Understandings:

1. Explain that animals are either osmoregulators or osmoconformers.

- First of all, we know that osmolarity is the concentration of solute (the substances that get dissolved) in a solution.

Osmoregulators are animals that regulate their osmolarity to keep it in constant level. In other words, their homeostasis keeps the concentration of solute in our blood to a constant value. Most terrestrial animals are osmoregulators.

Osmoconformers are animals that conform-meaning to adjust- their osmolarity in relation to environment. Thus their osmolarity fluctuate. This is the case for marine invertebrates such as crabs and mussels.

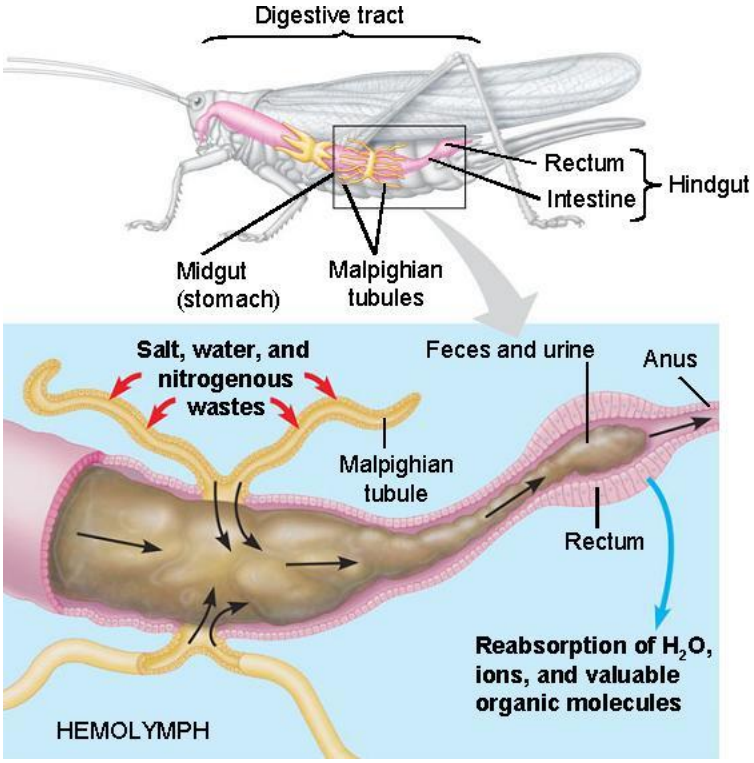
2. Describe the Malpighian tubule system in insects.

- Malpighian tubule is a structure in insects that correspond to the kidneys in humans.

So, insects have haemolymph while humans have blood. What basically happens is just the same as in humans, but the structure is slightly different.

In insects, when proteins are broken down to amino acids, they need to release some nitrogenous waste that is formed on the way. Insects have uric acid (humans have urea). But the question is how does the waste get out from the haemolymph and into the body?

This is where Malpighian tubules play its role. These tubes are small extensions of the gut that actively transports the waste from haemolymph to the gut. Of course, water and salt are also absorbed through osmosis and diffusion but these get reabsorbed at the very end.



3. Compare the composition of blood in the renal artery and renal vein.

- One could expect that renal artery contains "unwanted" substances. Then it passes to the kidneys and expect renal vein to contain a more "pure" and "filtered" blood. Let's look at these substances more closely, but it all makes sense.

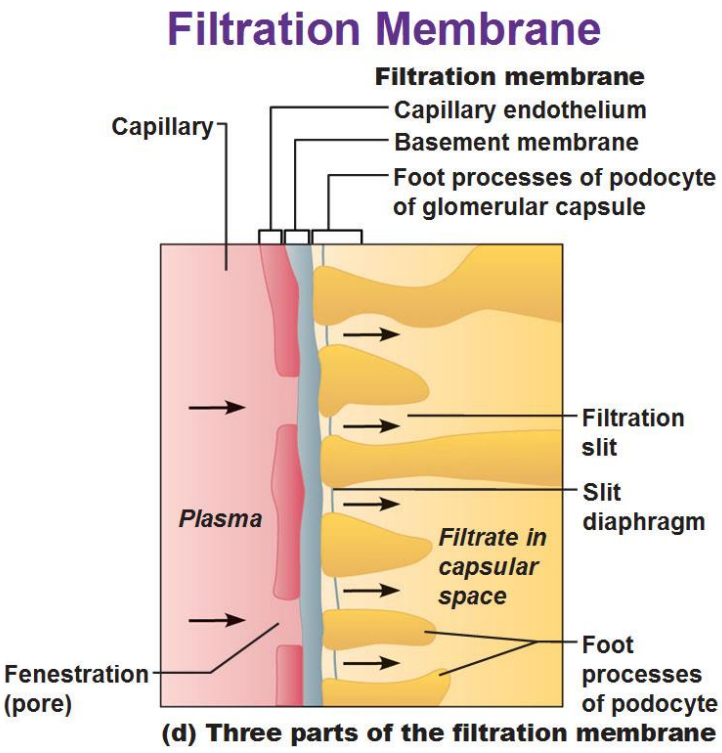
Renal artery (to the kidney)	Renal vein (from the kidney)
More toxins and not metabolized substances.	Less.
More nitrogenous waste.	Less.
More salt and water if in excess.	If there is no excess, concentration is the same since the body reabsorbs all salt and water.
High oxygen. Consequently, low carbon dioxide.	Less oxygen because reabsorption of salt and glucose requires active transport. More carbon dioxide.
Same amount of proteins because proteins are too large to be filtered from the first place.	

