Urine Formation by the Kidneys: I. Glomerular Filtration, Renal Blood Flow and Their Control.

Chapter 26

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Lecture-1 Introduction 31/3/2015

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Renal Physiology (*Medical*) spring 2014-2015
Textbook: Textbook of Medical Physiology
By : Arthur C. Guyton and John E. Hall, 12th ed. 2011

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Lect. No.	**Topic**	**12th Ed.**
1-2	Functional anatomy of the kidney. Role of the renal system in homeostasis (the functions of the kidney). Glomerular Filtration, Renal Blood Flow and their Control	303-321
3-5	Tubular Reabsorption and Secretion	323-343 361-378
6-7	Urine concentration and Dilution	345-360
8-9	Acid-Base Regulation	379-395

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Optional Reading:

1.Physiology, by: Robert Berne & Matthew Levy, 6th. ed. 2010
2. Human physiology, by: Lauralee Sherwood, last edition.

Renal System

Functions of kidney:

- Remove waste products from the blood
- Control the acid base balance (through HCO_3^- & H^+)
- Secrete Hormones and enzyme like erythropoietin and rennin.
- Activates Vitamin D.
- Make G from non CHO sources (make sugar from proteins at time of starvation (gluconeogenesis).)

Example of Metabolic Waste Products Excreted by the kidneys

- Urea (from protein metabolism)
- Uric acid (from nucleic acid metabolism)
- Creatinine (from muscle metabolism)
- Bilirubin (from hemoglobin metabolism)

