

RELAÇÕES HÍDRICAS NAS PLANTAS

9 DE MARÇO DE 2018

(5^a aula do bloco)

Sumário da Aula Anterior:

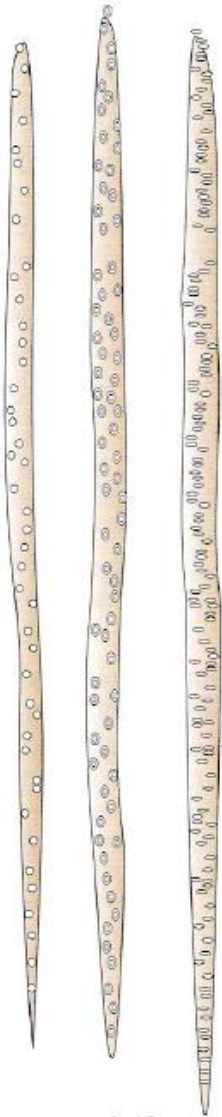
Granulometria do solo. A tomada de nutrientes: influência do pH da solução do solo. A função das estruturas radiculares na absorção da água: o papel dos pêlos radiculares. O transporte lateral de água na raiz: da epiderme até aos vasos condutores. O papel da endoderme e da banda de Caspari. Transporte apoplástico, simplástico e transcelular. Métodos de medição do estado hídrico do solo: gravimétrico; pela textura e aparência; com bomba de neutrões; tensiométrico; e pela resistência eléctrica.

Programa Para a Aula de Hoje:

Características e constituição do xilema: traqueídeos e traqueias ou elementos dos vasos. A cavitação. A teoria da Coesão - Tensão. A transpiração.

TRANSPORTE XILÉMICO

(A)



Tracheids

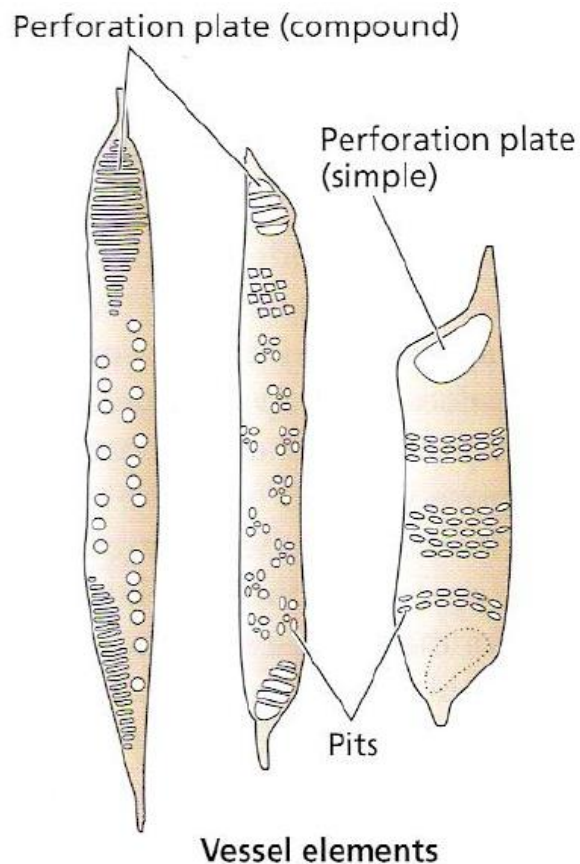
Traqueídos:

Células mortas, relativamente longas e estreitas, com parede secundária lenhificada.

As suas extremidades transversais são estreitas e cobertas por uma fina membrana, enquanto as paredes laterais são espessas e apresentam numerosas pontuações ou poros, locais onde não existe parede secundária, permitindo a passagem de substâncias.

Estas células alinham-se topo a topo, de modo a facilitar o movimento de água no seu interior.

elementos dos vasos (traqueias):



angiospérmicas

Células mais curtas e largas que os traqueídeos, apresentam a mesma parede secundária lenhificada.

Neste caso, as membranas transversais desaparecem, ficando as células, alinhadas topo a topo, a formar um tubo.

As paredes laterais apresentam pontuações, simples ou aureoladas.

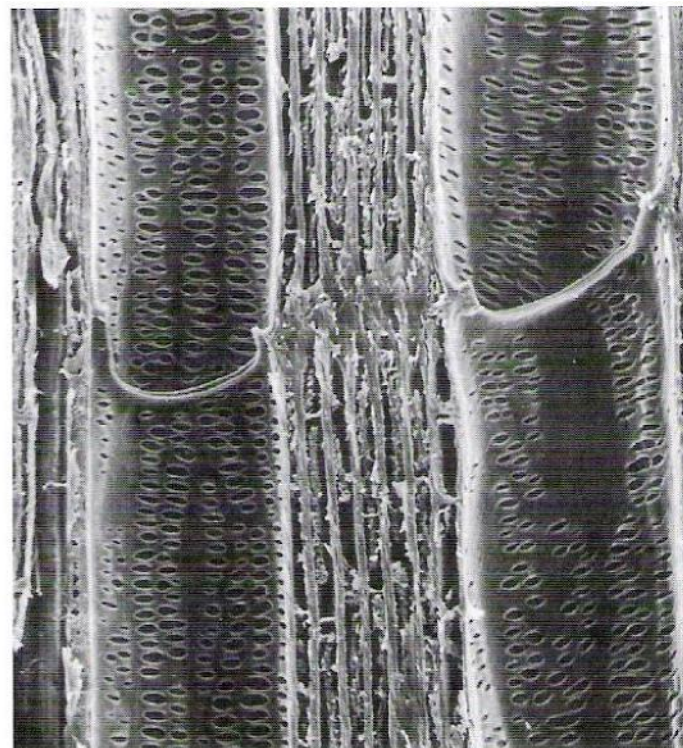
Este tipo de célula é muito mais eficiente na deslocação de água, mas menos eficiente como estrutura de suporte.

Pode apresentar, ainda, um importante problema: está muito mais sujeito à formação de bolhas de ar, que podem bloquear a passagem de água para as zonas superiores da planta.

