RELAÇÕES HÍDRICAS NAS PLANTAS

2 DE MARÇO DE 2018

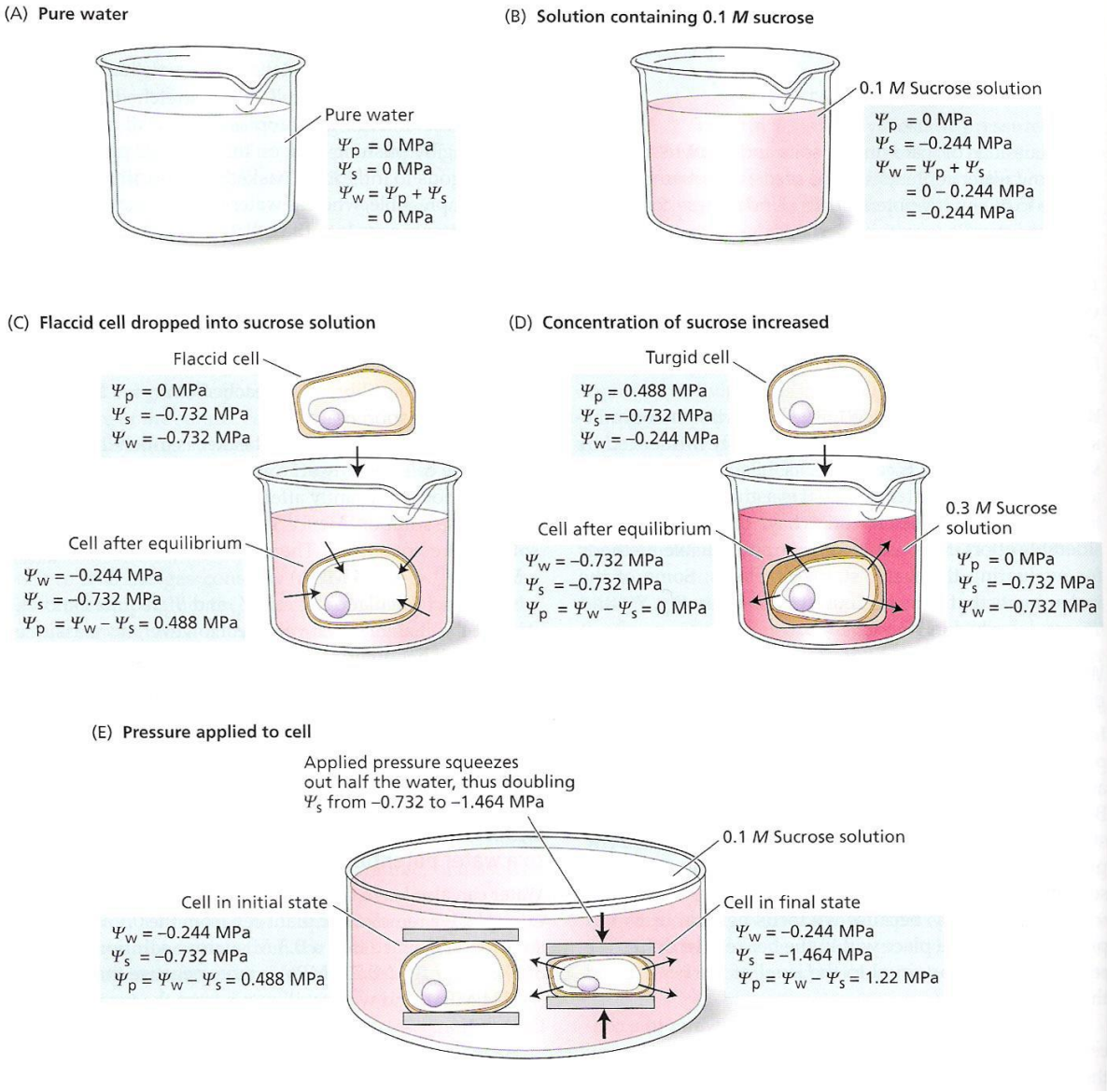
(3ª aula do bloco)

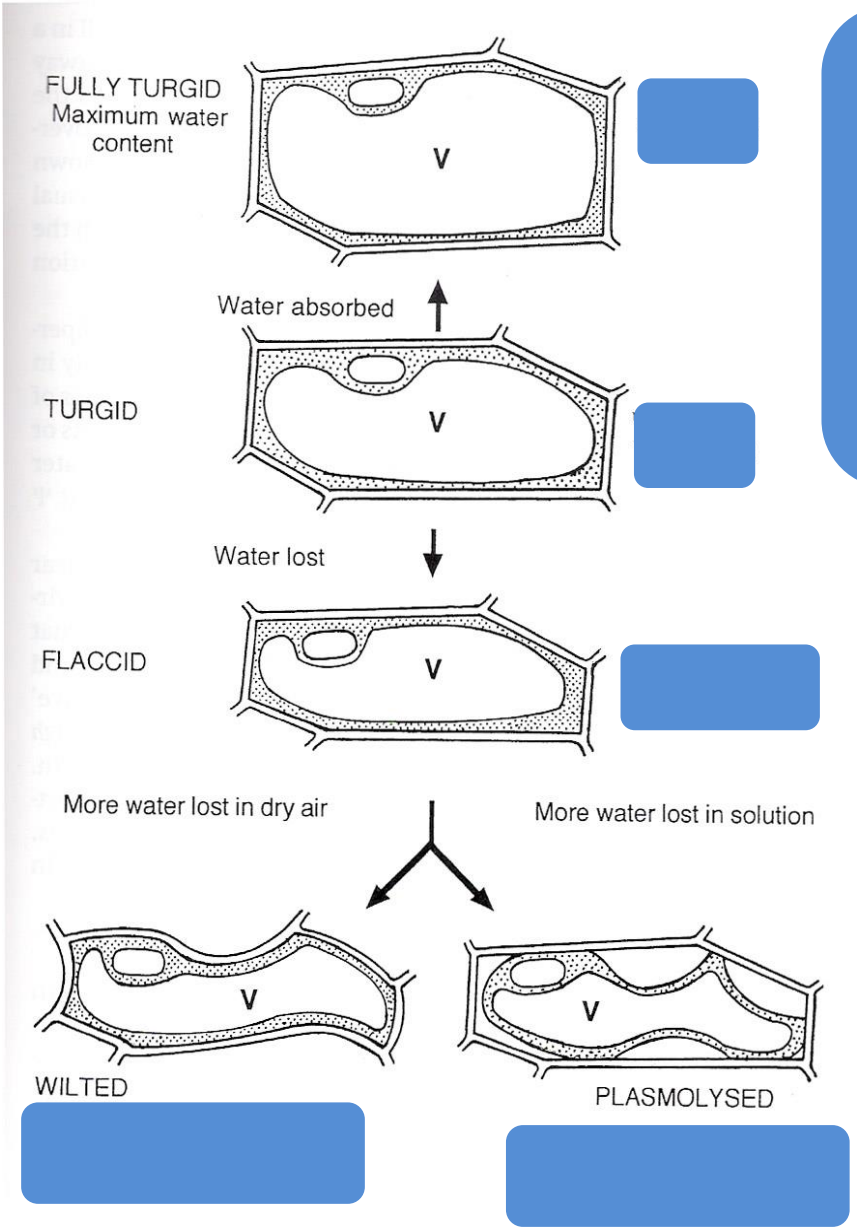
Sumário da Aula Anterior:

Aspetos da célula vegetal relevantes para as relações hIdricas: o vacúolo e a parede celular. A deslocação da água por fluxo de massa e por difusão. A osmose como um caso especial de difusão. O potencial hÍdrico e os seus componentes. Componentes do potencial hIdrico relevantes nos sistemas vegetais. Os potenciais hídrico, osmótico e de pressão no contexto da célula vegetal. Previsão de movimentos celulares de água. Turgescência e plasmólise.

