

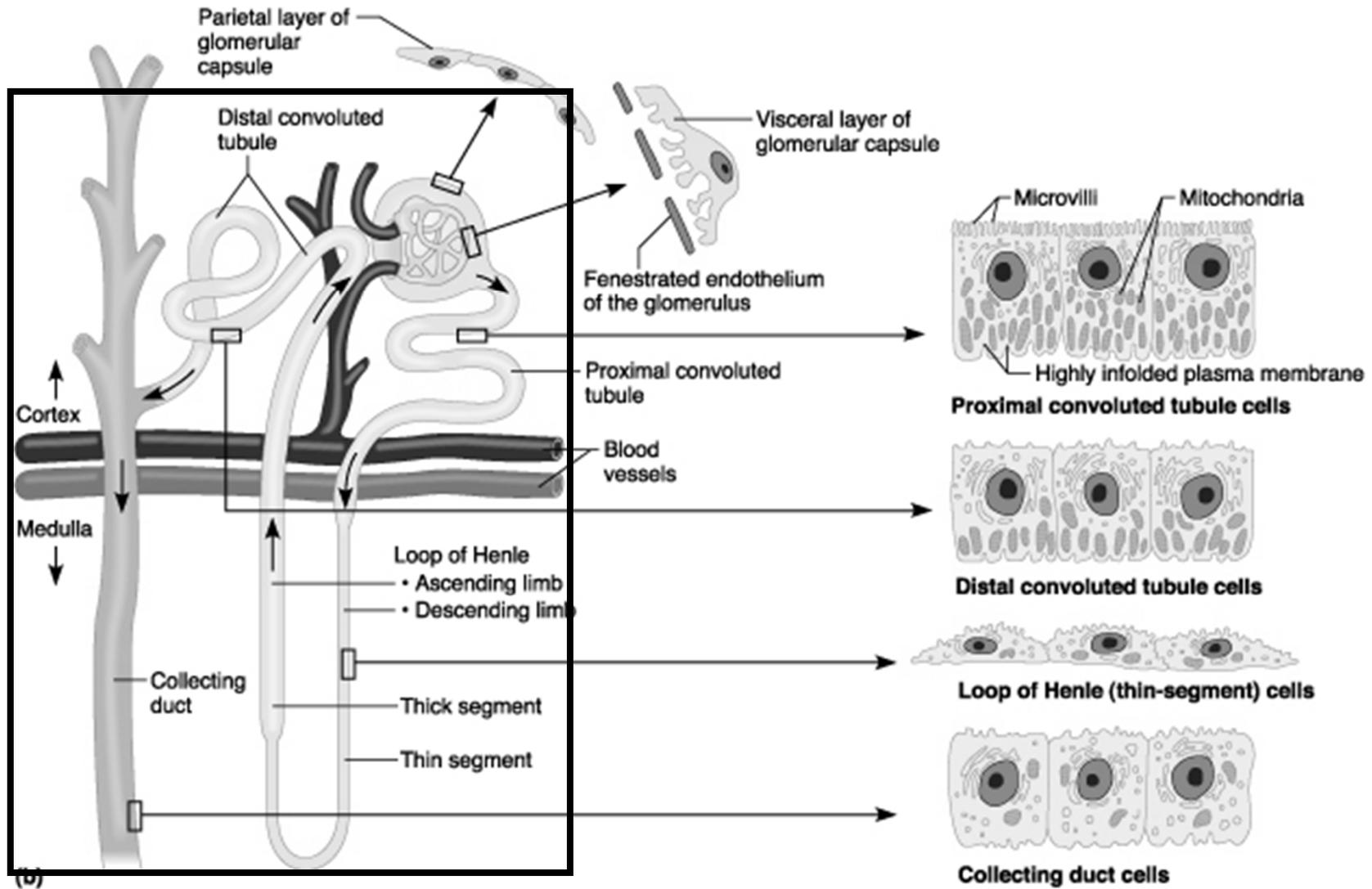
Overview of the Kidney and Kidney Diseases

