physiology
lecture 10 part 2

glomerular filtration depends on three main pressures

- glomerular blood hydrostatic pressure (GBHP): (blood pressure in glomerular capillaries)(55mmHg)(promotes filtration)(forcing water and solutes in blood plasma through the filtration membrane)
- capsular hydrostatic pressure (CHP) : (against the filtration membrane) (by fluid in the capsular space and renal tubule)(opposes filtration) (back pressure)(15 mmHg)
- blood colloid osmotic pressure (BCOP): (presence of proteins albumin,globulin, fibrinogen in plasma blood)(opposes filtration) (30mmHg)

Net filtration pressure (NFP)= the total pressure that promotes filtration

Net filtration pressure (NFP) = GBHP - CHP - BCOP

NFP = 55 mmHg -15 mmHg - 30 mmHg = 10 mmHg

pressure of only 10 mmHg causes a normal amount of blood plasma

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glomerular filtration rate (GFR) : the amount of filtrate formed in all renal corpuscle of both kidneys each minute (related to net filtration pressure)(related to blood flow that enter the kidneys)

- male (125ml/min)
- female (105 ml/min)

homeostasis of body fluids → kidneys maintain relatively constant GFR

if the GFR changes, then what will happen?

- GFR is too high → needed substances that should be reabsorbed are lost in the urine
- GFR is too low → all the filtrate may be reabsorbed and certain ways may not be secreted

ways of regulation of GFR

- adjusting a blood flow of the glomerulus (GFR increases when blood flow into the glomerular capillaries increases)
- altering the glomerular capillary surface area available for filtration (control of the diameter of both efferent and efferent arterios regulates glomerular blood flow) (construction of the affirant decrease blood flow and dilation of the efference increase it)

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mechanisms control GFR

- renal Autoregulation (kidneys themselves regulate normal everyday changes and the blood pressure)
- neural regulation (kidneys are supplied by sympathetic ANS fibers that release not norepinephrine)
- Hormonal regulation

myogenic mechanism (teaching triggers contraction of smooth muscle cells in the afferent arterios)

blood pressure rises → renal blood flow increase → stretching the walls of the afferent arterials → contraction of the afferent arterioles → renal blood flow decrease

tubuloglomerular feedback

- (so named because part of the renal tubules provides feedback to the glomerulus)
- the macula densa(closely backed specialized cells in the wall of the distal tubule) (ascending limp of the loop of Henle means the distal convoluted to tubule) (vasodilators and vasoconstrictors)

neural regulation

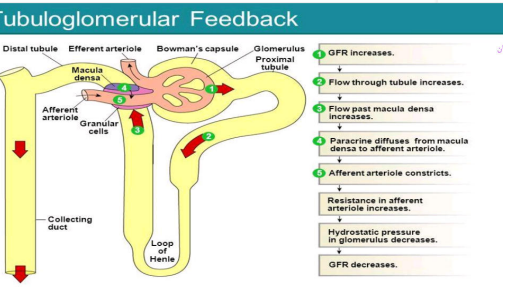
- at rest (sympathetic stimulation is low) → vasodilation of afferent and efferent arterioles → no effect so the renal autorigulation will prevail
- sympathic stimulation is moderate → vasoconstriction for both afferent and efferent arterioles to the same degree → blood flow decreases the same in both which decreases GFR only slightly
- sympathetic stimulation is high (exercise or hemorrhage) → vasoconstriction for afferent more than efferent → blood flow and GFR greatly decreased (drop)

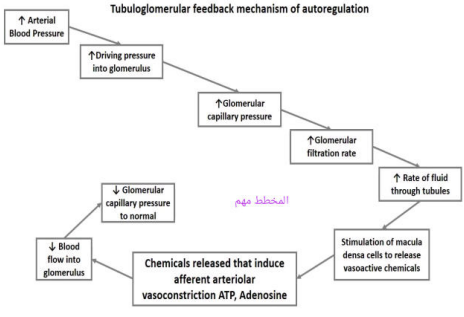
lowering of renal blood flow

- reduces urine output
- greater blood flow to other body tissues

hormone regulation

- decreased the blood volume or blood pressure → Angiotensin II → vasoconstriction of afferent and efferent arteriole → GFR decreases
- stretching of atria of heart → atrial natriuretic peptide(ANP) → increases the capillary surface area for filtration → GFR increases





