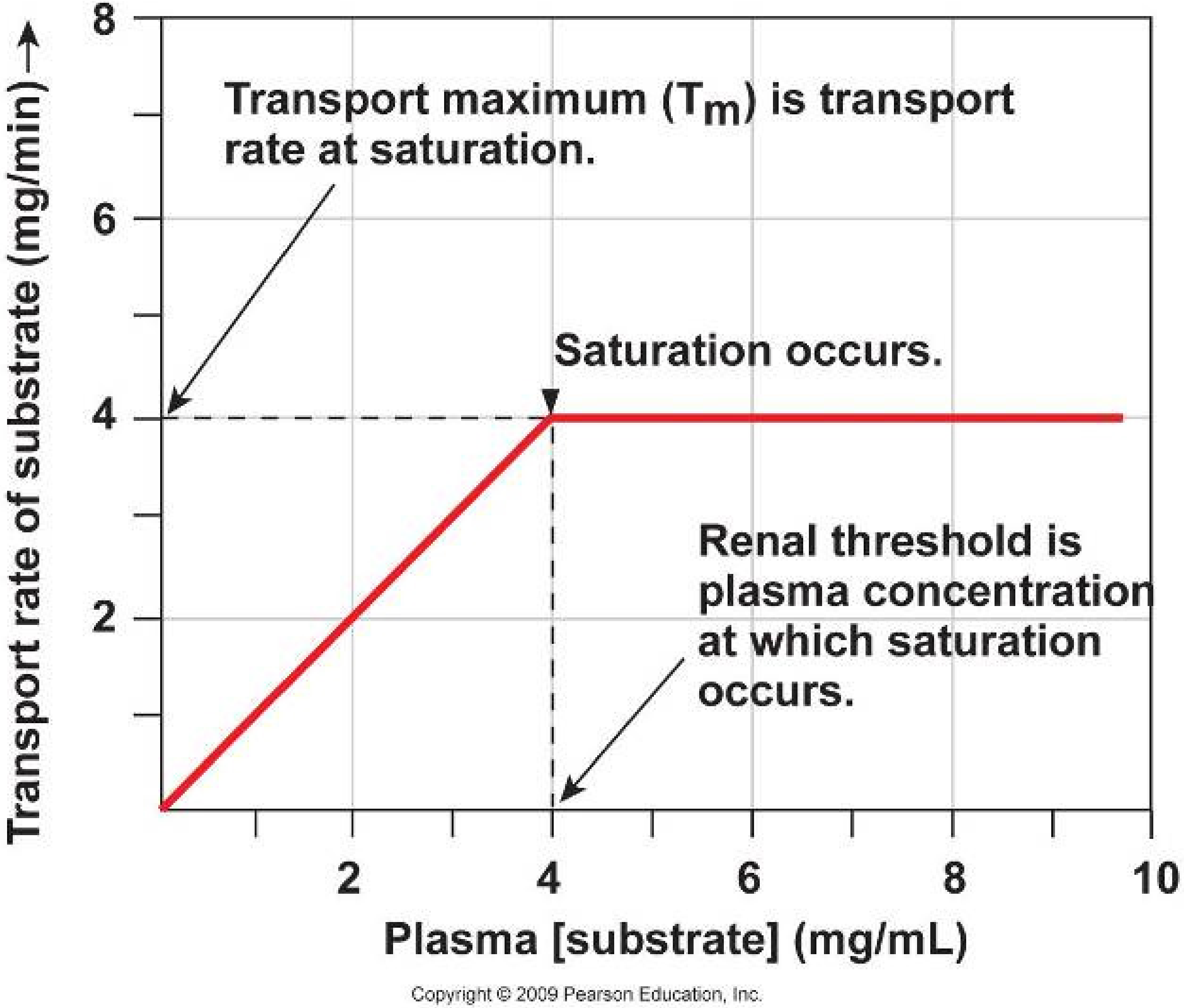
Renal physiology III

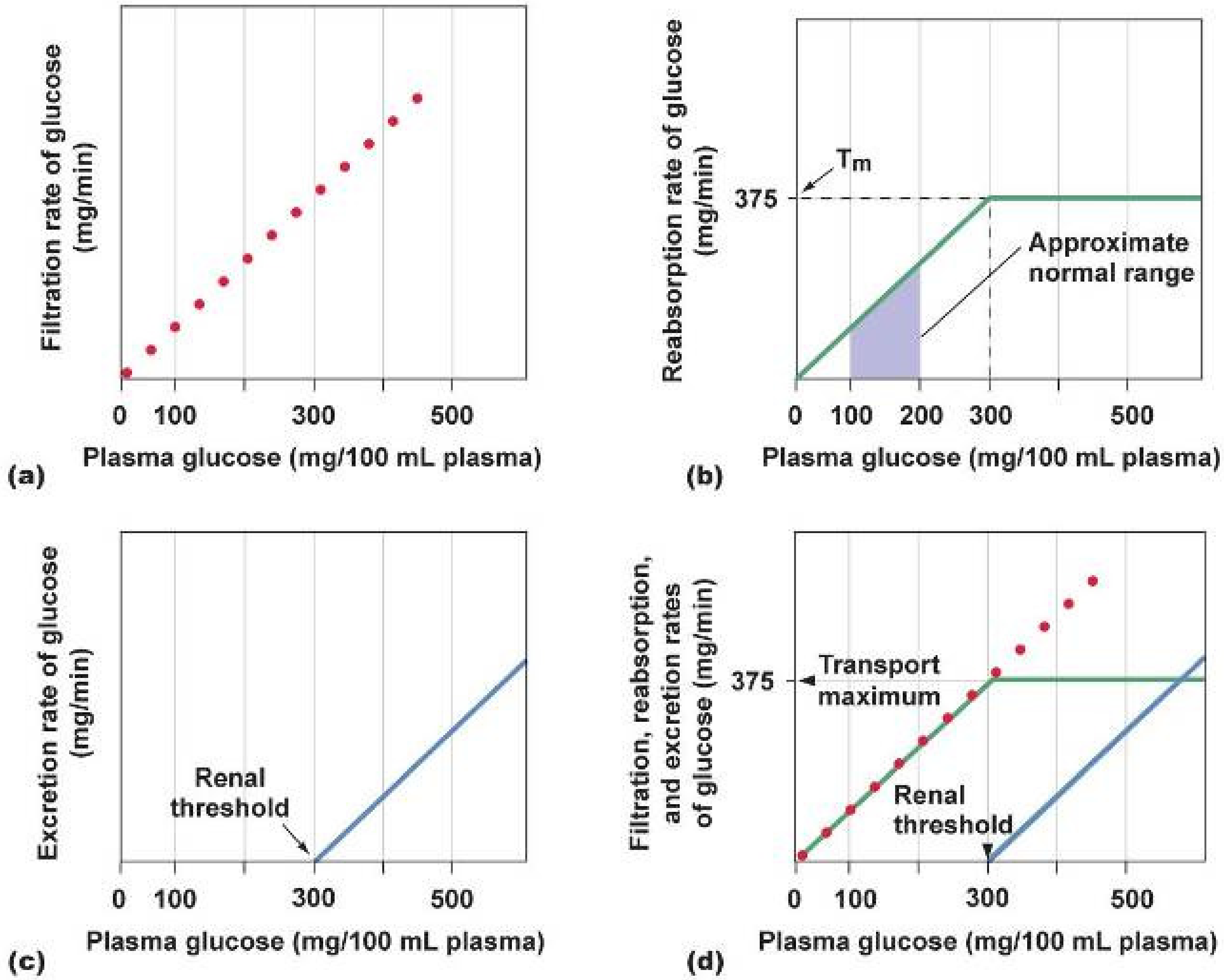
Quantification of renal function

Dr Alida Koorts
BMS 7-12
012 319 2921
akoorts@medic.up.ac.za

Transport rate



Handling of glucose



Threshold concentration

- plasma concentration of a solute at which it begins to appear in the urine
- characteristic of each substance
- for glucose: threshold concentration is 11 mmol/l
- glucosuria at plasma glucose concentration > 11 mmol/l (diabetes mellitus)
- T_m glucose = 16 mmol/l

Renal transport maximum (T_m)

- maximal amount of a substance that can be transported over tubular epithelium/min
- no T_m: inulin (not reabsorbed), or sodium – no upper limit
- high T_m: glucose (16 mmol/min)

Clearance is a non-invasive way of measuring GFR

Definition:
The amount of plasma in ml passing through the kidneys that have been cleared of a substance in a given amount of time

$$\text{Clearance} = \frac{\text{urinary excretion rate of substance (mg/min)}}{\text{plasma concentration of the substance (mg/ml)}}$$

where the urinary excretion rate is calculated by:

urine flow rate x urine concentration of the substance

$\text{Clearance}_{substance} = \text{V(urine flow rate)} \times [U]_{substance}/[P]_{substance}$

Measuring clearance with inulin

- inulin is a polysaccharide that comes from the dahlia root
- inulin is freely filtered and neither reabsorbed nor secreted by the nephron
- thus; inulin clearance is 125 ml/min = GFR

Example:

U_{IN} = 35 mg/ml

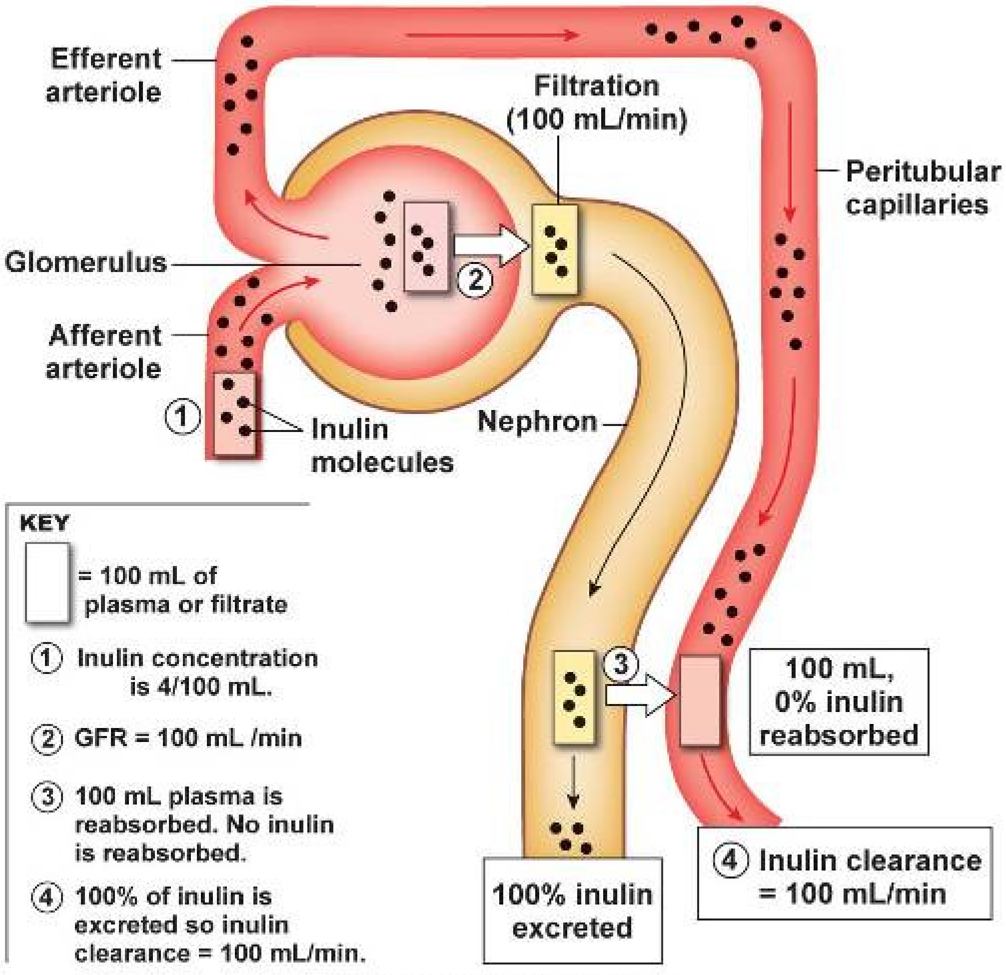
V = 0,9 ml/min

P_{IN} = 0,25 mg/ml

$C_{IN} = U_{IN} \times V/P_{IN}$

= 35 x 0,9/0,25

C_{IN} = 126 ml/min



Creatinine clearance

- injections are not necessary as with inulin
- routinely used to assess GFR
- plasma concentrations do not vary much
- a small amount is secreted by the proximal tubule

Determination of renal blood flow

- plasma load = total amount of substance in plasma which circulates through kidneys/min
- = effective renal plasma flow (ERPF in l/min) x $[substance]_{plasma}$ (mmol/l)
- use clearance of a substance that is cleared from the plasma in one circulation through the kidneys by filtration AND SECRETION
- PAH (para-aminohippuric acid) or diodrast
- effective renal plasma flow $= [U]_{PAH} \times V/[P]_{PAH}$
  $= C_{PAH}$
- renal blood flow = renal plasma flow x 1/1-haematocrit

Renal blood flow determination using clearance of PAH (para-amino hippuric acid)

Renal plasma flow **= clearance of PAH**

= $[U]_{PAH} \times V/[P]_{PAH}$

= 14 mg/ml x 0.9 ml/min/0.02 mg/ml

= 630 ml/min

Average PAH extraction ratio **= 0.9**

= 630/0.9

Renal plasma flow **= 700 ml/min**

Renal blood flow **= RPF x 1/1-Hct**

= 700 x 1/0.55

= 1273 ml/min

Substance	[ ] filtrate	mmol/24h filtered	mmol/24h reabsorbed	% reab-sorbed
Water		180 l	178,5 l	99
Na^+	142	26 000	25 850	99
K^+	4	600	560	93,3
Cl^-	100	18 000	17 750	98,6
HCO_3^-	28	5 040	5 040	100
Glucose	4,5	800	800	100
Urea	4,8	870	460	53
Urate	0,28	50	45	90
Creatinine	0,07	12	0	0,0