Eva M. Vivian, Pharm.D., MS, CDE, BC-ADM
Professor (CHS)
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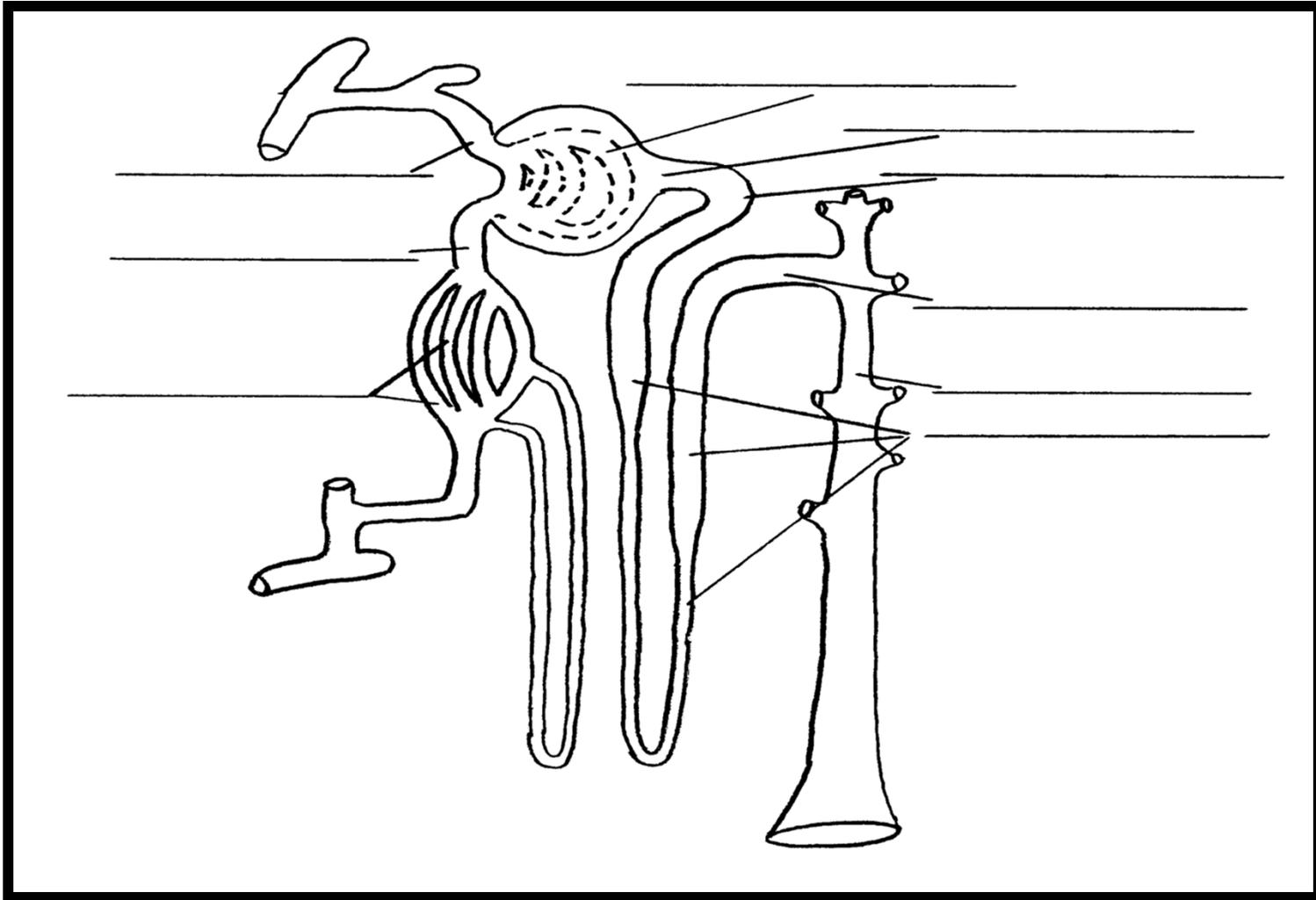
Objectives

- Describe the normal physiology of the kidneys:
 - Identify the contribution of each section of the nephron to kidney function.
 - Describe the flow of blood through the kidney.
 - Distinguish between filtration, secretion, and reabsorption.

