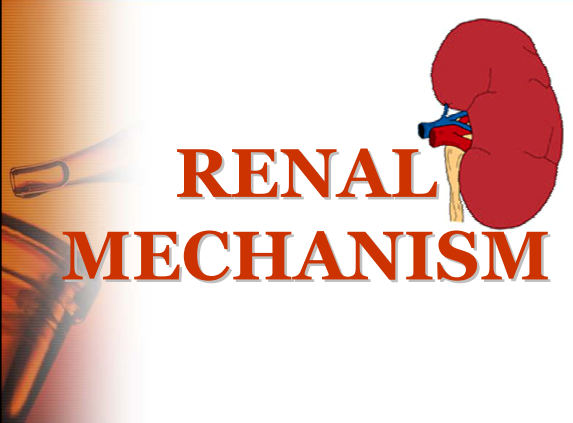


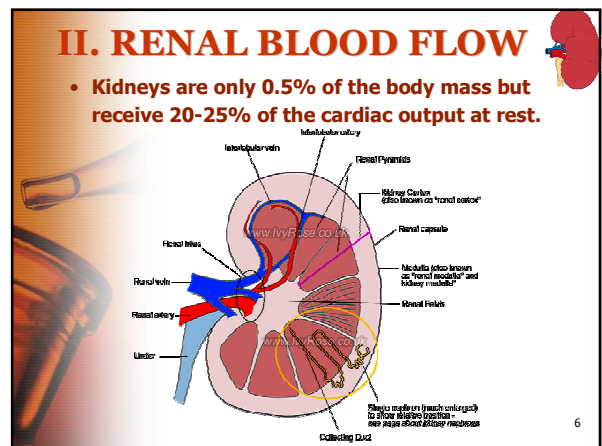
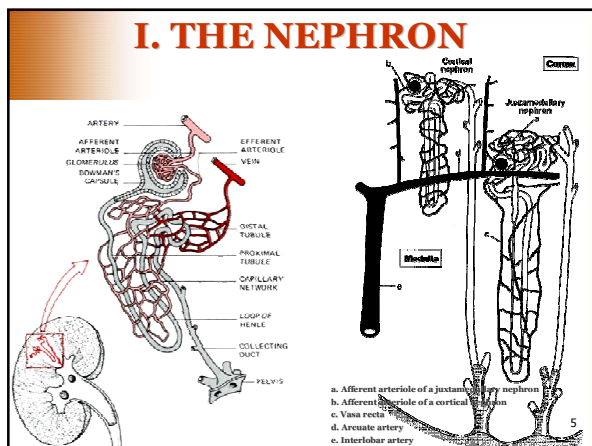
# RENAL MECHANISM



- ## PLAN
- Introduction
  - The nephron
  - Renal blood flow
  - The glomerula
  - The tubules and ducts
  - Important renal measurements
  - Some pathologies of the kidneys
  - Summary
- 2

- ## INTRODUCTION
- The kidney is primarily responsible for the maintenance of the internal environment.
  - Reddish-brown bean shaped organ located at the levels of the twelfth thoracic and the third lumbar vertebrae of the abdominal cavity.
  - Filters a large amount of plasma and reabsorbs specific substances.
  - Processes up to 200 l of plasma daily within its 2, 000,000 nephrons.
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- ## I. THE NEPHRON
- Nephron is the basic histological and functional unit of the kidney
  - Parts are:
    - Bowman's capsule
    - Proximal convoluted tubule (PCT)
    - Henle's loop (descending and ascending limbs)
    - Distal convoluted tubule (DCT)
  - Two types of nephrons
    - Cortical nephrons (shorter Henle's loop)
    - Juxtamedullary nephrons (longer Henle's loop)
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## II. RENAL BLOOD FLOW

- Venous blood follows a series of vessels that corresponds generally to the arterial pathways.
- Glomerular capillaries are formed in the course of an arteriole, allowing very precise regulation of the driving force for glomerular filtration.
- Glomerular capillaries and the Bowman's capsule together form the renal corpuscle.

