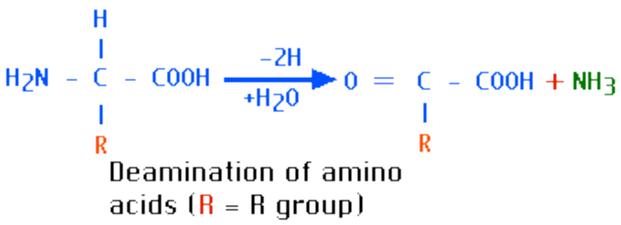
# Kidney Lab

Name: _____

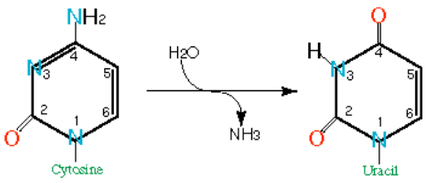
Kidneys do a grand job removing the toxic waste products of metabolism. This process is called excretion. Our kidneys produce urine which contains urea, excess salts and excess water.

By the end of this lab, you should:

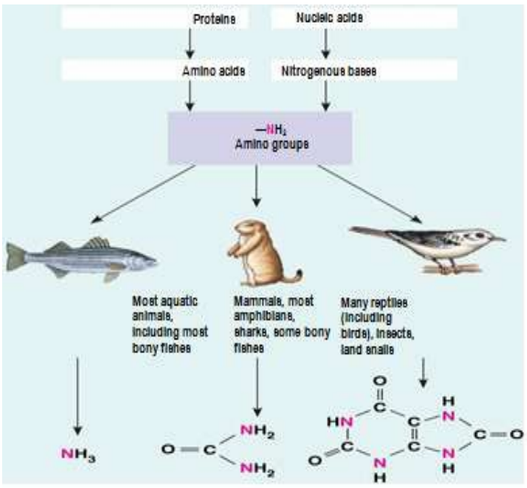
- be able to label a diagram of the kidney;
- explain what is meant by excretion;
- explain how a nephron works;
- understand the part played by the kidney in osmoregulation.




Deamination of amino acids (R = R group)



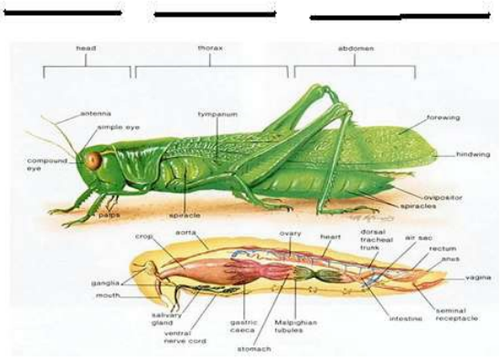

Amino acids and nucleotides can be broken down (sometimes to be to be used as fuel by the mitochondria). A toxic nitrogen compound called ammonia results.




Ammonia is not a problem for fish surrounded in water, ammonia just diffuses away.

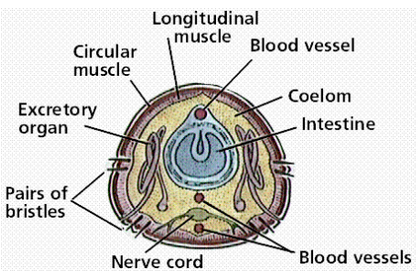
Terrestrial animals use energy to convert ammonia into urea, which is far less toxic. Urea is disposed by the kidneys together with much water in urine.

Birds use even more energy to produce Uric Acid. Uric Acid is excreted as a paste with little loss of water.




http://universe-review.ca/I10-82-grasshopper.jpg

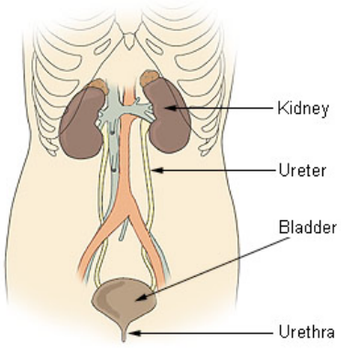
**The grasshopper uses Malpighian tubules to filter uric acid from its blood (called hemolymph as it does not have hemoglobin to carry oxygen).**




Excretory organs in the earthworm were called Nephridia.