The Nephron

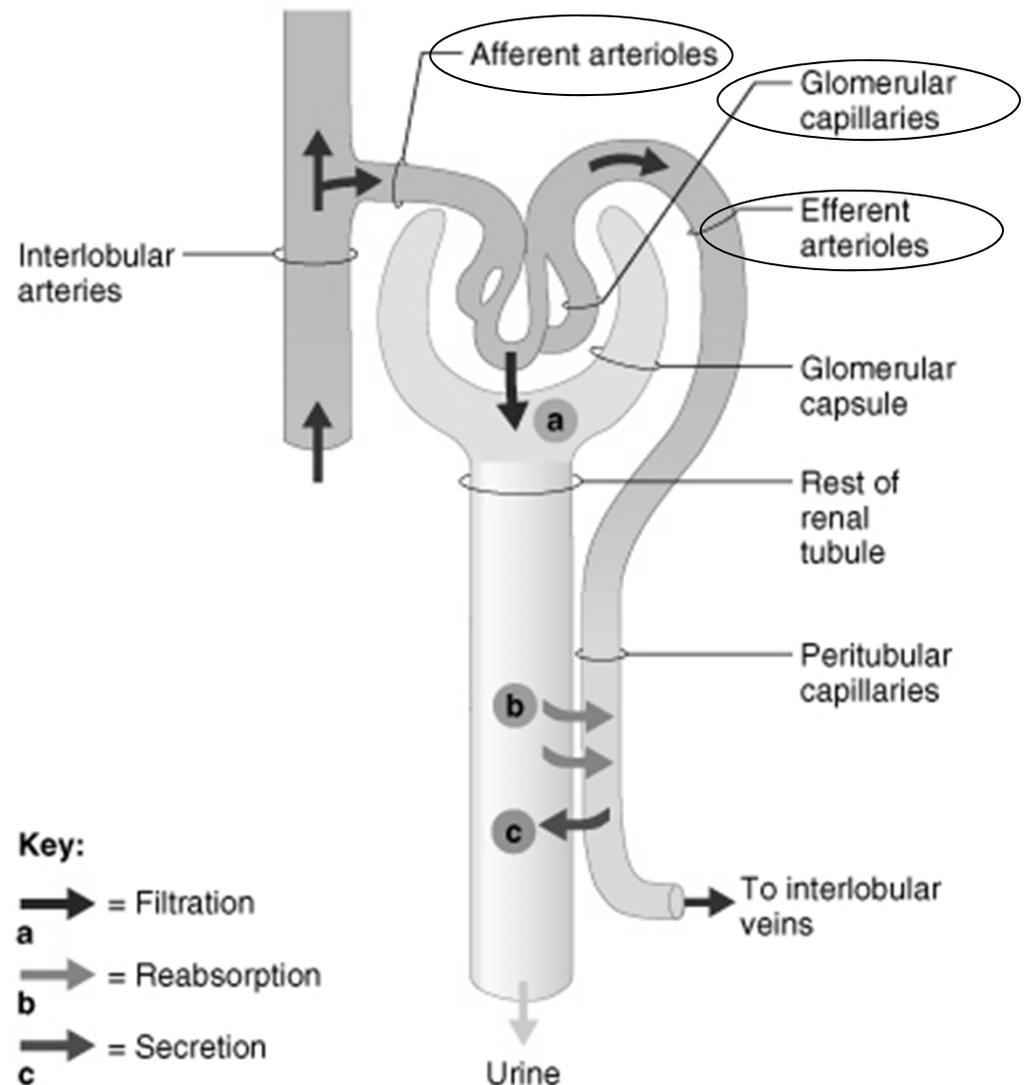


First Question on Exam



Mechanism of Urine Formation

- Urine formation and adjustment of blood composition involve three major processes
 - Glomerular filtration
 - Tubular reabsorption
 - Secretion



Why are the kidneys so important anyway?

- Principal functions of the kidney
 - Excretory
 - Maintenance of volume and solute composition
 - Excretion of metabolic waste products
 - The sum of filtration, reabsorption and secretion

Why are the kidneys so important anyway?

- Principal functions of the kidney (cont'd)

- Endocrine

- Regulation of fluid homeostasis and blood pressure

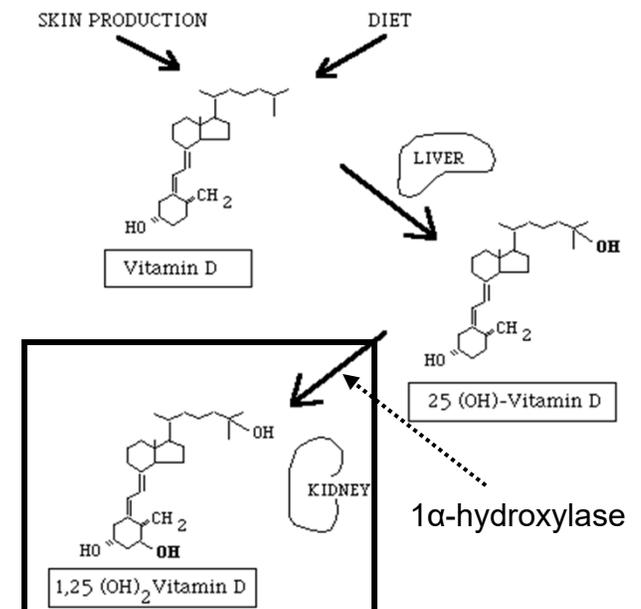
- Renin-angiotensin system

- Renal prostaglandins

- Renal kallikrein-kinin system

- Erythropoiesis

- Vitamin D metabolism



What happens if there is a failure of one or more of these functions of the kidney?

