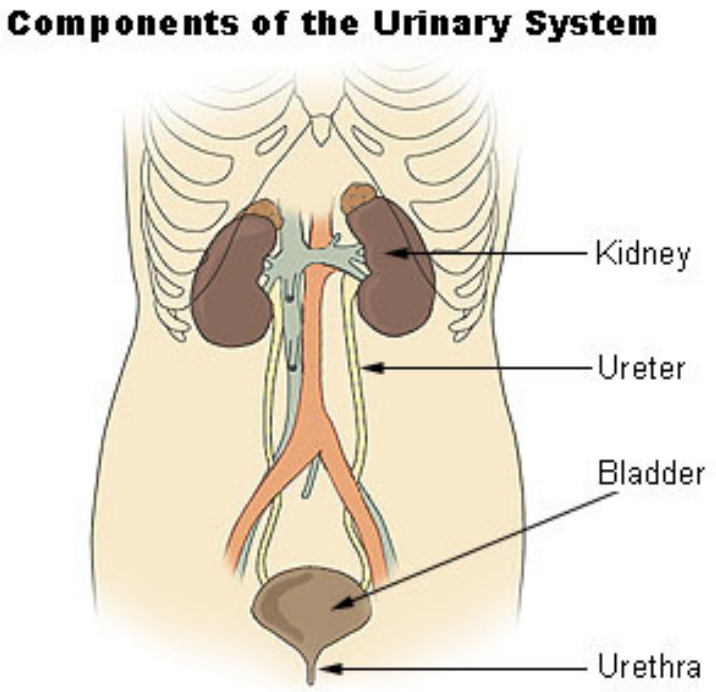
URINARY SYSTEM

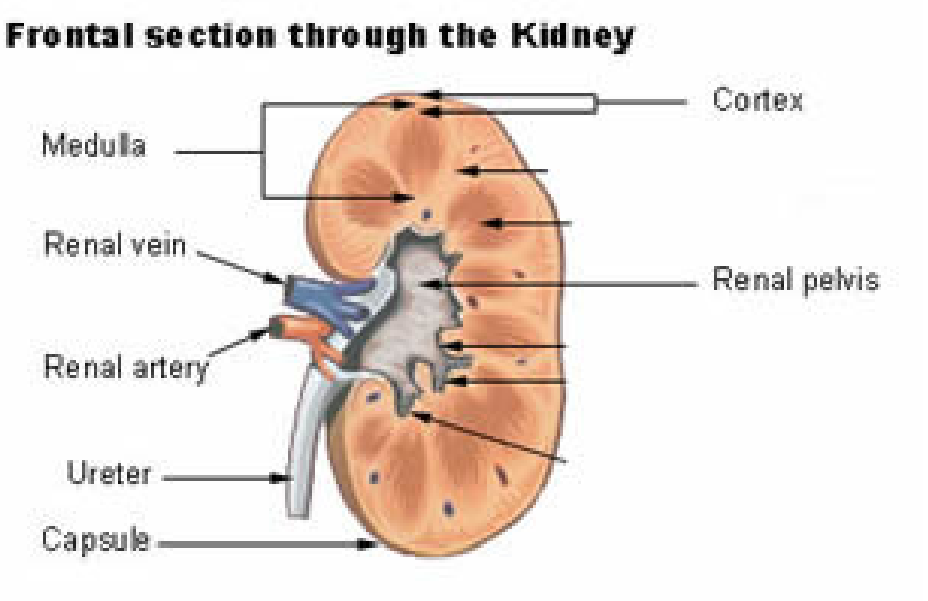
Structures of the Urinary System

- Kidneys: extract urea, excess H+, penicillin, histamines… from the blood
- Ureter: leads from the kidney to the bladder
- Bladder: urine storage
- Urethra: leads to the outside of the body



