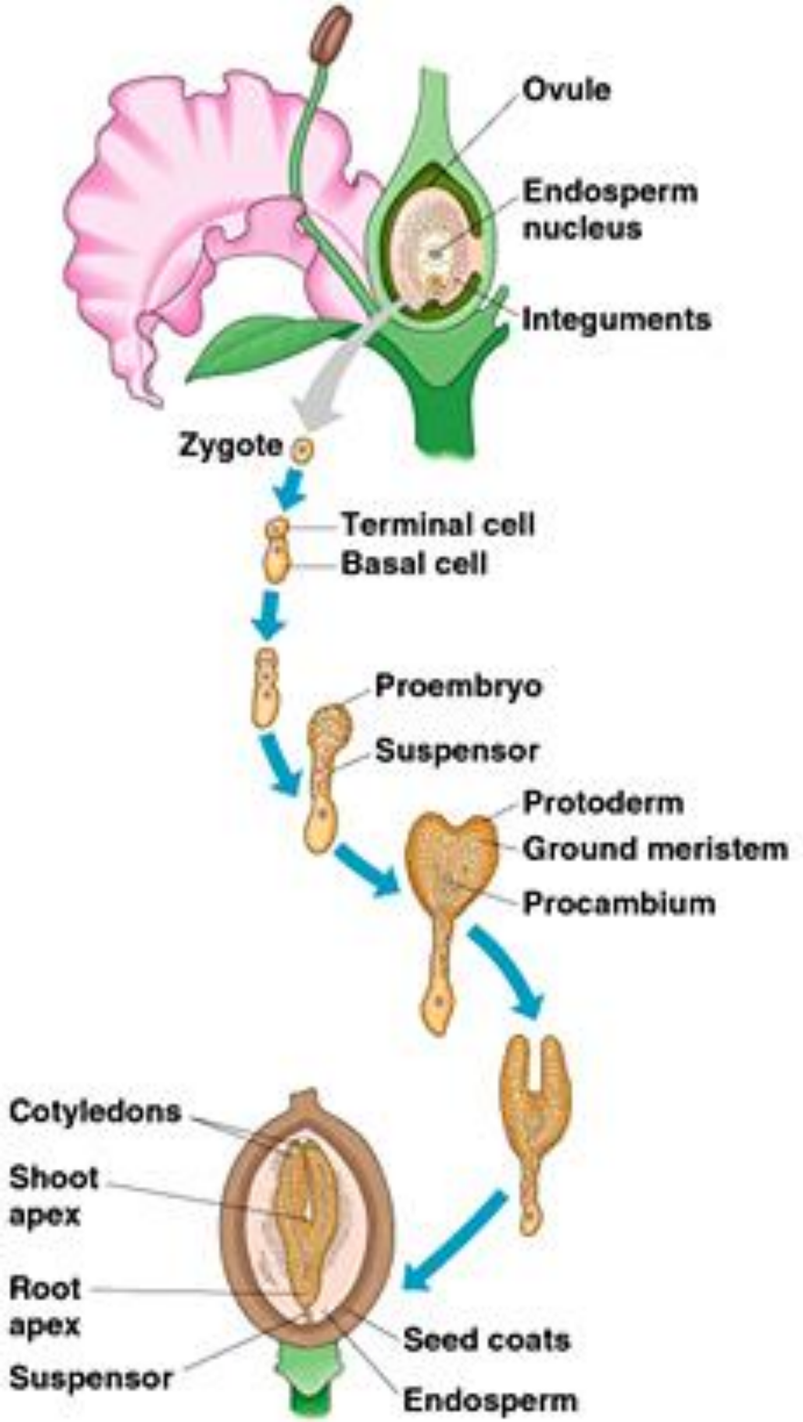
Fruits, seeds and germination

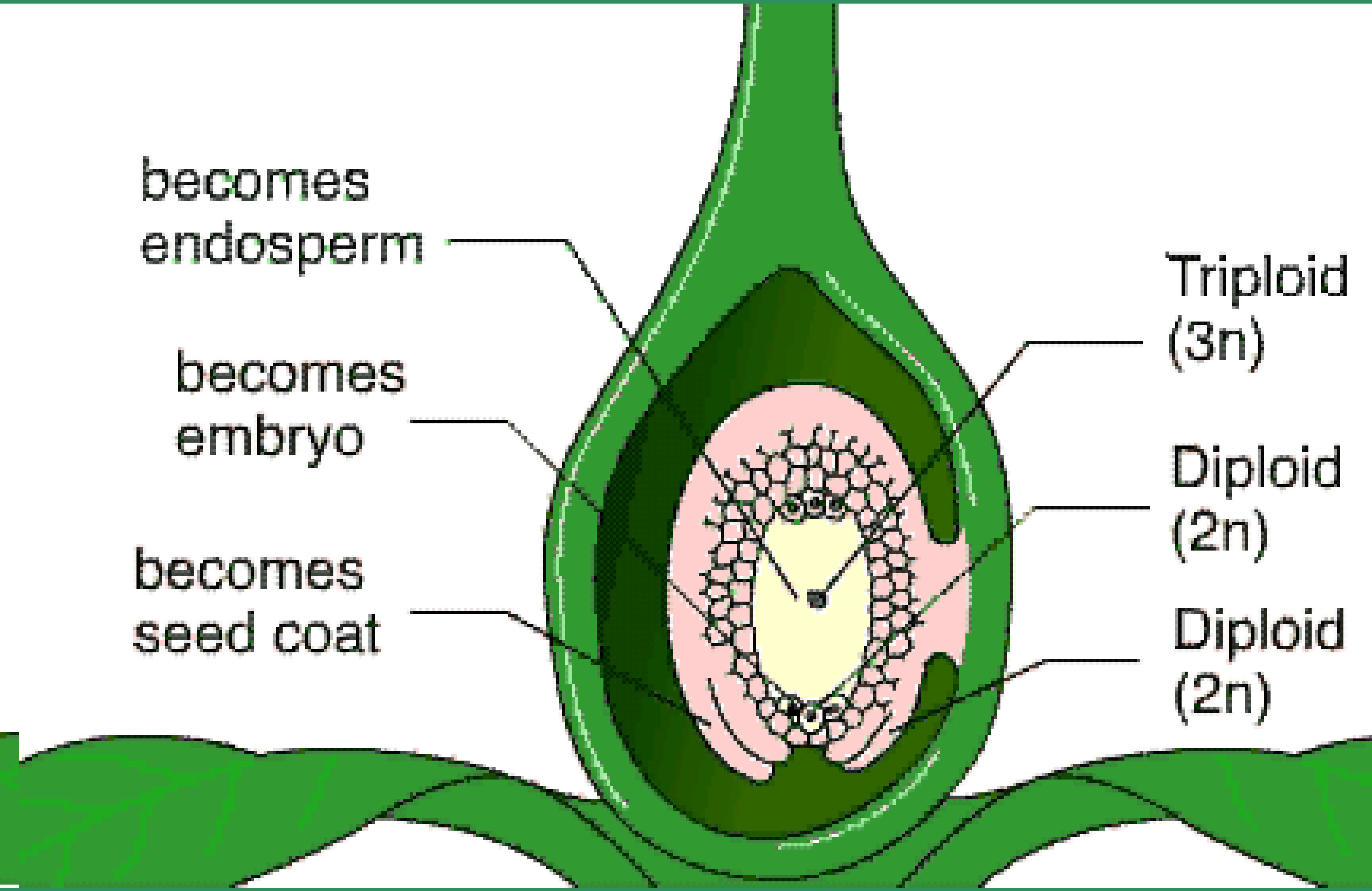
Dr. Haitham Kurbaj

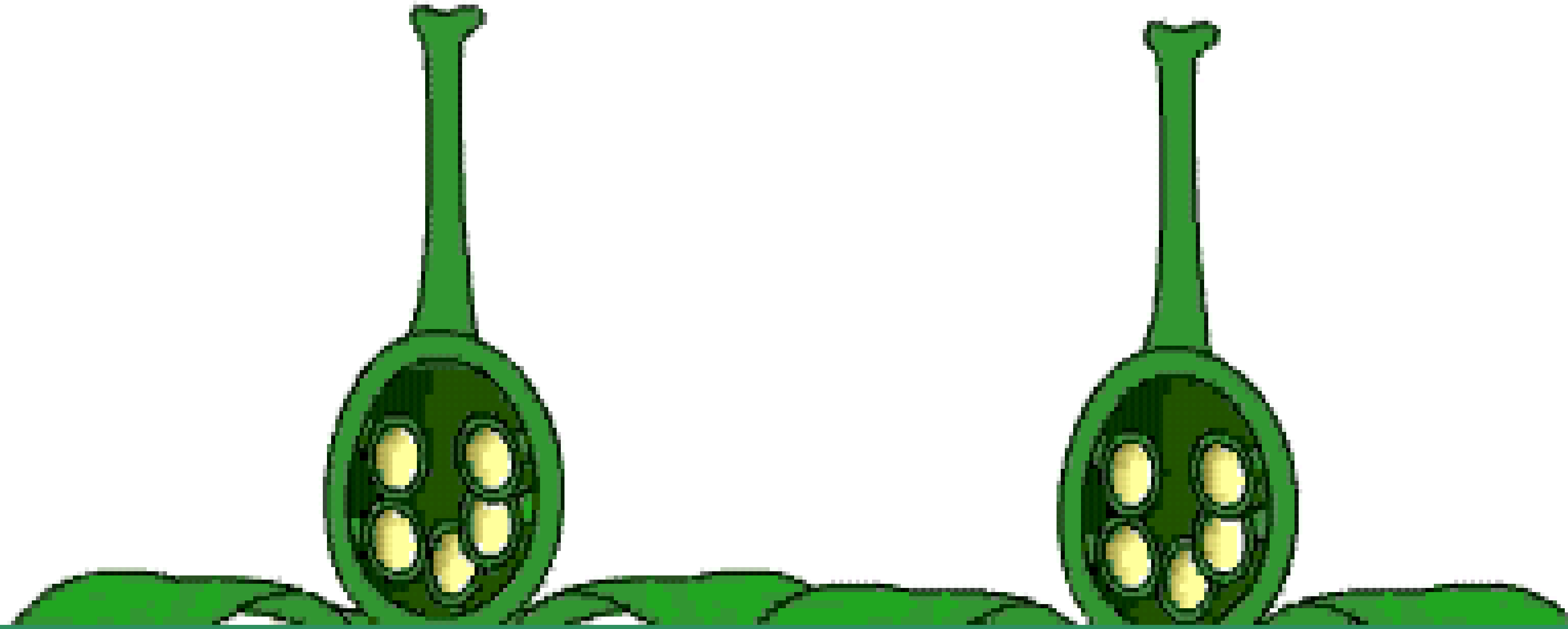


The triploid central cell of the ovule develops into a nutrient-rich, multicellular mass called the endosperm

