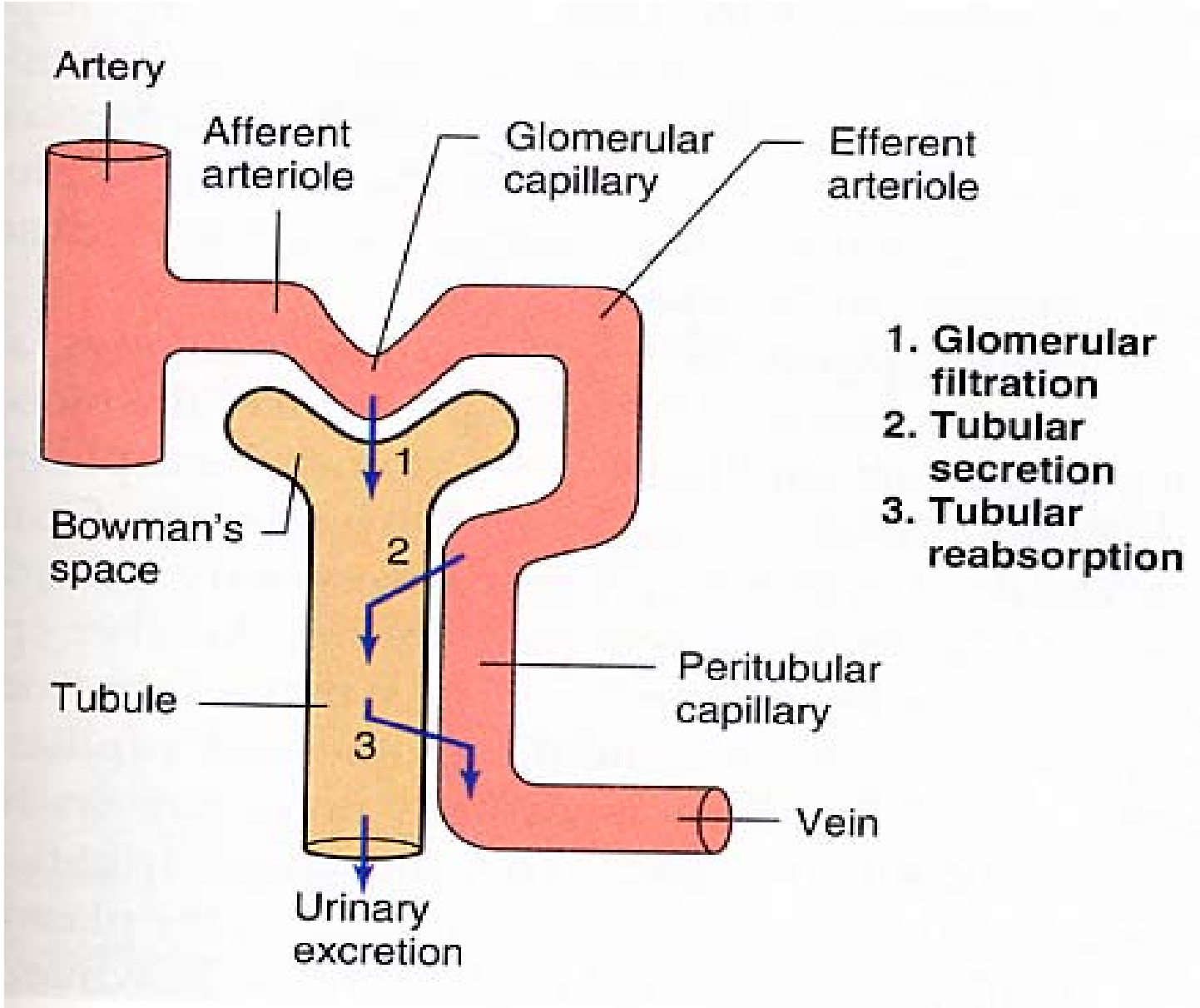
Urine formation

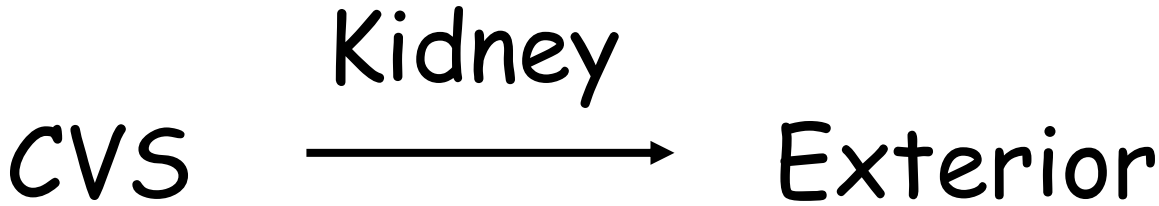


Excretion = Filtration – Reabsorption + Secretion

Clearance concept

- Clearance is an assessment of renal function

Clearance of a substance:

