



## Program of Medicine Studies

# MODULE HOMEOSTASIS AND EXCRETION

**Second Year  
Third Semester**

**Faculty of Medicine  
Kaunas University of Medicine**

# Contents

<b>1. General information.....</b>	<b>4</b>
<b>2. General contents of the module.....</b>	<b>5</b>
<b>3. Aim and objectives of the module.....</b>	<b>6</b>
<b>4. Tutorials.....</b>	<b>7</b>
4.1. Case 1. Low weight of the baby.....	7
4.2. Case 2. Edema of the body.....	12
4.3. Case 3. Blood in urine.....	16
4.4. Case 4. Color of the urine like “Coca-cola”.....	20
4.5. Case 5. Sweet urine.....	25
4.6. Case 6. Low urination flow.....	29
<b>5. Lectures.....</b>	<b>33</b>
5.1. Structure of the organs of the urinary system (2 hrs.).....	33
5.2. Histophysiology of the organs of the urinary system (2 hrs.).....	33
5.3. Role of kidneys in homeostasis (2 hrs.).....	33
5.4. Regulation of water and electrolyte homeostasis with hormones (2 hrs.).....	34
5.5. Disorders of renal functions. Changes in urine excretion and composition. Acute and chronic renal failure, etiology, mechanisms of pathogenesis, disorders of body functions (2 hrs.).....	34
5.6. Structural principles of homeostasis and pathology of the organs of the urinary system (2 hrs.).....	35
5.7. Environmental factors, influencing homeostasis and renal function (2 hrs.).....	35
5.8. Examination of the patients with diseases of the urinary system. Laboratory and instrumental diagnosis. Main clinical syndromes (2 hrs.).....	35
5.9. Preparation of a surgical patient for an operation, correction of homeostasis. Hemocorrectors (2 hrs.).....	36
5.10. Radiological diagnostics of the kidney, bladder and prostate disorders (2 hrs.).....	36
5.11. Intake of drugs in chronic renal failure (2 hrs.).....	36
5.12. Drugs affecting urine excretion –diuretics (2 hrs.).....	37
<b>6. Practical work.....</b>	<b>38</b>
6.1. Structure and skeletotopy of the organs of the urinary system (6 hrs.).....	38
6.2. Histology of the organs of the urinary system (3 hrs.).....	38
6.3. Diseases and syndromes of the kidneys and their morphological changes (3 hrs.).....	38

6.4. Examination of the patients with diseases of the urinary system (4 hrs.).....	39
6.5. Changes in homeostasis of a surgical patient (3 hrs.).....	40
6.6. Radiological diagnostics of the kidneys, bladder and prostate diseases (3 hrs.).....	40
6.7. Drugs affecting urine excretion (3 hrs.).....	41
<b>7. Seminars.....</b>	<b>43</b>
7.1. Hyperchloremic metabolic acidosis (3 hrs.).....	43
7.2. Molecular principles of ion an water reabsorption in the kidneys (2 hrs.).....	43
7.3. Nephrotoxic factors of occupational environment (3 hrs.).....	44
7.4. Main clinical syndromes of the organs of the urinary system (3 hrs.).....	44
7.5. Principles of homeostasis correction of a surgical patient (3 hrs.).....	44
7.6. Radiological techniques used in the examination of the organs of the urinary system (4 hrs.) .....	45
7.7. Intake of drugs in chronic renal failure (3 hrs.).....	45
<b>8. Module examination questions:.....</b>	<b>47</b>
8.1. Anatomy.....	47
8.2. Histology and Embryology.....	47
8.3. Biochemistry.....	47
8.4. Physiology.....	48
8.5. Pathological Physiology.....	48
8.6. Pathological Anatomy.....	48
8.7. Essentials of medical diagnosis.....	49
8.8. Pharmacology.....	49
8.9. Radiology.....	49
8.10. General Surgery.....	50
8.11. Environmental and occupational medicine.....	50
<b>9. Appendix.....</b>	<b>51</b>
9.1. Questions for the seminar “Molecular principles of reabsorption in the kidneys” (2 hrs.).....	51
9.2. Questions for the seminar “Hyperchloremic metabolic acidosis” (3 hrs.).....	51
9.3. Questions for the seminar “Principal clinical syndromes of the organs of the urinary system” (3 hrs.).....	52
9.4. Questions for the seminar “Nephrotoxic factors of occupational environment” (3 hrs.).....	53
9.5. Questions for the seminar “Potentials of radiological investigation of the organs of the urinary system” (4 hrs.).....	54

## 1. General information

**Supervisor of the module:** Prof. habil. dr. Konstancija Jankauskienė, Department of Physiology ([patfiz@kmu.lt](mailto:patfiz@kmu.lt))

**Coordinator of the module:** lect. dr. Vilma Jurkštienė, Department of Physiology ([patfiz@kmu.lt](mailto:patfiz@kmu.lt))

### Subjects and responsible persons:

Anatomy (assoc.prof. Vidmantas Aželis, e-mail: [vidmantas.azelis@med.kmu.lt](mailto:vidmantas.azelis@med.kmu.lt), assist. Saulius Rutkauskas, tel. 869838701)

Human Histology and Embryology (prof. Angelija Valančiūtė, e-mail: [angval@kmu.lt](mailto:angval@kmu.lt), tel.327210, assoc. prof. Ingrida Balnytė, tel 327282, lect. Jolita Palubinskienė, tel 327235)

Biochemistry (prof. L.Ivanovienė, 327323, e-mail: [ivanoviene@med.kmu.lt](mailto:ivanoviene@med.kmu.lt), prof. Vilmante Borutaitė, tel. 302968)

Physiology (prof. Egidijus Kėvelaitis, e-mail: [ekeve@med.kmu.lt](mailto:ekeve@med.kmu.lt), assoc. prof. Rimvydas Miliuskas, e-mail: [milius@med.kmu.lt](mailto:milius@med.kmu.lt), tel.327285)

Pathological Physiology (prof. Anatolijus Kondrotas, e-mail: [a.j.kondrotas@med.kmu.lt](mailto:a.j.kondrotas@med.kmu.lt), lect. dr. Darijus Skaudickas, [sdarijus@one.lt](mailto:sdarijus@one.lt), assist. Dalia Akramienė, [dalia.akramiene@takas.lt](mailto:dalia.akramiene@takas.lt), tel. 327258)

Pathological Anatomy (prof. Romualdas Gailys, e-mail: [patanat@kmu.lt](mailto:patanat@kmu.lt), prof. Vaiva Lesauskaitė, tel. 326865)

Essentials of Medical Diagnosis (assoc. prof. Palmira Leišytė, e-mail: [pleisyte@gmail.com](mailto:pleisyte@gmail.com), lect. dr. Eglė Kalinauskienė, tel. 306093)

Radiology (lect. Dalia Mitraitė, e-mail: [mitrdali@gmail.com](mailto:mitrdali@gmail.com), tel.327047, 868683106)

General Surgery of the Organs of the Urinary System (lect. dr. Juozas Juočas, e-mail: [juozasjuocas@hotmail.com](mailto:juozasjuocas@hotmail.com), lect. dr. Saulius Bradulskis, assist. Remigijus Žiugžda, tel. 306066)

Environmental and Occupational Medicine (assoc.prof. Rūta Ustinavičienė, e-mail: [aplinkos.katedra@med.kmu.lt](mailto:aplinkos.katedra@med.kmu.lt), tel. 327360)

Pharmacology (lect. dr. Rimas Jankūnas, e-mail: [farma@kmu.lt](mailto:farma@kmu.lt), tel. 327242)

## **2. General contents of the module**

Analyzing the problems of this module the students gain new knowledge and apply it to the following domains:

- Anatomy of the organs of the urinary system, blood circulation and innervation;
- Histology of the organs of the urinary system;
- Physiology of the organs of the urinary system;
- Kidney supply with the energy;
- Urine filtration and concentration in the kidneys;
- Reabsorption of electrolytes, glucose and amino acids in the kidneys;
- Role of the kidneys in the control of blood pH;
- Control of water balance in human organism;
- Disorders of the urinary system and their pathophysiological mechanisms;
- Pathological anatomy of diseases and syndromes of the urinary system;
- Fundamentals of examination of the organs of the urinary system;
- Homeostasis correction of surgical patients, hemocorrectors;
- Essentials of drug pharmacology affecting the organs of the urinary system.

### **3. Aim and objectives of the module**

The student after have studied this module must know how to define, analyze, explain and relate phenomena to the cases analyzed in the module. Attaining this aim, students must gain knowledge about the kidney structure, function and disorders in pathological condition, mechanisms and principles of their examination and treatment.

- Kidneys as an organ of homeostasis maintenance (anatomy, morphology, and physiology of the organs of the urinary system);
- Transport function of renal tubules and disorders of this function: transport disorders of calcium, phosphate, sodium, potassium and water; mechanism of action of diuretics; concentration of the urine in the kidneys; acid-base balance;
- Reabsorption of electrolytes, glucose and amino acids in the kidneys;
- Pathogenesis of the consequences caused by hyperhydration and dehydration; consequences of water intoxication. Etiology of edema and mechanisms of its pathogenesis;
- Disorders of body homeostasis in surgical diseases and causes of endogenous intoxication, principles of body detoxication and treatment;
- Etiology of glomerulonephritis, pathogenesis, disorders of the body function, morphological changes and principles of treatment;
- Etiology of nephrolithiasis, pathogenesis, morphological changes, techniques of examination and principles of treatment;
- Etiology of renal failure, pathogenesis, disorders of the body function, morphological expressions and principles of treatment;
- Pathogenetic mechanisms of the disorders of the urinary system with prostate hyperplasia, morphological changes, examination, principles of treatment.

## 4. Tutorials

### 4.1. Case 1. Low weight of the baby

J.Z., a 25-year-old female with her 3 months old baby (boy) visited the pediatrician for a routine checkup. The baby was full-termed, the course of delivery was normal, the baby's current weight is 3 380 g. The boy is the second child in the family; he has a 2-year-old sister. As the mother notes, the boy's behavior differs from that of his sister when she was at his age. The boy eats poorly (he is nursed with breast milk) and constantly falls asleep while being fed. During the examination the physician observed: small weight (4 100 g at 3 months of age) and tachypnea. No other irregularities were observed. Despite the recommendations to continue nursing, the condition has not improved. Therefore, the boy was hospitalized because acid-base disorder was suspected.