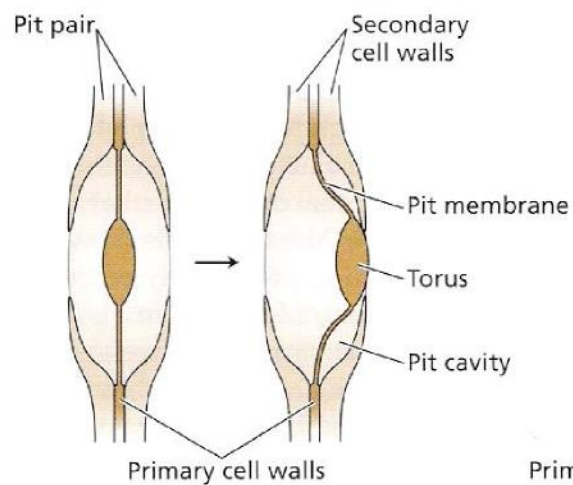
Nos traqueídeos tal não acontecia, não só porque o diâmetro celular era menor mas também pela presença de membranas transversais, que impedem a passagem das bolhas de ar.

traqueias

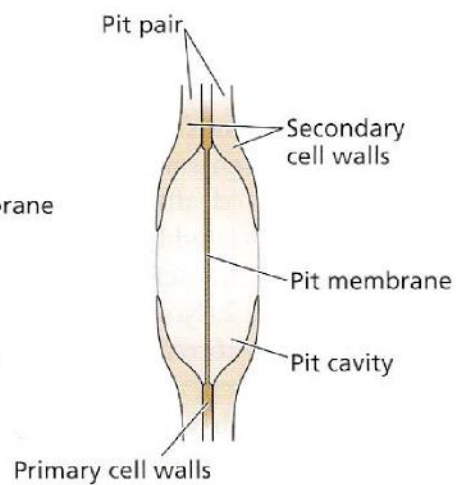
(B)



(C) Conifers



(D) Other vascular plants



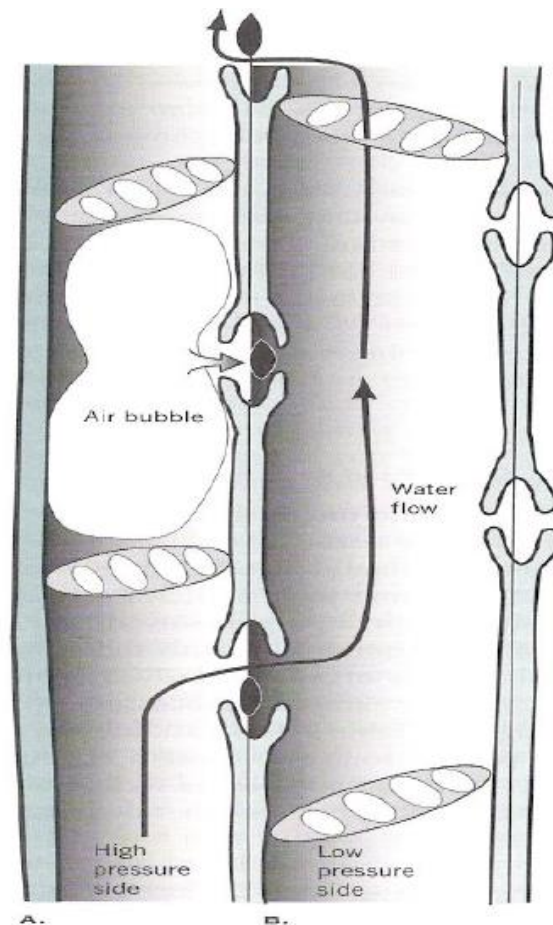


FIGURE 3.15 Containing embolisms. Air bubbles arising in the xylem are contained within the vessel element or tracheid. (A) The pressure differential resulting from an embolism causes the torus to seal off bordered pits lining the affected tracheary element. (B) Surface tension prevents the bubble from passing through the perforations in the end or side walls. Water continues to flow around the blocked tracheary element.

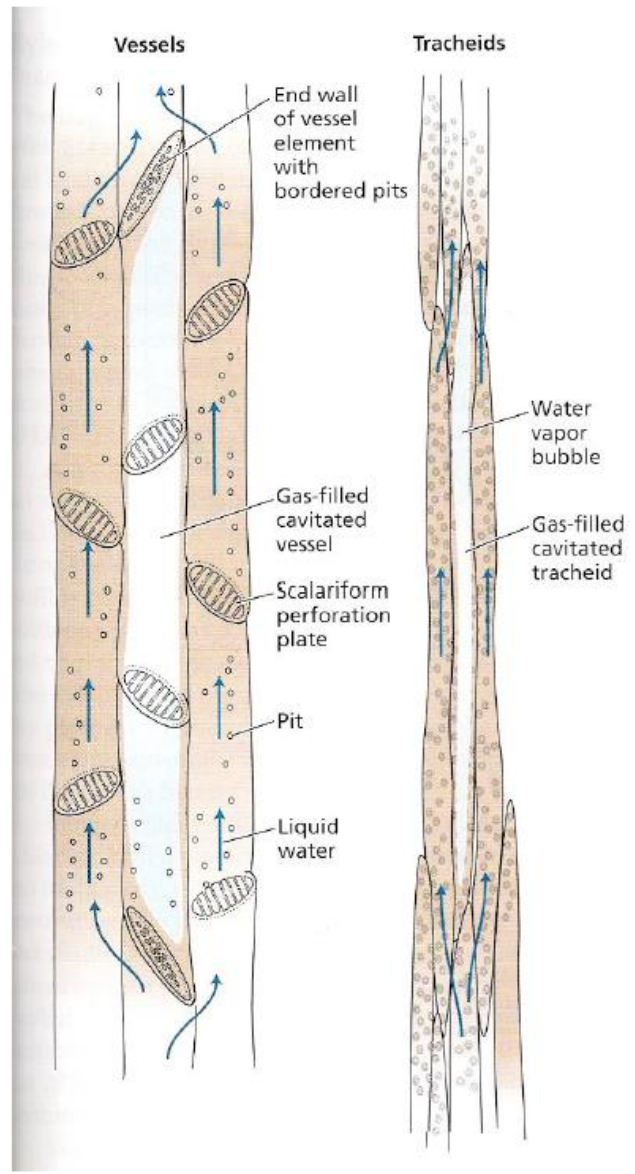
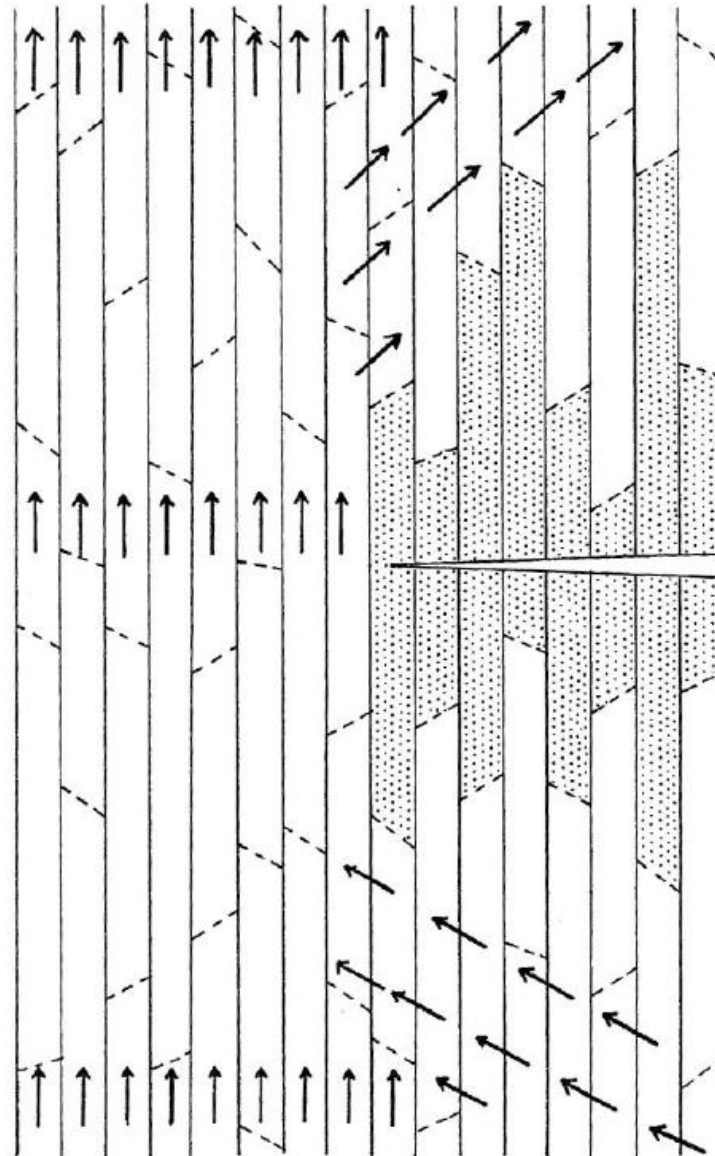