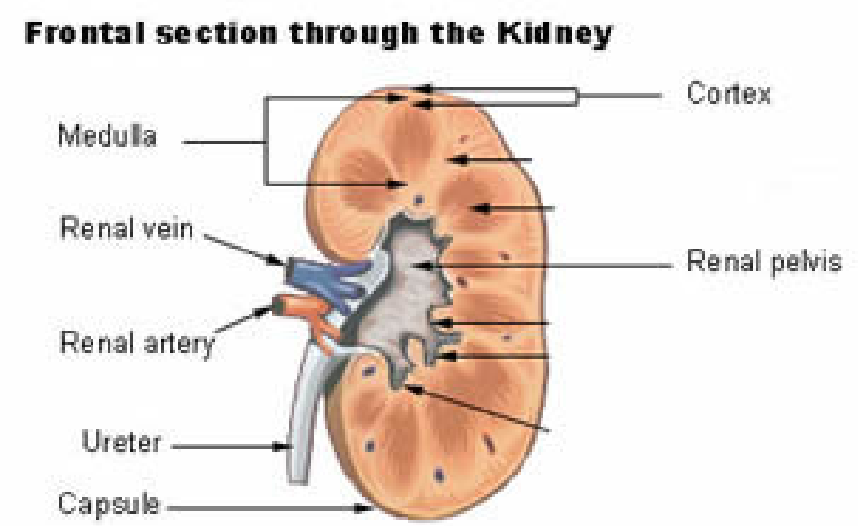
Kidney & Blood Supply

- Renal Artery: brings blood to the kidney to be filtered (cleaned)
- Renal Vein: takes clean, filtered blood back to the circulatory system

