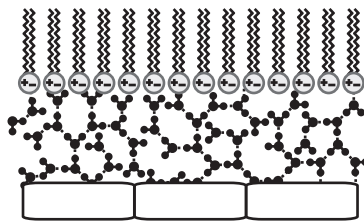


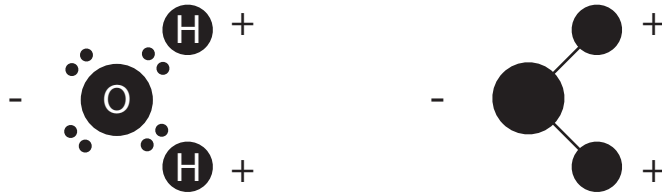
Surfactant

An Introduction to
Water Tension and Alveoli Structure
and the necessity for
Septal Cell Surfactant

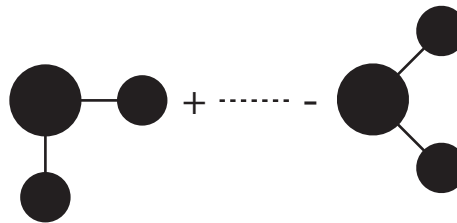


By Noel Ways

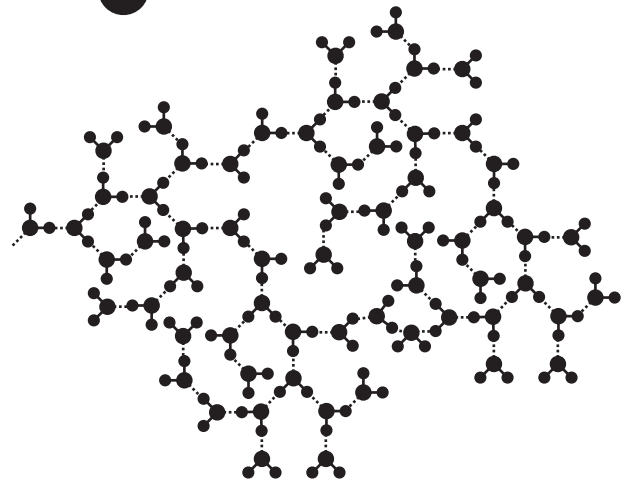
Gas exchange occurs over the moist surface of the alveoli, but water (H_2O) poses challenges due to its polar characteristics. Below, one notes a distribution of charges that renders a water molecule polar. The side with the positively charged protons (hydrogen: H^+) is positive, and the side where the negatively charged electrons are will be negative.



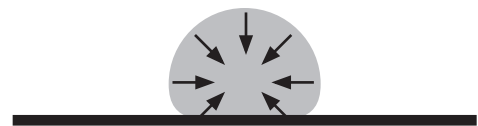
Due to water's polar characteristics, individual molecules will orient their negative and positive sides towards each other as opposite charges attract. Such a bond is called a hydrogen bond.

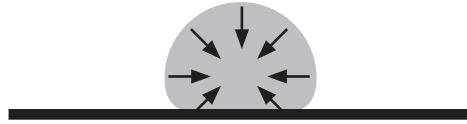


At right, many water molecules are seen attracted to one another.



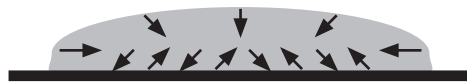
Due to the attractive characteristics of water, the molecules will be drawn toward each other and form a spherical structure. Therefore, on a hydrophobic surface, such as an oiled table, water will bead up.



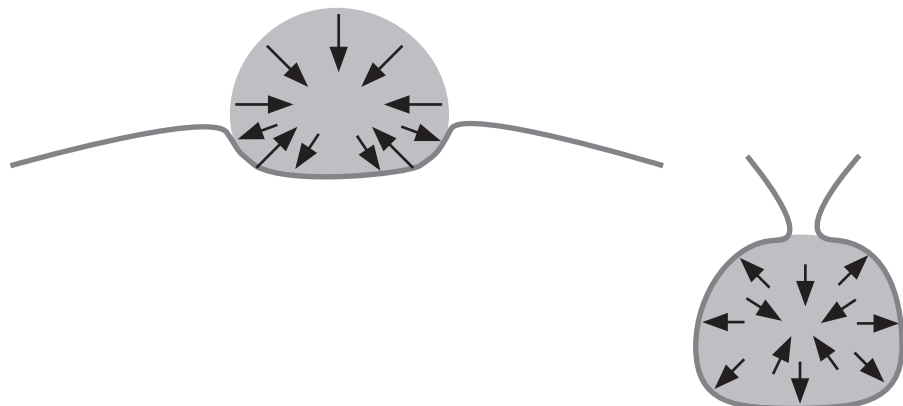
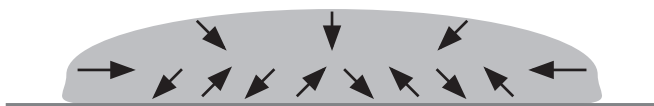