Fig. 3.10 Bypassing an airlock (embolism) in the xylem following a cut at the right. The slanted dashed lines represent vessel end wall perforation plates; the arrows show the pathways of water flow. Air-filled vessel elements are shaded. The necessity to move sideways through cell walls (via pits) increases the resistance to water movement in the damaged area.



The valve effect of the pit membrane, measured as a function of margo flexibility and torus overlap, explained more variably

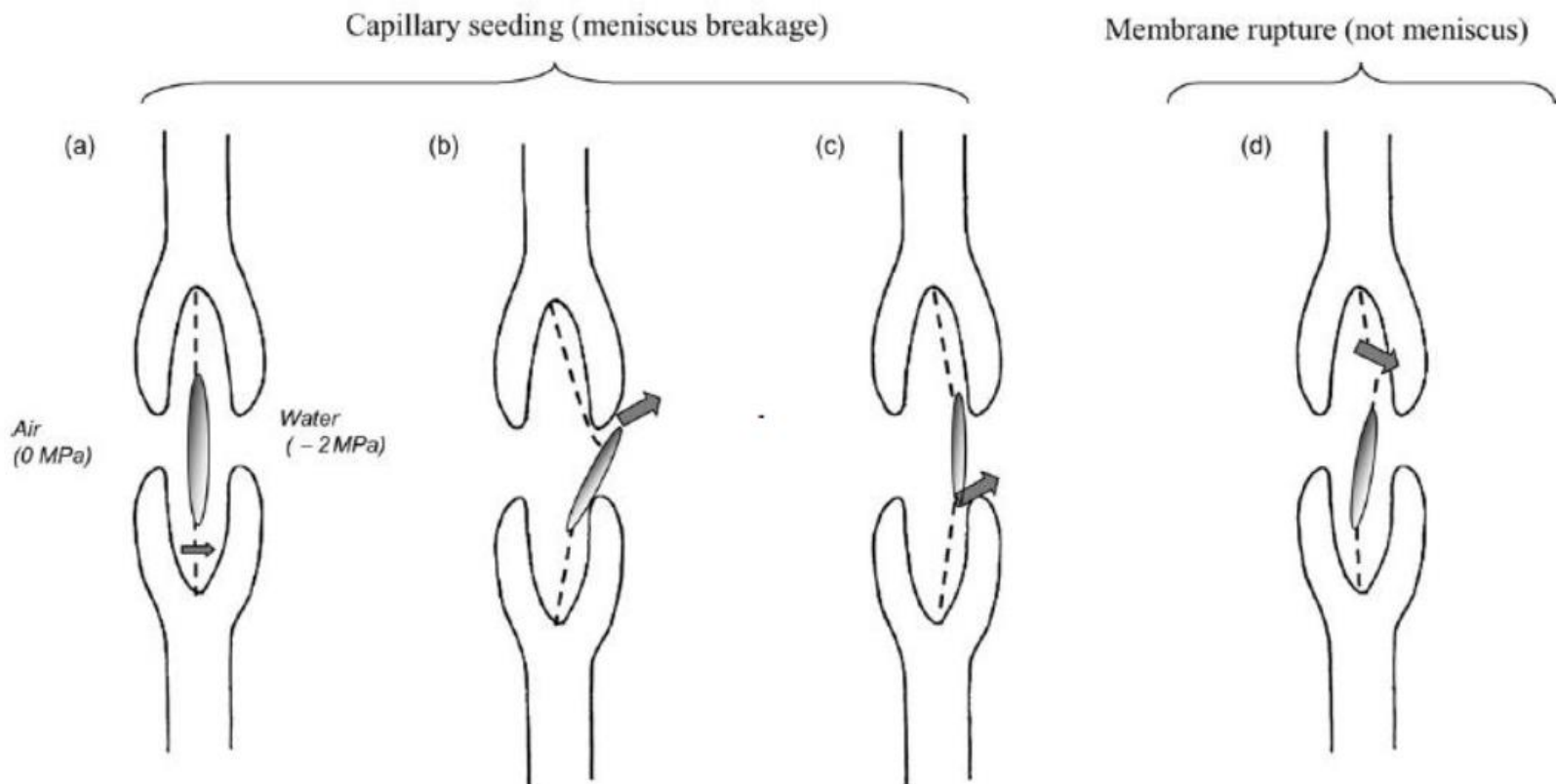


Figure 1. Different hypotheses of air-seeding through a conifer bordered pit membrane: (a) margo capillary-seeding, by capillary rupture of an air/water meniscus through pores in the margo when torus aspiration does not occur; (b) margo stretch-seeding, by elastic stretching allowing the torus to be pulled out through the pit aperture or through membrane slippage that allows the torus to move off-center; (c) seal capillary-seeding, when the torus is not tightly sealed against the pit border (weak aspiration or poor air tightness of torus/pit aperture interface); and (d) margo rupture-seeding, by membrane breakage.

