RBF (Renal Blood Flow) = 1250 ml / min

RPF (Renal Plasma Flow) = 650 ml / min — PAH used to estimate RPF (fully removed / cleared)

RPF = RBF × (1 − Hematocrit) [proportion of blood that is plasma]

$RPF \times P_x = U_x \times V_x \Rightarrow ERPF = \frac{U_x \times V_x}{P_x}$

U_x: Concentration of x in Urine
V_x: volume of x in urine
P_x: Concentration of x in Plasma

$tRPF \text{ (True RPF)} = \frac{\text{Estimated RPF}}{\text{Extraction Ratio}} = \frac{ERPF}{ER}$

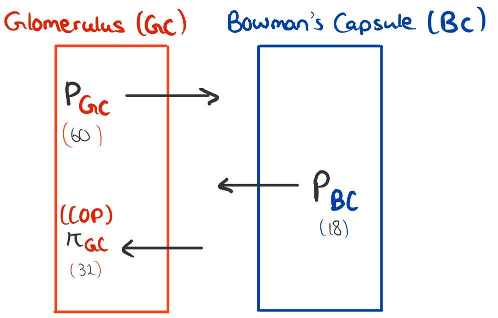
$\text{Filtration Fraction} = \frac{GFR}{RPF} \approx 20\%$

GFR (Glomerular Filtration Rate) = 125 ml / min (or 180 L / day)

Inulin used to Estimate GFR

Excretion = Filtration + ~~Secretion~~ − ~~Reabsorption~~

∴ Excretion = Filtration



Net filtration Pressure (Glomerulus) = $P_{GC} - (P_{BC} + COP)$

NFP = 60 − (18 + 32)

∴ **NFP = 10 mmHg**

Net Filtration (GFR) = NFP × K (K → Constant)

≈ 125 = 10 × K ∴ K = 12.5

Clearance (C_s)

$C_s \times P_s = U_v \times U_s$

$\Rightarrow C_s = \frac{U_v \times U_s}{P_s}$

U_v = Urine Volume
U_s = Urine Secretion
P_s = Plasma Concentration

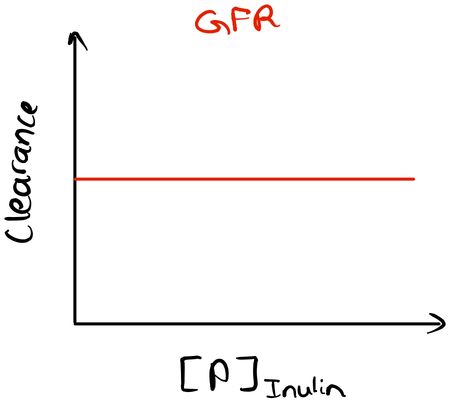
S only filtered : C_s = GFR
$C_{s\,Inulin}$ = GFR
All goes into glomerulus = All goes out

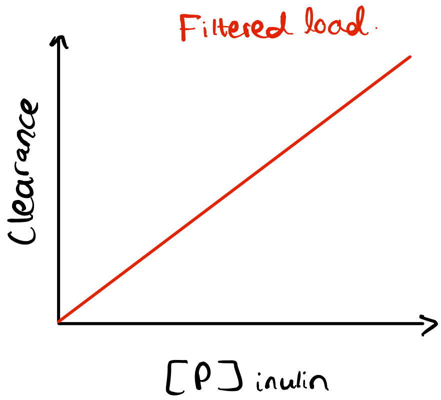
S filtered + 100% secreted : C_s = RPF
All that goes into glomerulus + all in plasma = RPF $C_{s\,PAH}$ = RPF