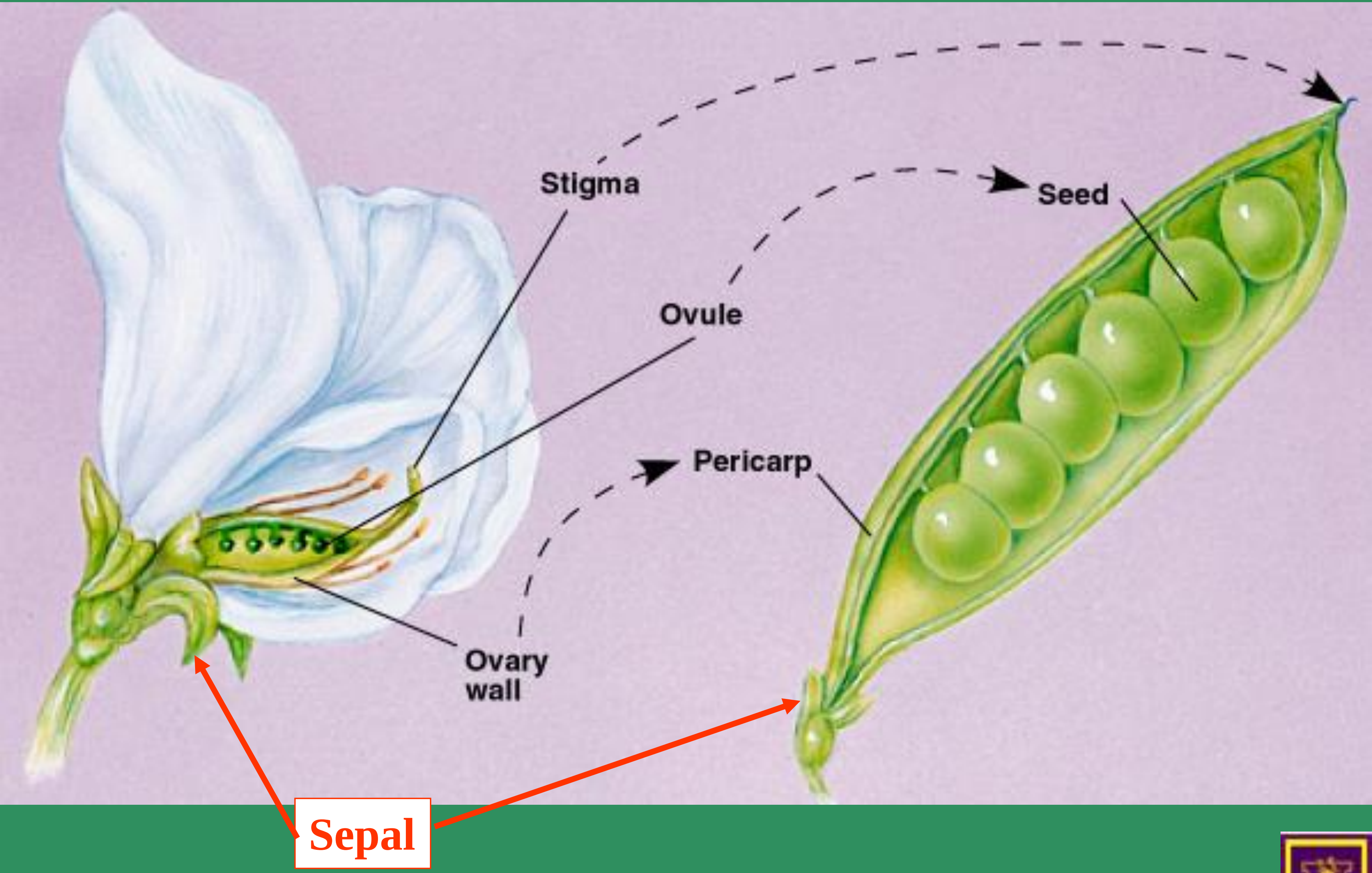
Embryonic development begins when the zygote divides into two cells

The seed becomes dormant when the cotyledons have formed and germination usually requires some environmental triggers, e.g., a period of cold


becomes endosperm
becomes embryo
becomes seed coat
Triploid (3n)
Diploid (2n)
Diploid (2n)