- Excretory failure
 - Creation of fluid, electrolyte, acid-base disorders. These disorders were discussed by Dr. Sorkness in previous lectures.
 - Development of the uremic syndrome. This syndrome will be discussed during the five lectures on chronic kidney disease.

What happens if there is a failure of one or more of these functions of the kidney?

- Endocrine failure
 - May lead to renal hemodynamic changes affecting blood pressure.
 - Anemia, part of the uremic syndrome.
 - Calcium-phosphorus-vitamin D-parathyroid hormone disorders, part of the uremic syndrome.
 - Some aspects of the endocrine failure of the kidney will be discussed in the lectures on chronic kidney disease

How well do you understand renal physiology?

Students should review Dr. Heideman's 522 Pharmacology II notes:

- glomerular filtration
- tubular reabsorption
- tubular secretion
- urinary excretion
- the renin-angiotensin-aldosterone system
- renal plasma clearance
- vasopressin activity, antidiuretic hormone
- erythropoietin production and activity
- vitamin D metabolism

Kidney Disease

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graph TD; A[Kidney Disease] --> B[Underperfusion (pre-renal)]; A --> C[Postrenal (obstructive)]; A --> D[Parenchymal (intrinsic)];
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A flowchart illustrating the classification of Kidney Disease. The root node is 'Kidney Disease', which branches into three categories: 'Underperfusion (pre-renal)', 'Postrenal (obstructive)', and 'Parenchymal (intrinsic)'. Each category is contained within a rectangular box, and arrows point from the root box to each of the three sub-boxes.

Underperfusion
(pre-renal)

Postrenal
(obstructive)

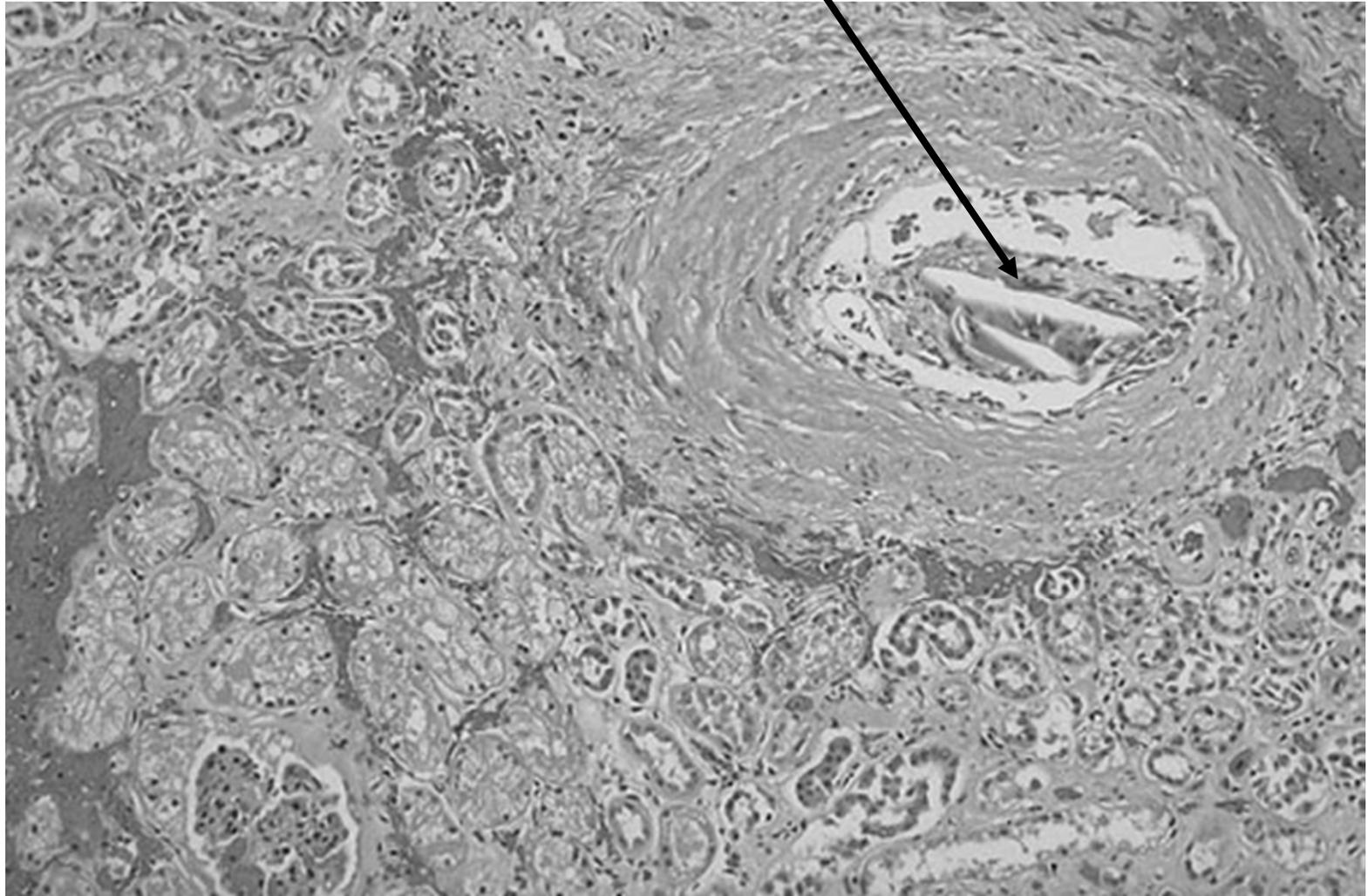
Parenchymal
(intrinsic)