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## II. RENAL BLOOD FLOW

- The control of renal blood flow consists in:
  - Intrinsic control mechanism, mainly the contraction of arterioles with the increase of blood pressure.
  - Extrinsic control mechanisms: vasoconstriction of afferent arterioles due to sympathetic nervous impulses, secretion of noradrenaline and angiotensine II.

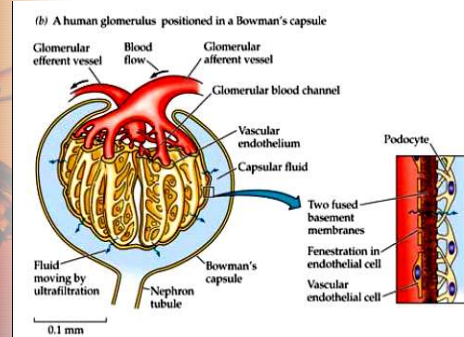
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## There are 3 steps for urine formation:

- Glomerular filtration
- Tubular reabsorption
- Tubular secretion

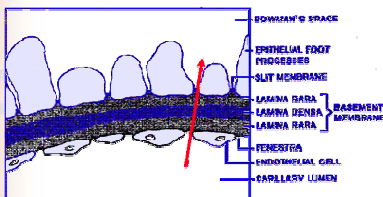
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## III. THE GLOMERULA



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## FILTRATION PATHWAY



- The filtration pathway, from the capillary lumen into Bowman's space, passes through the fenestra between the endothelial cells, across the trilaminar basement membrane and across the slit membrane that connects the epithelial foot processes.
- The filtrate contains all the substances that exist in plasma at the same concentration as in plasma except for plasma proteins and substances bound to the proteins. These are filtered at smaller concentrations.

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## III. THE GLOMERULA

- The main glomerular function is urine filtration
- Filtration pressure depends on:
  - Glomerular capillary hydrostatic pressure,  $P_{gc}$ 
    - Positive pressure that pushes fluid out in the Bowman's capsule
    - Main force for filtration
  - Colloid osmotic pressure in the glomerular capillary plasma,  $\pi_{gc}$  (Also known as oncotic pressure)
    - Negative pressure that prevents filtration
  - Tubular pressure,  $P_t$ , from the Bowman's capsule
    - Negative pressure that prevents filtration
- Net filtration pressure,  $P_f = P_{gc} - P_t - \pi_{gc}$

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### III. THE GLOMERULA

<b>Net Outward Pressure</b>	
Outward force, glomerular hydrostatic pressure	= +60 mm
Inward force of plasma colloid osmotic pressure	= -32 mm
Inward force of capsular hydrostatic pressure	= -18 mm
<b>Net outward pressure</b>	<b>= +10 mm</b>

### III. THE GLOMERULA

- The ultrafiltrate of plasma crossing the glomerular membrane to the capsular space is the *prime urine*
- Contains all plasma substances at same concentration, except of proteins and few substances bound to proteins as is the case of many drugs.
- Filtration rate is controlled through:
  - Autoregulation: *Myogenic response* and *tubuloglomerular feedback mechanism*
  - External control by the *juxtaglomerular apparatus*, the *nervous system* and the *humoral system*
- The regulation is most often integrated