Programa Para a Aula de Hoje:

Continuação da aula anterior: os potenciais hídrico, osmótico e de pressão no contexto da célula vegetal; previsão de movimentos celulares de água. Turgescência e plasmólise. Movimentos transmembranares de água e aquaporinas. Métodos de determinação do potencial hídrico e dos seus componentes: Shardakov, psicrometria, bomba de Scholander, sonda de pressão e osmometria crioscópica.


(A) Pure water
Pure water
Ψ_p = 0 MPa
Ψ_s = 0 MPa
$\Psi_w = \Psi_p + \Psi_s$
= 0 MPa
(B) Solution containing 0.1 M sucrose
0.1 M Sucrose solution
Ψ_p = 0 MPa
Ψ_s = –0.244 MPa
$\Psi_w = \Psi_p + \Psi_s$
= 0 – 0.244 MPa
= –0.244 MPa
(C) Flaccid cell dropped into sucrose solution
Flaccid cell
Ψ_p = 0 MPa
Ψ_s = –0.732 MPa
Ψ_w = –0.732 MPa
Cell after equilibrium
Ψ_w = –0.244 MPa
Ψ_s = –0.732 MPa
$\Psi_p = \Psi_w - \Psi_s$ = 0.488 MPa
(D) Concentration of sucrose increased
Turgid cell
Ψ_p = 0.488 MPa
Ψ_s = –0.732 MPa
Ψ_w = –0.244 MPa
Cell after equilibrium
Ψ_w = –0.732 MPa
Ψ_s = –0.732 MPa
$\Psi_p = \Psi_w - \Psi_s$ = 0 MPa
0.3 M Sucrose solution
Ψ_p = 0 MPa
Ψ_s = –0.732 MPa
Ψ_w = –0.732 MPa
(E) Pressure applied to cell
Applied pressure squeezes out half the water, thus doubling Ψ_s from –0.732 to –1.464 MPa
0.1 M Sucrose solution
Cell in initial state
Ψ_w = –0.244 MPa
Ψ_s = –0.732 MPa
$\Psi_p = \Psi_w - \Psi_s$ = 0.488 MPa
Cell in final state
Ψ_w = –0.244 MPa
Ψ_s = –1.464 MPa
$\Psi_p = \Psi_w - \Psi_s$ = 1.22 MPa


FULLY TURGID
Maximum water content
V
Water absorbed
TURGID
V
Water lost
FLACCID
V
More water lost in dry air
More water lost in solution
V
V
WILTED
PLASMOLYSED

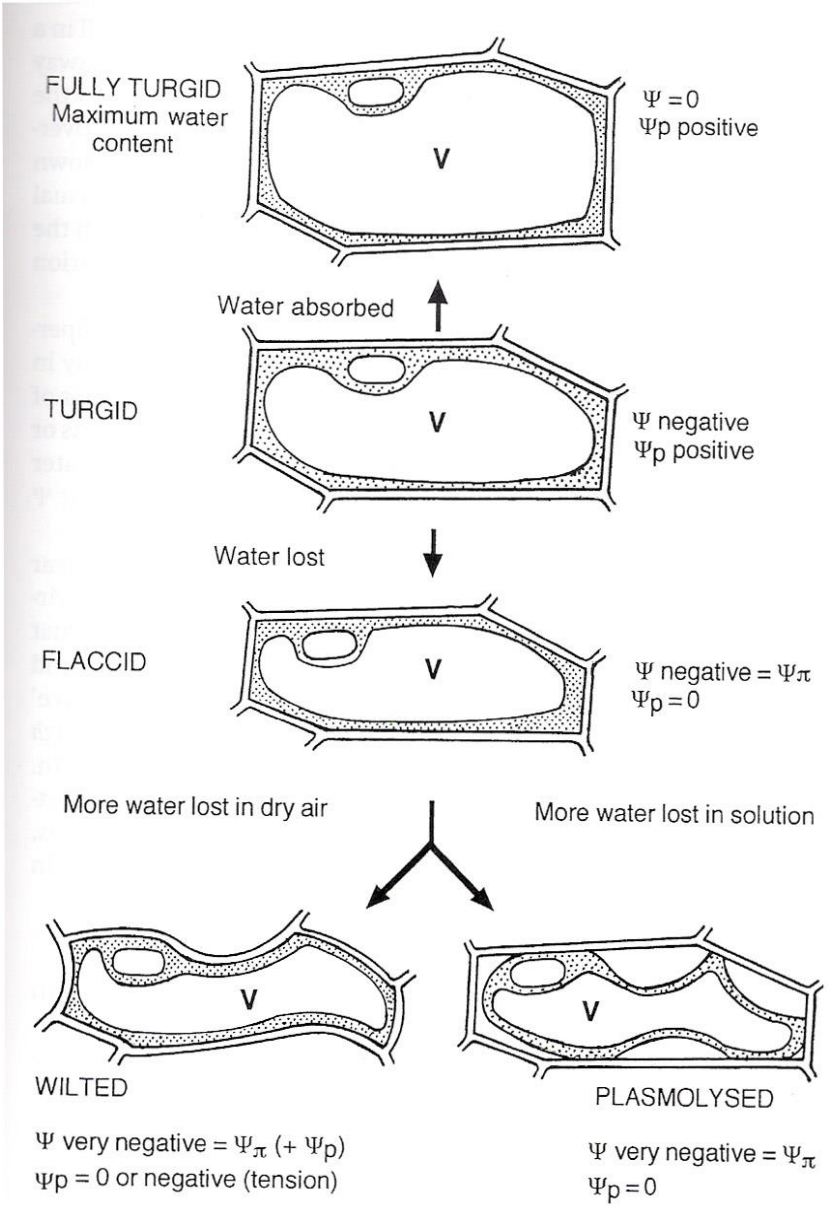


Fig. 3.1 Effect of water absorption and water removal on a plant cell. Starting with a turgid cell (second from top), *absorption of water* leads to increase in turgidity and Ψ increases up to a maximum of 0. *Water loss* beyond a certain level in a solution of low Ψ results in plasmolysis, shrinkage of cell contents from the wall. Water loss in dry air results in wilting and the pull of the shrinking contents on the wall can lead to a wall tension instead of a pressure. V = vacuole.