4. Explain the ultrastructure of the glomerulus and Bowman's capsule.

- So, the first step in kidney is ultrafiltration. This happens in the glomerulus that is inside Bowman's capsule. Substances below 65,000 atm (atomic mass) are filtered out, which is basically everything except proteins.

Well why are they filtered out? Simply, renal arteries become really narrow in the glomerulus, which increases pressure, hence almost "squeezed" out.

Now let's look at the membrane of our glomerulus and Bowman's capsule.



On the left, we have the capillary where blood flows in. On the right we have the lumen of Bowman's capsule. There are three sections.

1. Fenestrations (meaning window). These are not a "thing". It is essentially a gap between endothelial cells of the capillaries that allow small particles to flow through. Blood cells stay.

2. Basement membrane. This is negatively charged and covers the membrane. Proteins stay.

3. Podocytes. Cells cover with very narrow gaps, aiding filtration.

5. Explain the role of proximal convoluted tubule.

- Welcome to the closest section after Bowman's capsule. We call it the proximal convolute tubule, literally meaning "close curved tube".

Already here, most of the reabsorption takes place. We can expect that villi are present since they need to reabsorb. But what do they reabsorb and how?

1. Sodium ions. These are pumped out, thus requires ATP.

2. Chloride ions. It is diffused out because outside is positive due to sodium ions.

3. Glucose and amino acid. It is co-transported just like in villi in small intestine. Sodium ions are pumped out and then as it flows back this enables glucose to flow out.

4. Water. Transporting solutes automatically leads to osmosis.

6. Explain the role of loop of Henle.

- This is a small dip in of the nephron. It starts from the cortex but dips down to medulla, and travels up to again. Which materials enter? It is water, sodium and that's it (no glucose).

In the descending limb, membrane is permeable to water but not sodium ions. In addition, the medulla has a high concentration of solute thus water flows out by osmosis. Thus water is reabsorbed.

In ascending limb, membrane is permeable to sodium ions but not water. Although outside is hypertonic (more solute), water does not diffuse by osmosis. Sodium is pumped out from the proximal convoluted tubule. Note that sodium content in ascending is lower than descending. This contributes to high concentration of solute in ascending limb which enables further osmosis.

The solution flows to distal convoluted tubule.

7. Explain why some animals have longer loops of Henle.

- Animals in desert that need high absorption of water have got longer loops of Henle and therefore thicker medulla.

8. Explain the role of ADH.

- ADH is a hormone from pituitary gland that adjusts the permeability of collecting duct.

If blood is hypertonic (it has a lot of crap in it), more ADH is released because high ADH leads to high permeability of collecting duct. A more permeable collecting duct enables more absorption of water from urine to blood. Thus urine will look concentrated.

If blood is hypotonic (it has little crap and is diluted), less ADH is released because low ADH leads to low permeability of collecting duct. We simply don't need more water. Thus urine will look diluted.

9. Describe the types of nitrogenous waste in animals and the reason for different types.
- Different form of waste holds an evolutionary explanation.

It takes energy to convert from ammonia to urea and uric acid so they better have a reason.

Ammonia	Urea	Uric acid
Toxic	Not toxic	Less toxic than ammonia
Soluble	Soluble	Insoluble
Fish use this waste because the high toxicity is rapidly diluted.	Since it is soluble and not toxic, mammals can easily secrete it.	Releasing in high mass solids enables the bird to fly and maintain light mass.

Applications and skills:

1. Explain the consequences of dehydration and over-hydration.
- Water is needed for hydrolysis. So metabolism rate decreases. Also, blood pressure decreases because there is less blood plasma. Sweating decreases meaning that temperature regulation is not functioning.

Over-hydration causes cells to swell. It leads to headaches, dizziness and difficulty in nerve signalling.

2. Outline some treatment options for kidney failure.
- First of all, what is kidney failure? It is simply when the kidneys fail to filter out the waste. The cause can be due to high blood pressure (mainly diabetes).

The first method is haemodialysis. Dialysis means separation, so it separates waste from the blood by using a dialysis machine. Basically, an artery is connected to dialysis machine. There, it filters out the waste but keeps in the blood cells and proteins. The pure blood then is connected to the vein. This takes several hours.

The next treatment is transplant. A donor simply donates a kidney, and the donor can be either living or dead since a person has two kidneys and one is sufficient enough to live. This seems much better than the haemodialysis but the main disadvantage is that the receiving person can react to the new kidney. I can sort of expect that the kidney has got foreign antigens that trigger the immune system.