Correspondence between flower and fruit in the pea plant



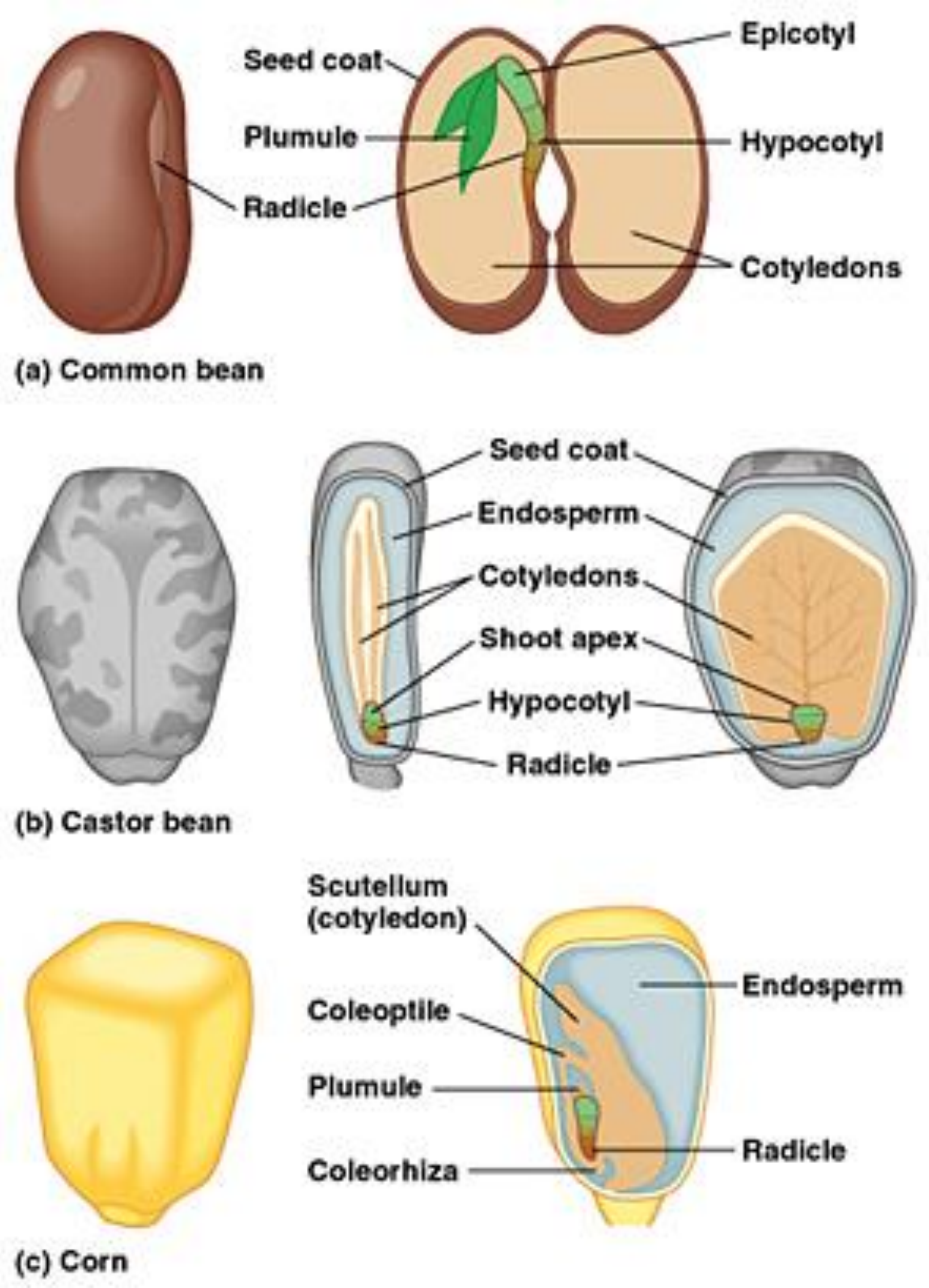
Types of Fleshy Fruits

Simple Single ovary of one flower

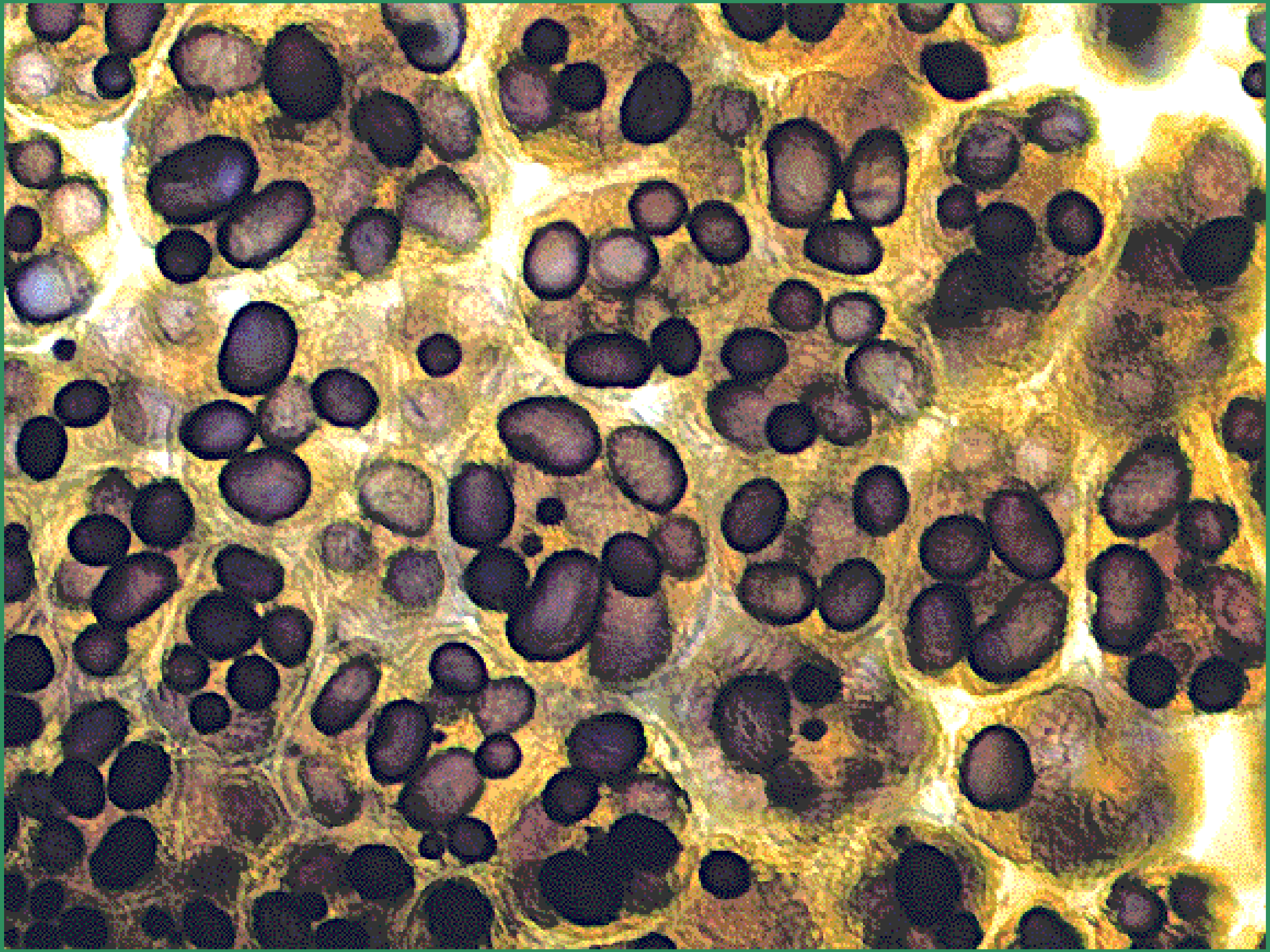
Aggregate Many ovaries of one flower

Multiple Many ovaries of many flowers

Seed structure

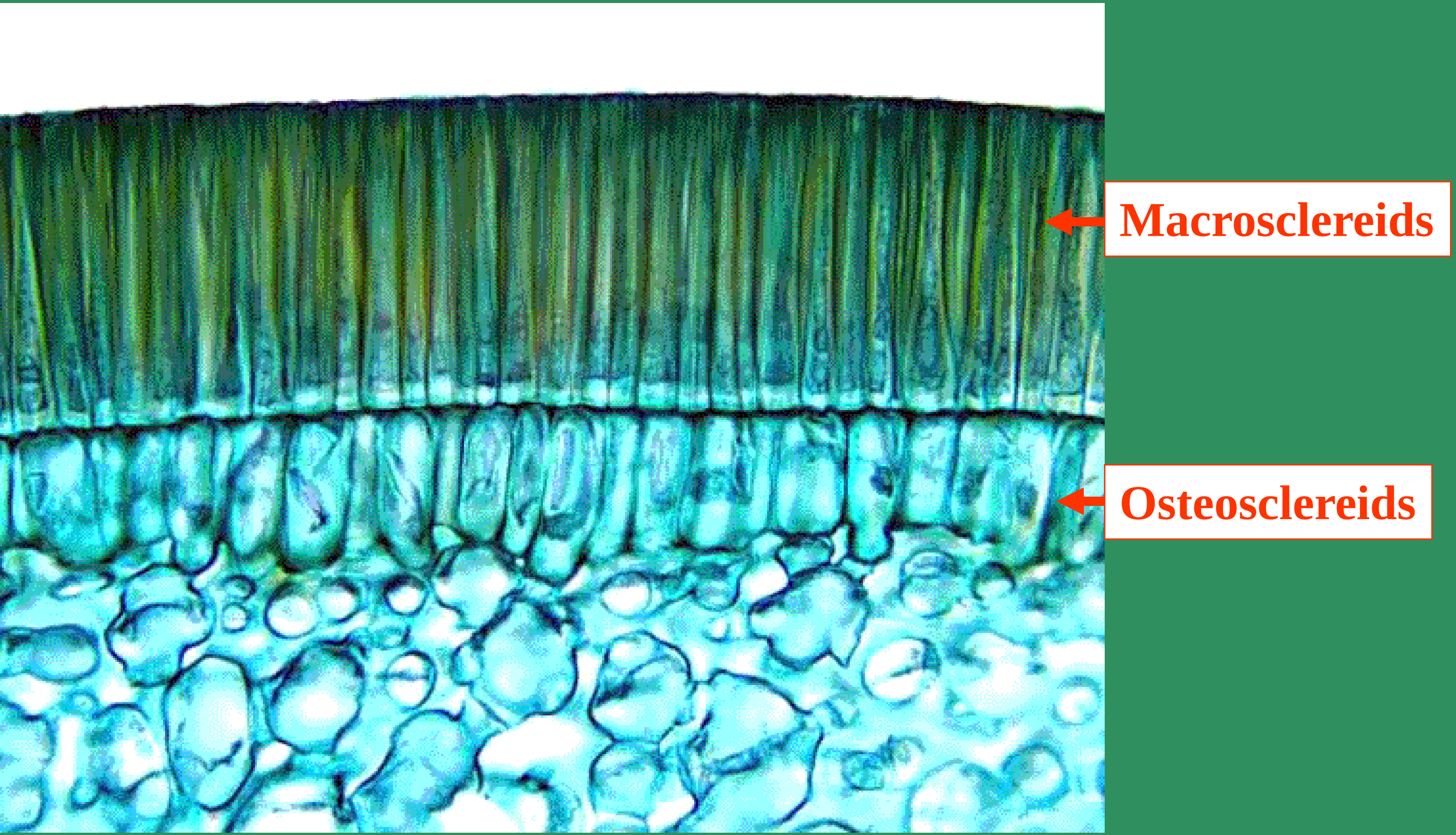


Storage parenchyma in bean cotyledon



- The purple structures are starch grains.
- What is this tissue stained with?

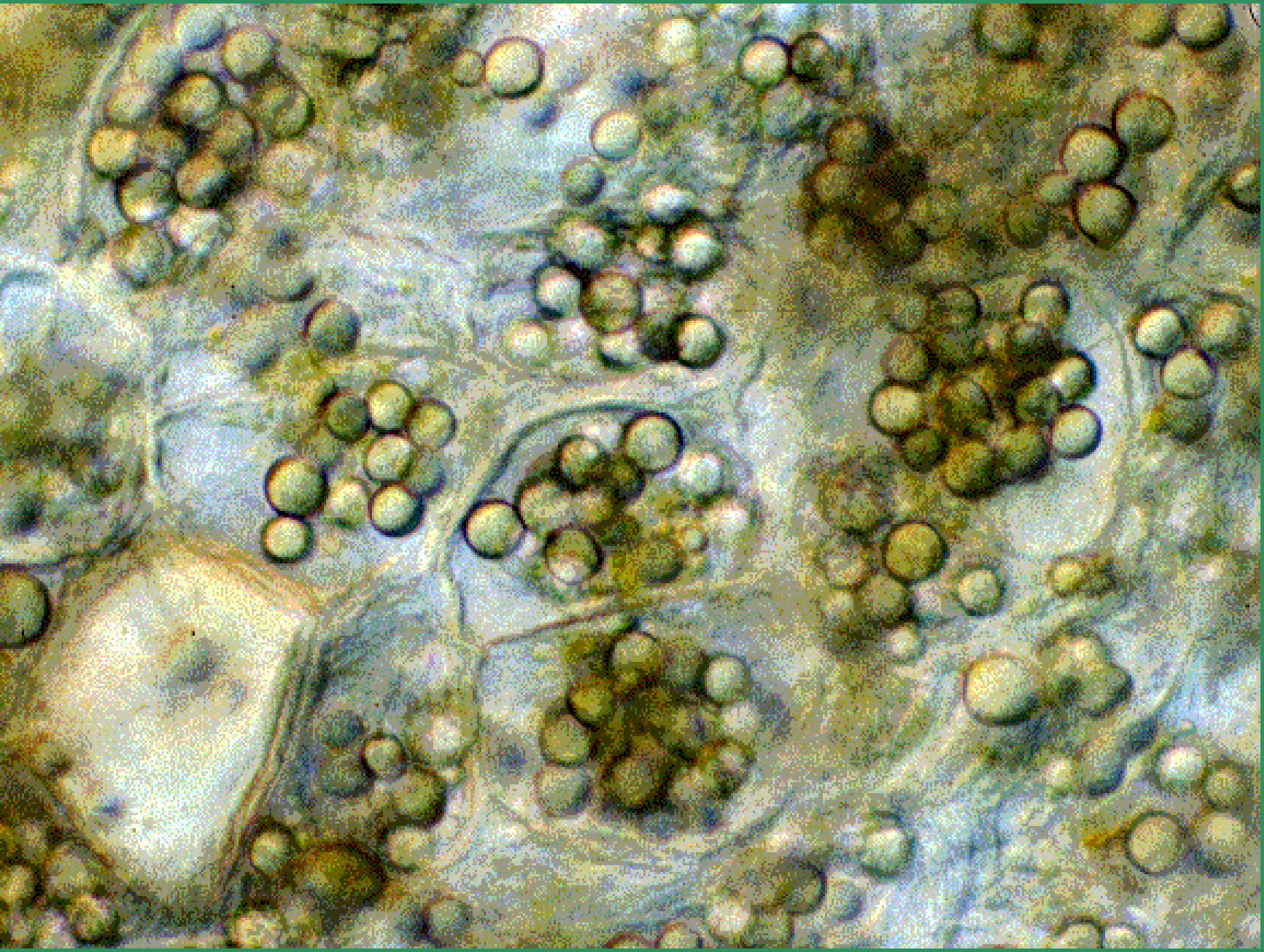
Cross section of the seed coat of a bean



Macrosclereids: column shaped, longer than wide

Osteosclereids: bone shaped, elongated with swollen ends

Section of avocado fruit



What are the spherical structures in this tissue?

How could they be distinguished from starch grains?