Blood tests:  $\text{Na}^+$  138 mmol/l (normal 135-148),  $\text{K}^+$  2.5 mmol/l (normal 3.1-4.6), chlorides 110 mmol/l (normal 95-105), urea 3.5 mmol/l (normal 2.0-7.2 for children up to 1 year), creatinine 32 mmol/l (normal 19-54 for children up to 1 year), blood pH 7.29 (normal 7.33-7.45 in arterial blood, 7.36-7.42 in venous blood). Partial pressure  $\text{CO}_2$  3.59 kPa (normal 4.2-6), bicarbonates 12 meq/l (normal 23-30).

Urine test: specific gravity 1.006 (1.015-1.020), pH 7, proteins, nitrites, leukocytes, glucose were not detected.

*What are the causes and mechanisms of low weight of the baby?*

*Explain the findings: pH, partial pressure  $\text{CO}_2$  and bicarbonate.*

*What are potential outcomes of acid-base disorder and principles of that disorder elimination?*

**Concept of the problem.** Regulation of blood pH.

**Clinical symptoms.** Low weight of the baby.

### **Aim**

To understand and explain the etiology of acid-base disorder, pathogenesis and principles of correction.

### **Learning objectives and contents**

To complete an analysis of this problem the student must know:

- Macroscopic structure of the kidneys, ureters, blood supply and innervation of the urinary systems.

**Subject – Anatomy**

**Institute of Anatomy**

**References:**

Gray's anatomy. The anatomical Basis of clinical Practice. Elsevier Churchill Livingstone. 2005, p. 320-327, 397-398.

**Additional readings:**

1.Gray's anatomy. The anatomical Basis of clinical Practice. Elsevier Churchill Livingstone. 2005, p. 1273-1284.

2. Anatomie des Menchen 1. (Ersten Teil) A.Waldeyer, A.Mayet. Walter de Grueter Berlin. New York 1987, p. 255-262.

3. Anatomy. A. Regional Atlas of the Human Body. Carmine D.Clemente. Lippincott Williams and Wilkins. Philadelphia. Baltimore. 2007, p. 241-249.

4. Waldeyer Anatomie des Menchen. Walter de Gruyter. Berlin. New York. 2003, p.1003-1013.

- Histological structures of the kidneys involved in formation of the urine, of water and Na<sup>+</sup> ionis balance and pH regulation.

**Subject – Human Histology and Embryology**

**Department of Histology and Embryology**

**References:**

1. Basic Histology, Luiz Carlos Junqueira, Jose Carneiro 2005, 11<sup>th</sup> Edition, p. 373-392.

2. Wheater's Functional Histology, fourth edition 2000, Barbara Young, John W.Heath, p. 286-309.

3. Human Histology, third edition. 2003 Alan Stevens, James S.Lowe, p. 293-321.
4. Concise histology, second edition. 2003 Bloom, Fawcett's, p. 237-246.
5. Color Textbook of Histology, second Edition, 2001, Leslie P.Gartner, James L.Hiatt.

**Additional readings:**

1. Digital atlas of Fathead Minnow Histology: Sensory organs-Renal

[www.aquaticpath.umd.edu/fhm/renal.html](http://www.aquaticpath.umd.edu/fhm/renal.html)

2. Ed's Histology Notes: Adrenal, Kidney, Bladder

[www.pathguy.com/urinehis.htm](http://www.pathguy.com/urinehis.htm)

3. Kidneys-Kidney Histology

[www.kidneydiseases.about.com/od/kidneys101/a/Article0045.htm](http://www.kidneydiseases.about.com/od/kidneys101/a/Article0045.htm)

4. Distal convoluted tubule-Wikipedia, the free encyclopedia

[www.wikipedia.org/wiki/Distal\\_convoluted\\_tubule](http://www.wikipedia.org/wiki/Distal_convoluted_tubule)

5. Renal Home page

Functional Histology of the Kidney Tubules

[www.137.122.151.31/medicine-histology/English/Renal/Default.htm](http://www.137.122.151.31/medicine-histology/English/Renal/Default.htm)

- To understand the mechanisms of acid-base balance maintenance and causes of their disorders.

**Subject – Biochemistry**

**Department of Biochemistry**

**References:**

1. Gas transport and pH regulation. In book MD. Devlin. Textbook of biochemistry with clinical correlations. Wiley-Liss; 4<sup>th</sup> ed, 1997. p. 1036-1052.
2. Wills' Biochemical basis of medicine, 3<sup>rd</sup> ed. B.Gillham, D.K.Papachristodoulou, J.H.Thomas, Butterworth-Heinemann, 1997, p.238-241.

**Additional readings:**

1. Marks basic medical biochemistry: a clinical approach, 2<sup>nd</sup> C Smith, AD Marks, DB.M Lieberman. Ed, Lippincott Williams&Wilkins, 2005, p. 41-53.
2. Clinical chemistry, 5<sup>th</sup> WJ Marshal, SK Bangert, ed. Mosby, 2004, p. 41-61.
3. Pathophysiology of disease: introduction to clinical medicine, 4th ed. SJ McPhee, VR Lingappa, WF Ganong. Lange Medical books/McGraw-Hill, 2003, p. 459-460.

- Mechanisms of bicarbonate reabsorption in the proximal tubules and in the loop of Henle, mechanisms of reabsorption and secretion in the collecting ducts, mechanisms of hydrogen ion secretion, mechanisms of ammonia reserve formation and transport in the loop of Henle and the collecting tubules, its impact on acidity of excreted substances.

**Subject – Physiology**

**Department of Physiology**

**References:**

W.F.Ganong. Review of Medical Physiology. McGraw-Hill Companies. 22<sup>nd</sup> ed., 2005. p. 720-723.

- Etiology of metabolic and respiratory acidosis and alkalosis, pathogenesis and compensatory mechanisms.

**Subject – Pathological Physiology**

**Department of Physiology**

**References:**

1. Pathophysiology, third edition, L.E.C. Capstead, J.L. Banasik, 2005; p. 675-679, 742.
2. Pathophysiology (The Biologic Basic for Disease in Adults and children), fifth edition, K.L. McCance, S.E. Huether, 2006, p. 113-119, 711-714, 724-725.

- Classification principles of kidney diseases and syndromes and their pathological anatomy. Interpretation of macroscopic and microscopic kidney changes in regulation of pH balance.

**Subject – Pathological Anatomy**

**Department of Pathological Anatomy**

**References:**

Robbins and Cotran Pathologic Basis of Disease, 7th Edition. V. Kumar, A.K. Abbas, N. Fausto, Elsevier Saunders 2005, p. 956-961.

- Etiology and pathogenesis of acid-alkaline balance disturbances in surgical patients. Types, methods for detection, principles of correction.

**Subject – General Surgery**

**Clinic of General Surgery**

**References:**

Principles of surgery. Fifth edition. Schwartz, Shires, Spencer, Storer, McGraw-Hill Book Company; 1996. p. 65-70,75-87.

**Additional readings:**

1. Principles and practice of Surgery. Garden O.J., Bradbury A.W., Forsythe J., Haddock G. Churchill Livingstone; 2002. p.18-19.
2. Surgery. Jarrell Bruce E., Carabasi R. Antody Pennsylvania, USA: Harwal Publishing Company; 1986. p.17-19.

## 4.2. Case 2. Edema of the body

B.Z., a 55-year-old heavily smoking patient, a week ago suddenly developed the symptoms of loss of perception and increase of weight. During physical examination swelling of the body is observed, and disorder of perception is determined.

Laboratory blood tests:  $\text{Na}^+$  118 mmol/l (normal 135-148), plasma osmolarity 242 mosm/kg  $\text{H}_2\text{O}$  (normal 290). Urine test:  $\text{Na}^+$  60 mmol/l and urine osmolarity 450 mosm/kg  $\text{H}_2\text{O}$ .

The physician advised the patient to limit water intake (less than 1 liter per day). Despite the recommendations, after a week the patient complained of perception disorders, nausea and vomiting. Laboratory tests:  $\text{Na}^+$  119 mmol/l, osmolarity 245 mosm/kg  $\text{H}_2\text{O}$ .

During the X-ray examination the increase of pulmonary size was determined.

*Explain the etiology and pathogenesis of the disorder.*

*Explain the clinical symptoms on the basis of laboratory findings.*

*Explain the pathogenetical mechanisms of edema.*

**Concept of the problem.** Osmoregulation.

**Clinical symptoms.** Accumulation of water and increase of body weight.

### **Aim**

To learn the causes of water balance disorders, positive water balance and principles of its correction.

### **Learning objectives and contents**

To complete an analysis of this problem the students must know:

- Renal histological structures involved in water, Na<sup>+</sup> ion balance, control of blood pressure, hormonal regulation of these processes. Processes of water and Na<sup>+</sup> ion balance maintenance taking place in the kidneys.

### **Subject – Human Histology and Embryology**

#### **Department of Histology and Embryology**

#### **References:**

1. Basic Histology, Luiz Carlos Junqueira, Jose Carneiro 2005, 11<sup>th</sup> Edition, p. 373-392.
2. Wheater's Functional Histology, fourth edition 2000, Barbar Young, John W.Heath, p. 286-309.
3. Human Histology, third edition. 2003 Alan Stevens, James S.Lowe, p. 293-321.
4. Concise histology, second edition. 2003 Bloom, Fawcett's, p. 237-246.
5. Color Textbook of Histology, second Edition, 2001,Leslie P.Gartner, James L.Hiatt.