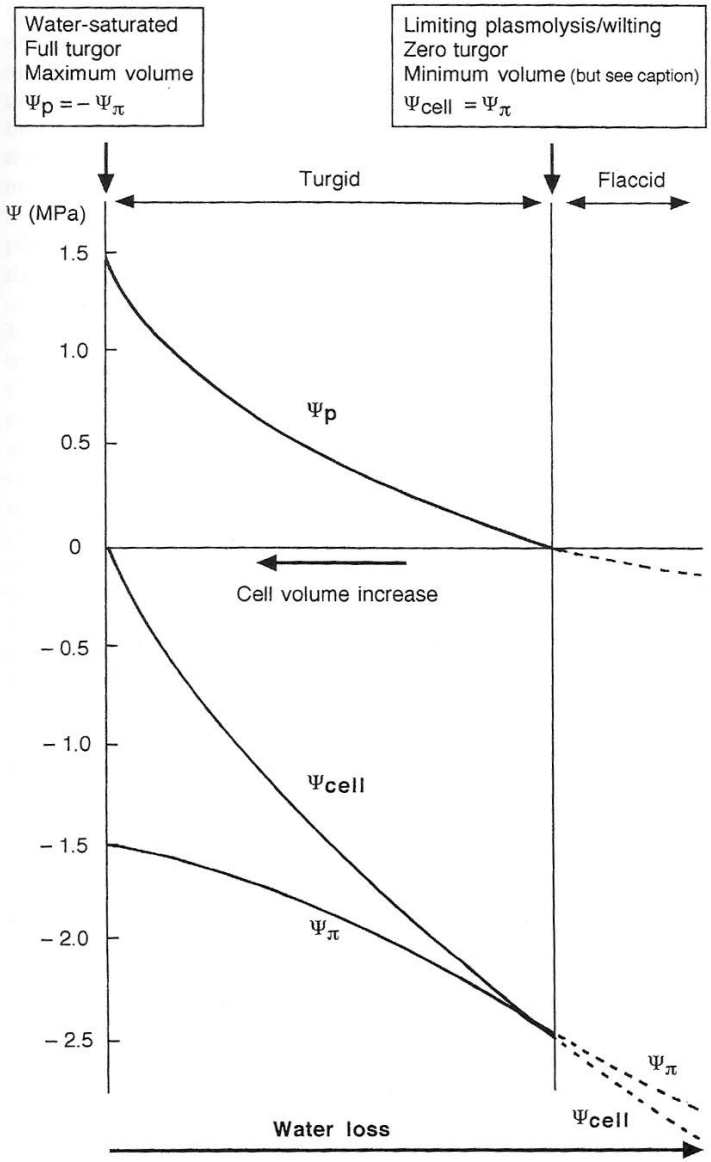
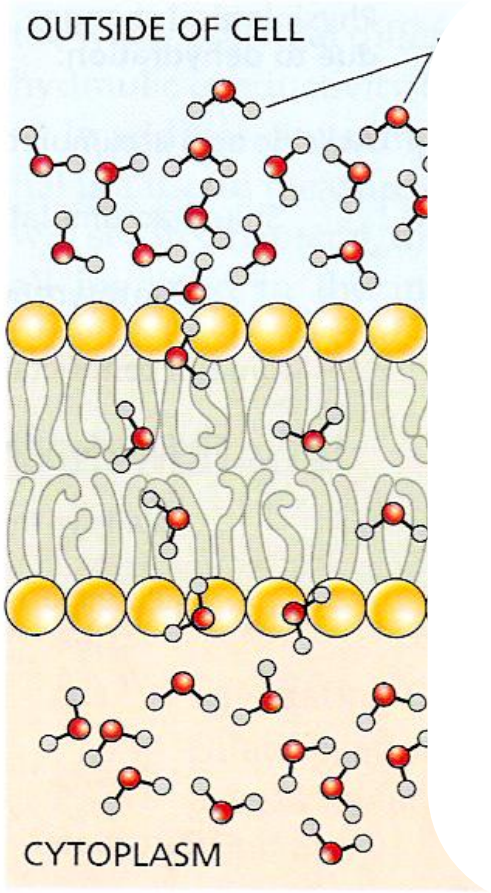


Fig. 3.2 Generalized quantitative relationship between overall cell Ψ, Ψ_p, Ψ_π and cell volume. Note that the *x*-axis scale runs from a maximum value for the volume on the left, at full turgor, to a minimum value at the point of limiting plasmolysis/ wilting. The extent to which the cell volume varies between these points depends greatly on the extensibility of the cell wall; hence no numerical values are given, but if the volume at full turgidity is taken as 100%, the minimum values quoted for different cells vary from about 95% to 70%. The dashed lines indicate what happens if the cell wall caves in under tension after limiting wilting: the volume decreases still further, Ψ_p becomes negative (top section of graph), and the cell Ψ falls below Ψ_π (bottom section of graph). If the wall does not cave in, but the cell wrinkles, Ψ continues to equal Ψ_π with further water loss.


OUTSIDE OF CELL
CYTOPLASM

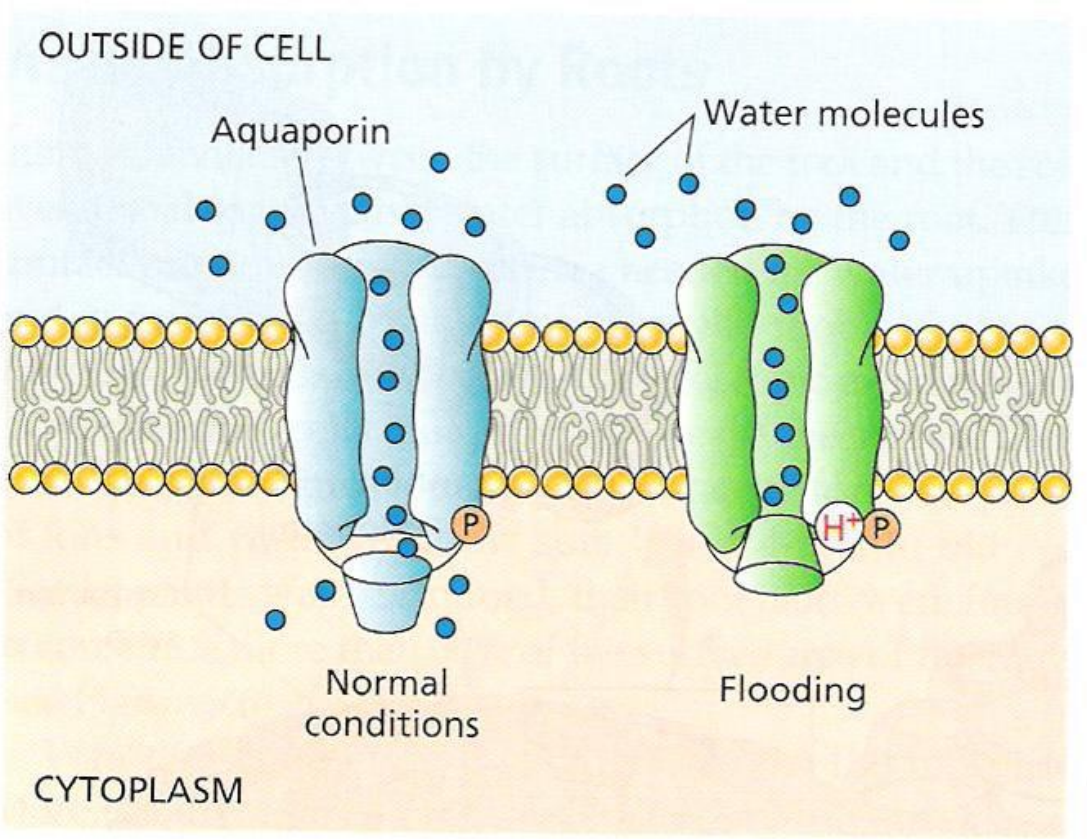


FIGURE 4.5 Stereo model of the spinach plasma membrane aquaporin (SoPIP2;1) in its open (blue) and closed (green) conformations. Closure in response to drought results from the dephosphorylation of two highly conserved serine residues, whereas closure during flooding results from the protonation of a conserved histidine. (After Törnroth-Horsefield et al. 2006).

Peter Agre (1992) John Hopkins University (Prémio Nobel da Química 2003)

