Republic of Iraq
Ministry of Higher Education
&Scientific Research
University of Anbar
College of Science

Lecture 4

Mathematical problems for calculating water potential

For
Dr. Enas Fahd Naji
Department of Biology

Mathematical problems for calculating water potentialWater potential (Ψ_w)

The sum of the forces that affecting on chemical energy (water potential) and these forces are the osmotic potential and the turgor pressure.

Osmotic potential (Ψ_s)

It is the decrease in water potential due to the presence of solutes, and its sign is negative.

Turgor pressure (Ψ_p)

It is the pressure formed inside the cell that pushes the membrane and the cell wall outward, and it is positive and its value is zero in the case of shrinking cells.

Cell wall pressure

Is the pressure which equal to turgor pressure and opposite in direction

$$\Psi_w = \Psi_s + \Psi_p$$

Q1/ What are the changes that happen to a shrunken plant cell A with an osmotic potential of -9 bar when placed in a solution with an osmotic potential of -3 bar and after the state of equilibrium with the solution was transferred and attached to another cell B with an osmotic potential of -5 bar and an turgor pressure of 4 bar?

$\Psi_p = 0$

$\Psi_w = \Psi_s$

$\Psi_w = -9$ bar

Equilibrium occurs when the water potentials are equal

$\Psi_{w(sol)} = \Psi_s$

$= -3$ bar

The water will move from the solution into the cell

$\Psi_{w(cell\ A)} = -3$

$-3 = -9 + \Psi_p$

$\Psi_p = 6$

Cell B

$\Psi_{w\ (cell\ B)} = -5+4$

$= -1$

The transition will be from B cell to A cell, After the equilibrium state between the two cell

Ψ_w for each cell after the equilibrium state $= \Psi_{w(cell\ A)} + \Psi_{w(cell\ B)} / 2$

$= -3+-1 / 2 = -2$

A cell $-2 = -9 + \Psi_p$

$= 7$

B cell $-2 = -5 + \Psi_p$

$= 3$

Q2/ Three adjacent cells, A cell has an osmotic potential of -7 bar and a turgor pressure of 2 bar, B cell with osmotic potential -11 bar and turgor pressure 5 bar and C cell with osmotic potential -6 bar and turgor pressure 2 bar:

a- What are the changes that happen to cells after the state of equilibrium occurs?

b- If cell C is immersed after the state of equilibrium in a solution whose osmotic potential is -3 bar, what are the changes that occur to the cells after the state of equilibrium between cells and solution occurs, then show the direction of water movement, explaining the reason?

The state of equilibrium between the three cells occurs when the water potentials of these cells are equal

$\Psi_{w\ (cell\ A)} = -7+2 = -5$

$\Psi_{w\ (cell\ B)} = -11+5 = -6$

$\Psi_{w\ (cell\ C)} = -6+2 = -4$

Ψ_w for each cell after equilibrium state $= \Psi_{w(cell\ A)} + \Psi_{w(cell\ B)} + \Psi_{w(cell\ C)} / 3$

$= -5 + -6 + -4 / 3 = -5$

After equilibrium state

$\Psi_{p\ (cell\ A)} = 7-5 = 2$

$\Psi_{p\ (cell\ B)} = 11-5 = 6$

$\Psi_{p\ (cell\ C)} = 6-5 = 1$

b-After equilibrium state between C cell and solution

$\Psi_{w(sol)} = \Psi_{s(sol)} + \Psi_p$

$\Psi_p = 0$

$\Psi_{w(sol)} = \Psi_{s(sol)} = -3$

Equilibrium state between the cell and solution occurs when the water potentials are equal , water potential for solution is constant .

$\Psi_{w\ (cell\ C)} = -3$

$-3 = -6 + \Psi_p = 3$

Thus, what is applied to cell C applies to cell A and B, The direction of water movement is from the least negative to the most negative in water potential.

References:

1. Plant Physiology, 3rd ed by Lincoln Taiz and Eduardo Zeiger, 2002

2. Plant Physiology, Development and Metabolism, Satish C Bhatla , Manju A. Lal, 2018. ISBN 978-981-13-2022-4 ISBN 978-981-13-2023-1 (eBook)

3. PLANT PHYSIOLOGY Vince Ördög , 2011 .

4. Plant Solute Transport Edited by ANTHONY YEO Haywards Heath, West Sussex, UK, TIM FLOWERS School of Life Sciences University of Sussex, UK, 2007.

5. اساسيات فسيولوجيا النبات ، أ.د. حشمت سليمان احمد الدسوقي، قسم النبات، كلية العلوم ، جامعة المنصورة ، جمهورية مصر العربية ، 2008.

6. أساسيات فسيولوجيا النبات ، د. بسام طه ياسين ، قسم العلوم البيولوجية ، كلية العلوم ، جامعة قطر ، 2001.