

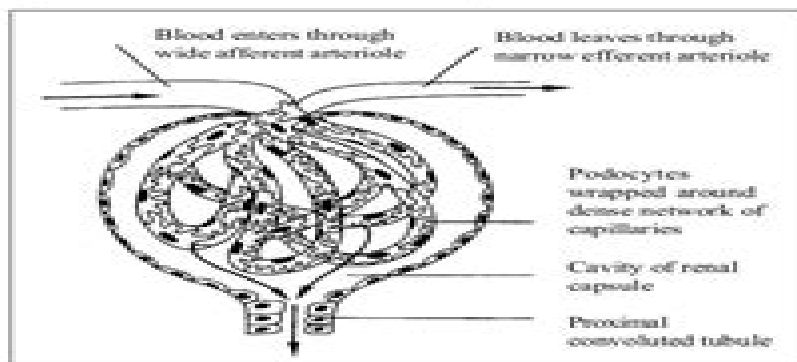
A. Ultrafiltration (Figure 3).

The Bowman's capsule contains a dense capillary network called the glomerulus. Blood flows into these capillaries through a wide **afferent** arteriole and leaves through a narrower **efferent** arteriole. The blood pressure inside these capillaries is high because:

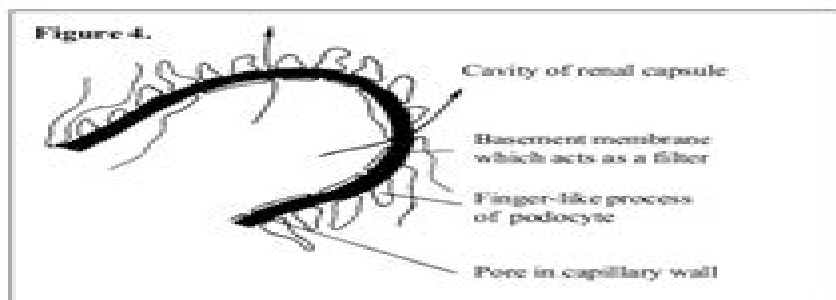
1. The renal artery contains blood at very high pressure which enters the glomerulus via the short afferent arteriole.
2. The efferent arteriole has a smaller diameter than the afferent arteriole.

The high pressure forces small molecules such as water, glucose, amino acids, sodium chloride and urea through the filter i.e. from the blood in the glomerular capsule across the basement membrane of the Bowman's capsule and into the nephron. This type of high-pressure filtration is known as **ultrafiltration**. The fluid formed in this way is called **glomerular filtrate**. Large molecules such as plasma proteins and blood cells do not pass through the filter because they are too big.

Figure 3. Structure of Bowman's capsule.

**The structure of the filter (Figure 4).**

Blood plasma is separated from the filtrate by two rows of cells, the lining cells of the capillary and the **podocytes** which make up the inner layer of the capsule. The capillaries have pores in their walls which the molecules in the plasma are able to pass directly through. The small molecules then pass through the basement membrane and once through this, they can pass between the processes of the podocyte directly into the cavity of the renal capsule. The actual filter is just the basement membrane and this is extremely thin.

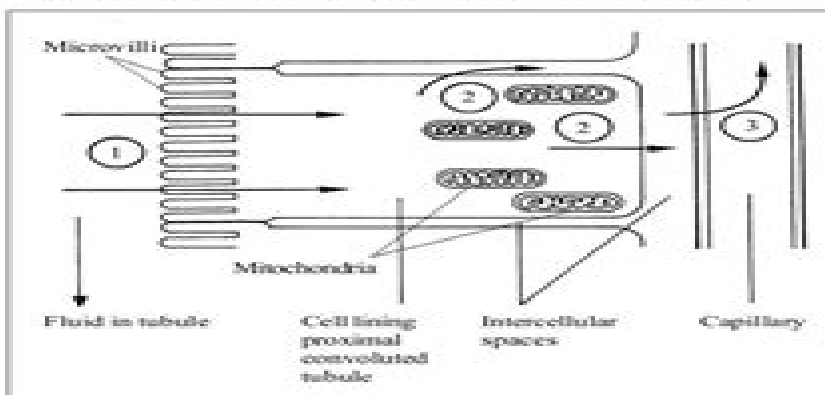
**Typical exam question**

Ultrafiltration often comes up in application questions, i.e. those questions which test a candidate's ability to apply factual knowledge to new situations. Often, candidates will be asked to make inferences about kidney malfunction from an analysis of the constituents of urine. If large molecules such as plasma proteins or red blood cells are present, the implication is that the filtration mechanism in the Bowman's capsule is not working properly. The presence of many small molecules such as amino acids would tell us nothing about the filtration mechanism, but would imply damage to the proximal convoluted tubule, where selective reabsorption occurs.

B. Selective reabsorption in the proximal convoluted tubule

The filtrate contains toxic substances such as urea which it is necessary to remove from the body but it also contains substances such as glucose which are required by the body. The function of the proximal convoluted tubule is to reabsorb these useful substances (Figure 5).

Figure 5. Reabsorption in the proximal convoluted tubule.



1. Glucose **diffuses** into the cells which line the proximal convoluted tubule. Microvilli increase the surface area for efficient absorption.
2. The glucose is **actively** transported out of the cells into the intercellular spaces. Mitochondria supply the necessary ATP.
3. Once in the intercellular spaces, the glucose diffuses through the walls of the capillaries and is transported away by the blood.
4. Active transport of glucose out of the tubule cells maintains a concentration gradient so more glucose is able to diffuse out of the tubule fluid.

Similar mechanisms result in the reabsorption of many of the **amino acids** and up to 90% of the **sodium ions** from the tubule fluid. The removal of all these soluble substances results in an osmotic gradient between the fluid in the tubule and the cells which line it. Water is therefore drawn out of the tubule fluid by osmosis, and passes into blood. This process is responsible for 85-90% of water reabsorption in the Nephron. It is only the remaining 10-15% which is regulated in the loop of Henle and collecting duct.

Typical exam question

State three ways in which the cells of the proximal convoluted tubule are adapted for efficient reabsorption.

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Thomas Griffiths



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