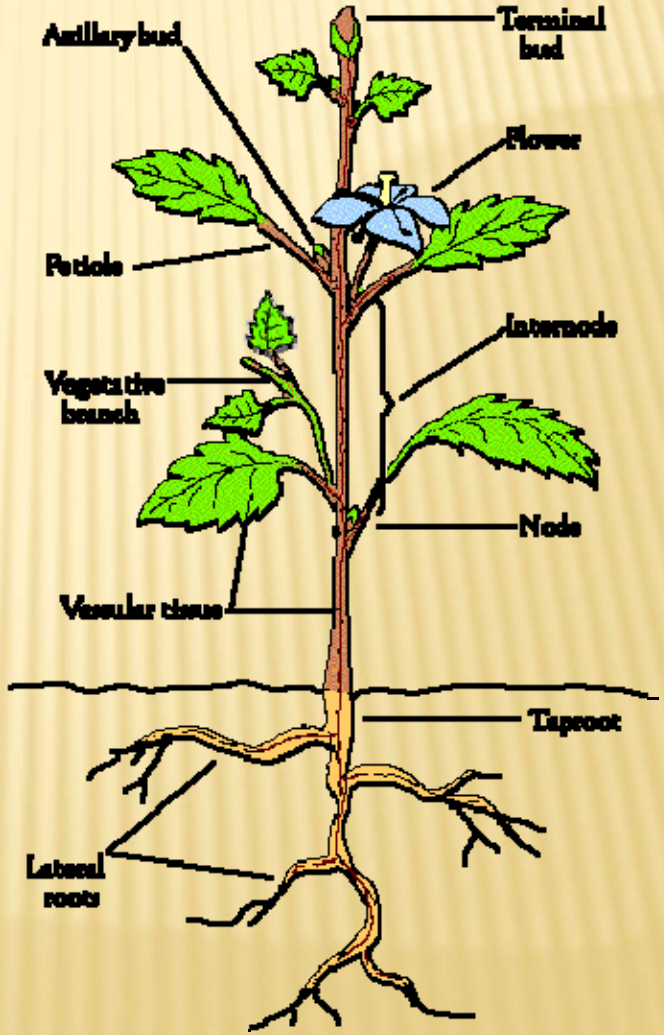
Stem



Leaf

PLANT ORGANS

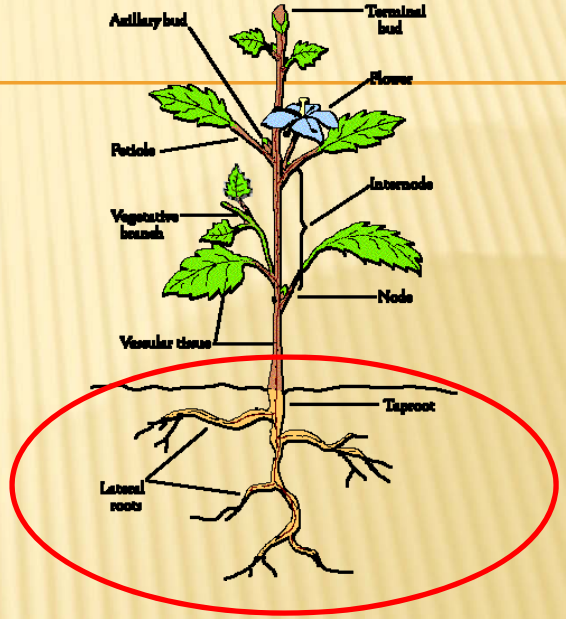
- Dermal
  Vascular
  Ground
- Dermal
  Vascular
  Ground
- Dermal
  Vascular
  Ground



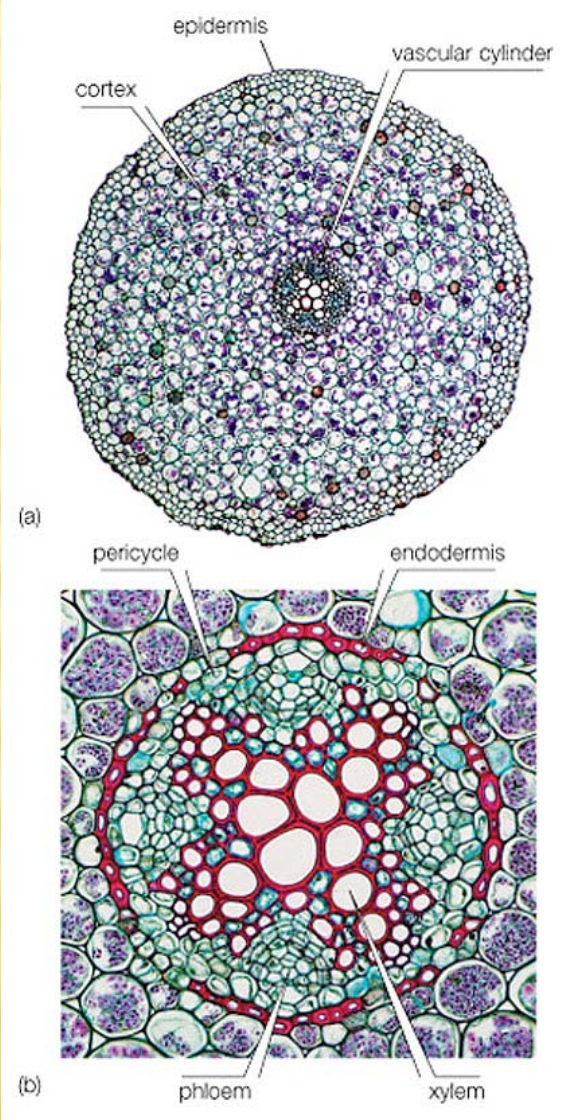
FUNCTIONS OF PLANT ORGANS:

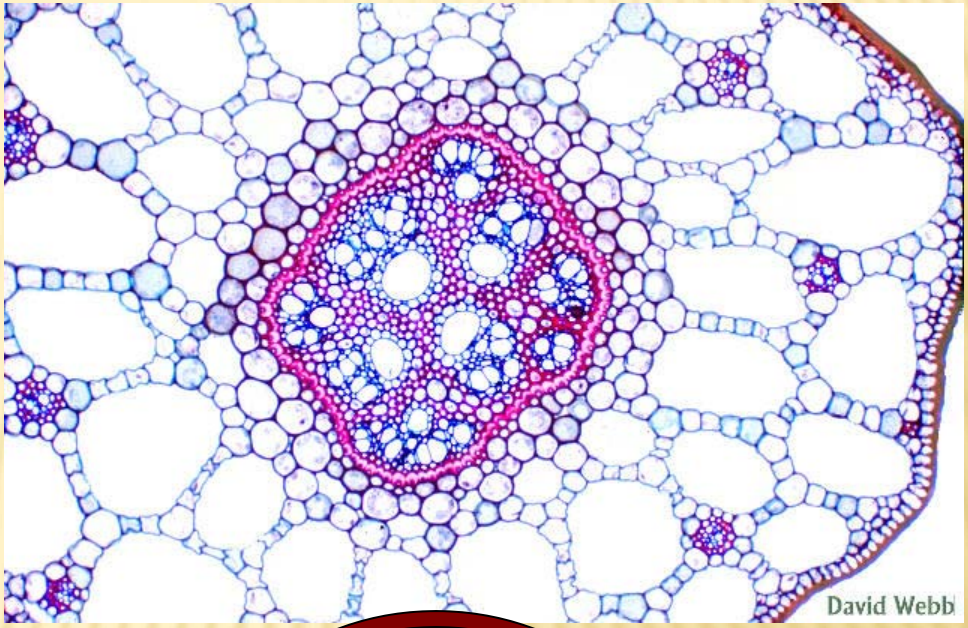
- _____
- _____
- _____

ROOTS

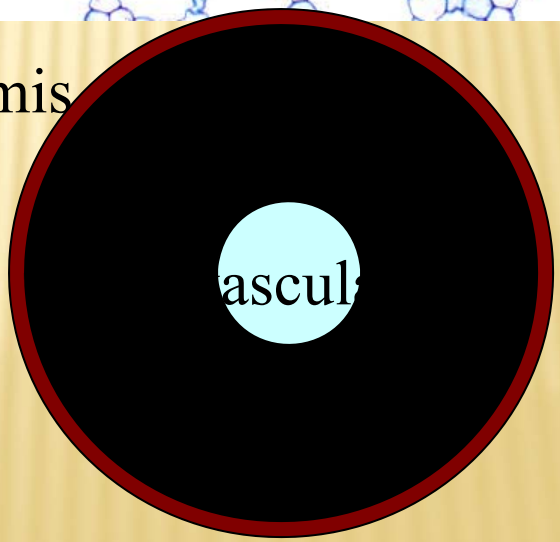

Axillary bud
Terminal bud
Flower
Petiole
Internode
Vegetative branch
Node
Vascular tissue
Taproot
Lateral roots

ANATOMY OF A ROOT

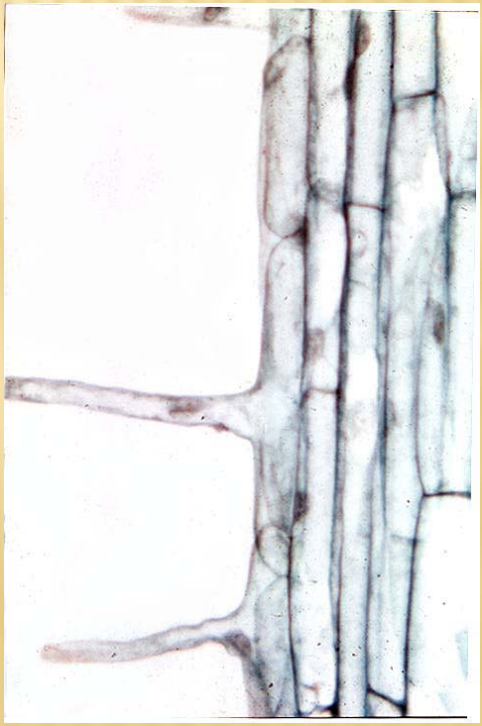




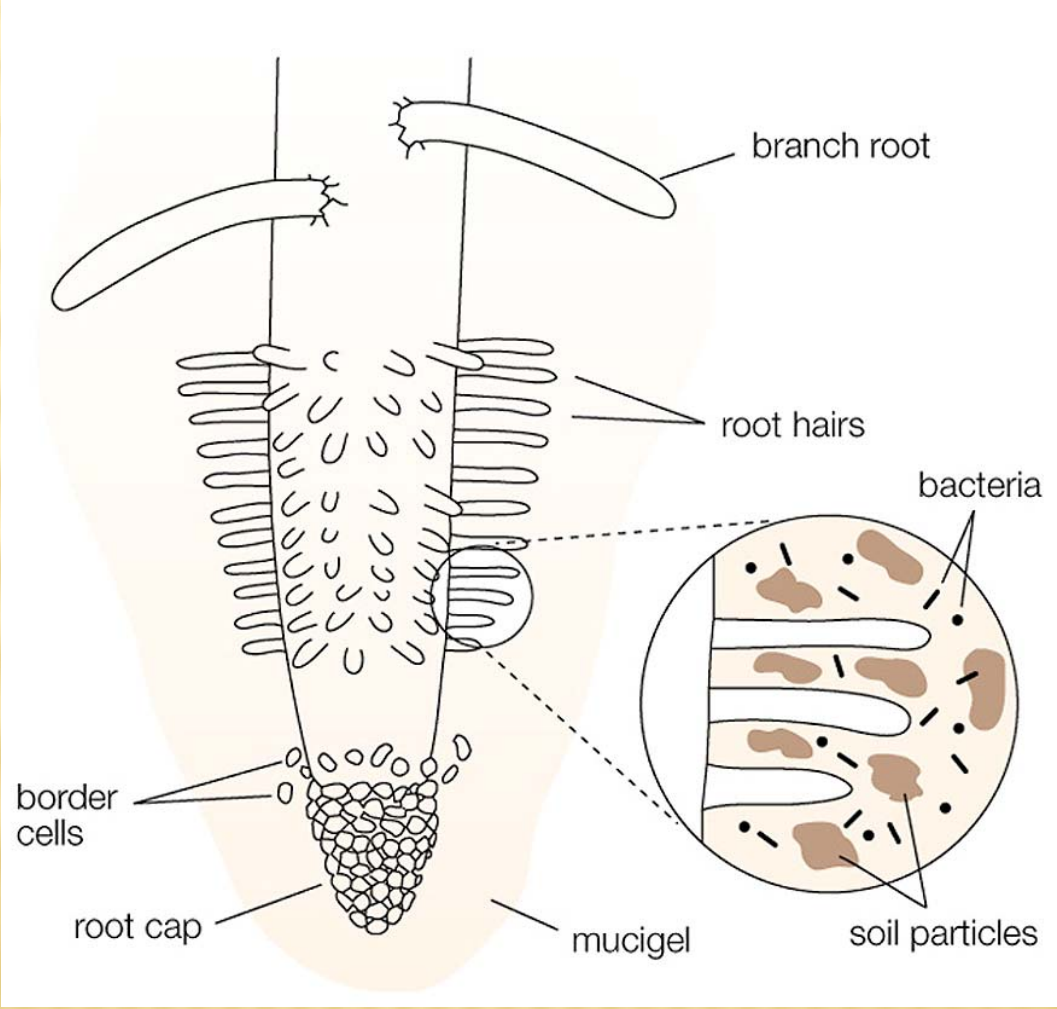
epidermis



ROOT EPIDERMIS



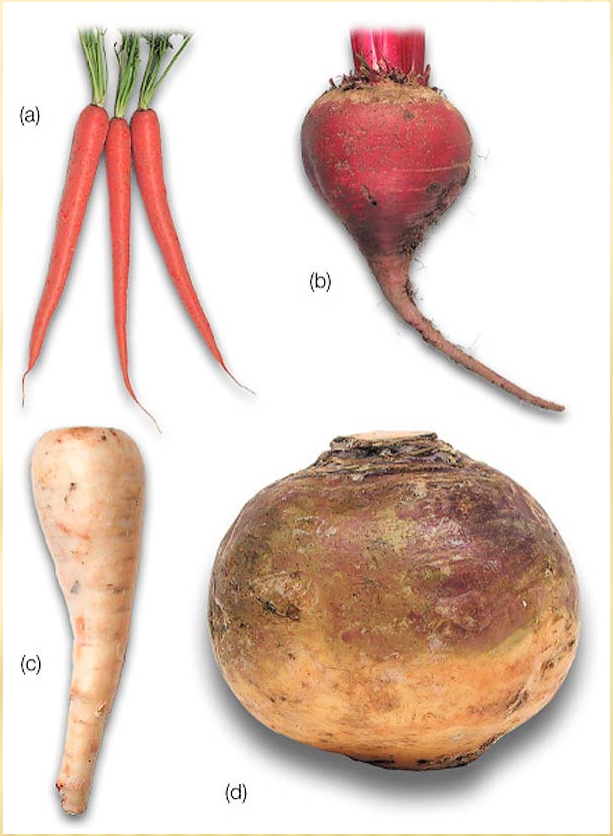
ROOT HAIRS: WATER AND MINERAL ABSORPTION