Examples of Foreign Chemicals Excreted by the kidneys

- Pesticides
- Food additives
- Toxins
- Drugs

Secretion, Metabolism, and Excretion of Hormones

Hormones produced in the kidney

Renal erythropoetic factor

1,25 dihydroxycholecalciferol (Vitamin D)•

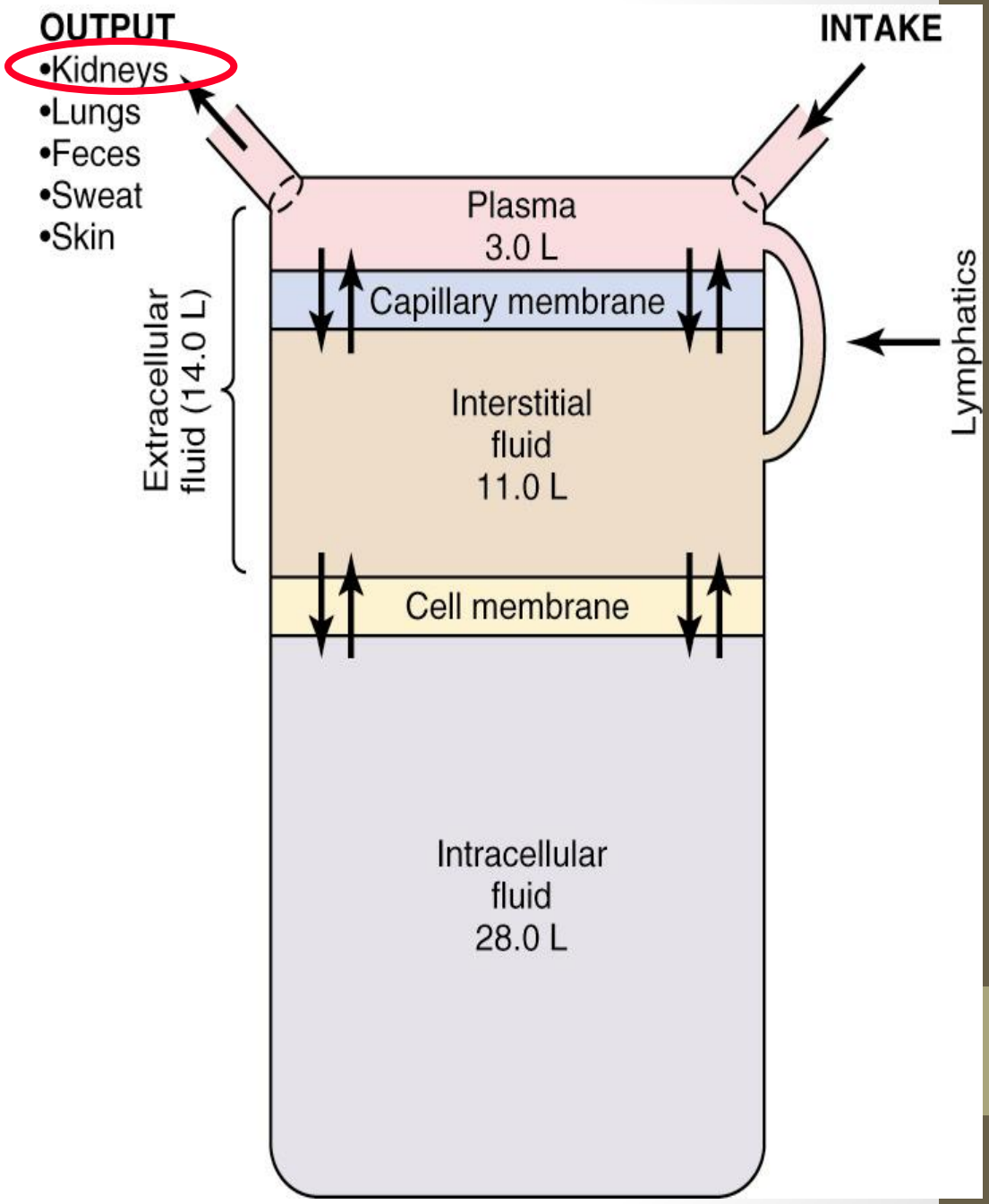
Renin•

Hormones metabolized and excreted by the kidney

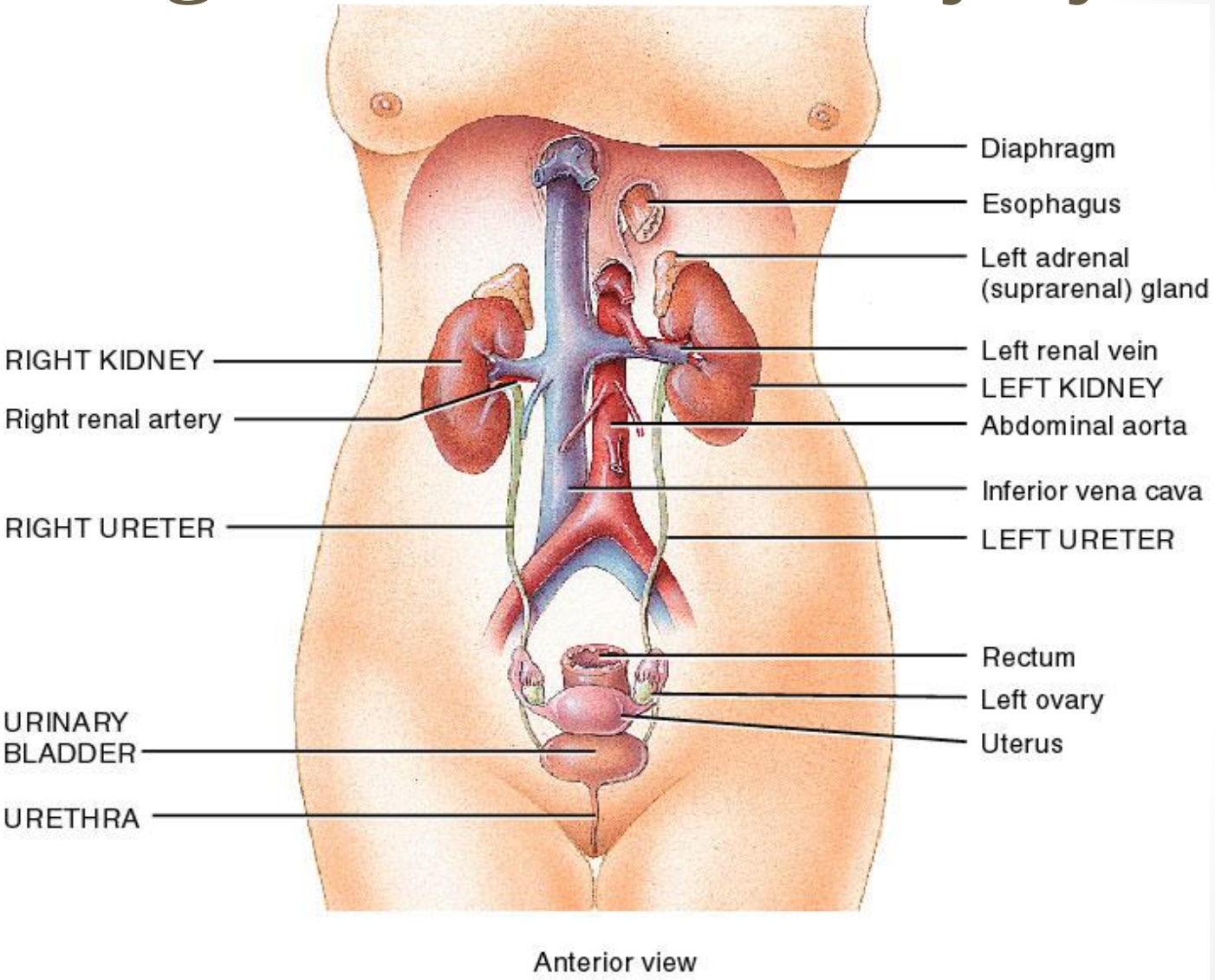
Most peptide hormones (e.g. insulin, angiotensin II, etc)

•-Hormones target the kidneys: Example: ADH, aldosterone etc.