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$$F = \frac{(D_m - D_t)}{D_m}$$

(a)

$$O = \frac{(D_t - D_a)}{D_t}$$

$$V_{ef} = F \times O$$

(b)

F = margo flexibility index

O = torus overlap against pit

V_{ef} = valve effect

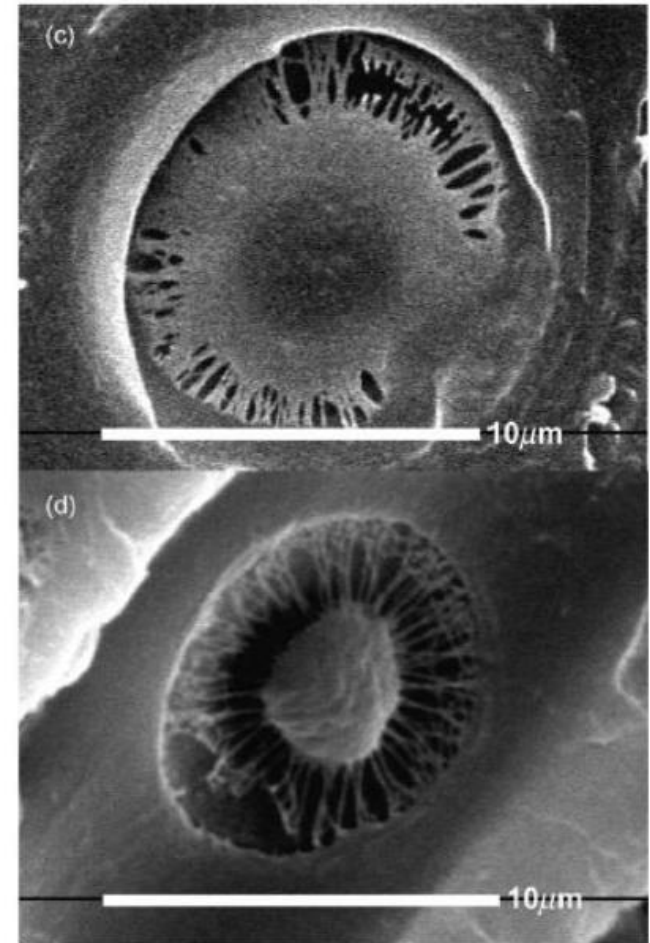
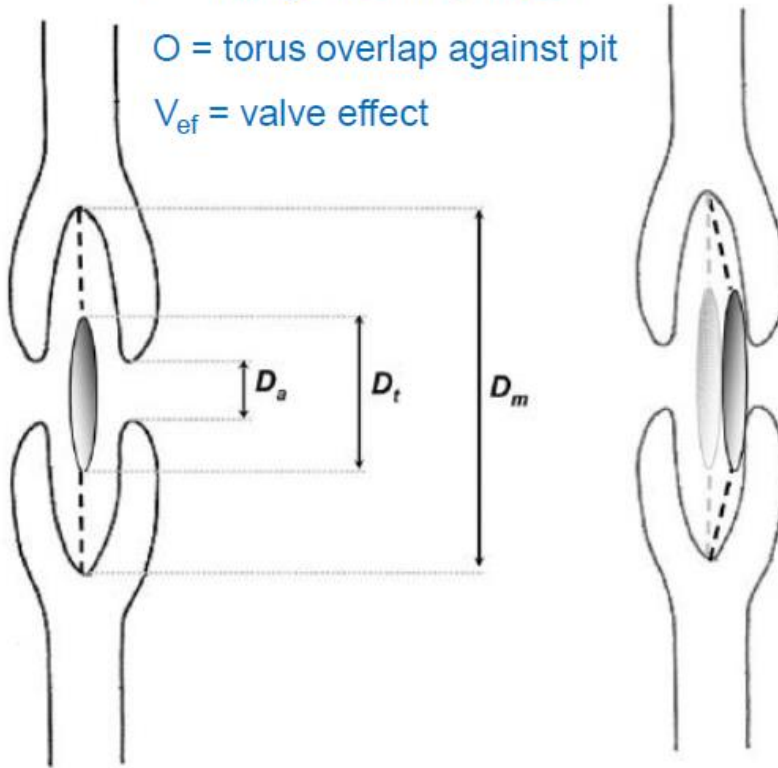


Figure 2. Schematic representation of a bordered pit membrane of conifer on the left. In the first inset (a), important features are represented, namely pit aperture diameter (D_a), torus diameter (D_t) and pit membrane diameter (D_m). The second inset (b) represents the torus valve effect (V_{ef} , i.e. pit aspiration and torus overlap between torus and pit aperture). Torus is both represented in its unaspirated (grey) and aspirated positions (black). On the right, comparison of bordered pit membrane anatomy between a species vulnerable to cavitation (*P. albicaulis*, c) and a species resistant to cavitation (*C. glabra*, d). White bars represent 10 μ m.

