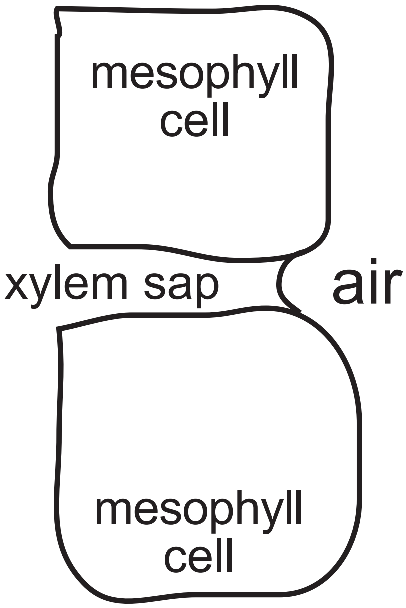

1. The meniscus surface is under tension because cohesive forces are attracting surface molecules down while adhesive forces are attracting surface molecules at the edge up (along the wall). Consequently the surface water deforms into a concave curve, which “stretches” the water, and hence the surface of the water is under tension.
2. The cohesive forces of water make the surface of water act like a stretched rubber band. The resistance to the tensile stress acts to collapse the meniscus to a flat surface to minimize the surface area. This is **surface tension**, which acts to minimize the surface area at a liquid-gas boundary (the minimal surace would be flat no curved into a meniscus). Think of this force geometrically as little arrows sticking perpendicularly from the meniscal surface into the air. The side components of the arrows cancel, so there is a net surface tension “force” pointing straight into the air from the bottom of the meniscus.
2a. Quantitatively, surface tension is the amount of energy per unit area needed to add a unit of surface area to a surface.
3.The strength of this “force” is inversely proportional to the radius of curvature of the menisucs. Think of the meniscus as the arc of a circle of radius r. The smaller the radius, the more curved the arc or the higher the curvature, $k=1/r$. Curvatureis a measure of the rate at which the tangent to a curve turns. So smaller circles have more curved surfaces and a smaller meniscus (half a circle) will have more cuved surfaces than a large meniscus. Since surface tension acts to straighten the surface, a more curved meniscus generates higher surface tension.
4. The straightening or collapse of the meniscus would create a vacuum on the fluid side of the meniscus. The meniscus doesn’t really collapse because the system is at equilibrium, that is the tensile stresses and the (surface tension) resistance of the water to tension balance.
5. when a water molecule evaporates, the system is out of balance, that is the surface gets a tiny bit more curved. Surface tension is now greater than the tensile loads stretching the surface and the surface tension acts to straighten the curve back to its equilibrium. This creates the region of low pressure in the sap on the convex surface that pulls the sap up the xylem.
5a. The energy to create more surface (which is necessary to make the surface more curved) comes from the energy of evaporation. This energy is stored in the surface and used to pull up the water when the surface returns to it equilibrium curvature.
6. Or, another way to think about it is, when the more curved surface (due to the evaporation) straightens a little to the equilibrium curve, the surface pulls up the column of water because of the cohesive forces.
7. **How not to think about it**: when a molecule evaporates, another one needs to replace it so it moves to the surface and cohesive forces pull everything else toward the surface. This isn’t a good explanation because you don’t need a menisus or surface tension for this.
8. Another way of **how not to think about it**. When a molecule evaporates the cohesive force between the evaporating molecule and a deeper molecule pulls the deep molecule to the surface. Again - no need for a meniscus or surface tension (plus the cohesive force simply isn’t strong enough to pull up a 100 m column of water!).
9. What creates the pulling force is the low pressure created by the surface returning to its equilibrium state.