Germination involves 4 major processes:

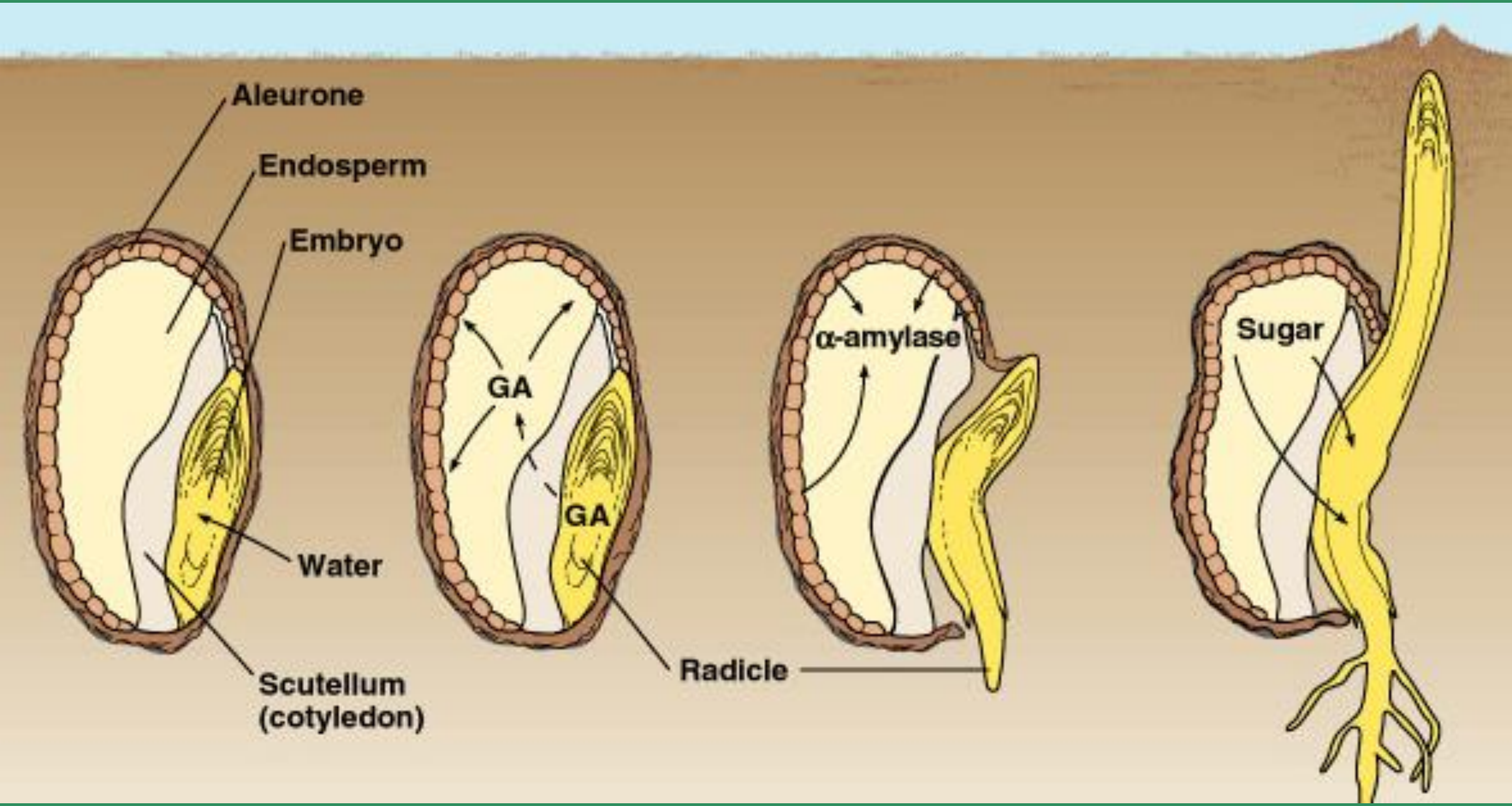
1) **Hydration (or imbibition)** - Seeds must take up water. A seed will absorb water only if the seed coat and / or other coverings are permeable. Water is absorbed by osmosis, driven by the existence / buildup of high solute concentration in the seed cells.

2) **Breaking dormancy** which initiates metabolism.

3) **Enzyme activation** - soon after seed hydration, respiratory enzymes are activated, and food reserves, such as starch, are metabolized to produce the fuel (mostly ATP) for synthesis of other enzymes needed for such growth.

4) Carbohydrate, fat and protein **reserves** in the cotyledons or endosperm **are mobilized** to support the renewed development of the embryo.

Nutrient mobilization during germination of barley seed



The embryo releases hormones called gibberellins as signals to the aleurone, the thin outer layer of the endosperm. The aleurone synthesizes and secretes enzymes that hydrolyze starch

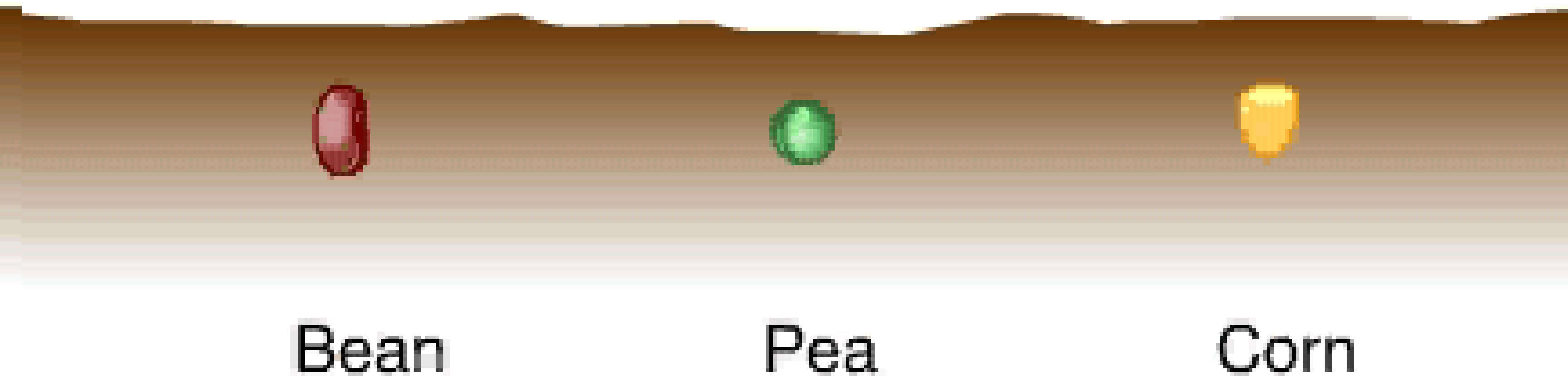
Steeping

The objective of steeping is to start the germination process by adding water to the barley. Germination is activated when moisture levels in the barley (12 - 13%) are brought up to 43 - 45%. Dominion Malting steeps have multiple immersion or spray steep capability. The steeped barley requires periods of rest and aeration in order to provide adequate oxygen for germination. Steep cycles last approximately 44 hours.

The general pattern of embryo growth and development differs among species.

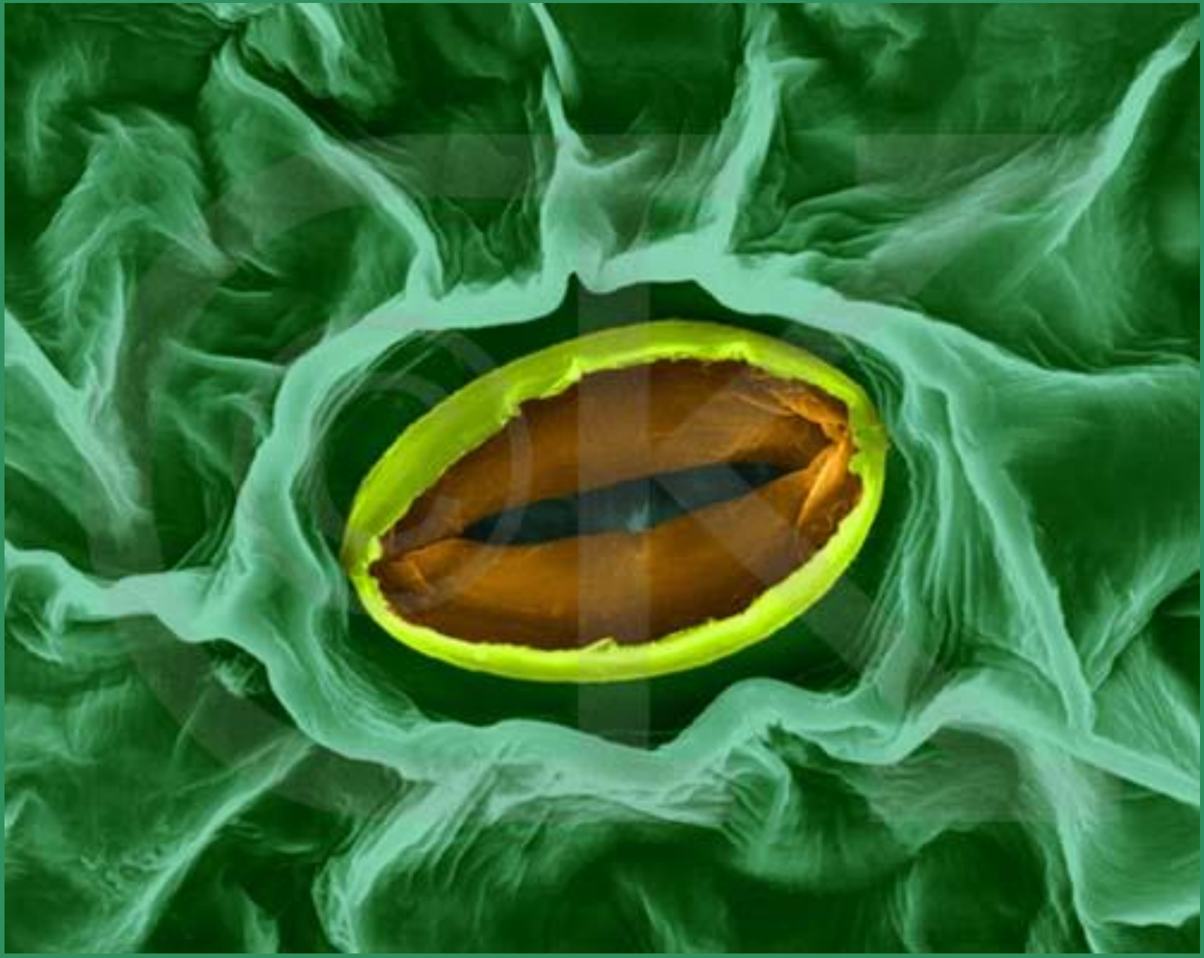
Some species, such as white pine, a Gymnosperm, have an epigeal pattern, where the cotyledons are raised into the light and quickly begin to photosynthesize as the first true leaves on the germinant.

Others, such as walnut and oak, leave their cotyledons on or below the soil surface, and simply draw on the starch and other food reserves contained in these organs during early germinant development.


Bean
Pea
Corn

Plant Water& Relations

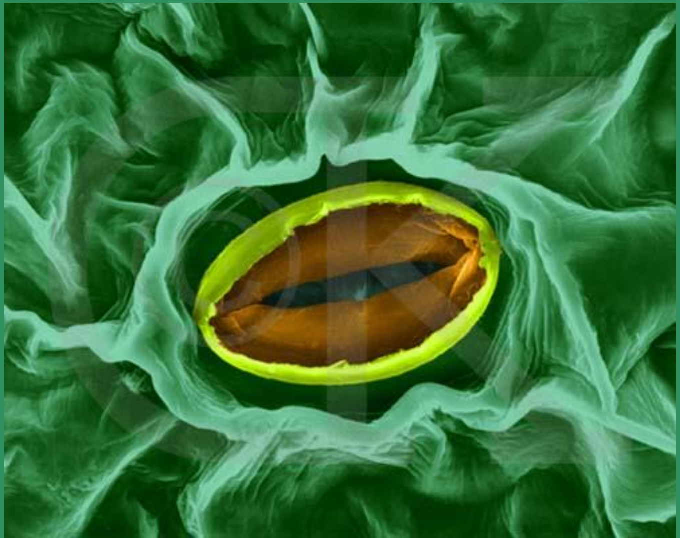
Dr. Haitham Kurbaj



Plant Water Relations

Plants need to obtain water (usually from the soil) and control water loss (through transpiration) to maintain a water balance conducive to metabolic processes.

