

# The Kidney, Homeostasis & Water Balance

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# Osmoregulation-differential permeability forming the basis of life processes.

- Osmoconformers – most marine invertebrates regulate individual ions,  $mg^{++}$ ; osmotic regulation equals the same medium in which they live.
- Osmoregulators – maintain internal solute levels & water levels
  - Freshwater – hi salt –hyperosmotic –water into body.
  - Land – lose water to air; conserve water to prevent dehydration.

# Nitrogenous Waste & Environment

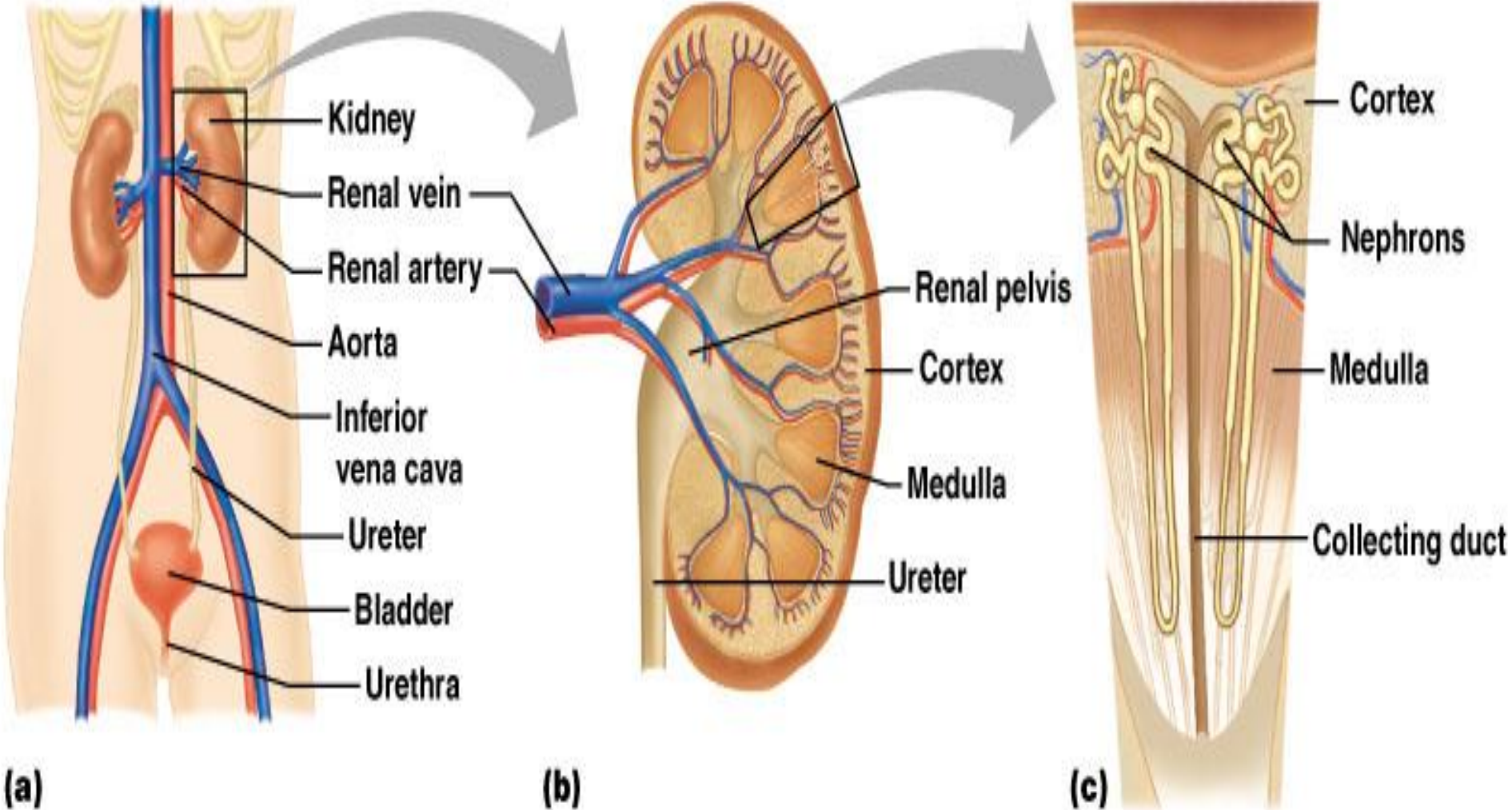
Ammonia	Marine Organism	Aquatic
Urea	Mammals & other land animals	Terrestrial
Uric Acid	Birds & Terrestrial Reptiles	Terrestrial

