Control of Plasma Volume

Curriculum:Phase1/Semester 4/Urology modules/Session3,Lecture 1

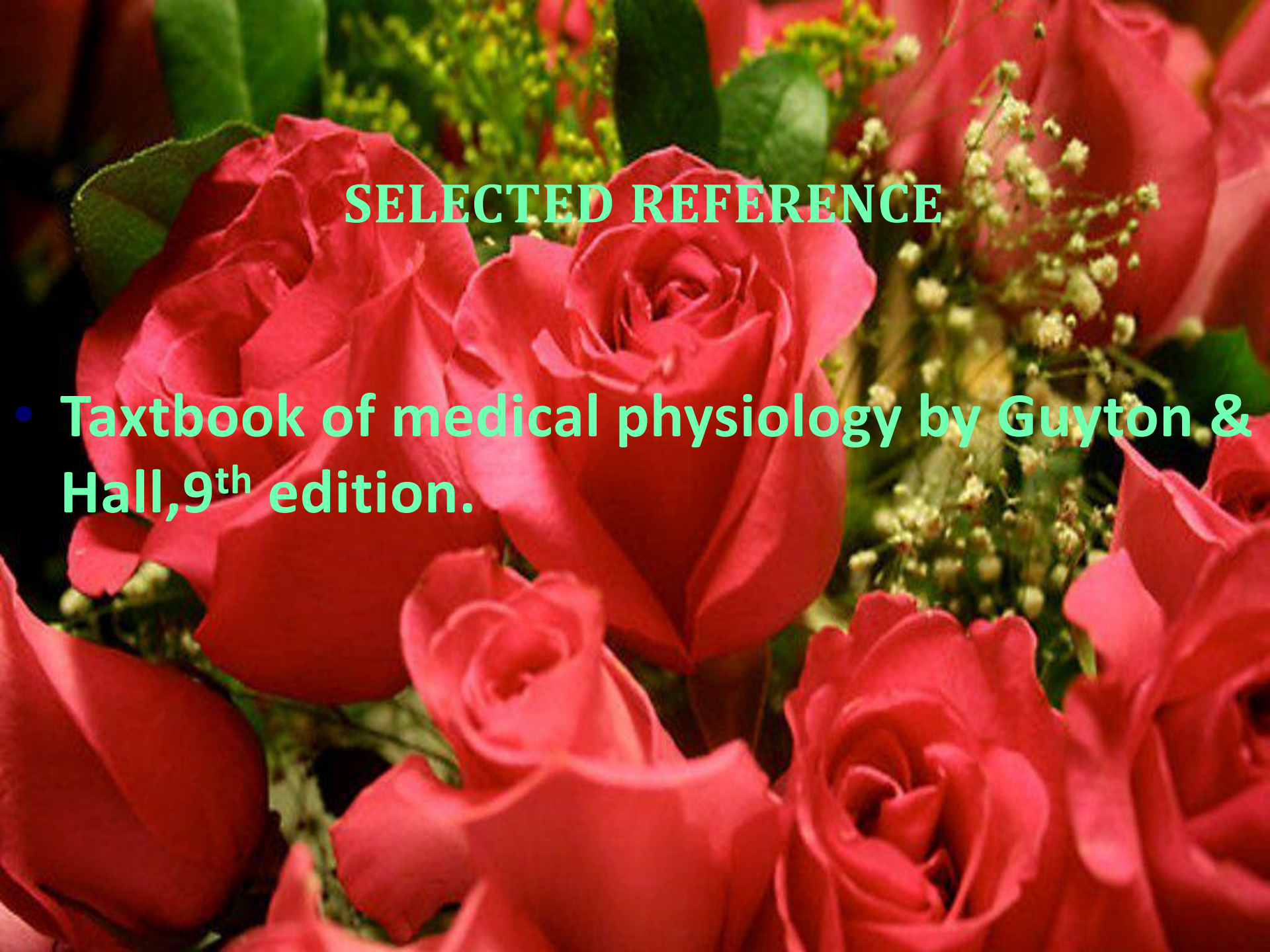
Lecturer : Dr. Shahlaa Kh. Chabuk

Degrees: M.B.Ch.B. /Ph.D. physiology

year: 2018-2019

Lecture objectives

- fluid compartments and their electrolyte compositions
- how the kidney handles sodium ions in order to change ECF volume
- handling of sodium ions in the PCT
- glomerulotubular (GT) balance and the effect of ECF volume
- sodium ion reabsorption in the loop of Henle (not counter current system)
- sodium ion uptake by the early and late distal tubule
- how hormones, sympathetic nerves, dopamine and Starling forces regulates NaCl reabsorptio.
- how the renin-angiotensin system regulates sodium ion uptake in response to changes in blood pressure
- the sympathetic control of ADH (anti-diuretic hormone) secretion and the role of the baroreceptor



