Water Potential and Living Plant Cells

Information for AP Lab 1

Before you read this material make sure you are familiar with the basics of osmosis. You should understand osmosis, diffusion and the terms turgor pressure, hypertonic, hypotonic and isotonic.

Plant Cells in Pure Water

If plant cells are placed in pure water(a hypotonic solution) water will initially move into the cells. After a period of time the cells will become turgid. Turgor pressure is the pressure exerted against the cell wall by contents of the cell. At first most water movement is into the cell. As the turgor pressure increases water will begin to diffuse out of the cell at a greater rate, eventually equilibrium will be reached and water will enter and leave the cell at the same rate.

Free Energy and Water Potential

Free energy can be simply defined as the energy available(without temperature change) to do work. Chemical potential of a substance is the free energy per mole of that substance. Water potential is the chemical potential of water and is a measure of the energy available for reaction or movement(Bidwell 1974:59). Water potential is important when studying osmosis because it measures the ability of water to move, water always moves from areas of high potential to areas of low water potential.

The symbol for water potential is the Greek letter Psi. A hint given by Bidwell(1974) is that psi also can mean pounds per square inch, a measure of pressure! Water potential is measured in units of atmospheric pressure; bars or dynes per square centimeter. (1bar= 10^6 dynes/cm^2)

When working with plant cells water potential has two components. Osmotic potential(due to presence or absence of solutes) and pressure potential(due to turgor pressure). These two pressures have opposite effects on water movement. These two factors working together determine the direction of net water movement into or out of cells(Weier, et al. 1974). The symbols used for these are the Greek letter Psi sub Pi for osmotic potential and the Greek letter Psi sub P for pressure potential.

The formula for calculating water potential is:

Water Potential = Osmotic Potential + Pressure Potential

Water Potential in Plant Cells

Water will move by osmosis into and out of cells due to differences in water potential between the cell

and its surroundings. Remember that water always moves from areas of high potential to areas of low water potential.

AP lab 1 uses a simple technique to determine the water potential of potato cells. Solutions of varying osmotic potential(using sucrose molarity) from pure water to 1.0 molar sucrose are used with potato cores. Six solutions are used, each increasing in molarity by 0.2. The potato samples are weighed before they are placed in the solutions and after 24 hours in each solution. The percent weight change is plotted on a graph and the point at which no weight change occurs is determined. The solution in which the potato cells do not change weight has the same water potential as the potato cell contents. This is the point on the graph where the line intersects 0(zero).

Some Basic Principles

- Water always moves from high water potential to low water potential.
- Water potential is a measure of the tendency of water to move from high free energy to lower free energy.
- Distilled water in an open beaker has a water potential of 0(zero).
- The addition of solute decreases water potential.
- The addition of pressure increases water potential.
- In cells, water moves by osmosis to areas where water potential is lower.
    - A hypertonic solution has lower water potential.
    - A hypotonic solution has higher water potential.

References

Bidwell, R.G.S. 1974. Plant Physiology. MacMillan Publ. Co. New York.643pp.

Weier, T. E., C.R. Stocking and M.G. Barbour.1974. Botany: An Introduction to Plant Biology. 5th ed. John Wiley & Sons. New York. 693pp.

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