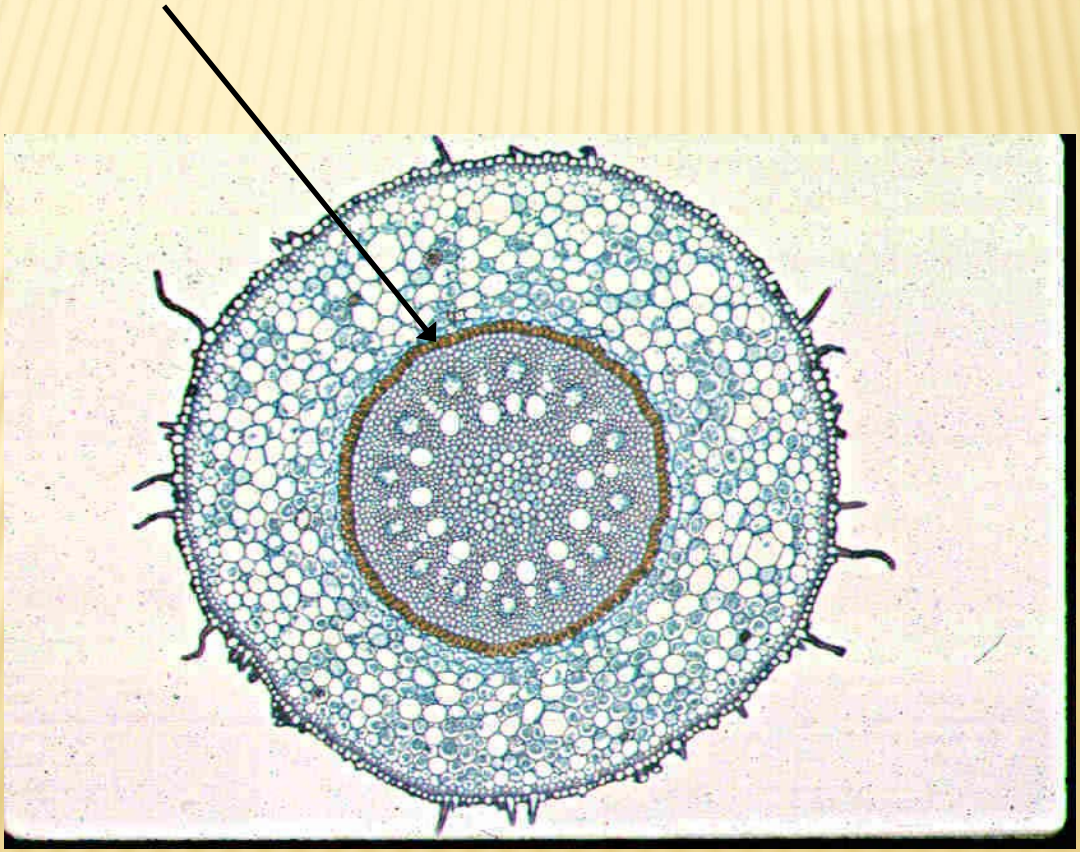

Root tip - cap & apical meristem

Root hairs increase surface area for better absorption

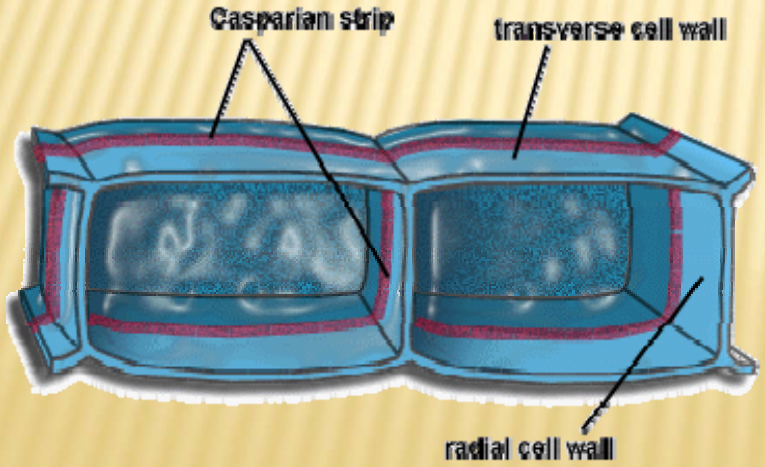
ROOT CORTEX

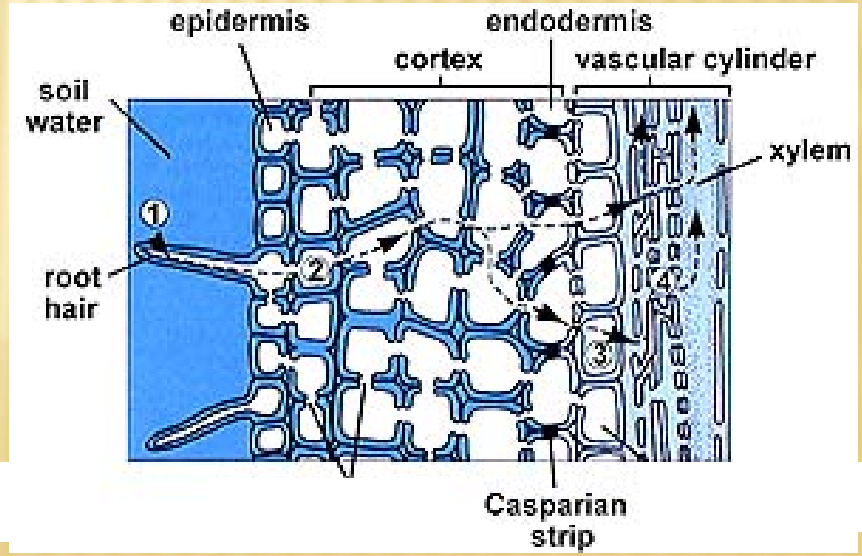


ROOT CORTEX: ENDODERMIS