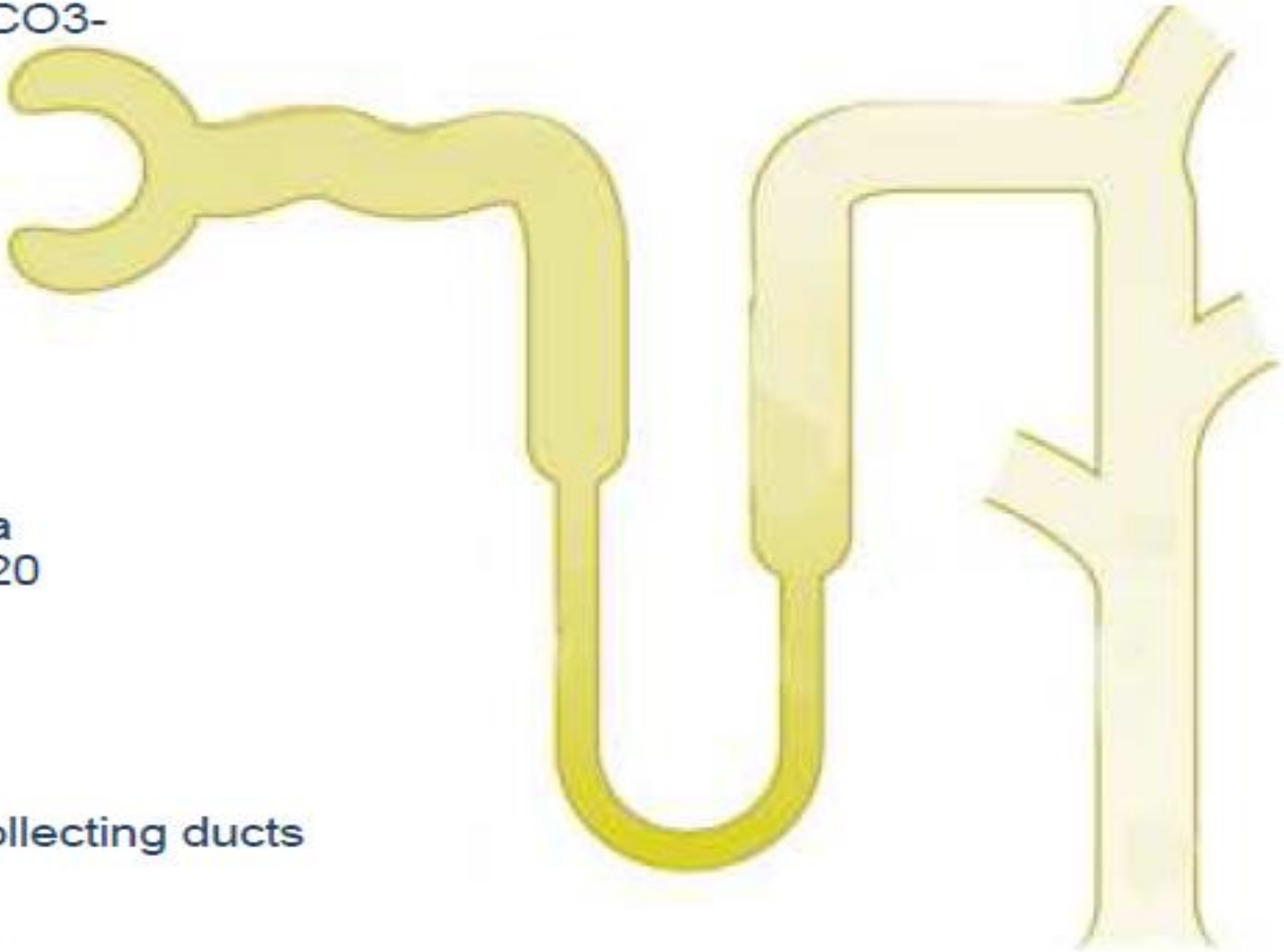
SELECTED REFERENCE

- Taxtbook of medical physiology by Guyton & Hall,9th edition.

Water in the body is located in either the intracellular or extracellular (composed of interstitial fluid and plasma) fluid, and the composition of the extracellular fluid affects the intracellular fluid.

The kidneys control the composition of the extracellular fluid, allowing for intracellular composition to be altered.

Proximal tubule
65% H20 and 67% Na
100% glucose and 100% Amino acids must have both
90% HCO3-



Loop
25% Na
15% H20

Distal and collecting ducts
20% H20
8% Na
10% HCO3-

Of all the functions of the kidney, handling of sodium ions is one of the most important. Sodium is the major cation of the ECF, the amount of sodium ions determines the ECF volume, and this, in turn, determines the volume of plasma, blood volume and, hence, blood pressure. The renal processes involved in sodium ion reabsorption are critically important for the maintenance of normal ECF volume and hence blood pressure.

Sodium ion Balance

On a daily basis, the kidneys must balance the amount of sodium ion excretion so that it matches the amount of sodium ion ingestion. This is a matching process known as sodium ion balance.

Expansion of the ECF

On a daily basis, the kidneys must balance the amount of sodium ion excretion so that it matches the amount of sodium ion ingestion. This is a matching process known as sodium ion balance.

Contraction of the ECF