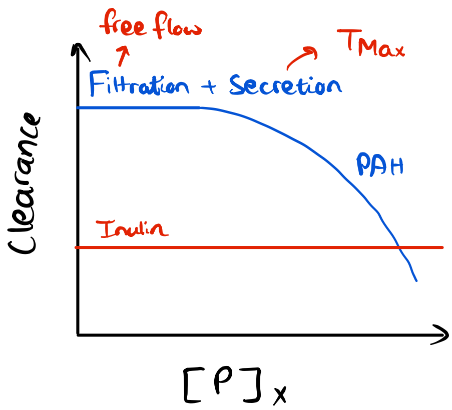
C_s > GFR : Net excretion

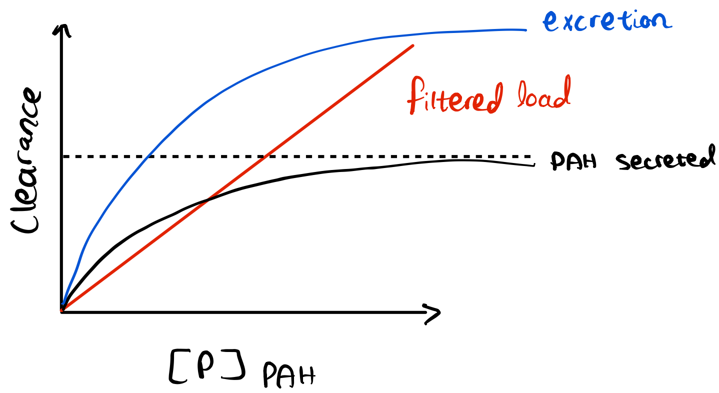
$\text{True GFR} = \frac{U_v \times U_{Cr}}{P_{Cr}}$

Clearance Curves



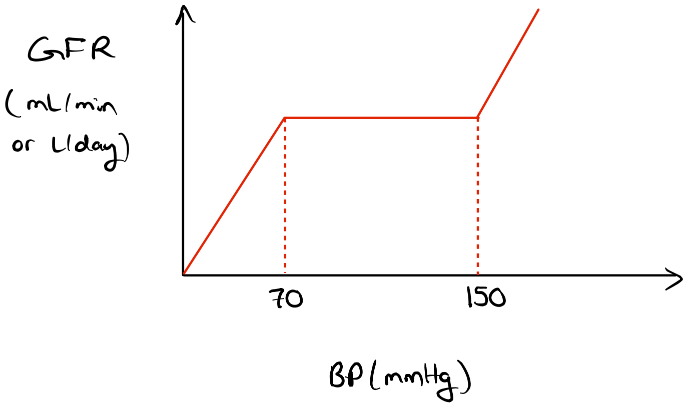


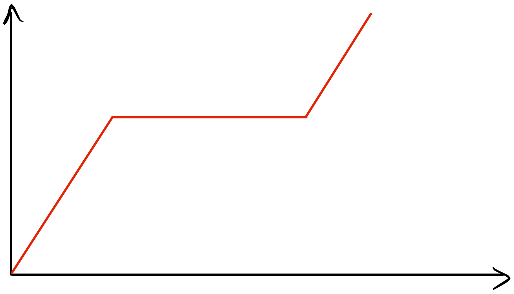


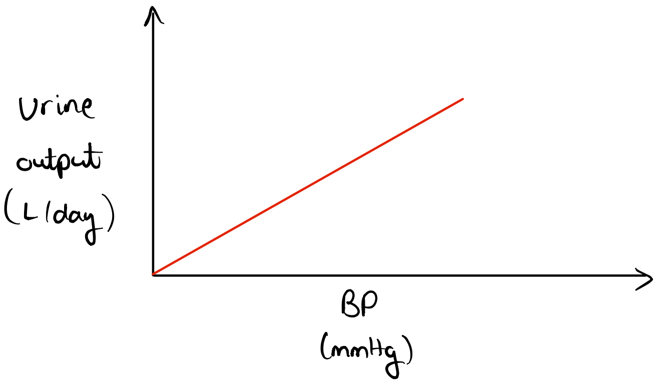


$[P]_{PAH}$ must be kept below saturation level of secretory transporters !!! (80 $\frac{mg}{min}$)