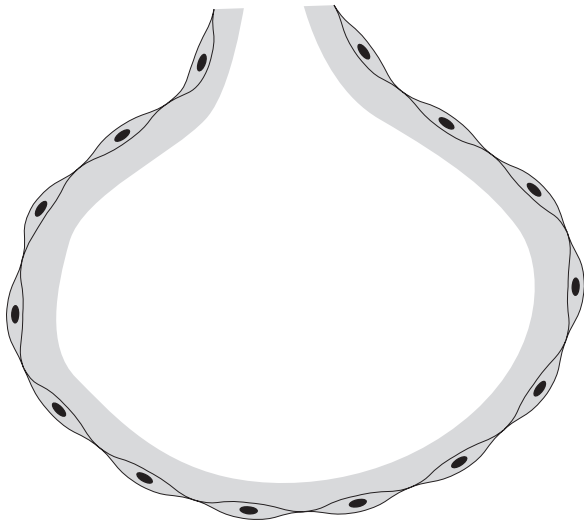
In the example above, the surface is hydrophobic, and the water beads up, the water molecules being attracted to each other.

If however, the surface is hydrophilic, then the water will be attracted both to itself as well as to the table and the water tends to spread more over the surface. The water still has the tendency to bead, but due to water being attracted to the table, the bead is flattened.



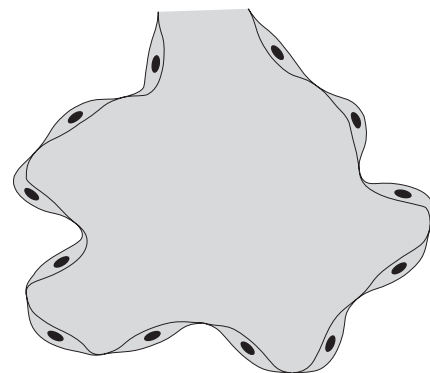
Suppose, however, that the surface is not a rigid table but a flexible membrane (such as cellophane wrap). Here the water will again be attracted to both itself and the flexible membrane. Since the membrane is flexible, and not rigid, the water will bead and while doing so draw the membrane with it.



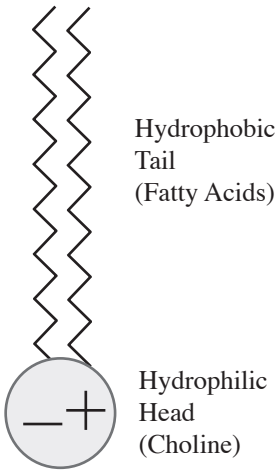


Now consider the alveoli. The simple squamous epithelia that lines these air spaces must be moist at all times, and is also quite thin and fragile. Since the water wants to bead, the danger to the alveoli is that the membrane will be drawn together by the water as it beads up and the alveoli will therefore collapse.

At right, note that the water molecules have drawn together and formed a "bead". Due to the fact that the water was also attracted to the membrane, the membrane was drawn with it in the process. As such, the alveolus has collapsed and is now non-functional.