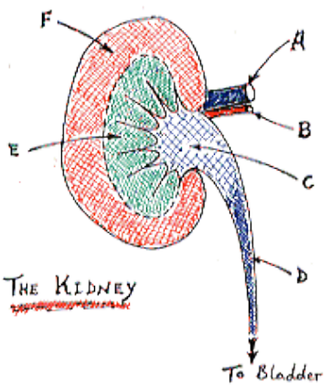
Excretory organs in grasshoppers are called Malphigian tubes.

**Components of the Urinary System**




Approximately one third of the aorta's output is shunted to the two kidneys in humans.

You need to know about the general structure of the kidney and how it works, so let's start with a diagram to show the regions of the kidney. The three main regions are called the cortex (F), medulla (E) and pelvis (C).




You should be able to name all the parts labelled A to F before doing the dissection.

## A. Renal Vein

This has a large diameter and a thin wall. It carries blood away from the kidney and back to the right hand side of the heart. Blood in the kidney has had all its urea removed. Urea is produced by your liver to get rid of excess amino-acids.

Blood in the renal vein also has exactly the right amount of water and salts. This is because the kidney gets rid of excess water and salts. The kidney is controlled by the brain. A hormone in our blood called Anti-Diuretic Hormone (ADH for short) is used to control exactly how much water is excreted.

## B. Renal Artery

This blood vessel supplies blood to the kidney from the left hand side of the heart. This blood must contain glucose and oxygen because the kidney uses much ATP to produce urine. Blood in the renal artery must have sufficient pressure or the kidney will not be able to filter the blood.

Blood supplied to the kidney contains a toxic product called urea which must be removed from the blood. Blood may become hyper or hyptonic. The kidney removes/adds salts/$H_2O$ to the blood; to make blood isotonic.

## C. Pelvis

This is the region of the kidney where urine collects. If you are very unlucky, you may develop kidney stones. Sometimes the salts in the urine crystallise in the pelvis and form a solid mass which prevents urine from draining out of the medulla of the kidney. You will need treatment: see your doctor.

D. **Ureter**

This one is easy-peasy: the ureter carries the urine down to the bladder. It does this 24 hours per day, but fortunately the urine can be stored in a bladder so that it is not necessary to wear a diaper!

E. **Medulla**

The medulla is the inside part of the kidney, in real life it is a very dark red colour. This is where the amount of salt and water in your urine is controlled. It consists of billions of loops of Henlé. These work very hard pumping sodium ions. ADH makes the loops work harder to pump more sodium ions. The result of this is that very concentrated urine is produced.  Sodium pumps are an example of active transport.

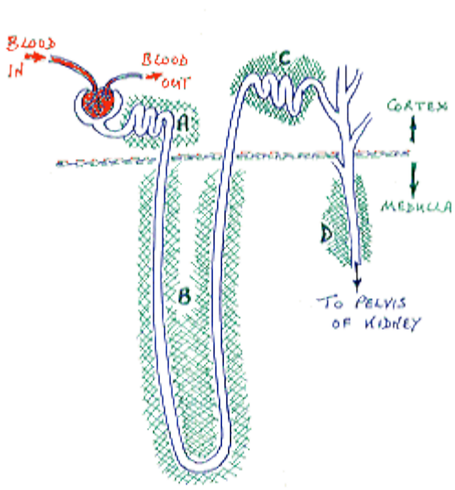
The opposite of an anti-diuretic is a "diuretic". Alcohol and tea are diuretics.