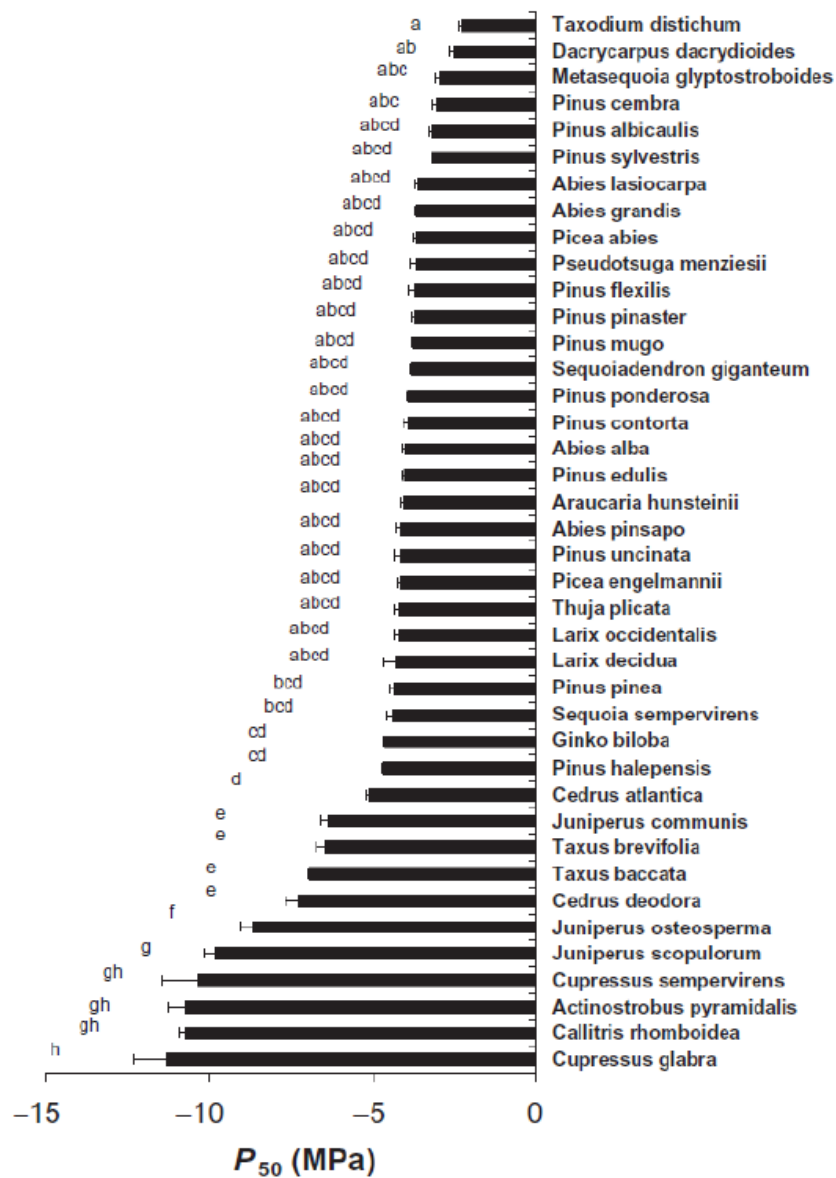


Figure 3. Xylem pressure inducing 50% loss in conductance (P_{50}) measured in 40 conifer species using the Cavitron technique ($n = 5$ per species). Error bars represent SE. Different letters indicate significant differences between species at $P < 0.05$ (SNK test).

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Teoria da Coesão-Tensão

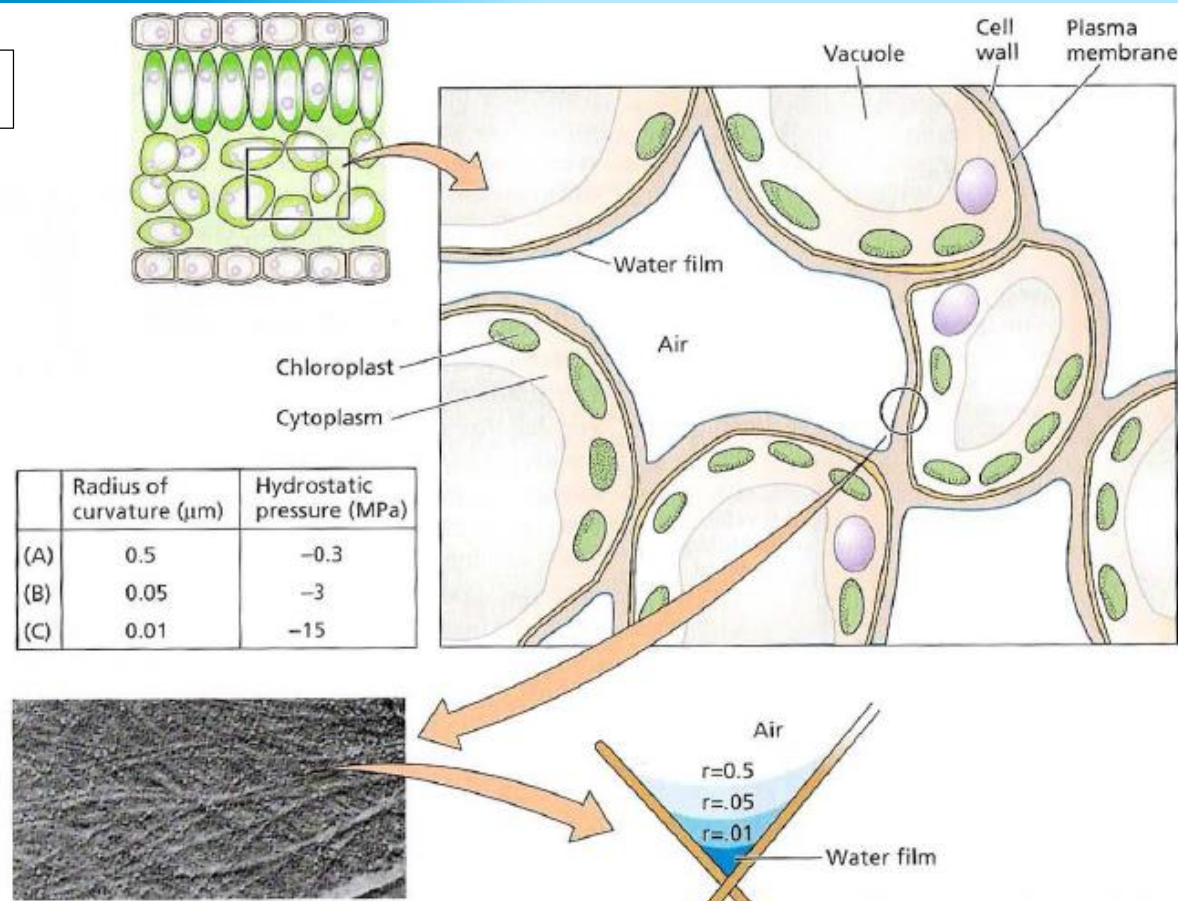
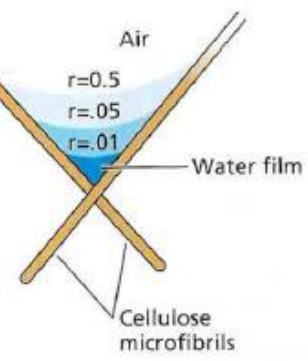


FIGURE 4.9 The driving force for water movement through plants originates in leaves. As water evaporates from the surface film that covers the cell walls of the mesophyll, water withdraws farther into the interstices of the cell wall. Because cellulose is hydrophilic (contact angle = 0°), the force resulting from surface tension causes a negative pressure in the liquid phase. As the radius of curvature of these air:water interfaces decreases, the hydrostatic pressure becomes more negative, as calculated from Equation 4.1. (Micrograph from Gunning and Steer 1996.)