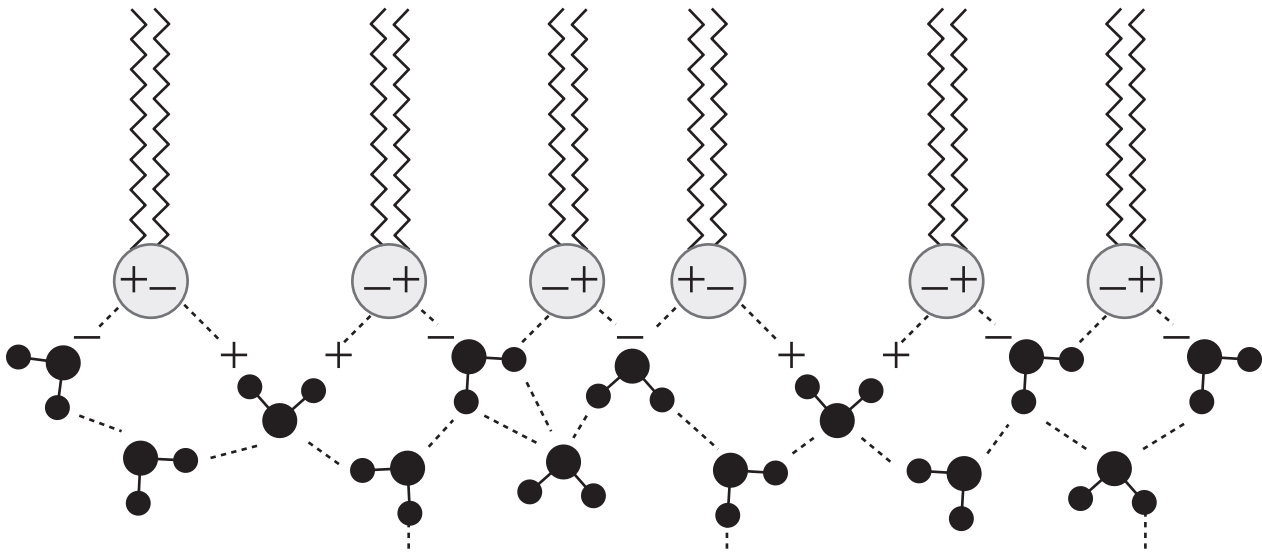


The most common cause of death among babies born prematurely in the US is due to this phenomenon. This disease is called Respiratory Distress Syndrome (RDS).



Disruption of the surface tension created by water is accomplished by the use of a surfactant - a detergent substance that will interfere with the hydrogen bonds which would otherwise cause the water to bead. The surfactant, produced by septal cells within the alveoli, will contain a hydrophobic fatty acid "tail" and have a hydrophilic head. This head may be structures other than a phosphate, but it's charged characteristics will have the same effect: to interact with water molecules.

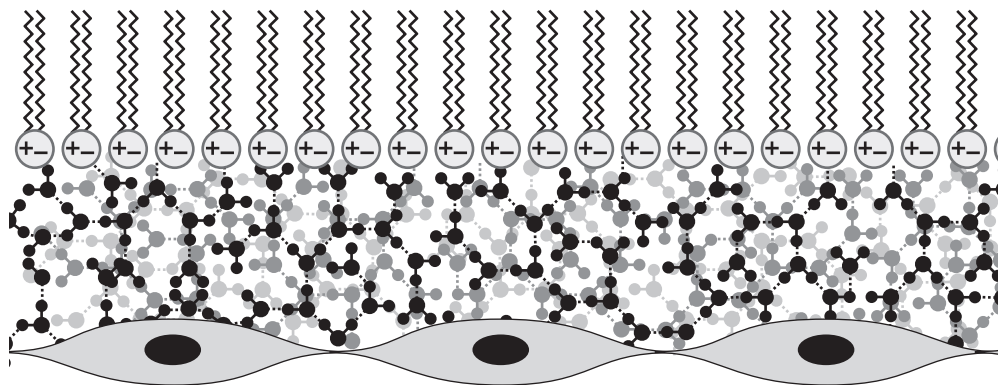
Below one notes this interaction. The heads are attracted to the water and thereby interfere with a potential hydrogen bond. The neutral hydrophobic tails do not interact with water and therefore face away from the water film. Since the tails have no charge, they can not be attracted to each other either, and therefore do not draw the water together in a bead-like manner.