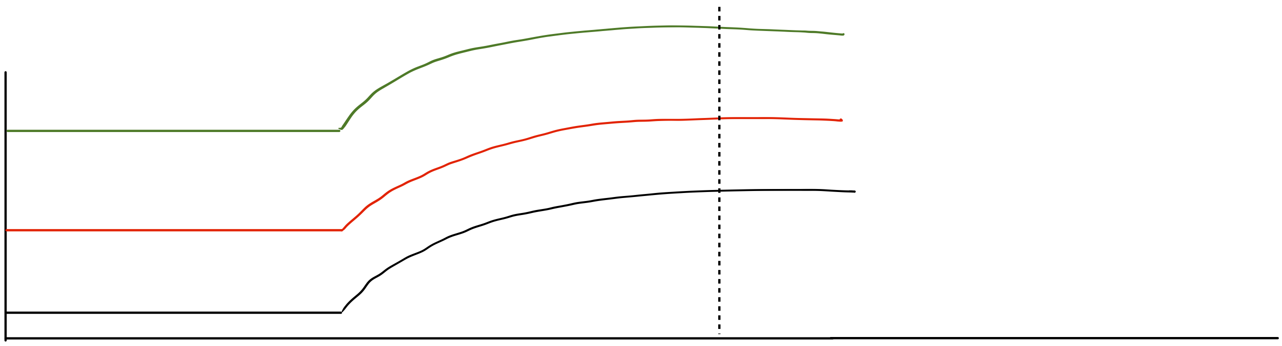
otherwise ⇒ PAH underestimated



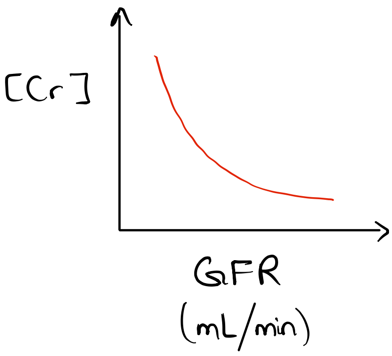




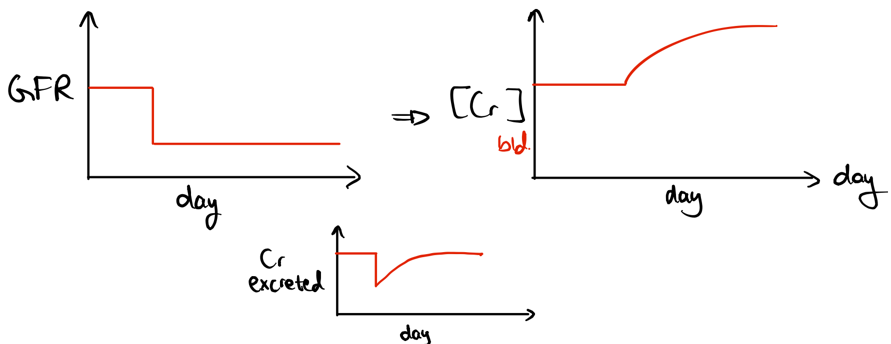
excrete more urine as BP ↑
(to decrease B.P. by removing H_2O)



Afferent Arteriole | Glomerulus (increase) ↓ H_2O | Efferent Arteriole | Peritubular Capillaries (plateau) H_2O back



as GFR ↑, $[Cr]_{blood}$ ↓



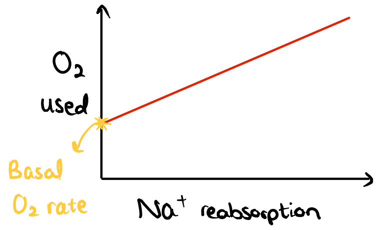
day ↑, GFR ↓
∴ [Cr] ↑

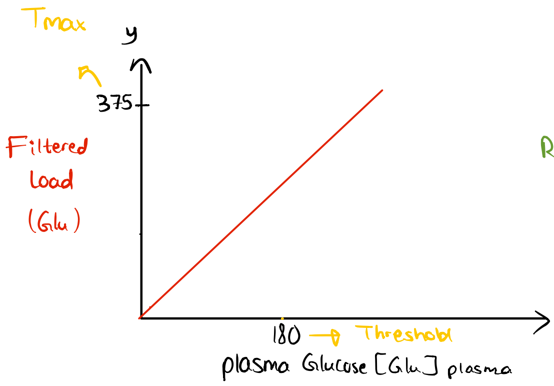
$$\text{Filtered Load} = GFR \times [Cr]$$