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# Urinary System: Contribution to Homeostasis

- Regulates body water levels
  - Excess taken in is excreted
  - Output varies from 2-1/2 liter/day to 1 liter/hour
- Regulates nitrogenous and other solute waste
  - Nitrogen from amino acids made into urea as waste
  - Others: sodium, chloride, potassium, calcium, hydrogen ions, creatinine

# Urinary System



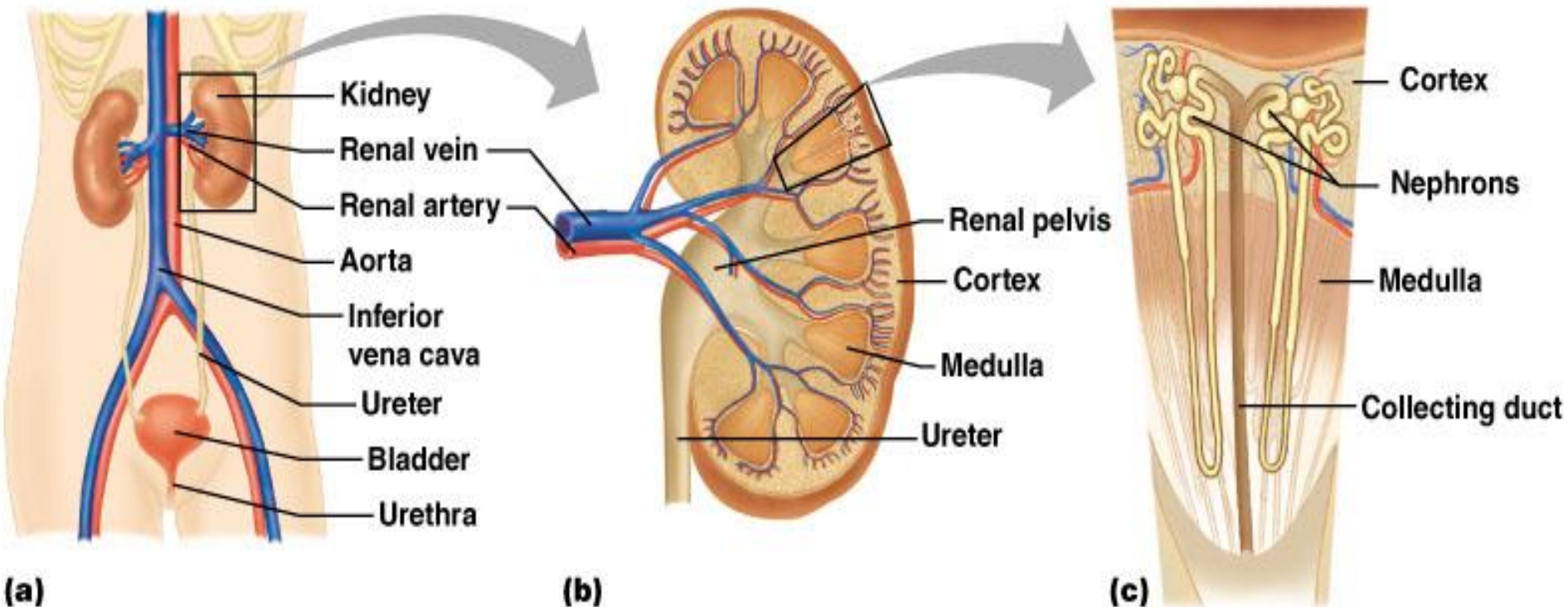
# Functions of Renal Organs

**Table 15.2** Functions of organs in urinary system

<b>Organ</b>	<b>Urinary Functions</b>	<b>Other Homeostatic Functions</b>
<b>Kidneys</b>	Regulate body water volume Regulate body concentrations of inorganic ions Remove metabolic wastes (primarily urea) from blood	Help regulate blood volume and blood pressure Assist in controlling body salt balance Help regulate acid-base balance and blood pH Control production of red blood cells Activate vitamin D
<b>Ureters</b>	Transport urine to bladder	
<b>Urinary bladder</b>	Stores urine until excretion	
<b>Urethra</b>	Transports urine to body sur	