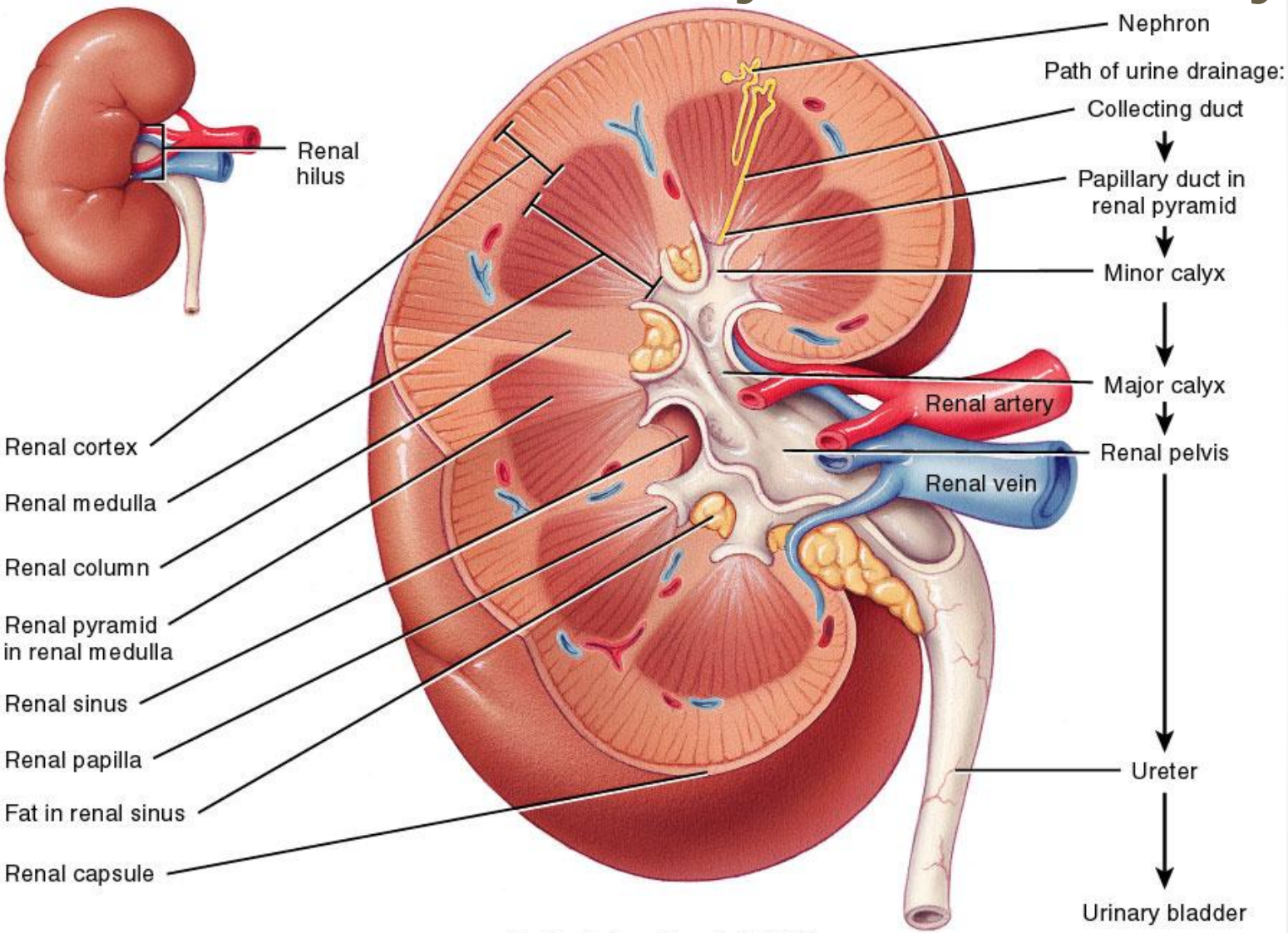
Body fluid regulation.