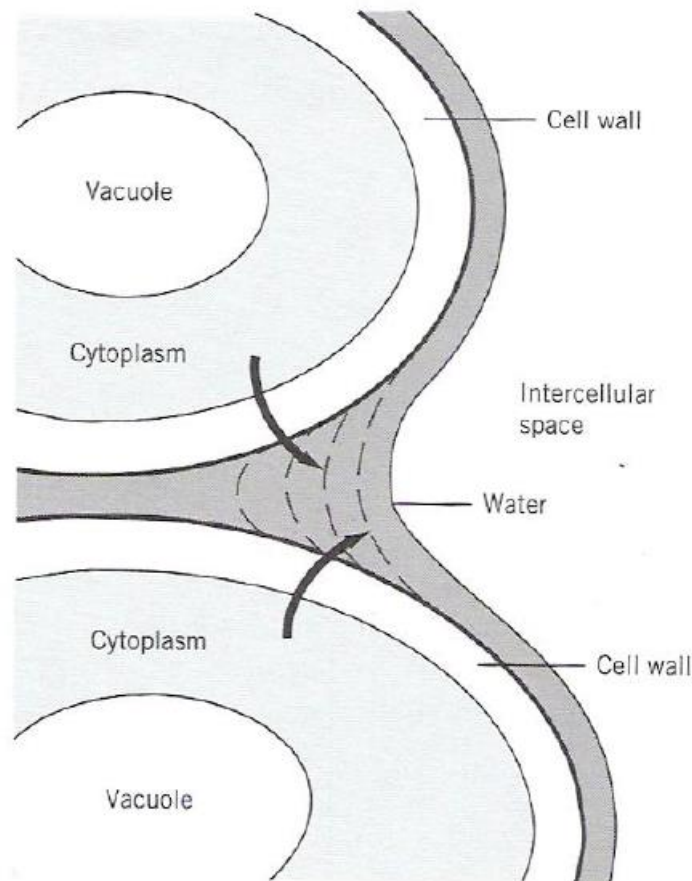
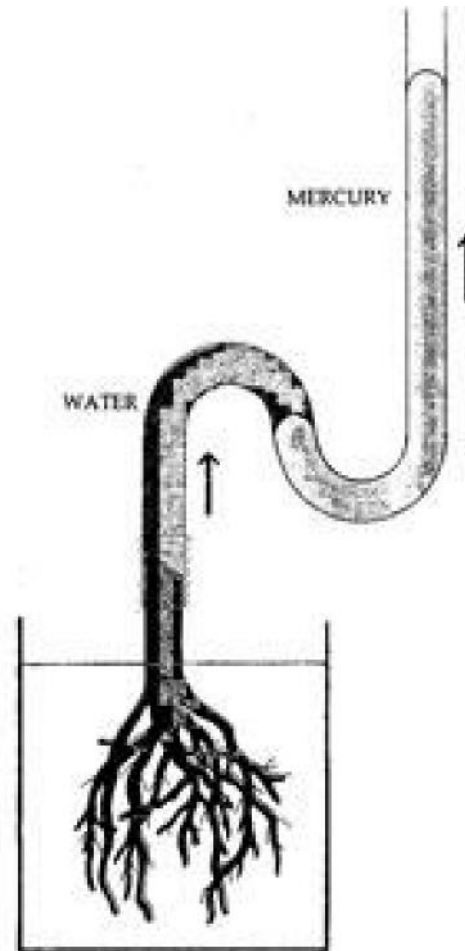


FIGURE 3.14 Tension (negative pressure) in the water column. Evaporation into the leaf spaces causes the water to retreat into the spaces between and at the junctions of leaf mesophyll cells. As the water retreats, the resulting surface tension pulls water from the adjacent cells. Because the water column is continuous, this tension is transmitted through the column, ultimately to the roots and soil water.

PRESSÃO RADICULAR

- desenvolve-se quando a transpiração (e, portanto, a tensão xilémica) é reduzida (e.g., à noite);
- resulta da acumulação activa de iões no xilema radicular;
- é responsável pela gutação;
- as pressões mais elevadas registadas garantem uma elevação da seiva até cerca de 7 metros.



