Bio390 **Clearance and Reabsorption**

thanks to Dr. J.F. Anderson,
Dept Zoology
Univ. of Florida, Gainesville

Use the following data to answer these questions.

renal inulin clearance: $\frac{100 \text{ ml}}{\text{min}}$

$[\text{inulin}]_{\text{arterial plasma}}$: $\frac{0.5 \text{ mg}}{\text{ml}}$

hematocrit: 0.40

renal PAH clearance: $\frac{600 \text{ ml}}{\text{min}}$

$[\text{glucose}]_{\text{arterial plasma}}$: $\frac{0.8 \text{ mg}}{\text{ml}}$

$[\text{glucose}]_{\text{urine}}$: $\frac{0.0 \text{ mg}}{\text{ml}}$

rate of urine formation: $\frac{0.5 \text{ ml}}{\text{min}}$

ESTIMATE:

a. plasma flow rate in the afferent arterioles:

ANS: 600 mL/min
This is the renal plasma flow, which is given as the Clearance of PAH.

b. plasma flow rate in the efferent arterioles:

ANS: This will be the renal plasma flow rate (RPF) minus the amount that the plasma volume is reduced by filtration. The amount of plasma lost by filtration must equal the GFR which is the clearance of inulin (100 ml/min here). Thus, the blood flow in the efferent arteriole is 600 - 100 ml/min = 500 ml/min in this problem

c. plasma flow rate in the renal veins:

ANS: by the time that blood enters the veins, nearly all of the water lost during filtration has made its way back to the blood (especially if the subject is dehydrated!). If urine is being formed at a rate of 0.5 mL/min, then that represents (essentially) the volume of water lost per min. So, the renal venous plasma flow rate = RPF- urine loss = 600 - 0.5 = 599.5 ml/min

d. renal blood flow rate in renal artery in ml/min

ANS: 833 mL/min
the hct = 40% (0.4). Therefore
RPF = Renal Blood Flow (1-hct)
(note that 1-hct is the proportion of the blood without cells – the plasma – 0.6 in this case)
re-arranging:
Renal Blood Flow = RPF/(1-hct) = 600 mL/min/(0.6)
= 1000 mL/min

e. GFR

ANS: GFR = clearance of inulin = UV_x/P_x – it is given as 100 mL/min

f. the factor by which small solutes that are neither secreted nor reabsorbed are concentrated as compared to the plasma

ANS: Note – all we need to do here is find the factor by which the filtrate volume was reduced or the factor by which the inulin concentration changes.
Filtrate volume = GFR = 100 mL/min,
Urine flow rate = 0.5 mL/min
Concentration factor = 100/0.5 = 200X

The inulin concentration in the urine was not given but it must be 200X that of the plasma = 0.5 mg/ml = 100 mg/ml

Check – GFR = $U_x V/P_x$
= 100 mg/ml *0.5ml/min/0.5 mg/ml = 100 ml/min

g. rate of glucose reabsorption:
ANS: Since there is no clearance of glucose, all the glucose that is filtered must be reabsorbed. So, if we calculate the rate of filtration of glucose, this equals the rate of reabsorption. The filtration rate will equal the rate at which water passes the glomerulus (which equals the GFR) times the concentration of glucose in the blood. So, the rate of filtration =

100 ml plasma/min * 0.8 mg glucose / ml plasma
= 80 mg/min which is also the reabsorption rate

ANS: For this one, we need to know the amount of inulin filtered per min and then divide it by the volume of urine per minute. The amount of inulin that ends up in the filtrate is the:

$GFR * [inulin]_{plasma}$ = 100 ml/min * 0.5 mg inulin/ml

= 50 mg inulin / min

h. concentration of inulin in urine: (also done in part (f)

and the rate of urine formation is 0.5 ml/min
so amt/vol = (50 mg inulin / min) / (0.5 ml/min)

= 100 mg inulin/ml urine

Note how the inulin has been concentrated as the urine volume is reduced.

i. inulin excretion rate:

This was worked out above. The amount of inulin that ends up in the filtrate is the:

$GFR * [inulin]_{plasma}$ = 100 ml/min * 0.5 mg inulin/ml

= 50 mg inulin / min

and all of this is excreted. Therefore this is the excretion rate.

j. inulin concentration in renal venous plasma:

ANS: = 0.42 mg inulin/ ml

To find this we, need to know the amount of inulin remaining in the blood after filtration. This amount is the difference between what entered in the renal plasma and what left in the filtrate. SO: The amount entering will be the:

RPF * $[\text{inulin}]_{plasma}$ = 600 ml/min * 0.5 mg/ml
= 300 mg inulin/min

We then want to subtract from this the amount of inulin that is lost in to the filtrate and urine (remember it is not reabsorbed). In the last problem we saw that the rate of filtration was 50 mg inulin / min

Thus, 300 - 50 = 250 mg of inulin leave via the veins each minute.

Finally, we need to turn it into a concentration. We earlier (c above) found that the volume of venous plasma

= 599.5 ml / min.

So, the concentration of inulin in venous blood is:
250 mg per minute in venous plasma / 599.5 ml / min venous plasma flow
= 0.42 mg inulin/ ml

Notice that nowhere near all of the inulin is actually cleared from the plasma