#### **Additional readings:**

1. Digital atlas of Fathead Minnow Histology: Sensory organs-Renal

[www.aquaticpath.umd.edu/fhm/renal.html](http://www.aquaticpath.umd.edu/fhm/renal.html)

2. Blue Histology-Urinary System.

[www.lab.anhb.uwa.edu.au/mb140/CorePages/Urinary/urinary.htm](http://www.lab.anhb.uwa.edu.au/mb140/CorePages/Urinary/urinary.htm)

3. Ed's Histology Notes: Adrenal, kidney, Bladder

[www.pathguy.com/urinehis.htm](http://www.pathguy.com/urinehis.htm)

4. Kidneys-Kidney Histology

[www.kidneydiseases.about.com/od/kidneys101/a/Article0045.htm](http://www.kidneydiseases.about.com/od/kidneys101/a/Article0045.htm)

- Mechanisms of water and electrolyte balance maintenance and causes of their disorders.

## **Subject – Biochemistry**

### **Department of Biochemistry**

#### **References:**

1. Harper's Biochemistry. 24<sup>th</sup> ed. R.K.Murray, D.K. Granner, P.A.Mayes, V.W.Rodwell. Prentice-Hall International, 1996, p.530-532; 549; 557-559.
2. Basic medical biochemistry: a clinical approach. DB. Marks, AD. Marks, CM. Smith. Williams & Wilkins, 1996, p. 719-725

#### **Additional readings:**

1. Clinical chemistry, 5<sup>th</sup> ed., Mosby. WJ Marshal, SK Bangert 2004, p. 13-39.
  2. Textbook of biochemistry with clinical correlations. MD Devlin. Wiley-Liss; 6<sup>th</sup> ed, 2006, p. 920-921, 925-935.
- Body osmoregulation, the role of osmo- and baroreceptors in this process, mechanisms of vasopressin secretion; impact of vasopressin on transport of water and its basic principles of physiological activity; specificity of sodium and water transport in separate renal tubules; urea recirculation and mechanisms of its transport; mechanisms of urine concentration and dilution, role of vasopressin in these processes.

## **Subject – Physiology**

### **Department of Physiology**

#### **References:**

W.F.Ganong. Review of Medical Physiology. McGraw-Hill companies, 22<sup>nd</sup> ed., 2005. p.713-720.

- Pathogenesis of consequences caused by hyperhydration and dehydration, consequences of water intoxication, etiology and pathogenesis of edema mechanisms.

## **Subject – Pathological Physiology**

### **Department of Physiology**

#### **References:**

1. Pathophysiology, third edition, L.E.C. Capstead, J.L. Banasik, 2005; p. 393, 395, 653-657, 882.
2. Pathophysiology (The Biologic Basic for Disease in Adults and children), fifth edition, K.L. McCance, S.E. Huether, 2006, p. 95-102.

- Changes of renal structures that result from disorders of water balance.

**Subject – Pathological Anatomy**

**Clinic of Pathological Anatomy**

**References:**

Robbins and Cotran Pathologic Basis of Disease, 7<sup>th</sup> Edition. V.Kumar, A.K.Abbas, N.Fausto. Elsevier Saunders 2005. p.37-38, 560-561.

- Etiology and pathogenesis of body fluid and electrolyte balance disturbances in surgical patients. Types, methods for detection, principles of correction.

**Subject – General Surgery**

**Clinic of General Surgery**

**References:**

Principles of surgery. Fifth edition. Schwartz, Shires, Spencer, Storer. McGraw-Hill Book Company; 1996. p. 65-70;75-87.

**Additional readings:**

1. Principles and practice of Surgery. Garden O.J., Bradbury A.W., Forsythe J., Haddock G. Churchill Livingstone; 2002. p.10-18.
2. Surgery. Jarrell Bruce E., Carabasi R. Antony. Pennsylvania, USA: Harwal Publishing Company; 1986. p.15-17;18-22.

### 4.3. Case 3. Blood in urine

A.J., a 38-year-old patient, having arrived at the emergency room complains of an intense pain (colic) in the right lumbar area that spreads down into the groin. The pain developed suddenly at night, woke him up and lasted for about 40 minutes. The pain was intermittent. The patient didn't mention either painful, more frequent micturition, or fever and chills. The patient was nauseous, vomiting, there was some blood noticed in the urine. It was discovered from the anamnesis that the patient had been suffering from a nervous stress, smoked heavily, drank a lot of coffee, and had inadequate nutrition. He denies taking alcohol or drugs. According to the familial anamnesis his father and his father's grandfather suffered from nephrolithiasis, and the mother had arterial hypertension.

Objectively – positive Jordan's symptom on the right side. Spasmolytic drugs relieve pain.

Temperature – 37.0°C; respiration rate – 22 breaths/min., arterial blood pressure – 145/90 mm/Hg, pulse rate – 100 beats/min.

Laboratory blood test: Hb – 148 g/l; erythrocytes. –  $5.0 \times 10^{12}/l$ ; leukocytes. –  $12 \times 10^9/l$ .

Laboratory urine test - 200 erythrocytes in the visual field (hematuria).

Echoscapy readings – collector system of the right kidney is extended up to 4.0 cm in width.

X-ray examination: the shadow of concrement detected in the third part of the right ureter.

*Explain the pathophysiological mechanisms of the pain and changes in the urine.*

*What pathological processes do you think are involved, and what diagnostic tests would be the most informative?*

*What are the potential complications and causes of death, if there are any, what are they and what are the main principles of treatment?*

**Concept of the problem.** Formation of calculi in the urinary system.

**Clinical symptoms.** Pain in the lumbar area, hematuria.

### **Aim**

To learn the structure of the ureters, their constricted sites, innervation. To understand histophysiology of urine formation and to relate histophysiological variations of renal histological structure to the development of nephrolithiasis, techniques of patients examination, principles of treatment.

### **Learning objectives and contents**

To complete an analysis of this problem the students must know:

- Peculiarities of renal innervation.

#### **Subject – Anatomy**

##### **Institute of Anatomy**

##### **References:**

Gray,s anatomy for students. Richard L. Drake, Wayne Vogl, Adam W.M. Mitchel. Elsevier Churchill Livingstone. 2005, p. 323-324, 330.

##### **Additional readings:**

Clinical anatomy for Medicine Students. Smell R.S. 1990. p. 162, 224-228, 261, 311.

- To know what structures are involved in water absorption and urine formation and relate to occurrence of nephrolithiasis.

#### **Subject – Human Histology and Embryology**

##### **Department of Histology and Embryology**

##### **References:**

1. Basic Histology, Luiz Carlos Junqueira, Jose Carneiro 2005, 11<sup>th</sup> Edition, p. 373-392.
2. Wheater's Functional Histology, fourth edition 2000, Barbar Young, John W.Heath, p. 286-309.
3. Human Histology, third edition. 2003 Alan Stevens, James S.Lowe, p. 293-321.
4. Concise histology, second edition. 2003 Bloom, Fawcett's, p. 237-246.
5. Color Textbook of Histology, second Edition, 2001,Leslie P.Gartner, James L.Hiatt.

- Mechanisms of transport in the renal tubules, role of basolateral membrane in the transport in the renal tubules, role of basolateral membrane in the transport, mechanisms of secretion and reabsorption in the kidney.

**Subject – Physiology**

**Department of Physiology**

**References:**

W.F.Ganong. Review of Medical Physiology. McGraw-Hill Companies. 21<sup>th</sup> ed., 2005. p. 708-713.

- Causes of nephrolithiasis, mechanisms calculi formation. Variations of urine composition with nephrolithiasis and other kidney diseases.

**Subject – Pathological Physiology**

**Department of Physiology**

**References:**

1. Pathophysiology, third edition, L.E.C. Capstead, J.L. Banasik, 2005; p. 719-722, 741-742, 1366-1367.
2. Pathophysiology (The Biologic Basic for Disease in Adults and children), fifth edition, K.L. McCance, S.E. Huether, 2006, p. 1291-1294, 1301-1304.

- Kinds of urinary calculi, changes caused by urinary nephrolithiasis, complications and potential cause of death.

**Subject – Pathological Anatomy**

**Clinic of Pathological Anatomy**

**References:**

Pathologic Basis of Disease 7th Edition. V. Kumar, A.K. Abbas, N. Fausto. Robbins and Cotran Elsevier Saunders 2005. p.1014-1015.

- Techniques of examination of the patients with diseased organs that excrete urine (anamnesis, inspection, palpation, percussion, tapping) and their application to the detection

of nephrolithiasis. Standards of the urine tests and pathological values of quantitative and qualitative changes.

## **Subject – Essentials of Medical Diagnostics**

### **Clinic of Internal Diseases**

#### **References:**

1. Propedeutics to Internal medicine. Compiled by Egidijus Bacevicius. Kaunas, 1998, p.217, 226-227.
2. Principles of Internal Medicine. A Fauci, E Braunwald, K.J Isselbacher et al. 14th edition Harrison's Volume 2, International Edition, 1998.p. 1495-1578

#### **Additional readings:**

1. Clinical Examination. Second Edition. Epstein O, Perkin G.D, de Bono D.P et al. 2001. p. 181-182, 191-192, 204-206.
2. <http://www.emedicine.com/med/NEPHROLOGY.htm>
3. Walter, M.D. Siegenthaler (Author), A. Aeschlimann (Contributor), E. Baechli (Contributor), C. Bassetti (Contributor), E. Battegay. Differential Diagnosis in Internal Medicine: From Symptom to Diagnosis 2007.
  - Radiological techniques in the examination of the kidneys, in diagnosing nephrolithiasis, assessment of the examination findings, echoscopy, techniques of ultrasound examination of the kidneys and bladder in diagnosing nephrolithiasis.

## **Subject – Radiology**

### **Clinic of Radiology**

#### **References:**

1. Textbook of radiology and imaging. 7th ed. Sutton D. Churchill Livingstone; 2003. Volume 2. p. 918, 965-71,997-98. (at the department)
2. The urinary tract. In: Rumack CM, Wilson SR, Charboneau JW, editors. Diagnostic ultrasound. 3d ed. Thurston W, Wilson SR. St Louis: Elsevier Mosby; 2005. Volume 1. p. 344-50. (at the department)

#### **Additional readings:**

Differential diagnosis in conventional radiology. 2nd ed. Thieme. Burgener FA, Korman M, editors.; 1991. p.777-823. (at the department).