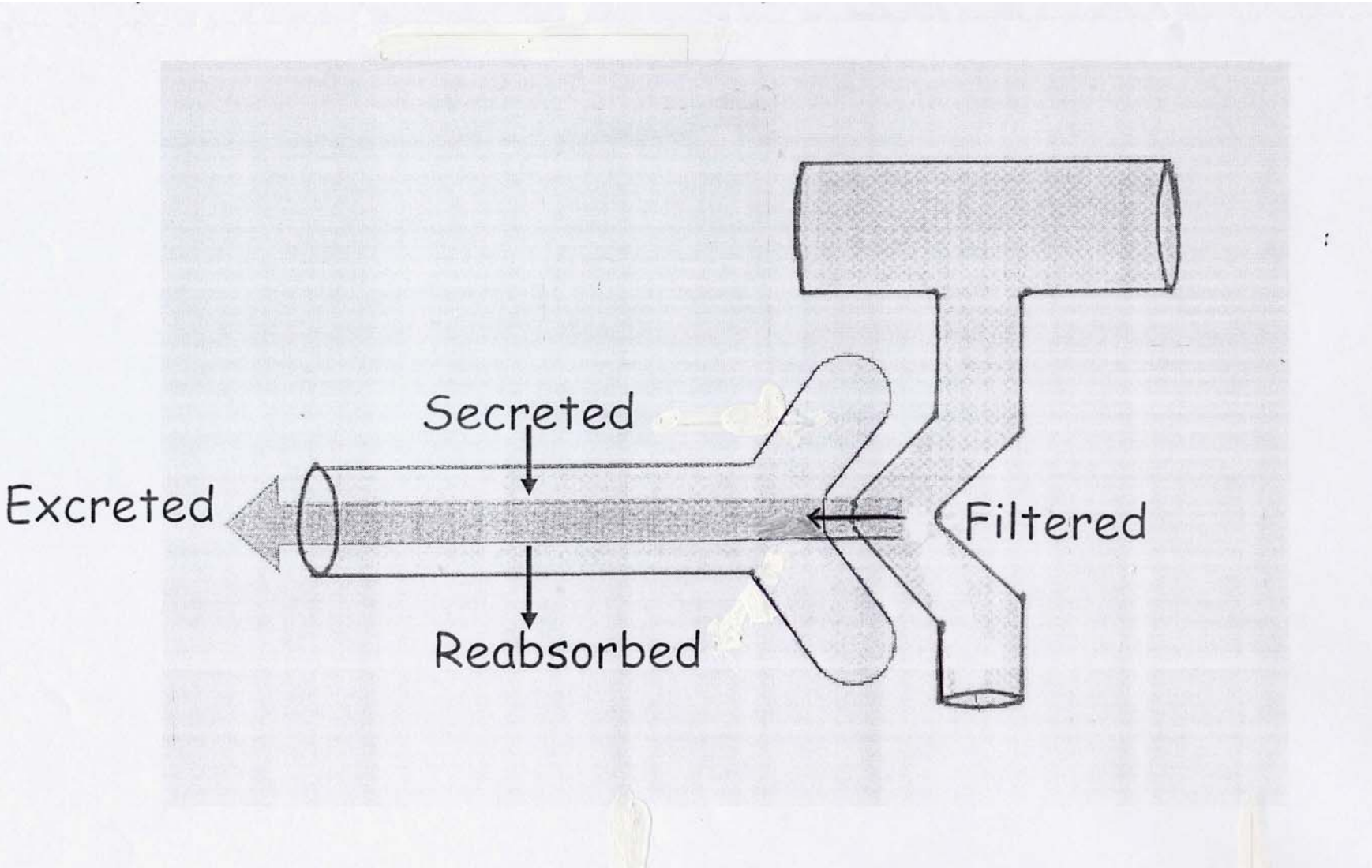


Def: the volume of plasma from which the subs is removed (cleared) by the kidney per unit time

Amount of a substance (x) excreted
= V X Ux

Ux = Urine concentration of x
V = Urine flow

Excreted = Filtered + Secreted - Reabsorbed