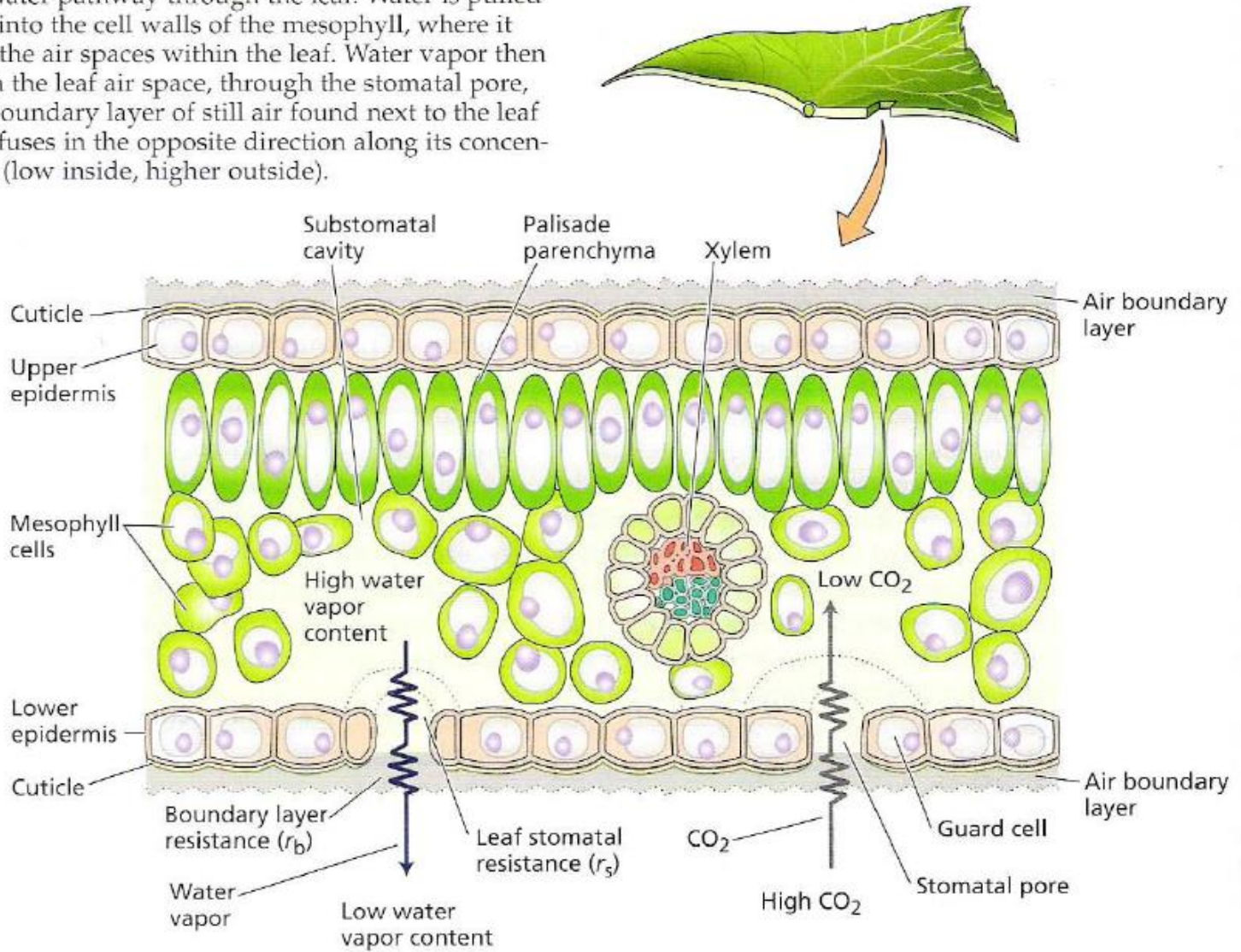


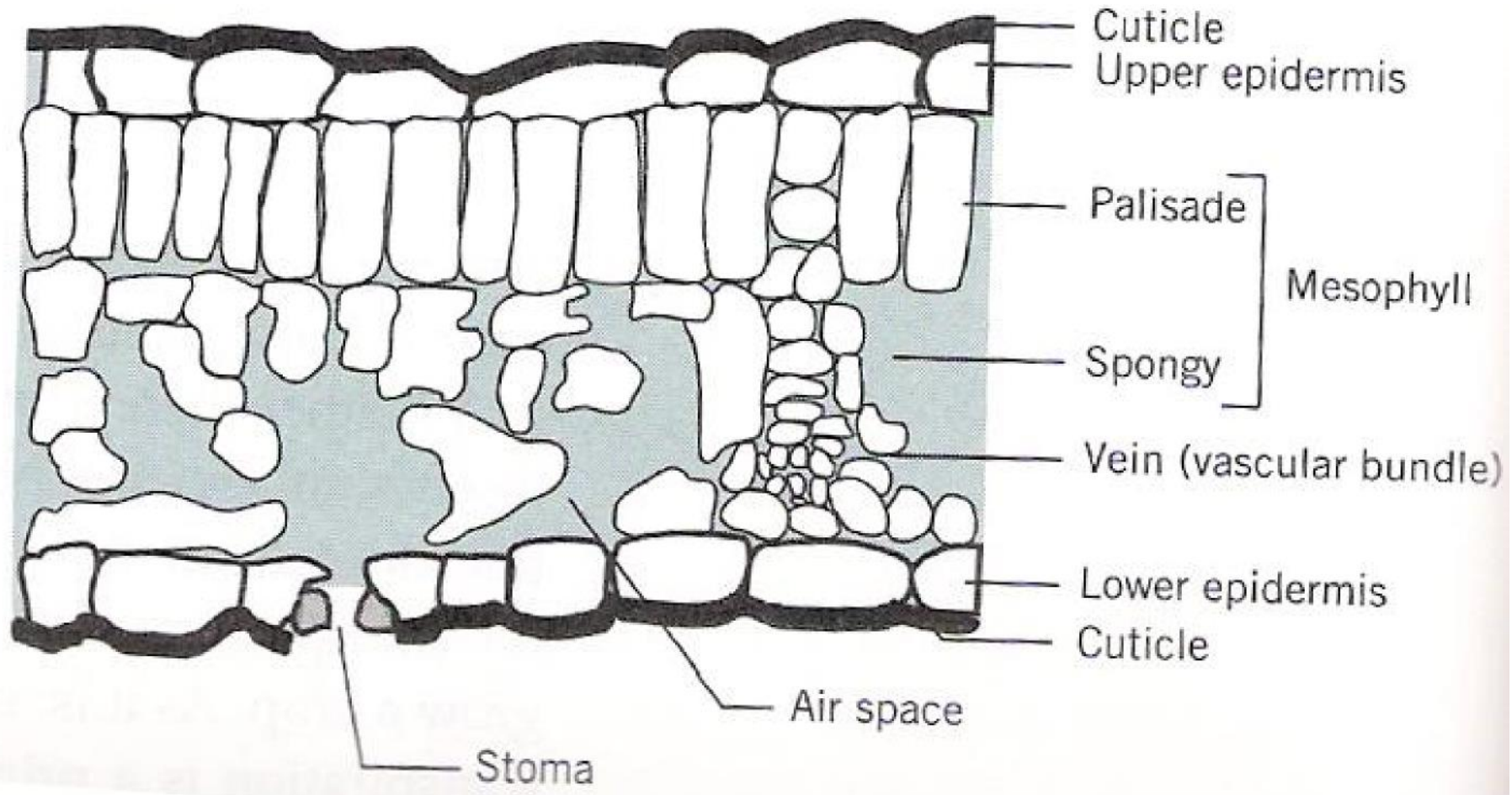
Demonstration of root pressure in the cut stump of a plant. Uptake of water by the plant roots causes the mercury to rise in the column. Pressures of 3 to 5 bars have been demonstrated by this method.

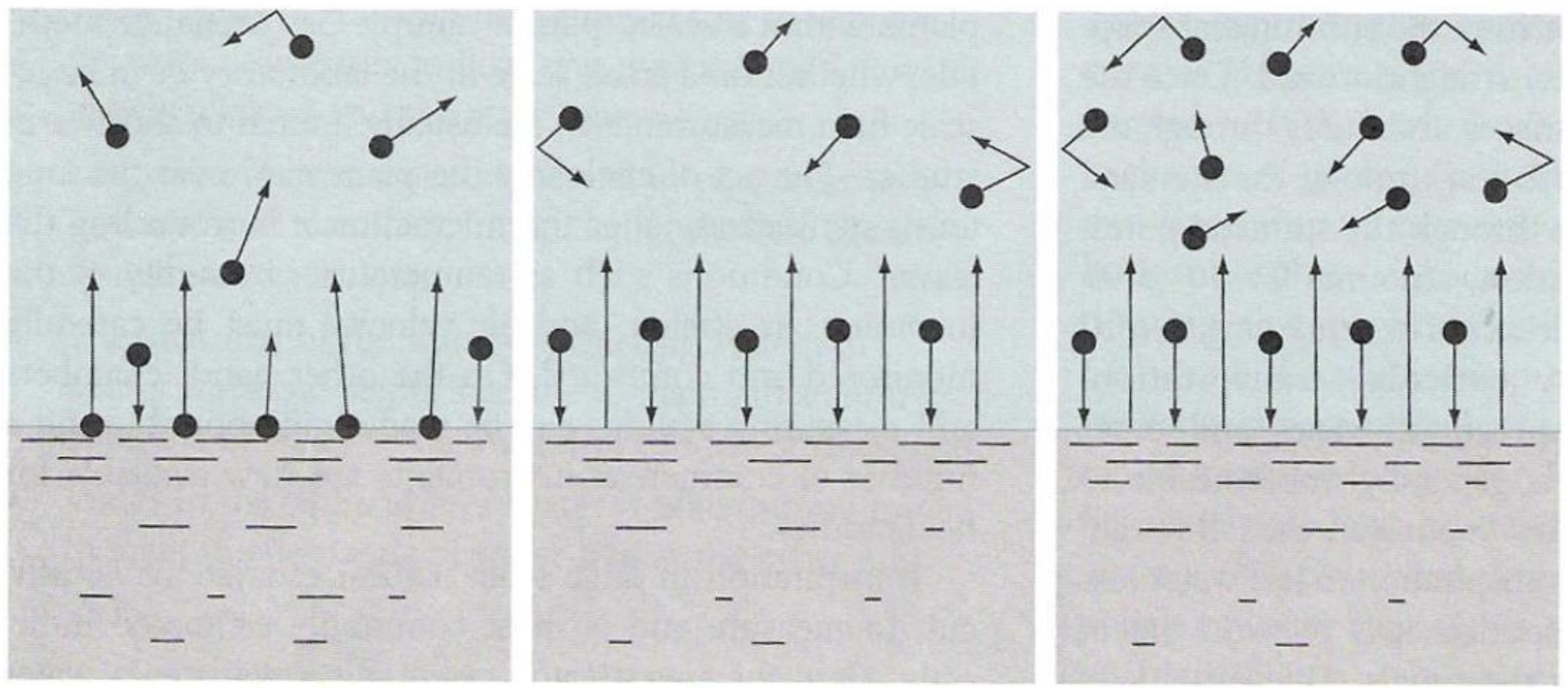
<http://www.biog1105-1106.org/demos/105/unit5/rootpressure.html>, April 27 2012, 13:46