#### **4.4. Case 4. Color of the urine like “Coca-cola”**

Patient A.S., a 8 years old girl, is brought to the physician because of fever, nausea, oliguria, puffy skin around the eyes, frequent micturition and the color of the urine similar to the drink “Coca-cola”.

Her mother states that the daughter is a healthy child. The mother said that two weeks ago the girl had returned from school with a sore throat. Therefore, she didn't attend classes for two days and afterwards medical advice was sought.

Examination – temperature 39°C; arterial blood pressure – 130/84 mm Hg, respiration and pulse rate is normal. Periorbital edema of the tissues is observed, and a pain in the lumbar area is present. Laboratory blood test: the amount of urea and creatinine level are slightly increased; reduced C<sub>3</sub> and cryoglobulin concentration and an elevated antistreptolysin O(ASO) titer. Analysis of urine reveals mild proteinuria (to 3 g/l) and hematuria (100 erythrocytes in the visual field).

*What pathology could be thought of and what tests might be the most informative?*

*In what way is the immune system involved in the etiology of kidney damage and what is the pathophysiological mechanism of pathology occurrence?*

*What are the potential complications, are there any potential causes of death, if any, what are they and what are the main principles of treatment?*

**Concept of the problem.** Glomerulonephritis.

**Clinical symptoms.** Fever, proteinuria.

### **Aim**

To study the etiology of glomerulonephritis, pathogenesis, disorders of the body function, morphological changes, peculiarities of examination and principles of treatment.

### **Learning objectives and contents**

To complete an analysis of this problem the students must know the internal macrostructure of the kidneys (cortex, medulla), peculiarities of blood circulation in the kidney.

**Subject – Anatomy**

**Institute of Anatomy**

**References:**

Gray's anatomy for students. Richard L. Drake, Wayne Vogl, Adam W.M. Mitchel. Elsevier Churchill Livingstone. 2005, p. 320-340.

**Additional readings:**

Clinical anatomy for Medicine Students. Smell R.S. 1995. p.162, 224-228, 261, 311.

- To know and differentiate structural elements of the kidneys, histophysiology of the urine formation, structure and function of the urine filtration barrier.

**Subject – Human Histology and Embryology**

**Department of Histology and Embryology**

**References:**

1. Basic Histology, Luiz Carlos Junqueira, Jose Carneiro 2005, 11<sup>th</sup> Edition, p. 373-392.
2. Wheater's Functional Histology, fourth edition 2000, Barbar Young, John W.Heath, p. 286-309.
3. Human Histology, third edition. 2003 Alan Stevens, James S.Lowe, p. 293-321.
4. Concise histology, second edition. 2003 Bloom, Fawcett's, p. 237-246.
5. Color Textbook of Histology, second Edition, 2001,Leslie P.Gartner, James L.Hiatt.

- Regulation of the renal blood flow, mechanisms of glomerular filtration.

**Subject – Physiology**

**Department of Physiology**

**References:**

W.F.Ganong. Review of Medical Physiology, McGraw-Hill Companies, 22<sup>nd</sup> ed., 2005. p.702-708.

- Biochemical principles of renal function and significance to homeostasis. Biological role of urea and creatinine and molecular mechanisms of synthesis.

**Subject – Biochemistry****Department of Biochemistry****References:**

1.D.K.Papachristodoulou, J.H.Thomas, Butterworth-Heinemann, 1997, p.230-236.

2.Textbook of biochemistry with clinical correlations. Wiley-Liss; 4<sup>th</sup> ed. Devlin MD. 1997, p. 1043-1052

**Additional readings:**

1.Textbook of biochemistry with clinical correlations. Wiley-Liss; 6<sup>th</sup> ed. Devlin MD. 2005.

2.Medical biochemistry. Mosby; 2<sup>nd</sup> ed. Baynes JW, Dominiczak MH. 2004.

- Changes of the urine amount and composition with glomerulonephritis. Autoimmune renal diseases, their etiology and pathogenesis.

**Subject – Pathological Physiology****Department of Physiology****References:**

1. Pathophysiology, third edition, L.E.C. Capstead, J.L. Banasik, 2005. p. 256-257, 725-730..

2. Pathophysiology (The Biologic Basic for Disease in Adults and children), fifth edition, K.L. McCance, S.E. Huether, 2006. p. 251, 1315-1320, 1342-1343.

- Morphological changes developed in glomerulonephritis, classification of glomerular lesions, terminology; peculiarities of clinical-morphological glomerulonephritis, peculiarities of its course, causes of death.

**Subject – Pathological Anatomy****Clinic of Pathological Anatomy**

**References:**

Pathologic Basis of Disease 7th Edition. Robbins and Cotran V. Kumar, A.K. Abbas, N. Fausto. Elsevier Saunders 2005. p. 966-982, 984-985, 987-1001.

- Techniques of examination of the patients with diseases of the urinary system (anamnesis, inspection, palpation, percussion, tapping) and their application to the detection of nephritic syndrome. Main symptoms of nephritic syndrome.

**Subject – Essentials of Medical Diagnosis****Clinic of Internal Diseases****References:**

1. Propedeutics to Internal medicine. Compiled by Egidijus Bacevicius. Kaunas, 1998, p.218, 224-228, 235-236.
2. Principles of Internal Medicine. A Fauci, E Braunwald, K.J Isselbacher et al. 14th edition Harrison's Volume 2, International Edition, 1998.p. 1495-1578

**Additional readings:**

1. Clinical Examination. Second Edition. Epstein O, Perkin G.D, de Bono D.P et al. 2001. p. 181-182, 191-192, 204-206.
2. <http://www.emedicine.com/med/NEPHROLOGY.htm>
3. Walter, M.D. Siegenthaler (Author), A. Aeschlimann (Contributor), E. Baechli (Contributor), C. Bassetti (Contributor), E. Battegay. Differential Diagnosis in Internal Medicine: From Symptom to Diagnosis 2007.

- Drugs affecting urine excretion (diuretics), their classification taking into consideration mechanisms of action and chemical composition. The most important representatives of separate classes of medicinal preparations, their mechanisms of action, clinical effect, pharmacokinetic properties, indications, side effects.

**Subject – Pharmacology****Department of Basic and Clinical Pharmacology****References:**

1. Lecture material

2. Illustrated Reviews: Pharmacology, 3rd (2<sup>nd</sup>) edition. Mycek M. J. Champe P.C. et al. Lippincott's Philadelphia: Lippincott Williams & Wilkins 2005 (2000). p. 16-18 (23-25) (20 books available at the department).

3. Pharmacology. Fifth edition. Rang H.P. Dale M.M. et al. Edinburgh: Churchill Livingstone 2003. p. 352-366.

4. Basic and Clinical Pharmacology Seventh Edition. Katzung B.G. Stamford: Appleton & Lange 1998. p. 242-259 (available at the department).

- Techniques of ultrasound examination of the kidneys in diagnosing glomerulonephritis, clinical values of findings of ultrasound examination of the kidneys.

**Subject – Radiology**

**Clinic of Radiology**

**References:**

The urinary tract. In: Rumack CM, Wilson SR, Charboneau JW, editors. Diagnostic ultrasound. 3d ed. Thurston W, Wilson SR. St Louis: Elsevier Mosby; 2005. Volume 1, p.380-82.

#### 4.5. Case 5. Sweet urine

A.B., an 82-year-old female with chronic diabetes mellitus seeks medical help because of shortness of breath and palpitation. Her niece explained the course of the patient's disease. It was discovered that hemodialysis had been performed three times a week over three recent years. Type II diabetes mellitus was determined when she was 49, and currently she takes insulin. From the family anamnesis (medical history) it turned out that her sister, brother and mother's grandfather suffered from diabetes mellitus as well. Hemodialysis was performed on her mother for the first time when she was 65, and after 10 years she died of renal failure. Her grandfather died from a heart attack aged 62.

Examination: temperature 40°C, respiration rate 23 breaths/min, arterial blood pressure 155/91 mmHg, pulse rate 102 beats/min. The patient is obese, she looks her age. Respiration in the apex of the right lung is weakened, rales are auscultated, friction of pericardium is present on the left and lower lateral side of the breastbone. Cyanosis is not observed, there are no edema in the limbs except subcutaneous edema in both knee joints.

Laboratory blood tests: glucose 15.57 mmol (normal 3.33-5.55), Na<sup>+</sup> – 146 mmol/l, K<sup>+</sup> – 5.2 mmol/l, Cl<sup>-</sup> – 90 mmol/l, HCO<sub>3</sub><sup>-</sup> – 5 mmol/l, urea – 39 – 27 mmol/l and creatinine 442 μmol/l; Hb 80 g/l; Ht 0.24, thrombocytes – 150×10<sup>9</sup>/l, blood culture × 2: E. Coli sensitivity is not determined; urine test – glucose +++, no ketones, proteins+, nitrites+, leukocyte esterase+, blood 2+, a lot of precipitates.

*Explain the causes of chronic renal failure, the disorders of body function and morphological expressions.*

*What are the potential complications of other organs and their systems and causes of death?*

*Principles of treatment in renal failure and its effects on pharmacokinetics and pharmacodynamics.*

**Concept of the problem.** Renal failure.

**Clinical symptoms.** Uremia, glucosuria.

### **Aim**

To learn the structure of the glomerular filtration barrier and histological physiology and relate it to the occurrence of the analyzed pathology;

To learn the causes and pathogenesis of renal failure, techniques of examination and principles of treatment.

### **Learning objectives and contents**

To complete an analysis of this problem the students must know:

- Regulation of Na<sup>+</sup> excretion. Regulation of extracellular fluid composition and volume. Effects of disordered renal function.

### **Subject – Physiology**

#### **Department of Physiology**

#### **References:**

W.F.Ganong Review of Medical Physiology. McGraw-Hill Companies, 22<sup>nd</sup> ed., 2005. p. 723-726, 729-730.