The Underperfusion (Pre-renal) Syndromes

Type	Examples of Causes
Renal hypoperfusion secondary to diminished effective blood volume	Hemorrhage, cardiomyopathy, cirrhosis
Occluded renal artery	Renal artery atherosclerosis, fibromuscular dysplasia
Vasoconstriction of renal microvasculature	Acute transplant rejection, vasoconstriction caused by drugs

Generally speaking, the underperfusion syndromes result in acute renal failure. You will get a more complete treatment of this subject next week.

Cholesterol embolus within a renal artery branch



The Renal Parenchymal Syndromes

- Renal calculus syndrome

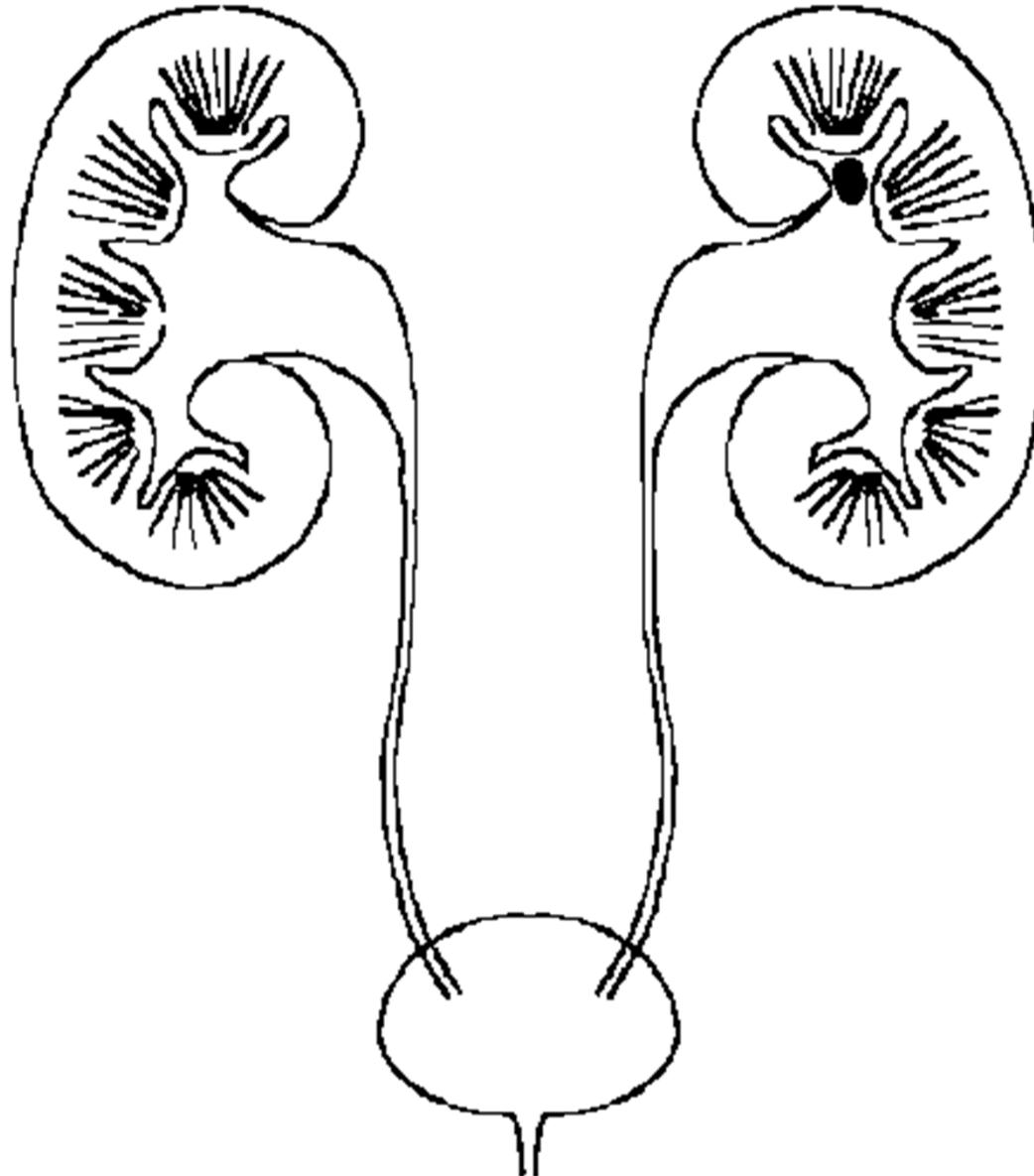
Renal calculi occur rather commonly. They may be asymptomatic or they may cause extreme discomfort as in the case of renal colic.