Amount of subs x transferred from CVS to the outside via the kidney

Plasma concentration of x (Px) X
Plasma volume that contains subs x

Cx = Plasma volume that contains x

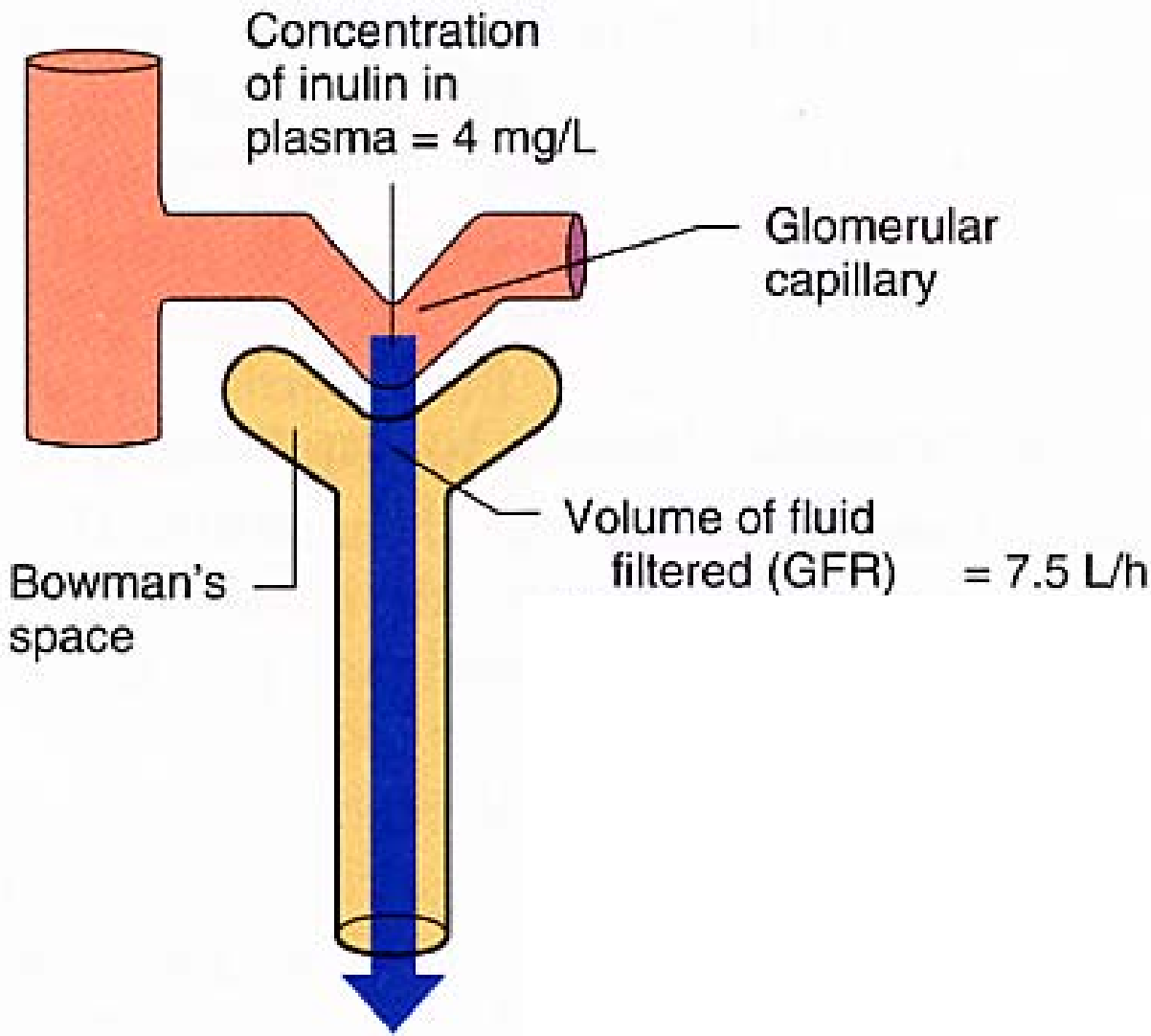
Excreted = Transferred from CVS to outside via the kidney