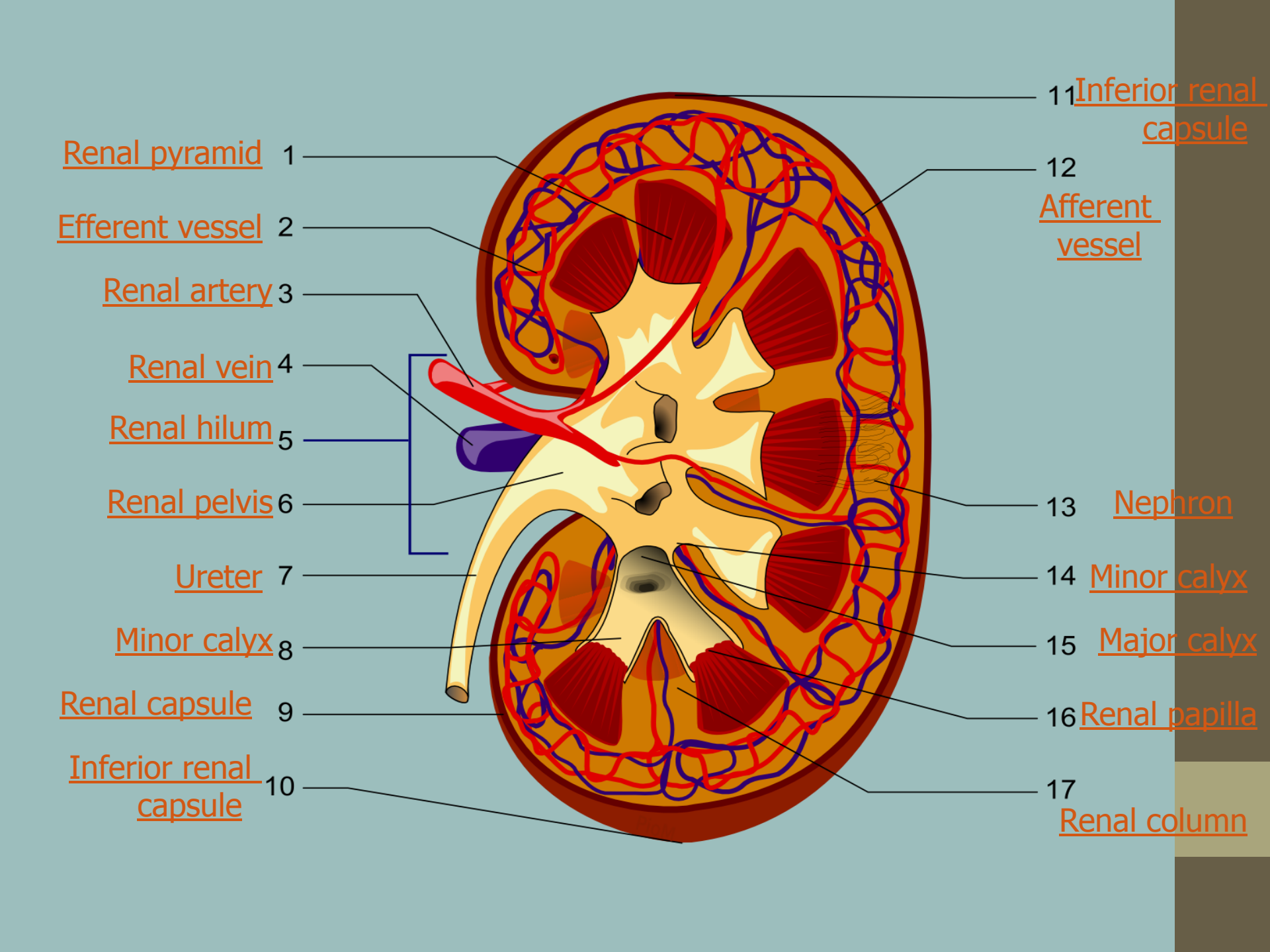
Organs of the urinary system



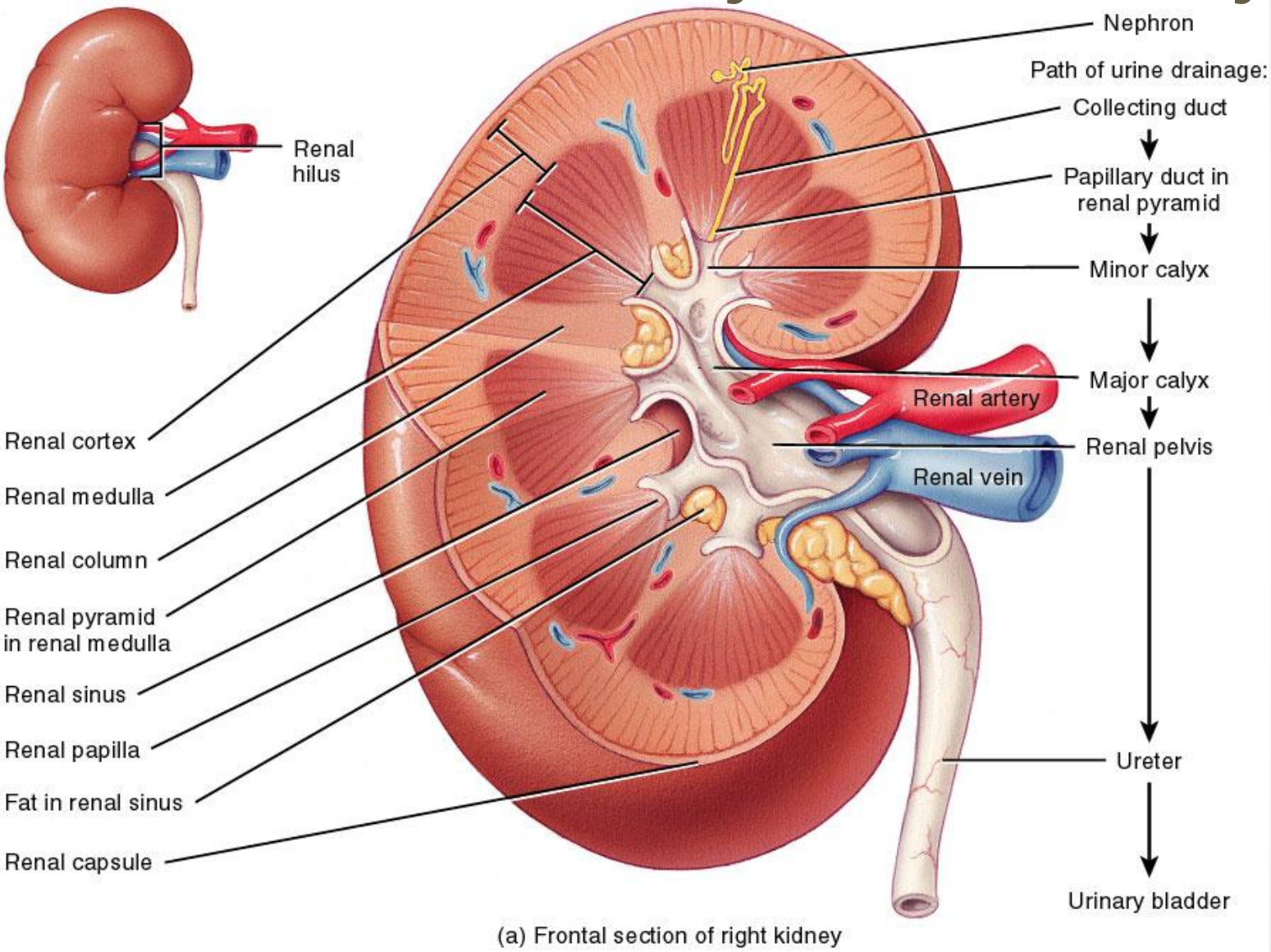
Internal anatomy of the kidneys



(a) Frontal section of right kidney


Renal pyramid 1
Efferent vessel 2
Renal artery 3
Renal vein 4
Renal hilum 5
Renal pelvis 6
Ureter 7
Minor calyx 8
Renal capsule 9
Inferior renal capsule 10
11 Inferior renal capsule
12 Afferent vessel
13 Nephron
14 Minor calyx
15 Major calyx
16 Renal papilla
17 Renal column