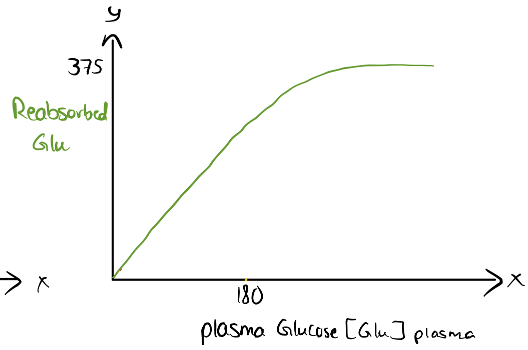
$$\left(\frac{mg}{min}\right) = \left(\frac{mL}{min}\right) \times \left(\frac{mg}{mL}\right)$$

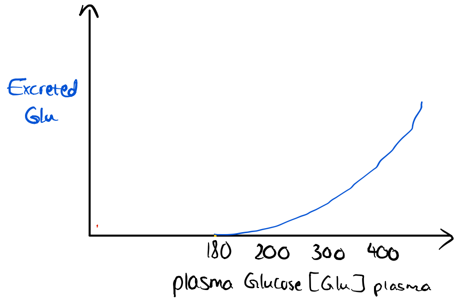
$$= 100 \times 0.5$$

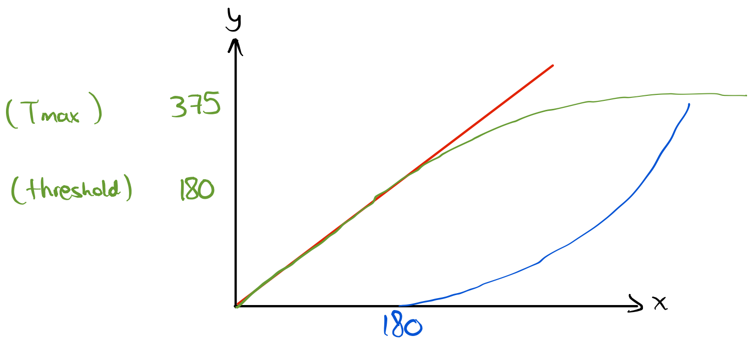
$$= 50 \ mg/min$$











Reabsorption (%)	Water	Na^+	K^+
PCT	65	65	65 + Secreted
Descending	15	Ø	Ø
Ascending	Ø	25	25
DCT	10	7	Ø
Collecting Duct	9.5	2.5	Ø + Secreted

Filtered load of:

$$Na^+ = [Na^+]_{plasma} \times GFR$$ → Constant, assume 180 $\frac{mL}{day}$

$$[Na]_{FL} = 140 \ \frac{mEq}{L} \times 180 \ \frac{L}{day}$$

$$[Na]_{FL} = 25,200 \ \frac{mEq}{day}$$

$$[K^+]_{FL} = [K^+]_{plasma} \times GFR$$

$$[K^+]_{FL} = 4 \ \frac{mEq}{L} \times 180 \ \frac{L}{day}$$

$$[K^+]_{FL} = 560 \ \frac{mEq}{day}$$

Urine Control

Plasma Osmolarity = 300 mOsm/L

Urine Input = 1000 mOsm/day

Urine Output = 1.5 L/day

$$\therefore \text{Urine Osmolarity} = \frac{\text{Input}}{\text{Output}} = \frac{1000 \ \frac{\text{mOsm}}{\text{day}}}{1.5 \ \frac{\text{L}}{\text{day}}} = 650 \ \frac{\text{mOsm}}{\text{L}}$$

Obligatory Urine Volume

= minimum urine volume in which the excreted urine solute can be dissolved & excreted = $\frac{600}{1200} \frac{\text{L}}{\text{day}}$

If < 0.5 L/day, Oliguria

(Lowest Range → Highest Range

30 $\frac{\text{mOsm}}{\text{L}}$ → 1400 $\frac{\text{mOsm}}{\text{L}}$)

