

Q23 What is the Glomerular Filtration Rate (GFR)? Discuss the physiological factors that can influence it. (March 2014)

The glomerulus is a specialized renal capillary bed located in the renal cortex responsible for the filtration of plasma and for adjusting the composition and volume of filtrate.

The filtration fraction is the percentage of renal plasma flow that is filtered at the glomerulus each minute (usually 15-20% - renal blood flow 550-600ml/min per kidney, GFR in a healthy adult 125ml/min).

Glomerular filtration rate is the amount of plasma filtered at the glomerulus per unit time. It is given by:

$$\text{GFR} = K_f \times [(P_G - P_B) - (\pi_G - \pi_C)]$$

Where K_f is the filtration coefficient

P_G is the hydrostatic pressure in the glomerular capillary

P_B is the hydrostatic pressure in Bowman's capsule

π_G is the oncotic pressure in the glomerular capillary

π_C is the oncotic pressure in the capsule

Hence, GFR is determined by:

1. The net filtration pressure across the membrane
 - The net hydrostatic pressure depends on the hydrostatic pressures in the afferent and efferent arterioles and that in Bowman's capsule. It may be influenced by systemic MAP, catecholamines, and local autoregulatory mechanisms (including renal autoregulation and tuboglomerular feedback) and usually favours filtration
 - The net oncotic pressure is dependent on plasma proteins (hence liver function) and the integrity of the glomerulus at preventing protein loss
 - Note that the net starling forces alter along the length of the arteriole as the oncotic pressure in the glomerular capillary increases (due to filtration of water and an increase in protein concentration)
 - NFP at the afferent end is ~ 24mmHg, at the efferent end ~10mmHg
2. The filtration coefficient
 - This is the product of surface area and membrane permeability
 - Surface area will depend on the number of functioning nephrons
 - Membrane permeability will depend on the functionality of the podocyte foot processes, the integrity of the basement membrane and the mesangial cells
 - Podocytes and basement membrane may be affected by disease such as glomerulonephritis which can increase or decrease permeability
 - Mesangial cells may contract under hormonal influences such as angiotensin II
 - Smaller molecules (<7KDa) are freely filtered as are positive molecules (as the basement membrane has a slight negative charge). Larger proteins and protein bound substances are not freely filtered by the healthy glomerulus

There is decline in nephron number with age and this explains some of the decrease in GFR in the elderly