- Causes and pathogenesis of renal failure. Changes in the balance of body fluids and electrolytes, in the skin, skeleton, blood, and in the cardiovascular, immune and nervous systems in chronic renal failure.

### **Subject – Pathological Physiology**

#### **Department of Physiology**

#### **References:**

1. Pathophysiology, third edition, L.E.C. Capstead, J.L. Banasik, 2005. p. 734-753.
2. Pathophysiology (The Biologic Basic for Disease in Adults and children), fifth edition, K.L. McCance, S.E. Huether, 2006. p. 1322-1331.

- Pathogenesis and morphology of uremic syndrome, causes of death, complications of hemodialysis.

**Subject – Pathological Anatomy**

**Clinic of Pathological Anatomy**

**References:**

Pathologic Basis of Disease 7th Edition. Robbins and Cotran V. Kumar, A.K. Abbas, N. Fausto. Elsevier Saunders 2005. p. 653, 960-961, 989-990, 1304.

- Techniques of examination of the patients with diseases of the urinary system (anamnesis, inspection, palpation, percussion, tapping) and their application to the detection of renal failure syndrome.

**Subject – Essentials of Medical Diagnosis**

**Clinic of Internal Diseases**

**References:**

1. Propedeutics to Internal medicine. Compiled by Egidijus Bacevicius. Kaunas, 1998, p.215-241.
2. Principles of Internal Medicine. A Fauci, E Braunwald, K.J Isselbacher et al. 14th edition Harrison's Volume 2, International Edition, 1998.p. 1495-1578

**Additional readings:**

1. Clinical Examination. Second Edition. Epstein O, Perkin G.D, de Bono D.P et al. 2001. p. 181-182, 191-192, 204-206.
2. <http://www.emedicine.com/med/NEPHROLOGY.htm>
3. Walter, M.D. Siegenthaler (Author), A. Aeschlimann (Contributor), E. Baechli (Contributor), C. Bassetti (Contributor), E. Battegay. Differential Diagnosis in Internal Medicine: From Symptom to Diagnosis 2007.

- The impact of renal failure on pharmacokinetics and pharmacodynamics; principles of drug dosage to the patients with renal failure. Drugs used to treat clinical symptoms of renal failure. To know excretion of drugs and their nephrotoxic effect.

**Subject – Pharmacology**

**Department of Basic and Clinical Pharmacology**

**References:**

Lecture material

Illustrated Reviews: Pharmacology, 3rd (2<sup>nd</sup>) edition. Mycek M. J. Champe P.C. et al. Lippincott's Philadelphia: Lippincott Williams & Wilkins 2005 (2000 ). p. 16-18 (23-25) (20 books available at the department).

**Additional readings:**

Pharmacology. Fifth edition. Rang H.P. Dale M.M. et al. Edinburgh: Churchill Livingstone 2003. p. 365-366.

- Techniques of ultrasound examination of the kidneys in diagnosis of renal failure and clinical value of findings.

**Subject – Radiology**

**Clinic of Radiology**

**References:**

1. The urinary tract. In: Rumack CM, Wilson SR, Charboneau JW, editors. Diagnostic ultrasound. 3d ed. Thurston W, Wilson SR. St Louis: Elsevier Mosby; 2005. Volume 1, p.380-82. (At the department).

#### 4.6. Case 6. Low urination flow

M.M., a 65-year-old male having visited the physician for physical examination complains of an ache in the lower abdominal area that spreads down into the perineum, weakened urination flow and more frequent urination. Symptoms of this kind occurred a year ago, and they have become more intense.

Prostate-specific antigen (PSA) 6.8 ng/ml (normal 3 ng/ml).

Echoscopia readings – prostate of 40 ml volume, residual urine 45 ml; hypoechogenic formation in the right lobe of the prostate. During palpation – the prostate is stiff, the right lobe is slightly rough.

Laboratory tests: Hb – 148 g/l; eryth.  $4.5 \times 10^{12}/l$ ; leukocytes. –  $8 \times 10^9/l$ ; Ht – 0.30.

*What pathology do you think it is, and what tests might be informative?*

*What are the pathological mechanisms of micturition disorder?*

*What are the potential complications and principles of treatment?*

**Concept of the problem.** Hyperplasia of the prostate

**Clinical symptoms.** Disorders of micturition

### **Aim**

To teach anatomical and histological peculiarities of the prostate, etiology and pathogenesis of micturition disorders, techniques of examination, principles of treatment.

### **Learning objectives and contents**

To complete an analysis of this problem the students must know:

- The structure, surfaces, lobes and skeletotopy of the prostate. The structure of the bladder and urethra, and skeletotopy.

**Subject – Anatomy**

**Institute of Anatomy**

#### **References:**

1. Gray,s anatomy for students. Richard L. Drake, Wayne Vogl, Adam W.M. Mitchel. Elsevier Churchill Livingstone. 2005, p. 378, 373, 397-407, 409-410.

#### **Additional readings:**

Clinical anatomy for Medicine Students. Smell R.S. 1990. p.262.

- Histological structure of the prostate, bladder and urethra.

**Subject – Human Histology and Embryology**

**Department of Histology and Embryology**

#### **References:**

Basic Histology, seventh edition. L.Carlos Junqueira, Jose Carneiro, Robert O.Kelley, p. 371-391.

Human Histology, third edition. Alan Stevens, James S.Lowe, 2003. p. 293-321.

Concise histology, second edition. Bloom, Fawcett's, 2003. p. 237-246.

- Mechanisms of micturition and the function of organs and systems involved in it as well as an impact of nervous and humoral factors on this regulation.

**Subject – Physiology**

**Department of Physiology**

**References:**

Review of Medical Physiology. W.F.Ganong McGraw-Hill companies. 22<sup>nd</sup> ed., 2005. p. 726-728.

- Disorders of micturition, pathophysiological mechanisms of their occurrence due to pathology of the prostate. Potential impact of the urine flow disorders on kidney pathology.

**Subject – Pathological Physiology**

**Department of Physiology**

**References:**

1. Pathophysiology, third edition, L.E.C. Capstead, J.L. Banasik. 2005. p. 801-804.
2. Pathophysiology (The Biologic Basis for Disease in Adults and children), fifth edition, K.L. McCance, S.E. Huether, 2006. p. 813-820.

- Dishormonal hyperplastic prostatopathy and morphology of the prostate tumors, complications and causes of death.

**Subject – Pathological Anatomy**

**Clinic of Pathological Anatomy**

**References:**

Robbins and Cotran Pathologic Basis of Disease 7<sup>th</sup> Edition. V.Kumar, A.K.Abbas, N.Fausto. Elsevier Saunders 2005. p. 1047-1050.

- Techniques of examination of patients with diseased urine excreting organs and their application to the detection of disordered urination syndrome.

**Subject – Essentials of Medical Diagnosis**

**Clinic of Internal Diseases**

**References:**

1. Propedeutics to Internal medicine. Compiled by Egidijus Bacevicius. Kaunas, 1998, p.215-223.
2. Principles of Internal Medicine. A Fauci, E Braunwald, K.J Isselbacher et al. 14th edition Harrison's Volume 2, International Edition, 1998,p. 1495-1578

**Additional readings:**

1. Clinical Examination. Second Edition. Epstein O, Perkin G.D, de Bono D.P et al. 2001. p. 181-182, 191-192, 204-206.

2. <http://www.emedicine.com/med/NEPHROLOGY.htm>

3. Walter, M.D. Siegenthaler (Author), A. Aeschlimann (Contributor), E. Baechli (Contributor), C. Bassetti (Contributor), E. Battegay. Differential Diagnosis in Internal Medicine: From Symptom to Diagnosis 2007.

- Techniques of ultrasound examination of the bladder and prostate in diagnosing pathology of the prostate.

**Subject – Radiology****Department – Clinic of Radiology****References:**

The urinary tract. In: Rumack CM, Wilson SR, Charboneau JW, editors. Diagnostic ultrasound. 3<sup>rd</sup> ed. Thurston W, Wilson SR. St Louis: Elsevier Mosby; 2005. Volume 1, p.395-421. (at the department)

## **5. Lectures**

### **5.1. Structure of the organs of the urinary system (2 hrs.)**

**Institute of Anatomy**

**Responsible person** – assoc.prof. V. Aželis

*Description*

Kidneys. Their skeletonotopy, lobar and horseshoe form. Descended kidney. Macrostructure of the kidneys: cortex, medulla, blood vessels, nerves. Kidney coating. Ureters: topography, structure, constrictions, blood vessels, nerves. Bladder skeletonotopy, structure, blood vessels, nerves. Bladder fixation. Urethra: its topography, structure, blood vessels and nerves. Prostate, its topography and structure, blood vessels, nerves and lymph drainage.

### **5.2. Histophysiology of the organs of the urinary system (2 hrs.)**

**Department of Histology and Embryology**

**Responsible person** – prof. A.Valančiūtė

*Description*

Development of the urinary system. Principal functions of the kidneys. Morphological structure of the kidneys. Structure of the nephron: glomerulus. Histological structure of Bowman's capsule, the nephron tubules and collecting ducts. Histological structure and function of the juxtaglomerular apparatus. Structure and function of the urine filtration barrier. Scheme of the urine formation and histological characteristics of the structure involved in it. Interstitial renal tissue. Histophysiology of the bladder and ureter.

### **5.3. Role of kidneys in homeostasis (2 hrs.)**

**Department of Physiology**

**Responsible persons** – prof. E.Kevelaitis

*Description*

Renal functions. Mechanisms of glomerular filtration, glomerular filtration rate and its determination. Clearance and its peculiarities. Function of the renal tubules. Mechanisms of urine concentration and dilution.

#### **5.4. Regulation of water and electrolyte homeostasis with hormones (2 hrs.)**

**Department of Biochemistry**

**Responsible person** – prof. L.Ivanovienė

*Description*

Structure of mineralcorticoids, synthesis, regulation of secretion, molecular mechanisms of aldosterone action, cellular targets, secretion disturbances, renin-angiotensin system, structure of vasopressin, regulation of secretion, cellular targets, molecular mechanisms of action, disturbances of secretion and action, types of atrial natriuretic peptides (ANP), secretion, molecular mechanisms of action will be analyzed. Role of antidiuretic hormone (vasopressin) in regulation of water balance. Molecular mechanism of antidiuretic hormone action.

