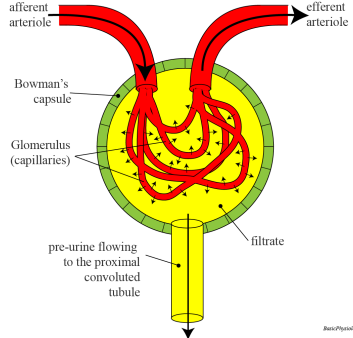


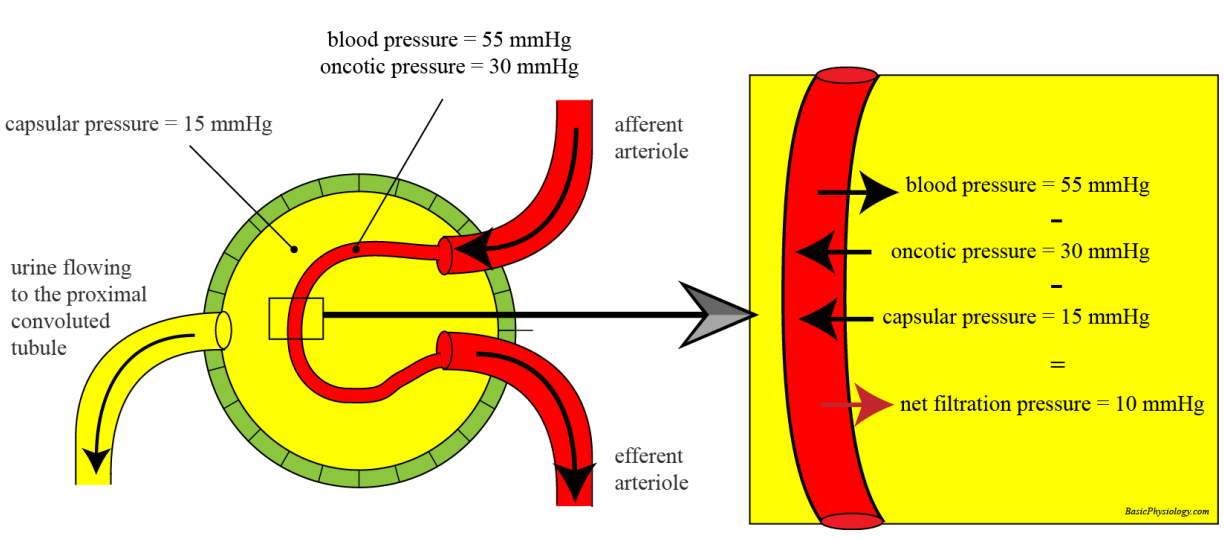
F.3.2. The Glomerulus

A. The Renal Corpuscle:

1. The nephron starts with the renal corpuscle (=small body) where blood is filtrated to produce the precursor of urine. The corpuscle consists of two parts: a) the glomerulus and b) Bowman's capsule.	2. The blood flows from the renal artery to the afferent arteriole and, inside the corpuscle, splits into numerous capillaries. All these capillaries together form the glomerulus.
3. These glomerular capillaries have relatively large holes (=fenestrated) so that the blood fluid (=plasma) can easily pass through the capillary wall into the space outside the capillary; the Bowman's capsule. (link)	
4. In principle, everything can go out of the capillary except the blood cells and proteins. So, the filtrate consists of large amounts of water, salts, nutrients, waste products etc.	5. But, in a normal person with normal kidneys, we don't see proteins or blood cells in the urine. In the urine, there should be only excess water and waste products.
6. Therefore, most of what has been filtered in the glomerulus must go back to the blood and remain in the body. This is the task of the renal tubule (proximal and distal convoluted tubules and the loop of Henle).	

