Kidney

المحاضرة السادسة

K , Urea , H & Ca Renal Handling
Plasma Clearance
Micturition

بتاريخ ٢٤ مارس ٢٠١٨

Tubular Handling of Potassium

K^+ excretion is determined by 3 processes

① K^+ filteration

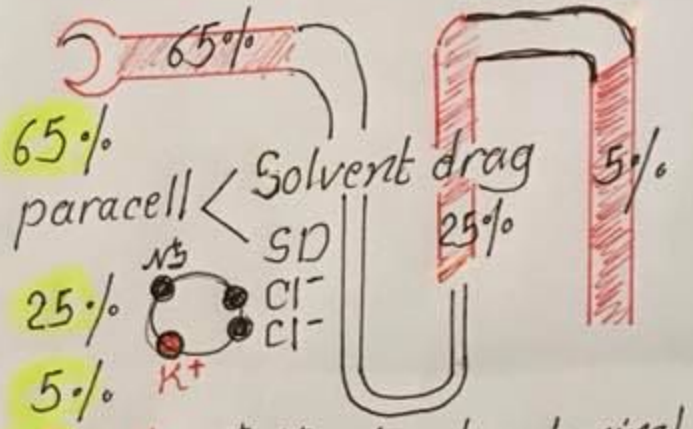
$180L \times 45 = 756\ mEq/day$

② K^+ reabsorption

a. PCT

b. Thick ascending

c. Collecting T



③ K^+ secretion

Late distal & cortical collecting

P cells Aldosterone

basolat border: $Na-K^+$ pump

luminal border: Diffusion

- K^+ secretion is increased by:

1. ↑ Dietary K^+ → ↑ Plasma K^+
2. Diuretics → ↑ Flow in DCT
3. Aldosterone
4. Alkalosis metabolic → ↑ Na^+-K^+ ATPase, ↓ K^+ efflux

Tubular handling of Urea

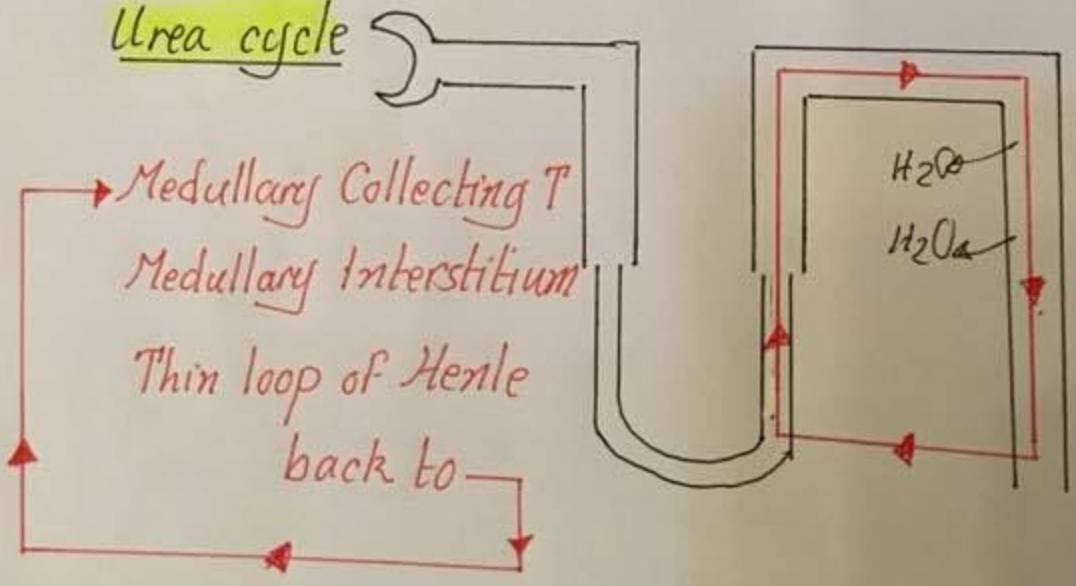
① PCT 40% back diff Parzcell solvent drag

② Thick ascending, DCT & Cortical collecting T
Impermeable to urea.
H_2O reab ⟶ ++ urea conc