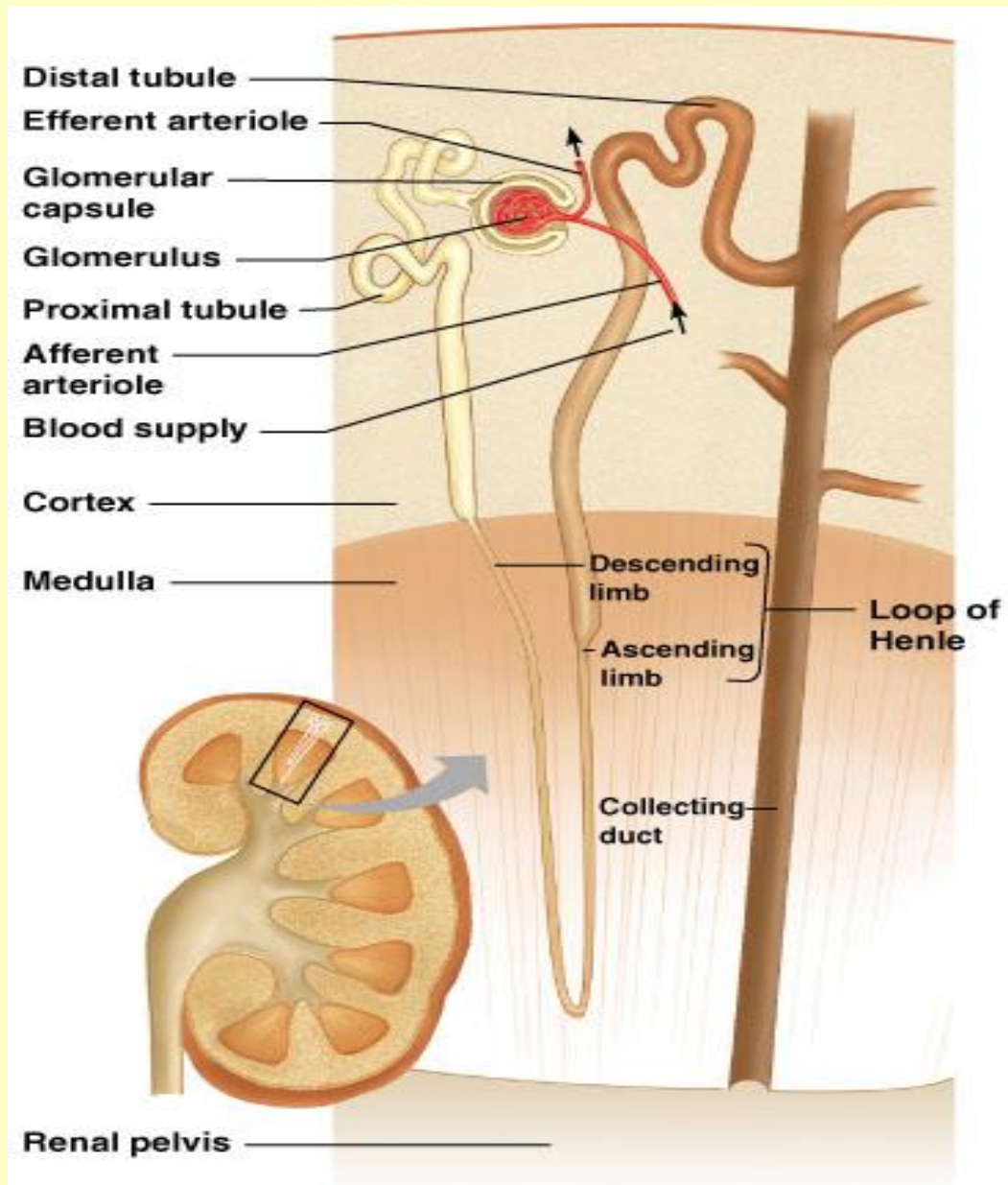
# Organs of the Urinary System

- Kidneys: principle organ, cortex, medulla
- Ureters: transports urine to bladder
- Urinary bladder: stores urine (600-1000 ml.)
- Urethra: carries urine from body, two sphincters