Leaf water relations and access to atmospheric CO_2 are controlled by stomates – openings in the leaf surface which have guard cells that can close or open the stomate. When guard cells are turgid (well hydrated), stomates are open. When guard cells are flaccid (low water level), stomates close.



How plants obtain and move water varies between non-vascular plants (hornworts, louseworts, bryophytes, etc.) and vascular (higher) plants.

Hornwort (aquatic)

lousewort

bryophyte

To move onto land, plants needed a waxy cuticle to avoid unsupportable water loss.

However, depending on diffusion to move water through the plant body, as in non-vascular plants, severely limits plant size. The non-vascular plants all are short.

Further, plant reproduction depends on the male gamete "swimming" to the female in those non-vascular plants.

Non-vascular plants all live in moist environments where that swim is possible.

Early vascular plants could increase in stature, and began the evolution of vascular tissue…

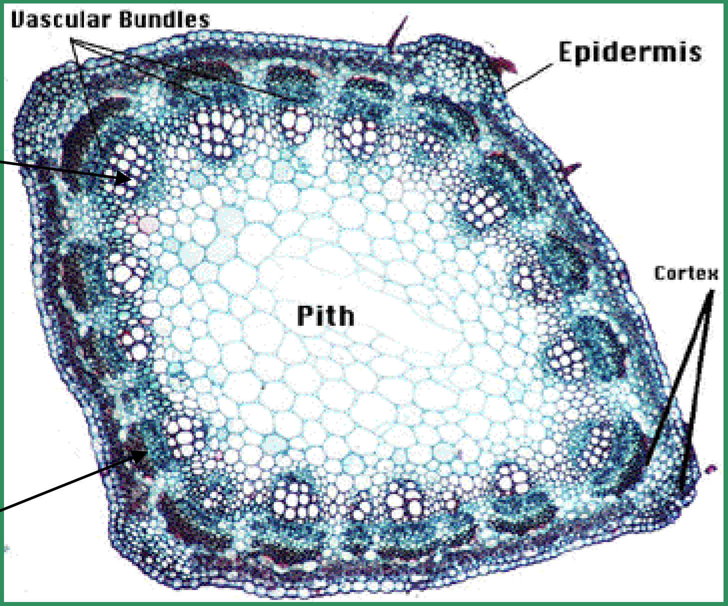
Throughout the plant body there must be a means to move water, minerals, and photosynthate. The vascular system achieves that. It is comprised of two systems:

xylem – conducts water and minerals from the roots upward

phloem – transports organic materials synthesized by the plant

xylem

Vascular bundles in a dicot stem

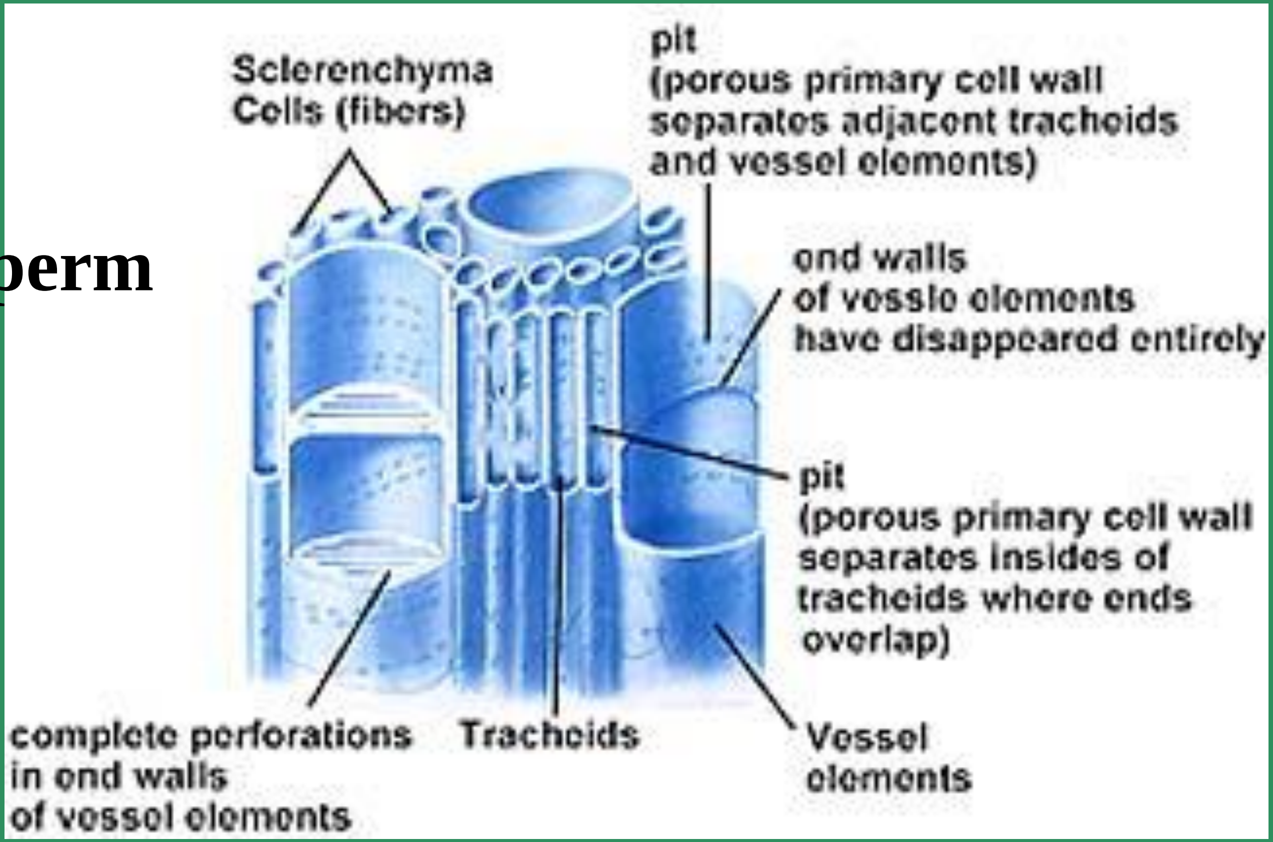


phloem

There is important structure within the phloem and xylem bundles, and they're different.

Xylem is comprised of tracheids, vessel elements, fibers, and some parenchyma.

Angiosperm xylem

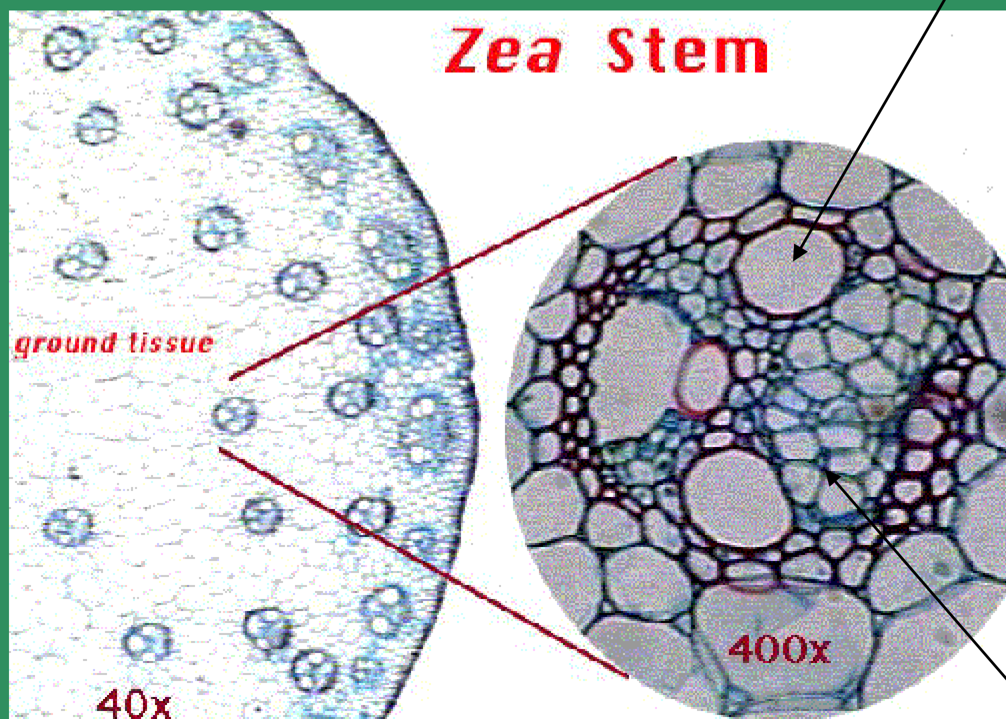


Tracheids function in support. They have both a primary and a secondary cell wall. At maturity, these cells are dead. They function in support, but they are the only conducting cell in vascular plants other than Angiosperms. They have numerous pits along their lateral cell walls, so that water and minerals can move between cells.

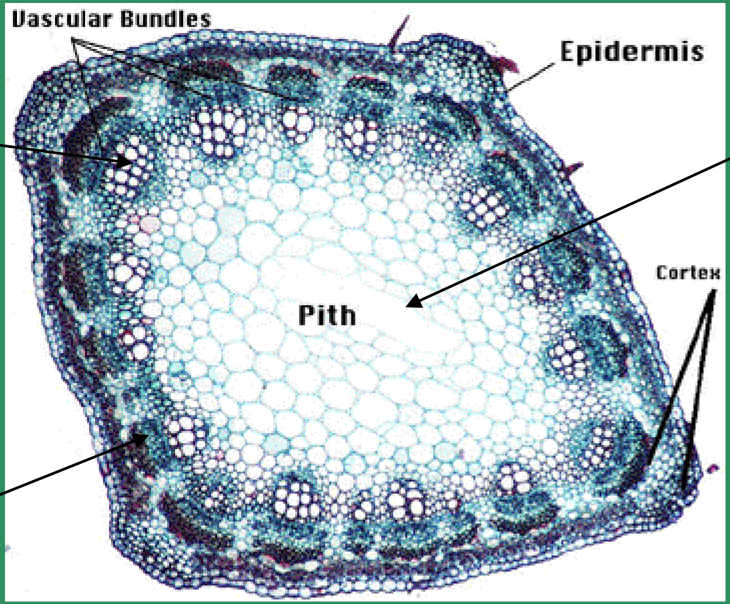
Vessel elements are shorter, wider, and have either many perforations in their end cell walls, or those end walls have virtually disappeared. They become what their name suggests – pipe like tubes. Remember, they are only present in the xylem of Angiosperms.