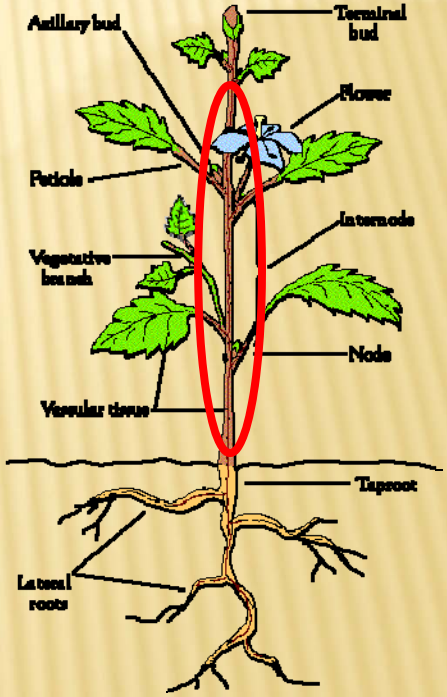


ROOT CORTEX: CASPARIAN STRIP

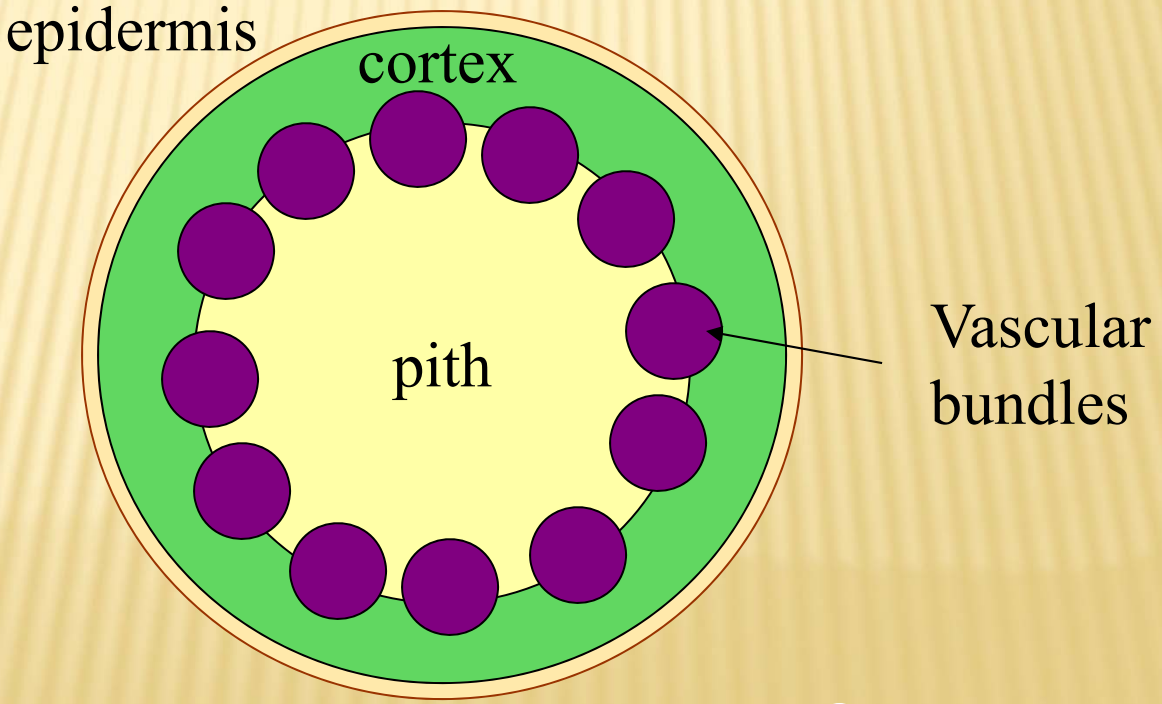




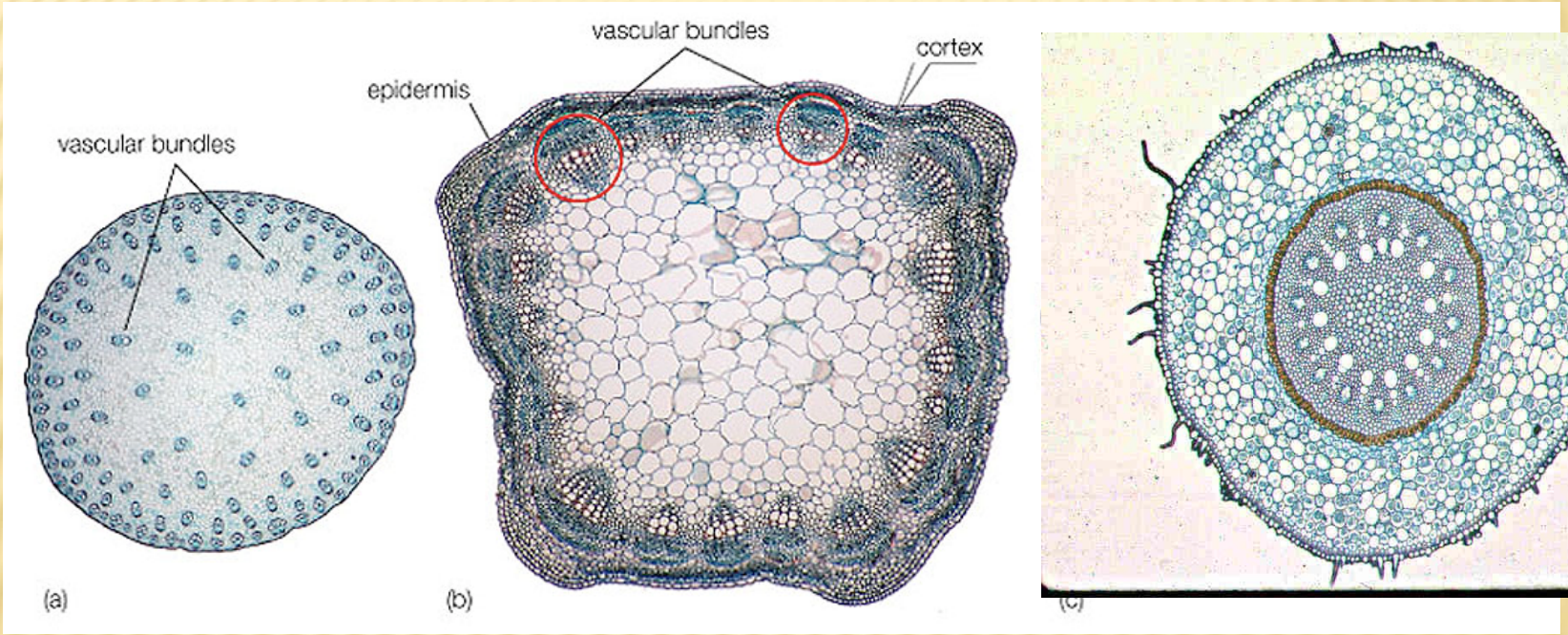
STEMS


Axillary bud
Terminal bud
Flower
Petiole
Internode
Vegetative branch
Node
Vascular tissue
Taproot
Lateral roots