Link: Bowman's capsule is named after Sir William Bowman, a British surgeon, anatomist, who described the first glomeruli, with a microscope, in 1842

B. Glomerular Filtration:

1. The amount of filtrate (= glomerular filtration rate) is very important as this determines how quickly the blood (and the body) is cleaned from waste.	2. This glomerular filtration rate (=GFR) is determined by several factors: - the blood pressure - the capsular pressure - the oncotic pressure.
 The diagram illustrates the process of glomerular filtration in a nephron. It shows the afferent arteriole entering the glomerulus and the efferent arteriole exiting. The glomerulus is surrounded by Bowman's capsule. Labels indicate the following pressures: blood pressure = 55 mmHg, oncotic pressure = 30 mmHg, and capsular pressure = 15 mmHg. An inset shows the pressure balance: blood pressure (55 mmHg) minus oncotic pressure (30 mmHg) minus capsular pressure (15 mmHg) equals a net filtration pressure of 10 mmHg. Urine is shown flowing into the proximal convoluted tubule.	
3. In fact, this is very similar to the Starling Exchange System that we discussed some time ago in the cardiovascular chapter (link).	4. First, there is the blood pressure (about 55 mmHg) that pushes the water out of the capillaries.
5. Then, there is an oncotic pressure (determined by all the proteins in the blood that are not allowed to pass through the blood vessel wall), which amounts to about 25 mmHg.	6. And then, finally, there is the pressure in the capsule itself, about 15 mmHg.
7. Therefore, the net filtration pressure usually amounts to about $(55 - 25 - 15) = 15$ mmHg.	8. Because the kidneys receive so much blood from the heart (a bit more than 1 litre/min), the amount of filtrate produced in the glomeruli is also quite high: about 120 ml/min (=180 Litres/day!!).
9. Obviously, we do not pee this amount of water every day. We would dry up immediately if that were the case!	10. Therefore, this vast amount of water (and nutrients) is reabsorbed in the kidneys and not lost in the urine. This is the job of the remainder of the nephron.

Link: B.5.3. The Capillaries, panel C.

C. Comparison with the Starling Exchange System:

1. It is actually interesting and worthwhile to compare the glomerular filtration with the Starling exchange system.	2. For starters, the blood pressure is much higher in the glomerulus than in any other ordinary arteriole; 55 instead of 35 mmHg.
3. This is mainly because of the short distance of the renal artery from the abdominal aorta (shorter distance -> less resistance -> higher pressure).	4. This higher blood pressure is very useful because this leaves the blood pressure after the glomeruli still high (about 35 mmHg) which is necessary for the function of the convoluted tubule (<i>see later</i>).
5. The oncotic pressure is, at the start of the capillary, about the same as in other normal capillaries.	6. However, it increases during the course of the capillary as much more fluid leaves the capillary, thereby increasing the concentration of proteins in the blood.
7. This gradual increase in oncotic pressure actually decreases the filtration of fluid from the capillary.	8. Also, the pressure in Bowman's capsule is much larger than in the interstitial space elsewhere in the body, which is usually around 0 mmHg.
9. In Bowman's capsule, the pressure is about 15 mmHg. This is useful because this capsular pressure pushes the filtrate down the tubular system.	10. The most important and interesting difference to me is that there is no filtration back into the capillaries in the nephrons. This is because the net filtration never becomes negative, in contrast to a normal capillary elsewhere in the body. (<i>link</i>)

Link: B.5.3. The Capillaries, panel C.

D. Glomerular Filtration Rate (GFR):

1. In fact, we can now describe the most important tool to determine the quality and the function of the kidney: The Glomerular Filtration Rate (GFR).	2. After all, like any other organ in the body, we would like to determine how well (or how bad) the two kidneys function.
3. For example, it would be nice if we could determine the amount of filtration that all the glomeruli produce.	4. Of course, one could inject a substance into the blood that is then fully filtered in the glomeruli but not reabsorbed or secreted in the blood.
5. Such a substance for example is inulin (not to be confused with insulin!). It is actually a starchy substance, available in a variety of fruits and vegetables.	6. But it would be much easier if we did not have to inject a substance but use something that is already available in the blood. And yes, there is such a substance available: Creatinine!
7. Creatinine is a compound that is continuously produced by the skeletal muscles in our body. In man slightly more than in females as usually males have more skeletal muscles. This creatinine is then filtered in the glomerulus and appears in the urine.	8. If for some reason the kidney (=nephrons) doesn't work properly, the concentration of creatinine in the blood will increase. If this is measured in a patient, this may indicate malfunctioning of the kidneys.