Regulation of Glomerular Filtration Rate (GFR)

ملخص

TYPE OF REGULATION	MAJOR STIMULUS	MECHANISM AND SITE OF ACTION	EFFECT ON GFR
Renal autoregulation			
Myogenic mechanism	Increased stretching of smooth muscle fibers in afferent arteriole walls due to increased blood pressure.	Stretched smooth muscle fibers contract, thereby narrowing lumen of afferent arterioles.	Decrease.
Tubuloglomerular feedback	Rapid delivery of Na^+ and Cl^- to the macula densa due to high systemic blood pressure.	Decreased release of nitric oxide (NO) by juxtaglomerular apparatus causes constriction of afferent arterioles.	Decrease.
Neural regulation	Increase in activity level of renal sympathetic nerves releases norepinephrine.	Constriction of afferent arterioles through activation of α_1 receptors and increased release of renin.	Decrease.
Hormone regulation			
Angiotensin II	Decreased blood volume or blood pressure stimulates production of angiotensin II.	Constriction of afferent and efferent arterioles.	Decrease.
Atrial natriuretic peptide (ANP)	Stretching of atria of heart stimulates secretion of ANP.	Relaxation of mesangial cells in glomerulus increases capillary surface area available for filtration.	Increase.

reabsorption : the return of most of the filtered water and solutes to the bloodstream

Glucose: 100% reabsorption, 0% secretion

creatinine: 0% reabsorption, 100% secretion

tubular secretion : transfer of materials from the blood and tubule cells into glomerular filtrate

- control blood pH (secretion of hydrogen ions)
- secretion of other substances helps eliminate them

transport maximum: the maximum amount of ions are substances that can the transport protein carry

reabsorption (هون بالقنوات الاولى)

- paracellular reabsorption → diffusion by Gap junctions
- transcellular reabsorption → Apical membrane → basolateral membrane (by sodium-potassium pump)(or diffusion)

diffusion

- symporters (sodium and the glucose) (secondary active transport) (at the same direction)
- antiporters (sodium and the proton) (at the opposite direction)
- Na , Cl , K (they can enter it by symptoms) (at the same direction) (but the K return back by the diffusion) (in the loop of Hanle)

reabsorption

- obligatory water reabsorption → always 90% of the absorption of water with solutes → 1. proximal convoluted tubule 2. descending loop of Henle
- facultative water reabsorption → final 10% regulated by (antidiuretic hormone) → 1.late distal convoluted tubule 2. collective ducts

aldosterone increases → increase in the reabsorption of water and sodium → hypernatremia (Na sodium increase in the blood) → hypokalemia (k+ potassium drop in the blood)

والعكس صحيح (هاي مو بالسلايدات بس الدكتورة قالت مطلوبة)

parathyroid hormone (PTH) → reabsorption of calcium ions → in the early distal convoluted tubule

reabsorption (in the late or terminal part) (يلي هو بالقنوات الاخيرة) → the difference is sodium and potassium will transport by Leakey channels → there are two types of cells