TRANSPIRAÇÃO

FIGURE 4.11 Water pathway through the leaf. Water is pulled from the xylem into the cell walls of the mesophyll, where it evaporates into the air spaces within the leaf. Water vapor then diffuses through the leaf air space, through the stomatal pore, and across the boundary layer of still air found next to the leaf surface. CO₂ diffuses in the opposite direction along its concentration gradient (low inside, higher outside).







A.

B.

C.

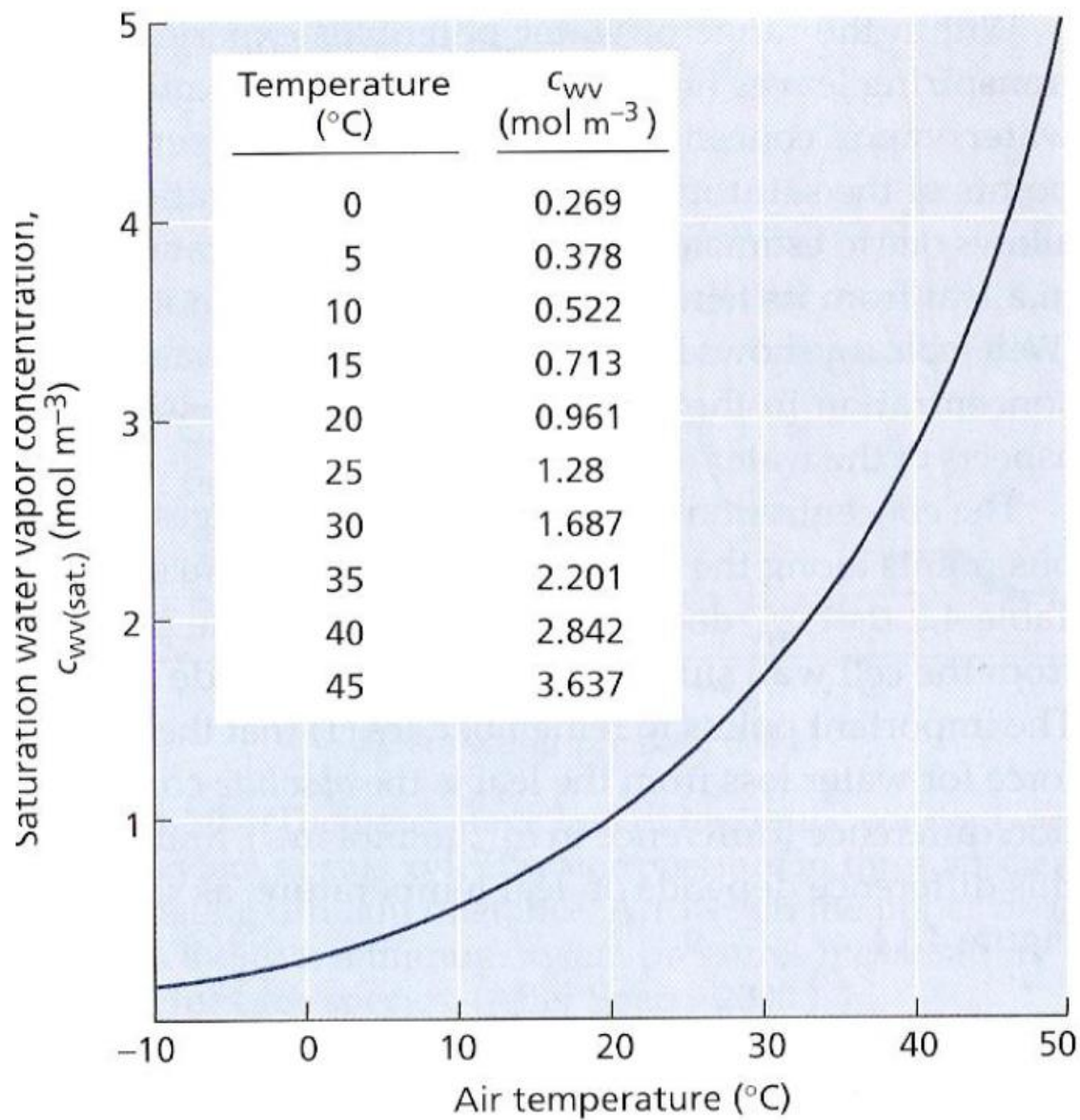


TABLE 3.1 Water vapor pressure (kPa) in air as a function of temperature and varying degrees of saturation. Air is saturated with water vapor at 100% relative humidity (RH).

Temperature (C)	Relative Humidity				
	100%	80%	50%	20%	10%
30	4.24	3.40	2.12	0.85	0.42
20	2.34	1.87	1.17	0.47	0.23
10	1.23	0.98	0.61	0.24	0.12

TABLE 3.2 Some values for water potential (Ψ) as a function of relative humidity (RH) at 20 °C.

RH(%)	Ψ (MPa)*
100	0
95	-6.9
90	-14.2
50	-93.5
20	-217.1

***Checklist* de Conhecimentos e Competências a Adquirir:**

- Conhecer a constituição do xilema e a relação entre a sua estrutura e a função de transporte.
- Conhecer o fenómeno da cavitação, as suas causas e as suas consequências fisiológicas.
- Ter capacidade para explicar, à luz da teoria da coesão - tensão, a ascensão de água nas plantas
- Compreender a relação entre transpiração e transporte xilémico; conhecer os factores ambientais que condicionam a transpiração.

Sumário:

Características e constituição do xilema: traqueídeos e traqueias ou elementos dos vasos. A cavitação. A teoria da Coesão - Tensão. A transpiração.

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Nuclear

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Complementar

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