$C_x \times P_x = U_x \times V$

C_x = Clearance of X
P_x = Plasma concentration of X
U_x = Urine concentration of X
V = Urine flow
$U_x \times V$ = Mass of X excreted per unit time

$$Cx = \frac{Ux \times V}{Px}$$

Glomerular filtration rate (GFR)



Measurement of GFR

Use of a substance, which is

1. freely filtered,
2. non-toxic,
3. not reabsorbed by nor secreted from renal tubules

Inulin (MW= 5500)

$$C_{In} = \frac{U_{In} \times V}{P_{In}} = 120 \text{ ml/min}$$

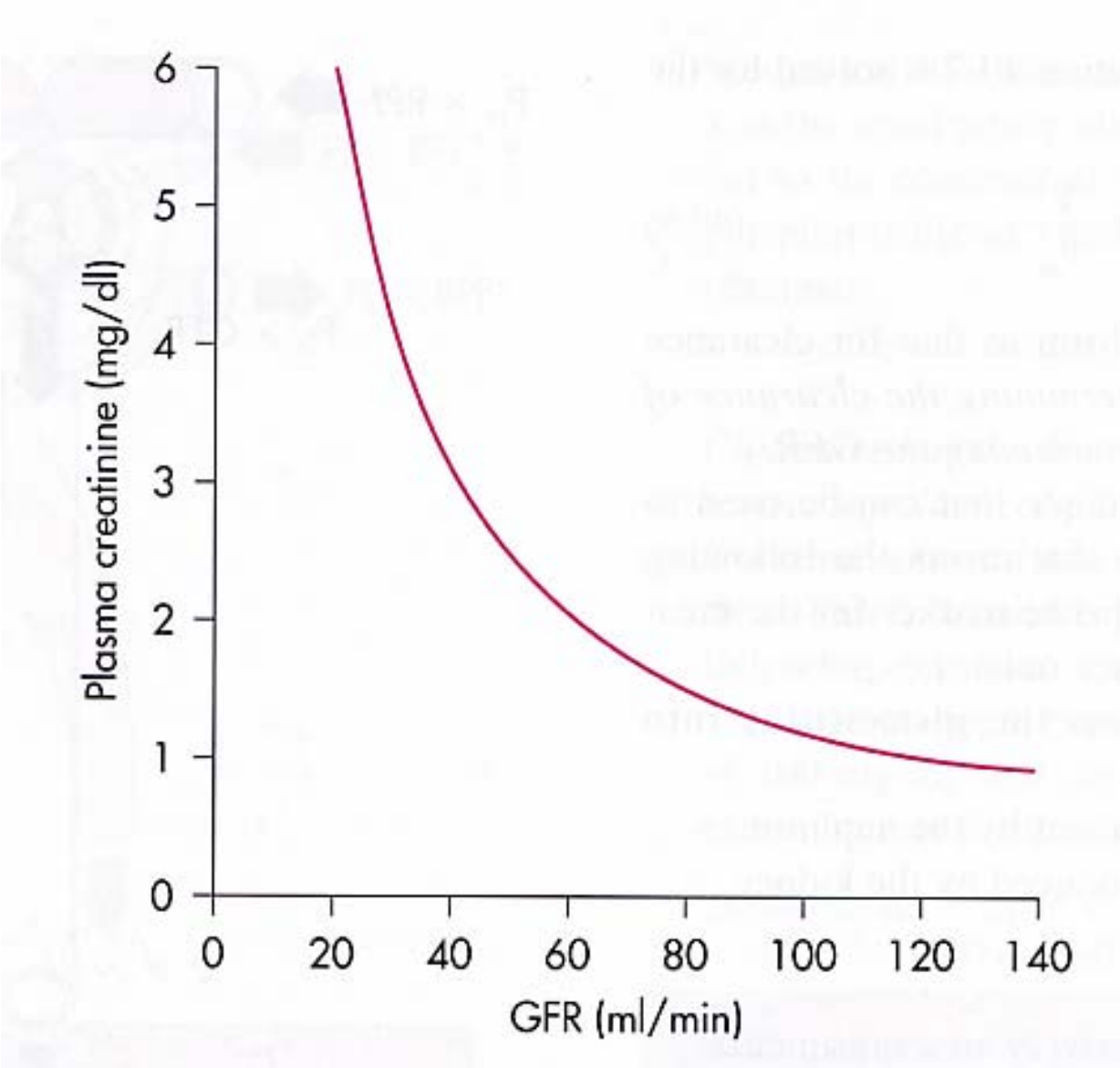
Use creatinine for the measurement of GFR