(<http://www-medlib.med.utah.edu/WebPath/RENAHTML/RENAL123.html>)

Calculi may cause obstruction to urine flow and pyelonephritis.

Renal colic is usually accompanied by hematuria.

Passage of a calculus (stone)



Postrenal Syndromes

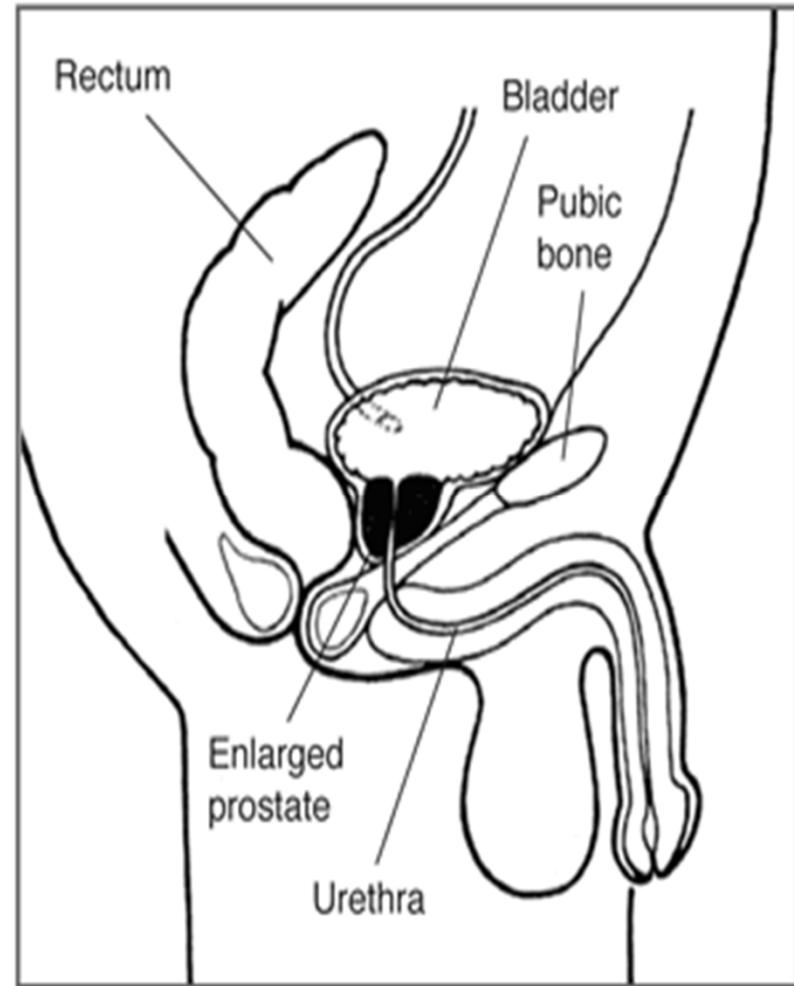
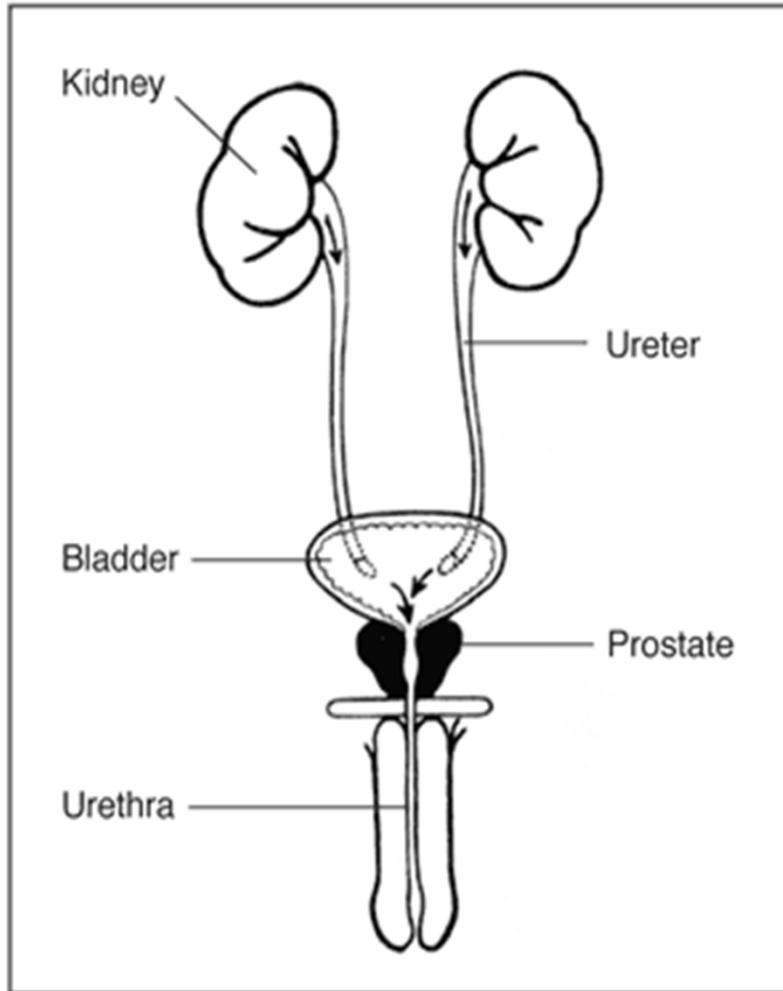
These syndromes result from the obstruction of urine flow at points beyond the renal papillae. In order for azotemia to develop, **both** kidneys must be affected, or the patient may have only one functioning kidney.