STEM ANATOMY



TYPES OF STEMS



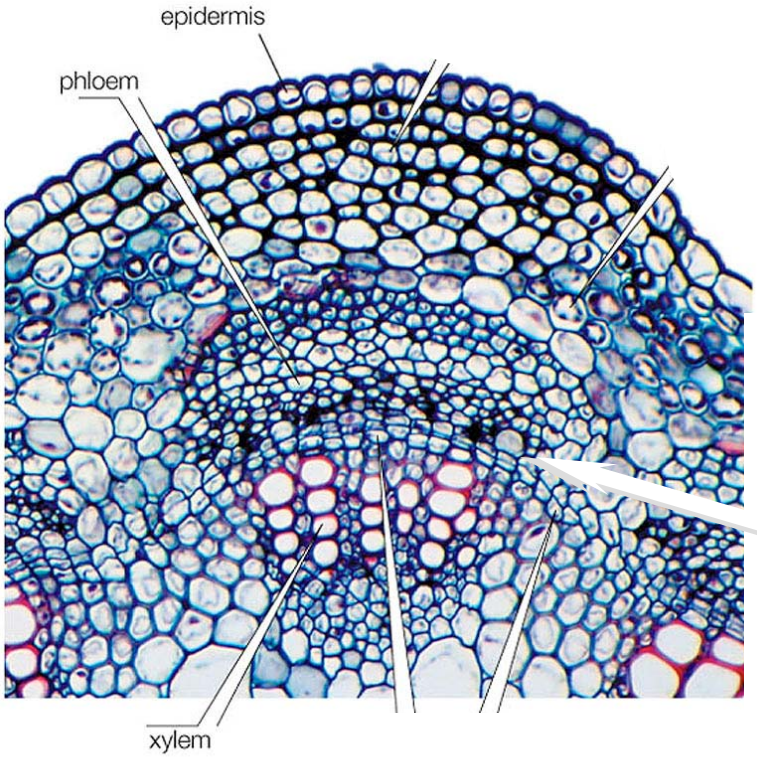
Monocot stem Dicot stem Root

TYPES OF STEMS

- yv1

TISSUES OF STEMS

STEM VASCULAR TISSUE



VASCULAR CAMBIUM

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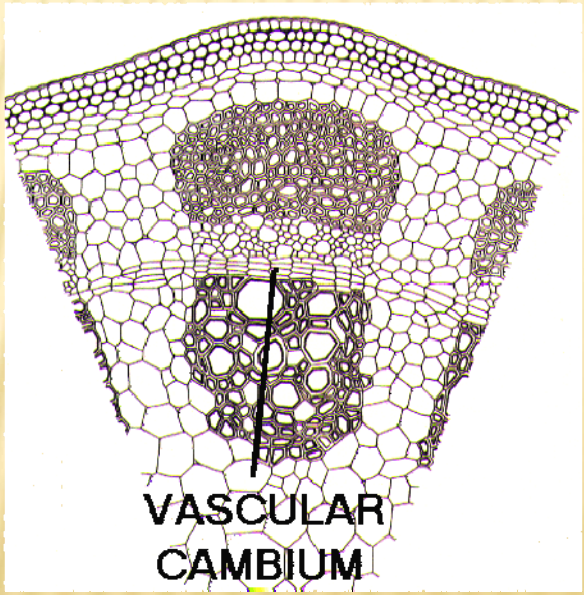
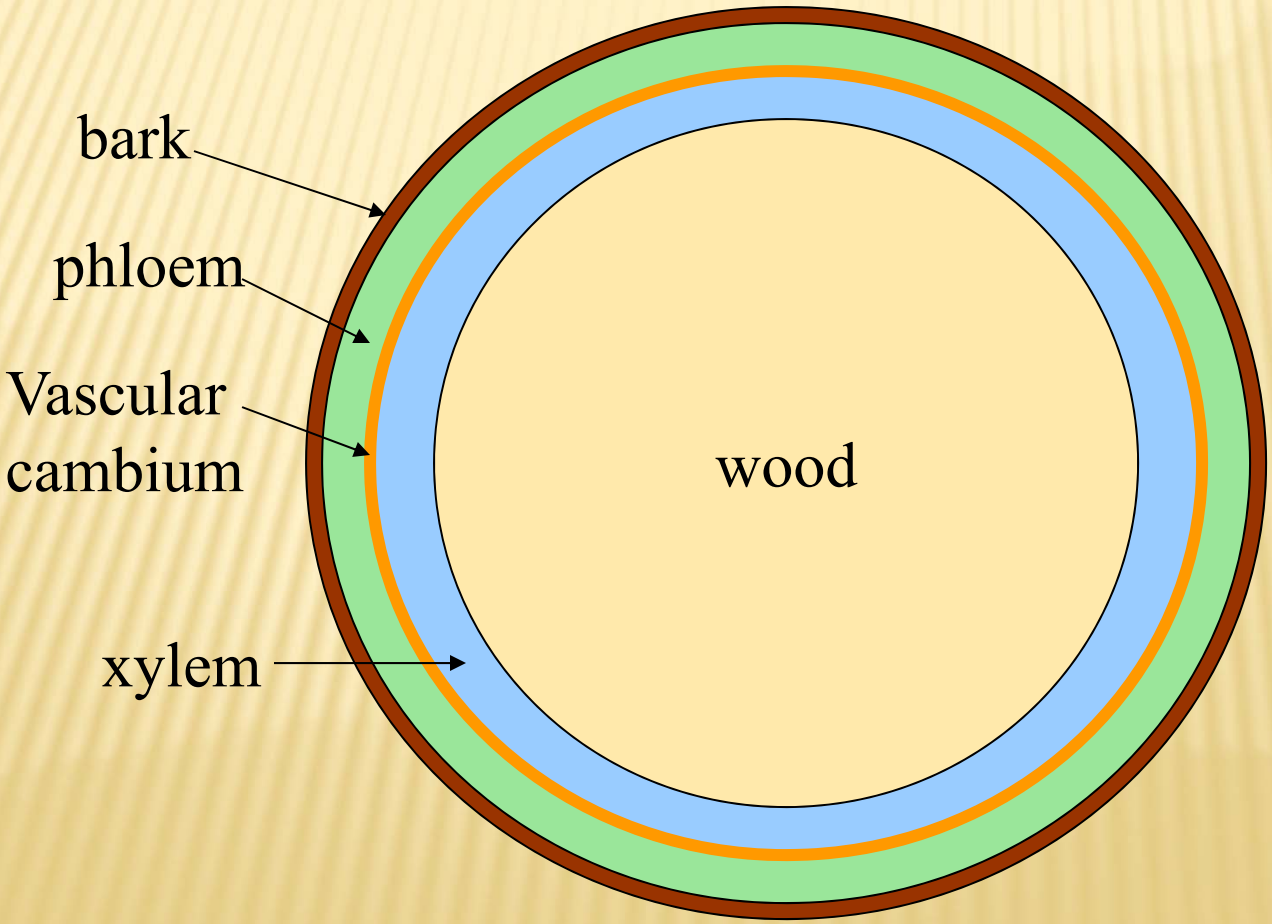
- _____