1. Produced by skeletal muscle at a constant rate
2. Freely filtered,
3. Non-toxic,
4. A small amount secreted by renal tubules
5. Not reabsorbed by renal tubules

In the steady state

Filtered load = Total excretion = Production

Plasma creatinine level as an indicator of GFR

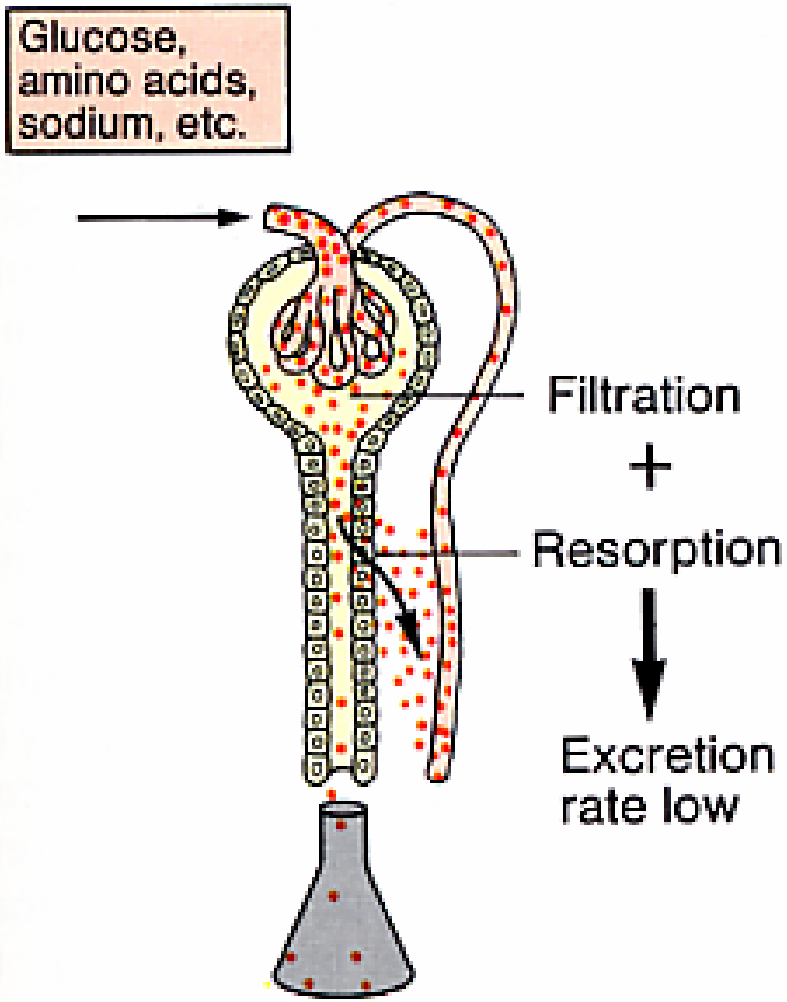


Serum creatinine level is NOT an accurate indicator of GFR

1. Non linear relationship of the serum level and GFR;

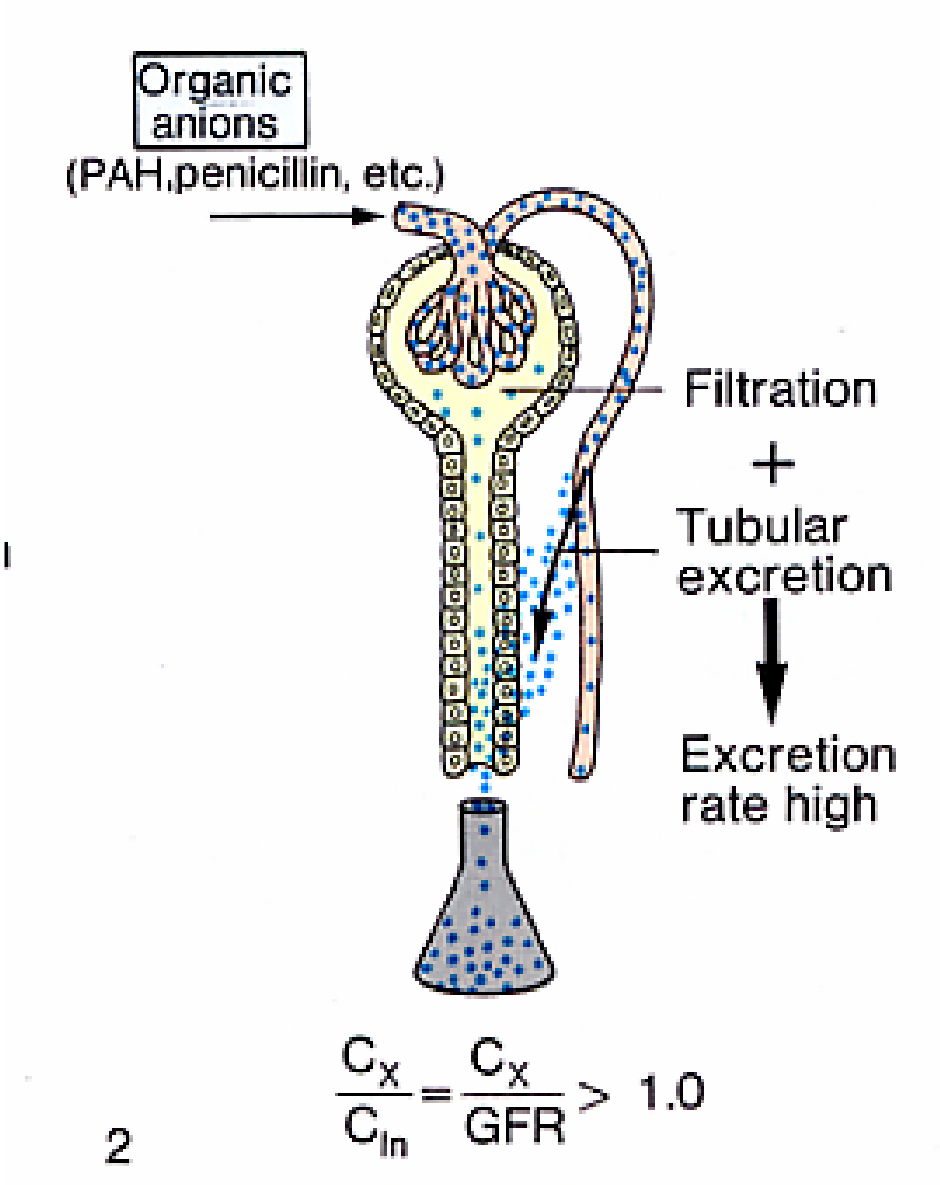
2. Muscle mass determines the serum level