#### **5.5. Disorders of renal functions. Changes in urine excretion and composition. Acute and chronic renal failure, etiology, mechanisms of pathogenesis, disorders of body functions (2 hrs.)**

**Department of Physiology**

**Responsible persons** – prof A.Kondrotas, assist. D.Akramienė

*Description*

Disorders of renal function, their etiology, consequences. Filtration disorders of renal glomeruli. Changes in urine excretion and composition. Acute and chronic renal failure, etiology, mechanisms of pathogenesis, disorders of body function.

## **5.6. Structural principles of homeostasis and pathology of the organs of the urinary system (2 hrs.)**

**Department of Pathological Anatomy**

**Responsible persons** – prof. R.Gailys

*Description*

Principles of classification of diseases and syndromes of the urinary system. Morphological expressions of the most common lesions of diseases of the urinary system, complications and causes of death. Morphology of renal failure syndrome. Pathological anatomy of hemodialysis.

## **5.7. Environmental factors, influencing homeostasis and renal function (2 hrs.)**

**Department of Environmental and Occupational Medicine**

**Responsible person** – assoc.prof. R.Ustinavičiene

*Description*

Environmental factors (physical, chemical) influencing human body homeostasis and the urinary system.

## **5.8. Examination of the patients with diseases of the urinary system. Laboratory and instrumental diagnosis. Main clinical syndromes (2 hrs.)**

**Clinic of Internal Diseases**

**Responsible person** – assoc. prof. P. Leišytė

*Description*

Examination of the patients with diseases of the urinary system. The most important aspects of anamnesis and objective examination. Principal laboratory and instrumental tests. Main clinical, morphological and functional syndromes.

## **5.9. Preparation of a surgical patient for an operation, correction of homeostasis. Hemocorrectors (2 hrs.)**

**Clinic of General Surgery**

**Responsible persons** – lect. S.Bradulskis

*Description*

Kinds of body homeostasis disorders. Etiology and pathogenesis of water, electrolyte, acid-base disorder in surgical diseases, types, ways of determination, principles of correction. Corrections and principles of replacement and maintenance therapy. Hemocorrectors.

## **5.10. Radiological diagnostics of the kidney, bladder and prostate disorders (2 hrs.)**

**Department – Clinic of Radiology**

**Responsible person** – lect. dr. D.Mitraitė

*Description*

Radiological imaging of the organs of the urinary system. Comparative value of various techniques – radiography, echoscopy, computerized tomography, scintigraphy, angiography – in diagnostics of diseases of the urinary system.

Impact and significance of intravenous contrast media in radiological examination of the kidneys.

Early radiological diagnostics of oncological diseases of the urinary system.

Application of the most modern technologies to the radiological diagnostics of the urinary system.

## **5.11. Intake of drugs in chronic renal failure (2 hrs.)**

**Department of Basic and Clinical Pharmacology**

**Responsible person** – lect. R.Pilviniė

*Description*

An impact of renal function failure on drug pharmacokinetics and pharmacodynamics. Principles of drugs dosage to the patients with renal failure are explained. Mechanisms of drug excretion through the kidneys are analyzed. Information about nephrotoxic effect of drugs is presented.

## **5.12. Drugs affecting urine excretion –diuretics (2 hrs.)**

**Department of Basic and Clinical Pharmacology**

**Responsible person** – lect. R. Pilviņiene

### *Description*

Diuretics - drugs stimulating the urine excretion. Five main groups of diuretics: carbonic anhydrase inhibitors, osmotic diuretics, loop diuretics, thiazides, aldosterone antagonists are described. Mechanism of action of each drug group, site of effect and triggered pharmacological effect are discussed. Information about the properties of the most important representatives of separate classes of drugs, indications and side effects are presented.

## **6. Practical work**

### **6.1. Structure and skeletotopy of the organs of the urinary system (6 hrs.)**

**Institute of Anatomy**

*Description*

Microscopic structure of the kidneys, ureters, bladder, prostate and urethra.

**References:**

Gray,s anatomy for students. Richard L. Drake, Wayne Vogl, Adam W.M. Mitchel. Elsevier Churchill Livingstone. 2005, p. 320-327, 33-340, 397-410.

### **6.2. Histology of the organs of the urinary system (3 hrs.)**

**Department of Histology and Embryology**

*Description*

Histology of the kidneys, ureters, bladder, prostate and urethra.

**References:**

1. L.C. Jungeira, J.Carneiro. Basic Histology, 2005, 11<sup>th</sup>. Ed., p. 373-391.
2. W. Kuehnel, Color atlas of Cytology, Histology and Microscopic Anatomy, 2003, 4 th ed., p. 352-374, 396-399.

### **6.3. Diseases and syndromes of the kidneys and their morphological changes (3 hrs.)**

**Clinic of Pathological Anatomy**

**Responsible persons** – prof. R.Gailys, prof. V.Lesauskaitė

*Description*

Studying electronograms, histological and macroslides and doing modeled morphological tasks the students learn morphological manifestations of diseases and syndromes of various hierarchical

structural lesions of the organs of this system (glomerulonephritis, pyelonephritis, nephrotic and uremic syndromes, urinary nephrolithiasis, tumors). Morphological expressions of diseases and syndromes, complications and potential causes of death.

**Mitochondrial swelling.** Electronogram (x32,000). Note, that mitochondria are enlarged, edematous, their cristae are fragmented and decomposed. Compare them with the normal ones.

**Glomerulonephritis.** Electronogram (x30,000). Pay attention to the changes of glomerular filter: swollen endothelium with pinocytotic vacuoles, edematous, irregularly arranged fibrillary structures basal membrane with deposits, morphological changes of foot processes of podocytes: compare these changes with the common structure of glomerular filter.

**Hydrosis et proteinosis cytoplasmatica nephrocytorum.** Histological slide (H+E). Find tiny protein granules and water vesicles in the swollen cellular cytoplasm of the renal tubular epithelium.

**Glomerulonephritis diffusa proliferativa.** Histological slide (H+E). Find changed glomeruli: thickened basic membrane of their capillaries, proliferated endothelium and capsule cells („semilunar“ form): protein cylinders and erythrocytes in tubular lumens, cytoplasmic proteinosis in the tubular epithelium.

**Pyelonephritis chronica.** Histological slide (H+E). Observe focal infiltrates of the immune cells (macrophages, lymphocytes, plasmocytes, granulocytes) in the interstitial fluid and granulocytes in the tubular lumen and scarring with atrophic tubules. Pay attention to the dilated tubules with atrophic epithelium which lumen is filled with protein-carbohydrate cylinders and sclerotic renal glomeruli, and blood vessels.

#### **References:**

Pathologic basis of Disease/eds I.L.Robbins, R.S.Cotran. 7<sup>th</sup> edition, 2005. p. 966-982, 987-1001, 1047-1050.

## **6.4. Examination of the patients with diseases of the urinary system (4 hrs.)**

### **Clinic of Internal Diseases**

#### *Description*

Anamnesis, inspection, palpation, percussion, tapping, auscultation. Laboratory and instrumental diagnostics.

#### **References:**

1. Propedeutics to Internal medicine. Compiled by Egidijus Bacevicius. Kaunas, 1998, p.215-241.
2. Principles of Internal Medicine. A Fauci, E Braunwald, K.J Isselbacher et al. 14th edition Harrison's Volume 2, International Edition, 1998.p. 1495-1578

**Additional readings:**

1. Clinical Examination. Second Edition. Epstein O, Perkin G.D, de Bono D.P et al. 2001. p. 181-182, 191-192, 204-206.
2. <http://www.emedicine.com/med/NEPHROLOGY.htm>
3. Walter, M.D. Siegenthaler (Author), A. Aeschlimann (Contributor), E. Baechli (Contributor), C. Bassetti (Contributor), E. Battegay. Differential Diagnosis in Internal Medicine: From Symptom to Diagnosis 2007.

## **6.5. Changes in homeostasis of a surgical patient (3 hrs.)**

### **Clinic of General Surgery**

#### *Description*

Normal fluid and electrolyte balance; their loss through the digestive tract, drains, burnt surface; disorders of water, Na<sup>+</sup>, K<sup>+</sup>, and acid-base balance; monitoring of a patient.

#### **References:**

Principles of surgery. Fifth edition. Schwartz, Shires, Spencer, Storer. McGraw-Hill Book Company; 1996. p.65-87.

#### **Additional readings:**

1. Principles and practice of Surgery. Garden O.J., Bradbury A.W., Forsythe J., Haddock G. Churchill Livingstone; 2002. p.10-19.
2. Surgery. Jarrell Bruce E., Carabasi R. Antony. Pennsylvania, USA: Harwal Publishing Company; 1986. p.15-22.

## **6.6. Radiological diagnostics of the kidneys, bladder and prostate diseases**

**(3 hrs.)**

### **Clinic of Radiology**

#### *Description*

Various techniques of radiological examination of the urinary system (X-ray images, ultrasound, computerized tomography, radionuclide). Usage of contrast media in the examination of the urinary system.

**References:**

1. Textbook of radiology and imaging. 7th ed. Sutton D. Churchill Livingstone; 2003. Volume 2. p. 885-928, additional reading - 929-1016. (at the department)
2. The urinary tract. In: Rumack CM, Wilson SR, Charboneau JW, editors. Diagnostic ultrasound. 3d ed. Thurston W, Wilson SR. St Louis: Elsevier Mosby; 2005. Volume 1. p. 344-59, 361-63, 376-82, 395-421 (at the department)

**Additional readings:**

1. Prokop M, Galanski M, editors. Spiral and multislice computed tomography of the body. Stuttgart - New York: Thieme; 2003. p.641-98 (at the department)
2. Differential diagnosis in conventional radiology. 2nd ed. Thieme. Burgener FA, Korman M, editors. 1991. p. 733-823. (at the department)

**6.7. Drugs affecting urine excretion (3 hrs.)**

**Department of Basic and Clinical Pharmacology**

*Description*

Diuretics. The most important representatives of separate classes of drugs. Mechanism of action, clinical effect, pharmacokinetic properties, indications, side effects.