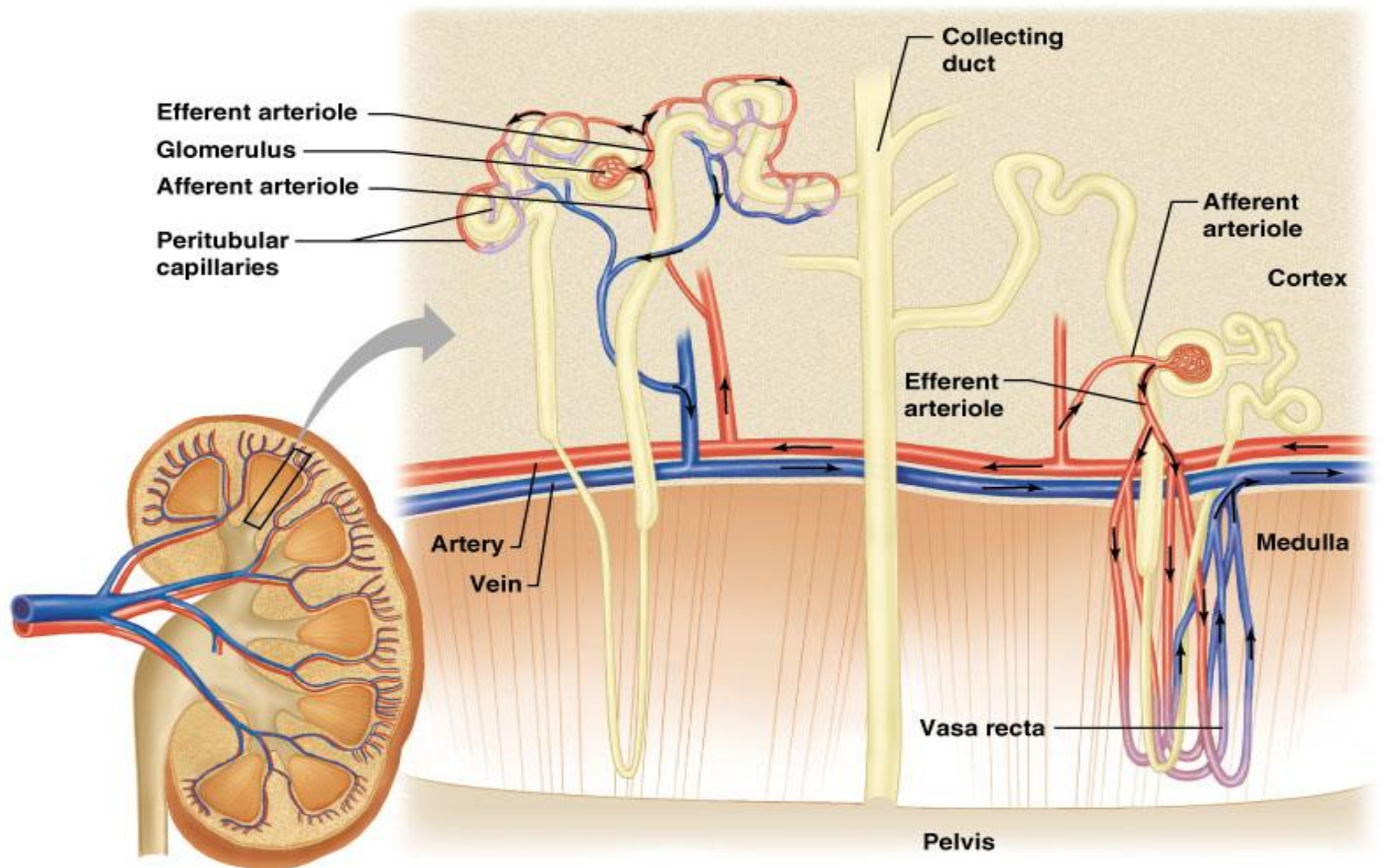


# Nephrons Produce Urine





# Tubular and Vascular Nephron Components



(a)