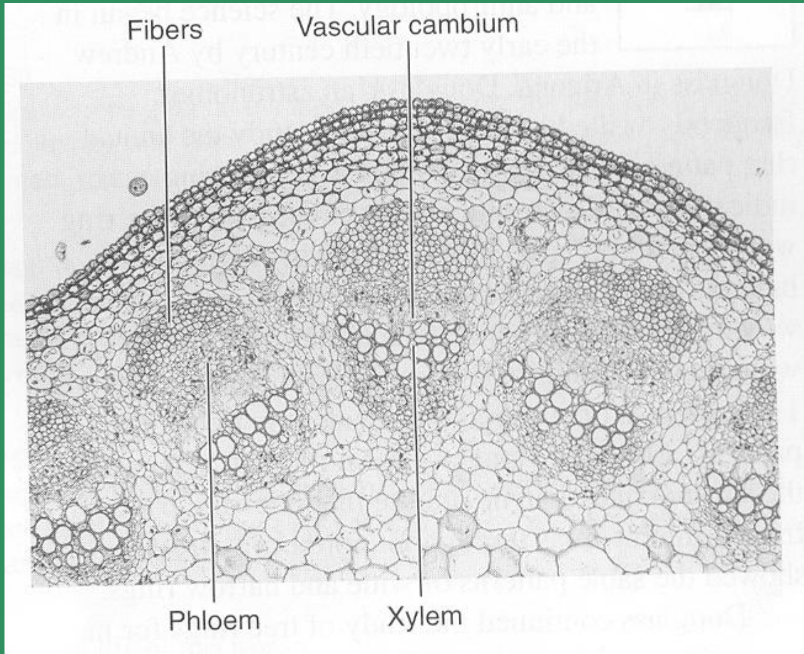
Each vascular bundle is (generally) surrounded by a bundle sheath, and how they are placed within a stem differs in differing types of plants. In monocots, the vascular bundles are scattered through the stem; in dicots they form a ring.

In monocots:



In a dicot stem (shown again):



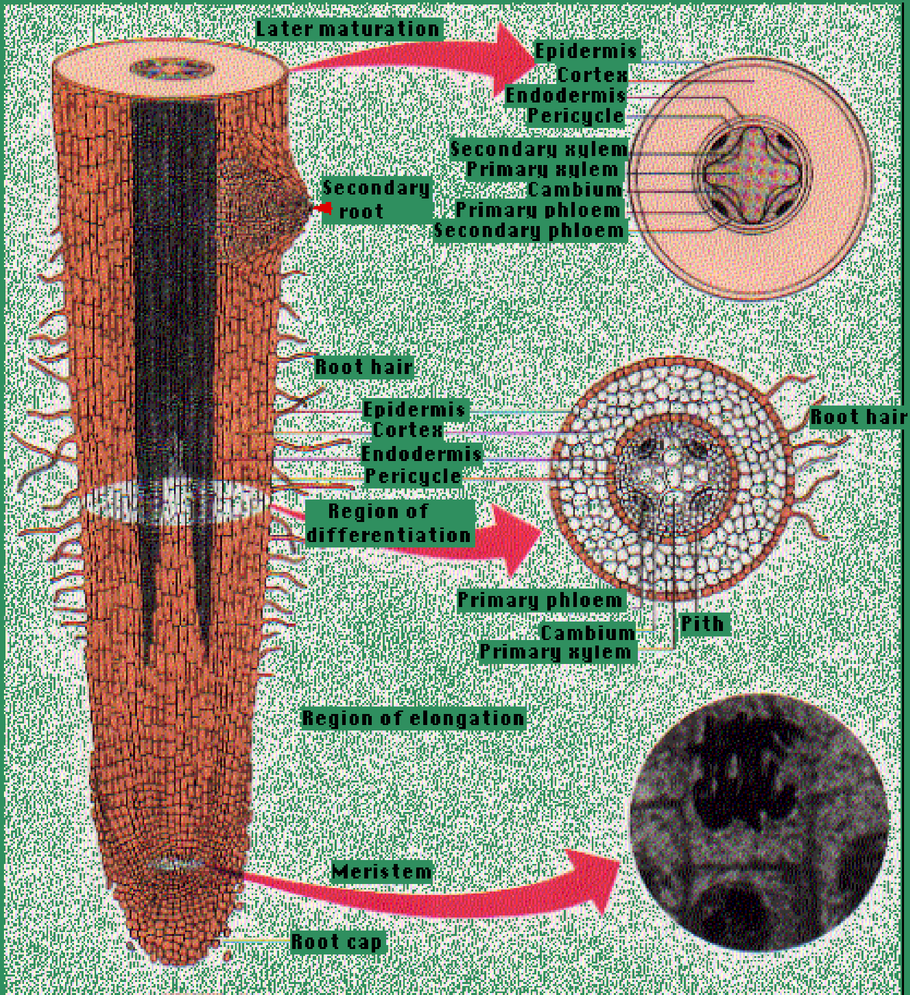


Annual rings in the cross section of a woody plant represent the annual growth of xylem from the vascular cambium. The rings are visible because the cells of spring growth (called springwood) are larger (due to the wetter conditions) and apparently lighter in colour than those produced during summer (summerwood). The size (thickness) of annual rings can be used to estimate the climate during the year of formation. Climates covering a number of centuries can, using this method (called dendrochronology), be evaluated.

<u>This is an important tool in estimating climate change.</u>

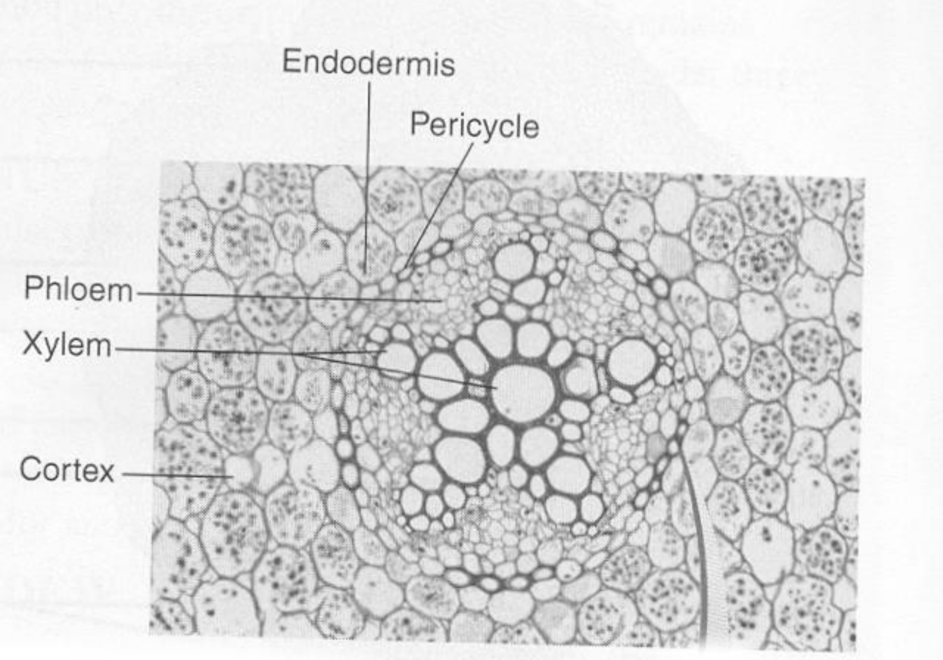
Roots

Roots have a meristem (growth region) protected by a root cap. Just behind that is a region of the root where cells elongate.

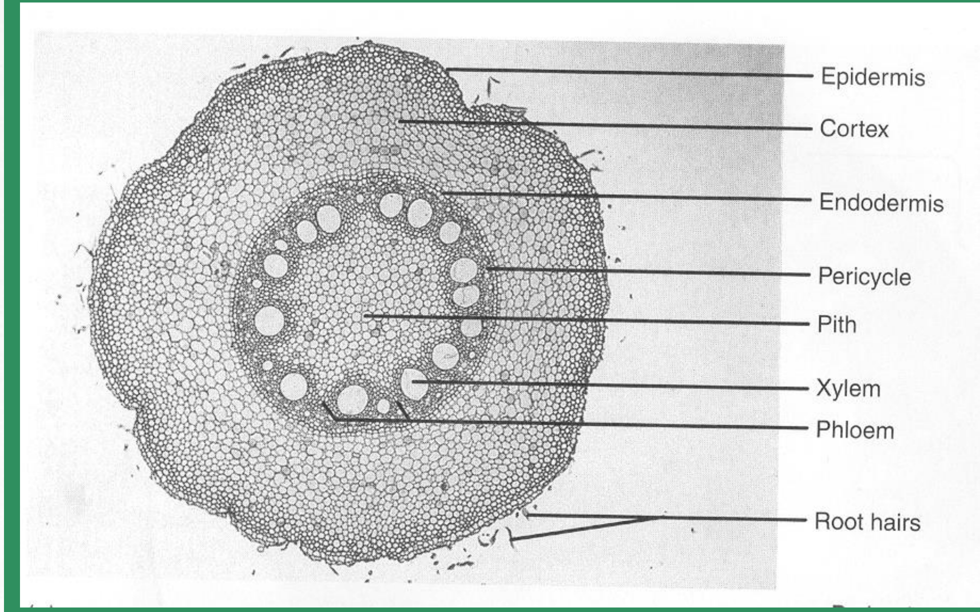


In cross section, the center of the root contains the vascular bundles (the vascular cylinder). It is called the stele.