Free water clearance (C_{H_2O})

$$C_{H_2O} = V - \frac{U_{osm} \times V}{P_{osm}}$$

$$C_{H_2O} = V\left(1 - \frac{U_{osm}}{P_{osm}}\right)$$

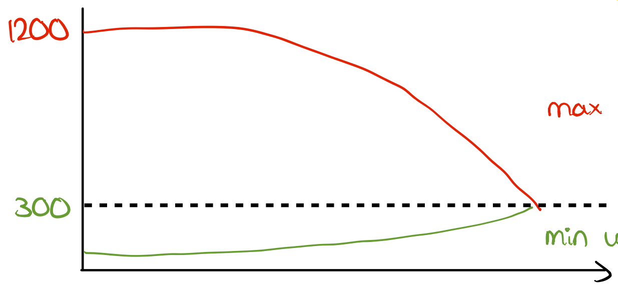
V = Urine flow rate

U_{osm} = Urine Osmolarity

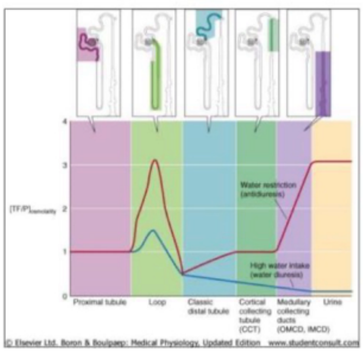
P_{osm} = Plasma Urine Concentration

$U_{osm} < P_{osm}$ ⇒ $\frac{U_{osm}}{P_{osm}} < 1$ ∴ C_{H_2O} = +ve (dilution)

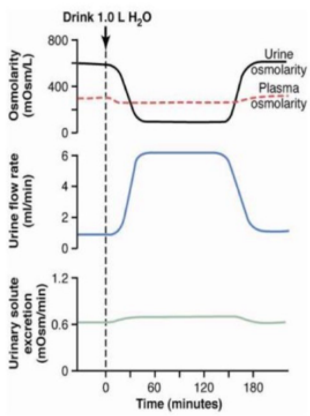
$U_{osm} > P_{osm}$ ⇒ $\frac{U_{osm}}{P_{osm}} > 1$ ∴ C_{H_2O} = −ve (Concentration)



- Red = water restriction
- Blue = high water intake
- Initial concentration of tubular fluid at loop of Henle, then finally at collecting ducts.

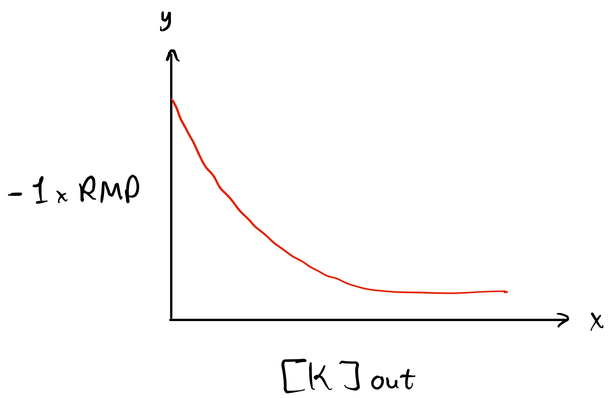


Water diuresis in a human after ingestion of 1 liter of water.



Nernst Equation (1st year physio !!)

$$RMP = -61 \times \log \frac{[X]_{in}}{[X]_{out}} \quad \left(-1 \times RMP = 61 \times \log \frac{[X]_{in}}{[X]_{out}}\right)$$



as $[X]_{out}$ ↑, −RMP ↓

Acid - Base Balance

$pH = -\log [H^+]$

$\therefore [H^+] = 10^{-7}$, $pH = -\log(10^{-7}) = +7$

Normal pH: 7.35 ⟶ 7.45

< 7.35 Acidosis

> 7.45 Alkalosis

Henderson - Hasselbach eqn:

$$pH = pKa + \log \frac{[X^-]}{[HX]}$$

for HCO_3^-: $pKa = 6.1$

$$\therefore \quad pH = 6.1 + \log \frac{[HCO_3^-]}{0.03 \times P_{CO_2}}$$