Internal anatomy of the kidneys



(a) Frontal section of right kidney

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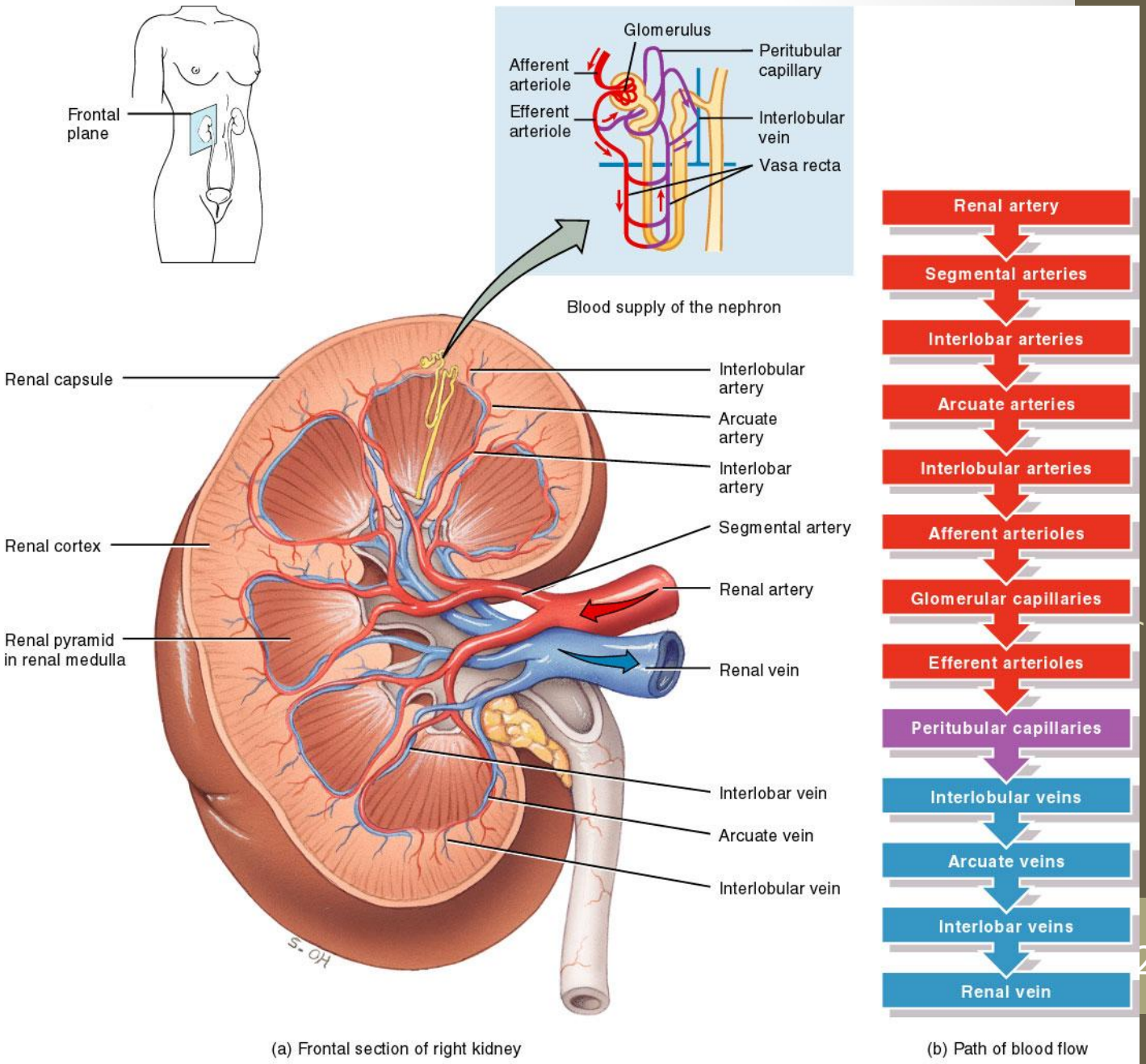
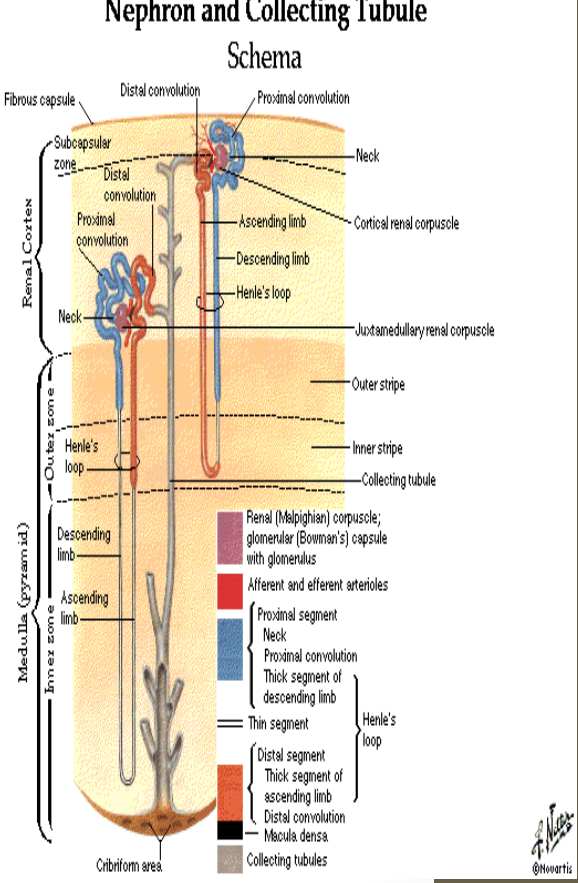


(a) Frontal section of right kidney

(b) Path of blood flow

Anatomy of kidneys:

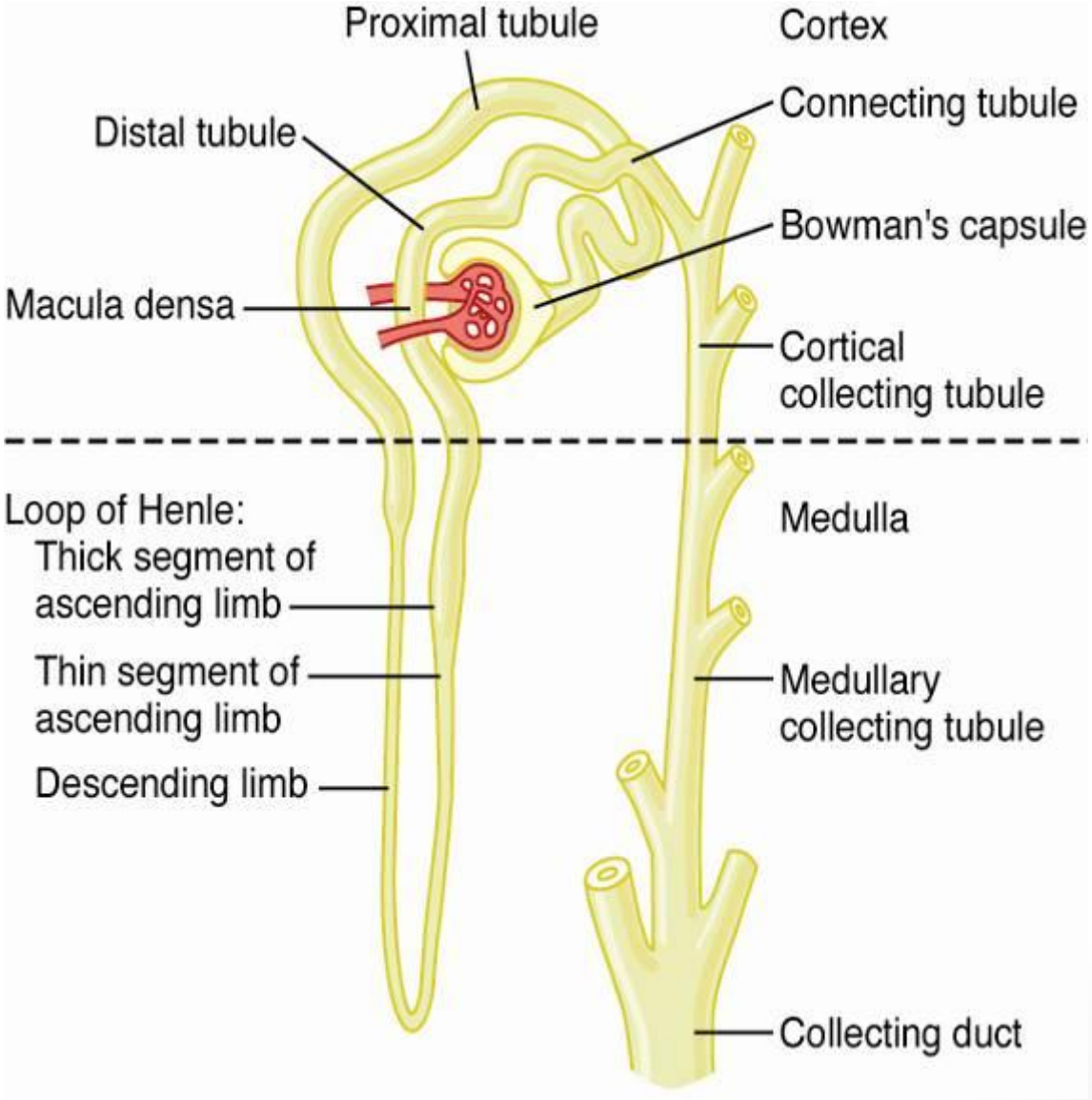


- Cortex : contain glomeruli ----->filtration
- Medulla : contain tubules ----->secretion and reabsorption
- (each tubule is 5-6 cm long)
  - * Cortical atrophy : glomerulonephrits
  - * Medullary atrophy : tubular nephritis
- Cortical nephron have short loop of henle
- Juxta-medullary nephron Have long loop of Henle and this is important in urine concentration (15-20%).
- In each kidney we have 1 million afferent arteriole & nephron.