Reabsorption

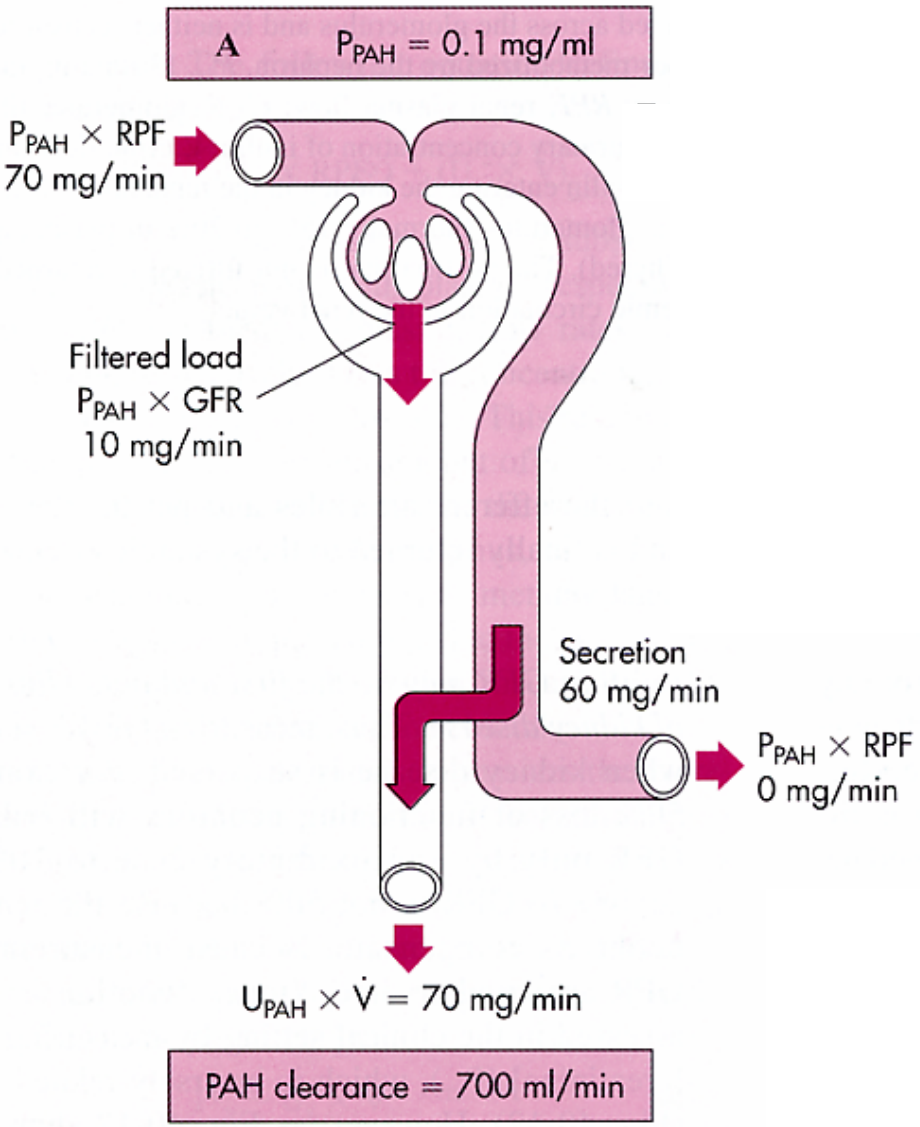


$$\frac{C_x}{C_{in}} = \frac{C_x}{GFR} < 1.0$$

Secretion


Organic anions
(PAH,penicillin, etc.)
Filtration
+
Tubular excretion
Excretion rate high
$\frac{C_X}{C_{In}} = \frac{C_X}{GFR} > 1.0$

Clearance of PAH as renal plasma flow



C_{inulin} or $C_{creatinine}$ = GFR (120 ml/min)

C_{PAH} = Renal plasma flow (600 ml/min)

Cx > GFR: x secreted from renal tubules

Cx < GFR: x reabsorbed by renal tubules

$$C_{Na^+} = \frac{1 \text{ ml/min} \times 140 \text{ mmol/L}}{140 \text{ mmol/L}}$$