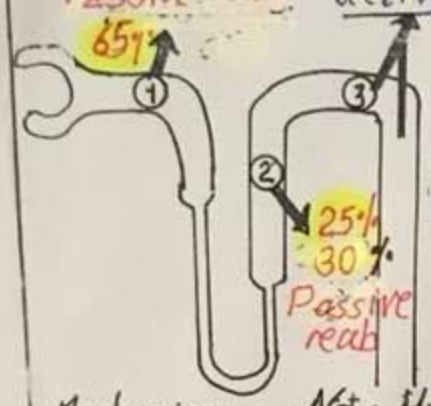
③ Medullary part of collecting T
40%-60% diffuses to medullary interstitium
⟶ Hyperosmolarity

Urea excretion is increased by
↑ Plasma urea
↑ GFR

Urea cycle



Ca^{++} handling by renal tubules



↑ Ca^{++} reab
- PTH
- 1,25(OH)$_2$ CC
- Metabolic acidosis

↓ Ca^{++} reab
- ↓ $PO_4^{\equiv}$ plasma
- CT
- Metabolic alkalosis

Mechanism of 1 & 2: ++ Na^+ & H_2O reab. → ++ Ca^{++} conc in lumen → ++ Ca^{++} reabsorption

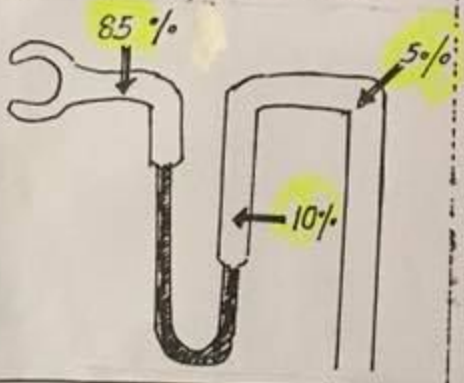
Secretion of hydrogen and Reabsorption of HCO_3^-

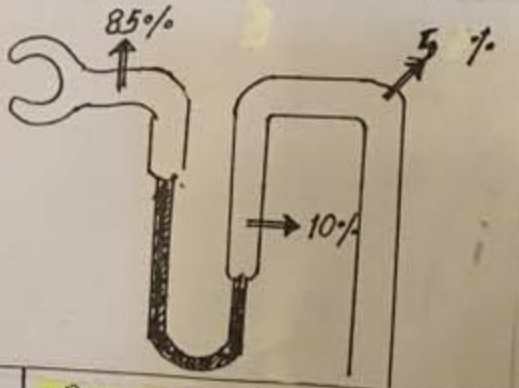
For each H^+ ion secreted → One HCO_3^- ion is reabsorbed

H^+ ions are secreted in all except descending & ascending thin limbs of Loop of Henle

Tubules are poorly permeable to HCO_3^-

Reab. HCO_3^- is formed by tubular cells from $CO_2 + H_2O \xrightarrow{CA} H_2CO_3 \rightarrow HCO_3^- + H^+$





	Secondary active transport	Primary active transport
Site	PCT, loop of Henle (thick) 1st part of DCT	Late DCT and collecting tubules
%	95%	5%
Mechanism	Na^+ dependent Antiport carrier at luminal border	Na^+ independent H^+ ATPase pump at luminal border
Control	Not stim by aldosterone	Stimulated by aldosterone

Plasma clearance

- **Definition** Volume of plasma cleared completely from a substance excreted in urine per minute.
- **Calculation**

Amount cleared = Amount excreted

$C \times P = V \times U$

$C \text{ (vol. cleared)} = \frac{V \times U}{P}$

V = Vol of urine/min U = Urince conc. P = Plasma conc.

