Kidneys I

Glomerular filtration, function of tubules

**Laboratory exercise and seminar in medical physiology**

Home preparation, study materials and learning objectives

**Learning objectives - what you will be able to do**

• Explain the concept of renal clearance.

• Calculate the amount of primary urine produced and blood flow through the kidney.

• Describe the events taking place in the renal tubules.

• Examine urine using diagnostic strips and explain the method of excretion of selected substances in urine.

• Explain the principles of maintaining potassium in the body.

**Studying materials**

• Kidney Lectures

(the recording of the lecture from 2020 can be found here:

<https://www.youtube.com/watch?v=xZZ6SVLtMkE>

<https://www.youtube.com/watch?v=ZK1wj7k2R-U> )

• Textbook L. Constanzo – Physiology, 6th or 7th edition

o Pages 255 – 288

• Additional resources:

o Guyton AC, Hall JE: Textbook of Medical Physiology. Elsevier, 2020. (Unit V The Body Fluids and Kidneys. Chapters 26 – 29)

**Student presentations**

• **Examination of glomerular function, advantages and limitations of individual methods**

• **Examination of tubular function**

**Home preparation**

Brief theoretical introduction:

**Determination of the amount of glomerular filtrate (GFR)**

The gold standard for measuring the amount of glomerular filtrate is the substance inulin (fructose polymer). It is freely filtered through the glomerular capillary wall and is neither secreted nor reabsorbed in the tubules. The entire filtered amount of inulin is excreted in the definitive urine, i.e. the amount of inulin in the primary kidney ultrafiltrate (per time unit) is equal to the amount of inulin excreted in the urine.

**Determination of Renal Plasma Flow (RPF)**

Fick's principle states that the amount of substance that enters the organ (kidney) is equal to the amount of substance that leaves the kidney. Para-aminohippuric acid (PAH) is a substance that is filtered in the glomerulus and secreted in the tubules. The entire amount of PAH that flows into the kidneys per unit of time dissolved in the plasma will leave in the final urine (simplified for clarity, see other sources for details). The amount of PAH in plasma (= concentration x volume, PPAH x RPF) is the same as the amount of PAH in urine (again concentration x volume, UPAH x V). Both, of course, for a unit of time.

**Clearance**

Kidney clearance is a concept that describes the cleansing function of the kidneys. Clearance is defined as the volume of blood plasma that is completely cleared of a certain substance per time unit. Note: Inulin clearance = GFR

PAH clearance = RPF

**Homework - print and bring to the seminar**

The following test results were obtained in humans during a 2-hour infusion of inulin and para-aminohippuronic acid (PAH):

|  |  |
| --- | --- |
| Urine volume (V)  Concentration of inulin in urine (Uin)  Inulin concentration in plasma (Pin)  Concentration of urea in urine (Uurea)  Urea concentration in plasma (Purea)  Urine PAH concentration (UPAH)  Plasma PAH concentration (PPAH)  Hematocrit | = 0.14 l  = 100 mg/100 ml  = 1 mg/100 ml  = 220 mmol/l  = 5 mmol/l  = 700 mg/l  = 2 mg/l  = 0.40 |

1. What is the clearance (C) of inulin and thus the amount of glomerular filtrate (GFR)?

2. What is the clearance of urea?

3. What is PAH clearance and thus renal plasma flow (RPF)?

4. What is renal blood flow (RBF)?