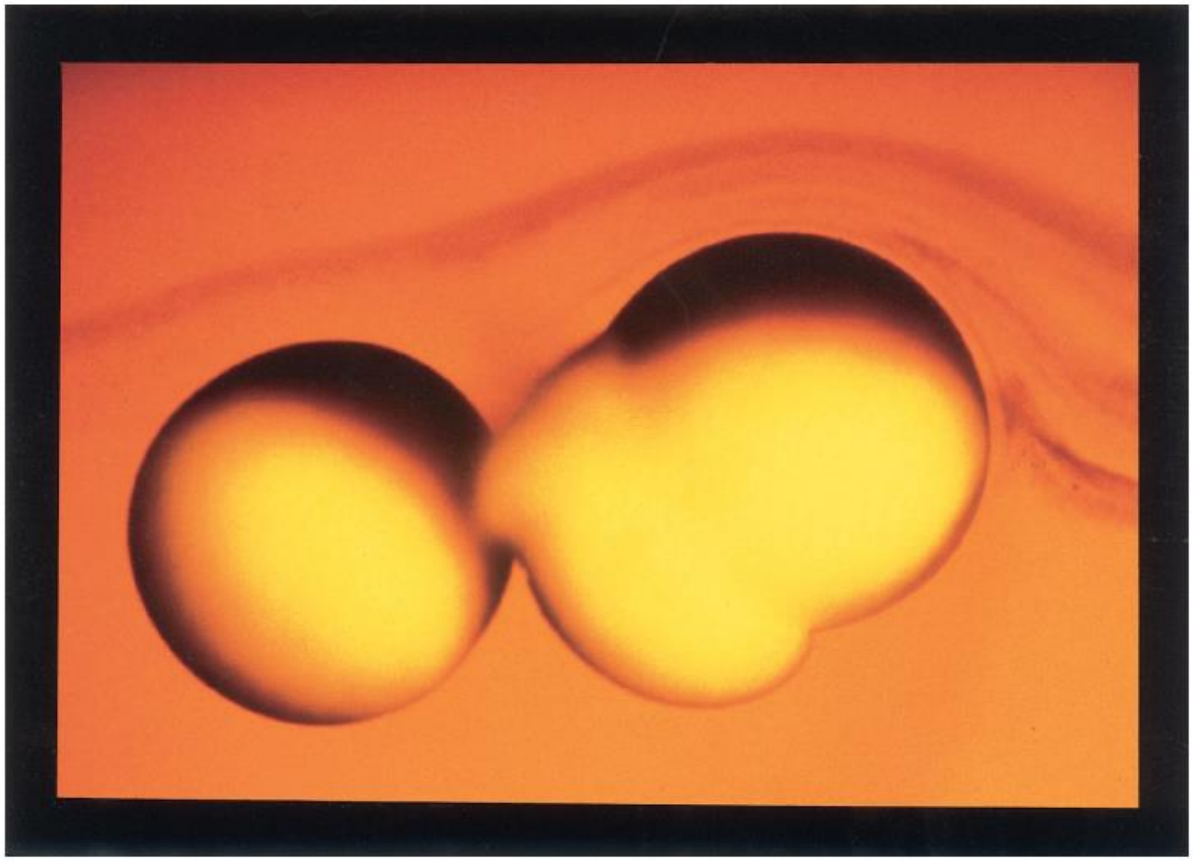


Figure 1 Water permeability of aquaporin-1 expressed in *Xenopus* oocytes. (*left*) When transferred to hypo-osmolar buffer for 2 min, control oocytes exhibit negligible water permeability. (*right*) Under the same conditions, oocytes previously injected with aquaporin-1 (AQP1) cRNA rapidly swell and explode. Reproduced and modified with permission (175).

Annu. Rev. Biochem. 1999. 68:425–458

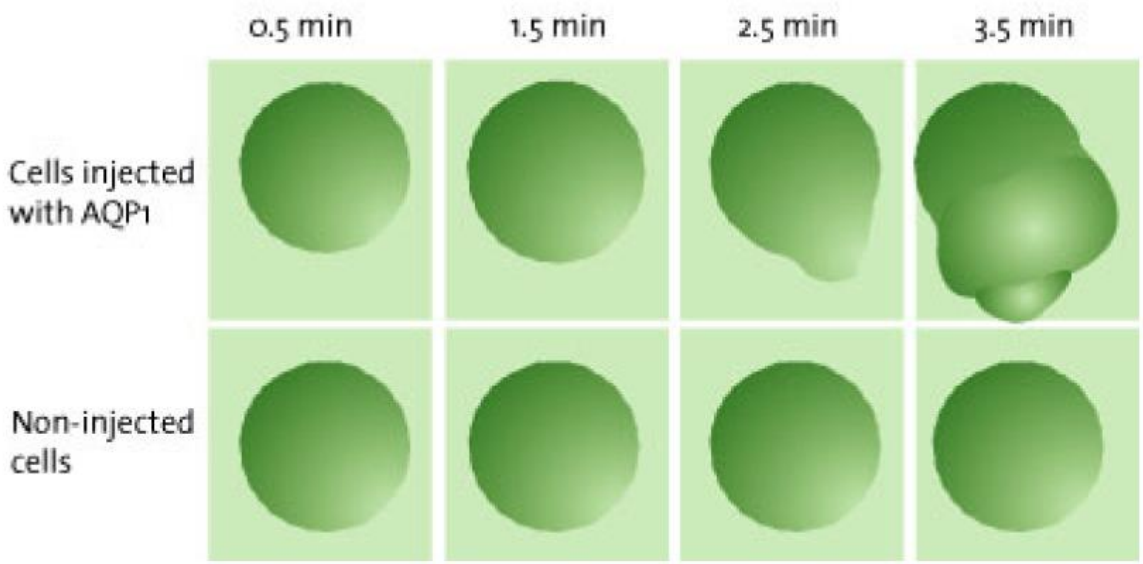
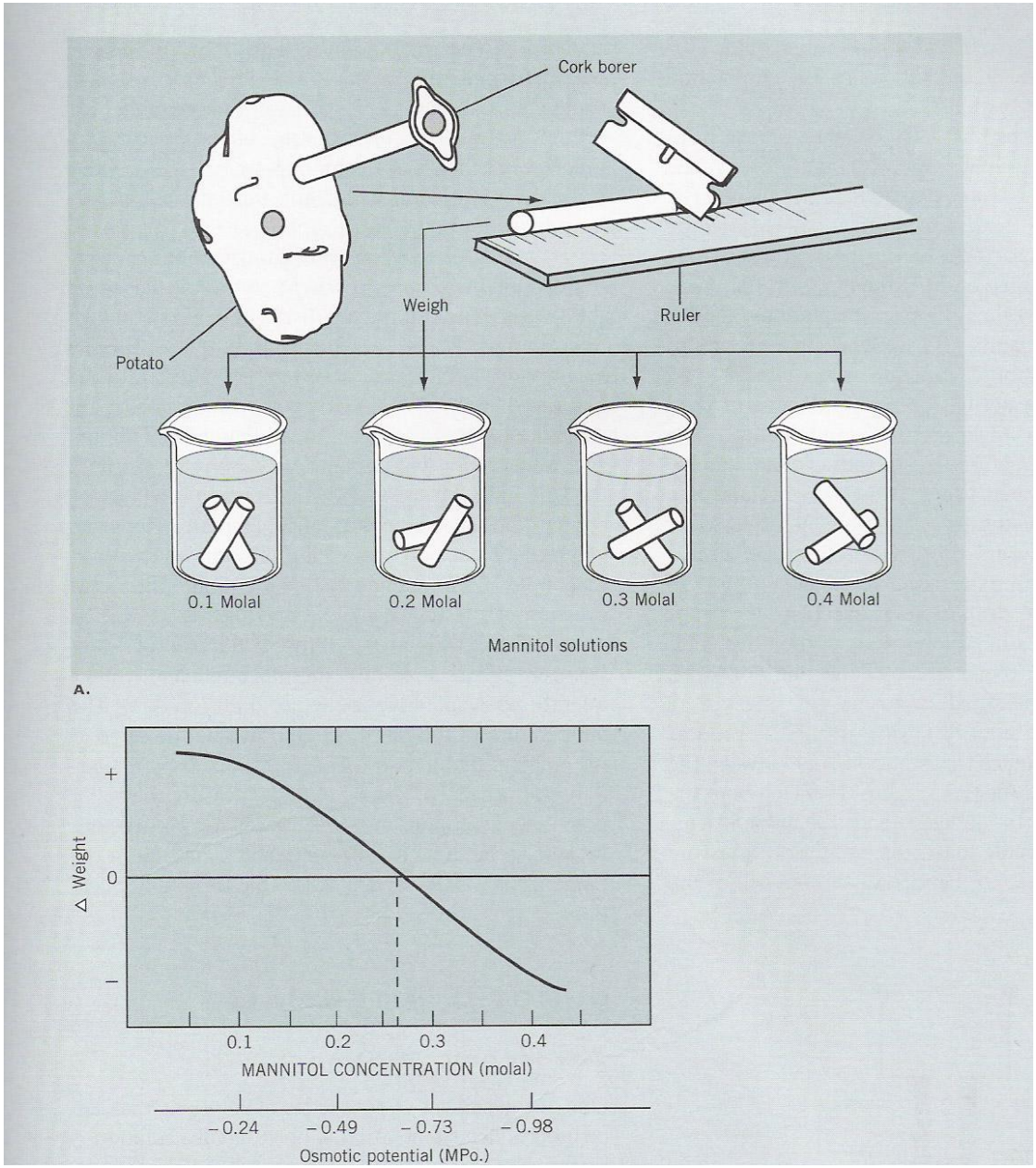