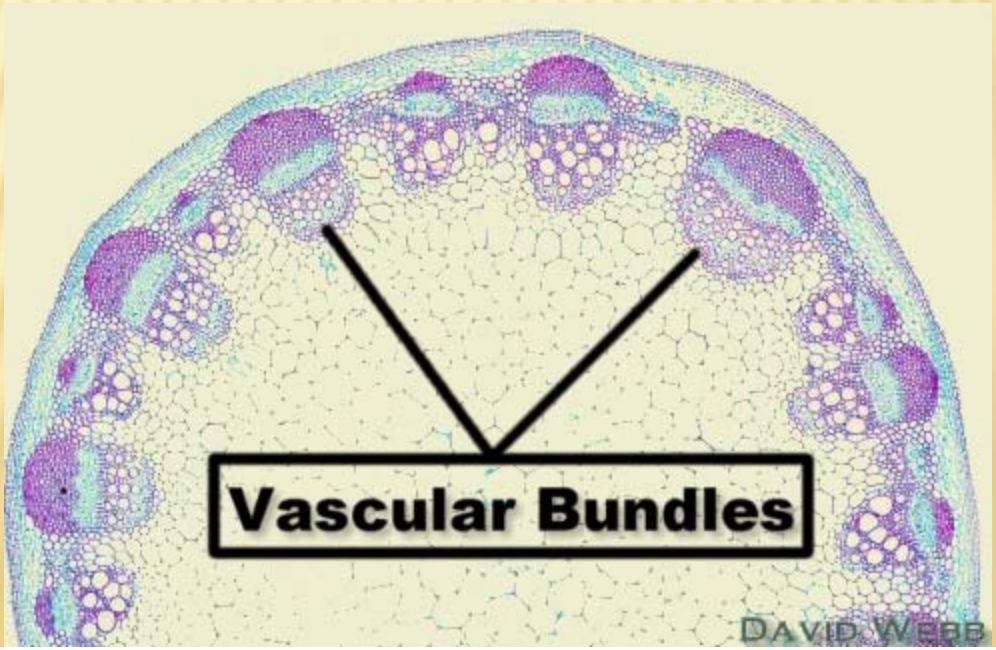


VASCULAR TISSUE: TREES



GIRDLING: CUTTING AROUND A TREE

LATERAL GROWTH



LATERAL GROWTH

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LATERAL GROWTH CONTINUED

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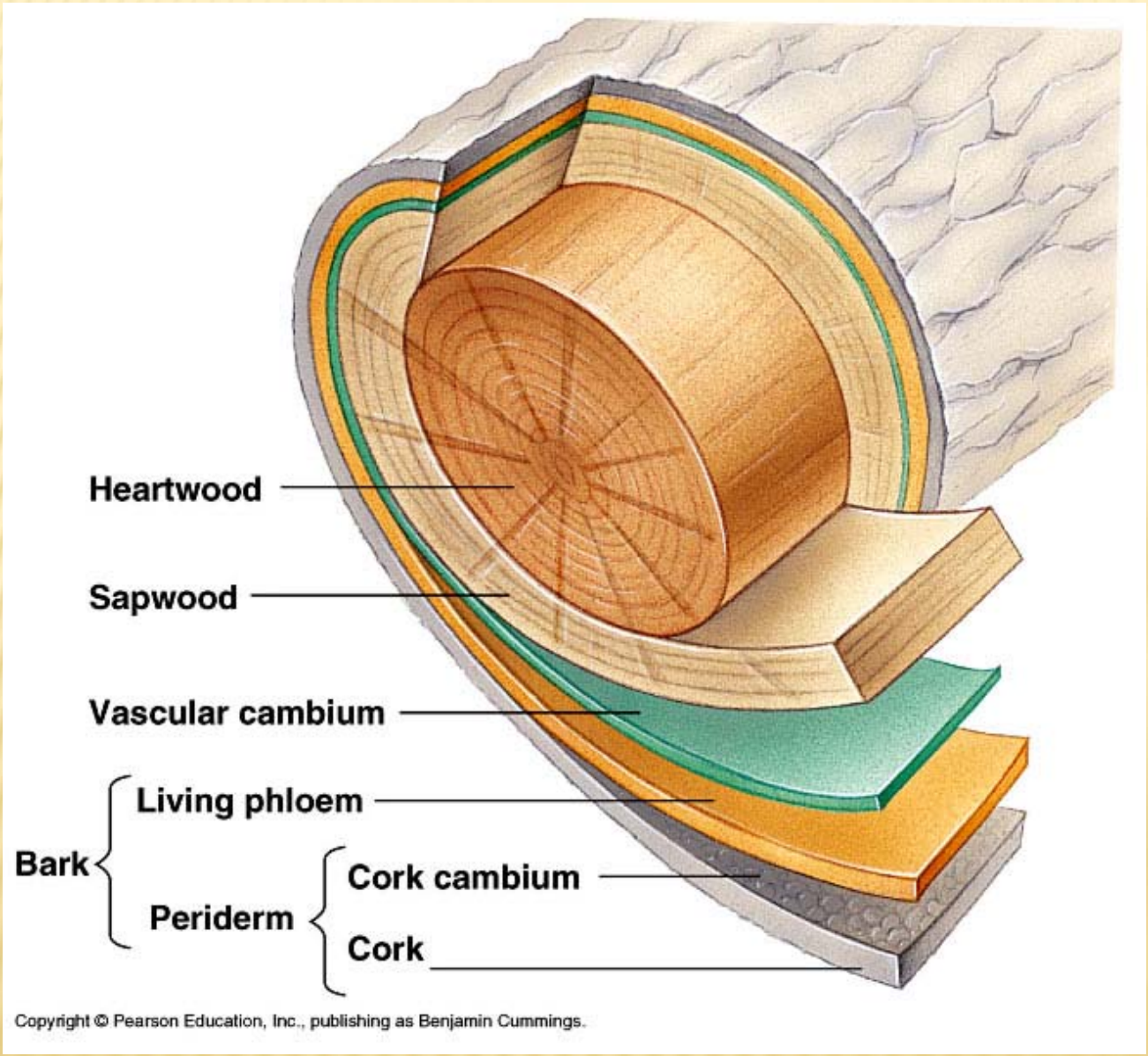
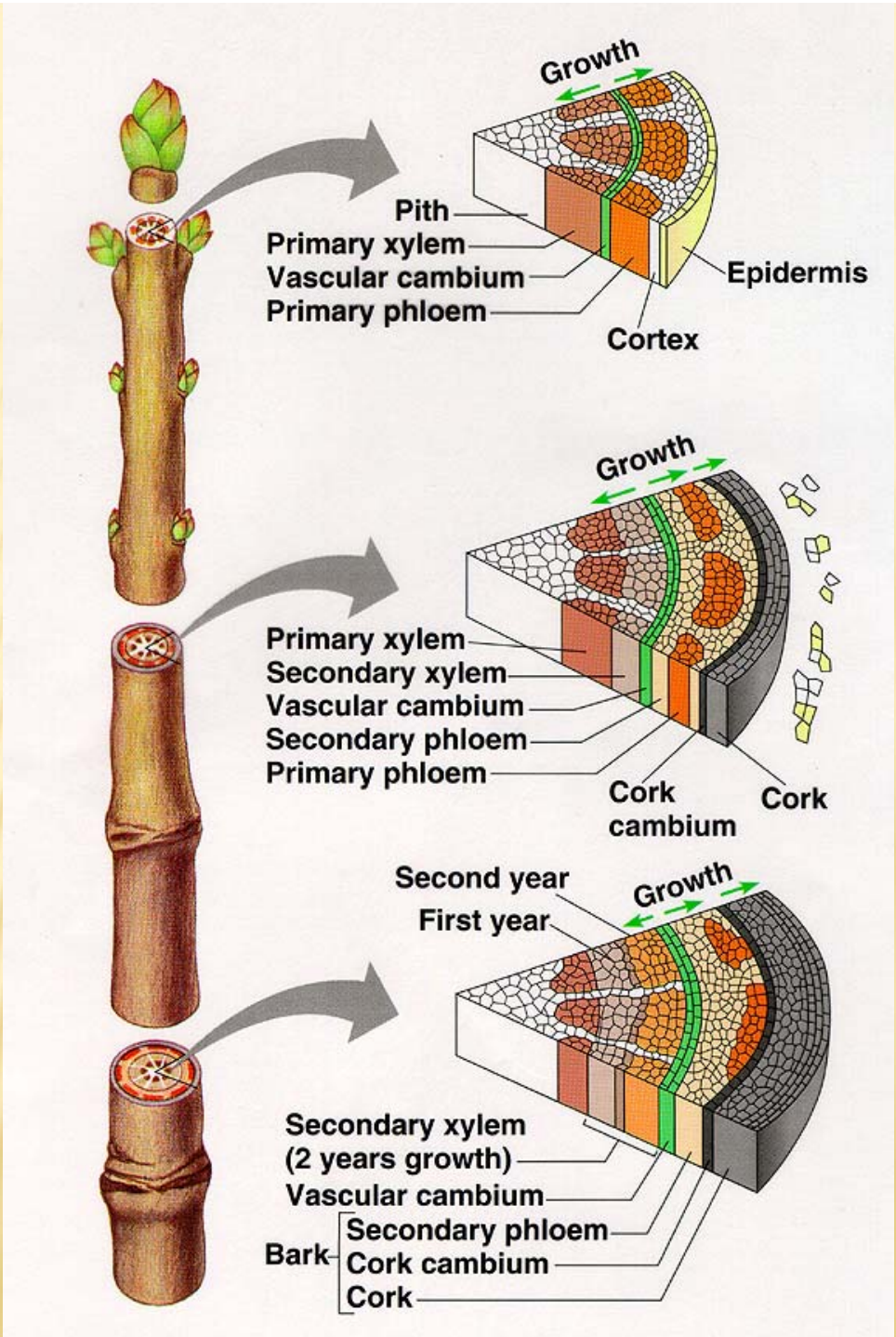