In the center of the stele is the xylem, usually star-shaped (i.e. having projections outward) in dicots. Between the arms of the star is the phloem. In monocots there is a ring of vascular bundles, alternating xylem and phloem.



dicot pattern

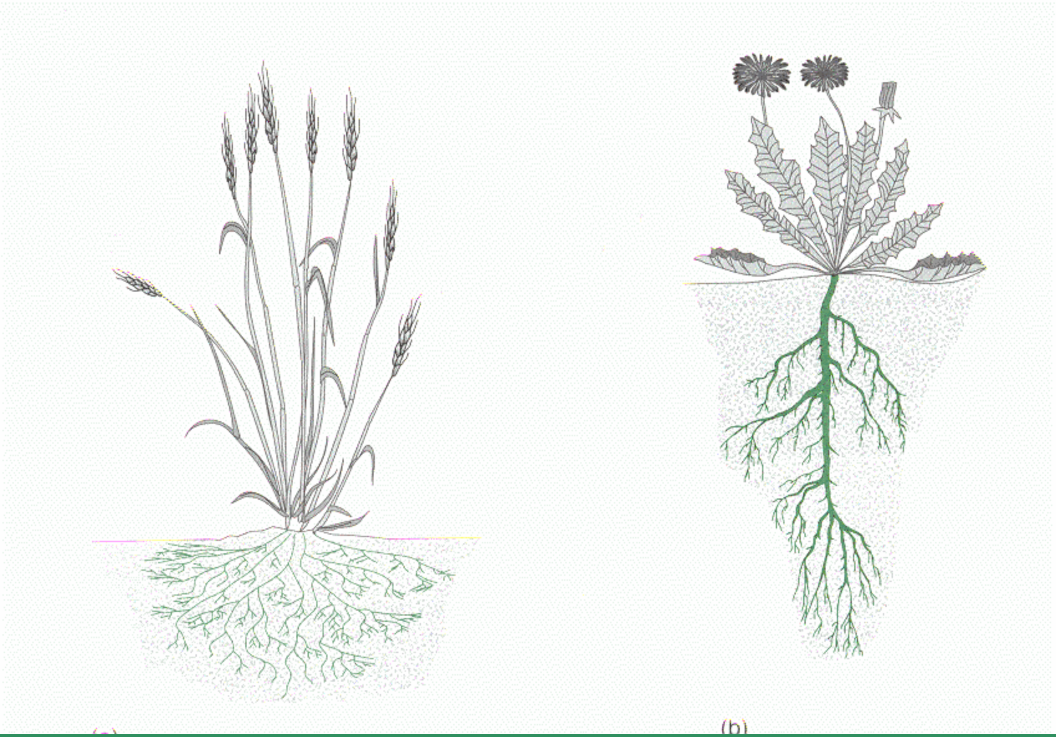


monocot pattern

In both root forms the outer layer of the stele is called the pericyclic. This tissue is meristematic, that is it can give rise to new growth in the form of root branches.

From the surface epidermis project root hairs. They are key to maximizing absorption of water and minerals, enormously increasing the effective surface area of the roots.

Roots have differing patterns of growth in different habitat conditions and among species. The basic difference is between a taproot design – a thick principal root from which branches develop, and a branched fibrous root system – many essentially equal diameter roots with branching.

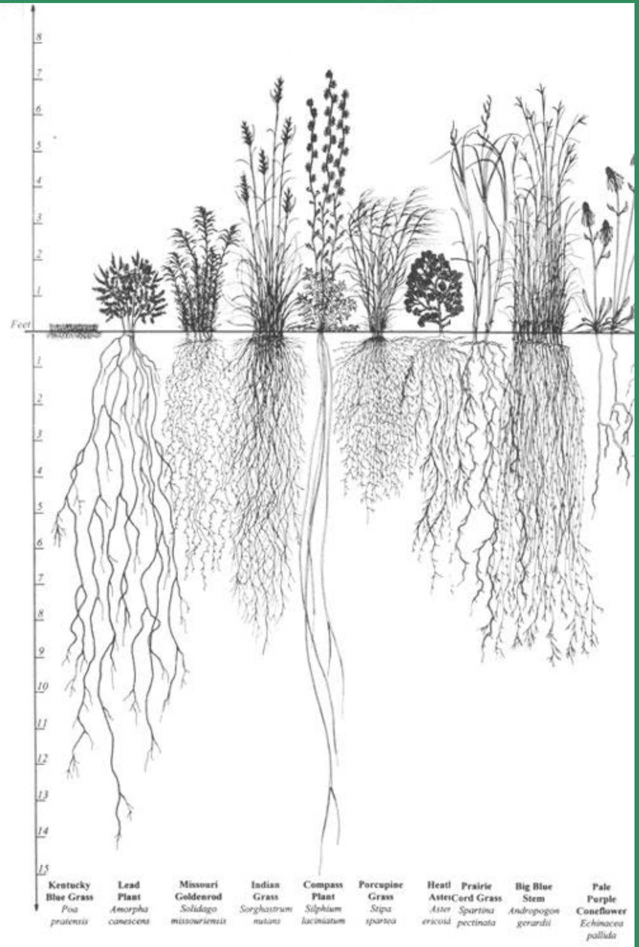


fibrous roots of barley

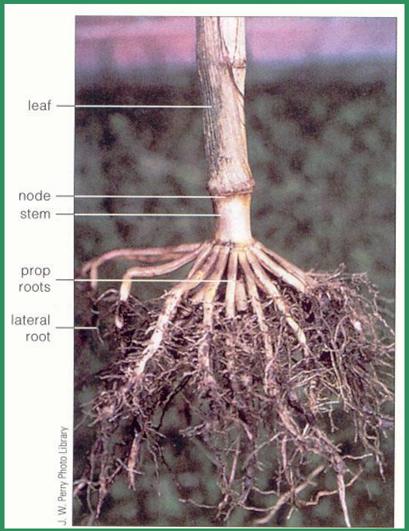
tap root of a dandelion

By having differing types of roots and extension to different depths, plants can reduce the intensity of competition for water and nutrients.

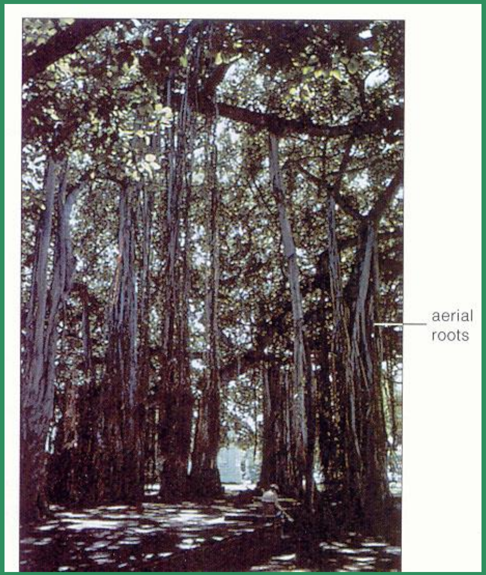
On the prairies of central North America, some plants have roots that go down < 1m, while others, e.g. *Andropogon gerardii*, the characteristic grass of tall grass prairie, extend down at least 4m, and *Rosa suffulta*, the prairie rose, has roots that extend > 7m.



In addition to totally below ground roots, some species have adventitious roots. These roots originate on leaves and stems above ground. Corn has prop roots that originate from the stem just above ground. Banyan trees from Australia have extensive aerial roots, reaching down to the soil from far up in the branches of the tree. Mangroves have extensive, spreading adventitious roots above the surface of the water.



corn – prop roots



banyan aerial roots

mangrove mangle

Transport

You've already seen the structure of xylem and phloem. How does transport in these systems work? How is a redwood tree able to move water from the soil to leaves 100m above the soil?

Successful movement is based on the chemical nature of water. Water molecules are bonded to each other by hydrogen bonds. That makes the water in roots, xylem, and leaves a continuous network. How does water move?

There are 5 major forces that move water from place to place:

1. diffusion – the net flow of molecules from regions of higher to regions of lower concentration. This is the major force moving water in gaseous (vapor) phase.

The remaining forces determine the water potential, from which we can understand water movement…

$$\Psi = \Psi_\pi + \Psi_P + \Psi_m + \Psi_g$$

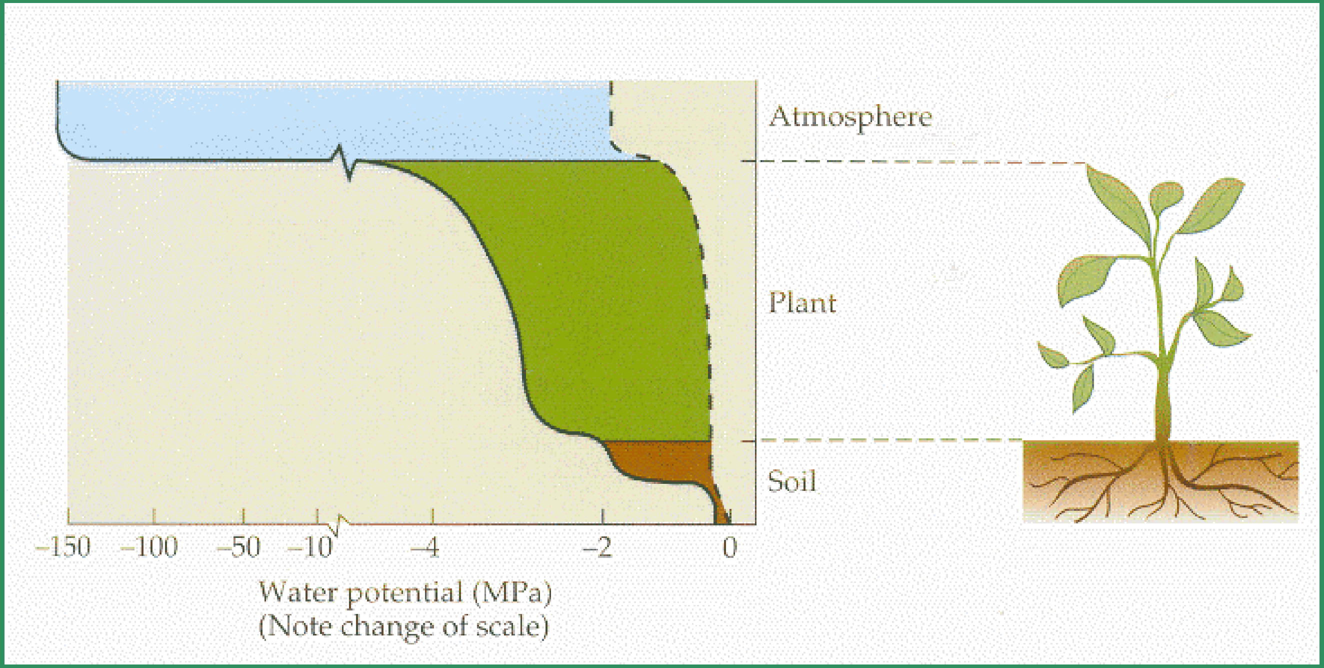
2. Osmotic potential (Ψ_π) – the diffusion of liquid water molecules from a dilute solution (more water, less solute) across a selectively permeable membrane into a more concentrated solution (less water, more solute). Osmosis is important in moving water from the solution bathing cells (the apoplast) into the cytoplasm. This flow will continue until the hydrostatic pressure (turgor pressure) inside the cell balances the osmotic pressure.