F. Cortex

The cortex is the outer part of the kidney. This is where blood is filtered. We call this process "ultra-filtration" or "high pressure filtration" because it only works if the blood entering the kidney in the renal artery is at high pressure.

Billions of glomeruli are found in the cortex. A glomerulus is a tiny ball of capillaries. Each glomerulus is surrounded by a "Bowman's Capsule". Glomeruli leak. Things like red blood cells, white blood cells, platelets and fibrinogen stay in the blood vessels. Most of the plasma leaks out into the Bowman's capsules. This is about 160 litres of liquid every 24 hours.

Most of this liquid, which we call "ultra-filtrate" is re-absorbed in the medulla and put back into the blood.




**Glomerulus and Bowman's Capsule**

This is where ultra-filtration takes place. Blood from the renal artery is forced into the glomerulus under high pressure. Most of the liquid is forced out of the glomerulus into the Bowman's capsule which surrounds it. This does not work properly in people who have very low blood pressure.

### Proximal Convoluted Tubules

Don't worry about remembering the name for your Bio 11. Jolly good though if you can. Proximal means "near to" and convoluted means "coiled up" so this is the coiled up tube near to the Bowman's capsule.

This is the place where all that useful glucose is re-absorbed from the ultra-filtrate and put back into the blood. If the glucose was not absorbed it would end up in your urine. This happens in people who are suffering from diabetes and have far too much glucose in their blood. Excess glucose ends up in the urine potentially damaging kidney function in the long term. High blood pressure can also be a problem. Losing protein in your urine is bad news indicating some mechanical breakdown in ultra-filtration!

### Loop of Henlé

This part of the nephron is where water is reabsorbed. Kidney cells in this region spend all their time pumping sodium ions. This makes the medulla very salty; you could say that this is a region of very low water concentration. If you remember the definition of osmosis, you will realize that water will pass from a region of high water concentration (the ultra-filtrate and urine) into a region of low water concentration (the medulla) through cell membranes which are semi-permeable.

### Distal Convoluted Tubules

Don't worry too much about the name. Distal means "distant" so it is at the other end of the nephron from the Bowman's capsule. This is where most of the salts in the ultra-filtrate are re-absorbed.

### Collecting Duct

Collecting ducts run through the medulla and are surrounded by loops of Henlé. The liquid in the collecting ducts (ultra-filtrate) is turned into urine as water and salts are removed from it. Although our kidneys make about 160 litres of filtrate every 24 hours, we only produce about ½ litre of urine.It is called a collecting duct because it collects the liquid produced by lots of nephrons.

## Coloring Instructions

1. Color the renal artery red, and continue the flow of blood through the capillaries. It will remain red until it reaches the area of the Loop of Henle, then the blood is deoxygenated, and should be colored blue. The renal vein should be colored blue, tracing its path until the blue capillaries meet the red capillaries (near the loop of henle). You'll have to be careful when coloring the arteries and veins, as they are twisted about the entire nephron. Also note that the blood from the renal artery enters the glomerulus and then exits again, to twist around the distal tubule. The capillaries should be colored purple, to show the mixing of the blood (blue and red make purple)

2. Color the renal vein (blue) and the renal artery (red) on the kidney as well as the nephron.

3. Color the proximal tubule dark green, until it reaches the loop of henle. The loop of henle should be colored pink, and then when it changes into the distal tubule, color the distal tubule light green.