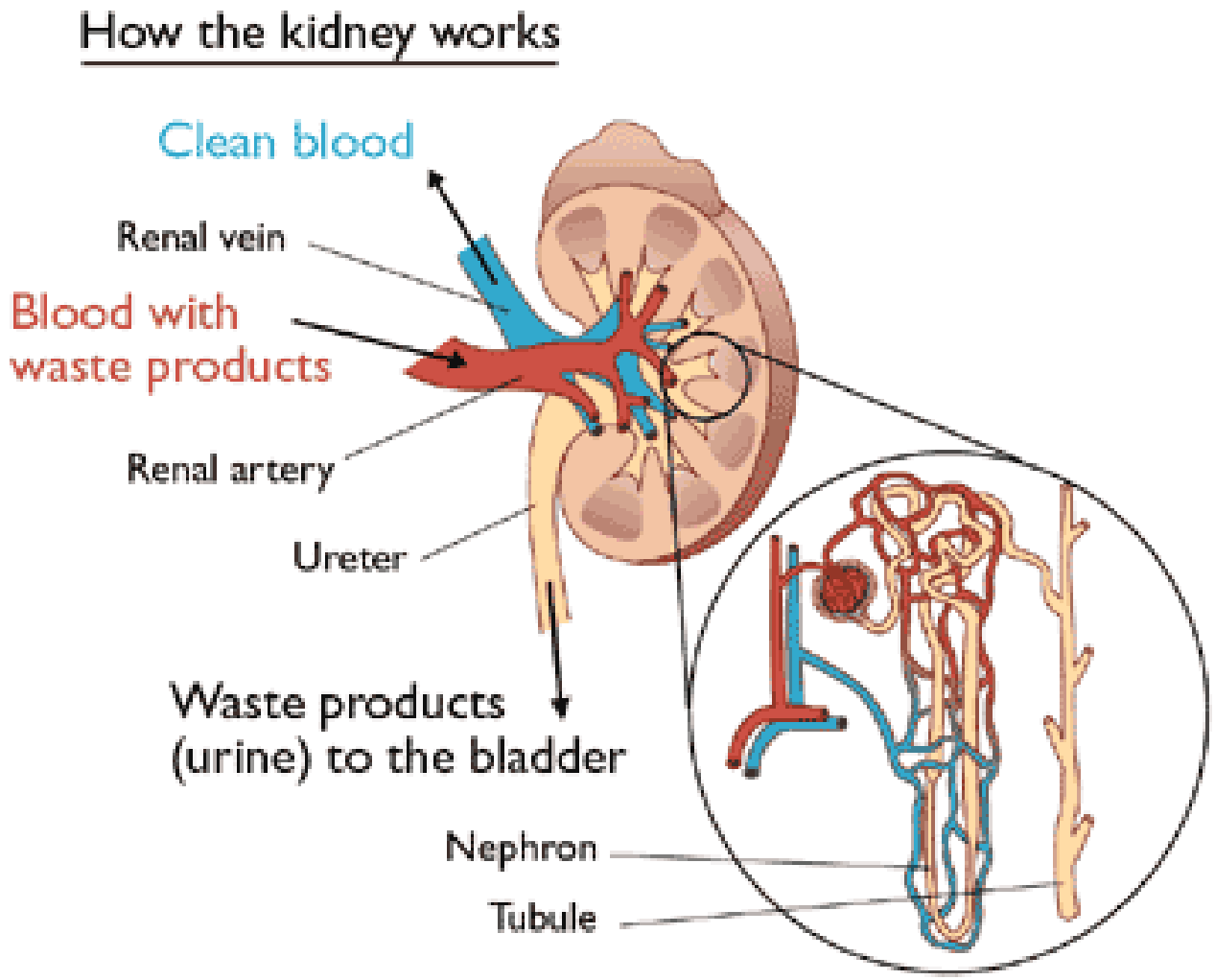


Kidney Structure

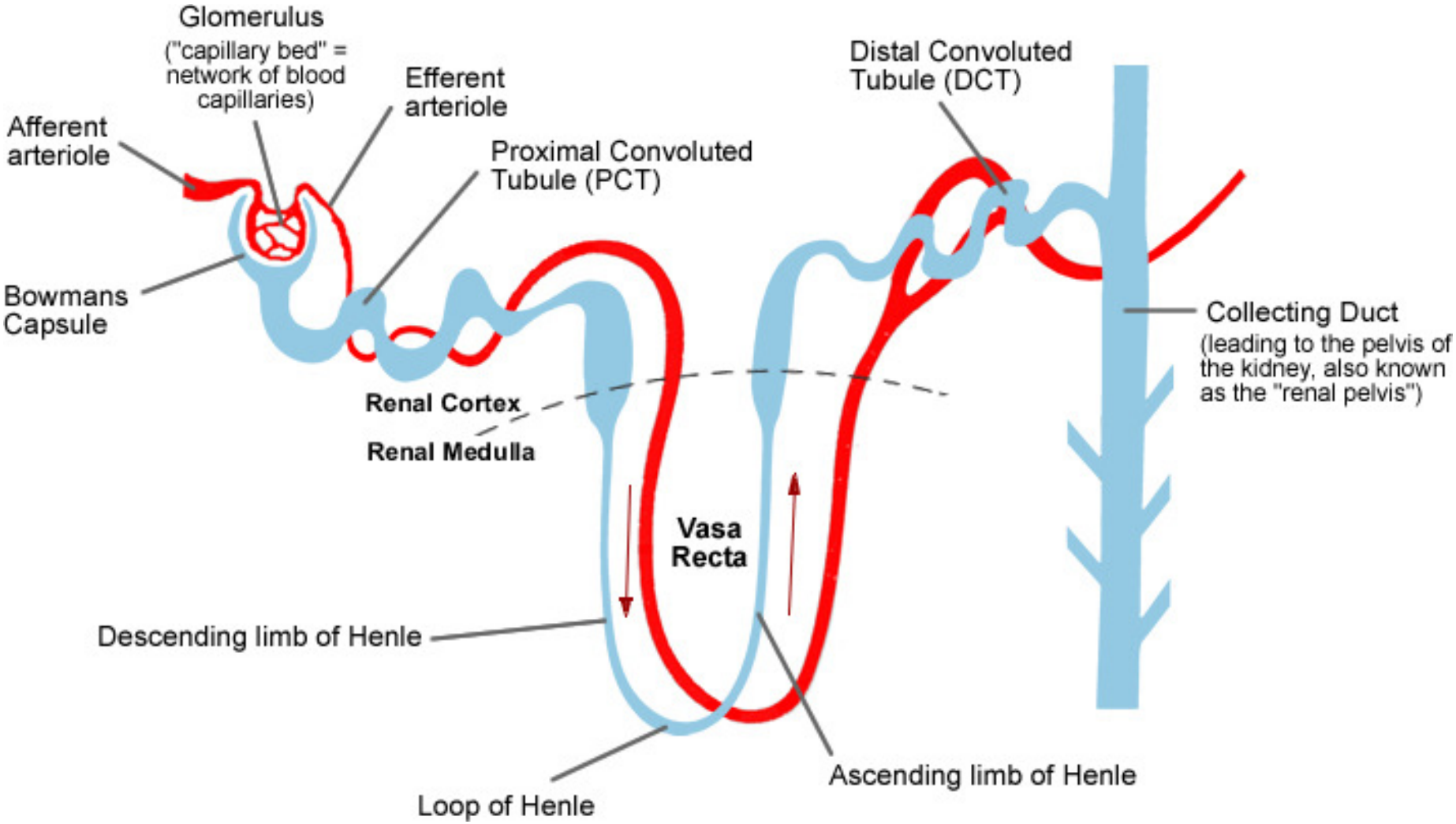
- The kidney is divided into 3 main sections
- Renal Cortex: the outermost layer
- Renal Medulla: the middle section
- Renal Pelvis: The inner section of the kidney