### The juxtaglomerular apparatus

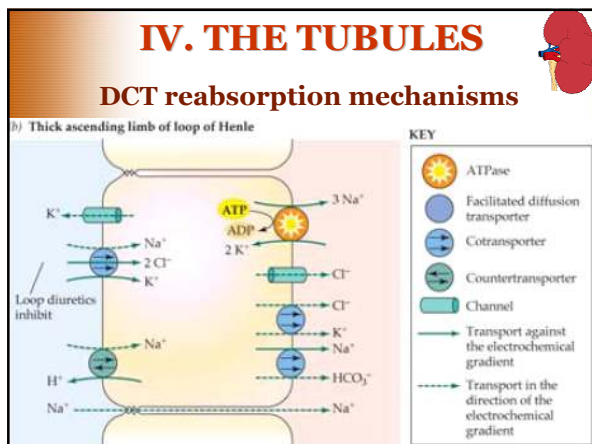
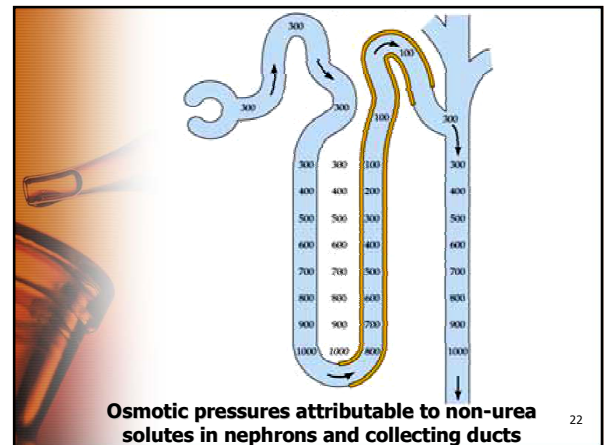
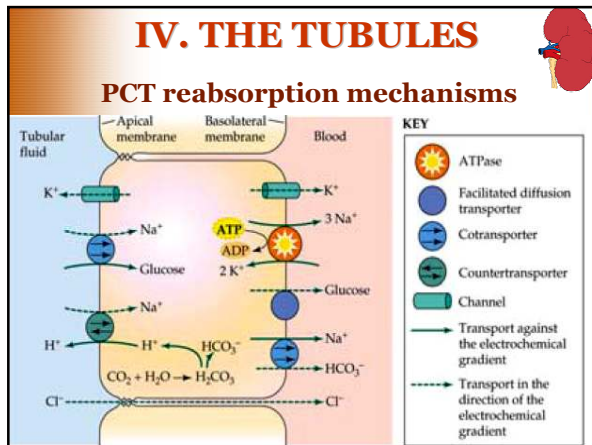
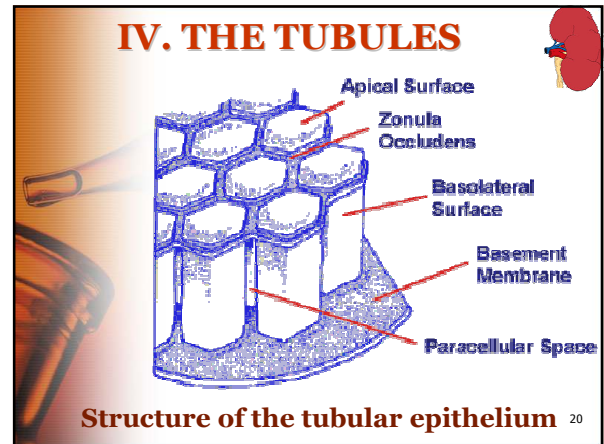
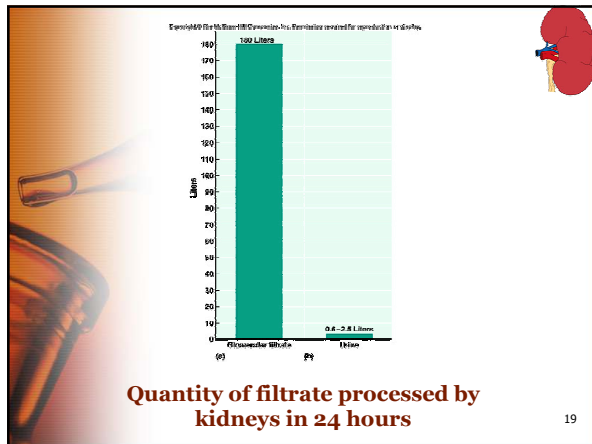
### The tubuloglomerular feedback mechanism