- **Importance**

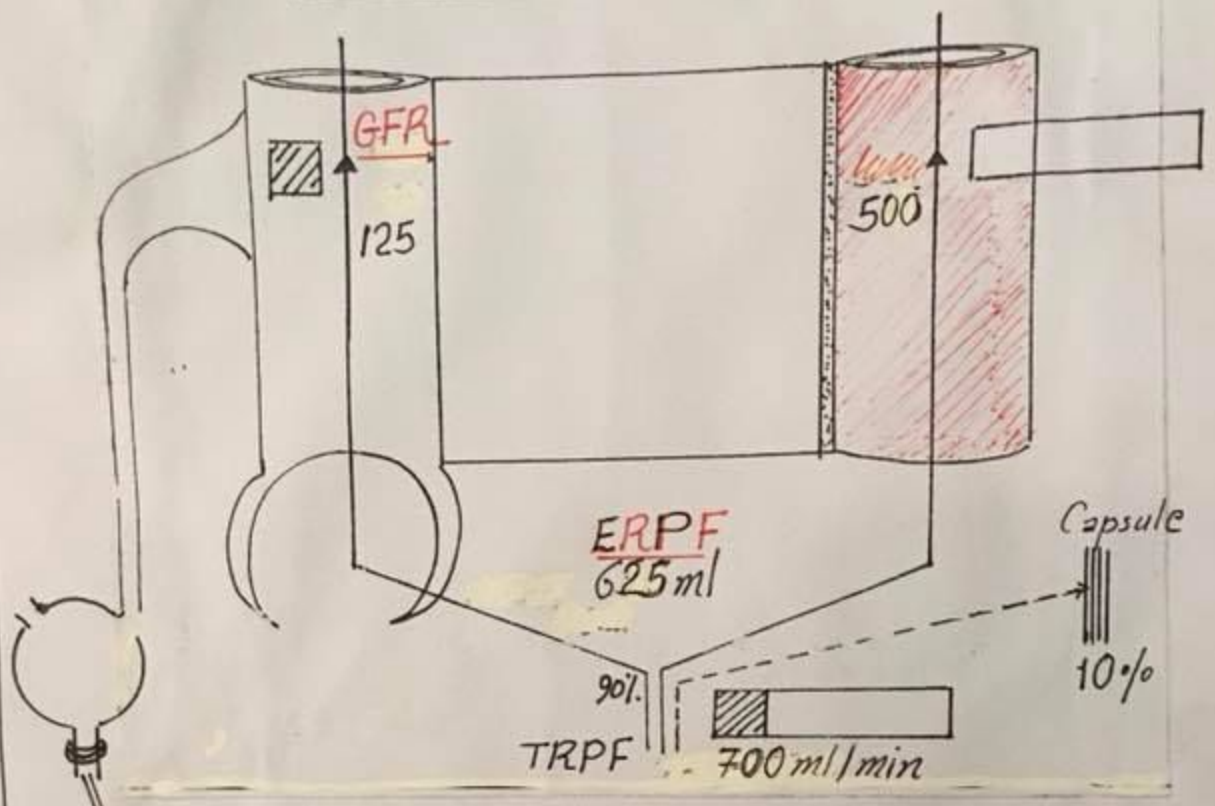
1. Study of tubular handling of different solutes (p.21)
2. Measurement of GFR refer to inulin clearance
3. Measurement of total renal plasma flow
   a) ERPF = PAH clearance
   b) TRPF Extraction ratio 90% i.e only 90% of TRPF goes to nephron
   c) TRBF From Hematocrite value $TRBF = \frac{TRBF}{1 - HV}$

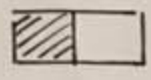
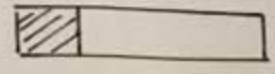
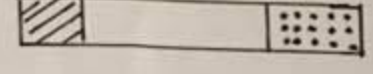
   Characters of PAH: Completely secreted through a single circul. Freely filtered
4. Calculation of filtration fraction $\frac{GFR}{RPF} = 0.2$
5. Free water clearance
   = H_2O free of solute
   It tests power of kidney to conc. or dilute urine
   Free H_2O is generated by diluting segment
   - If ADH is low : free H_2O clearance is +ve
   - If ADH is high : fee H_2O clearane is −ve

   $C_{H_2O} = V - \frac{V \times U_{osm}}{P_{osm}}$
6. Kidney function tests

- **Disadvantages** It gives net effect not the details
  e.g K^+ clearance less than 125 ml
  so • net effect : partial reabsorption
  • Details : K^+ is completely reab. in PCT then secreted in DCT

Plasma clearance



	Clearance ml/min	Renal mechanism	e.g
	125	neither reab. nor secreted	Inulin
	Less than 125	partially reab	K^+ Urea
	0	completely reab	Glucose
	More than 125	partially secreted	Creatinine
	625	completely secreted	PAH diodrast
	More than 625	formed & secreted	NH_3