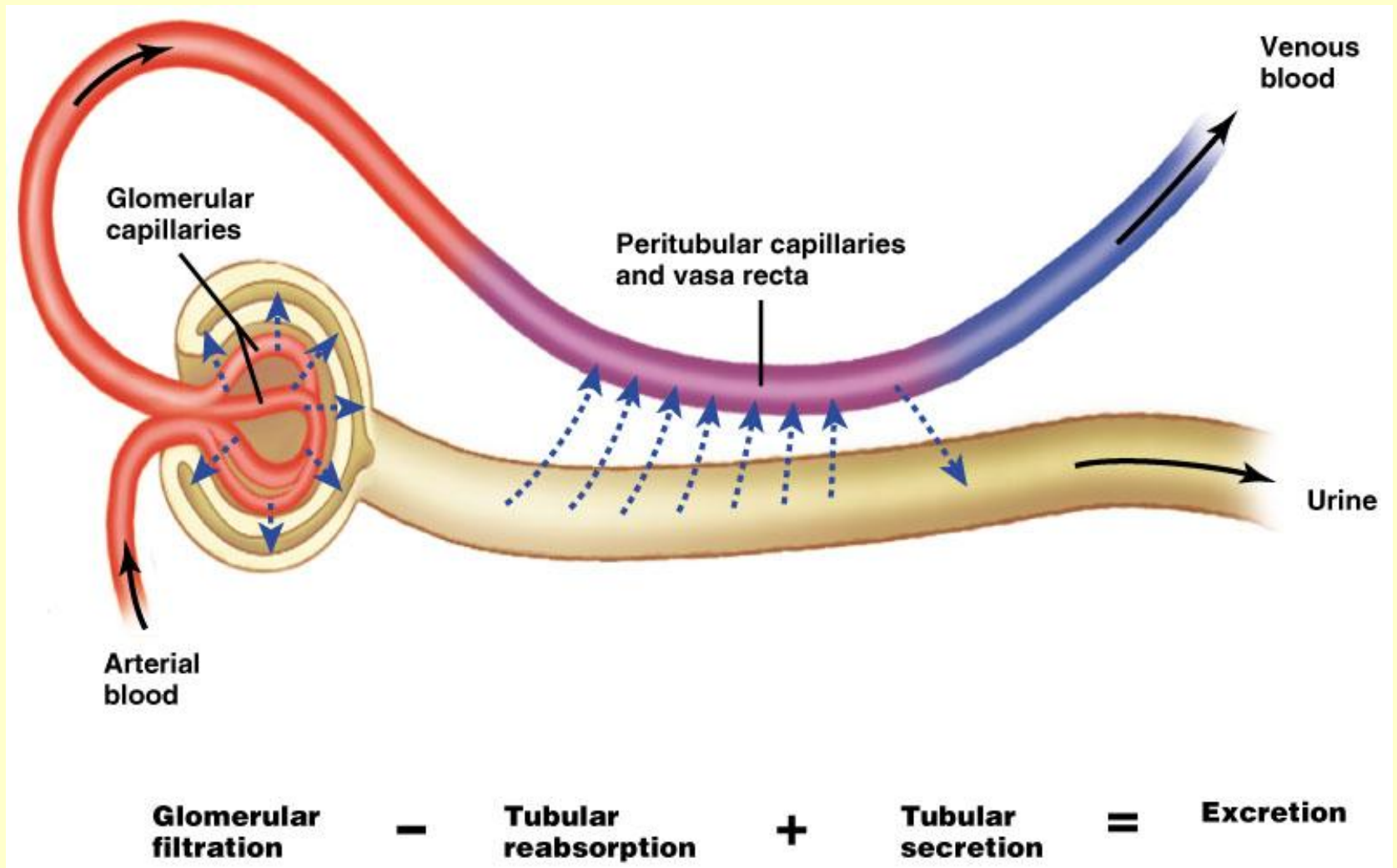
(b)

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# Nephrons: Produce Urine

- Tubules: filter fluid and reabsorb needed substances
- Tubules: proximal, loop of Henle, distal, collecting
- Blood vessels associated with tubules
- Arterioles: afferent, efferent
- Capillaries: glomerular, peritubular, vasa recta

# Formation of Urine



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# Formation of Urine: Glomerular Filtration

- Glomerular filtration: filters fluid from capillaries into glomerular capsule
  - Rate of filtration:
    - Resting rate under local chemical control
    - Stress causes sympathetic nervous system to reduce flow

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# Formation of Urine: Tubular Reabsorption

- Tubular reabsorption: returns water and needed solutes to blood capillaries
  - Process:
    - Sodium moved by active transport from tubule cells to interstitial fluid and diffuses to capillaries
    - Chloride passively accompanies sodium (balanced charge)
    - Water reabsorbed with salts
    - Movement of sodium creates energy to transport glucose and amino acids into renal tubule then diffuses to the interstitial fluid