- principal cells
- intercalated cells

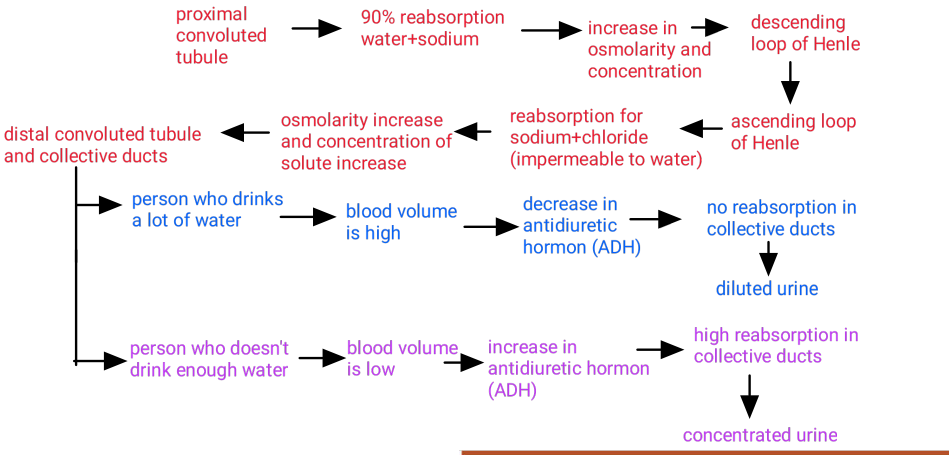
TABLE 26.4

Hormonal Regulation of Tubular Reabsorption and Tubular Secretion

ملخص

HORMONE	MAJOR STIMULI THAT TRIGGER RELEASE	MECHANISM AND SITE OF ACTION	EFFECTS
Angiotensin II	Low blood volume or low blood pressure stimulates renin-induced production of angiotensin II.	Stimulates activity of Na^+–H^+ antiporters in proximal tubule cells.	Increases reabsorption of Na^+, other solutes, and water, which increases blood volume and blood pressure.
Aldosterone	Increased angiotensin II level and increased level of plasma K^+ promote release of aldosterone by adrenal cortex.	Enhances activity of sodium–potassium pumps in basolateral membrane and Na^+ channels in apical membrane of principal cells in collecting duct.	Increases secretion of K^+ and reabsorption of Na^+, Cl^-; increases reabsorption of water, which increases blood volume and blood pressure.
Antidiuretic hormone (ADH)	Increased osmolarity of extracellular fluid or decreased blood volume promotes release of ADH from posterior pituitary gland.	Stimulates insertion of water channel proteins (aquaporin-2) into apical membranes of principal cells.	Increases facultative reabsorption of water, which decreases osmolarity of body fluids.
Atrial natriuretic peptide (ANP)	Stretching of atria of heart stimulates ANP secretion.	Suppresses reabsorption of Na^+ and water in proximal tubule and collecting duct; inhibits secretion of aldosterone and ADH.	Increases excretion of Na^+ in urine (natriuresis); increases urine output (diuresis) and thus decreases blood volume and blood pressure.
Parathyroid hormone (PTH)	Decreased level of plasma Ca^{2+} promotes release of PTH from parathyroid glands.	Stimulates opening of Ca^{2+} channels in apical membranes of early distal tubule cells.	Increases reabsorption of Ca^{2+}.

بس العمود يلي بالنص محذوف والباقي مطلوب



1. urinalysis

(بس الاشياء المحددة)

TABLE 26.5

Characteristics of Normal Urine

CHARACTERISTIC	DESCRIPTION
Volume	One to two liters in 24 hours; varies considerably.
Color	Yellow or amber; varies with urine concentration and diet. Color due to urochrome (pigment produced from breakdown of bile) and urobilin (from breakdown of hemoglobin). Concentrated urine is darker in color. Color affected by diet (reddish from beets), medications, and certain diseases. Kidney stones may produce blood in urine.
Turbidity	Transparent when freshly voided; becomes turbid (cloudy) on standing.
Odor	Mildly aromatic; becomes ammonia-like on standing. Some people inherit ability to form methylmercaptan from digested asparagus, which gives characteristic odor. Urine of diabetics has fruity odor due to presence of ketone bodies.
pH	Ranges between 4.6 and 8.0; average 6.0; varies considerably with diet. High-protein diets increase acidity; vegetarian diets increase alkalinity.
Specific gravity (density)	Specific gravity (density) is ratio of weight of volume of substance to weight of equal volume of distilled water. In urine, 1.001–1.035. The higher the concentration of solutes, the higher the specific gravity.