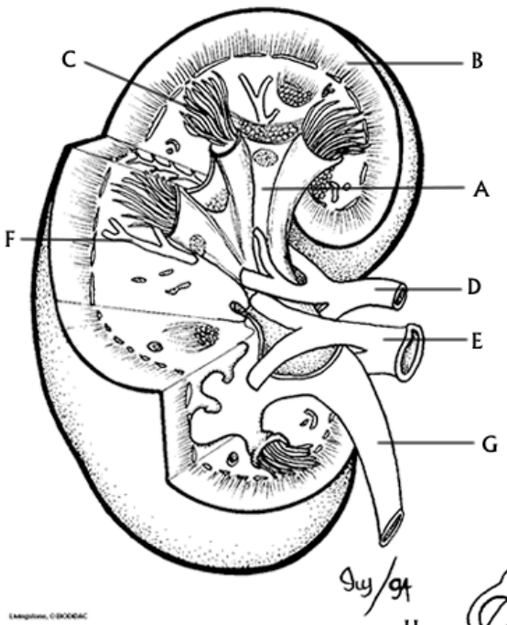
4. Color the Bowman's capsule brown, leave the glomerulus white,

5. Color both the collecting duct and the ureter yellow.

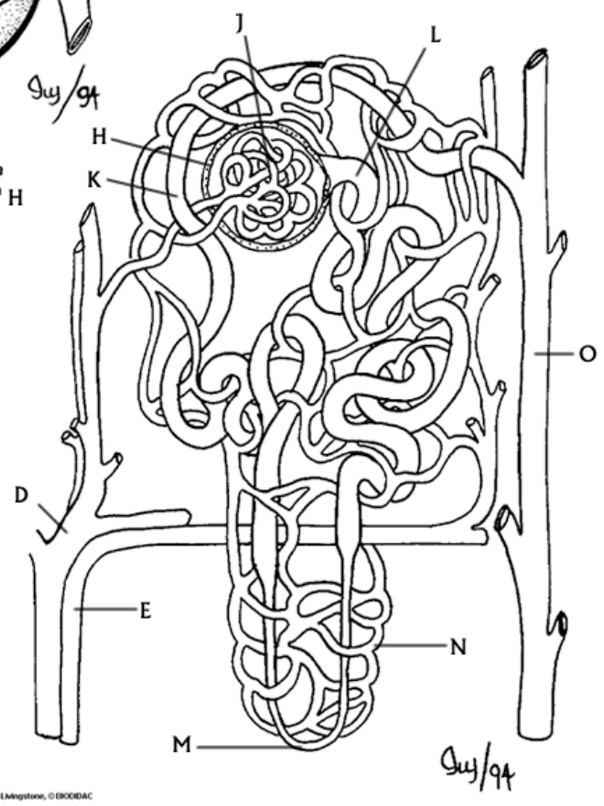
6. Color the medulla (there are 3 pictured) light green. Color the cortex pink, and the renal pelvis yellow. The nephron pictured on the kidney should be colored orange.

Slice your kidney open longitudinally.  Identify each structure shown in the diagram with a labeled pin.

## STRUCTURE OF THE NEPHRON




RENAL PELVIS$_A$
CORTEX$_B$
MEDULLA$_C$
RENAL ARTERY$_D$
RENAL VEIN$_E$
NEPHRON$_F$
URETER$_G$




BOWMAN'S CAPSULE$_H$
GLOMERULUS$_J$
DISTAL TUBULE$_K$
PROXIMAL TUBULE$_L$
LOOP OF HENLE$_M$
CAPILLARIES$_N$
COLLECTING DUCT$_O$

Your Text refers to three kidney process – Identify them and explain where they are performed

_____

_____

_____

Identify a dangerous waste product – an immediate result of “deamination”. _____

Distinguish between

Ammonium _____

Urea _____

Uric Acid _____

Where is Urea produced?_____

What does “Osmoregulation” mean? _____

_____

Explain why these two conditions are dangerous from a Nephrologist’s point of view:

Low Blood Pressure: _____

High Blood Pressure: _____

Distinguish between

Ureter: _____

and Urethra _____

Kidney stones are most painful when passing through the _____

The Medula is a much darker colour of red than the cortex. Explain why: _____

_____

How many liters of filtrate do your kidneys produce? _____ of urine? _____

Distinguish between

Diuretic: _____

and anti-Diruretic _____

In summary, two important functions of the Kidney are:

_____

_____ _____