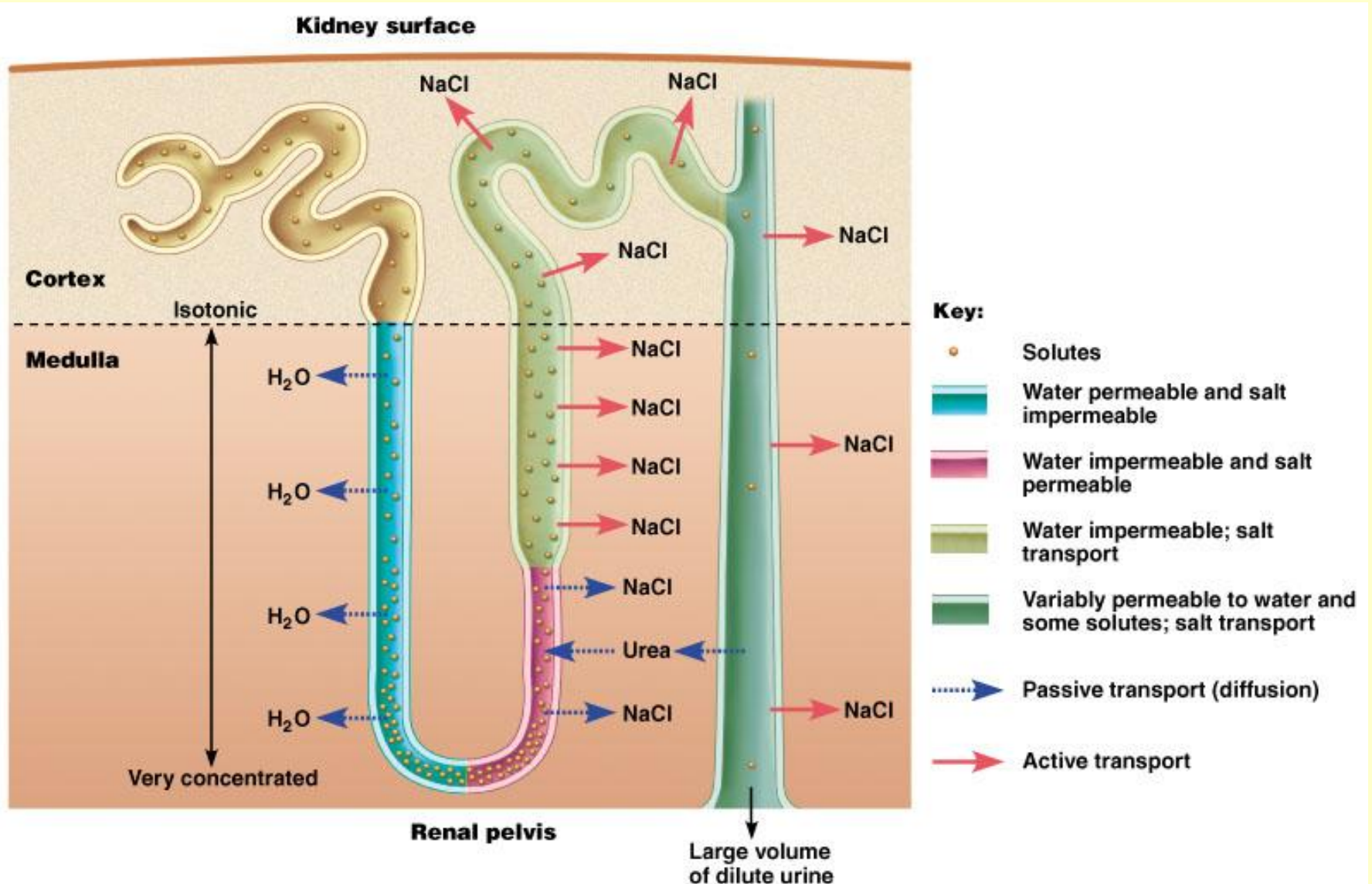
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