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ERPF PAH Clearance

TRPF Excretion Ratio

TRBF HV

Micturition = Filling + Micturition reflex

Anatomy

1 **Body**: detursor ms
Functional syncitium
Cont. → ↑↑P to 40-60 mmHg

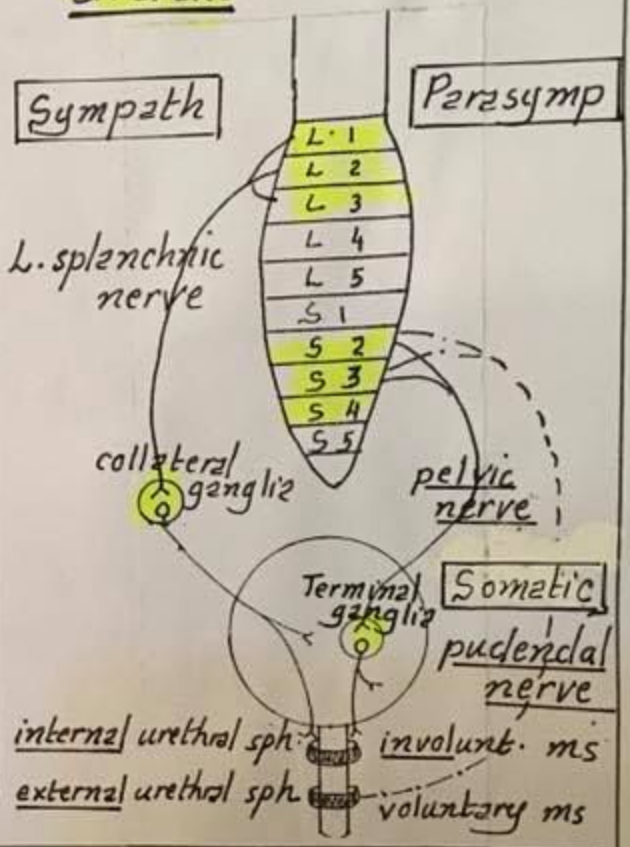
2 **Neck** Internal urethral sphincter
Extension of detursor ms
- It keeps post. urethra empty.
- Prevents reflux of semen.

3 **External urethral sphincter**
Voluntary muscle

Ureter passes obliquely few cms in bladder wall
So, tone of detursor ms prevents reflux of urine in ureter.

Innervation of bladder ssphincters

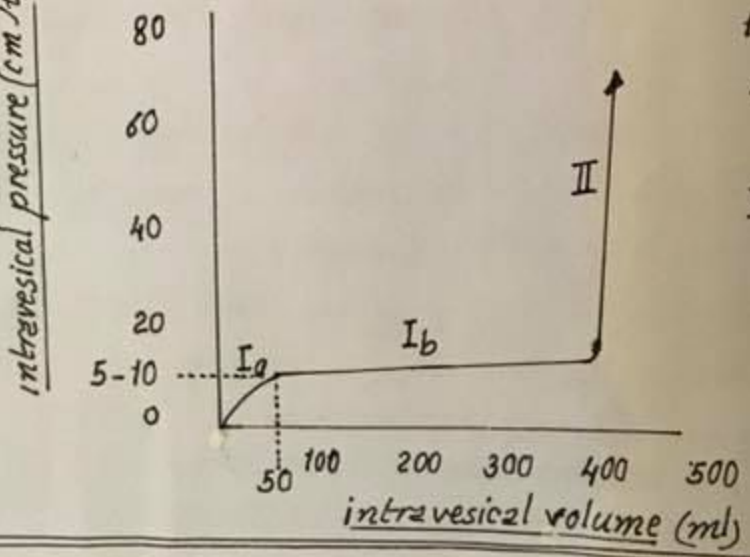
Efferent



Bladder filling

Cystometrogram

Intravesical p is plotted against urine volume.



1st urge 150 ml
Marked sensation of fullness 400 ml

I_b is due to plasticity

Laplace law

$\pm P = \frac{2T}{r}$

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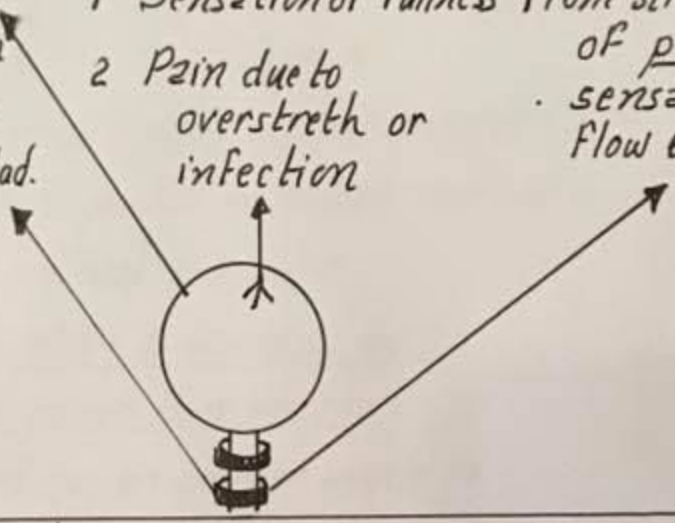
Afferents