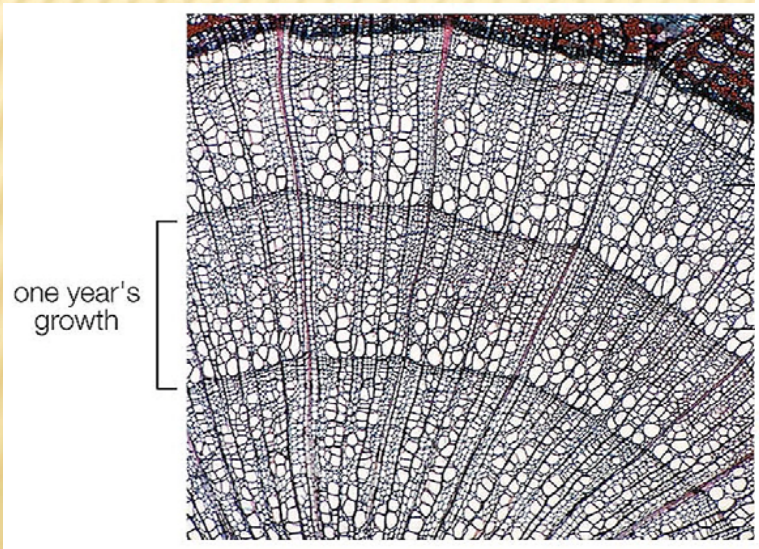
Heartwood = dead, older xylem

Sapwood = new xylem still carrying water

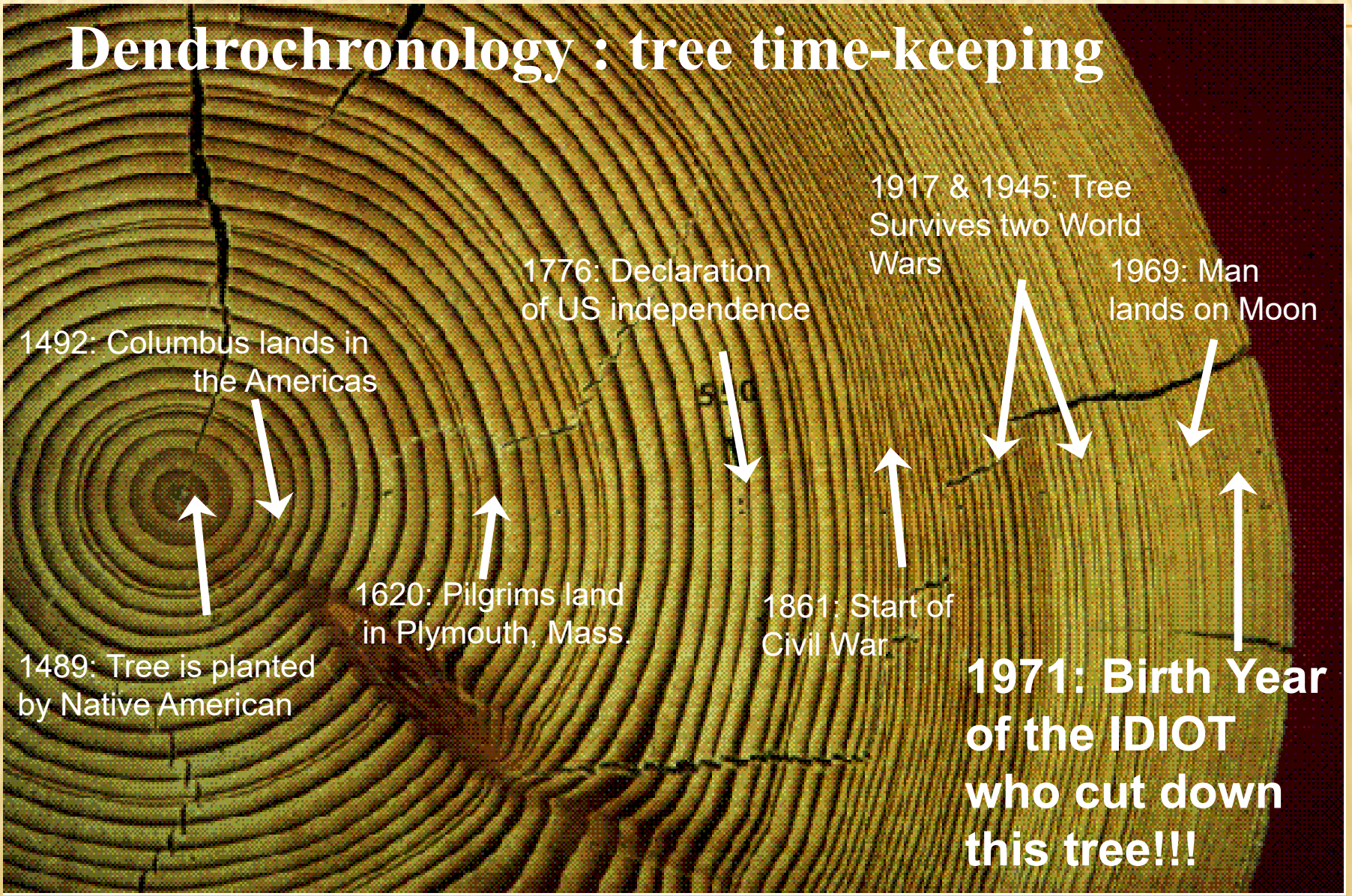
Phloem – carries food - old phloem sloughs


Growth
Pith
Primary xylem
Vascular cambium
Primary phloem
Epidermis
Cortex
Growth
Primary xylem
Secondary xylem
Vascular cambium
Secondary phloem
Primary phloem
Cork cambium
Cork
Second year
First year
Growth
Secondary xylem
(2 years growth)
Vascular cambium
Bark
Secondary phloem
Cork cambium
Cork