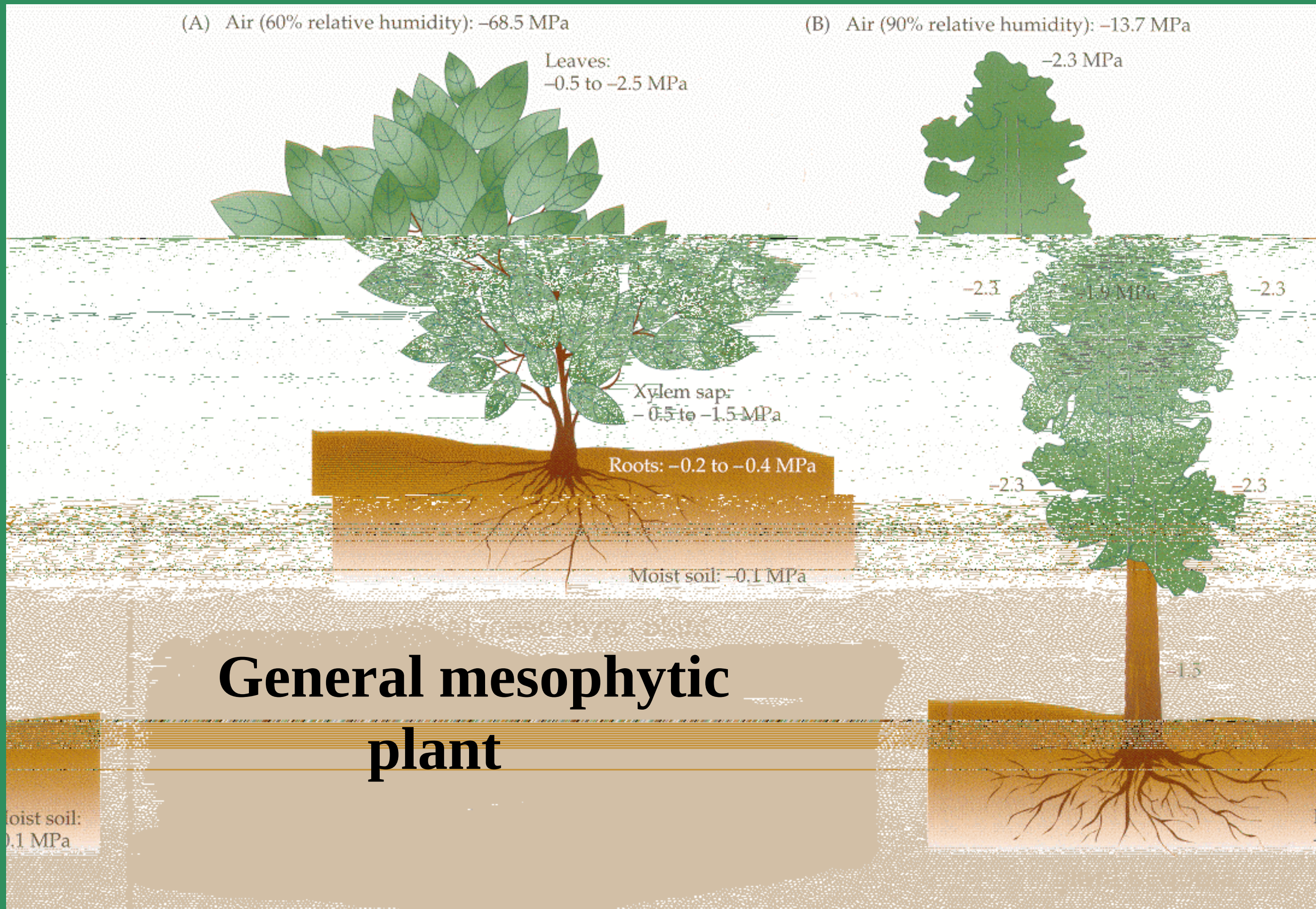
3. capillary forces (or matric potential Ψ_P) – not only is water cohesive (tends to stick together), it is also adhesive, sticking to hydrophilic surfaces. That includes carbohydrates (cellulose) of the xylem tubes' walls. They are very narrow in bore, and water is pulled to cover the surface of the inside of the tube. The force pulling is capillary force. How large can it be? 1,000 atmospheres, or 15,000 lbs. Eventually the force of gravity balances the upward pull, in theory. That balance is not reached in plants, and capillary force moves water upward to replace evaporative loss.

4. Gravitational force (Ψ_g) – shouldn't really need description.

What are the observed potentials in soil and at different levels in the plant?

Two figures from the text show the pattern of water potentials:

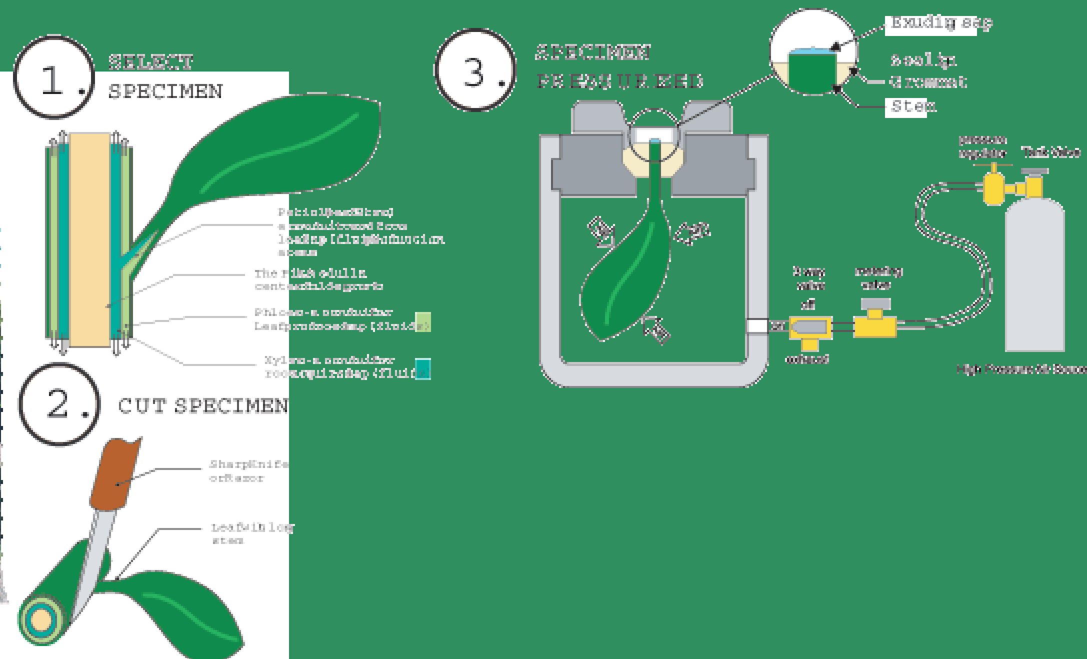


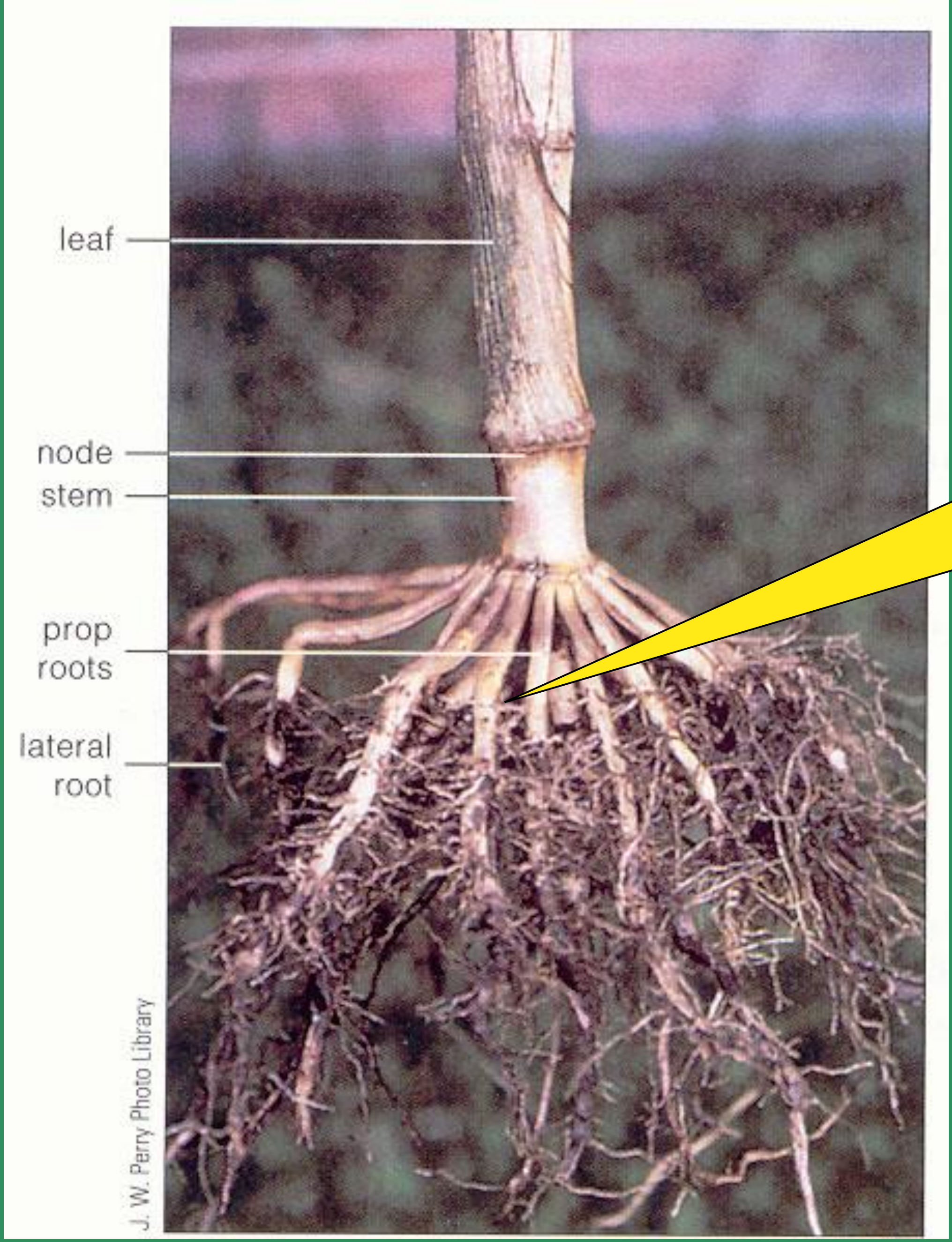


General mesophytic plant

Giant sequoia

Ecologists can measure the force exerted in a plant stem using a tool called a Schollander Bomb.





Finally, I made it! You got any questions?

THANK YOU FOR YOUR ATTENTION