Parasympathetic n.s.	Sympathetic n.s.	Somatic n.s
1 detect degree of bladder stretch	1 Sensation of fullness	From stretch receptors of post. urethra: sensation of urine flow to urethra
2 of post. urethra: initiates reflex blad. emptying	2 Pain due to overstreth or infection	



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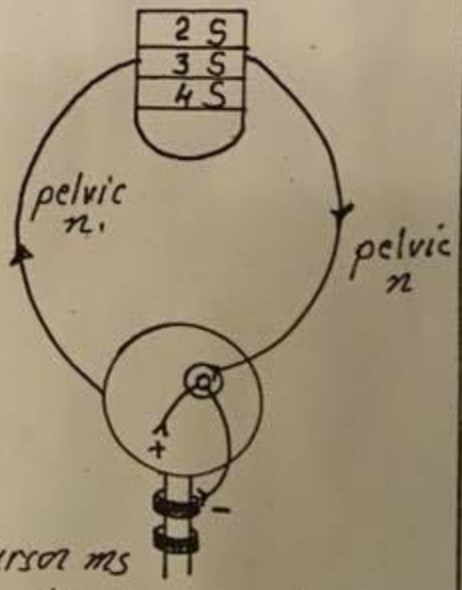
Micturition reflex

Occurs in infant
adult Complete TS of sp.cd above sacral region

Initiated at 300 - 400 ml urine vol

Reflex

- Stimulus bladder distension
- Receptors Stretch receptors in bladder wall post. urethra
- Afferent Pelvic parasymp nerve
- Centre 2, 3 & 4 Sacral
- Efferent Pelvic parasymp nerve
- Response - Contraction of wall detursor ms
  - Relaxation of internal sphincter (involuntary)



N.B Micturition is self regenerative i.e contraction activates stretch receptors (bladder & post urethra) → further ++ in bladder cont

Once micturition reflex is powerful → another reflex viz pudendal nerve to relax external urethral sphincter

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Higher control of micturition reflex

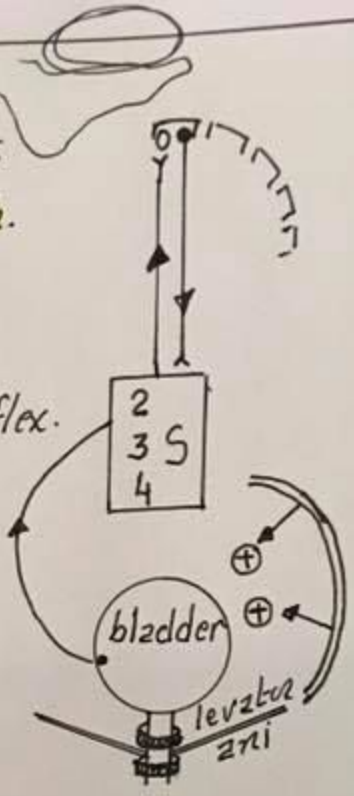
Cortical micturition centre : Superior frontal gyrus

Facilitatory centre : Pons Post. hypoth.

Inhibitory centre : Midbrain

When it is time to urinate, cortical centres

- Facilitate sacral centre to initiate mict. reflex.
- Inhibit ext. urethral sphincter



Voluntary micturition is initiated by :

a Relaxation of pelvic floor muscles

→ downward tug on detrusor muscle to initiate its contraction.

b Voluntary cont. of abdom. muscles

→ +r intravesical p → entery of urine in bladder neck

→ stretch of bladder neck → stim. stretch receptors

→ excite micturition reflex

c Relaxation of external urethral sphincter

Effer micturition ♀ urethra empties by gravity.

♂ urethra empties by contraction of bulbocavernous muscle.

Abnormalities of micturition

Items \ lesion	Deafferentiation	Denervation	Sp cd damage
Cause	Damage of aff. e.g tabes dorsalis	Damage of aff & efferent nerves	T.S. of sp. cd above sacral region
Mict. reflex	Abolished	Abolished	lost then recovered
Volunt. control	Lost	Lost	Lost
Bladder	Thin distended hypotonic	Thick shrunken hyperactive	Shock stage: flaccid Recovery » hypertrophy
Urination	Bladder is full & overflows in drops by intrinsic response	Hyperactive bladd. expels drops	Shock stage: retention with overflow Recovery stage automatic bladder

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