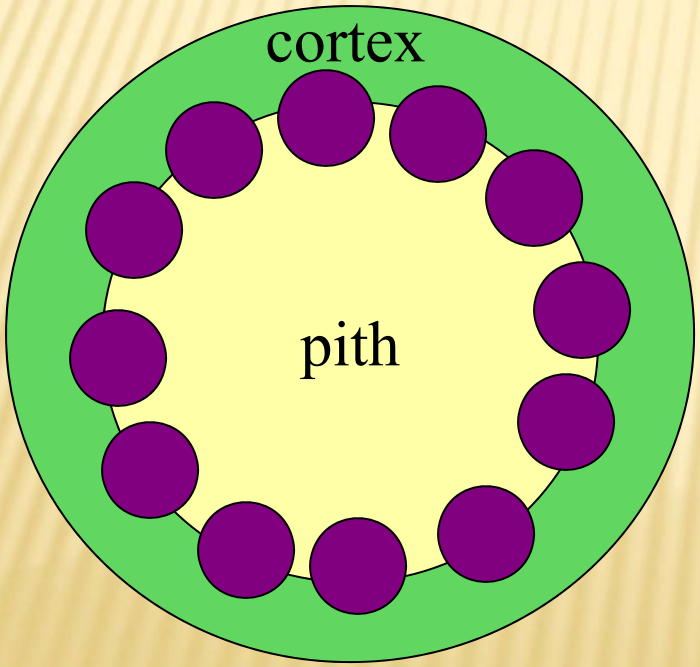
VASCULAR TISSUE FORMS RINGS IN TREES

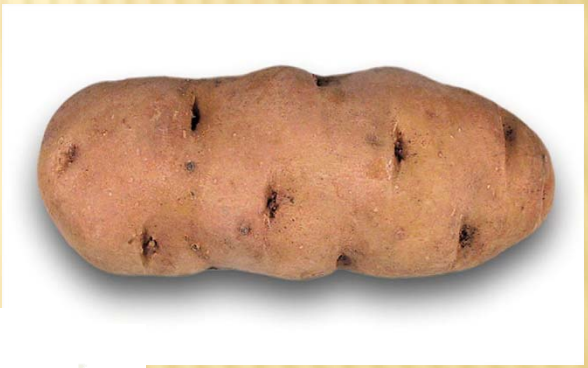


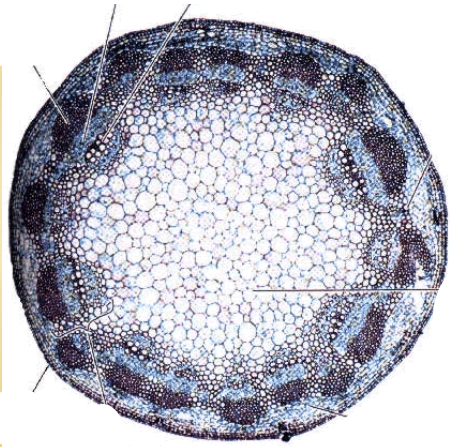
HISTORY OF THE TREE: ANNUAL RINGS



GROUND TISSUE: CORTEX & PITH







LEAVES:

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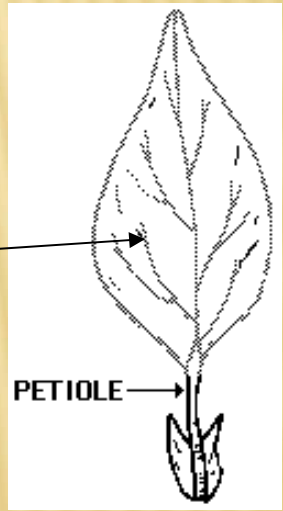
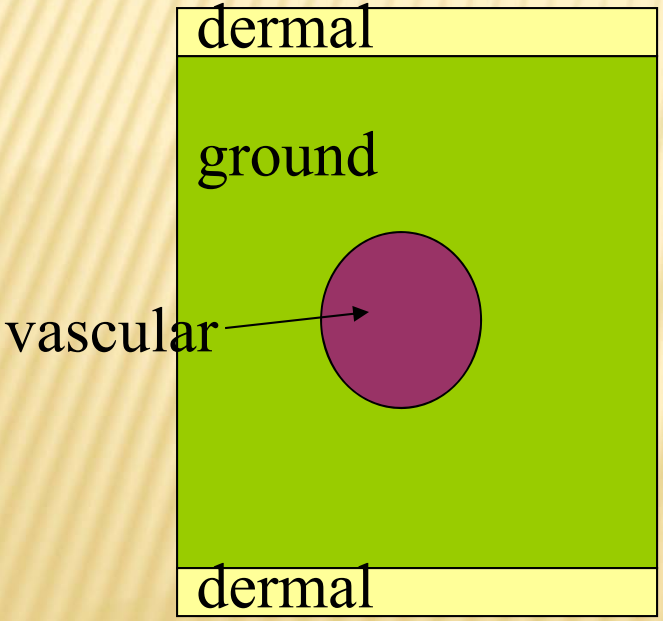


LEAF ANATOMY



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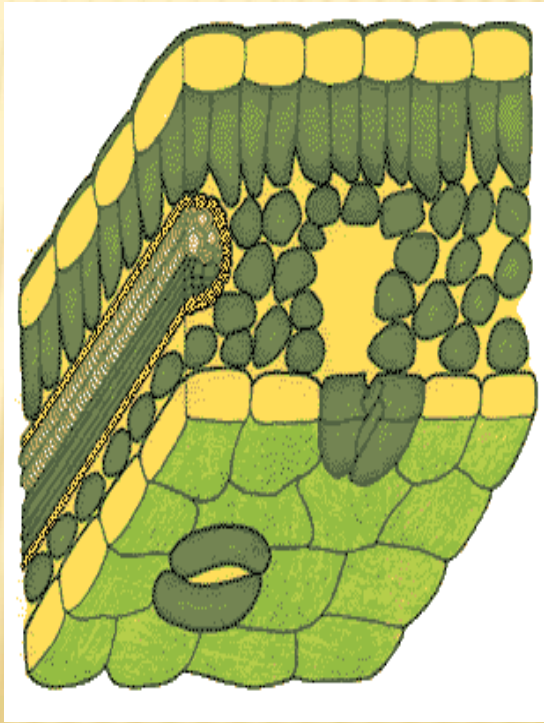
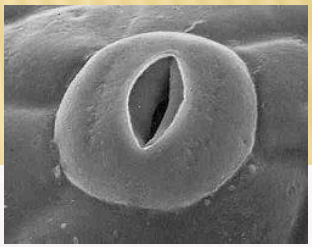
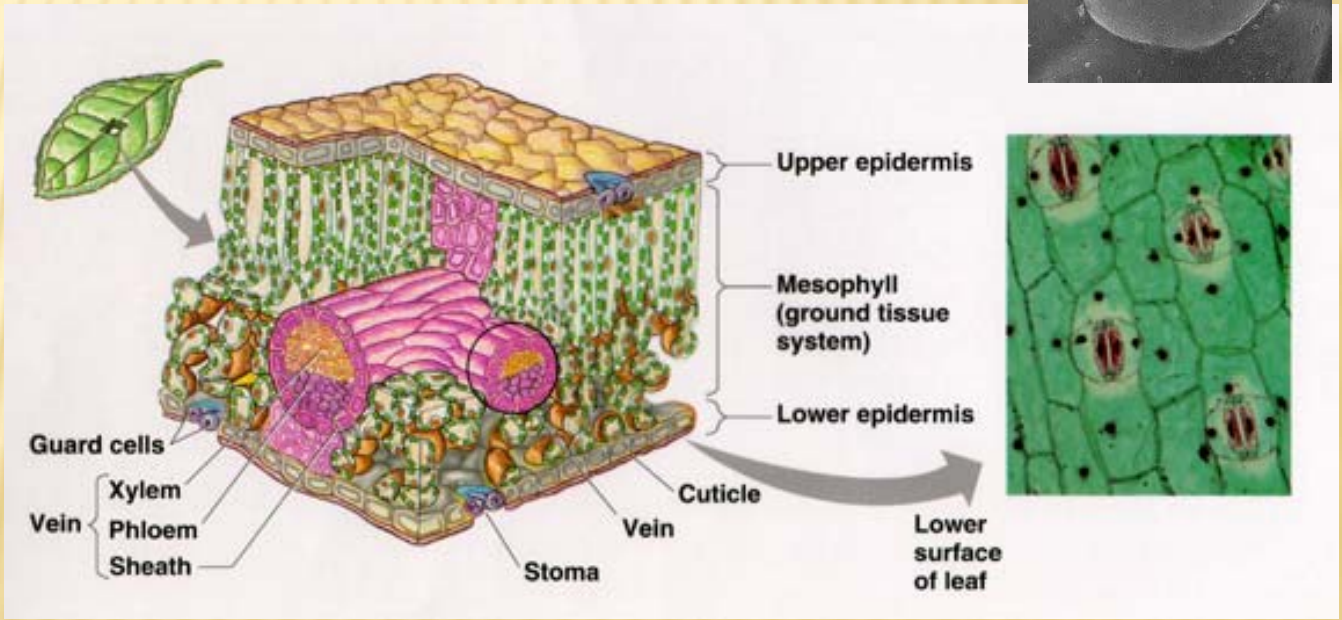


LEAF EPIDERMIS





LEAF EPIDERMIS

("Panda plant")