### Renine/angiotensin/aldosterone control of glomerular filtration

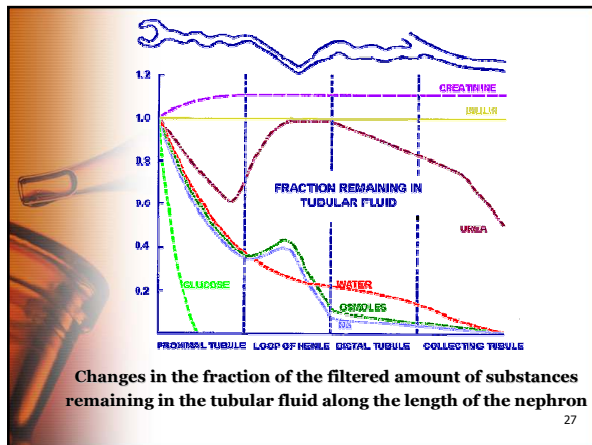
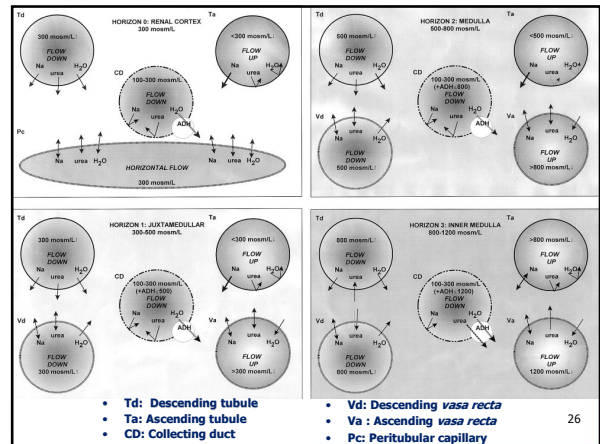
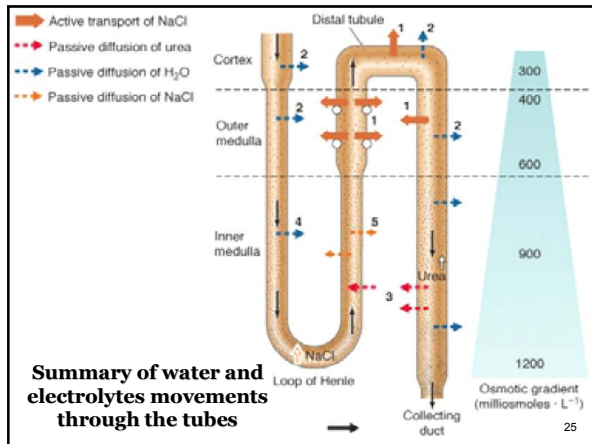
- Vasoconstriction
- Increased aldosterone secretion
- Increased ADH secretion
- Increased thirst

### III. THE GLOMERULA

- The *glomerular filtration rate GFR* is the amount of filtrate that enters Bowman's capsule per minute.
- Can be experimentally measured with inuline or para-aminohippuric acid (PAH), using the relationship  $GFR = U_x V / P$ 
  - U and P are the concentrations of the substance in urine and plasma respectively
  - V is the volume of filtrate entering Bowman's capsule



- IV. THE TUBULES
- The collecting ducts
- Two major cell types:
    - the principal cells which reabsorb sodium and secrete potassium
    - the intercalated cells which secrete protons and bicarbonate.
  - Aldosterone stimulates this transport.
  - Permeability of the paracellular pathway to electrolytes is very low.
  - Permeability to water is low in the absence of ADH, high in its presence.
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### Some important renal measurements

- **GFR:** Net flow of water across the filtration membrane (about 12.5 mL/Mn)
- **RPF:** Quantity of a specific substance that crosses the filtration membrane/Mn
- **RBF:** Amount of blood flowing through the kidneys per minute = CO x % renal perfusion
- **Clearance:** Net flow of a substance across the filtration membrane

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### Some pathologies of the kidneys

- **Signs:**
  - **Glycosuria:** Diabetes mellitus
  - **Proteinuria:** Nephrotic syndrom
  - **Abdominal pains and fever:** Glomerulo-nephritis
  - **Oedema:** Renal failure
  - **Oliguria and anuria:** Chronic or acute renal failure
  - **Rosted tongue:** Urea poisoning in acute renal failure

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