Fig.1. *Xenopus* oocytes microinjected with AQP1 mRNA swell rapidly when placed in a hypo-osmotic medium, in contrast to noninjected oocytes.

http://www.nobelprize.org/nobel_prizes/chemistry/laureates/2003/advanced-chemistryprize2003.pdf


Cork borer
Weigh
Ruler
Potato
0.1 Molal
0.2 Molal
0.3 Molal
0.4 Molal
Mannitol solutions
A.
+
0
−
△ Weight
0.1
0.2
0.3
0.4
MANNITOL CONCENTRATION (molal)
– 0.24
– 0.49
– 0.73
– 0.98
Osmotic potential (MPo.)

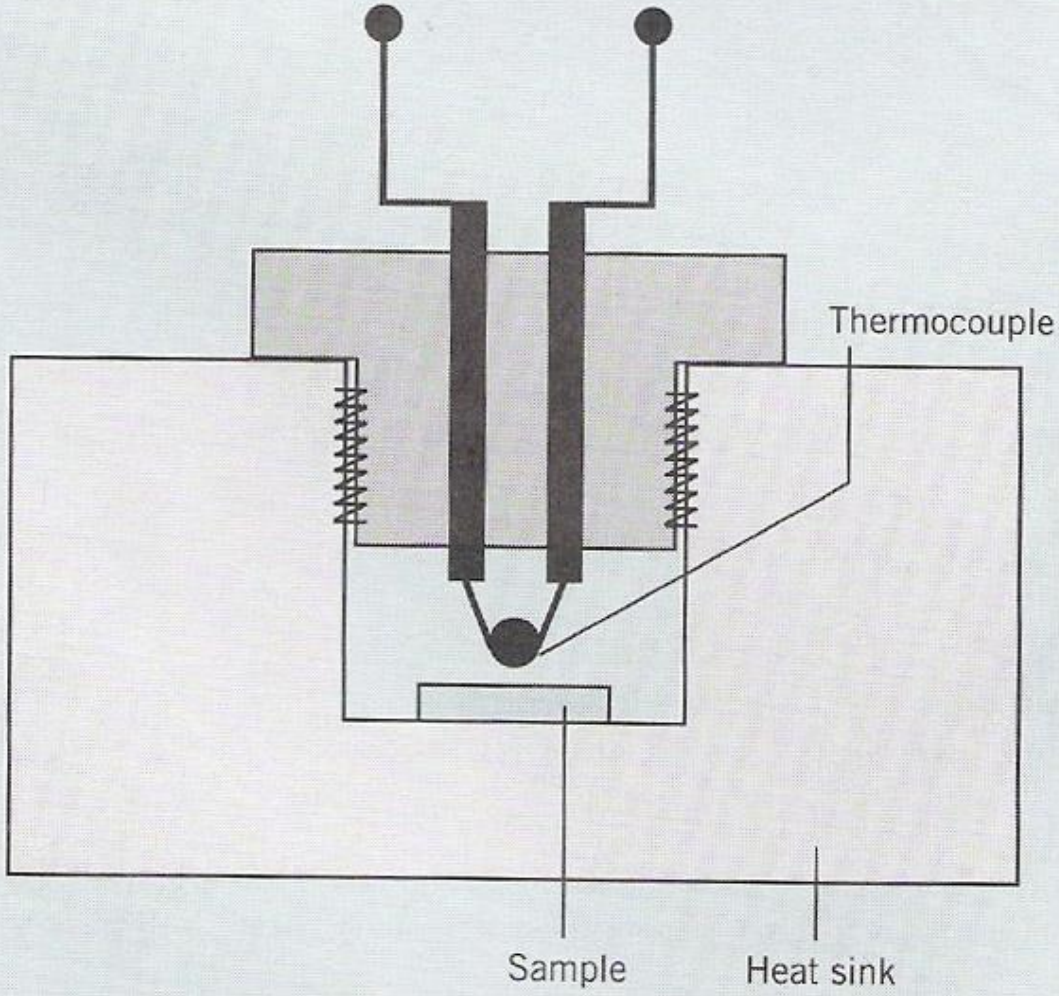
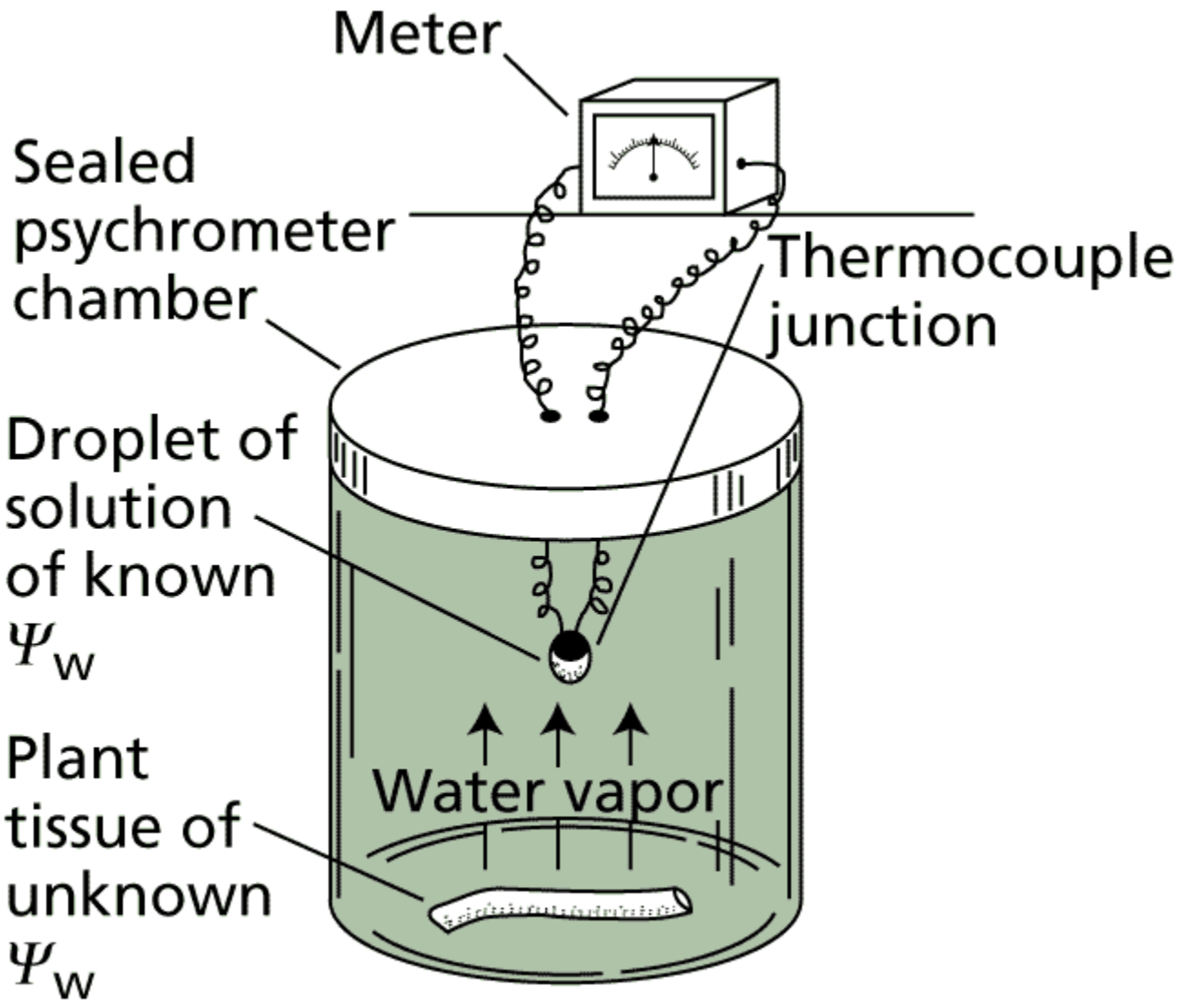
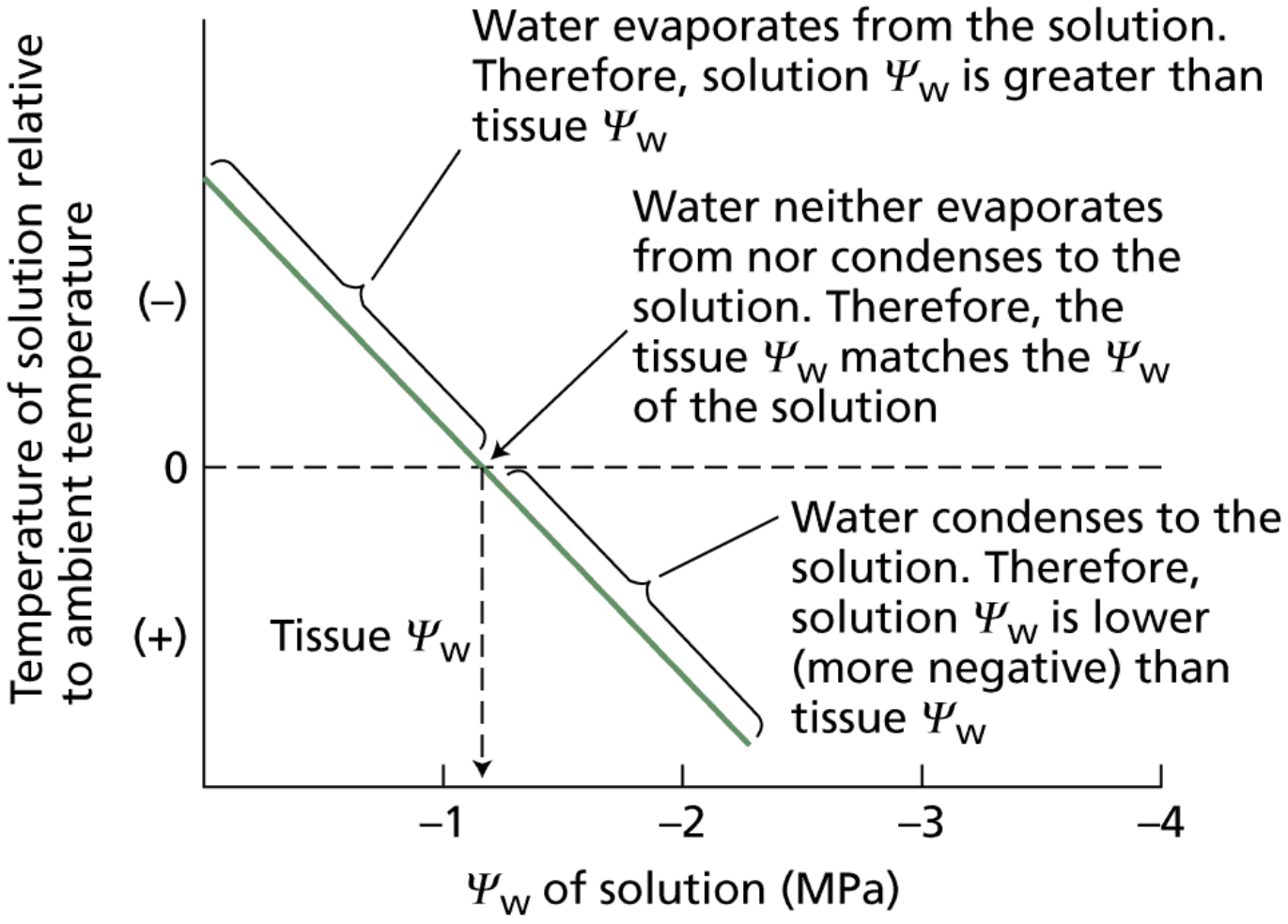
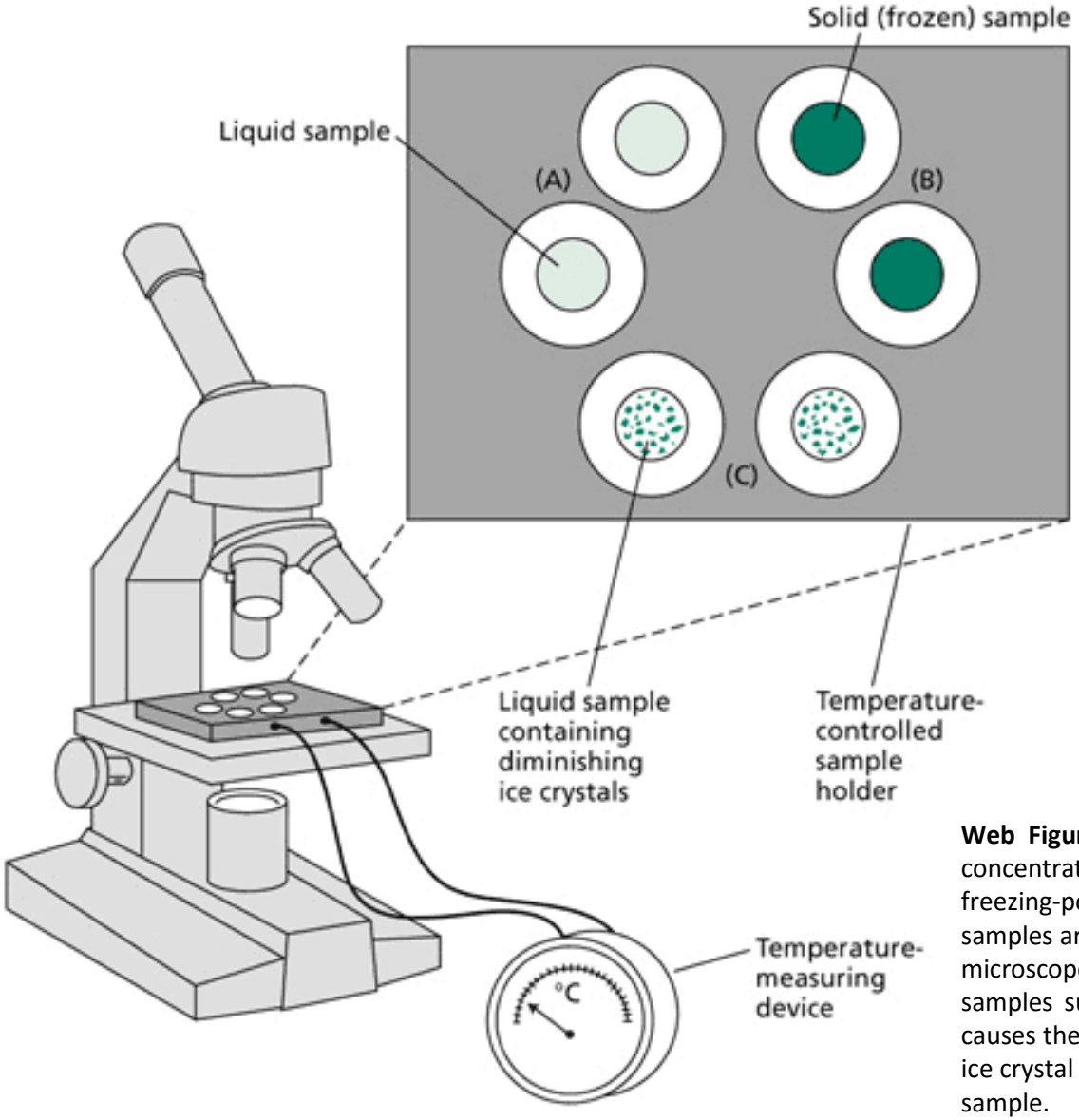


FIGURE 2.8 Continued.
(C) Diagram of the thermocouple psychrometer sample chamber.