Obstruction often causes anuria.

Potential causes of urinary obstruction

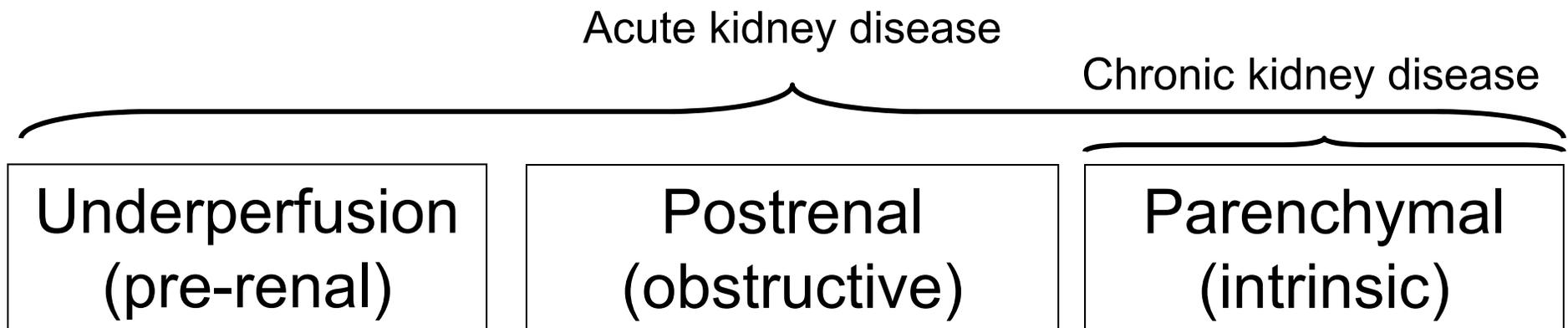
1. Bilateral ureteral obstruction
2. Bladder outflow obstruction
 - a. Prostatic enlargement

Benign Prostatic Hyperplasia



Summary (The Big Picture)

The clinical presentation of various kidney diseases may overlap. By knowing renal anatomy and physiology, it is possible to categorize the renal diseases. This categorization assists in developing an appropriate treatment plan and avoiding further kidney damage.



Effects of Aging on Kidney

Morphologic Changes

- Decrease in renal mass
 - 20-30% decrease between ages 30-90, primarily cortical
- Decrease in glomeruli
- Decrease in number, volume, length of renal tubules
- Intimal thickening of renal arterioles

Functional Changes

- Renal plasma flow decreases 10% per decade after 4th decade
- Progressive decrease in renal blood flow
- Progressive decrease in GFR after age 40 (wide inter-individual variability)
- Decreased tubular capacity for reabsorption.
- Increased glomerular permeability leading to protein in urine.