The Nephron:
(functional unit of the kidney)



Nephron Structure



Parts of the nephron

- **Afferent arteriole:** takes blood to the glomerulus
- **Glomerulus:** the capillary `ball` where pressure filtration occurs
- **Efferent arteriole:** takes blood from the glomerulus to the peritubular capillary network
- **Bowman`s capsule:** the end of the nephron that surrounds the glomerulus and receives substances that are filtered out of the blood

More Parts of the Nephron

- **Proximal convoluted tubule:** leads from Bowman`s capsule to the loop of Henle
- **Loop of Henle:** runs from the proximal convoluted tubule down through the medulla and back up the distal convoluted tubule
- **Distal convoluted tubule:** between the loop of Henle and the collecting duct

Even More Parts of the Nephron

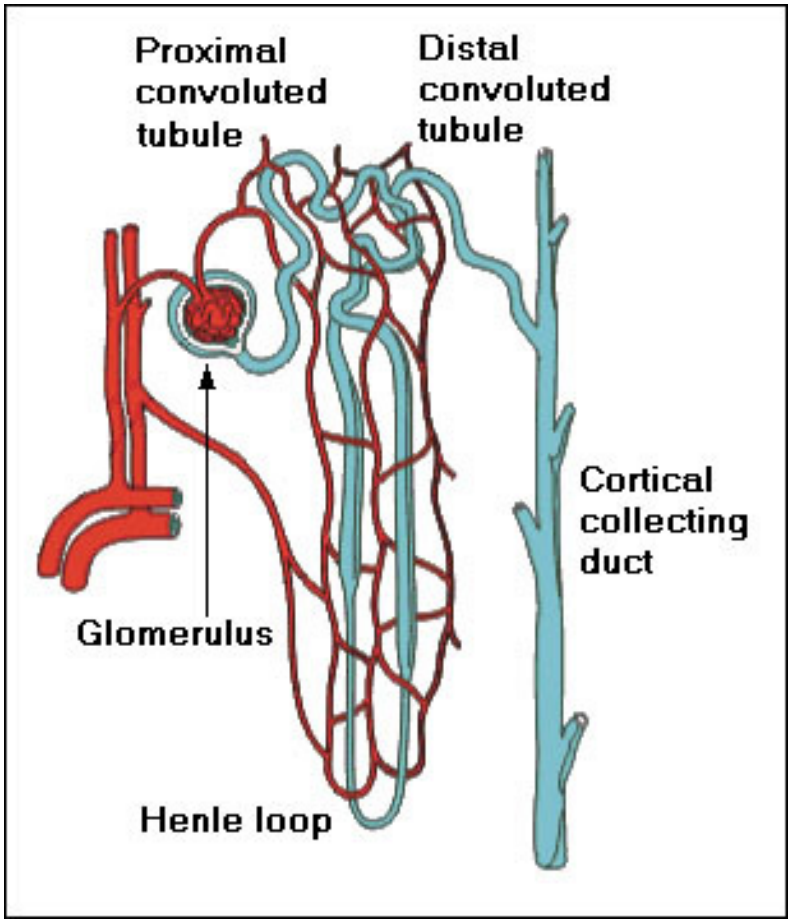
- Peritubular capillary network: winds around the nephron (convoluted tubules and loop of Henle) and eventually takes clean blood to the renal vein
- Collecting duct: located at the end of the nephron . Starts at the end of the distal convoluted tubule and ends in the renal pelvis