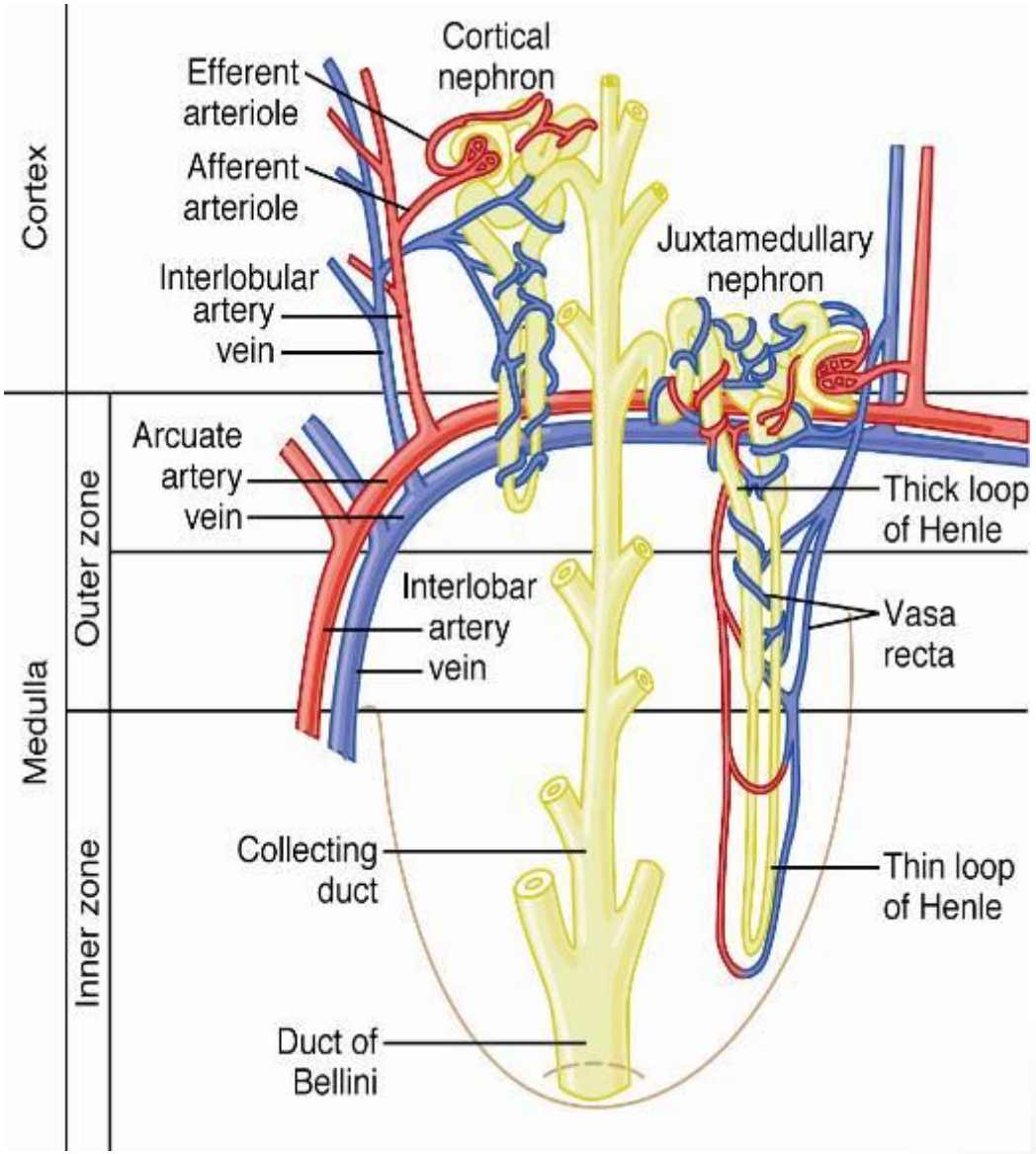
Renal Blood Flow…Introduction

- The kidney weighs 113-170 gm each. Receives 1200 ml blood/min (> 4 ml blood per gram tissue weight)
- Renal artery arises as the fifth branch of the abdominal aorta. The renal artery arises from the aorta at the level of the second lumber vertebra. Because the aorta is to the left of the midline, the right renal artery is longer. The inferior vena cava lies to the right midline making the left renal vein two times longer than the right renal vein. For this reason it is better to take the donor left kidney (short artery, long vein) & place it in the right pelvis of the recipient. Multiple arteries & veins can supply the kidney.

