IB Biology HL 3-4
Kidney Simulation

Purpose: To physically simulate the functioning of the nephron of a kidney in osmoregulation.

Read the steps and move the colored paper molecules appropriately as you go. Place the appropriate summary cards on the diagram as you go.

1. Put all of the molecules and blood into the **renal arteriole**
2. Move the blood with its molecules into the **glomerulus**
3. Force of **pressure** due to movement from a large tube (afferent) into small tube (efferent) causes of the small molecules from the blood into the kidney tubule. The **fenestrated** nature of the glomerulus enhances this crude removal from blood since the pores are big enough to let molecules pass. HOWEVER, the **basement membrane** on the outside of the capillaries acts as a crude filter allowing only smaller molecules to pass out of the glomerulus into **Bowman's capsule.** Finally, the **podocytes** further limit the entry of molecules into the Bowman's capsule. Therefore, blood cells and plasma proteins remain in the blood, while the rest of the molecules and much of the water leave the blood and form the **filtrate.**
4. Move the molecules into the **proximal convoluted tubule**, where there is crude removal of water and molecules by diffusion, osmosis, and active transport. Move all of the nutrients (glucose and amino acids), half of the water, and some of the minerals back into the blood by diffusion.
5. Move the nephron filtrate into the **descending Loop of Henle**, which is permeable to water, but not to sodium chloride. Move more of the water out of the tubule into the interstitial tissue and from there into the blood.
6. As the filtrate moves into the **ascending Loop of Henle** salt is able to diffuse out but water cannot. In the last part of the ascending Loop of Henle active transport removes sodium chloride from the tubule and into the surrounding tissue.
7. As the filtrate continues into the **distal convoluted tubule** there is fine-tuning of minerals and pH under the direction of mineralocorticoid hormones, which affect membrane permeability and allow ions, such as K^+ and H^+, to be reabsorbed into the bloodstream.
8. Move the filtrate into the **collecting tubule.** As the filtrate moves down the tubule the salt concentration of the surrounding medulla increases and more water is able to return by osmosis into the surrounding tissue (and eventually into the blood). The permeability of the membrane to water can be altered by many chemicals. The hormone ADH (antidiuretic hormone) is specifically designed to maintain homeostasis to water in the blood/body by increasing permeability of the membrane of the collecting tubule to the degree needed. However, alcohol as well as other chemicals, counteract this by making the membrane less permeable to water (blocking aquaporins) so that more water is lost.
9. The blood has been fairly stagnant in this demo, but it would be continually moving. Move it and all the molecules it is carrying until it is in the renal venule.
10. The rest of the filtrate will exit the collecting tubule into the renal pelvis and then out the ureter.
11. Examine the filtrate. What is left? What was reabsorbed into the blood?

12. Examine the blood: How is blood different in the renal arteriole as compared to the renal venule?

13. If this person had uncontrolled diabetes, how would the filtrate differ?

14. What other components in the filtrate would be a sign of kidney dysfunction?