If sodium ion excretion is greater than ingestion then a patient is in negative balance. Excess sodium ions are lost from the body, the sodium ion content of the ECF decreases and water remains in the nephron. The ECF volume decreases, as does blood volume and arterial pressure. Remember we are talking about the total amount of sodium ions not the concentration of the sodium; (you could have a low or high concentration of sodium depending on the volume of water without affecting the overall sodium ion amount.

Remember just because sodium is the major ion of the ECF, this does not mean that changes in sodium ion balance affect ECF osmolarity. This is not, generally, the case if the concentration of sodium ions in the ECF increases the volume increases.This volume expansion results in increased vascular volume and cardiac output

Increases in ECF volume are detected by a number of different sensors

A number of these sensors are located in the vascular system. They are commonly called the volume or baroreceptors. Low-pressure baroreceptors in the atria and pulmonary vasculature send signals to the brainstem via the vagus nerve.

ctivity modulates both sympathetic nerve outflow and secretion of a hormone called ADH. So a decrease in filling of the pulmonary vasculature and cardiac atria increases sympathetic nerve activity and causes ADH secretion and, thus, water uptake. Because of the location of these low-pressure sensors in the venous or high compliance side of the circulatory system where the majority of blood is, they respond to total venous volume. Distension of these low-pressure baroreceptors decreases sympathetic nerve activity. In general, a 5-10% change in pressure is needed to evoke a response.

The kidneys respond to an increase in volume of the ECF by increasing the excretion of NaCl and water and a decrease in ECF volume by decreasing the excretion of NaCl and hence water.


THANKS