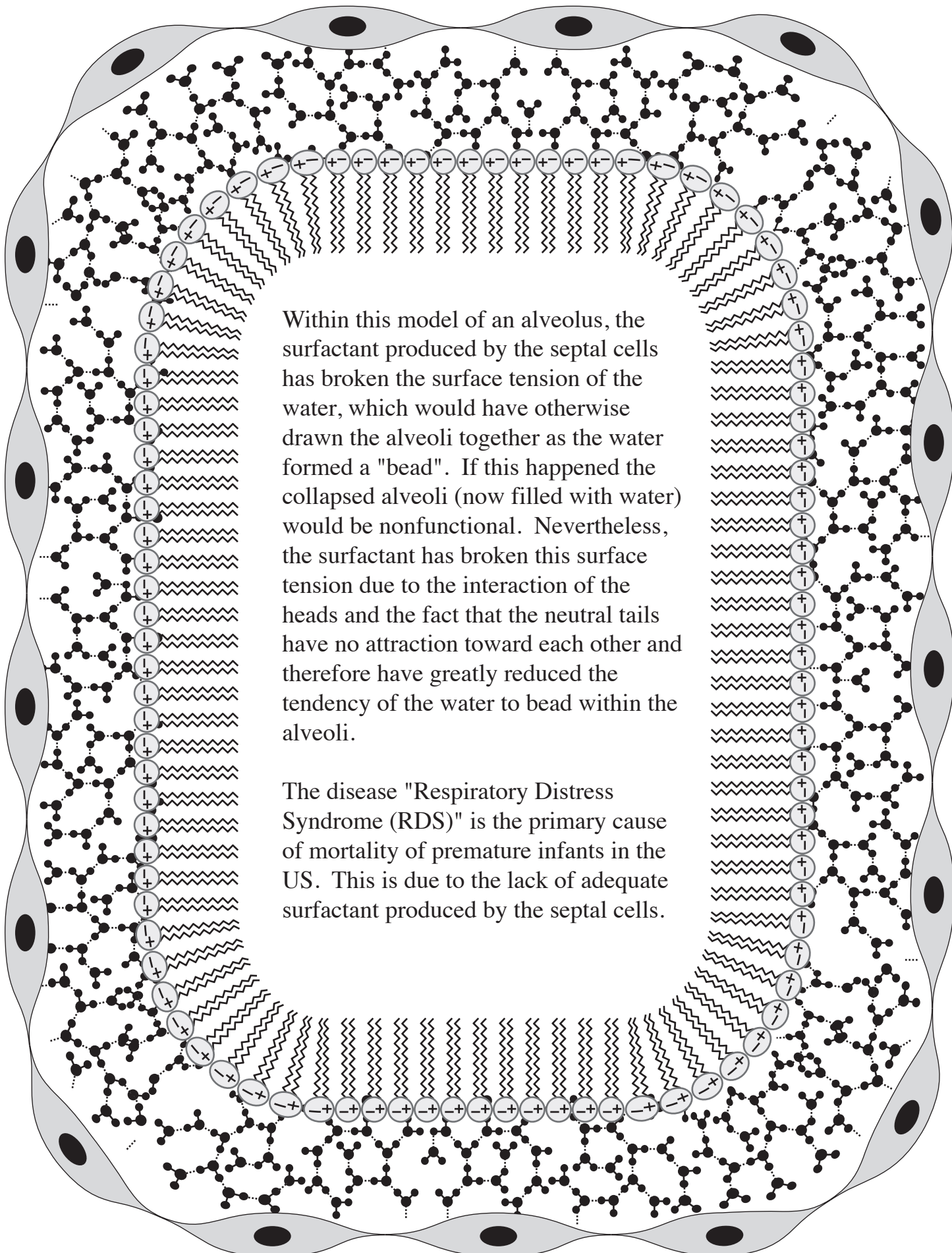
Hydrophobic tails are neutral and will not be attracted to water nor themselves. This effectively prevents "beading" and therefore prevents the collapse of the alveoli

Water film is strongly polar and maintains hydrogen bonds amongst molecules

Squamous cells are hydrophilic and are attracted to the water.



(not to scale - by a long shot!)



Within this model of an alveolus, the surfactant produced by the septal cells has broken the surface tension of the water, which would have otherwise drawn the alveoli together as the water formed a "bead". If this happened the collapsed alveoli (now filled with water) would be nonfunctional. Nevertheless, the surfactant has broken this surface tension due to the interaction of the heads and the fact that the neutral tails have no attraction toward each other and therefore have greatly reduced the tendency of the water to bead within the alveoli.

The disease "Respiratory Distress Syndrome (RDS)" is the primary cause of mortality of premature infants in the US. This is due to the lack of adequate surfactant produced by the septal cells.