3. Explain urinalysis.

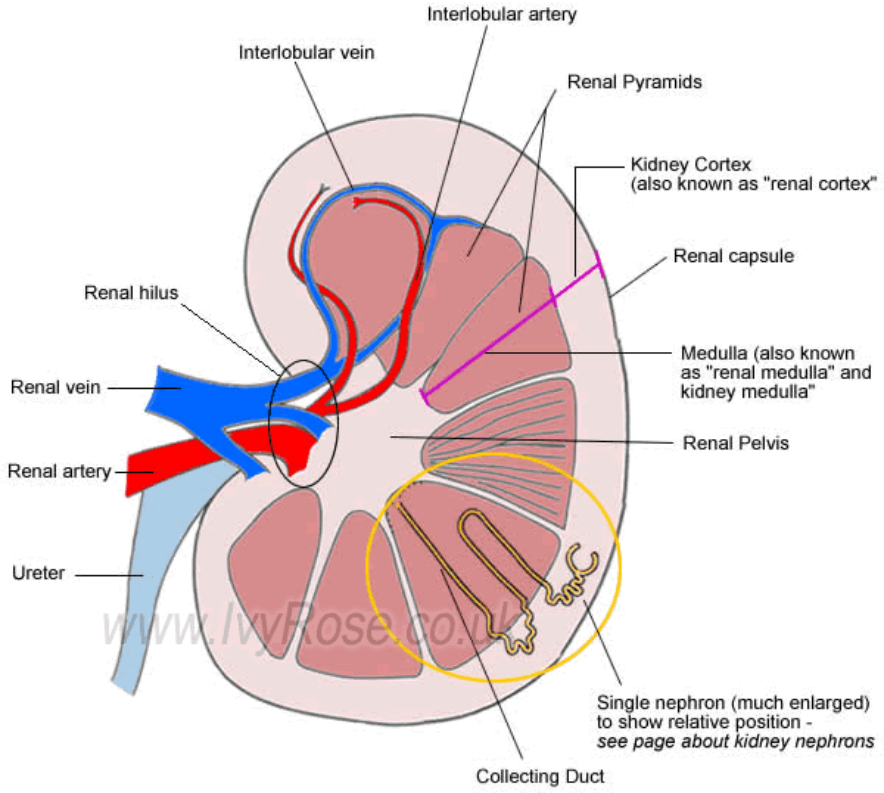
- Urinalysis is an analysis of the urine. The analysis is usually done with a test kid that indicates presence of certain factors. Those are pH, glucose and proteins. We want to know glucose because of diabetes and we want to know proteins because it can indicate the permeability of a kidney. High protein is bad.

4. Be able to draw and label a diagram of the human kidney.

-

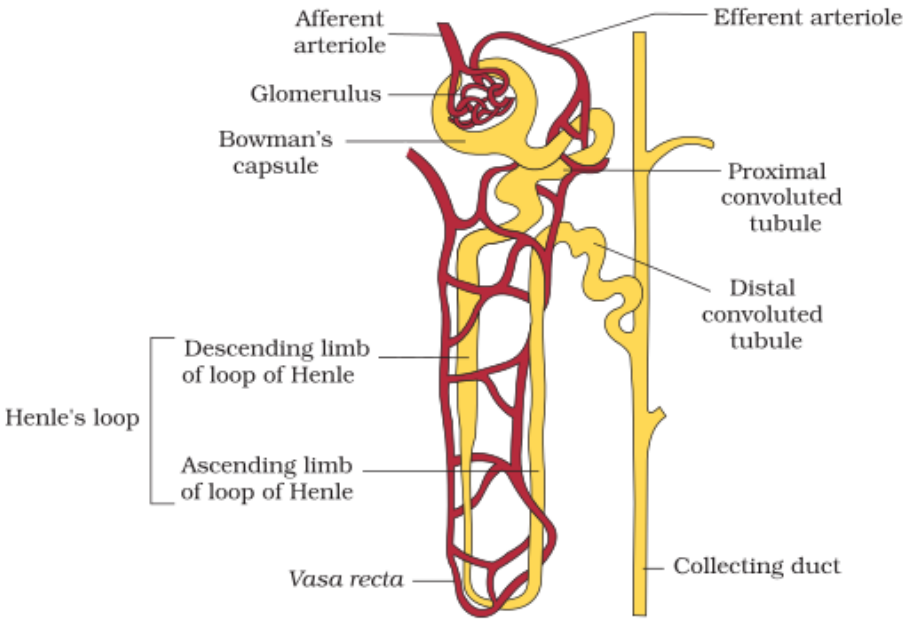
The structures we have to know are renal artery, cortex, medulla, renal pelvis, renal vein and ureter.

Only six structures!



5. Be able to annotate diagrams of the nephron.

-



Note that loop of Henle is in the medulla and everything above is in the cortex.

Know EVERY structure on the picture.