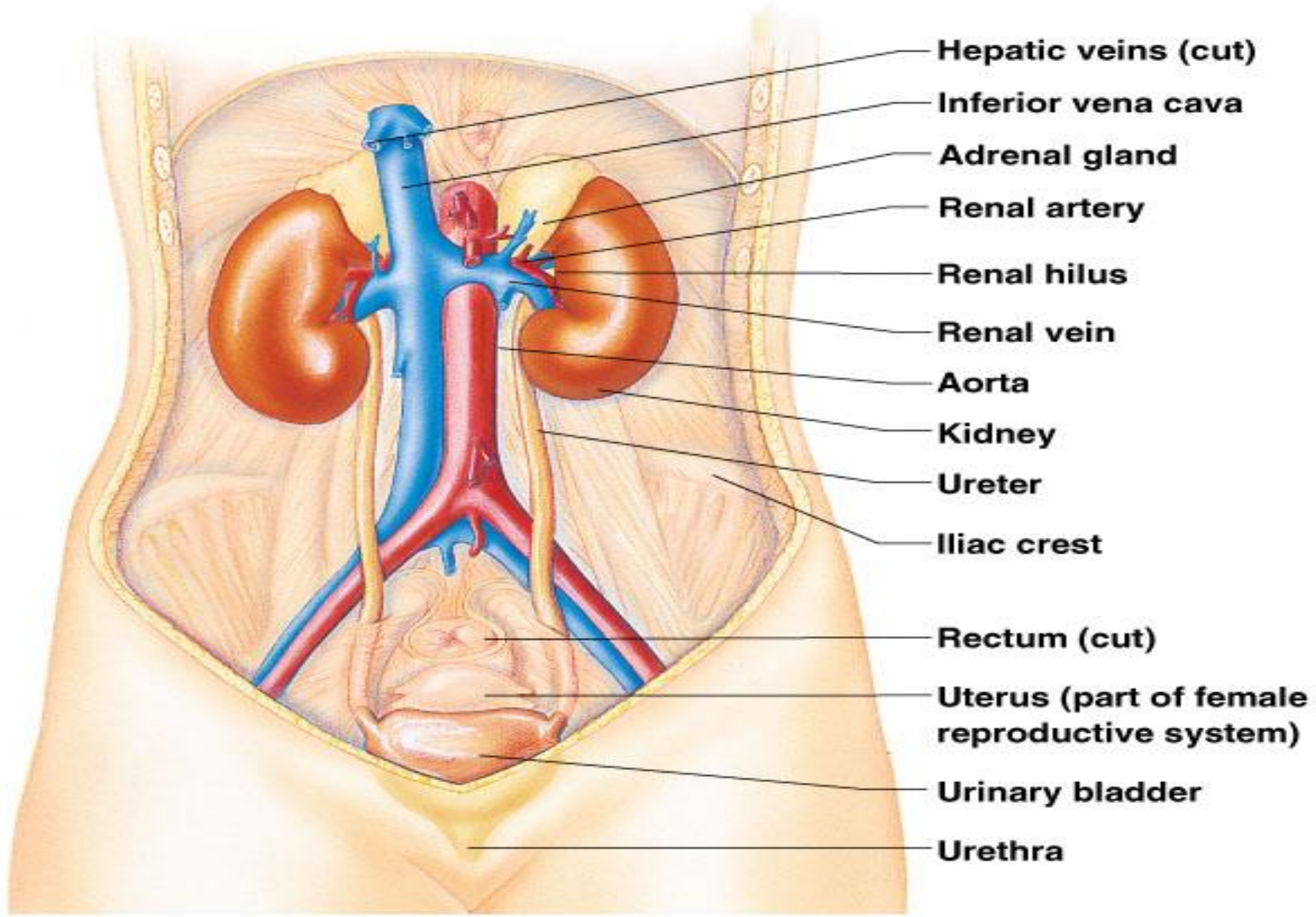
# Tubular Secretion