Homeostatic Consequences

- Decreased ability to concentrate and dilute urine
- Decreased ability to conserve sodium
- Impaired urinary acidification
- Tendency for hyperkalemia
- Decreased ability to metabolize and excrete drugs
- Increased susceptibility to nephrotoxicity

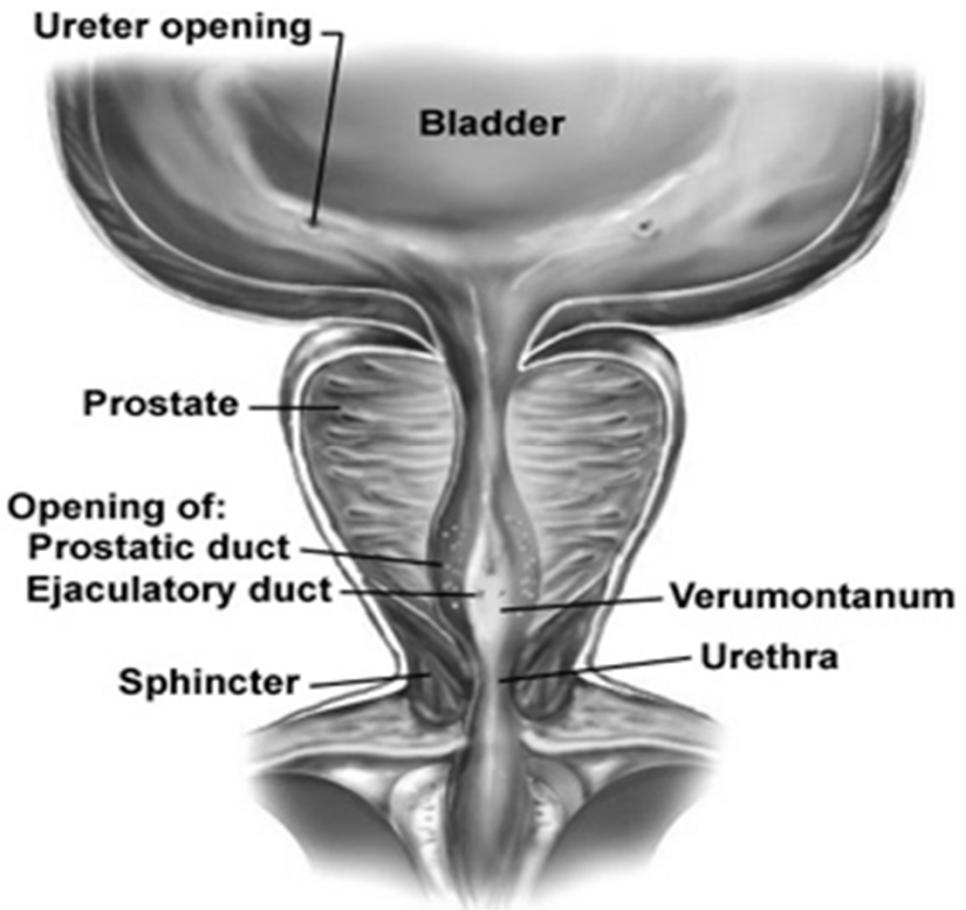
Pyelonephritis

- Caused by infection in kidneys
- Causes fever, CVA tenderness, WBCs in urine (pyuria), painful urination (dysuria)

Cystitis

- Caused by infection in bladder
- Causes WBCs in urine (pyuria), painful urination (dysuria)
- Urinary frequency and urgency

Prostate



Prostatitis

- Infection or inflammation of the prostate gland
- May be acute or chronic
- Fever, chills, arthralgias, myalgias
- Urinary frequency and pain
- Low back and abdominal pain, rectal pain
- Urethral discharge
- Bacterial or other infectious causes

Sample Exam Question

- A 62-yo woman is complaining of swollen legs and trouble breathing. She has a PMH significant for HTN, hyperlipidemia, MI and a new CHF diagnosis two weeks ago.
 - Medications: atenolol 25 mg po daily, ASA 81 mg po daily, fosinopril 10 mg po daily
 - Blood pressure: 110/80 mm Hg
 - PE: 3+ edema in legs, crackles in lungs, weight increased by 3 kg.
 - Lab: SCr 1.9 mg/dl (baseline 1.1), FENa- 0.5%
- What is a possible cause of acute renal failure in this patient?