TABLE 26.6

Summary of Abnormal Constituents in Urine

ABNORMAL CONSTITUENT	COMMENTS
Albumin	Normal constituent of plasma; usually appears in only very small amounts in urine because it is too large to pass through capillary fenestrations. Presence of excessive albumin in urine—**albuminuria** (al″-bū-mi-NOO-rē-a)—indicates increase in permeability of filtration membranes due to injury or disease, increased blood pressure, or irritation of kidney cells by substances such as bacterial toxins, ether, or heavy metals.
Glucose	Presence of glucose in urine—**glucosuria** (gloo-kō-SOO-rē-a)—usually indicates diabetes mellitus. Occasionally caused by stress, which can cause excessive epinephrine secretion. Epinephrine stimulates breakdown of glycogen and liberation of glucose from liver.
Red blood cells (erythrocytes)	Presence of red blood cells in urine—**hematuria** (hēm-a-TOO-rē-a)—generally indicates pathological condition. One cause is acute inflammation of urinary organs due to disease or irritation from kidney stones. Other causes: tumors, trauma, kidney disease, contamination of sample by menstrual blood.
Ketone bodies	High levels of ketone bodies in urine—**ketonuria** (kē-tō-NOO-rē-a)—may indicate diabetes mellitus, anorexia, starvation, or too little carbohydrate in diet.

Summary of Abnormal Constituents in Urine

ABNORMAL CONSTITUENT	COMMENTS
Bilirubin	When red blood cells are destroyed by macrophages, the globin portion of hemoglobin is split off and heme is converted to biliverdin. Most biliverdin is converted to bilirubin, which gives bile its major pigmentation. Above-normal level of bilirubin in urine is called **bilirubinuria** (bil″-ē-roo-bi-NOO-rē-a).
Urobilinogen	Presence of urobilinogen (breakdown product of hemoglobin) in urine is called **urobilinogenuria** (ūr″-rō-bi-lin″-ō-je-NOO-rē-a). Trace amounts are normal, but elevated urobilinogen may be due to hemolytic or pernicious anemia, infectious hepatitis, biliary obstruction, jaundice, cirrhosis, congestive heart failure, or infectious mononucleosis.
Casts	Casts are tiny masses of material that have hardened and assumed shape of lumen of tubule in which they formed, from which they are flushed when filtrate builds up behind them. Casts are named after cells or substances that compose them or based on appearance (for example, white blood cell casts, red blood cell casts, and epithelial cell casts that contain cells from walls of tubules).
Microbes	Number and type of bacteria vary with specific urinary tract infections. One of the most common is *E. coli*. Most common fungus is yeast *Candida albicans*, cause of vaginitis. Most frequent protozoan is *Trichomonas vaginalis*, cause of vaginitis in females and urethritis in males.

2. blood tests

blood urea nitrogen (BUN) TEST

directly related to the glomerular filtration rate GFR

GFR decreased will increase BUN

one strategy in treatment: minimize protein intake , therapy reducing the rate of urea production

plasma creatinine

normally, creatinine level remains steady because the excretion equals it's discharged from muscle

1.5 mg/dL (135mmol/L) usually is indication of poor renal function

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Renal plasma clearance : is the volume of blood that is "cleaned" or cleared of a substance per unit of time

Low clearance indicates inefficient excretion

drugs clearance is essential to know the correct doses

for ex : penicillin is with high clearance → high dosage and several times

the clearance depends on
- glomerular filtration
- tubular reabsorption
- tubular secretion

The following equation is used to calculate clearance:

مهمة

تصفية المادة S في بلازما الكلي =

$$\text{Renal plasma clearance of substance S} = \left(\frac{U \times V}{P}\right)$$

where U and P are the concentrations of the substance in urine and plasma, respectively (both expressed in the same units, such as mg/mL), and V is the urine flow rate in mL/min.