Osmotic pressure and oncotic pressure

Osmotic pressure

Plasma Osmotic Pressure 5530 mmHg

Osmotic pressure is defined as the hydraulic pressure required to prevent the migration of solvent from the area of low solute concentration to an area of high solute concentration.

Osmotic pressure is calculated with the van ‘t Hoff equation:

\[ \text{Osmotic pressure} = n \times \frac{C}{M} \times R \times T \]

- \( n \): number of particles into which the substance dissociates
- \( C \): concentration in g/l
- \( R \): universal gas constant, which is 0.082
- \( T \): absolute temperature
- \( M \): molecular weight of the molecules

Thus, the total osmotic pressure of the human plasma is 5535 mmHg. This is 7.1 atmospheres. Each mOsmole contributes about 19.3 mmHg. This is the pressure one would need to apply to prevent pure water from moving into the plasma. Intracellular osmotic pressure is about the same.

Oncotic pressure

Oncotic pressure is the part of osmotic pressure which is contributed by the large molecules, the “colloid osmotic pressure”. This is 25-30 mmHg, or about 0.5% of the total osmotic pressure. It's not much, but it's enough to keep the water in the vascular compartment.

The flow of lymph keeps the protein out of the interstitial space, and thus prevents oedema from developing. One of the roles of lymph is to de-proteinate the interstitial fluid.

The calculated oncotic pressure is lower than the actual oncotic pressure, because of the Gibbs-Donnan Effect. The calculated pressure is 20 mmHg; the measured is around 30 mmHg. Because the anionic proteins in the blood attract sodium, there is a net increase in 0.4 mOsm/L, which contributes the additional 10 mmHg difference.

Albumin contributes 75% to the oncotic pressure of the plasma. There are four albumin molecules for every globulin molecule, and it has more anionic charge.

Oedema does not develop until plasma oncotic pressure has decreased below 11 mmHg. That equates to an albumin level around 20 g/l.

From Ganongs Review of Medical Physiology, 23rd edition, Vanders Renal Physiology, 7th edition, Wests Respiratory Physiology: the Essentials, as well as public works by the eminent Dr Kerry Brandis to whom I owe much of the inspiration for my shambolic efforts at self-education.