**References:**

Lecture material

Illustrated Reviews: Pharmacology, 3rd (2<sup>nd</sup>) edition. Lippincott's Mycek M. J. Champe P.C. et al. Philadelphia: Lippincott Williams & Wilkins 2005 (2000 ). p, 257-270, (223-234). (20 books available an the department)

**Additional readings:**

Basic and Clinical Pharmacology Seventh Edition. Katzung B.G. Stamford: Appleton & Lange 1998. p. 242-260 (available at the department).

Pharmacology. Fifth edition. Rang H.P. Dale M.M. et al. Edinburgh: Churchill Livingstone 2003. p. 362-366.

## 7. Seminars

### 7.1. Hyperchloremic metabolic acidosis (3 hrs.)

#### Department of Biochemistry

##### *Description*

Concepts of metabolic acidosis and hyperchloremic metabolic acidosis, their causes and damaging effects, mechanisms of  $\text{HCO}_3^-$  reabsorption in the kidneys, which mechanisms function and in what membranes, and how this relates to the increased amount of  $\text{HCO}_3^-$  in the urine.

##### **References:**

1. Textbook of biochemistry with clinical correlations. Wiley-Liss; 4<sup>th</sup> ed. Devlin MD. 1997, p. 1041 – 1046, 1048-1052.
2. Clinical chemistry, 5<sup>th</sup> ed, Marshall WJ, Bangert SK. Mosby, 2004, p. 63-84.
3. Pathophysiology of disease: introduction to clinical medicine, 4<sup>th</sup> ed. McPhee SJ, Lingappa VR. Ganong WF. 2003, p. 430.

### 7.2. Molecular principles of ion and water reabsorption in the kidneys (2 hrs.)

#### Department of Biochemistry

##### *Description*

To understand the importance of the kidneys in homeostasis, to explain how the kidneys are supplied with energy, how reabsorption of electrolytes, glucose, amino acids takes place in the kidneys, what is a biological role of these processes.

##### **References:**

- Textbook of biochemistry with clinical correlations. Wiley-Liss; 4<sup>th</sup> ed., Devlin TM. 1997, p. 1043 – 1046.
- R.K. Murray, D.K. Granner, P.A.Mayes, V.W.Rodwell. Harper's Biochemistry. Prentice-Hall International, 1996 p.530-532, 549, 552-554, 557-559.
- Marks' Basic Medical Biochemistry. A clinical approach. 2<sup>nd</sup> edd. Smith C., Marks A.D., Lieberman M. Lippincott Williams & Wilkins, 2005, p.p. 767-770.

Pathophysiology of disease: introduction to clinical medicine, 4<sup>th</sup> ed, McPhee SJ, Lingappa VR. Ganong WF. 2003, p. 444 – 470.

### **7.3. Nephrotoxic factors of occupational environment (3 hrs.)**

#### **Department of Environmental and Occupational Medicine**

##### *Description*

Occupational factors of chemical origin, those have a toxic effect on the organs of the urinary system.

##### **References:**

Casaret and Doull's Toxicology C.D.Klaassen. 2001, p. 491-514.

### **7.4. Main clinical syndromes of the organs of the urinary system (3 hrs.)**

#### **Clinic of Internal Diseases**

##### *Description*

Syndromes: edema, renal hypertension, nephritic, nephrotic, acute and chronic renal failure.

##### **References:**

1. Principles of Internal Medicine. A Fauci, E Braunwald, K.J Isselbacher et al. 14th edition Harrison's Volume 2, International Edition, 1998.
2. Clinical Examination Second Edition. Epstein O, Perkin G.D, de Bono D.P et al. 2001.
3. <http://www.emedicine.com/med/NEPHROLOGY.htm>
4. Walter, M.D. Siegenthaler (Author), A. Aeschlimann (Contributor), E. Baechli (Contributor), C. Bassetti (Contributor), E. Battegay. Differential Diagnosis in Internal Medicine: From Symptom to Diagnosis 2007.

### **7.5. Principles of homeostasis correction of a surgical patient (3 hrs.)**

#### **Clinic of General Surgery**

##### *Description*

Hemocorrectors; correction principles of homeostasis changes.

##### **References:**

Principles of surgery. Fifth edition. Schwartz, Shires, Spencer, Storer. McGraw-Hill Book Company; 1996. p.65-87.

**Additional readings:**

1. Principles and practice of Surgery. Garden O.J., Bradbury A.W., Forsythe J., Haddock G. Churchill Livingstone; 2002. p.10-19.
2. Surgery. Jarrell Bruce E., Carabasi R. Antony. Pennsylvania, USA: Harwal Publishing Company; 1986. p.15-22.

**7.6. Radiological techniques used in the examination of the organs of the urinary system (4 hrs.)****Clinic of Radiology***Description*

Radiological techniques used in the examination of the kidneys, bladder and prostate, to evaluate clinical value of findings of various radiological examinations of the urinary system. To introduce the students with early radiological diagnostics of oncological diseases of the urinogenital system.

**References:**

1. Textbook of radiology and imaging. 7th ed. Sutton D. Churchill Livingstone; 2003. Volume 2. p. 885-928, additional reading - 929-1016. (at the department)
2. The urinary tract. In: Rumack CM, Wilson SR, Charboneau JW, editors. Diagnostic ultrasound. 3d ed. Thurston W, Wilson SR. St Louis: Elsevier Mosby; 2005. Volume 1. p. 344-59, 361-63, 376-82, 395-421 (at the department)

**Additional readings:**

1. Spiral and multislice computed tomography of the body. Prokop M, Galanski M, editors. Stuttgart - New York: Thieme; 2003. p.641-98 (at the department)
2. Differential diagnosis in conventional radiology. 2nd ed. Thieme. Burgener FA, Kormano M, editors. 1991. p. 733-823. (at the department)

**7.7. Intake of drugs in chronic renal failure (3 hrs.)****Department of Basic and Clinical Pharmacology***Description*

The influence of renal failure on drug pharmacokinetics and pharmacodynamics; principles of drug dosage to the patients with renal failure. Drug excretion. Nephrotoxic drug effect.

**References:**

1. Lecture material
2. Illustrated Reviews: Pharmacology, 3rd (2<sup>nd</sup>) edition. Mycek M. J. Champe P.C. et al. Lippincott's. Philadelphia: Lippincott Williams & Wilkins 2005 (2000) p.16-18 (23-25) (20 books available at the department).

## **8. Module examination questions:**

### **8.1. Anatomy**

1. Structure of the kidneys. Skeletotopy of the kidneys and their innervation.
2. Extraorganic circulation of the kidneys.
3. Skeletotopy of the ureters, innervation, macrostructure, constrictions and their sites, and innervation.
4. Structure of the bladder and urethra, their skeletotopy, blood circulation, innervation.

### **8.2. Histology and Embryology**

1. Histological structure of the kidney cortical and medullary part. Histological structure of the nephron.
2. Histological characteristic of the cells that make up Bowman's capsule and tubules.
3. Histological structure of the juxtaglomerular apparatus.
4. Structure of the glomerular filtration barrier.
5. Histophysiology of the prostate.
6. Histological characteristic of the urinary bladder, ureters and urethra.

### **8.3. Biochemistry**

1. Structure of aldosterone, cellular targets, molecular mechanisms of action, disorders of secretion.
2. Structure of vasopressin, cellular targets, molecular mechanisms of action, disturbances of secretion and action.
3. Types of atrial natriuretic peptides (ANP), secretion, molecular mechanisms of action.
4. Renin-angiotensin system, its biological role and significance.
5. Reabsorption of electrolytes in the kidneys and its regulation by hormones.
6. Reabsorption of glucose and amino acids in the kidneys.
7. Causes of respiratory and metabolic acidosis, development of alkalosis, their molecular mechanisms, consequences.
8. Causes and development of hyperchloremic metabolic acidosis, molecular mechanisms, consequences. Biological significance of hydrocarbonate reabsorption in the kidneys, molecular mechanisms.

## **8.4. Physiology**

1. Renal functions. Renal structural and functional unit of the kidney.
2. Mechanisms of glomerular filtration of the kidneys. Glomerular filtration rate and its determination. Factors influencing glomerular filtration. rate.
3. Clearance, its peculiarities and practical application.
4. Function of renal proximal tubules, transport processes and their mechanisms.
5. Function of the loop of Henle, distal tubules and collecting ducts, transport processes and their mechanisms.
6. Mechanisms of urine concentration and dilution.
7. Mechanisms of micturition and the function of the organs and systems involved.

## **8.5. Pathological Physiology**

1. Etiology and pathogenesis of renal diseases.
2. Pathological changes of the urine excretion, and urine composition.
3. Disorders of renal incretion function.
4. Acute renal failure, etiology, pathogenesis, changes of the body functions.
5. Chronic renal failure, etiology, pathogenesis, changes of the body functions.
6. Etiology and pathogenesis of nephrolithiasis.

## **8.6. Pathological Anatomy**

1. Glomerulonephritis, its pathogenesis, classification, morphology, complications and causes of death.
2. Pyelonephritis, its pathogenesis, classification, morphology, complications and causes of death.
3. Nephrolithiasis, its pathogenesis, morphology, complications and causes of death.
4. Kidney tumors, classification, morphology, complications and causes of death.
5. Causes of acute and chronic uremic syndrome development, morphological expressions and causes of death.
6. Dishormonal hyperplastic prostatopathia, pathogenesis, morphology, complications and causes of death.