Steps of Urine Formation

- Pressure Filtration
- Selective Reabsorption
- Water Reabsorption
- Na^+ Retention
- Tubular Secretion
- Water Reabsorption
- Excretion

Pressure Filtration

- Blood pressure in glomerulus forces water and other small components of blood out of the glomerulus and into Bowman`s capsule
- Substances removed from the blood are called filtrate & include water, nitrogenous wastes, salts & ions

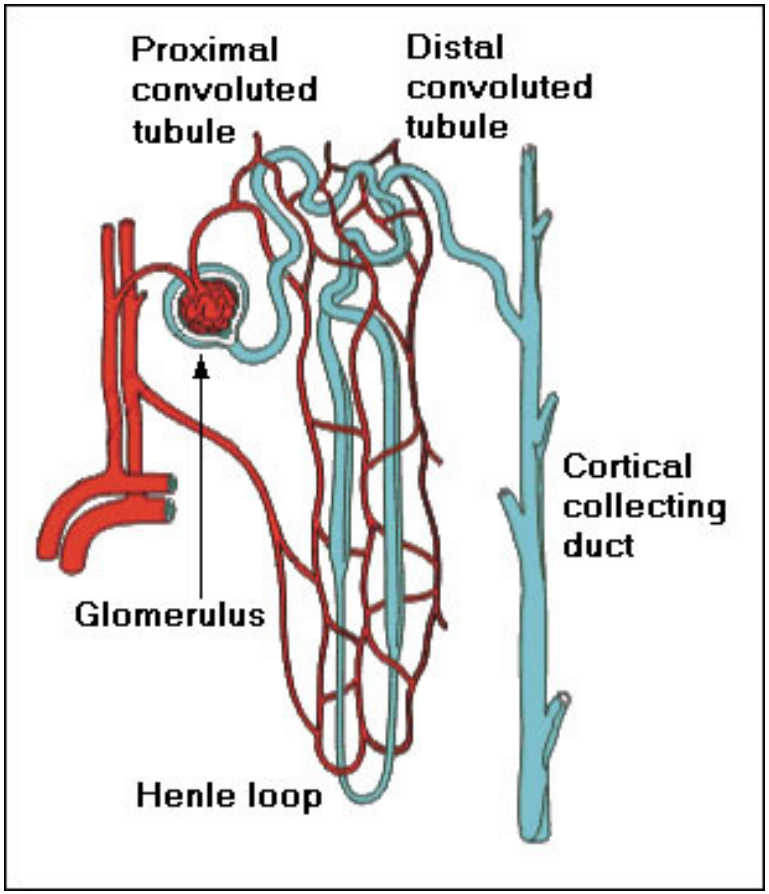


Tubular Reabsorption

- Occurs in the proximal convoluted tubule
- Carrier proteins move needed materials (glucose, amino acids, nutrients…) back into the peritubular capillaries via active transport (ATP)
- Na^+ is actively pumped out of the PCT
- Water and Cl^- move out by passive transport