- Tubular secretion: removes other substance from blood
  - Purpose: regulating chemical levels in body, excretion of harmful chemicals
  - Substances secreted: penicillin, cocaine, marijuana, pesticides, preservatives, hydrogen ions, ammonium, potassium



# Formation of Dilute Urine

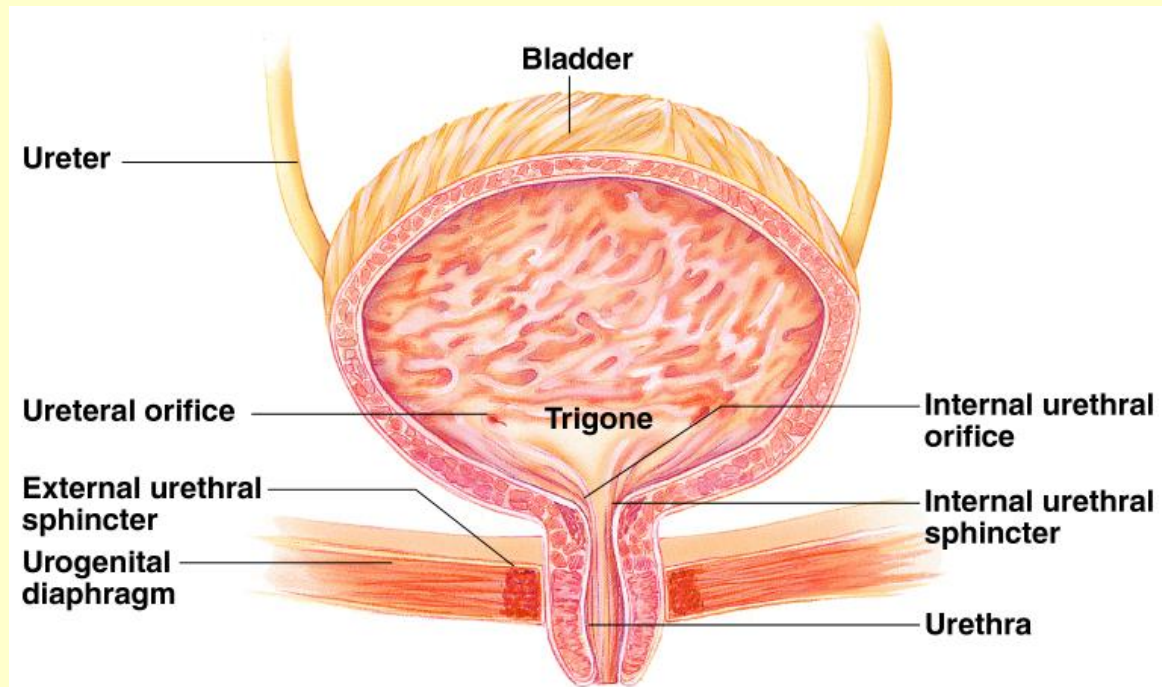




**(a)**

# Urinary Bladder

- Smooth, collapsible, muscular sac
- Temporarily stores urine



# Urethra

- Thin-walled tube that carries urine from the bladder to the outside of the body by peristalsis
- Release of urine is controlled by two sphincters
  - Internal urethral sphincter (involuntary)
  - External urethral sphincter (voluntary)

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# Kidney's Role in Homeostasis

- Maintains water balance: adjusts blood volume and blood pressure
- Aldosterone help maintain salt balance in order to control blood volume
- Maintains acid-base balance and blood pH
- Regulates red blood cell production via erythropoietin
- Activates an inactive form of vitamin D



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# Disorders of the Urinary System

- Kidney stones = minerals in urine crystallize and form solid masses.
- Acute and chronic renal failure – damaged nephrons cannot be regrown by the body.
  - Therapies:
    - Dialysis
    - Kidney transplant



# Characteristics of Urine Used for Medical Diagnosis

- Colored somewhat yellow due to the pigment urochrome (from the destruction of hemoglobin) and solutes
- Sterile
- Slightly aromatic
- Normal pH of around 6 (varies 4.5-8)

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# Concentration or Dilution of Urine: ADH

- Dilute urine: excreting excess water
  - Absence of ADH, lower salt and urea levels
- Concentrated urine: conserving water
  - Higher ADH, higher salt and urea levels

# Sweet Urine( Diabetes mellitis)

- Warning signs – frequent urination, slow healing, fatigue, weight loss.
- Insulin (gate keeper); no Glucose in cells → no energy → no respiration; fatigue.

Glucose stays in blood → Hi conc., more in Henley's loop → more water in urine to dilute sugar → feedback thirst → also urinate frequently → sugar in urine.

# Sweet Urine( Diabetes mellitis)

## continued

- Plasma volume drops → gets dizzy.
- No Glucose → no energy, cells can't divide → slow healing.
- Weight loss → No G → no respiration of cells → protein & cellular tissue → stored fat → lose fat quickly → weight loss.