## **8.7. Essentials of medical diagnosis**

1. The most important complaints of patients with diseases of the uropoetic system, their clinical meanings.
2. Changes in micturition and urinary output, their characteristics and clinical meanings.
3. Inspection, palpation, percussion of the patients with diseases of the uropoetic system, pathological changes, causes.
4. Specific gravity of the urine: normal values, pathological changes, clinical meanings; protein in the urine: normal values, pathological changes, clinical meanings.
5. Urinary sediment examination: normal and pathological findings, standards, pathological meanings of quantitative and qualitative changes.
6. Zimnitsky's test: indications, method of performance, evaluation, pathological findings and clinical meanings.
7. Creatinine clearance: definition, method of performance, normal values, pathological findings, clinical meanings.
8. Main symptoms of nephritic and nephrotic syndrome, clinical meanings.
9. Syndrome of acute renal failure: causes, principal clinical and laboratory changes, clinical meanings
10. Syndrome of chronic renal failure: definition, causes, principal clinical and laboratory changes, clinical meanings

## **8.8. Pharmacology**

1. The influence of renal failure on drug pharmacokinetics and pharmacodynamics.
2. Carbonic anhydrase inhibitors and osmotic diuretics.
3. Thiazide and thiazide-like diuretics.
4. Loop diuretics.
5. Potassium-sparing diuretics.

## **8.9. Radiology**

1. Potentials of radiological imaging of the organs of the urinary system. Comparative value of the different methods.
2. Potentials of early radiological diagnostics of oncological diseases of the urinogenital system.
3. Kidney and bladder indications for computerized tomography (CT).

4. Radiological examination of nephrolithiasis and obstruction.
5. Influence and significance of intravenous contrast media on radiological examination of the kidneys.
6. Radiological diagnostics of kidney cancer and cysts (X-ray images and CT).
7. Significance and potentials of radionuclide investigation of the kidneys.
8. Potentials of radiological examination of renal blood circulation.
9. Significance and potentials of ultrasound examination of the kidneys.
10. Potentials of ultrasound examination of the bladder and prostate.

### **8.10. General Surgery**

1. Body fluids, fluid compartments, factors determining distribution of body fluids. Exchange of body fluids.
2. Water balance. Ways and causes of fluid loss in the surgical patient. Fluid balance disturbances. Main hormones in regulation of fluid exchange. Signs of dehydration.
3. Electrolytes. Distribution of electrolytes. Regulation of fluid-electrolyte balance. Composition of fluids lost by the surgical patient, principles of correction.
4. Factors influencing disturbances of fluid-electrolyte balance in the surgical patient.
5. Methods for detection of electrolytes imbalance and principles of correction.
6. Acid-base balance. Maintenance by the pH buffer systems of blood, lungs, kidneys.
7. Types of disturbances of acid-base balance. Principles of correction.
8. Shock. Classification. Causes. Hemorrhagic and hypovolemic shock, causes, classification, methods of assessment, principles of treatment.

### **8.11. Environmental and occupational medicine**

1. What physical environmental factors may influence the functions of the urinary system?
2. Describe the etiology of overheating, heat stroke, their symptoms and first aid.
3. What environmental pollutants may influence the functions of the urinary system?
4. Legal acts restricting pollution of chemical factors in the environment.

## **9. Appendix**

### **9.1. Questions for the seminar “Molecular principles of reabsorption in the kidneys” (2 hrs.)**

**Department of Biochemistry**

**Responsible person** – prof. V.Borutaitė

#### ***Questions:***

1. How are the kidneys supplied with energy?
2. How does reabsorption of sodium and chloride take place in the kidneys?
3. How does reabsorption of potassium take place in the kidneys?
4. Explain what hormones and how they regulate reabsorption of the electrolytes in the kidneys?
5. How does reabsorption of glucose take place in the kidneys?
6. How does reabsorption of amino acids take place in the kidneys?

#### **References:**

#### **Additional readings:**

1. Textbook of biochemistry with clinical correlations. Wiley-Liss; 4<sup>th</sup> ed Devlin TM., 1997, p. 1036 – 1041.
2. Clinical chemistry, 5<sup>th</sup> ed. Marshall WJ, Bangert SK. Mosby, 2004, p. 63-84.
3. Pathophysiology of disease: introduction to clinical medicine, 4<sup>th</sup> ed., McPhee SJ, Lingappa VR. Ganong WF. 2003, p. 444 – 470.

### **9.2. Questions for the seminar “Hyperchloremic metabolic acidosis” (3 hrs.)**

**Department of Biochemistry**

**Responsible person** – prof. V.Borutaite

#### ***Questions:***

#### ***Questions:***

1. Explain the concepts of acidosis and alkalosis.

2. Explain the causes of metabolic and respiratory acidosis development, molecular mechanisms and consequences.
3. Explain the causes of development of metabolic and respiratory alkalosis, molecular mechanisms and consequences.
4. Explain what hyperchloremic metabolic acidosis means, what may cause it and what it is harmful for.
5. What systems carry out reabsorption of  $\text{HCO}_3^-$  in the kidneys, their localization and molecular mechanisms of action?

**References:**

**Additional readings:**

1. Textbook of biochemistry with clinical correlations. Wiley-Liss; 4<sup>th</sup> ed., Devlin MD. 1997, p. 1041 – 1052.
2. Clinical chemistry, 5<sup>th</sup> ed. Marshall WJ, Bangert SK. The kidneys in book Marshall WJ, Bangert SK. Mosby, 2004, p. 63-84.
3. Pathophysiology of disease: introduction to clinical medicine, 4<sup>th</sup> ed. McPhee SJ, Lingappa VR. Ganong WF. Lange Medical books/McGraw-Hill, 2003, p. 444 – 470.

**9.3. Questions for the seminar “Principal clinical syndromes of the organs of the urinary system” (3 hrs.)**

**Clinic of Internal Diseases**

**Responsible person** – asocc. Prof. Palmira Leišytė, assist Edita Mašanauskienė

**Questions:**

1. The most important complaints of patients with diseases of the uropoetic system, their clinical meanings.
2. Changes in micturition and urinary output, their characteristics and clinical meanings.
3. Inspection, palpation, percussion of the patients with diseases of the uropoetic system, pathological changes, causes.
4. Specific gravity of the urine: normal values, pathological changes, clinical meanings; protein in the urine: normal values, pathological changes, clinical meanings.
5. Urinary sediment examination: normal and pathological findings, standards, pathological meanings of quantitative and qualitative changes.

6. Zimnitsky's test: indications, method of performance, evaluation, pathological findings and clinical meanings.
7. Creatinine clearance: definition, method of performance, normal values, pathological findings, clinical meanings.
8. Main symptoms of nephritic and nephrotic syndrome, clinical meanings.
9. Syndrome of acute renal failure: causes, principal clinical and laboratory changes, clinical meanings
10. Syndrome of chronic renal failure: definition, causes, principal clinical and laboratory changes, clinical meanings
11. Causes of renal hypertension and renal eclampsia, the most important clinical and laboratory changes, clinical meanings.

**References:**

1. Propedeutics to Internal medicine. Compiled by Egidijus Bacevicius. Kaunas, 1998, p.215-241.
2. Principles of Internal Medicine. A Fauci, E Braunwald, K.J Isselbacher et al. 14th edition Harrison's Volume 2, International Edition, 1998.p. 1495-1578

**Additional readings:**

1. Clinical Examination. Second Edition. Epstein O, Perkin G.D, de Bono D.P et al. 2001. p. 181-182, 191-192, 204-206.
2. <http://www.emedicine.com/med/NEPHROLOGY.htm>
3. Walter, M.D. Siegenthaler (Author), A. Aeschlimann (Contributor), E. Baechli (Contributor), C. Bassetti (Contributor), E. Battegay. Differential Diagnosis in Internal Medicine: From Symptom to Diagnosis 2007.

#### **9.4. Questions for the seminar “Nephrotoxic factors of occupational environment” (3 hrs.)**

**Department of Environmental and Occupational Medicine**

**Responsible persons** – assoc.prof. R.Ustinaviciene

To acquaint students with occupational factors of the chemical origin that have a toxic effect on the organs of the urinary system.

**Questions:**

1. What are chemical occupational factors or groups of chemical substances that have an effect on the urinary system?

2. In what working activities, professions are chemical substances used that have an effect on the urinary system?
3. Individual and organization preventive measures used in prevention from intoxication with chemical substances?
4. Legal acts, regulating protection from chemical substances in the working place.

**References:**

Toxicology. C.D.Klaassen. Casaret and Doull's 2001, p. 491-514.

**9.5. Questions for the seminar “Potentials of radiological investigation of the organs of the urinary system” (4 hrs.)**

**Clinic of Radiology**

**Responsible person** – lect. D.Mitraite

*Questions:*

1. Indications of the kidneys and bladder for radiological examination.
2. Indications of the kidneys, bladder and prostate for ultrasound examination.
3. Indications of the kidneys and prostate for computerized tomography.
4. Indications for digital subtraction renal angiography and endovascular revascularization.
5. Indications for radionuclide examination of the kidneys.
6. X-ray examination of nephrolithiasis and renal obstruction.
7. Ultrasound diagnostics of inflammatory diseases of the kidneys.
8. Computerized tomography diagnostics of kidney cancer and cysts.
9. Ultrasound and computerized tomography diagnostic of kidney traumas.
10. Ultrasound semiotics of various nephropathies, and nephrocalcinosis.
11. Ultrasound semiotics of the bladder tumors, prostate hyperplasia and cancer.
12. Algorithm of radiological examination of the patients with kidney diseases.
13. Potentials of radiological examination of kidney blood circulation.

**References:**

1. Textbook of radiology and imaging. 7th ed. Sutton D. Churchill Livingstone; 2003. Volume 2. p. 885-928, additional reading - 929-1016. (at the department)

2. The urinary tract. In: Rumack CM, Wilson SR, Charboneau JW, editors. Diagnostic ultrasound. 3d ed. Thurston W, Wilson SR. St Louis: Elsevier Mosby; 2005. Volume 1. p. 344-59, 361-63, 376-82, 395-421 (at the department)

**Additional readings:**

1. Spiral and multislice computed tomography of the body. Prokop M, Galanski M, editors. Stuttgart - New York: Thieme; 2003. p.641-98 (at the department)

2. Differential diagnosis in conventional radiology. 2nd ed. Thieme. Burgener FA, Kormano M, editors. 1991. p. 733-823. (at the department)