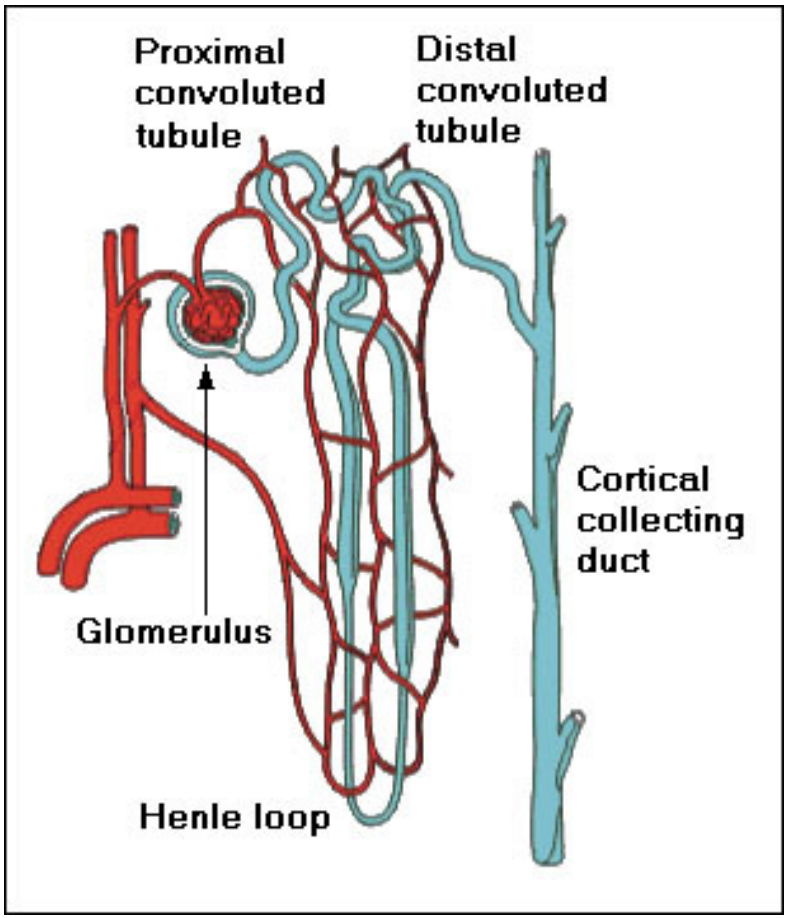
Water Reabsorption

- The decending loop of Henle is permeable to water but not Na^+
- It passes through the renal medulla which has a high solute concentration (hypertonic)
- Water moves out of the nephron resulting in the concentration of the filtrate



Na^+ Reabsorption

- The ascending loop of Henle is permeable to Na+ and not water
- Na+ moves out by diffusion in the lower portion (medulla region) and by active transport in the upper region (cortex)



Tubular Secretion

- Occurs at the distal convoluted tubule
- Substance in excess in the blood (penicillin, histamines, vitamins...) are pumped out (active transport) of the peritubular capillaries and enter the filtrate

Water Reabsorption & Urine Formation

- The top of the collecting duct is isotonic to the cells of the renal cortex so no movement here
- As filtrate moves down the collecting duct through the renal medulla (hypertonic) water moves out of the collecting duct concentrating the filtrate even further
- Normally 99% of water from original filtrate is reabsorbed
- Urine moves from collecting duct to renal pelvis

Kidneys & Blood pH

- The kidneys maintain blood pH at about 7.4
- When blood is too acidic hydrogen ions & ammonia are excreted while sodium & bicarbonate ions are reabsorbed

Renal Artery vs. Renal Vein

	Renal Artery	Renal Vein
Glucose content of blood	Same as renal vein	Same as renal artery (100% reabsorption)
Urea content of blood	High urea content	Low urea content (some is reabsorbed)

ADH: Antidiuretic Hormone

- Produced in the hypothalamus
- Stored and released from the posterior pituitary (source gland)
- Release is triggered by low blood volume/high solute concentration of plasma – this is sensed by receptor cells in the hypothalamus

ADH: Antidiuretic Hormone

- Targets the collecting ducts and the distal convoluted tubule (increases permeability to water)
- Results in increased water reabsorption
- When blood volume/solute concentration returns to normal less ADH is released (negative feedback) and less water would be reabsorbed

Aldosterone

- Source gland is the adrenal cortex (outer portion of the adrenal glands which sit on top of the kidneys)
- Release is triggered by low blood sodium levels and/or low blood volume
- Results in increased Na^+ reabsorption which leads to increased reabsorption of water

ADH & Aldosterone

- ADH & aldosterone both increase water reabsorption but both are ‘fixing’ different ‘problems’ with homeostasis in the blood

ADH vs. Aldosterone

ADH	Aldosterone
• Response to dehydration/high solute concentration of the blood • Possible cause = inadequate water intake • Increases water reabsorption	• Response to low blood volume/low Na^+ levels •Possible causes = diarrhea, injury, blood loss •Increases Na^+ reabsorption and water reabsorption