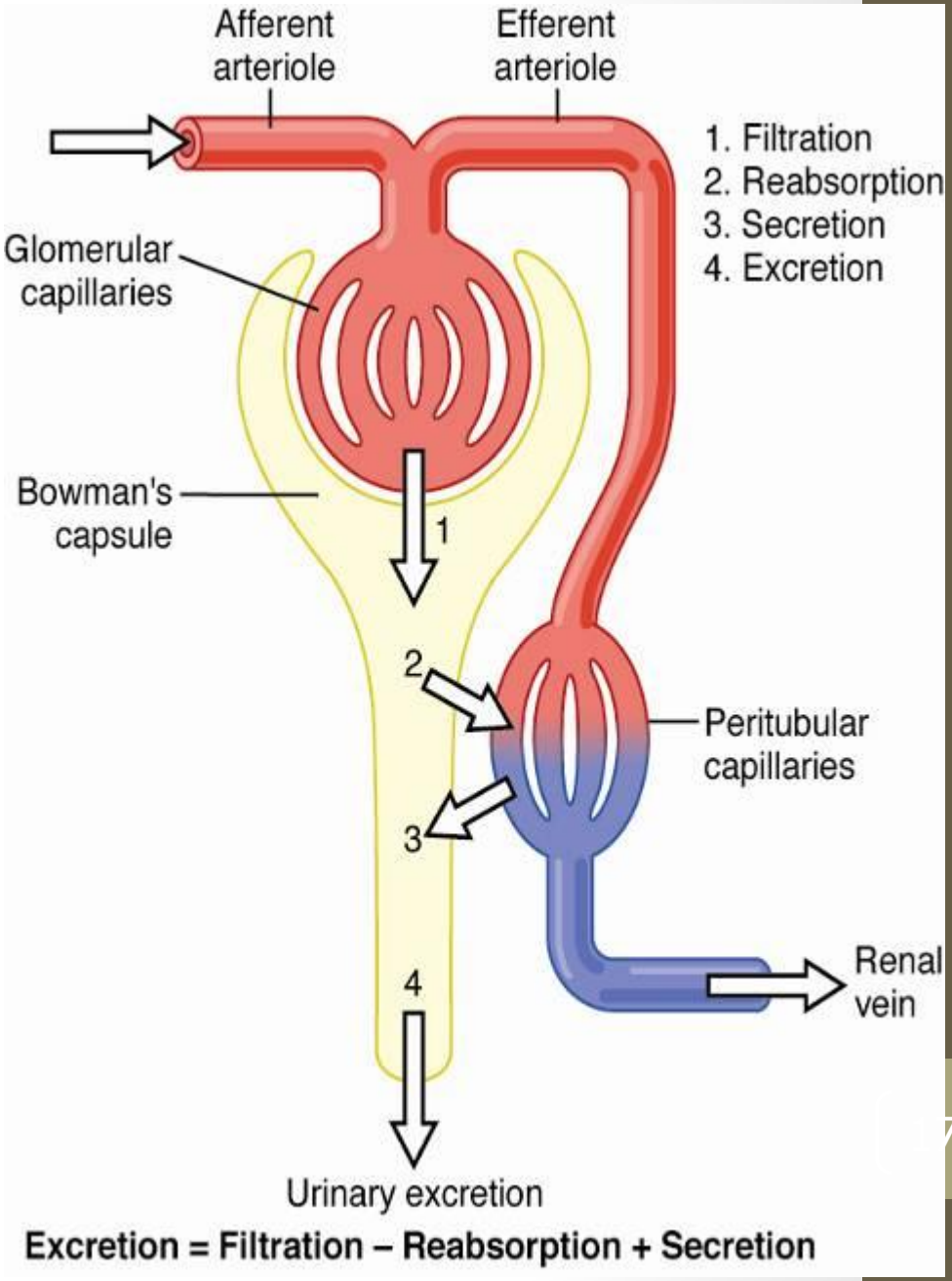
Nephron Tubular Segments



Cortical and juxtamedullary nephrons



Basic Mechanisms of Urine Formation

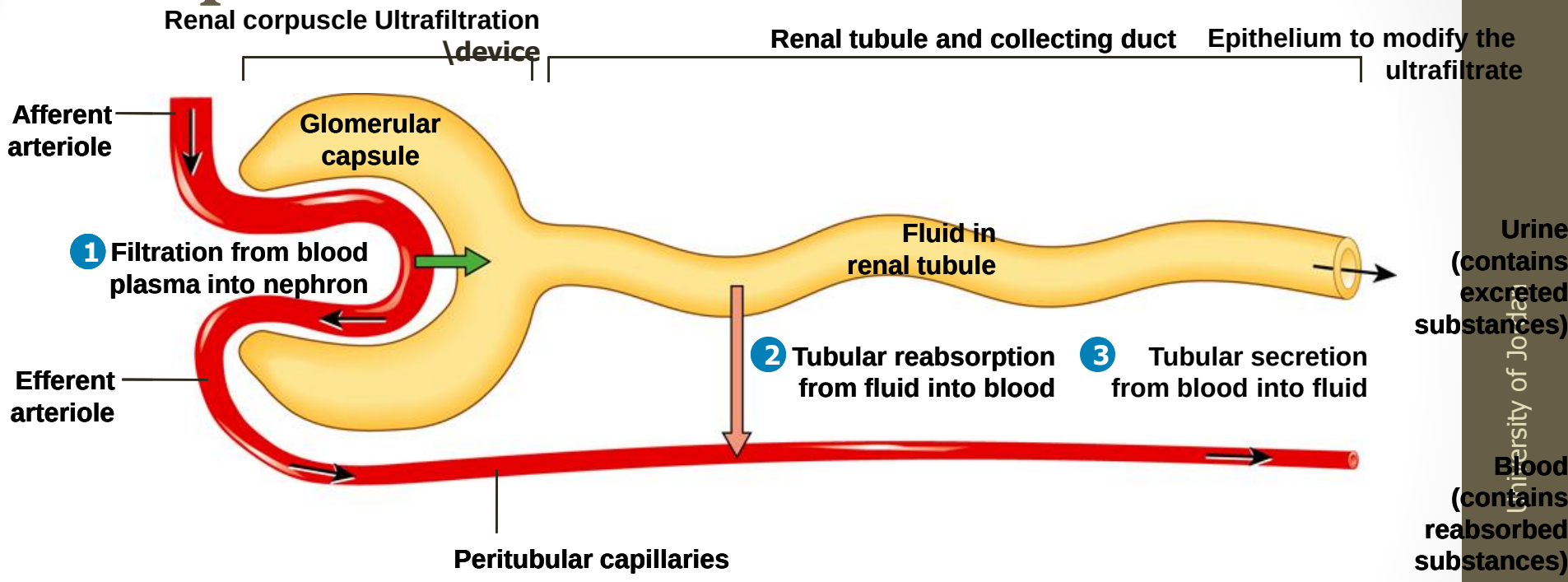


Functional Anatomy of the Kidney

- Structure & function of the kidney are closely matched. The kidney is a combination of:

1. Ultrafiltration device (the glomerular apparatus).
2. Epithelium, which modifies the ultrafiltrate by:
   - addition (secretion) or
   - removal (reabsorption).

Structures and functions of a nephron



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Excretion = Filtration - Reabsorption + Secretion

Filtration : somewhat variable, not selective (except for proteins), averages 20% of renal plasma flow

Reabsorption : highly variable and selective mos electrolytes (e.g. Na^+, K^+, Cl^-) and nutritional substances (e.g. glucose) are almost completely reabsorbed; most waste products (e.g. urea) poorly reabsorbed

Secretion : highly variable; important for rapidly excreting some waste products (e.g. $H^+$and K^+), foreign substances (including drugs), and toxins

Renal Handling of Different Substances