Meter
Sealed psychrometer chamber
Thermocouple junction
Droplet of solution of known Ψ_w
Plant tissue of unknown Ψ_w
Water vapor


Water evaporates from the solution. Therefore, solution Ψ_w is greater than tissue Ψ_w
Water neither evaporates from nor condenses to the solution. Therefore, the tissue Ψ_w matches the Ψ_w of the solution
Water condenses to the solution. Therefore, solution Ψ_w is lower (more negative) than tissue Ψ_w
Tissue Ψ_w
Temperature of solution relative to ambient temperature
(–)
0
(+)
–1
–2
–3
–4
Ψ_w of solution (MPa)



Web Figure 3.6.D A cryoscopic osmometer measures the concentration of total dissolved solutes by measuring the freezing-point depression of a solution. (A) Very small liquid samples are loaded onto the temperature-controlled stage of a microscope. (B) When the temperature is quickly reduced, the samples supercool and freeze. (C) Slowly warming the stage causes the samples to thaw. The temperature at which the last ice crystal melts provides a measure of the melting point of the sample.

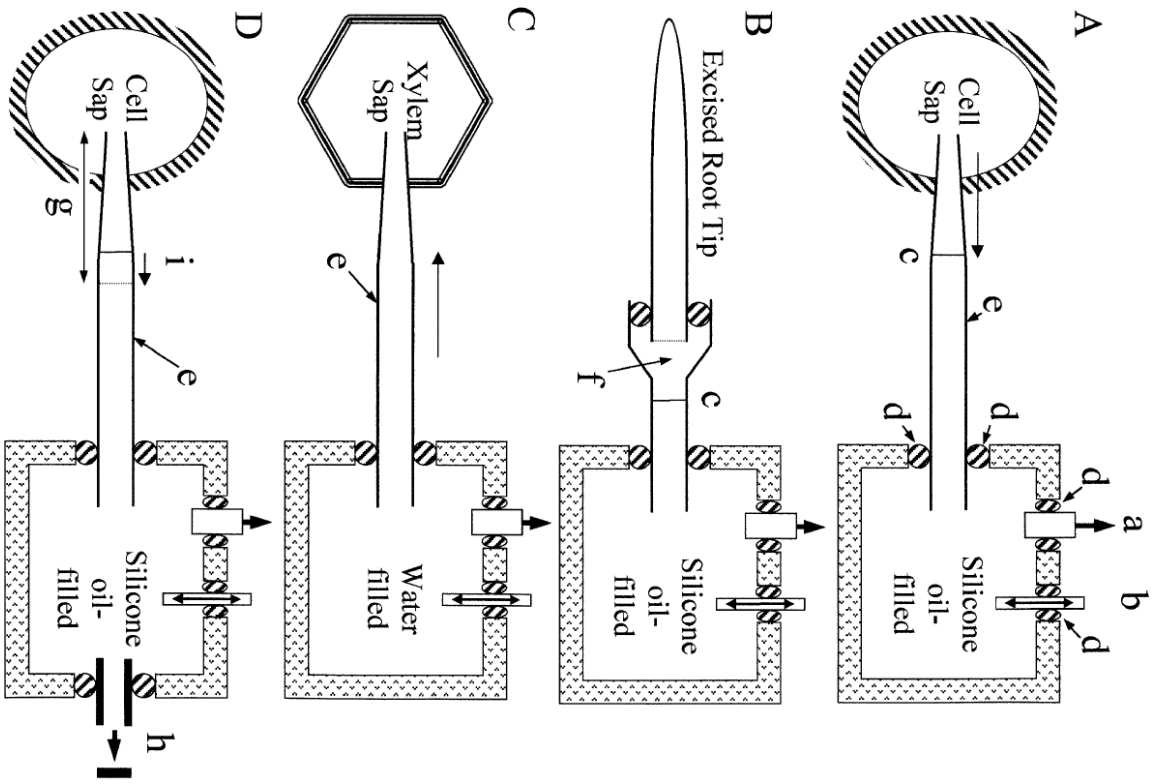


Figure 1 Diagrammatic representations (somewhat simplified) of the variants of the pressure probe currently being used. *A*, cell pressure probe; *B*, root pressure probe; *C*, xylem pressure probe; *D*, sampling pressure probe; *a*, pressure transducer and output; *b*, remote-controlled piston; *c*, water/oil interface (meniscus); *d*, compressible rubber seals; *e*, glass micro-capillary; *f*, solution placed in the probe prior to the attachment of the root; *g*, sample volume of cell sap that can be removed from cell in SiCSA technique; *h*, valve venting oil reservoir to atmospheric pressure; and *i*, movement of meniscus on opening of valve.

