

The Activity for Relating Kidney Function and Blood Composition

This task is a role playing demonstration to provide a visual aid for the students so that they can understand the function of the kidneys as it relates to blood composition and urine formation.

The students will each play the role of the blood, the urine or the parts of the kidney. Colored balls representing the different substances that are found in the excretory system will be used to show how the different substances are transported around. At the end of the demonstration, the students will have a visual aid for the different parts of the kidney and how they effect the blood composition and urine production.

Procedure:

- 1) Set up the room so that it represents the basic structure of a kidney (using tables and chairs)
- 2) Divide up the role playing parts:
 - i. The Kidney
 - ii. The Blood (carries around a bucket)
 - iii. The Urine (carries around a bucket)
 - iv. The Glomerulus
 - v. The Bowman's Capsule
 - vi. The Proximal Convoluted Tubule
 - vii. The Extracellular Fluid surrounding the Proximal Convoluted Tubule
 - viii. Descending Limb
 - ix. The Loop of Henle and part of the Ascending Limb in the Inner Medulla
 - x. Extracellular Fluid surrounding the Loop of Henle and Ascending Limb
 - xi. The Distal Convoluted Tubule
 - xii. The Collecting Duct
- 3) Pass out the packages of colored balls to the blood and extracellular fluids:
 - i. Blue balls – water
 - ii. Red balls – blood cells, platelets, and large proteins
 - iii. Yellow balls – urea
 - iv. Green balls – salt (NaCl)
 - v. Pink balls – small proteins
 - vi. Black balls – small waste molecules unable to be filtered (uric acid, creatine, hydrogen ions, ammonia, penicillin, histamine, etc.)
- 4) Position the students where they should be
- 5) Start off with the kidney telling everyone what its overall function is, then move on to the blood and the other parts of the kidney with the blood, urine and the various extracellular fluid exchanging colored balls as the students read out what they are and their characteristics

Kidney: "Together we make up the kidney. We control the composition of the blood by filtering it to remove waste substances and returning nutrients such as water and salts to the blood."

Blood: "I am the blood. Upon entering the kidney, I am transporting blood cells, platelets, large proteins, water, salts, small proteins, urea and numerous small waste molecules."

Glomerulus: "Welcome to the glomerulus. I am a capillary bed with an extremely high pressure. I use this pressure to filter the blood by a process called glomerular filtration. I am permeable

only to water, salts, small proteins and urea. These substances can pass into the Bowman's Capsule. Everything else will have to stay inside the capillary network."

Bowman's Capsule: "I am the Bowman's Capsule. I accept the water, salts, small proteins and waste products such as urea from the Glomerulus. These molecules are called the glomerular filtrate and they are the first parts of the urine."

Urine: "I am the urine. Right now I am made up of water, salts, small proteins and the urea that was filtered from the blood in the Glomerulus and Bowman's Capsule. From the Bowman's Capsule I travel to the Proximal Convoluted Tubule."

Proximal Convoluted Tubule: "Welcome to the Proximal Convoluted Tubule. I am permeable to salt, water and proteins. Along with the extracellular fluid surrounding me, we are responsible for the process known as resorption. I don't like salt molecules and proteins. So my main goal is to get rid of as much of these as I can. I do this by using active transport to move them from inside the proximal convoluted tubule to the extracellular fluid. By doing this, I am able to get rid of all of the proteins but I am not able to remove all of the salts. As a result of me actively transporting the salt and proteins I lose some water along with it through a process called osmosis."

Extracellular Fluid surrounding the Proximal Convoluted Tubule: "I am the extracellular fluid surrounding the Proximal Convoluted Tubule. I have a high concentration of salt. I accept the salt, proteins and water from the Proximal Convoluted Tubule by a process known as diffusion and I transport them back into the blood."

Blood: "I receive the salt, proteins and water from the extracellular fluid surrounding the Proximal Convoluted Tubule."

Urine: "After leaving the Proximal Convoluted Tubule, I have lost all of my proteins, most of my salt and some of my water. From here, I travel to the descending limb."

Descending Limb: "Welcome to the descending limb. My walls are freely permeable to water but are impermeable to salt or urea."

Extracellular Fluid surrounding the descending limb: "I am the extracellular fluid surrounding the descending limb. I have a high concentration of urea."

Urine: "Because the concentration of urea is higher in the extracellular fluid surrounding the descending limb than inside, I will give some of water, through osmosis, to the extracellular fluid which in turn gives it to the blood. I am now transporting mainly urea, some water and some salt. From here I travel to the Loop of Henle."

Blood: "I receive the water from the extracellular fluid surrounding the descending limb."

Loop of Henle and Ascending Limb: "Welcome to the Loop of Henle and the Ascending Limb. My walls are not permeable to water but are permeable to salt. Like the Proximal Convoluted Tubule, I do not like salt and I use active transport to remove the salt from the urine."

Extracellular Fluid surrounding the Loop of Henle and the Ascending Limb: "I am the extracellular fluid surrounding the Loop of Henle and the Ascending Limb. I have a very high salt and urea concentration."

Urine: "The active transportation of salt into the extracellular fluid causes a reduction of my salt concentration, however I do not lose any water passively because the walls of the Loop of Henle are impermeable to water. I am now transporting a lot of urea, some water and a little salt. From here I continue up into the Distal Convoluted Tubule."

Distal Convoluted Tubule: "I am the Distal Convoluted Tubule. My walls are permeable to water and small molecules but are not permeable to urea or salt. I am responsible for tubular excretion and the removal of water from the urine. Tubular excretion is the process by which wastes that were not filtered from the blood by the Glomerulus can be excreted into the urine. The high concentration of salt in the extracellular fluid contributes to the removal of water from the urine by osmosis."

Urine: "After passing through the Distal Convoluted Tubule, the waste products that were too small to be filtered have been removed from the blood and added to the urine. In addition, I have lost some more water through osmosis into the blood. From here I travel into the collecting duct."

Blood: "I have removed my waste products that were too small to be filtered."

Collecting Duct: "I am the Collecting Duct. My walls are impermeable to salt but they are permeable to both water and urea. My main goal is to remove as much water as I can from the urine. This is accomplished because the high concentrations of urea and salt in the extracellular fluid allow the passage of water via osmosis from the collecting duct to the blood. In addition to this, I also remove some urea from the urine to add to the extracellular fluid. The reason why I do this is to maintain a high concentration of urea in the extracellular fluid, so that water can move out of the descending limb by osmosis."

Extracellular Fluid surrounding the Loop of Henle and the Ascending Limb: "I receive some of the urea from the Collecting Duct."

Extracellular Fluid surrounding the descending limb: "I receive some of the urea from the Collecting Duct."

Urine: "As I move down the Collecting Duct, almost all of my water is returned to the blood. As a result of my passage through the kidney, almost all of my water, salts and small proteins have been returned to the blood, while small waste molecules have been added and my urea concentration has been increased. I then travel to the bladder where I am excreted out of the body."

Blood: "As a result of my passage through the kidney, I have maintained my blood cells, platelets, and protein concentrations, while I only lost a little of my salt and water. In addition to this, I also was able to remove some of my waste products such as urea, uric acid, penicillin and histamine. I then travel through the renal vein and return to general circulation."