Annu. Rev. Plant Physiol. Plant Mol. Biol. 1999. 50:447–72

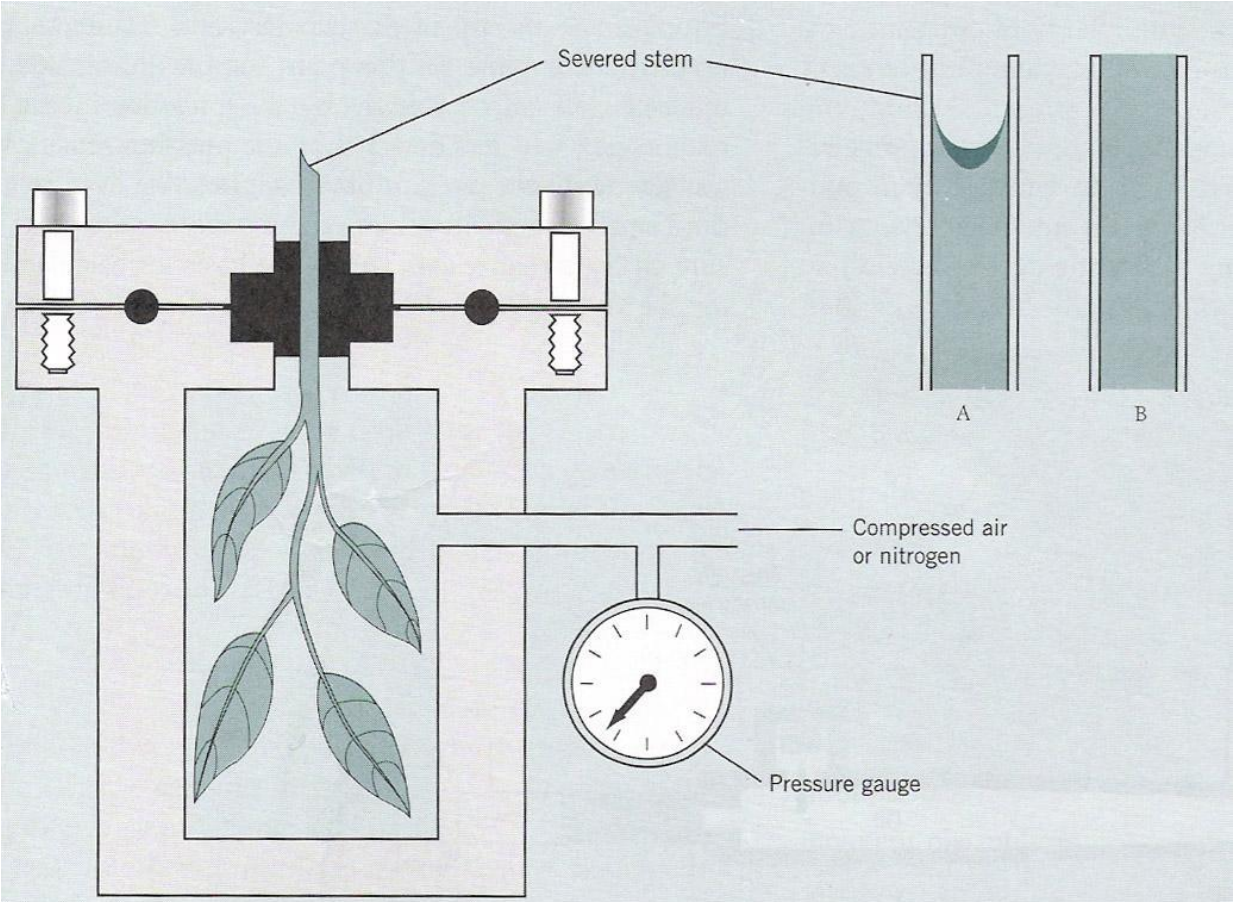
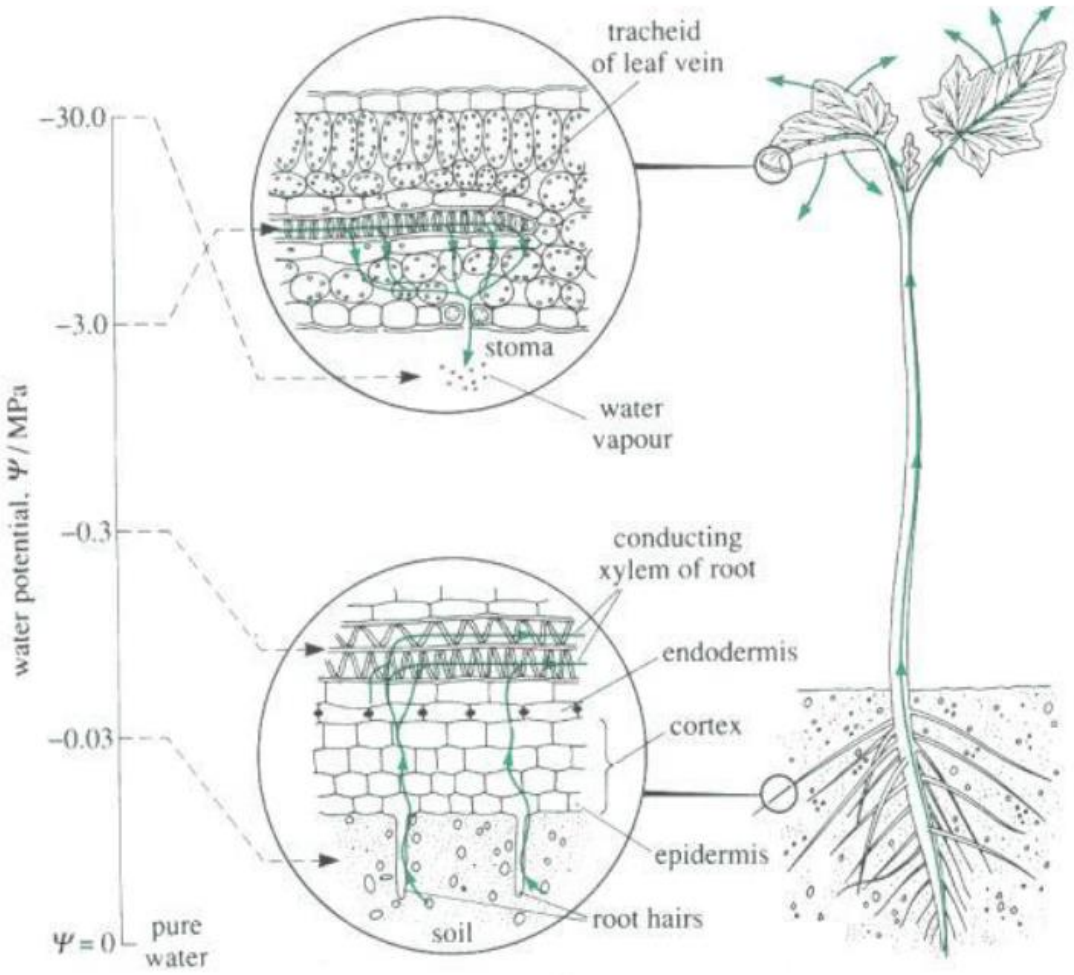
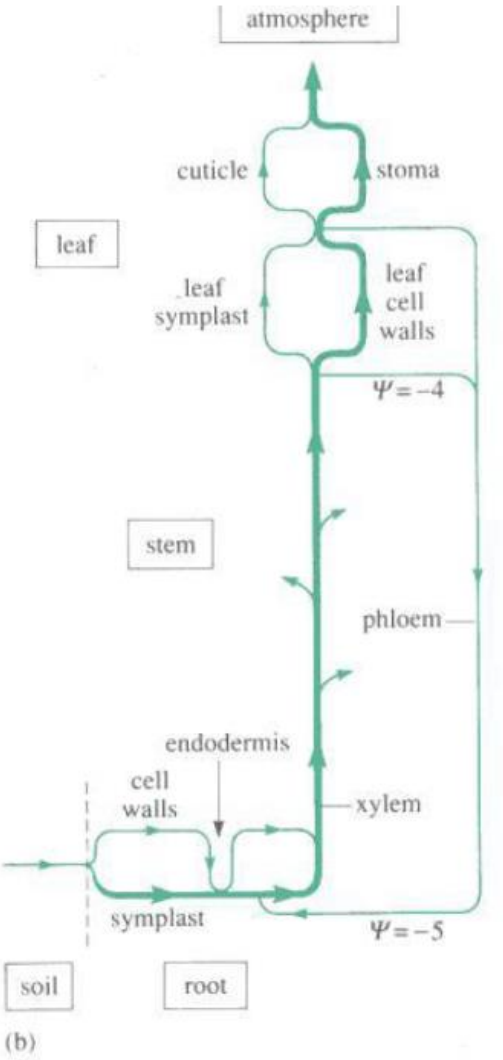


FIGURE 2.8 Continued.

(D) Diagram of a pressure bomb for measuring xylem pressure. To make a measurement, a severed shoot or branch is quickly sealed in a pressure chamber. Only the severed end is left protruding from the chamber. The chamber is then pressurized with nitrogen gas until xylem sap just emerges at the cut surface. At this point, the positive pressure required to force xylem exudate from the tissue (displayed by the pressure gauge) is equal to the negative water potential of the xylem. If it is assumed that the osmotic potential of the xylem is small and can be ignored, the pressure in the xylem is approximately equal to its water potential. The position of the water column in a xylem vessel before and after pressurizing the chamber is illustrated in (A) and (B), respectively.





Soil-Plant-Atmosphere continuum

Checklist de Conhecimentos e Competências a Adquirir:

- Ser capaz de, calculando o potencial hídrico a partir das suas componentes, prever o movimento de água entre células ou compartimentos celulares vegetais;

- Compreender os conceitos de turgescência (máxima) e de plasmólise (incipiente);

- Compreender o papel das aquaporinas nos movimentos transmembranares de água;

- Conhecer os métodos experimentais de medição do potencial hídrico e dos seus componentes (Shardakov, psicrometria, bomba de Scholander, sonda de pressão e osmometria crioscópica); compreender o seu fundamento físico e ser capaz de enunciar as vantagens e desvantagens de cada um.

Sumário:

Continuação da aula anterior: os potenciais hídrico, osmótico e de pressão no contexto da célula vegetal; previsão de movimentos celulares de água. Turgescência e plasmólise. Movimentos transmembranares de água e aquaporinas. Métodos de determinação do potencial hídrico e dos seus componentes: Chardakov, psicrometria, bomba de Scholander, sonda de pressão e osmometria crioscópica.

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Complementar

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